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STATE OF HAWAII
LAND USE COMMISSION

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI'I

In the Matter of the Petition of **TOM GENTRY AND GENTRY-PACIFIC, LTD** To Amend the Agricultural Land Use District Boundary into the Urban Land Use District for Approximately 1,395 Acres at Waiawa, Ewa, Oahu, State of Hawaii, Tax Map Key Nos.: 9-4-06: Portion of 26; 9-6-04: Portion of 1 and Portion of 16; and 9-6-05: Portion of 1, Portion of 7 and Portion of 14	DOCKET NO. A87-610 TRUSTEES OF THE ESTATE OF BERNICE PAUAHI BISHOP, DBA KAMEHAMEHA SCHOOLS, MOTION FOR MODIFICATION AND TIME EXTENSION; MEMORANDUM IN SUPPORT OF MOTION; AFFIDAVIT OF DANA K. N. SATO; AFFIDAVIT OF JENNIFER A. LIM; EXHIBITS 1 - 25; CERTIFICATE OF SERVICE

TRUSTEES OF THE ESTATE OF BERNICE PAUAHI BISHOP, DBA KAMEHAMEHA SCHOOLS, MOTION FOR MODIFICATION AND TIME EXTENSION

I. RELIEF OR ORDER SOUGHT

Successor Petitioner LANCE KEAWE WILHELM, ROBERT K.W.H. NOBRIGA, ELLIOT K. MILLS, MICAH A. KANE, and CRYSTAL KAUILANI ROSE, as TRUSTEES OF THE ESTATE OF BERNICE PAUAHI BISHOP, dba KAMEHAMEHA SCHOOLS, by and through its legal counsel, CARLSMITH BALL LLP, hereby requests that the STATE OF HAWAI'I LAND USE COMMISSION issue an order modifying the Commission's November 26, 2014, *Order Granting Motion for Order Amending Findings of Fact, Conclusions of Law and Decision and Order dated May 17, 1988*, to allow for modifications to the solar farm authorized thereunder and the related timeframe for development of said solar farm, and to allow for the modified solar farm to be in place within an identified portion of the Petition Area for a period not to exceed 39 years from the Commission's approval of this Motion (with decommissioning to be completed on or before December 31, 2059).

II. GROUNDS FOR MOTION

This Motion is made pursuant to Chapter 205, Hawai'i Revised Statutes ("**HRS**") and §§ 15-15-70 and 15-15-94 of Title 15, Subtitle 3, Chapter 15 of the Hawai'i Administrative Rules ("**HAR**"), the other authorities and arguments stated in the attached Memorandum in Support of Motion, and the pleadings and files herein.

Pursuant to HAR § 15-15-70(c), Successor Petitioner Kamehameha Schools requests a hearing on this Motion.

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Dated: Honolulu, Hawai'i, July 24, 2019.

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BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI‘I

In the Matter of the Petition of **TOM GENTRY AND GENTRY-PACIFIC, LTD** To Amend the Agricultural Land Use District Boundary into the Urban Land Use District for Approximately 1,395 Acres at Waiawa, Ewa, Oahu, State of Hawaii, Tax Map Key Nos.: 9-4-06: Portion of 26; 9-6-04: Portion of 1 and Portion of 16; and 9-6-05: Portion of 1, Portion of 7 and Portion of 14	DOCKET NO. A87-610 MEMORANDUM IN SUPPORT OF MOTION

MEMORANDUM IN SUPPORT OF MOTION

I. INTRODUCTION & IDENTIFICATION OF THE KS PROPERTY

By Findings of Fact, Conclusions of Law and Decision and Order filed May 17, 1988 (the "**1988 Order**"), the State of Hawai‘i Land Use Commission ("**Commission**") reclassified approximately 1,395 acres of land situate at Waiawa, Ewa, Oahu (the "**KS Property**" or "**Petition Area**"), from the State Land Use Agricultural District to the State Land Use Urban District, subject to 10 conditions of approval. By Order dated November 30, 1990, the Commission amended Condition No. 6 of the 1988 Order and reaffirmed all other conditions (the 1988 Order as amended shall hereinafter be referred to as the "**Waiawa Order**"). At that time, the KS Property was designated by Tax Map Key Nos. (1) 9-4-006:026 (por.); 9-6-004:001 (por.), 016 (por.); 9-6-005:001 (por.), 007 (por.) and 014 (por.). *See* Exhibit A of the Commission's 1988 Order. The current Tax Map Key designations of the KS Property are (1) 9-

4-006: 034(por.), 035(por.), 036, 037(por.); 9-6-004:024 (por.), 025, 026; 9-6-005: 003 (por.). **KS Exhibit 1**.[1] Attached hereto and incorporated herein as **KS Exhibit 2** is a graphic showing the State Land Use Districts of the KS Property and surrounding properties.

On November 26, 2014, the Commission issued its *Order Granting Motion for Order Amending Findings of Fact, Conclusions of Law and Decision and Order Dated May 17, 1988* (hereinafter referred to as the "**2014 Order**"), amending the Waiawa Order to: (1) expressly authorize the use of portions of the KS Property (an area of approximately 387 acres and an area of approximately 268 acres) for solar farm development for an interim period not to exceed 35 years from the issuance of the 2014 Order, i.e., a period terminating as of November 26, 2049, and (2) recognize the Trustees of the Estate of Bernice Pauahi Bishop dba Kamehameha Schools ("**KS**") as the successor Petitioner ("**Successor Petitioner**") in this Docket.

Successor Petitioner, KS, now seeks an amendment to the 2014 Order to extend the period of time for which portions of the KS Property can be used as a solar farm, from November 2049 to December 31, 2059, and to make related alterations to the 2014 Order. The components of the solar farm currently proposed by Waiawa Solar Power, LLC ("**WSP**") are similar in many respects to the solar farm previously approved by the Commission under the 2014 Order, but there are some differences that are not consistent with prior representations. For that reason, KS respectfully requests the Commission's approval of the revised solar farm project as proposed by WSP.

II. SUCCESSOR PETITIONER'S INTEREST IN THE KS PROPERTY

The original Petitioner in this Docket was Tom Gentry and Gentry Pacific, Ltd. (collectively, "**Gentry**"). However, then, as now, the KS Property was owned in fee simple by KS. The Commission recognized KS as the Successor Petitioner in this Docket, and KS therefore has standing to bring this Motion and to seek the relief requested.

III. BACKGROUND

The Commission reclassified the KS Property to the Urban District in 1988, making all appropriate findings regarding consistency with the Hawai'i State Plan, Chapter 226 Hawai'i Revised Statutes ("**HRS**"). Waiawa Order at 32-33 (conclusions of law). At that time, Gentry

[1] The map enclosed as KS Exhibit 1 is a July 10, 2015 update of the survey map licensed professional land surveyor Kevin Kea prepared in 2014. The updated map shows that a parcel previously identified by TMK No. (1) 9-6-005: 001 (por.) is actually designated by TMK No. (1) 9-6-005: 003 (por.).

had a development agreement with KS, and Gentry had filed the Petition for District Boundary Amendment. Gentry intended to develop the KS Property as Waiawa Ridge with up to 7,906 residential dwellings, half of which would be retirement/leisure housing units for those 55 and older. Waiawa Order, finding of fact ("**FOF**") 29, 30; 2014 Order, FOF 3 - 6, 9. Waiawa Ridge also included parks, open space, and two golf courses (approximately 30 percent of the KS Property was planned for open space), and commercial and light industrial uses within approximately 110 acres. Waiawa Order, FOF 36, 37.

In furtherance of the development of Waiawa Ridge, in 1998 the Honolulu City Council passed Ordinance 98-55, amending a portion of the Development Plan Land Use Map to support the Waiawa project. Next, the City Council rezoned approximately 1,049 acres within the KS Property. Ordinance Nos. 98-01, effective January 15, 1998 (as amended by Ordinance 98-69, effective December 17, 1998) rezoned 874 acres within the KS Property from Restricted Agriculture (AG-1) to Neighborhood Business District (B1), Community Business District (B2), Low Density Apartment District (A1), Industrial-Commercial Mixed Use District (IMX1), Residential (RS) and General Preservation (P-2). Ordinance No. 03-01, effective February 12, 2003, rezoned 175.43 acres within the KS Property from AG-1 to R-5, A-1, Medium Density Apartment District (A-2) and P-2. A map of the KS Property with an overlay of the current City & County ("**City**") of Honolulu zoning is provided as **KS Exhibit 3**. Figures showing the current (approved 2002) Central O'ahu Sustainable Communities Plan designations for the KS Property, and the currently proposed update, are provided as **KS Exhibit 4** and **KS Exhibit 5**, respectively.

Gentry informed the Commission in 2008 that the development entity for Waiawa Ridge (Waiawa Ridge Development LLC) had secured construction financing and ground breaking was scheduled for fall 2009. 2014 Order, FOF 15. However, the development did not proceed as planned due to the unprecedented worldwide financial crisis starting in September 2008. *Id.* at FOF 16. After the 2008 financial collapse Gentry and KS started the process of returning the KS Property to KS' control. KS obtained full control of the KS Property late in 2012. *Id.*

A. 2014 ORDER AND SOLAR AND AN INTERIM USE

On May 13, 2014, KS, as Successor Petitioner, filed a motion to amend the Waiawa Order to seek permission from the Commission to use portions of the KS Property for the development of a large, utility scale, potentially two-phase, renewable energy solar farm project.

KS identified approximately 655 acres of the 1,395 acre KS Property for photovoltaic ("**PV**") development. A graphic showing the areas the Commission approved for a two-phase solar farm project under the 2014 Order is provided as **KS Exhibit 6**.

The Commission granted KS' request, subject to 16 conditions of approval. *See* 2014 Order at 59-65. Five of the conditions (Conditions 12 - 16) were "standard" conditions related to notice of change of ownership, annual reports, and recordation of conditions.[2] *Id.* at 64-65. Several conditions related to specifics of the two-phase solar farm project (Conditions 2 - 11). *Id.* at 60-64. Condition No. 1 requires KS to submit a revised master plan and schedule for development for the KS Property to the Commission by November 26, 2019. *Id.* at 60.

Under the 2014 Order, the Commission concluded "upon the clear preponderance of the evidence that the development and operation of the solar farm is consistent with the prior conditions of approval imposed under the Waiawa Order." 2014 Order at conclusions of law ("**COL**") 2.

As KS first reported to the Commission in its June 2016 Annual Report, SunEdison, the intended solar developer for the initial solar project, along with other proposed solar farm developers including Hanwha Q Cells and Nextera Energy Resources, faced difficulty obtaining the necessary approvals from the Hawaii Public Utilities Commission ("**PUC**") for its power purchase agreement ("**PPA**") with Hawaiian Electric Company, Inc. ("**HECO**"). Shortly thereafter, SunEdison went bankrupt. Accordingly, KS cancelled its agreements with SunEdison. However, KS continued to be on the lookout for new renewable energy opportunities that would be compatible with the future development of the KS Property.

As KS reported to the Commission in its May 31, 2017 Annual Report, and subsequent Annual Reports, at that time KS was aware of other potentially interested parties who wished to pursue development of a solar farm on the KS Property and KS was continuing to explore acceptable alternatives for the development of a utility scale solar farm within a portion of the KS Property. KS alerted the Commission that HECO had issued a request for information for large landowners with an interest in allowing their property to be used for energy development

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[2] Condition 15 required successor Petitioner to record a Notice of Imposition of Conditions with the Bureau of Conveyances of the State of Hawaiʻi ("**Bureau**") and file a copy with the Commission in connection with the 2014 Order. KS satisfied this condition by filing recording said Notice on December 9, 2014 as Document No. A-54560727. Condition 16 required successor Petitioner to record in the Bureau the conditions set forth in the 2014 Order. KS satisfied this condition by recording a Declaration of Conditions on January 21, 2015 as Document No. A-549913388. A certified copy of said Declaration was filed with the Commission on January 22, 2015.

projects, and that KS had identified the KS Property as a potential site for solar development. *See also* **KS Exhibit 7** (KS Annual Report dated May 29, 2019).

KS encourages the use of portions of the KS Property for solar development because renewable energy is consistent with KS' prudent approach to managing its land resources in order to ensure the perpetual nature of the Trust, while at the same time furthering KS' educational mission and the education of more than 56,000 learners and caregivers annually.

B. HAWAIIAN ELECTRIC ISSUES NEW RFP FOR RENEWABLE ENERGY PROJECTS

In 2017, HECO sought out large landowners in Hawaiʻi that had an interest in, and lands available for, energy projects. KS responded, alerting HECO that KS has land available on Oʻahu, Maui, and Hawaiʻi Island, and KS identified the KS Property as suitable for a solar energy project. *See* KS Exhibit 6.

Meanwhile, the Hawaiian Electric Companies (*i.e.,* HECO, Maui Electric Company, Limited, and Hawaii Electric Light Company, Inc.), sought PUC approval to engage in a competitive procurement process to acquire new dispatchable and renewable energy resources for O'ahu, Maui, and Hawai'i Island, which was the focus of PUC Docket No. 2017-0352. The PUC approved the requested competitive bidding process by Order No. 35286, filed on February 20, 2018, noting that the competitive bidding process would be "fair in its design and implementation so that selection is based on the merits" and that the projects selected through a competitive bidding process would have to be consistent with the Hawaiian Electric Companies' Power Supply Improvement Plans, and that the process would be aligned with the public interest. *See* generally PUC Order No. 35286. On February 20, 2018, the PUC approved the Hawaiian Electric Companies' Request for Proposals ("**RFP**"), which was issued on February 27, 2018.

The primary purpose of the RFP was to obtain variable renewable generation that would be dispatchable by the utility companies at a competitive, reasonable cost, with reliability, viability, and operational characteristics consistent with the utility companies' long-term planning and energy policy requirements. The RFP closed on April 30, 2018. In September 2018, HECO announced that WSP, and the PV farm it proposed to develop on the KS Property, was one of the awardees.

WSP is a wholly-owned indirect subsidiary of Clearway Energy Group LLC ("**Clearway**"). Clearway was formed in August 2018 with the sale of NRG Energy's renewables division. Clearway and its affiliate, Clearway Energy, Inc., own and operate 4.1 gigawatts

("**GW**") of renewable energy, comprised of 2.8 GW of wind and 1.1 GW of utility solar, and over 300 megawatts ("**MW**") of distributed and community solar across 28 states. The solar farm WSP plans for a portion of the KS Property is just one of several projects Clearway is developing on O'ahu. Nicola Park is the project lead for the WSP project and is the Origination Manager for Clearway. Ms. Park has experience in the United States and overseas doing environmental consulting, land use planning and utility-scale solar developments. Patrick Sullivan is Vice President, Development, overseeing the development of all Clearway's U.S. assets and acts as Officer and Vice President of WSP.

Clearway is also currently developing a 39 MW solar and storage (4 hours/156 MW-hours of battery storage) project in Mililani. In addition, Clearway has also constructed and energized three utility-scale projects totaling approximately 110 MW of generating capacity on O'ahu, including Kawailoa Solar, which at 49 MW is the largest in the State of Hawaiʻi. The Kawailoa Solar project is on lands owned by Kamehameha Schools. Clearway has also developed Waipio Solar (45.6 MW) and Mililani II Solar (14.7 MW). It is anticipated that these five Clearway projects will generate 185 MW of renewable energy for the State, equal to the energy consumed by approximately 48,075 homes on Oʻahu in a year.

C. PUC APPROVES POWER PURCHASE AGREEMENT BETWEEN HECO AND WAIAWA SOLAR POWER, LLC

HECO and WSP entered into a PPA for a 36 MW/144 megawatt-hour ("**MWh**") battery energy storage system ("**BESS**") solar farm to be developed within an approximately 200-acre area within the KS Property (the "**WSP Project**" or "**Project**") on December 30, 2018. Immediately thereafter, HECO filed an application requesting PUC approval of the PPA, and the PUC approved the PPA by Decision and Order No. 36231 in Docket No. 2018-0435, dated March 25, 2019.

In support of its request that the PUC approve the PPA, HECO presented a number of justifications for approval, including: (1) the WSP Project is the result of a competitive bidding procurement process; (2) the WSP Project is advantageous due to the discretion it provides HECO regarding the dispatch of energy from its PV system and/or BESS; (3) the PPA represents a new model of a renewable dispatchable generation PPA that has many advantageous terms to protect HECO and its customers, and represents improvements over prior PPAs; (4) the PPA's unit price is fixed for the duration of the PPA and is anticipated to result in lower effective rates for customers; (5) the WSP Project is expected to provide bill savings for customers over the term of the PPA; and (6) the WSP Project will reduce HECO's consumption of fossil fuel, resulting in a reduction of greenhouse gas emissions and progress towards the State's Renewable Portfolio Standard goals. *See* PUC D&O No. 36231 at 21-22. The PUC determined that the PPA furthered the four specified criteria under HRS § 269-6(b), and further found that the PPA was:

> reasonable and in the public interest because the PPA advances Hawaii's goal of reducing reliance on fossil fuels through energy efficiency and increased renewable energy generation through clean energy resources, and does so at a price that is estimated to result in savings for HECO's ratepayers between 2022 and 2041.

Id. at 87-88.

1. <u>Potential Second PV Farm and HECO Round 2 RFP</u>

KS has no immediate plans for the development of the Phase 1 portion of the solar farm approved under the 2014 Order. *See* KS Ex. 6. Nevertheless, KS wishes to retain the entitlement to have a solar farm project developed within the previously approved Phase 1 area, and its master planning efforts incorporate both the previously approved Phase 1 area as well as the WSP Project under consideration in this Motion (which is largely within the previously approved Phase 2 area). KS previously determined that the area is suitable for solar development and that a utility scale solar farm for an interim period is consistent with KS' desires for the KS Property. Moreover, HECO recently submitted its Round 2 RFP for PUC approval, indicating that additional PV development is desired.

HECO's draft Round 2 RFP seeks approximately 500 additional MW of solar power on O'ahu, up to 200 MW on Hawai'i, and approximately 100 MW on Maui. HECO filed its final draft RFPs with the PUC for approval in July 2019. At this stage, HECO's final Round 2 RFP is expected to be issued in August 2019, and HECO's decisions on the final awardees is expected in April 2020. KS has previously confirmed to HECO that the Phase 1 area approved by the Commission in the 2014 Order is still identified for solar development. Clearway has indicated to KS its intention to submit a proposal in response to HECO's Round 2 RFP.

At this time, KS does not have sufficient information about the timing or size of the development of an additional solar farm pursuant to HECO's Round 2 RFP. As such, KS anticipates that the future Commission approval may be required to refresh the entitlement to use the prior Phase 1 area for a future solar farm.

IV. WAIAWA SOLAR POWER LLC'S PROPOSED PV PROJECT

The WSP Project is expected to generate enough power to supply approximately 14,655 homes each year. The WSP Project will replace approximately 1,084,388 barrels of oil and 29 tons of coal over the term of the PPA.

Similar to the solar farm approved under the 2014 Order, the key components of the WSP Project are PV panels within an array, substation, transformers, overhead generation tie-line ("**gen-tie line**"), and storage, each of which are discussed in more detail below. *See* 2014 Order, FOF 80 ("The solar farm improvements may consist of substation(s), battery storage system(s), PV panels, pad mounted inverters and electrical equipment, and substations.") Unlike the project under the 2014 Order, the WSP Project intends to have the power storage and transmission improvements within that portion of the KS Property that overlies the Waiawa Shaft Zone of Contribution ("**ZOC**").

A. PROJECT SITE - DIFFERENCES IN AREA FROM 2014 ORDER

The utility easement area for the WSP Project is roughly within the previously approved 268-acre Phase 2 area (*see* KS Exhibit 5), and located over the ZOC. However, the WSP Project will occupy considerably less land than the Phase 2 area the Commission approved under the 2014 Order, and the WSP Project will not be within the precise metes and bounds area previously identified for Phase 2.[3] The WSP Project area will be within an approximately 200 acre area, with the actual footprint, including the battery and substation, being approximately 185-acres ("**Project Site**"). A conceptual site plan of the Project Site is provided as **KS Exhibit 8**.

B. PROJECT TERM - CHANGES FROM 2014 ORDER

The term of the WSP Project includes an initial operational term of 20 years, with an expected extension, allowing for a total operational term of 35 years, which is similar to the operational terms of the solar projects approved under the 2014 Order. However, the proposed decommissioning deadline for the WSP Project is on or before December 31, 2059, which is later than the previously approved timeline of November 2049. In the 2014 Order, the Commission approved the use of approximately 655-acres of the KS Property for solar farm development for a period not to exceed 35 years from the date of the 2014 Order, *i.e.*, both Phase

[3] Condition 9 of the 2014 Order required Petitioner to submit a metes and bounds map and description of Phase 1 and Phase 2. KS submitted that information to the Commission by letter dated October 2, 2015. The WSP Project Site is similar, but not entirely consistent with the Phase 2 area submitted to the Commission.

1 and Phase 2 had to be decommissioned by November 26, 2049. 2014 Order, COL 1. Condition No. 8 of the 2014 Order provides:

> The interim use of the Petition Area for the proposed solar farm, including any and all permitting, construction, operation, and decommissioning activities associated with the solar farm, shall not exceed a period of 35 years from the date of this Decision and Order without the prior written approval of the Commission.

The instant request for the WSP Project is for an extension of 10 years, to the end of 2059.

The 2014 Order also has conditions relating to the specific timeframes for development of the two-phase solar farm. The area referred to as Phase 1 (*see* KS Ex. 6) is required to be "substantially completed" by November 26, 2019, and the area referred to as Phase 2 is required to be "substantially completed" by November 26, 2024. *See* 2014 Order Condition No. 6. Assuming the timely receipt of all necessary approvals (all future State and City permitting is the responsibility of Clearway and/or WSP), WSP represents that construction of the current WSP Project will be substantially completed before November 2024. In that respect the WSP Project is in compliance with the timing authorized in the 2014 Order.

The term of the WSP Project, taking into account permitting, construction, operations, and decommissioning, will run approximately 40 years, to 2059.[4] That includes a development and construction period of approximately 2.5 years, followed by an operational period of approximately 35 years, followed by a decommissioning period of no more than one year.

C. <u>DECOMMISSIONING - CHANGES FROM 2014 ORDER</u>

WSP confirms that the Project will be fully decommissioned and removed from the KS Property no later than the end of 2059.[5] WSP's decommissioning obligations to KS are

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[4] The initial term of the PPA will run for 20 years from the Commercial Operations Date. However, in order to underwrite the financing of the Project, WSP assumes the full 35-year operational life of the Project, in line with the operational life of the modules and other major components of the Project. This is typical for financing utility-scale solar projects and allows the full value of the asset to be realized in the financing, thereby allowing WSP to offer the lowest cost of power to ratepayers during the first 20 years life of the Project. To continue using the KS Property after the initial term of the PPA, the agreement between KS and WSP requires WSP to demonstrate to KS that the PPA has been extended, another PPA has been entered into, or some other means of evidencing WSP's ability to continue selling energy from the WSP Project.

[5] WSP is highly motivated to have the Project achieve its Commercial Operations Date prior to December 31, 2023, in order to secure the full 30 percent Federal Investment Tax Credit available for renewable energy projects. In order to Safe Harbor the Project for the 30 percent Federal ITC, WSP will meet Safe Harbor tests by December 31, 2019 to qualify as well as demonstrate continuous construction efforts either off-site or on-site from that point until Guaranteed Commercial Operations of December 31, 2021 under the terms of the PPA.

substantially similar to what the Commission imposed in Condition No. 10 of the 2014 Order, which provides in relevant part:

> The solar farm shall be decommissioned following its operational timeframe. The decommissioning activities shall include, but not be limited to, the complete removal of the foundational piers and modules and all associated components. All metal components shall be recycled to the extent possible and no solar farm components shall be disposed of in any landfill in the State of Hawai'i.

Decommissioning of the WSP Project will involve complete removal of the foundational piers and modules and all associated components, including the inverters, inverter pads, Project substation and substation pad. WSP will construct the 46kV gen-tie line, which will either be conveyed to HECO or removed by WSP during decommissioning. Once all of the components have been removed from the Project Site, WSP will seed and stabilize the land to KS' satisfaction.

To the extent possible, WSP represents that decommissioned materials will be recycled rather than disposed of in a landfill, and that the PV modules and racking will be recycled. WSP plans to keep all batteries on site until their capacity is depleted. Augmentations will be done as additions to the battery system rather than as replacements that require any disposal of any components during the Project term. WSP plans to recycle and dispose of all battery components at the end of the Project term in accordance with WSP's decommissioning plan being developed specific to the Project for recycling and removal of all Project components.

The agreement between KS and WSP requires WSP to provide KS with decommissioning security in the form of a letter of credit prior to the start of the operational term of the Project. This provides KS with financial security to be used toward decommissioning costs, in the unlikely event that KS has to take over decommissioning the Project due to any default by WSP.

D. SOLAR FARM COMPONENTS

The solar farm will be a low impact, quiet, low maintenance facility. Fencing approximately 7 feet high with no barbed wire will surround the Project Site, with additional fencing of 12 feet high around the substation/battery area. Currently, the KS Property is secured by a gate system whereby ingress/egress can only be conducted if those entering or exiting have the approved and secured key. Key inventory is managed and maintained by KS. This system will remain in place during the duration of the WSP Project. In addition, WSP will install a security system with 24/7 camera surveillance to protect the Project improvements.

Maintenance of the solar farm is simple. A variety of easily controlled grasses are anticipated to be used as a vegetated groundcover. The vegetated groundcover will be maintained through mechanical means, by utilizing zero-turn mowers and weed trimmers. Animals will not be used for grass control. WSP will have technicians remotely monitor the system's performance 24 hours per day, seven days per week, from its operations center located in Scottsdale, Arizona. WSP will clean the solar panels once or twice a year (depending upon rainfall) with water that it will truck onto the KS Property. No cleansers or other additives will be added to the water or used to clean the PV panels. No significant vegetation improvements are anticipated, but a vegetative buffer will be left around the Project Site for aesthetic/visual shielding of the Project (there is extensive existing vegetation).

1. Solar Array

The PV modules proposed for the WSP Project are substantially similar to what was approved by the Commission under the 2014 Order, except that the current PV modules will be mounted on single-axis trackers that face south and follow the sun (the solar farm described in the 2014 Order planned to use fixed-tilt tracking). 2014 Order FOF 87.

The Project will utilize approximately 110,000 to 135,000 PV panels. The top of the PV panels will be between 4 feet to 15 feet from the ground (depending on the angle of their tilt). The racks to hold the PV modules are made of steel and aluminum. Although the trackers will have moving parts, they will utilize sealed bearings. Thus, there are no serviceable parts nor any parts that require lubrication. No lubricants will be stored on site or used in maintenance of the solar array.

Each PV panel consists of silicon cells electrically connected inside a glass and aluminum frame to function as a single unit. The modules will be dark blue in color, being designed to absorb as much solar energy as possible, and therefore create minimal glare. The planned modules reflect back no more than 1.25 percent light. For context, typical window glass reflects approximately 1.5 percent light, and smooth water reflects approximately 1.3 percent light. Thus, the PV modules are less reflective than window glass and water.

As with the solar farm in the 2014 Order, the rack system will be designed in accordance with the building permit structural requirements to withstand hurricane-type winds. *See* 2014

Order, FOF 88.

In addition to the power transmission components described below, the Project also includes several temporary storage trailers to house operations and maintenance equipment. The operations and maintenance facilities are temporary trailers that will not include any septic, sewer, water, or solid waste disposal infrastructure. However, the trailers will require electrical service, which WSP will coordinate with HECO.

2. Inverters

Pad mounted inverters will be located throughout the PV array. The inverters will be interconnected by underground medium voltage lines that feed into the Project substation, which steps up to 46 kilovolt ("**kV**"), and battery storage area that will be sited within the Project Site. *See* Utility Improvements Area in KS Ex. 8. From there, the solar energy will connect to an existing 46kV transmission line that runs directly west of the Project Site across the gulch near the Ka Uka Boulevard exit of the H-2 Freeway, to reach the point of interconnection on the existing HECO 46kV Waiau-Mililani line. The utility poles supporting the transmission lines will range in height between approximately 41 and 70 feet and will be placed approximately 250 feet apart.

3. Substation

The most significant change between the WSP Project and the larger, two-phase solar project approved under the 2014 Order, is that the current Project proposes to incorporate the substation and battery storage area within the ZOC. The Project substation will be located within an area of approximately 1 acre, and the control building for the substation within that 1 acre will have a building area of under 500 square feet. The perimeter of the substation will be surrounded an approximately 12-foot high fence, with no barbed wire. Similar to the substation identified in the 2014 Order, the physical size of the current substation will be similar to those seen in residential neighborhoods. It is projected to be between 15 to 20 feet in height. 2014 Order, FOF 85.

The substation will contain a switchgear cabinet, bus supports, meter supervisory control and data acquisition, power transformer circuit breaker, current transformer, and power transformers for metering pole mounts and dead-end structure. The substation will also house the PV controls, HECO remote terminal units, relays and meters, and a small battery system to serve as a back-up power system for data collection. The substation equipment will be mounted on equipment pads or concrete footers. The substation will include a step-up transformer that collects energy at the PV facility voltage and steps it up to the HECO grid voltage (46 kV).

4. Battery Energy Storage System

The Project will include a BESS that will be designed, constructed, operated, and maintained in accordance with applicable industry best practices, as well as regulatory requirements. Battery storage for the Project will be adjacent to the substation area and utilize approximately 1.5 acres of land within the Project Site. *See* Utility Improvements Area in KS Ex. 8. The batteries will be housed inside fully contained modular enclosures. The dimensions of the modular enclosures vary based on manufacturer, but are anticipated to be the size of a standard shipping container (in which case, approximately 37 - 40 enclosures would be used), or smaller, such as the size of a refrigerator (in which case there may be approximately 820 enclosures used). In the case of shipping container enclosures, each 40-foot shipping container would contain approximately 238 batteries, for a total of 4.2 MWh of capacity per container. For the refrigerator sized enclosures, each would hold approximately 17 battery modules, storing approximately 300 kWh of battery capacity each, which are then arranged together in blocks that collectively store approximately 6 MWh. In all cases, the enclosures will be mounted on pier foundations over gravel or on concrete foundations, and the full system capacity will be 154 MWh. The final foundation design is pending site specific geotechnical analysis.

The containers will be outfitted with a heating, ventilation, and air conditioning (HVAC) system to keep the battery system at the correct temperature. *See* **KS Exhibit 9** (examples of battery storage systems). The HVAC systems will not generate exhaust and no emissions are anticipated from the battery system operation. The battery storage system will be AC coupled (i.e., the batteries will be located all in one area and electrically connected after the output of the PV inverters).

The Project will use lithium-ion batteries, such as those provided by Samsung SDI Power Platform or a similar tier 1 battery supplier. The batteries do not contain any liquid that can spill or leak. Instead, batteries use dry-cell technology and are comprised of chemicals in powder form. *See* **KS Exhibit 10** (Samsung fact sheet). The battery enclosures are rated IP56 / NEMA-3R.

Best practices for fire safety for the battery system is to use a chemical agent suppressant-based system to detect and suppress fires. As recognized in the 2014 Order, water does not extinguish fires at battery storage or substation areas. Therefore, these improvements are designed with controls that shut down the components if there is a fire and prevent the heat from moving to other components of the storage area. 2014 Order, FOF 256-257. Additionally, the enclosures themselves act as containment for any fire.

The fire suppressant material proposed for this Project is the FM 200, NOVEC 1230, or a similar product. *See* **KS Exhibit 11** (NOVEC fact sheets). This product is not a fire suppression foam. The fire suppressant is stored as a liquid, however, it immediately converts to a gas once exposed to the air (it evaporates at a rate 50 times faster than water). If smoke or heat is detected, or if the fire suppression system is manually triggered, an alarm will sound, emergency strobe lights will flash, and the system would release the suppressant. Final fire safety design will follow applicable standards and will be specific to the battery technology selected. With any system chosen, no water will be used should a fire occur. The Honolulu Fire Department ("**HFD**") will be trained on the proper fire response protocol for the system. The Project will comply with any fire suppression requirements of Hawai'i Department of Health (**"DOH"**) and HFD.

The battery system proposed for the WSP Project differs from older battery systems that used lead acid batteries, which are far more susceptible to fire than lithium-ion batteries. Furthermore, the technology used for older systems was lacking in that if a fire started in one battery, the fire essentially had to run through the entire system before it could be put out. That is not the case with the WSP Project system. The Project will be integrated with a hardline SCADA system and will include pre-alarm triggers that shut down the battery if a thermal event is detected at the cell level.

No lubricants, coolant fluids, or other liquid chemicals will be used in the maintenance and operation of the inverters, medium voltage transformers, or battery storage area. The high-voltage transformers will use a soy-based vegetable oil coolant (ester dielectric fluid) by the trade name of Envirotemp FR3. The oil is not composed of any hazardous material and would not contaminant groundwater should a leak occur. *See* **KS Exhibit 12** (technical specifications of Envirotemp FR3).

KS and WSP met with the DOH and the U.S. Department of the Navy to discuss the Project in general, and particularly with respect to the power transmission improvements proposed within the ZOC. Under Condition No. 2 of the Waiawa Order, "Any urban development within the [KS] Property shall be subject to further review and subsequent approval by the Department of Health. The Department of Health may require appropriate mitigative measures and conditions relating to the proposed development's impact on the groundwater resources in the area." Although the proposed WSP Project does not constitute "urban development", KS nevertheless wanted to confer with DOH on this matter and WSP, as the party with the technical expertise, joined in those discussions.

DOH reviewed the technical information and determined that the Project as proposed within the ZOC is not expected to have any impact on groundwater resources and is therefore acceptable to DOH with appropriate mitigation measures incorporated in the Project. *See* **KS Exhibit 13** (DOH 3/28/19 letter to KS).

V. OTHER CONSIDERATIONS

A. CIVIL ENGINEERING

Access to the KS Property is through an existing driveway located on Waiawa Prison Road along the northern edge of the KS Property, with regional connections to the H-2 Freeway via Mililani Memorial Cemetery Road and Ka Uka Boulevard, and also from a driveway located on Waihona Street, mauka of Kamehameha Highway, located in the southern portion of the KS Property. 2014 Order, FOF 52. Due to the prior use of the KS Property for sugarcane cultivation, there are several unpaved roads throughout the KS Property that KS maintains. To the extent possible, access to and within the Project Site will use these existing access roads, with minor modifications as needed, i.e., existing accessways will be widened, compacted, and graveled. No concrete/asphalt driveways or roadways are required for the Project. The Project Site is planned to have two points of access approximately 3,000 feet apart.

According to the Preliminary Civil Engineering Considerations report prepared by G70, a copy of which is enclosed as **KS Exhibit 14** ("**PER**"), the WSP Project will generally be located on the ridgelines where the former tilled sugar cane fields were located. Based on available topographic information, the Project Site generally slopes mauka to makai. Elevations range from 550 feet to 240 feet above mean sea level (MSL). Optimal placement of the PV panels will be on the flatter, more gradually sloped areas on the ridgelines and away from the steep ravines that slope into to the adjacent gulches.

The Project Site will need to be cleared, grubbed, and graded to allow for the placement of the PV panels and related equipment and facilities, as well as access driveways, fences and a vegetated buffer. Initial rough estimates of potential earthwork volumes for the Project Site contemplated roughly 350,000-400,000 cubic yards of balanced cut/fill across the Project Site in order to construct access driveways, equipment pads, substation/battery storage pads, and to install the tracking-type PV racks on relatively consistent slopes. *See* PER at 2. It is anticipated that the earthwork volumes and related construction costs will be minimized by optimal placement of the PV racks by following the existing grades and elevations. Where possible, the existing agricultural roads will continue to be utilized for access. All grubbed material not reused on the Project Site will be hauled off-site. No foreign or organic material will be used as fill material. *Id.*

WSP will have all required permits secured prior to starting any work at the Project Site. Anticipated permits include a State DOH - NPDES General Permit for Construction Activities, Notice of Intent (NOI-C), and a City Grading, Grubbing and Stockpiling Permit. These permits require the applicant to submit associated grading plans, erosion and sediment control plans, storm water pollution prevention plans, and drainage reports. Grading will be in accordance with the Revised Ordinances of Honolulu Chapter 14, Articles 13-16. *Id.* As required under the grading ordinance, a geotechnical engineer will provide cut and fill recommendations prior to design, and testing/observation during construction. Applications for the permits noted above require the applicable agency to review and approve Grading Plans, Erosion and Sediment Control Plans with temporary best management practices ("**BMP**"), a Storm Water Pollution Prevention Plan, and Drainage Reports that discusses permanent BMP.

Existing runoff from the Project Site currently exhibits sheet flow or shallow concentrated flow into swales that discharge toward adjacent, downstream areas. *Id.* Development of the WSP Project is not expected to alter existing drainage patterns. *Id.* at 2-3. Earthwork will be limited to leveling for access driveways, equipment pads, substation and battery storage, and for smoothing of contours as necessary for installation of the PV racks. Minimal additional impervious area approximately 3 acres (there will be concrete equipment pads, equipment buildings and micro-pile/pier foundations), is proposed, and the distribution of new impervious areas will be evenly distributed throughout the Project Site, with a concentration within the area containing the substation and BESS. The PER concludes that there will not be a significant pre-development to post-development increase in stormwater flows from the construction of the WSP Project. If there is any increase of stormwater generated within the

Project Site, it will be detained within the Project Site. *Id.* at 3. If required, diversion channels will be constructed with check dams, drop structures or other velocity reducing controls prior to discharge back into the natural drainage features. To minimize erosion, stormwater will be directed away from equipment pads and any other structures. Drainage channels with velocity reduction controls will be constructed in which water will flow through stormwater basin(s) and/or other volume control facilities. The volume control facilities will be situated at the proper downstream locations and will discharge back into the natural drainage features with non-erosive velocities. *Id.*

Temporary BMP will be implemented during construction activities to minimize soil loss and erosion hazards. *Id.* Erosion control BMP may include the following (pending final design): preservation of natural vegetation; minimizing areas of clearing and grubbing; utilization of vegetated buffers; temporary soil stabilization with grass and/or mulch; silt fences/fiber filtration tubes; gravel bag berms/check dams; stabilized construction entrances; sediment traps and basins; temporary diversion swales and ditches; dust control (through water application and/or dust screens). *Id.* at 3.

Permanent erosion control BMP will be implemented as required to close out the grading and erosion control permits. *Id.* Typical permanent BMP include final stabilization of exposed soils through landscaping or installation of impervious services such as pavement or buildings. City regulations establish minimum thresholds for additional BMP for stormwater quality based on total disturbed area regardless of added impervious area or expected pollutant generation from a project. *Id.* at 4. Accordingly, additional BMP may be required. *See Id.* at 4. Because the Project is not anticipated to adversely impact stormwater quality due to the Project Site being mostly grass following construction, it is not anticipated that the City will impose Low Impact Development requirements on the Project. *See Id.*

Construction of the WSP Project will generate short-term noise, but all construction will comply with the regulations for community noise control under HAR Chapter 11-46. Due to the remote location of the Project Site, it is anticipated that any impacts would be minimal. *See Id.* at 4. If necessary, noise permits will be obtained through DOH. During Project operations impacts from noise and dust are expected to be minimal. A solar farm is a relatively passive operation. Although the racking systems are a tracking-type system, motors are small and will not generate noise that exceeds acceptable noise levels as limited in HAR Chapter 11-46. The electrical equipment does not include any mechanical or motorized equipment that will generate noise. There may be some minimal corona noise coming from the electrical equipment and BESS, but it will be within acceptable levels. Operation and maintenance activities may result in minimal vehicular noise from maintenance staff. *Id.* at 4.

Construction will also bring about short-term air quality impacts in the form of exhaust from increased traffic and fugitive dust generated by the construction activity. Construction activities at the Project Site will comply with the regulations for fugitive dust control in HAR, Section 11-60.1. Temporary BMP will be used to mitigate impacts from fugitive dust during construction. These BMP may include dust fences, windbreaks, watering of disturbed areas and other soil management measures. BMP will be identified and included on the erosion and sediment control plans that are required for both City and State grading and erosion control permit approvals. The operation of a PV farm does not generate direct air emissions. Operation and maintenance activities may result in temporary fugitive dust or tailpipe emissions from vehicular traffic and landscape maintenance. However, it is not anticipated that the operations at the Project Site would adversely affect air quality. *See Id.* at 5.

B. TRAFFIC

The Project will generate a negligible amount of vehicle traffic during the solar farm operations. However, during the estimated 12-month construction period, construction-related activity is expected to generate some 300 daily vehicle trips. Based on its experience with past projects of a similar nature and scale, WSP estimates that the maximum labor force needed to build the WSP Project is approximately 175 workers, with peak on-site employment occurring for the five to six months in the middle of construction, when the foundations, modules and inverters are installed. During the majority of construction period, there will likely be a maximum average of 100 workers, and during the grading period the number of workers on site will be even less. Once operational, the Project is anticipated to have a maximum of five (5) employees on site at any given time, however, there will be no permanent employees on-site.

WSP had Fehr & Peers prepare a Construction Traffic Assessment for the Proposed Waiawa Solar Farm (O'ahu, HI), a copy of which is provided as **KS Exhibit 15** (**"Traffic Assessment"**) to assess the impacts from construction of the Project. The Traffic Assessment evaluated operations at four intersections near the KS Property: (1) Ka Uka Boulevard/H-2 south-bound Off-Ramp; (2) Ka Uka Boulevard/H-2 south-bound On-Ramp; (3) Ka Uka

Boulevard/H-2 north-bound Off-Ramp; and (4) Kamehameha Highway/Waihona Street. *Id.* at 2. Construction staff is anticipated to be on the Project site between 6:00 am and 5:00 pm Monday through Saturday and will be encouraged to carpool. *Id.* at 1-2.

The Traffic Assessment used a conservative estimate for determining baseline and construction-related traffic. Existing (2019) traffic volumes were increased by an average growth factor of 1 percent and rounded to the nearest tenth to forecast the 2020 construction year traffic volumes. Although this methodology is consistent with other traffic studies done for local and regional projects on Oahu, given the limited existing traffic mauka of the H-2 Freeway, this approach for forecasting 2020 volumes is considered extremely conservative. For instance, at the intersection of Ka-Uka Boulevard/H-2 NB ramps, the existing westbound right turn traffic volume is four (4) vehicles in the AM peak hour. Increasing that by 1 percent for the year 2020 brings the forecasted volume to 10 vehicles. *Id.* at 5.

Approximately 20 heavy haul trucks (e.g., 18-wheelers, water trucks, garbage trucks, etc.), 30 work trucks (e.g., crew, foreman, superintendents), and 100 worker personal vehicle are estimated to be on the Project Site daily during the height of the construction period. *Id.* at 2. Due to the location and undeveloped nature of the KS Property, no conflicts with pedestrian, public transit, and non-vehicular traffic, are anticipated. *Id.* at 4.

The four study intersections currently operate at Level of Service ("**LOS**") D or better during the AM and PM peak hours, with the exception of the Kamehameha Highway/Waihona Street intersection, which operates at LOS F during the PM peak hours. During the relatively short construction period for the Project the Ka Uka Boulevard/H-2 Northbound Off-Ramp intersection is forecast to operate at LOS E during the PM peak hours. *Id.* at 11. To address construction traffic impacts, Fehr & Peers recommended that at least one of three measures be incorporated into WSP's construction traffic management plan.

- Adjust work schedule shifts slightly so that worker trips are reduced during the PM peak hour. Existing traffic counts show that the PM peak hour at the H-2 southbound ramps occurs at 4:30 to 5:30 PM. Therefore, it is recommended that the volume of departures be reduced between 4:30 PM and 5:30 PM to avoid the busiest or peak traffic time.
- Encourage more carpooling greater than the currently proposed rate (1.75 workers per car) for workers.

- Implement an employee shuttle service to bring workers to/from an off-site location.

The Traffic Assessment also reviewed potential impacts to access roads leading to the KS Property during the Project construction period. Mililani Cemetery Road is a two-lane roadway with lane widths of approximately 12 feet plus shoulder areas. Construction vehicle traffic is not anticipated to result in any operational or safety issues on Mililani Cemetery Road. *Id.* at 12. Waiawa Prison Road is more narrow, at approximately 20 feet wide, and the roadway is curved, which could cause large construction trucks to conflict with opposing traffic (although Waiawa Prison Road is not heavily used). While these roads have been used by heavy construction vehicles in the recent past without incident (for the decommissioning of reservoirs and HECO pole replacements), Fehr & Peers provided measures to be incorporated into the contractor's construction management plan to reduce the potential for conflict.

- Signage between the Ka Uka Boulevard interchange and the KS Property driveway on Waiawa Prison Road that trucks are traveling and entering/exiting the roadway.
- Ensure that adequate sight distance is provided for drivers on Waiawa Prison Road approaching and departing the KS Property driveway. Measures may include traffic control signage (ex. stop or yield signs) and removal of vegetation that impede standard approach, departure, and height sight distances.
- If needed, coordinate with the City to remove vegetation in the public right of way that might impede large construction vehicles on both Mililani Cemetery Road and Waiawa Prison Road.
- Manual traffic control on Waiawa Prison Road to manage construction and prison traffic and to minimize conflicts. This could include the use of radios, flag persons, and/or temporary signals and lighting to assist with the control of vehicles and the provision of adequate sight distance (as needed).
- Maintain access to the Waiawa Correctional Facility.

The Traffic Assessment concludes that the preparation of a construction traffic management plan that minimizes traffic during the peak commute hours to the extent possible, ensures adequate sight distance at the driveway access point, and informs other drivers on Waiawa Prison Road of construction activities and heavy vehicle traffic, should be sufficient to address the short-term traffic impacts anticipate during Project construction.

C. VISUAL IMPACTS

Similar to the solar farm approved in the 2014 Order, existing views from the surrounding communities will remain intact. *See* 2014 Order FOF 206. Visual impacts from the WSP Project are expected to be minimal. G70 prepared visual simulations of the WSP Project with views from Kaweloka Street, to the south/east of the Project Site, and A‘aniu Loop, directly to the east of the Project Site, are provided as in **KS Exhibit 16**. In addition, as with the solar farm approved in the 2014 Order, the solar farm developer will be required to obtain a Conditional Use Permit (Minor) from the City Department of Planning and Permitting ("**DPP**") prior to constructing the Project. The CUP Minor will require the developer to submit a landscape plan to the DPP. To the extent required by the DPP under the CUP Minor process, a vegetation buffer may also be left intact.

WSP had Capitol Airspace Group prepare a Glint & Glare Analysis, a copy of which is provided as **KS Exhibit 17**. The Glint & Glare Analysis evaluated the Project's potential to impact (1) federally funded airports (including the air traffic control towers) within a 7 mile radius of the Project; (2) residents along 8 routes with an estimated single story viewing height 8 feet or a second story viewing height of 16 feet within areas near the KS Property; and (3) vehicles along 8 routes near the KS Property with an estimated viewing height of 4 feet and large trucks with an estimated viewing height of 8 feet. *Id.* at 1. Because there are no non-aviation guidelines for glint and glare, Capitol Airspace Group applied the Federal Aviation Administration's guidelines for the both the aviation and non-aviation aspects of the study. *Id.*

The airports included in the analysis were the Daniel K. Inouye International Airport and the Wheeler Army Airfield. *Id.* The 8 routes analyzed for impacts to nearby residents and vehicular traffic routes are shown on page 17 of the Glint & Glare Analysis, which include views of the Project Site from Kamehameha Highway to the south of the KS Property, the H-2 Freeway and Ka Uka Boulevard to the west of the KS Property, and routes from the neighborhoods to the east of the KS Property. *Id.* at 17. The Glint & Glare Analysis concludes that no glare from the Project is predicted to impact the Daniel K. Inouye International Airport, the Wheeler Army Airbase, or air traffic control towers within the study area. *Id.* at 26. No glare from the Project is anticipated to impact residents or vehicular traffic along the 8 routes studied. *Id.*

D. ARCHAEOLOGICAL AND HISTORIC RESOURCES

In March 2015, an Archaeological Inventory Survey[6] ("**AIS**") of the entire KS Property was prepared by Christopher Monahan, PhD, of TCP Hawai'i, LLC and submitted to the Hawai'i Department of Land and Natural Resources State Historic Preservation Division ("**SHPD**"). The AIS recommended preservation of some of the 25 features of Site 2273, which is an extensive system of plantation infrastructure that was previously used for irrigation of commercial sugarcane. SHPD accepted the AIS by letter dated April 24, 2015, a copy of which is provided as **KS Exhibit 28**.

Subsequently, in May 2015, Dr. Monahan submitted an Archaeological Preservation Plan ("**APP**") identifying the preservation measures for four features of State Site #50-80-09-2273.[7] A copy of the APP and SHPD's acceptance letter dated September 14, 2015, are provided as **KS Exhibit 19**. Feature 19 (a large dam-like retention structure in the west end of Gulch B) and Feature 22 (a large water-distribution and -retention basin of the plateau east of Gulch A) will be preserved in their entirety. A representative (100-ft. long) section of Feature 14 (a cut basalt and mortar irrigation ditch draining into Gulch B) will be preserved as will a representative (75-ft. long) section of Feature 23 (a cut basalt and mortar irrigation ditch). Preservation will be in the form of "avoidance and protection," through temporary fencing during construction. Long-term preservation measures entail permanent fencing with a suitable buffer around the features. *See* APP at 23-24.

Features 22 and a portion of 23 are within the larger 200-acre area of the WSP Project. By letter dated March 12, 2019, WSP confirmed to SHPD that WSP would install the fencing with the appropriate buffers as required under the approved APP. By letter dated July 19, 2019, Dr. Monahan, on behalf of WSP, confirmed to SHPD that the fencing had been installed in compliance with the APP. *See* **KS Exhibit 20**.

E. BIOLOGICAL RESOURCES

WSP had AECOS, Inc. prepare a report titled "Biological surveys for a solar electrical generating facility in Waiawa, central O'ahu", a copy of which is filed as **KS Exhibit 21**.

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[6] *Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Land in Waiawa and Waipi'o Ahupua'a, 'Ewa District, O'ahu Island, Hawai'i* (Monahan, Sept. 2014).

[7] *Archaeological Preservation Plan State Site No. 50-80-09-2273 Features 14 (portion), 19, 22 & 23 (portion) Kamehameha Schools' Land in Waiawa Ahupua'a, 'Ewa District, O'ahu Island, Hawai'i TMK (1) 9-6-004: 024 (portion)* (Monahan, May 2015).

AECOS conducted site visits of the Project Site in March 2019 to identify natural resources of interest in or near the Project Site. Based on a literature review conducted prior to the field work, and scientific expectations for former sugarcane lands at a low elevation, AECOS did not anticipate species of concern would be found. AECOS conducted a botanical survey, avian survey, and mammalian survey. Additionally, AECOS determined that the Project Site does not contain waters that would be considered jurisdictional under the Clean Water Act. *Id.* at 16. The Project Site is located on an interfluve with no perennial or intermittent streams present. The National Wetlands Inventory Wetlands Mapper shows no wetlands or streams in the survey area, and no hydrology or vegetation indicative of wetlands were observed the Project Site survey.

None of the plant species found within the Project Site are considered important from a natural resource perspective, and none of the species found are currently protected, or proposed for protection, under either the federal or the State of Hawaii endangered species programs. *Id.* at 14. Furthermore, the KS Property and Project Site are not designated as critical habitat by the U.S. Fish and Wildlife Service. *Id.* at 17. Four terrestrial mammalian species were detected in the vicinity of the Project Area (mongoose, house mouse, pig, and dog), all four of which are alien to the Hawaiian Islands and deleterious to native wildlife. *Id.* at 12. Although not seen, AECOS believes it is likely that cats, the O'ahu roof rat, brown rat, and Polynesian rat, use resources within the Project Site on a seasonal basis. *Id.* at 15.

Twenty-three bird species were observed, only one of which (the Pacific Golden Plover) is an indigenous, migratory shorebird, the remaining 22 species are alien to the Hawaiian Islands. *Id.* at 10. The Pacific Golden Plover (*Pluvialis fulva*), is a migratory shorebird species that nests in the high Arctic during the late spring and summer and returns to Hawai'i and the tropical Pacific for the fall and winter. They are commonly encountered in open areas throughout the Hawaiian Islands from late summer through midspring. *Id.* at 14. The Pacific Golden Plover is not listed as an endangered or threatened species. In fact, no vertebrate species currently protected or proposed for protection under either the federal or State of Hawai'i endangered species programs were detected during the course of the survey. *Id.* at 14.

The Hawaiian hoary bat was not detected during the survey. Nevertheless, AECOS concluded that it is possible that the Hawaiian hoary bat overflies the area on a seasonal basis. AECOS does not foresee any impacts to the Hawaiian hoary bat from operations of the Project, but warned that there is a potential for impacts during the clearing and grubbing phase of construction when taller vegetation is being removed, which may temporarily displace individual bats that use trees for roosting. *Id.* at 15. Although the Hawaiian hoary bat uses multiple roosts within a home territory, meaning that impacts from tree removal within the Project Site would be minimal, there is an increased risk during bat pupping season (June 1 to September 15). A female carrying a pup may be less able to rapidly vacate a roost site when an inhabited tree is being felled, and a pup left alone in a tree while the adult female forages would not be able to flee a felling tree. Therefore, although no Hawaiian hoary bats were detected, AECOS recommended avoidance measures of not clearing woody vegetation taller than 15 feet during the bat pupping season. Additionally, barbed wire along the top of security fences is a potential threat to flying bats, and AECOS recommended that no fencing should use strands of barbed wire. *Id.* at 17.

No seabirds were detected during the survey, but AECOS recognized that it is possible that the endangered Hawaiian Petrel (*Puffinus sandwichesis*) and the threatened Newell's Shearwater (*Puffinus newelli*) over-fly the Project Site area between April and the middle of December each year in very small numbers. Newell Shearwaters are not known to breed on the Island of O'ahu, but recent acoustical surveys conducted on O'ahu have recorded low numbers of this species calling over the higher reaches of the Island, as well as the recording of one Hawaiian Petrel. *Id.* at 14. To mitigate any risk to these species, that can become disoriented by lights during fledging season, AECOS recommended that if night-time construction activity or equipment maintenance is conducted, all associated lighting should be shielded and, if large work lights are used, these must be placed on poles that are high enough to allow the lights to be pointed directly towards the ground. Furthermore, if exterior facility lighting is installed, it is recommended that the lights be manual, timed, or motion sensor configured and downward shielded to reduce the potential for causing interactions between nocturnally flying seabirds and man-made structures. *Id.* at 17.

F. CULTURAL RESOURCES; TRADITIONAL AND CUSTOMARY PRACTICES; *KA PA'AKAI* ANALYSIS

In *Ka Pa'akai 'O Ka 'Āina v. Land Use Comm'n*, the Hawai'i Supreme Court held that every state agency has a duty to preserve and protect native Hawaiian traditional and customary practices while reasonably accommodating competing private interests. 94 Hawai'i 31, 47, 7 P.3d 1068, 1084 (2000). Under the *Ka Pa'akai* framework, prior to an agency taking action that may impact native Hawaiian traditional and customary practices, the agency must make specific findings of fact and conclusions of law as to: (1) the identity and scope of "valued cultural, historical, or natural resources" in the affected area, including the extent to which traditional and customary native Hawaiian rights are exercised in the affected area; (2) the extent to which those resources – including traditional and customary native Hawaiian rights – will be affected or impaired by the proposed action; and (3) the feasible action, if any, to be taken by the LUC to reasonably protect native Hawaiian rights if they are found to exist." *Id.*

In June 2003, a Cultural Impact Assessment ("**CIA**") for approximately 3,600 acres of KS lands, including all 1,395 acres of the Petition Area, was prepared by Cultural Surveys Hawai'i, Inc. A copy of that CIA was submitted as KS Exhibit 20 in the 2014 Motion to Amend proceedings. In 2005, Aki Sinoto Consulting prepared a Cultural Resources Preservation Plan for sites that are not within the Petition Area, which SHPD approved in 2007. *See* KS Exhibits 21, 22 in the 2014 Motion to Amend proceedings & 2014 Order at 36, FOF 185-87. No cultural practices or resources were or have been identified within the Petition Area. *Id.* FOF 189-190. To KS' knowledge, there are no active traditional and customary practices taking place within the Petition Area and no native Hawaiian cultural resources have been identified on the KS Property. Affidavit of Dana K.N. Sato ¶¶ 4, 6, 7. There have also been no kuleana claims of prior ownership of lands within the KS Property. *See Id.* at ¶ 8; 2014 Order at 37, FOF 192.

In 2014, the Commission found that the proposed solar project (both Phase 1 and Phase 2) would not significantly impair any valued cultural resources. 2014 Order at 59. As discussed, certain aspects of the proposed Project are different from what was presented to the Commission in 2014. However, the WSP Project footprint will remain within the Phase 2 project site approved in 2014 and the overall scope of the Project has decreased. Because no new cultural resources or practices have been identified, the proposed Project will not adversely impact any protected traditional and customary practices or resources.

VI. APPLICABLE STATUTES, ORDINANCES AND RULES

A. USE OF THE KS PROPERTY AS A SOLAR FARM IS PERMITTED BY CITY LAW

The proposed solar farm development is permitted within the State Land Use Urban District because it is allowed under the existing land use classification and City zoning. HAR §15-15-24 provides:

> *Any and all uses permitted by the counties either by ordinance or rules may be allowed within this [the "U" Urban] district, subject*

to any conditions imposed by the commission pursuant to section 205-4(g), HRS.

HAR §15-15-24.

The City zoning designations of the KS Property are: AG-1 Restricted Agriculture; R-5 Residential District, A-1 Low Density Apartment District, A-2 Medium Density Apartment District, IMX-1 Industrial-Commercial Mixed Use District, B-1 Neighborhood Business District, B-2 Community Business District; and (g) P-2 General Preservation. *See* KS Exhibit 3. The proposed Project is within the portion of the KS Property zoned AG-1. A solar farm is a "utility installation" as defined under the Honolulu Land Use Ordinance, Revised Ordinances of Honolulu, Chapter 21 ("**LUO**"). Under Sec. 21-10.1 of the LUO, a "utility installation" is defined as "uses or structures, including all facilities, devices, equipment, or transmission lines, used directly in the distribution of utility services, such as water, gas, electricity, telecommunications other than broadcasting antennas, and refuse collection other than facilities included under waste disposal and processing." Utility installations also include accessory uses and structures directly associated with the distribution of the utility service.

Type A and Type B utility installations are permitted uses in all zoning districts in Honolulu. The key difference is that a Conditional Use Permit/minor (no public hearing required) is required for a Type B utility installation. *See* LUO Table 21-3 (Master Use Table), portions of which are enclosed as **KS Exhibit 22**. As such, the proposed solar farm is permitted under City law and therefore allowed within the State Land Use Urban District.

B. SOLAR FARM IS CONSISTENT WITH THE HAWAI'I STATE PLAN

HRS §205-16 provides that "No amendment to any land use district boundary nor any other action by the land use commission shall be adopted unless such amendment or other action conforms to the Hawaii state plan." The Commission already determined that use of portions of the KS Property for solar farm development is consistent with applicable goals, objectives and policies of the Hawai'i State Plan, HRS Chapter 226. *See* 2014 Order, FOF 272 - 275 (citing HRS §§ 226-18 (Objectives and Policies for Facility Systems - Energy); 226-103 (Economic Priority Guidelines).

C. SOLAR FARM IS CONSISTENT WITH GOVERNOR IGE'S RENEWABLE ENERGY POLICY

Since taking office at the end of 2014, Governor Ige has strongly supported renewable energy policies, with focus to create programs and incentives to increase clean energy production in the State. On June 8, 2015, Governor Ige signed Act 97 into law, committing the State's utilities to generate 100 percent electricity from renewable energy resources by the year 2045. **KS Exhibit 23** (Act 97); *see also* **KS Exhibit 24** (6/5/18 press release). The Governor has stated his support for the Clearway solar farms that are underway in Kawailoa, Mililani, and Waipio, which together are expected to produce enough new electricity to power many thousands of homes. "Building solar energy at this scale represents tremendous progress toward our renewable energy goals." GOVERNOR.HAWAII.GOV, *New Solar Farms in 2019*, https://governor.hawaii.gov/featured/new-solar-farms-in-2019/ (Apr. 24, 2018). Similarly, this Project will help to achieve the State's energy goals of 100 percent renewable energy from 2045.

D. SOLAR FARM AND THE COSTS OF ELECTRICITY

The Project is estimated to provide approximately $237,336,050 in total savings to ratepayers (net present value) (this figure is based on the increases in electricity costs that are projected by HECO). *See* PUC Decision and Order No. 36231. The average cost for residential electricity on O'ahu as of 2017 is 28.22 cents per kilowatt hour ("**kWh**"), and HECO's current avoided cost of power from primary fossil fuel baseload generation is 12.52 cents per kWh (as of June 2019 Schedule Q Rates published by HECO). That average cost for residential electricity is more than double the national average of 12.47 cents per kWh (as of February 28, 2019). However, the average cost of the solar power to be sold to HECO from WSP is substantially less at 9.5 cents per kWh, which will result in significant savings to O'ahu ratepayers.

WSP will not inhibit or restrict HECO's ability to accept PV power from individual homes and businesses that also wish to use solar energy. Residential and commercial PV systems connect to the HECO grid at a distribution level of 12kV. In contrast, utility scale solar power, such as proposed by Clearway, connects to the grid at a sub-transmission level, at 46kV. The 46kV connection is the same as what HECO uses to bring power from its existing fossil fuel power plants. In other words, utility scale solar farms will not prevent individual PV systems from connecting to the grid because the connection points are different for those uses. Additionally, the WSP Project includes 144 MWh of battery storage which will allow the Project to store energy produced during the daytime peak solar energy production across the grid and discharge that solar energy during the evening. This will further alleviate any congestion caused by having too much total solar being put onto the grid during the daytime peak production. If at some point in the future the total amount of solar energy generated from residential, commercial and utility scale systems exceeds what can be absorbed by the HECO grid, the utility scale projects will be temporarily curtailed. The utility scale sources will be made to stop generating power, while the residential and commercial PV systems will be allowed to continue generating power. Unlike utility scale power, which can be curtailed, there is currently no mechanism that allows HECO to curtail the amount of power produced by individual residences or businesses.

VII. COMMISSION CRITERIA FOR A MOTION TO AMEND

The Commission is authorized to amend the 2014 Order upon a showing of good cause under HAR § 15-15-94(b). "The term 'good cause' has been defined to mean 'a substantial reason amounting in law to a legal excuse for failing to perform an act required by law.'" *Miller v. Tanaka*, 80 Hawai'i 358, 363, 910 P.2d 129, 134 (Ct. App. 1995) (citation omitted). "'Good cause' also 'depends upon [the] circumstances of [the] individual case, and [a] finding of its existence lies largely in [the] discretion of [the] officer or court to which [the] decision is committed.'" *Id.* at 363-64, 910 P.2d at 134-35 (citation omitted). "As a general rule, 'good cause' means a substantial reason; one that affords a legal excuse." *State v. Estencion*, 63 Haw. 264, 267, 625 P.2d 1040, 1042 (1981) (citations omitted). Successor Petitioner respectfully submits that good cause exists to amend the 2014 Order as requested. Pursuant to HAR § 15-15-94, Petitioner must serve a copy of this Motion "on all parties to the boundary amendment proceeding in which the condition was imposed or in which the order was issued, and to any person that may have a property interest in the subject property as recorded in the county's real property tax records at the time that the motion is filed." This Motion was properly served.

A. GOOD CAUSE SHOWN FOR MODIFICATION OF 2014 ORDER

For the following reasons KS respectfully believes that the Commission has good cause to modify the Waiawa Order, as amended, to expressly allow the KS Property to be used for a second solar farm development for an interim period, with complete decommission to be completed no later than December 31, 2059.

1. Community Outreach

In addition to the mandatory service requirements noted above, representatives of Clearway reported to KS that they contacted elected officials and community leaders to alert them about the proposed WSP Project. Such contacted individuals include the following: State Senator Michelle Kidani, Senate District 18 (Mililani Town, portion of Waipi'o Gentry, Waikele, Village Park, Royal Kunia), Senator Donavan Dela Cruz, Senate District 12 (Mililani Mauka, Waipi'o Acres, Wheeler, Wahiawa, Whitmore Village, portion of Poamoho), Representative Roy Takumi, House District 35 (Pearl City, Manana, Waipio), Representative Roy Yamane, House District 37 (Mililani, Waipio Gentry, Waikele), Representative Lauren Matsumoto, House District 45 (Schofield, Mokuleia, Waialua, Kunia, Waipio Acres, Mililani), Representative Val Okimoto, District 36 (Mililani Mauka, Mililani), Carilyn Shon, Interim Chief Energy Officer of the Hawaii State Energy Office, Honolulu City Council members Ron Menor and Heide Tsuneyoshi, and chairs of the Pearl City Neighborhood Board, the Mililani/Waipio/Melemanu Neighborhood Board, and the Mililani Mauika/Launani Valley Neighborhood Board. Clearway also held a community meeting on November 13, 2018, at Mililani Waena Elementary School to gather feedback on the Project. Prior to that meeting, Clearway had published notice of the meeting in two editions of MidWeek. Public feedback on the Project was minimal but positive.

2. Outreach to Key Agencies

On February 14 and March 5, 2019, representatives from KS and Clearway met with Joanna Seto, Chief of Safe Water Drinking Branch of the DOH, and staff in the Clean Water Branch, Wastewater Branch, and Solid and Hazardous Waste sections of DOH, to discuss the WSP Project. Representatives from the Department of the Navy ("**Navy**") joined the March 5, 2019 meeting. The meetings were positive resulting in the March 28, 2019 letter from DOH to KS stating that DOH does not anticipate any adverse impacts to groundwater resources provided that the proper mitigation measures are implemented. *See* KS Ex. 13.

On March 22, 2019, representatives from KS and WSP/Clearway also met with DPP staff to discuss the WSP Project, changes proposed from the project presented in 2014, as well as the Conditional Use Permit Minor required for the Project. This meeting was also positive and WSP/Clearway will continue to work with DPP for any and all DPP required approvals. KS has also reached out to Waiawa Correctional Facility about the WSP Project.

3. Community Benefits

Consistent with KS' educational mission, the agreement between KS and WSP requires WSP to cooperate with KS in establishing educational programs for Hawai'i students and teachers. WSP is required to provide funding of $200,000.00 toward such programs until the funding is fully disbursed.

B. KS VALUES AND WAIAWA VISION

Mindful of its obligations to its approximately 62,000 learners Statewide, KS must always seek to maximize a financial return on all KS properties in a way that is consistent with KS' five values: (1) environment; (2) culture; (3) education; (4) economics; and (5) community. KS is collectively moving toward a thriving lahui, and in one generation's time (25 years) KS envisions providing its learners the opportunities to be set up for educational and well-being success. KS' kuleana is more than just its 3 campuses and 29 preschools. Education and well-being means KS land assets must be looked at in a more holistic manner, and KS seeks to enhance its lahui's entire learning and living environment. That means viewing its land assets through a regional approach, seeking long-term growth in value and income, and taking into consideration education, housing, infrastructure (including energy and transportation), business, health, and aina. Renewable energy development within the KS Property is consistent with these values and guiding principles and will help Hawaii become energy self-sufficient.

C. SERVICE OF MOTION

All of the parties and entities who were served with the 2014 Motion were also served with a copy of this Motion. No new and currently effective encumbrances or other property interests have been recorded against the KS Property since the time of the 2014 Order, with the exception of the Notice and Declaration required to be recorded by Conditions 15 and 16 of the 2014 Order, and the Memorandum of Agreement to Grant Easement, by and between KS and WSP regarding the solar farm easement for the WSP Project, recorded in the Bureau on July 19, 2019 (Document No. A71390768). *See* Affidavit of Dana K.N. Sato ¶ 10; **KS Exhibit 25** (Service of Motion/Recorded Property Interest Chart).

VIII. STATUS OF CONDITIONS OF APPROVAL

KS is in compliance with the ten conditions of approval imposed under the Waiawa Order. *See* KS Ex. 7 (KS Annual Report May 29, 2019). Except for the conditions related to the timeframe of the development of a solar farm, KS is in substantial compliance with the conditions of approval under the 2014 Order.

2014 Order Condition 1 requires Petitioner to submit a revised master plan and schedule for development of the KS Property by November 26, 2019. This deadline will be met, and the solar farms as approved under the 2014 Order, and as currently proposed for amendment, are being incorporated into the KS revised master plan.

Condition 2 requires the solar farm developer to ensure its construction does not prevent roadway access to Waiawa Correctional Facility. WSP's construction traffic management plan takes this into account.

Condition 3 requires the completion of a supplemental AIS for the entire KS Property. As discussed in Section V.D. *supra*, an AIS was completd and SHPD accepted the AIS in April 2015. *See* KS Ex. 17. The remainder of Condition 3, requiring action should any historic resources or burials be found during ground disturbing activities, is ongoing and compliance will continue.

Condition 4 requires the solar farm operator to mitigate any glare hazard to pilots upon notification by the DOT-Airports Division, or the Federal Aviation Administration. WSP will comply with this condition during development and operation of the Project. As discussed *supra* at Section V.C., WSP had a Glint & Glare Analysis prepared, which conclude that the Project will not generate glint or glare that affects Daniel K. Inouye International Airport or Wheeler Army Airfield. *See* KS Ex. 17.

Condition 5 addresses traffic management during construction of the solar farm. Condition 5a is tied to Phase 1 of the solar farm and is therefore does not require implementation unless Phase 1 goes forward. Condition 5b requires the solar developer to prepare and submit a traffic assessment for Phase 2 to DOT prior to the start of construction. As discussed in Section V.B. *supra*, WSP had Fehr & Peers prepare a Traffic Assessment to address construction traffic impacts. *See* KS Ex. 15. Once operational, the Project is not anticipated to generate any traffic. For the construction phase of the Project, the recommendations under the Traffic Assessment are that WSP have at least one of the following three measures incorporated into its construction traffic management plan: adjust work schedules slightly to reduce PM peak hour impacts; encourage more worker carpooling; or implement an employee shuttle service. Measures recommended to manage construction traffic on Waiawa Prison Road and to maintain access to the Waiawa Correctional Facility include: signage between the Ka Uka Boulevard interchange and the KS Property driveway on Waiawa Prison Road; ensuring that adequate sight distance is provided for drivers on Waiawa Prison Road through traffic control signage (ex. stop or yield signs) and removal of vegetation that impede standard approach, departure, and height sight distances; if needed, coordinate with the City to remove vegetation in the public right of way that might impede large construction vehicles on both Mililani Cemetery Road and Waiawa Prison Road; employ manual traffic controls (radios, flag persons, and/or temporary signals and lighting) on Waiawa Prison Road to manage construction and prison traffic and to minimize conflicts.

Condition 6 requires Phase 1 of the solar farm to be substantially complete by November 2019, and requires Phase 2 to be substantially completed within 10 years (by November 2024) of the 2014 Order. As discussed above, Phase 1 is not currently being pursued, therefore the timing of the start and completion of any solar farm to be developed within the Phase 1 area is currently unknown. The WSP Project is in the Phase 2 area and it will be substantially completed by November 2024.

Condition 7 prohibits any interim use of the KS Property for anything other than a utility-scale solar energy facility. The WSP Project is consistent with this condition.

Condition 8 limits the term of the solar farm interim use to 35 years from the date of the 2014 Order, i.e, to November 2049. By this Motion, KS requests that the Commission extend the use period for the modified Phase 2 area to December 31, 2059.

Condition 9, requiring submission of metes and bounds and a map description of Phase 1 and Phase 2, was satisfied by KS' submission of October 2, 2015.

Condition 10 provides decommissioning requirements. WSP will decommission the Project consistent with these requirements.

Condition 11 requires substantial compliance with the representations it has made to the Commission. The WSP Project is substantially similar to the project presented to the Commission in 2014, and will be developed in substantial compliance with all applicable representations made to the Commission.

Condition 12 requires notice to the Commission of any change of ownership in the KS Property, and compliance with this is ongoing.

Condition 13 requires the submission of annual reports. KS is in compliance and compliance is ongoing.

Condition 14 states that the Commission may fully or partially release conditions upon motion by KS. KS is not currently seeking release of any conditions, but is seeking some modifications to allow for the WSP Project.

Conditions 15 and 16, requiring Notice of Imposition of Conditions and Recordation of Conditions, has been satisfied the Successor Petitioner. *See* FN 2.

IX. SUMMARY AND CONCLUSION

Based on the foregoing, HAR §§ 15-15-70, 15-15-94, testimony to be provided at the hearing on this Motion, and the records and files in this Docket, Successor Petitioner LANCE KEAWE WILHELM, ROBERT K.W.H. NOBRIGA, ELLIOT K. MILLS, MICAH A. KANE, and CRYSTAL KAUILANI ROSE, as Trustees of the Estate of Bernice Pauahi Bishop, dba KAMEHAMEHA SCHOOLS, respectfully requests that the Commission grant the Motion and issue an order modifying the 2014 Order to expressly authorize the use of identified portions of the KS Property for the proposed WSP Project as described herein, with decommissioning of the WSP Project to be completed no later than December 31, 2059.

Jennifer A. Lim

JENNIFER A. LIM
PUANANIONAONA P. THOENE
Attorneys for Successor Petitioner
KAMEHAMEHA SCHOOLS

Dated: Honolulu, Hawai'i, July 24, 2019

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI'I

In the Matter of the Petition of **TOM GENTRY AND GENTRY-PACIFIC, LTD** To Amend the Agricultural Land Use District Boundary into the Urban Land Use District for Approximately 1,395 Acres at Waiawa, Ewa, Oahu, State of Hawaii, Tax Map Key Nos." 9-4-06: Portion of 26; 9-6-04: Portion of 1 and Portion of 16; and 9-6-05: Portion of 1, Portion of 7 and Portion of 14	DOCKET NO. A87-610

AFFIDAVIT OF JENNIFER A. LIM

STATE OF HAWAI'I)
) ss.
CITY AND COUNTY OF HONOLULU)

JENNIFER A. LIM, being first sworn on oath, deposes and says that:

1. I am a partner in the firm of Carlsmith Ball LLP, located at 1001 Bishop Street, Suite 2100, American Savings Tower, Honolulu, Hawai'i, 96813, am duly admitted to practice law in the State of Hawai'i and am one of the attorneys for Successor Petitioner LANCE KEAWE WILHELM, ROBERT K.W.H. NOBRIGA, ELLIOT K. MILLS, MICAH A. KANE, and CRYSTAL KAUILANI ROSE, as Trustees of the Estate of Bernice Pauahi Bishop dba KAMEHAMEHA SCHOOLS in the above-referenced Docket (hereinafter referred to as "**KS**").

2. I have personal knowledge of the matters set forth herein and am qualified and competent to make this affidavit.

3. Attached hereto as KS Exhibit 1 is a true and correct copy of the survey map outlining the 1,395 acre property that was reclassified to the State Land Use Urban District in State of Hawai'i Land Use Commission ("**LUC**") Docket A87-610 (the "**KS Property**") over the current City and County of Honolulu tax maps. The survey outline was completed according to the metes and bounds description in the Declaration recorded in the Bureau of Conveyances, State of Hawai'i in Liber 22151, Page 250.

4. Attached hereto as KS Exhibit 2 is a true and correct copy of a graphic prepared by PBR Hawaii showing the State Land Use Districts of the KS Property and surrounding properties.

5. Attached hereto as KS Exhibit 3 is a true and correct copy of a graphic prepared by PBR Hawaii showing the current Honolulu City and County zoning districts within the KS Property.

6. Attached hereto as KS Exhibit 4 is a true and correct copy of a graphic prepared by PBR Hawaii showing the 2002 Central O'ahu Sustainable Communities Plan overlaid on the KS Property.

7. Attached hereto as KS Exhibit 5 is a true and correct copy of a graphic prepared by PBR Hawaii showing the proposed (2016) Central O'ahu Sustainable Communities Plan overlaid on the KS Property.

8. Attached hereto as KS Exhibit 6 is a true and correct copy of a graphic prepared by PBR Hawaii showing the two phased solar farm within the KS Property approved by the LUC under that certain *Order Granting Motion for Order Amending Findings of Fact, Conclusions of Law and Decision and Order Dated May 17, 1988.*

9. Attached hereto as KS Exhibit 7 is a true and correct copy of KS's Annual Report to the LUC dated May 29, 2019, obtained from the LUC's website.

10. Attached hereto as KS Exhibit 8 is a true and correct copy of a graphic prepared by G70 showing the conceptual site plan for the solar farm project proposed by Waiawa Solar Power, LLC ("**WSP**").

11. Attached hereto as KS Exhibit 9 are true and correct examples of battery storage systems similar to that proposed for the Project prepared by WSP.

12. Attached hereto as KS Exhibit 10 are true and correct copies of the Samsung Fact Sheets with technical information on the type of batteries proposed to be used for the WSP Project, obtained by WSP from Samsung SDI.

13. Attached hereto as KS Exhibit 11 are true and correct copies of the NOVEC fact sheets with technical information on the type of fire suppressant proposed to be used at the WSP Project, obtained by WSP from 3M.

14. Attached hereto as KS Exhibit 12 are true and correct copies of the Envirotemp FR3 fact sheets with technical information on the type of transformer lubricant oil proposed to be

used for the WSP Project obtained by WSP from Global Safety Management.

15. Attached hereto as KS Exhibit 13 is a true and correct copy of the March 28, 2019 letter from the State of Hawai'i Department of Health to KS regarding the WSP Project.

16. Attached hereto as KS Exhibit 14 is a true and correct copy of the Preliminary Civil Engineering Considerations report dated July 19, 2019 prepared by G70 for the proposed Project.

17. Attached hereto as KS Exhibit 15 is a true and correct copy of the Construction Traffic Assessment dated July 19, 2019, prepared by Fehr & Peers for the proposed Project.

18. Attached hereto as KS Exhibit 16 is a true and correct copy of visual simulations of the WSP Project prepared by G70 in March 2019.

19. Attached hereto as KS Exhibit 17 is a true and correct copy of the Glare & Glint Analysis dated March 26, 2019 prepared by Capitol Airspace Group for the proposed Project.

20. Attached hereto as KS Exhibit 18 is a true and correct copy of the State of Hawai'i Historic Preservation Department ("**SHPD**") letter dated April 24, 2015, approving the Archaeological Inventory Survey dated September 2014, for the KS Property.

21. Attached hereto as KS Exhibit 19 is a true and correct copy of the SHPD letter to Dr. Chris Monahan, TCP Hawai'i, LLC, confirming acceptance of the Final Archaeological Preservation Plan for the KS Property, a true and correct copy of which is also enclosed as KS Exhibit 19.

22. Attached hereto as KS Exhibit 20 is a true and correct copy of an email and letter, both dated July 19, 2019, from Dr. Chris Monahan, TCP Hawai'i, LLC, to Dr. Susan Lebo, Archaeology Branch Chief, SHPD, seeking concurrence of determination of effect for the WSP Project, and confirming the installation of preservation construction fencing in compliance with the Archaeological Preservation Plan for the KS Property.

23. Attached hereto as KS Exhibit 21 is a true and correct copy of the Biological surveys for solar electrical generating facility in Waiawa, Central O'ahu report dated July 22, 2019 prepared by AECOS Inc. for the proposed Project.

24. Attached hereto as KS Exhibit 22 is a true and correct copy of portions of the City and County of Honolulu Land Use Ordinances Master Use Table 21-3 obtained from http://www.honolulu.gov/ocs/roh.html.

25. Attached hereto as KS Exhibit 23 is a true and correct copy of Act 97 (2015)

relating to renewable standards obtained from the Hawai'i State Legislature's website at https://www.capitol.hawaii.gov/session2015/bills/GM1197_.pdf .

26. Attached hereto as KS Exhibit 24 is a true and correct copy of the June 8, 2015 press release from Governor Ige regarding Act 97 obtained from https://governor.hawaii.gov/newsroom/press-release-governor-ige-signs-bill-setting-100-percent-renewable-energy-goal-in-power-sector/.

27. Attached hereto as KS Exhibit 25 is a true and correct copy of the recorded property interests recorded against the KS Property, as prepared by Jennifer A. Lim based upon a review of the title reports prepared by First American Title Company, Inc.

I make this affidavit under Hawai'i Administrative Rules, § 15-15-70(c).

Further affiant sayeth naught.

DATED: July 24, 2019

JENNIFER A. LIM

The attached document:
Affidavit of Jennifer A. Lim,
dated this 24th day of July ~~X~~, 2019,
which consists of four
(4) pages (including this page), was
executed by Jennifer A. Lim who was
subscribed and sworn to before me
this 24th day of July, 2019 in the First
Judicial Circuit of the State of Hawai'i.

[Notary Signature]

Printed Name: Jeannie Hirabara

(notary stamp or seal)

JEANNIE HIRABARA
NOTARY PUBLIC
No 82-84
STATE OF HAWAII

My commission expires: 2/7/22

4845-3403-3541.11.030088-00319

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAI'I

In the Matter of the Petition of **TOM GENTRY AND GENTRY-PACIFIC, LTD** To Amend the Agricultural Land Use District Boundary into the Urban Land Use District for Approximately 1,395 Acres at Waiawa, Ewa, Oahu, State of Hawaii, Tax Map Key Nos." 9-4-06: Portion of 26; 9-6-04: Portion of 1 and Portion of 16; and 9-6-05: Portion of 1, Portion of 7 and Portion of 14	DOCKET NO. A87-610

AFFIDAVIT OF DANA K. N. SATO

STATE OF HAWAI'I)
) ss.
CITY AND COUNTY OF HONOLULU)

DANA K.N. SATO, being first sworn on oath, deposes and says that:

1. I am the O'ahu Island Director of Asset Management for the Community Engagement and Resources Group of Kamehameha Schools ("**KS**") and have worked in this capacity for four years, since March 2015. I have worked for KS for over 16 years, since April 2003. Immediately prior to being the O'ahu Island Director of Asset Management I was Senior Legal Counsel for KS.

2. I have personal knowledge of the matters set forth in the foregoing Motion and Memorandum in Docket No. A87-610 and am qualified and competent to make this affidavit.

3. I am familiar with the approximately 1,395-acre Petition Area (referred to in this Motion for Modification and Time Extension as the "**KS Property**") that is the subject of this Motion for Modification and Time Extension before the State of Hawai'i Land use Commission.

4. To my knowledge, there are no past or current cultural practices identified on the KS Property. The KS Property is not used today, nor any time during my tenure at KS, for gathering.

5. Historically, the KS Property had been used for cultivation of rice, pineapple, and

sugar, as well as cattle grazing, and three small residential plantation era camps. The last known uses of the KS Property ceased in 1983 and the land has remained vacant since that time.

6. A Cultural Impact Assessment ("**CIA**") for 3,600 acres of KS lands in the Waiawa area, which includes the entirety of the KS Property, identifies some cultural resources, these resources were identified in an area north of the KS Property and are not within the KS Property.

7. Since KS last appeared before the State of Hawai'i Land Use Commission in 2014, KS has not received any requests from cultural practitioners for access to the KS Property for the purposes of engaging in traditional and customary practices.

8. KS is not aware of any kuleana claims on the KS Property.

9. Attached hereto as **KS Exhibit 25** is a true and correct copy of a chart prepared by KS and its counsel, Carlsmith Ball LLP, in connection with KS' 2014 motion to amend Docket No. A87-610 listing all parties who have a recorded property interest in the KS Property.

10. With the exception of the Memorandum of Agreement to Grant Easement, by and between KS and Waiawa Solar Power, LLC, regarding the solar farm easement for the Waiawa Solar Power, LLC solar farm, which Memorandum was recorded in the Bureau of Conveyances of the State of Hawaii as Document No. A71390768 against portions of the KS Property on July 19, 2019, and the Notice and Declaration required to be recorded by Conditions 15 and 16 of the Commission's 2014 Order, no new and currently effective encumbrances or other property interests have been recorded against the KS Property since KS last appeared before the LUC in 2014.

I make this affidavit under Hawai'i Administrative Rules, § 15-15-70(c).

Further affiant sayeth naught.

DATED: July 23, 2019

BILLIE J. HAIRSTON
NOTARY
18-553
PUBLIC
STATE OF HAWAII

DANA K. ~~N.~~ SATO

4845-3403-3541.11.030088-00319

The attached document:
Affidavit of Dana K.N. Sato,
dated this _____ day of July 23, 2019,
which consists of ________________
(3) pages (including this page), was
executed by Dana K.N. Sato who was
subscribed and sworn to before me
this 23rd day of July, 2019 in the Fifth
Judicial Circuit of the State of Hawaiʻi.

Billie J Hairston
[Notary Signature]

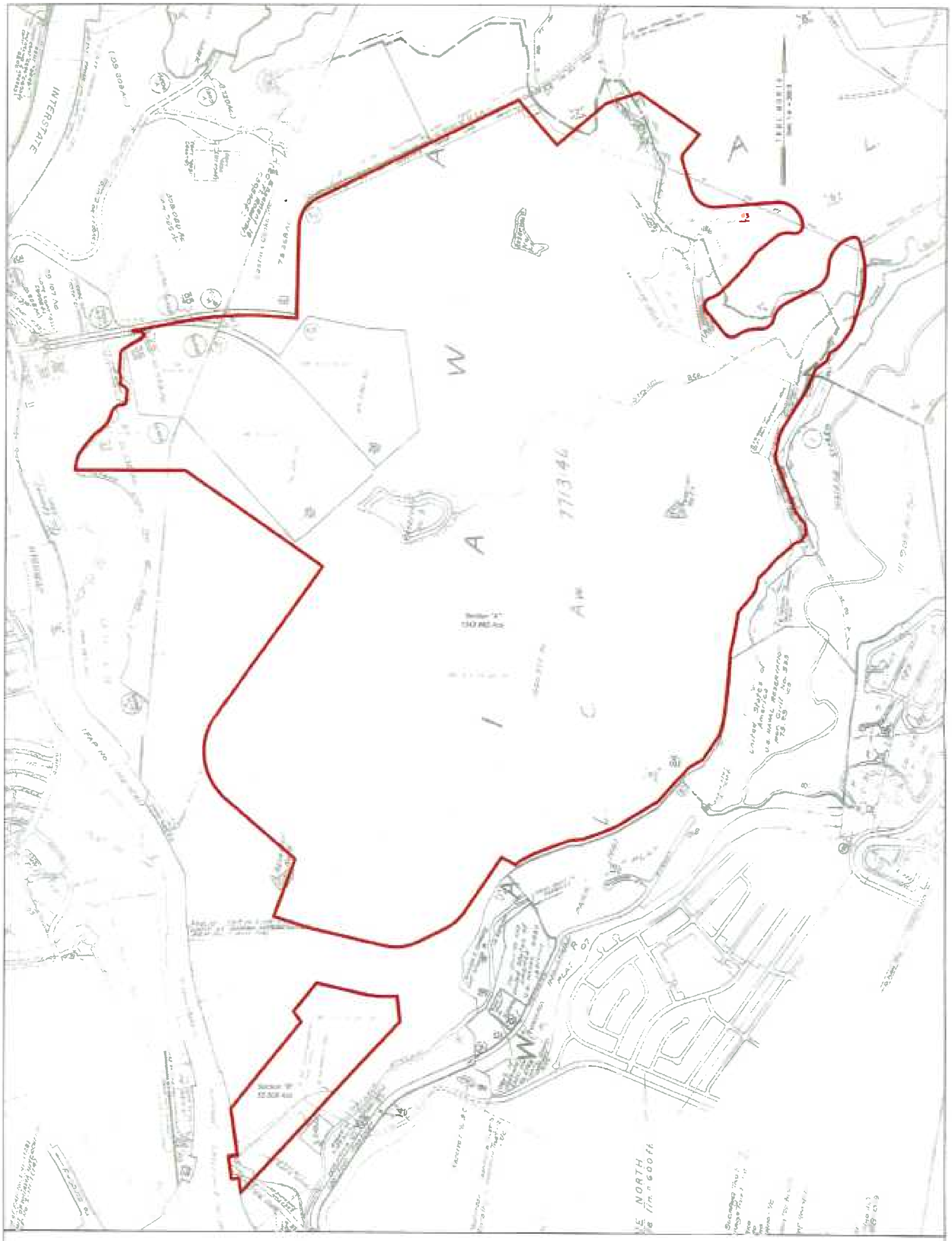
(notary stamp or seal)

BILLIE J. HAIRSTON
NOTARY PUBLIC
18-353
STATE OF HAWAII

Printed Name: Billie J. Hairston

My commission expires: 10/7/2022

4845-3403-3541.11.030088-00319



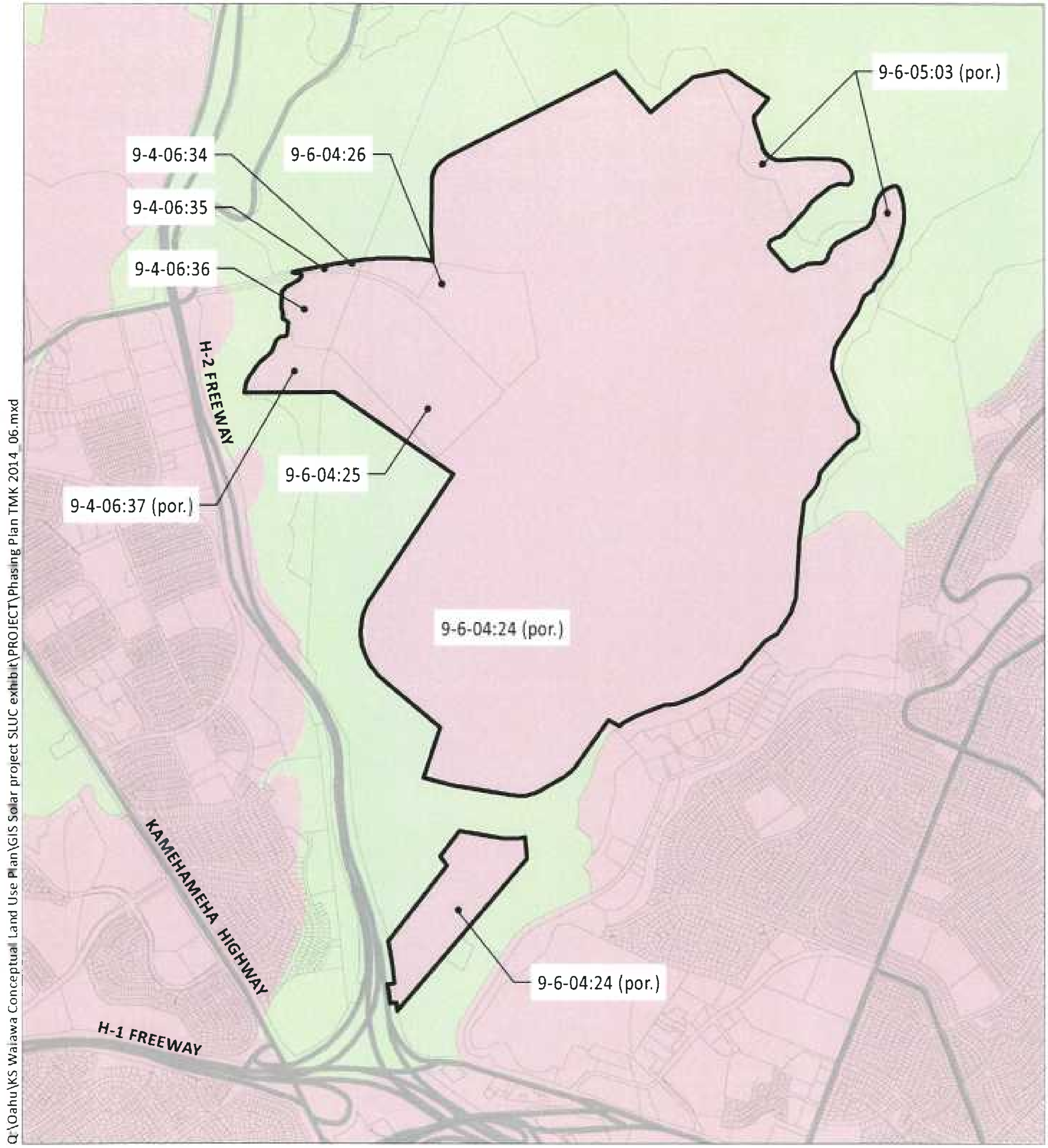
SURVEY SHOWING
SECTIONS "A" & "B"
described in Liber 22151 Pg 250
overlayed on Tax Map Keys:
9-4-06, 9-6-04, and 9-6-05

AT WAIAWA AND WAIPIO, EWA, OAHU, HAWAII

KS Exhibit 1

ACE LAND SURVEYING LLC

Revised July 10, 2015



DATE: 3/21/2019

KS Exhibit
Urban District Boundary

KAMEHAMEHA SCHOOLS WAIAWA MOTION TO AMEND

Island of O'ahu

North

Linear Scale (feet)
0 1,000 2,000

PBR HAWAII

LEGEND

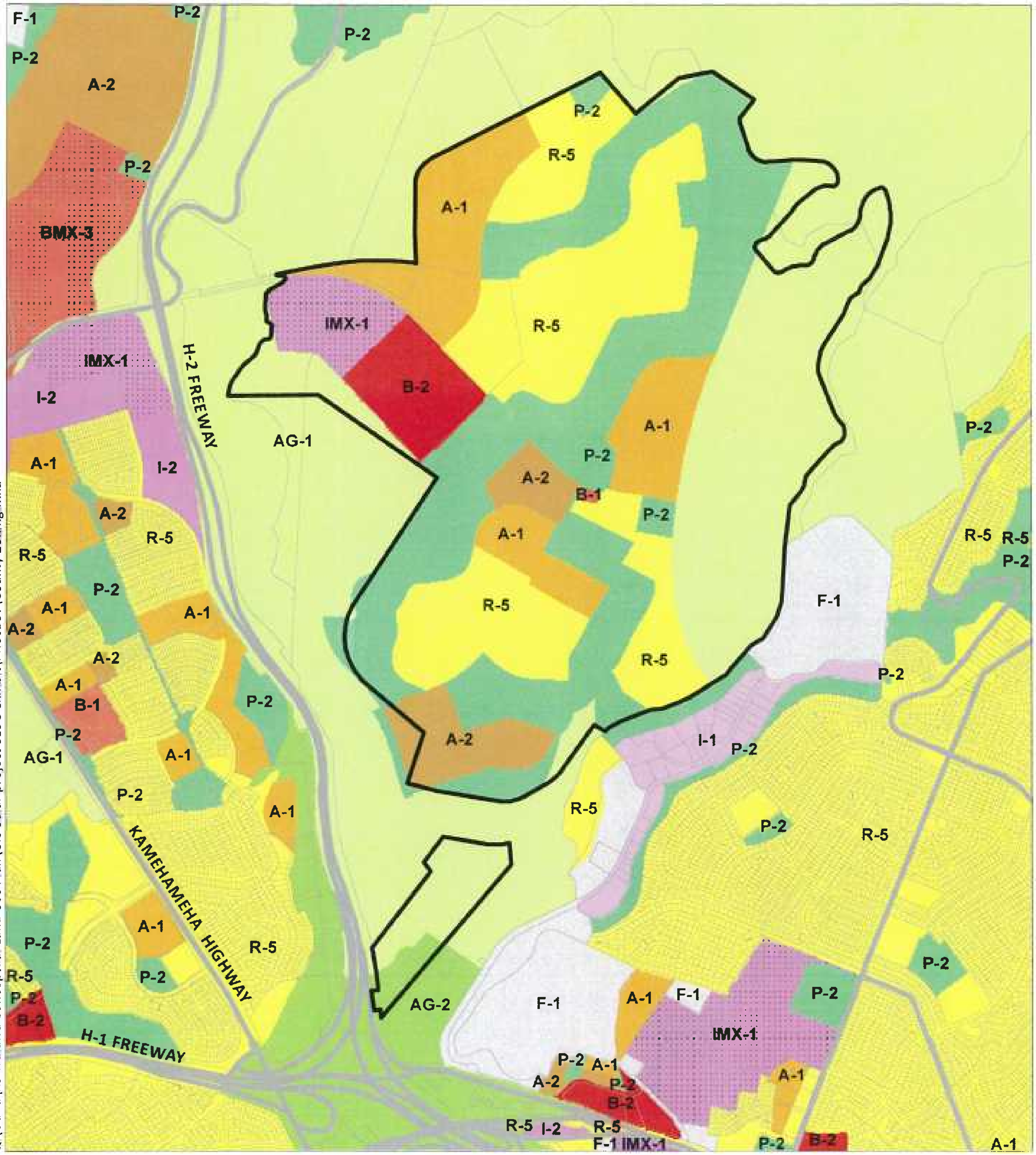
Agricultural District
Rural District
Conservation District
Urban District

Source: SunEdison (2014), State Land Use Commission (2019)

Disclaimer: This Graphic has been prepared for general planning purposes only and should not be used for boundary interpretations or other spatial analysis.

KS Exhibit 2

Q:\Oahu\KS Waiawa Conceptual Land Use Plan\GIS Solar project SLUC exhibit\PROJECT\County Zoning.mxd



DATE: 3/20/2019

LEGEND

KS Waiawa Property (SLU Urban, Docket A87-610)

AG-1	R-5	B-1	F-1
AG-2	A-1	B-2	I-1
P-2	A-2	BMX-3	I-2
			IMX-1

Source: City and County of Honolulu (2019)

Disclaimer: This Graphic has been prepared for general planning purposes only and should not be used for boundary Interpretations or other spatial analysis.

KS Exhibit
County Zoning

KAMEHAMEHA SCHOOLS WAIAWA MOTION TO AMEND

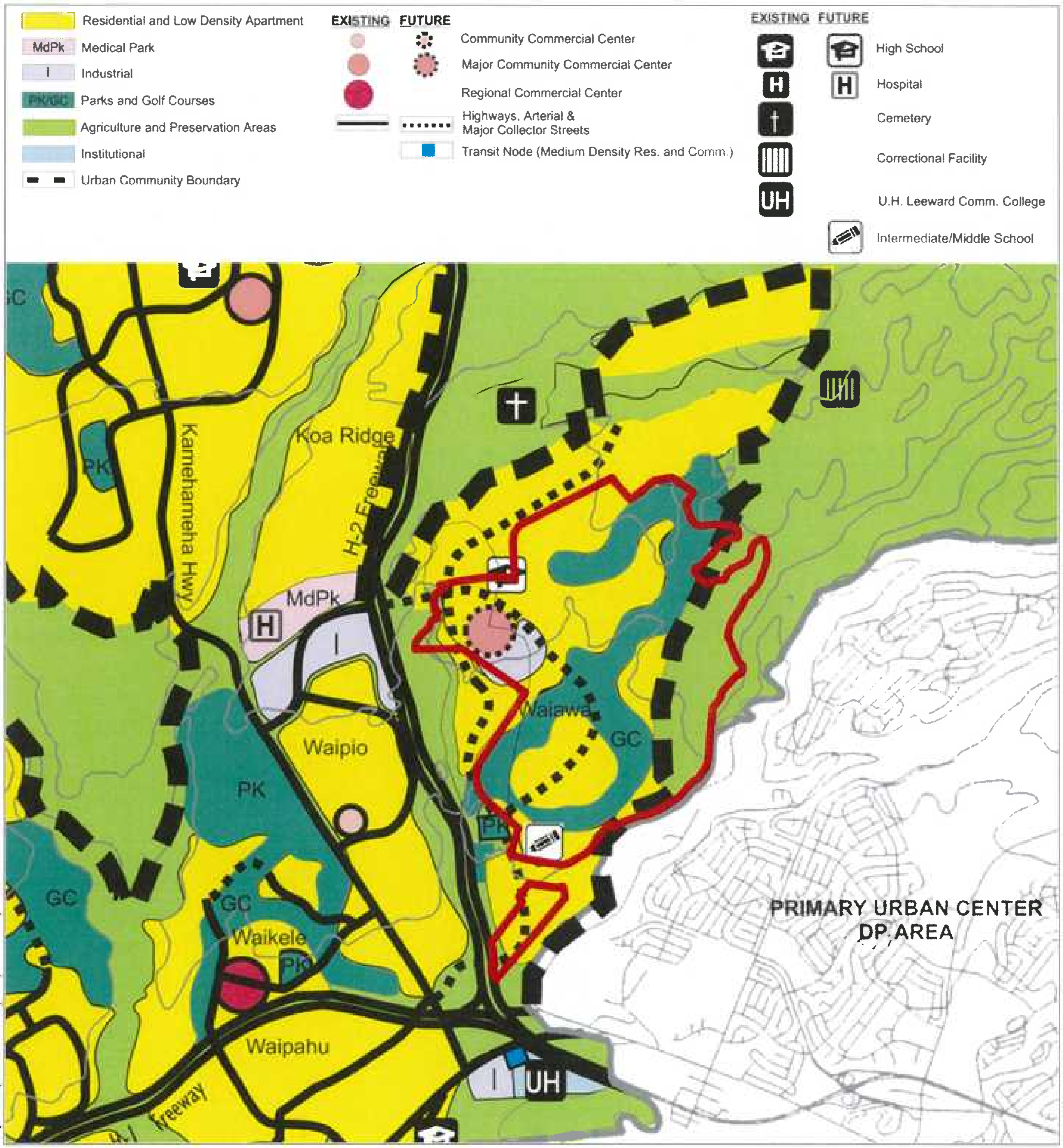
Island of O'ahu

North

Linear Scale (feet)
0 1,000 2,000

PBR HAWAII

KS Exhibit 3



Q:\Oahu\KS WAIAWA\GIS\PROJECT\SusCommPlan.mxd

DATE: 5/13/2014

LEGEND

KS Waiawa Property (SLU Urban, Docket A87-610)

KS Exhibit
Central Oahu
Sustainable Communities Plan

KAMEHAMEHA SCHOOLS WAIAWA
MOTION TO AMEND

Island of O'ahu

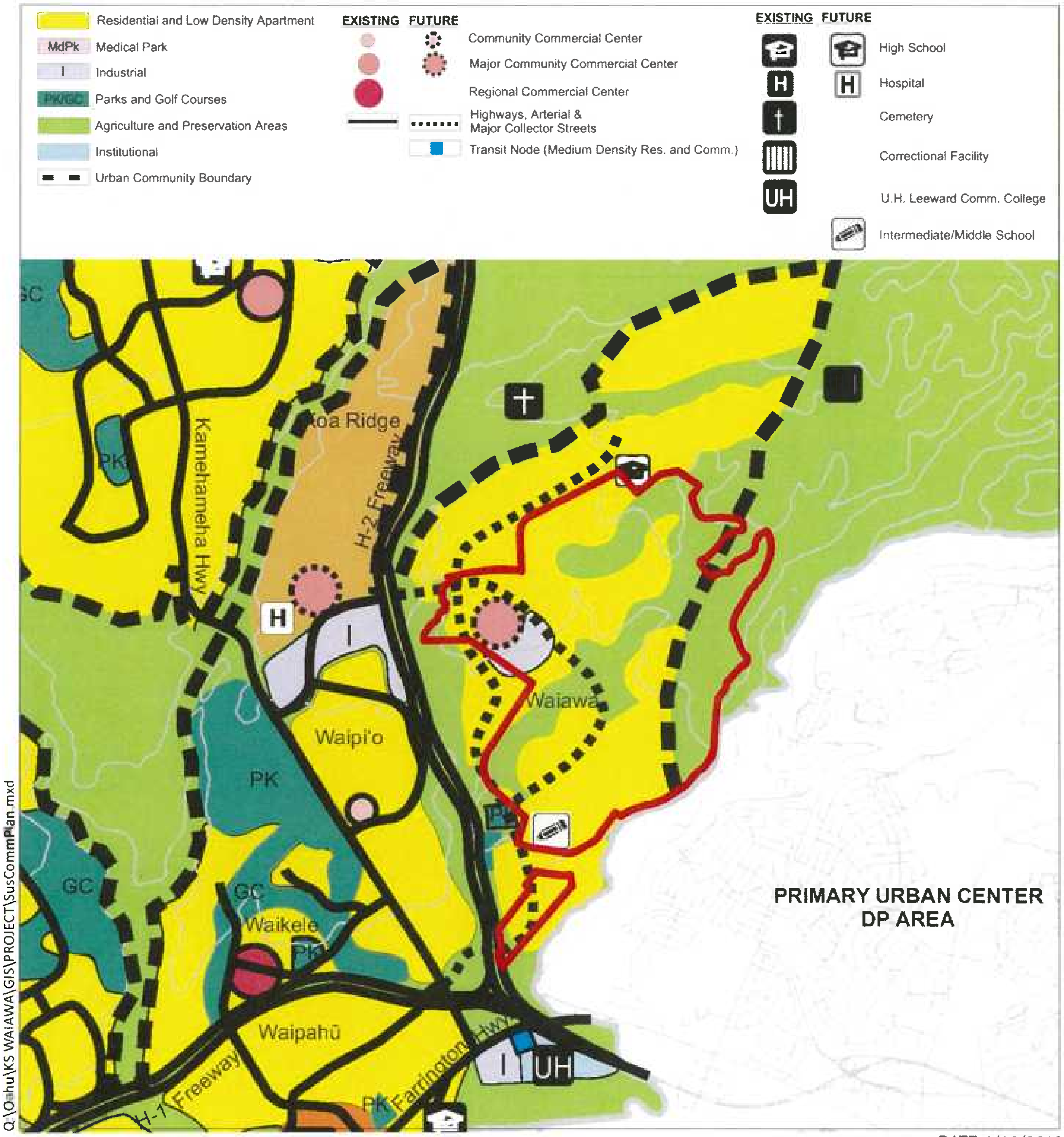
North

(Not to Scale)

PBR HAWAII

Source: City and County of Honolulu (2002)
Disclaimer: This Graphic has been prepared for general planning purposes only and should not be used for boundary interpretations or other spatial analysis.

KS Exhibit 4



DATE: 4/10/2019

LEGEND

KS Waiawa Property (SLU Urban, Docket A87-610)

KS Exhibit
Central Oahu Sustainable Communities Plan

KAMEHAMEHA SCHOOLS WAIAWA MOTION TO AMEND

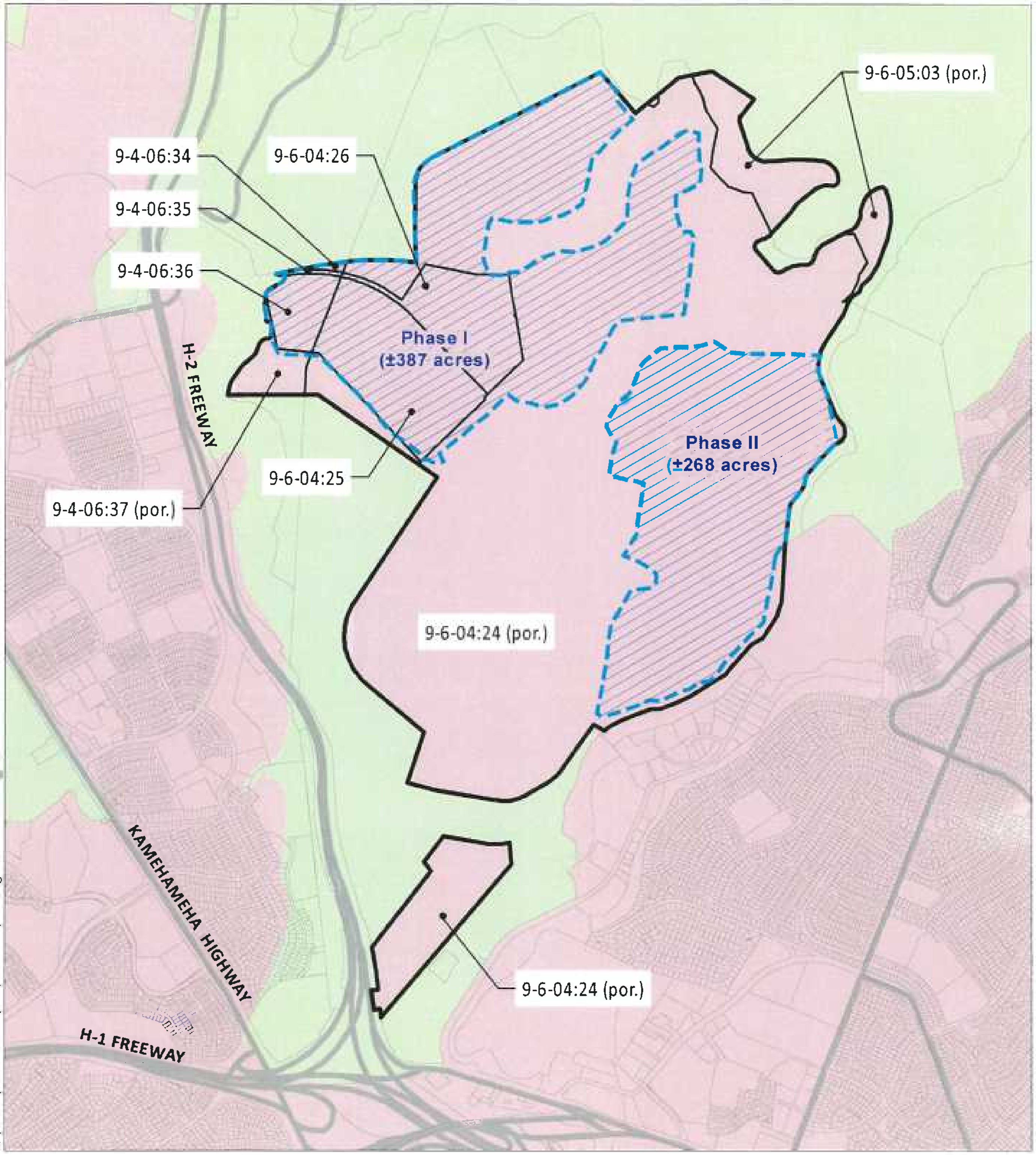
Island of O'ahu

North

(Not to Scale)

Source: City and County of Honolulu (2016)
Disclaimer: This Graphic has been prepared for general planning purposes only and should not be used for boundary interpretations or other spatial analysis.

KS Exhibit 5



Q:\Oahu\KS WAIAWA\GIS\PROJECT\Phasing Plan TMK 2014_06.mxd

DATE: 6/13/2014

LEGEND

KS Waiawa Property (SLU Urban, Docket A87-610)

Photovoltaic Locations

Agricultural District

Conservation District

Rural District

Urban District

Source: SunEdison (2014), State Land Use Commission (2014)

Disclaimer: This Graphic has been prepared for general planning purposes only and should not be used for boundary interpretations or other spatial analysis.

KS Exhibit
Phasing Plan

KAMEHAMEHA SCHOOLS WAIAWA MOTION TO AMEND

Island of O'ahu

North

Linear Scale (feet)
0 1,000 2,000

PBR HAWAII

KS Exhibit 6

KAMEHAMEHA SCHOOLS®

LAND USE COMMISSION STATE OF HAWAII

2019 JUN -3 A 10:49

May 29, 2019

Daniel E. Orodenker, Executive Officer
Land Use Commission
235 South Beretania Street, Suite 406
Honolulu, Hawaii 96813

Subject: **Docket No. A87-610, Trustees of the Estate of Bernice Pauahi Bishop dba Kamehameha Schools, Successor Petitioner to Tom Gentry and Gentry-Pacific, Ltd.**

Dear Mr. Orodenker:

On behalf of Successor Petitioner, Trustees of the Estate of Bernice Pauahi Bishop, dba Kamehameha Schools ("KS"), we hereby submit this 2019 Annual Report to the State of Hawaii Land Use Commission.

By Findings of Fact, Conclusions of Law and Decision and Order filed May 17, 1988, the State of Hawai'i Land Use Commission ("Commission") reclassified approximately 1,395 acres of land situate at Waiawa, Ewa, Oahu (the "KS Property"), from the State Land Use Agricultural District to the State Land Use Urban District, subject to 10 conditions of approval. By Order dated November 30, 1990, the Commission amended Condition No. 6, and reaffirmed all other conditions to the 1988 Decision and Order.[1] Then, on November 26, 2014, the Commission issued its Order Granting Motion for Order Amending Findings of Fact, Conclusions of Law and Decision and Order Dated May 17, 1988, subject to 16 conditions of approval (the "2014 Order").

KS sought the Commission's approval under the 2014 Order so that it could have time to reevaluate the development proposal that had originally been presented to the Commission, while at the same time, for an interim period, pursue a means of obtaining some financial return on the KS Property, in a manner consistent with KS' five values of: (1) culture; (2) environment; (3) education; (4) economics; and (5) community.

To that end, KS sought Commission approval to utilize a portion of the KS Property (approximately 655 acres) for the development of a two-phase utility scale solar farm. Phase 1 of the solar farm project was planned to be within approximately 387-acres and could generate up to 50 MW of power. Phase 2 of the solar farm was planned to be within approximately 268-acres of the KS Property,

[1] After the Commission approved the Urban District reclassification in 1988, rezoning approvals were sought from the Honolulu City Council. In 1998 the City Council passed Ordinance 98-55, amending a portion of the Development Plan Land Use Map to support the Waiawa project. Next, the City Council approved the rezoning of approximately 1,049 acres within the KS Property. Ordinance Nos. 98-01, effective January 15, 1998 (as amended by Ordinance 98-69, effective December 17, 1998) rezoned 874 acres within the KS Property from Restricted Agriculture (AG-1) to Neighborhood Business District (B1), Community Business District (B2), Low Density Apartment District (A1), Industrial-Commercial Mixed Use District (IMX1), Residential (RS) and General Preservation (P-2). Ordinance No. 03-01, effective February 12, 2003, rezoned 175.43 acres within the KS Property from AG-1 to R-5, A-1, Medium Density Apartment District (A-2) and P-2. Copies of these zoning ordinances were previously transmitted for your files.

KS Exhibit 7

and could generate up to 65 MW of power. The development of a renewable energy project was determined by KS to be consistent with the values, vision, mission, guiding principles and strategic goals set forth in the KS Strategic Plan 2000 - 2015, and the 2009 KS Strategic Agricultural Plan.

As reported in our 2016 Annual Report, SunEdison, the intended solar developer for the initial solar project (along with several other proposed solar farm developers), faced difficulty obtaining the necessary approvals from the Hawaii Public Utilities Commission for its power purchase agreement with Hawaiian Electric Company, Inc. ("HECo"). Shortly thereafter, SunEdision went bankrupt. Accordingly, KS cancelled its agreements with SunEdison, but KS has remained on the lookout for new renewable energy opportunities that would be compatible with the future development of the KS Property.

As reported in our 2017 Annual report, HECo issued a request for information for large landowners with an interest in allowing their properties to be used for energy development projects. KS responded to that request, identifying the KS Property as a potential site for solar development. Early in 2018, HECo released a request for proposals for renewable energy projects. In September 2018, HECo announced that Waiawa Solar Power LLC was one of the RFP awardees. Subject to obtaining all necessary approvals, including Commission approval, the Waiawa Solar Power LLC solar farm (36 megawatt/144 megawatt-hour battery energy storage system solar farm) is proposed for development within the KS Property. The Public Utilities Commission approved the power purchase agreement between HECo and Waiawa Solar Power LLC in March 2019. In the near future, KS intends to file the appropriate motion with the Commission to obtain authorization for the Waiawa Solar Power LLC solar farm.

A matrix of all of the Commission's conditions of approval in this Docket, and the status of those conditions, is enclosed. Please feel free to contact me at 534-8033 if you have any questions regarding this report.

Very truly yours,

Paul Kay
KAMEHAMEHA SCHOOLS
Development Director, Commercial Real Estate

Enclosure

cc:

Mary Alice Evans, Director, Office of Planning
Kathy Sokugawa, Acting Director, Honolulu Department of Planning
Mike McCartney, Director of Business, Economic Development and Tourism (DBEDT)

State Land Use Commission Docket No.: A87-610
2019 Report re Compliance with Conditions of Approval

Conditions Nos. 1 - 10 of the 1988 Order, as amended by the 1990 Order as to Condition No. 6, and Conditions Nos. 1 - 16 of the 2014 Order.

No.	Condition	Status	Comments
1. (1988)	A study funded by the U.S. Department of the Navy to review the potential for groundwater contamination resulting from the urbanization of the Property shall be completed prior to any site development and construction unless the Department of Health after consultation with the United States Navy and after review of the proposed study scope makes a determination that development and construction within a specified area will not cause groundwater contamination to wells in the area. Petitioner shall not proceed with the project until the study shows to the satisfaction of the Department of Health that groundwater contamination will not occur as a result of the proposed project, or until the Department of Health makes a determination that development or partial development may be allowed.	Satisfied	Condition 1 has been satisfied. In compliance with Condition 1, the DOH prepared a study ("Report to the Office of State Planning by the Department of Health Safe Drinking Water Branch on the Delineation of the Hydrologic Zone of Contribution for the U.S. Navy Waiawa Shaft" (Revised Dec. 1990)) ("ZOC Study"). The ZOC Study was undertaken to identify the zone of contribution of the Waiawa Shaft. The Navy concurred with the methodology of the ZOC Study and the location of the zone of contribution, and the DOH sent a copy of the ZOC Study to the State Office of Planning on January 2, 1991.
2. (1988)	Any urban development within the Property shall be subject to further review and subsequent approval by the Department of Health. The Department of Health may require appropriate mitigated measures and conditions relating to the proposed development's impact on the groundwater resources in the area.	On-going	Successor Petitioner acknowledges this condition and continues to comply. In 2018, KS consulted with the State of Hawaiʻi Department of Health ("DOH") about KS's master plan development, including development within the Petition Area. DOH approved KS' proposed urban development, subject to several standard conditions related to the various divisions within DOH.
9. (1988)	Petitioner shall provide public access to the Conservation District land mauka of the Property.	Satisfied	There are no Conservation District lands adjacent to the KS Property. Furthermore, as determined by the State Department of Land and Natural Resources by letter dated June 21, 2000, the only feasible means of accessing any Conservation District lands is via the Waiawa Correctional Facility, and there are no public hiking trails or hunting areas that required public access over the KS Property.

2. (2014)	Access to the Waiawa Correctional Facility. Petitioner shall cause the solar farm operator to ensure that the construction and installation of the solar farm within the KS Property shall not prevent roadway access to the Waiawa Correctional Facility.	On-going	Successor Petitioner shall comply with this condition.
3. (1988)	For the first 1,000 dwelling units which may be constructed on the Property, Petitioner shall provide housing opportunities for low, low-moderate, and moderate income Hawaii residents by offering for sale at least thirty percent (30%) of the units at prices which families with an income range of 80 to 120 percent of Oahu's median income can afford and thirty percent (30%) of the units which families with an income range of 120 to 140 percent of Oahu's median income can afford. This condition may be fulfilled through projects, under such terms as may be mutually agreeable, between Petitioner and the Housing Finance and Development Corporation of the State, or other appropriate governmental agency. This condition may also be fulfilled, with the approval of the Housing Finance and Development Corporation, through the construction of rental units to be made available at rents which families in the specified income ranges can afford.	On-going	Successor Petitioner shall comply with this condition.
4. (1988)	For the balance of the Property, the affordable housing requirements shall be satisfied in a manner that meets with the approval of the City and County of Honolulu and the State Housing Finance and Development Corporation. Said requirements shall take into consideration affordable on-site or off-site housing units or cash payments that satisfy the then current housing needs, or other necessary or desirable community facilities as determined above.	On-going	Successor Petitioner shall comply with this condition.
7. (1988)	Petitioner shall participate in an air quality monitoring program as specified by the State Department of Health.	On-going	Successor Petitioner shall comply with this condition.

5. (1988)	Petitioner shall fund and construct the necessary improvements as determined by the State Department of Transportation which would mitigate impacts from the subject project. These improvements shall be implemented on a schedule acceptable to and approved by the Department of Transportation.	Partially satisfied	As stated in the July 1, 2013 annual report to the Commission, substantial steps have been taken toward satisfaction of this condition. As reported to the Commission, lands valued in excess of $637,000 were dedicated for the construction of Waipio Interchange. Prior to 2012, $1.4 million dollars were paid by the developer to the State of Hawaii for improvements to Ka Uka Boulevard and for the construction of HOV lanes between the Waiawa and Waipio Interchanges of the H-2 Freeway.
6. (1990)	Petitioner shall appoint and fund a transportation manager whose function is the formulation, use, and continuation of alternative transportation opportunities that would maximize the use of existing and proposed transportation systems. This will include construction and operation of a park and ride facility or other activities to encourage transit use or ridesharing. These activities and facilities shall be implemented on a schedule acceptable to and approved by the State Department of Transportation. In the alternative, Petitioner may participate in a regional program for the transportation management with other developers and/or land owners. This program shall address the formulation, use and continuation of alternative transportation opportunities that would optimize the use of existing and proposed transportation systems.	Satisfied and on-going	As reported in the 2013 annual report, KS has been an active participant in the Leeward Oahu Transportation Management Association, which is a regional program that seeks to promote alternative transportation opportunities and to optimize the capacity and use of existing and proposed transportation systems. Over the past few years, LOTMA has been somewhat dormant. However, KS continues to be a willing participant with LOTMA or any other suitable programs for regional transportation management. In addition, KS has retained a consultant to explore transportation management solutions with an eye toward KS' planned revised master plan for the Petition Area.
5. (2014)	Traffic Impacts. a. Phase 1. Prior to the start of construction of Phase 1 of the solar project, Petitioner shall cause the solar farm operator to address any comments that may be made by the DOT regarding the August 1, 2014, "Construction Traffic Assessment for the Proposed Waiawa Solar Farm" that was prepared for the solar farm project, and to implement the mitigations recommended in the Fehr & Peers Traffic Assessment. b. Phase 2. Petitioner shall cause the solar farm operator to prepare and submit to the DOT for review and to obtain acceptance of a Traffic Assessment for Phase 2 of the solar project prior to the start of construction of Phase 2.	On-going	This condition will be satisfied prior to development of the applicable Phase of the solar farm.

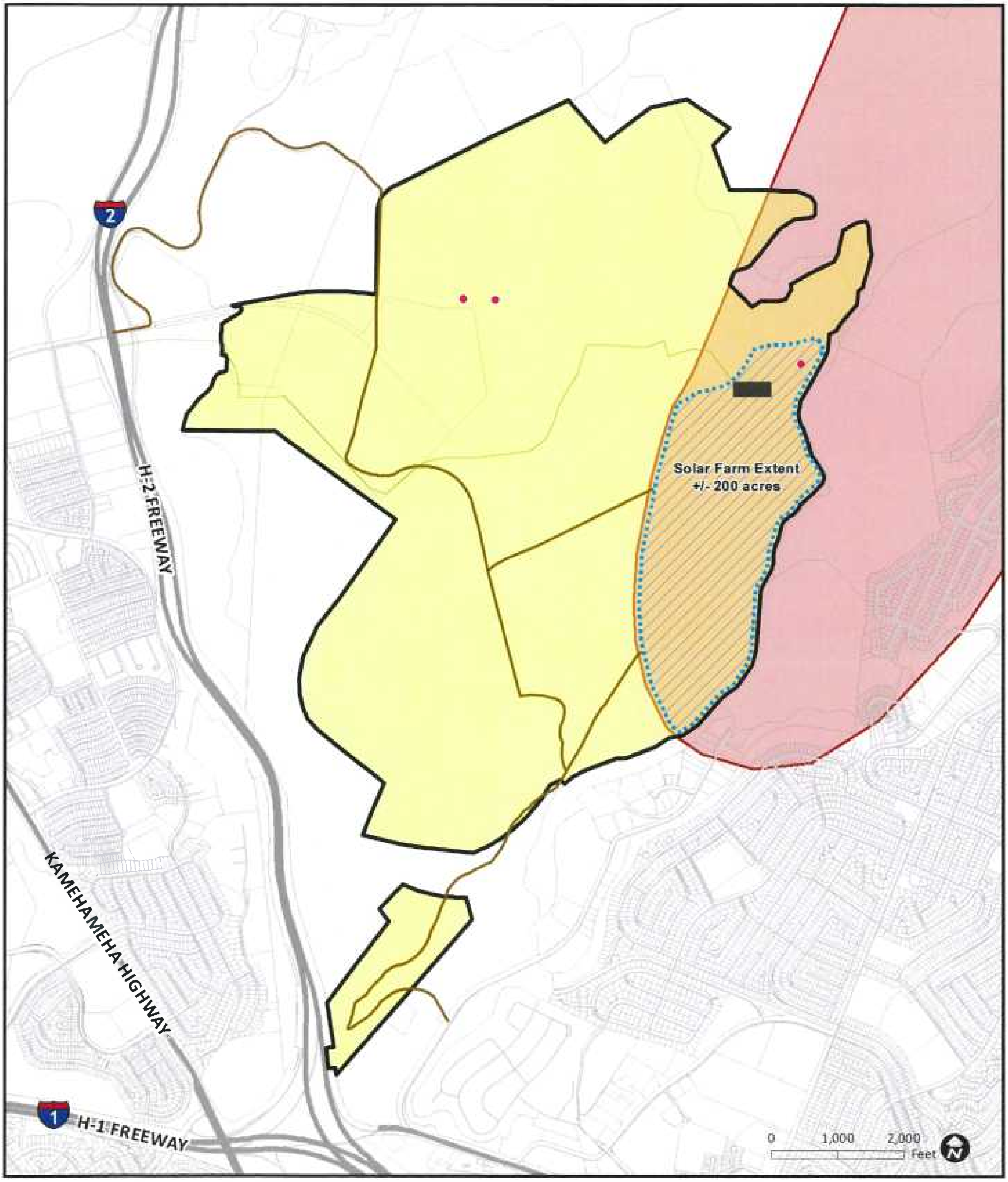
4. (2014)	Aircraft Hazard. If glint or glare from the photovoltaic array creates a hazardous condition for pilots, Petitioner shall cause the solar farm facility operator to be prepared to immediately mitigate the hazard upon notification by the DOT, Airports Division, or the FAA.	On-going	Successor Petitioner shall comply with this condition.
1. (2014)	Revised Master Plan. Petitioner shall submit to the Commission a revised master plan and schedule for development for the approximately 1,395-acre KS Property within five (5) years from the date of the Commission's issuance of an order approving the Motion to Amend.	On-going	Successor Petitioner shall comply with this condition. A revised master plan and schedule for development of the Petition Area will be submitted to the LUC by November 26, 2019.
6. (2014)	Development Schedule. Phase 1 of the solar farm shall be substantially completed within five (5) years from the date of the Commission's issuance of an order approving the Motion to Amend. Phase 2 of the solar farm shall be substantially completed within ten (10) years from the date of the Commission's issuance of an order approving the Motion to Amend.	On-going	The difficulties faced by the original solar farm developer have been reported to the Commission in prior Annual Reports. Notwithstanding those difficulties, KS has remained on the lookout for new renewable energy opportunities that would be compatible with the future development of the KS Property. The timing of any new solar farm development is not anticipated to be entirely consistent with Condition No. 6. It is anticipated that KS will be seeking Commission approval to allow for a solar farm to be developed in approximately the area previously identified for Phase 2. The solar farm currently under consideration is expected to be "substantially completed" by November 26, 2024, as required by this Condition. However, the duration of that solar farm will exceed the 35 years approved under Condition 8. KS will be seeking appropriate authorizations from the Commission prior to allowing any solar farm inconsistent with what was approved under the 2014 Order to be developed within the KS Property.
7. (2014)	Interim Use of the Petition Area. The interim use of the Petition Area shall be limited to a utility-scale solar energy development, or solar farm. No other use shall be permitted without the prior written approval of the Commission.	On-going	Successor Petitioner shall comply with this condition.
8. (2014)	Timeframe of Interim Use. The interim use of the Petition Area for the proposed solar farm, including any and all	On-going	Taking into account permitting, construction, operations, and decommissioning, the solar farm currently under consideration by KS

	permitting, construction, operation, and decommissioning activities associated with the solar farm, shall not exceed a period of 35 years from the date of this Decision and Order without the prior written approval of the Commission.		could be in place through 2058, subject to Commission approval.
8. (1988)	Petitioner shall immediately stop work and contact the State Historic Preservation Office should any archaeological resources such as artifacts, shell, bone, or charcoal deposits, human burial, rock or coral alignments, pavings or walls be encountered during the project's development.	On-going	Successor Petitioner will comply with this condition.
3. (2014)	Previously Unidentified Burials and Archaeological/Historic Sites. A supplemental AIS for the entire 1,395-acre Petition Area shall be prepared by a qualified archaeologist to determine potential impacts and to ensure that appropriate mitigation is implemented as needed. The supplemental AIS shall be submitted to the SHPD and accepted prior to the start of construction. In the event that historic resources, including human skeletal remains, are identified during construction activities, all work shall cease in the immediate vicinity of the find, the find shall be protected from additional disturbance, and the SHPD, O'ahu Island Section, shall be contacted immediately. Without any limitation to any other condition found herein, if any burials or archaeological or historic sites, such as artifacts, marine shell concentrations, charcoal deposits, stone platforms, paving, and walls not previously identified in studies referred to herein, are discovered during the course of construction of the solar farm project, all construction activity in the vicinity of the discovery shall stop until the issuance of an archaeological clearance from the SHPD that mitigative measures have been implemented to its satisfaction.	Satisfied and On-going	An Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Lands, Waiawa and Waipi'o Ahupua'a, 'Ewa District, Island of O'ahu was prepared by TCP Hawai'i LLC, and accepted by SHPD by letter dated April 24, 2015. SHPD approved the Archaeological Site Preservation Plan for State Site No. 50-80-09-2273 by letter dated September 14, 2015. Successor Petitioner will comply with this condition.

9. (2014)	Metes and Bounds of Map and Description. The proposed solar farm shall be limited to the acreage and boundaries identified in Petitioner's Phasing Plan shown in Petitioner's Exhibit 8 Errata (filed 6/20/14). Petitioner shall provide a metes and bounds map and description of both phases to the Commission within one year from the date of this Decision and Order.	Satisfied	A map and metes and bounds of the proposed solar farm areas were submitted to the Commission by letter dated October 2, 2015.
10 (2014)	Decommissioning of the Solar Farm. The solar farm shall be decommissioned following its operational timeframe. The decommissioning activities shall include, but not be limited to, the complete removal of the foundational piers and modules and all associated components. All metal components shall be recycled to the extent possible and no solar farm components shall be disposed of in any landfill in the State of Hawai'i. Any future use of the Petition Area following the decommissioning of the solar farm shall be subject to the environmental review process promulgated under HRS chapter 343, as applicable, and shall require the filing of a motion to amend the Decision and Order with the Commission. Such motion to amend shall include a revised master development plan of the proposed use and shall further include, but not be limited to, a revised Traffic Impact Analysis Report, Engineering Report, Socio-Economic Analysis Report, Environmental Report, and AIS.	On-going	Successor Petitioner shall comply with this condition.
11. (2014)	Compliance with Representations. Petitioner shall cause the solar farm operator to develop and operate Phase 1 and Phase 2 of the solar farm, including the implementation of measures to mitigate potential impacts of the development, in substantial compliance with the representations made to the Commission as reflected in this Decision and Order. Such mitigation measures include, but are not limited to, the use of temporary and permanent BMPs to ensure that the development and operation of the solar farm do not result in	On-going	Should the solar farm project get developed, its development will be in substantial compliance with the representations that were made to the Commission.

	an increase in stormwater runoff that adversely impacts downstream properties. Failure to do so may result in reversion of the Petition Area to its former classification, or change to a more appropriate classification.		
12. (2014)	Notice of Change of Ownership. Petitioner shall give notice to the Commission of any intent to sell, lease, assign, place in trust, or otherwise voluntarily alter the ownership interests in the Petition Area, prior to development of the Petition Area.	On-going	Successor Petitioner acknowledges this condition. Successor Petitioner is in discussions with Waiawa Solar Power LLC regarding a potential agreement to grant an easement within a portion of the previously approved Phase 2 solar farm area. Prior to Waiawa Solar Power LLC taking occupancy of the easement area, KS intends to file the appropriate motion with the Commission to obtain authorization for the proposed Waiawa Solar Power LLC solar farm.
10. (1988)	Petitioner shall provide annual reports to the Land Use Commission, the Department of Business and Economic Development and the City and County of Honolulu Department of General Planning in connection with the status of the project and Petitioner's progress in complying with the conditions imposed.	On-going	Successor Petitioner acknowledges these conditions, and submits this 2018 LUC Annual Report in compliance with Condition No. 10 (1988) and Condition No. 13 (2014). Successor Petitioner shall provide copies of this 2019 Annual Report to the State Office of Planning, the Department of Planning and Permitting of the City & County of Honolulu, and the Department of Business and Economic Development.
13. (2014)	Annual Reports. Petitioner shall timely provide without any prior notice, annual reports to the Commission, OP, and the DPP in connection with the status of the subject project and Petitioner's progress in complying with the conditions imposed herein. The annual report shall be submitted in a form prescribed by the Executive Officer of the Commission.		
14. (2014)	Release of Conditions. The Commission may fully or partially release the conditions provided herein as to all or any portion of the Petition Area upon timely motion and upon the provision of adequate assurance of satisfaction of these conditions by Petitioner.	On-going	Successor Petitioner acknowledges this condition.
15. (2014)	Notice of Imposition of Conditions. Within seven (7) days of the issuance of the Commission's Decision and Order granting the Motion to Amend, Petitioner shall: (a) record	Satisfied	The Notice of Imposition of Conditions by the Land Use Commission was recorded at the Bureau of Conveyances on December 9, 2014, as Document No. A-54560727.

	with the Bureau of Conveyances of the State of Hawai'i a statement that the Petition Area is subject to conditions imposed herein by the Commission in the granting of the Motion to Amend; and (b) shall file a copy of such recorded statement with the Commission.		
16. (2014)	Recordation of Conditions. Petitioner shall record the conditions imposed herein by the Commission with the Bureau of Conveyances pursuant to HAR section 15-15-92	Satisfied	A Declaration of Conditions was recorded at the Bureau against the Petition Area as Document No. A-54991338 on January 21, 2015. A certified copy of said Declaration filed with the Commission on January 22, 2015, by Jennifer A. Lim, attorney for Successor Petitioner.



WAIAWA SOLAR POWER, LLC CONCEPTUAL SITE PLAN

July 19, 2019

Legend

- Solar Farm Extent, ~200 acres
- Utility Improvements Area (~ 2.5 acres)
- KS Waiawa Property (SLUD- Urban, Docket A87-610)
- Hydrologic Zone of Contribution (ZoC)
- Archaelogical Preservation Area
- Gen-Tie Alignment
- Access Route

G70

Disclaimer: This Graphic has been prepared for general planning purposes only and should not be used for boundary interpretations or other spatial analysis.

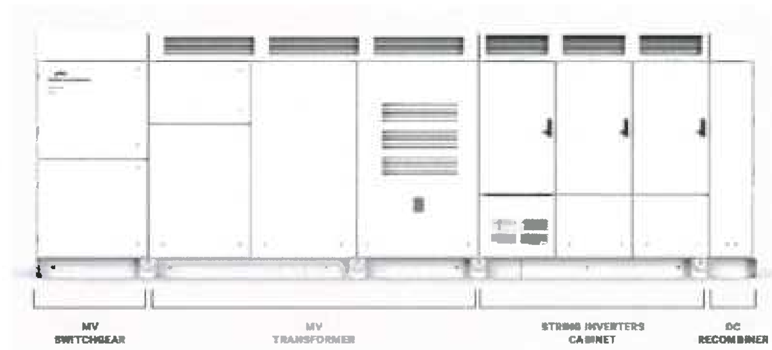
KS Exhibit 8

Clearway

Major Battery System Components

Battery Inverter

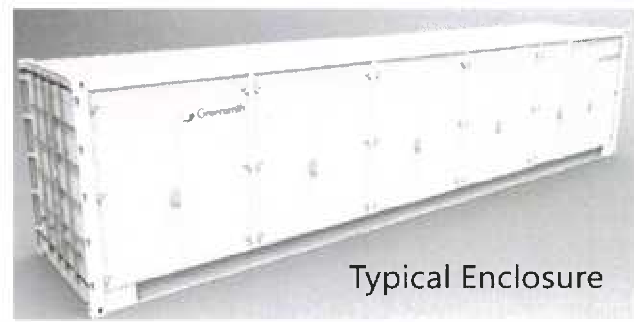
- Converts battery Direct Current to Alternating Current
- Includes dry-type transformer (no oil)
- No liquids or chemicals



Battery Cells, Modules and Enclosure

- Lithium ion cell technology
- Enclosure tested to IP56 / NEMA-3R
- Integrated fire suppression and controls

Typical Battery Module



Typical Enclosure

Safety systems

- Configurable safety systems based on fire response strategy and environmental factors
- Waterless Novec 1230 fire suppression system (evaporating fluid)
  - Sustainable clean agent (not an HFC)
- Alternative fire suppression approaches can be implemented (e.g. inert gas)

KS Exhibit 9

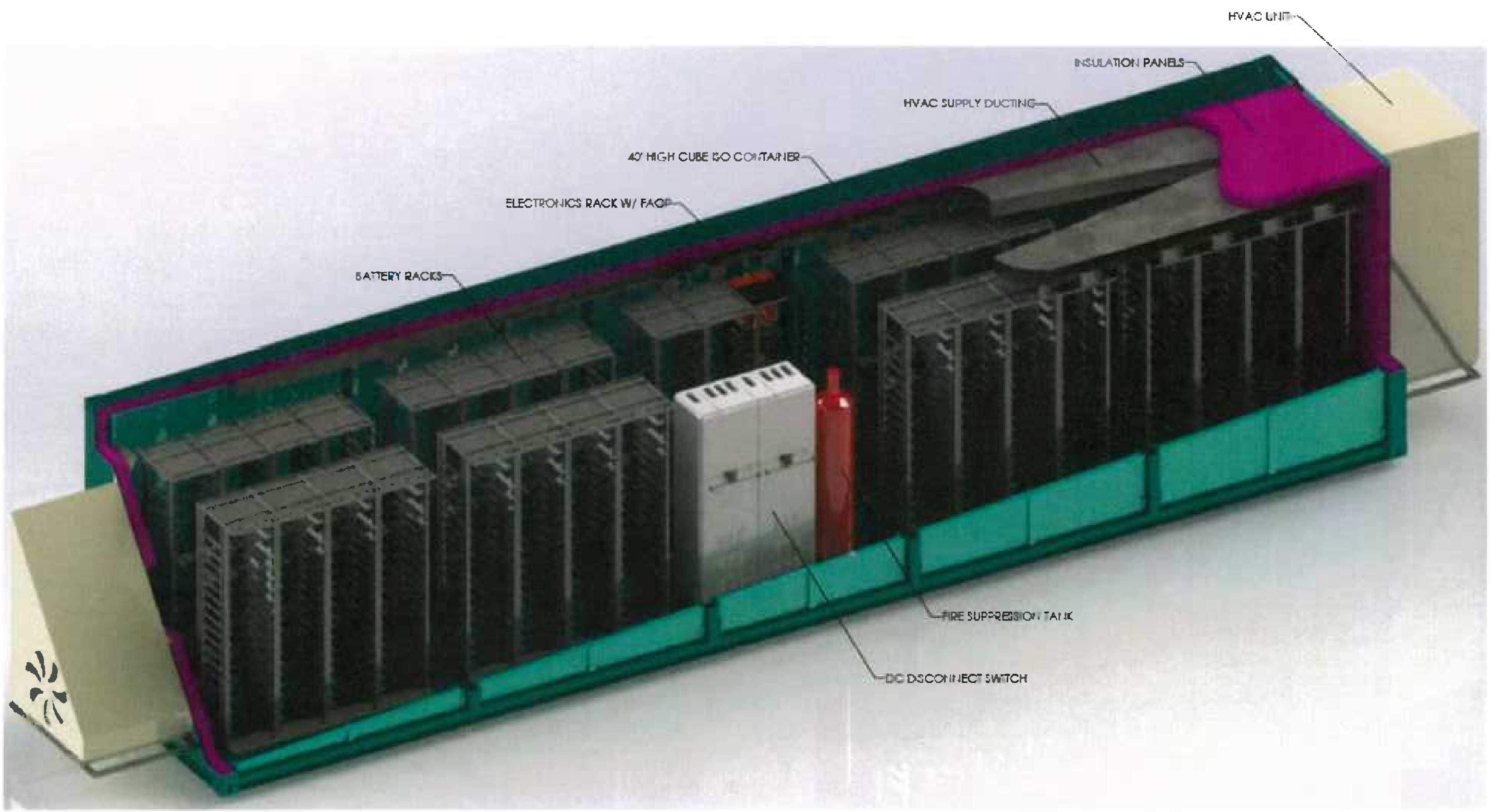
Clearway

Example of Battery Storage System

TEP Iron Horse Project (Battery integrator: Greensmith with EON)

Clearway

Typical Energy Storage Enclosure Detail



SAMSUNG SDI
150-20, GONGSE-RO GIHEUNG-GU, YONGIN-SI, GYEONGGI-DO, S. KOREA (446-577)
E mail : dohyun.joo@samsung.com
http://www.samsungsdi.com

SAMSUNG SDI

TECHNICAL DOCUMENT

No. of Document	**SSES-M24-TD-XXXXX**
Revision	**A**
Theme/Topic	**Cell SDS**
Product Description	**BATTERY ENERGY STRORAGE SYSTEM**

SAMSUNG SDI

KS Exhibit 10

SAMSUNG SDI
150-20, GONGSE-RO GIHEUNG-GU, YONGIN-SI, GYEONGGI-DO, S. KOREA (446-577)
E mail : dohyun.joo@samsung.com
http://www.samsungsdi.com

SAMSUNG SDI

Cell SDS

1. Product and Company Identification USA, EU

Important Note: As a solid, manufactured article, exposure to hazardous ingredients is not expected with normal use. This battery is an article pursuant to 29 CFR 1910.1200 and, as such, is not subject to the OSHA Hazard Communication Standard requirement. The information contained in this Material Safety Data Sheet contains valuable information critical to the safe handling and proper use of the product. This SDS should be retained and available for employees and other users of this product.

Commercial product name
MODEL CM0940R0003A (94Ah capacity)

Use of the substance/preparation
Lithium-Ion battery

Company/undertaking identification

Manufacturer
SAMSUNG SDI Co. LTD
428-5 Gongse-dong, Giheung-gu, Yongin-si,
Gyeonggi-do, 446-577 Korea

Telephone: ++82 31 210 8535
Telefax: ++82 31 210 8289

Contact person: Euiryong Bang

Telephone:

Responsible Department: Development Team

Responsible for the safety data sheet: er.bang@samsung.com

Further Information
Battery-System: Lithium-Ion (Li-ion)
Voltage: 3.68V
Anode (negative electrode): based on intercalation graphite
Cathode (positive electrode): based on lithiated metal oxide (Cobalt, Nickel, Manganese)

Remark:

The information and recommendations set forth are made in good faith and believed to be accurate as of the date of preparation. SAMSUNG SDI Co., Ltd. makes no warranty, expressed or implied, with respect to this information and disclaims all liabilities from reliance on it.

2. Hazards Identification USA

Route(s) of Entry
There is no hazard when the measures for handling and storage are followed.

Signs and Symptoms of Exposure
In case of cell damage, possible release of dangerous substances and a flammable gas mixture.

OSHA Hazard Communication: This material is not considered hazardous by the OSHA Hazard Communication Standard 29CFR 1910.1200.

Carcinogenicity (NTP):	Not listed
Carcinogenicity (IARC):	Not listed
Carcinogenicity (OSHA):	Not listed

Special hazards for human health and environment
There is no hazard when the measures for handling and storage are followed.
In case of cell damage, possible release of dangerous substances and a flammable gas mixture.

2. Hazards Identification USA, EU

Explication of special hazards for human health and environment
Not classified as dangerous according to directive 1999/45/EEC
There is no hazard when the measures for handling and storage are followed.
In case of cell damage, possible release of dangerous substances and a flammable gas mixture.

3. Composition/information on ingredients USA, EU

Hazardous components

EC-No.	CAS-No.	Chemical name	Quantity	EU-Classification
215-154-6	1307-96-6	Cobalt oxide	< 30 %	Xn, N R22435053
215-202-6	1313-13-9	Manganese dioxide	< 30 %	Xn R20/22
215-215-7	1313-99-1	Nickel oxide	< 30 %	Carc. Cat. 1, T R49-43-48/23--53
231-153-3	7440-44-0	Carbon	10 - 30 %	
		Electrolyte (*)	10 - 20 %	Carc. Cat. 3, C, R10-34-40-43
	24937-79-9	Polyvinylidene fluoride (PVdF)	< 10 %	
231-072-3	7429-90-5	Aluminium foil	2 - 10 %	
231-159-6	7440-50-8	Copper foil	2 - 10 %	
		Aluminium and inert materials	5 - 10 %	

Full text of each relevant R phrase can be found in heading 16.

Further Information

For information purposes:
(*) Main ingredients: Lithium hexafluorophosphate, organic carbonates

Because of the cell structure the dangerous ingredients will not be available if used properly.
During charge process a lithium graphite intercalation phase is formed.

Mercury content:	Hg < 0.1mg/kg
Cadmium content:	Cd < 1mg/kg
Lead content:	Pb: < 10mg/kg

4. First Aid Measures USA, EU

General information
The following first aid measures are required only in case of exposure to interior battery components after damage of the external battery casing.
Undamaged, closed cells do not represent a danger to the health.

After inhalation
Ensure of fresh air. Consult a physician.

After contact with skin
In case of contact with skin wash off immediately with plenty of water.
Consult a physician.

After contact with eyes
Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
Seek medical treatment by eye specialist.

After ingestion
Drink plenty of water.
Call a physician immediately.

5. Fire Fighting Measures USA, EU

Suitable extinguishing media
Cold water and dry powder in large amount are applicable.
Use metal fire extinction powder or dry sand if only few cells are involved.

Special hazards arising from the chemical
May form hydrofluoric acid if electrolyte comes into contact with water.
In case of fire, the formation of the following flue gases cannot be excluded:
Hydrogen fluoride (HF), Carbon monoxide and carbon dioxide.

Protective equipment and precautions for firefighters
Wear self-contained breathing apparatus and protective suit.
Additional information
If possible, remove cell(s) from fire fighting area. If heated above 125°C, cell(s) can explode/vent. Cell is not flammable but internal organic material will burn if the cell is incinerated.

6. Accidental Release Measures USA, EU

Personal precautions
Use personal protective clothing.
Avoid contact with skin, eyes and clothing.
Avoid breathing fume and gas.

Environmental precautions
Do not discharge into the drains/surface waters/groundwater.
Methods for cleaning up/taking up
Take up mechanically and send for disposal.

7. Handling and Storage USA, EU

Handling

Advice on safe handling
Avoid short circuiting the cell. Avoid mechanical damage of the cell. Do not open or disassemble.
Advice on protection against fire and explosion
Keep away from open flames, hot surfaces and sources of ignition.

Storage

Requirements for storage rooms and vessels
Storage at room temperature (approx. 20°C) at approx. 20-50% of the nominal capacity (OCV approx. 3.5-3.7 V).
Keep in closed original container.

8. Exposure Controls/Personal Protection Exposure limit values Exposure limits USA

8. Exposure controls/personal protection Exposure limit values Exposure limits (EH40) EU

CAS-No.	Chemical name	ml/m³	mg/m³	F/ml	Category	Origin
7440-44-0	Graphite, respirable	 -	4 -		TWA (8 h) STEL (15 min)	WEL WEL

Additional advice on limit values
During normal charging and discharging there is no release of product.

Occupational exposure controls
No specific precautions necessary.

Protective and hygiene measures
When using do not eat, drink or smoke. Wash hands before breaks and after work.

Respiratory protection
No specific precautions necessary.

Hand protection
No specific precautions necessary.

Eye protection
No specific precautions necessary.

Skin protection
No specific precautions necessary.

9. Physical and Chemical Properties USA, EU

Appearance

Form:	Solid
Color:	Various
Odor:	Odorless

Important health, safety and environmental information

Test method

pHValue:	n.a.
Flash point:	n.a
Lower explosion limits:	n.a.
Vapour pressure:	n.a.
Density:	n.a.
Water solubility:	Insoluble
Ignition temperature:	n.a.

10. Stability and Reactivity USA, EU

Stability
Stable

Conditions to avoid
Keep away from open flames, hot surfaces and sources of ignition. Do not puncture. crush or incinerate.

Materials to avoid
No materials to be especially mentioned.

Hazardous decomposition products
In case of open cells, there is the possibility of hydrofluoric acid and carbon monoxide release.

Possibility of Hazardous Reactions
Will not occur

Additional information
No decomposition if stored and applied as directed.

11. Toxicological Information USA, EU

Empirical data on effects on humans
If appropriately handled and if in accordance with the general hygienic rules, no damages to health have become known.

12. Ecological Information USA, EU

Further information

SAMSUNG SDI
150-20, GONGSE-RO GIHEUNG-GU, YONGIN-SI, GYEONGGI-DO, S. KOREA (446-577)
E mail : dohyun.joo@samsung.com
http://www.samsungsdi.com

Ecological injuries are not known or expected under normal use. Do not flush into surface water or sanitary sewer system.

13. Disposal Considerations USA, EU

Advice on disposal
For recycling consult manufacturer.

Contaminated packaging
Disposal in accordance with local regulations.

14. Transport Information USA, EU

US DOT 49 CFR 172.101

Proper shipping name
Lithium-ion batteries

ID Number:	UN3480
Hazard Class or Division:	9
Packing group:	II
Label:	9

Land transport (ADR/RID)

UN number:	3480
ADR/RID class:	9
Classification code:	M4
Warning plate	
Hazard label:	9

ADR/RID packing group:	II
Limited quantity:	LQ 0
Tunnel restriction code:	E
Description of the goods	Lithium-ion batteries

Other applicable information (land)
LQ 0: No exemption under the conditions of 3.4.2.
Transport category: 2

Marine transport

UN number:	3480
IMDG code:	9
Marine pollutant:	No
Hazard label:	9

IMDG packing group:	II

EmS:	F-A, S-I
Limited quantity:	None
Description of the goods	Lithium-ion batteries

Air transport

UN/ID number:	3480
ICAO/IATA-DGR:	9
Hazard label:	9

ICAO packing group:	II
Limited quantity Passenger:	-
IATA-packing instructions - Passenger:	965
IATA-max. quantity - Passenger:	5 kg G
IATA-packing instructions - Cargo:	965
IATA-max. quantity - Cargo:	35 kg G
Description of the goods	Lithium-ion batteries

Other applicable information

Lithium equivalent: 35.1g

Wh-rating per cell: 346 Wh

15. Regulatory Information USA

U.S. Regulations

National Inventory TSCA
SAMSUNG SDI certifies that all chemical components of the Model CM0940R0003A (94 Ah capacity) Lithium-Ion Battery are listed on the US EPA TSCA 8(b) Inventory or are exempt from listing.

SARA
To the best of our knowledge this product contains no toxic chemicals subject to the supplier notification requirements of Section 313 of the Superfund Amendments and Reauthorization Act (SARA/EPCRA) and the requirements of 40 CFR Part 372.

15. Regulatory information EU

Labeling
Hazardous components which must be listed on the label
As an article the product does not need to be labeled in accordance with EC directives or respective national laws.

EU regulatory information

1999/13/EC (VOC): 0 %

16. Other Information USA

Hazardous Materials Information Label (HMIS)
Health: 0
Flammability: 0
Physical Hazard: 0

NFPA Hazard Ratings
Health: 0
Flammability: 0
Reactivity: 0
Unique Hazard:

16. Other Information EU

Full text of R-phrases referred to under sections 2 and 3

R10	Flammable.
R20/22	Harmful by inhalation and if swallowed.
R22	Harmful if swallowed.
R34	Causes burns.
R40	Limited evidence of a carcinogenic effect.
R43	May cause sensitization by skin contact.
R48/23	Toxic: danger of serious damage to health by prolonged exposure through inhalation.
R49	May cause cancer by inhalation.
R50	Very toxic to aquatic organisms.
R53	May cause long-term adverse effects in the aquatic environment.

Further Information USA, EU

Data of sections 4 to 8, as well as 10 to 12, do not necessarily refer to the use and the regular handling of the product (in this sense consult package leaflet and expert information), but to release of major amounts in case of accidents and irregularities. The information describes exclusively the safety requirements for the product (s) and is based on the present level of our knowledge. This data does not constitute a guarantee for the characteristics of the product(s) as defined by the legal warranty regulations. "(n.a. = not applicable; n.d. = not determined)"

The data for the hazardous ingredients were taken respectively from the last version of the sub-contractor's safety data sheet.

3M

How 3M™ Novec™ 1230 Fire Protection Fluid is stored as a liquid and discharged as a gas.

3M™ Novec™ 1230 Fire Protection Fluid has been developed for use as a gaseous, total-flooding extinguishing agent. To understand the ability of Novec1230 fluid to transform from a liquid into a gas upon discharge, some important physical properties need to be understood. For illustration, let's compare **Novec 1230 fluid** to the best known liquid: water.

Intermolecular Forces (or Attraction between Molecules)

Water

Each molecule within the liquid water is strongly attracted to its nearest neighboring molecules, forming what's called a hydrogen bond. These strong attractive forces have a profound effect on the physical properties of water.

Novec 1230 Fluid

Novec 1230 fluid does not contain any hydrogen atoms, and therefore has no hydrogen bonds. The bonds between the molecules in Novec 1230 fluid are much weaker than the hydrogen bonds formed between water molecules. This weak attraction between molecules gives Novec 1230 fluid its unique physical properties.

Heat of Vaporization

Water

Because of its strong hydrogen bonds, water has a relatively high heat of vaporization. This means that a significant amount of energy (heat) is required to separate the molecules and convert it from a liquid to a gaseous state (steam or water vapor). When discharged through a nozzle, water tends to stay as liquid droplets since sufficient energy to convert it to vapor cannot be transferred into it in such a short period of time.

Novec 1230 Fluid

Novec 1230 fluid, on the other hand, has a low heat of vaporization. Because of its much weaker attraction between molecules, significantly less energy is needed to evaporate the fluid (25 times less than for water). The energy needed to convert the agent into a gaseous state is readily absorbed from the air when the fluid is discharged from the nozzle. In fact, if you pour Novec 1230 fluid onto a surface, it will evaporate in a matter of seconds.

Vapor Pressure

Water

Vapor pressure is also a measure of ease of evaporation. Water has a low vapor pressure, meaning that the air has a limited capacity to hold water in its vapor form. At 25°C, water vapor will saturate the air at about 3 percent by volume before it begins to recondense into liquid form.

Novec 1230 Fluid

Novec 1230 fluid has a vapor pressure that is about 12 times that of water, indicating the ease with which it can transform from a liquid to a gas. At 25°C, the air can hold 40% by volume of the agent without it recondensing to liquid form.

Liquid to Gas Upon Discharge

These physical properties allow 3M™ Novec™ 1230 Fire Protection Fluid to transition from a liquid to a gaseous state, even at cold discharge. In a properly designed extinguishing system, Novec 1230 fluid will be discharged through a nozzle that evenly distributes the agent throughout the enclosure. The low heat of vaporization and relatively high vapor pressure will allow rapid transformation from a liquid into a gas, extinguishing the fire, protecting valuable equipment, and leaving no residue.

Comparison of Key Physical Properties of Water and 3M™ Novec™ 1230 Fire Protection Fluid

Property	Unit	Water	Novec 1230 fluid
Boiling Point	°C	100	49
Freezing Point	°C	0	-108
Vapor Pressure @ 25°C	kPa	3.2	40.4
Heat of Vaporization @ 25°C	kJ/kg	2442	95

United States
3M Specialty Materials
3M Center, Building 223-6S-04
St. Paul, MN 55144-1000
800 810 8513
800 810 8514 (Fax)

Europe
3M Specialty Materials
3M Belgium N. V.
Haven 1005, Canadastraat 11
B-2070 Zwijndrecht
32 3 250 7874

Canada
3M Canada Company
Specialty Materials
P.O. Box 5757
London, Ontario
N6A 4T1
800 364 3577

Japan
Sumitomo 3M Limited
33-1, Tamagawadai 2-chome
Setagaya-ku, Tokyo
158-8583 Japan
813 3709 8250

Asia Pacific and Latin America
Call (U.S.) **651 736 7123**

3M

3M Specialty Materials

3M Center, Building 223-6S-04
St. Paul, MN 55144-1000
www.3m.com/novec1230fluid

Issued: 11/02

4448 (HB)
98-0212-2650-5

Safety Data Sheet

Document Group:	16-3425-2	**Version Number:**	29.01
Issue Date:	07/25/18	**Supercedes Date:**	02/16/18

SECTION 1: Identification

1.1. Product identifier
3M™ Novec ™ 1230 Fire Protection Fluid

Product Identification Numbers
98-0212-3203-2, 98-0212-3217-2, 98-0212-3414-5

1.2. Recommended use and restrictions on use

Recommended use
Streaming and Flooding Fire Protection

1.3. Supplier's details

MANUFACTURER:	3M
DIVISION:	Electronics Materials Solutions Division
ADDRESS:	3M Center, St. Paul, MN 55144-1000, USA
Telephone:	1-888-3M HELPS (1-888-364-3577)

1.4. Emergency telephone number
1-800-364-3577 or (651) 737-6501 (24 hours)

SECTION 2: Hazard identification

2.1. Hazard classification
Not classified as hazardous according to OSHA Hazard Communication Standard, 29 CFR 1910.1200.

2.2. Label elements
Signal word
Not applicable.

Symbols
Not applicable.

Pictograms
Not applicable.

SECTION 3: Composition/information on ingredients

Ingredient	C.A.S. No.	% by Wt
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	756-13-8	> 99.5

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation:
Remove person to fresh air. If you are concerned, get medical advice.

Skin Contact:
Wash with soap and water. If signs/symptoms develop, get medical attention.

Eye Contact:
Flush with large amounts of water. Remove contact lenses if easy to do. Continue rinsing. If signs/symptoms persist, get medical attention.

If Swallowed:
No need for first aid is anticipated.

4.2. Most important symptoms and effects, both acute and delayed
See Section 11.1. Information on toxicological effects.

4.3. Indication of any immediate medical attention and special treatment required
Not applicable

SECTION 5: Fire-fighting measures

5.1. Suitable extinguishing media
Material will not burn. Use a fire fighting agent suitable for the surrounding fire.

5.2. Special hazards arising from the substance or mixture
Exposure to extreme heat can give rise to thermal decomposition.

Hazardous Decomposition or By-Products

Substance	Condition
Carbon monoxide	During Combustion
Carbon dioxide	During Combustion
Toxic Vapor/Gas	During Combustion

5.3. Special protective actions for fire-fighters
When fire fighting conditions are severe and total thermal decomposition of the product is possible, wear full protective clothing, including helmet, self-contained, positive pressure or pressure demand breathing apparatus, bunker coat and pants, bands around arms, waist and legs, face mask, and protective covering for exposed areas of the head.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Evacuate area. Ventilate the area with fresh air. For large spill, or spills in confined spaces, provide mechanical ventilation to disperse or exhaust vapors, in accordance with good industrial hygiene practice. Refer to other sections of this SDS for information regarding physical and health hazards, respiratory protection, ventilation, and personal protective equipment.

6.2. Environmental precautions
Avoid release to the environment. For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water.

6.3. Methods and material for containment and cleaning up
Contain spill. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Remember, adding an absorbent material does not remove a physical, health, or environmental hazard. Collect as much of the spilled material as possible. Place in a closed container approved for transportation by appropriate authorities. Seal the container. Dispose of collected material as soon as possible in accordance with applicable local/regional/national/international regulations.

SECTION 7: Handling and storage

7.1. Precautions for safe handling
Contents may be under pressure, open carefully. Do not breathe thermal decomposition products. For industrial or professional use only. Do not use in a confined area with minimal air exchange. Avoid release to the environment.

7.2. Conditions for safe storage including any incompatibilities
Protect from sunlight. Store in a well-ventilated place. Store at temperatures not exceeding 38C/100F Store away from strong bases. Store away from other materials. Store away from amines.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Occupational exposure limits
If a component is disclosed in section 3 but does not appear in the table below, an occupational exposure limit is not available for the component.

Ingredient	C.A.S. No.	Agency	Limit type	Additional Comments
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	756-13-8	Manufacturer determined	TWA:150 ppm(1940 mg/m3)	

ACGIH : American Conference of Governmental Industrial Hygienists
AIHA : American Industrial Hygiene Association
CMRG : Chemical Manufacturer's Recommended Guidelines
OSHA : United States Department of Labor - Occupational Safety and Health Administration
TWA: Time-Weighted-Average
STEL: Short Term Exposure Limit
CEIL: Ceiling

8.2. Exposure controls

8.2.1. Engineering controls
Provide appropriate local exhaust when product is heated. For those situations where the material might be exposed to extreme overheating due to misuse or equipment failure, use with appropriate local exhaust ventilation sufficient to maintain levels of thermal decomposition products below their exposure guidelines. Use general dilution ventilation and/or local exhaust ventilation to control airborne exposures to below relevant Exposure Limits and/or control dust/fume/gas/mist/vapors/spray. If ventilation is not adequate, use respiratory protection equipment.

8.2.2. Personal protective equipment (PPE)

Eye/face protection

Eye protection not required.

Skin/hand protection

No chemical protective gloves are required.

Respiratory protection

If thermal degradation products are expected, use a full facepiece supplied-air respirator.
If thermal decomposition occurs:

Use a positive pressure supplied-air respirator if there is a potential for over exposure from an uncontrolled release, exposure levels are not known, or under any other circumstances where air-purifying respirators may not provide adequate protection.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

General Physical Form:	Liquid
Specific Physical Form:	Liquid
Odor, Color, Grade:	Clear colorless liquid with low odor
Odor threshold	*No Data Available*
pH	*Not Applicable*
Melting point	-108 ºC
Boiling Point	49 ºC [@ 760 mmHg]
Flash Point	No flash point
Evaporation rate	> 1 [*Ref Std:*BUOAC=1]
Flammability (solid, gas)	Not Applicable
Flammable Limits(LEL)	None detected
Flammable Limits(UEL)	None detected
Vapor Pressure	40.4 kPa [@ 25 ºC]
Vapor Density	11.6 [*Ref Std:*AIR=1]
Density	1.6 g/ml
Specific Gravity	1.6 [@ 68 ºF] [*Ref Std:*WATER=1]
Solubility in Water	Nil
Solubility- non-water	*No Data Available*
Partition coefficient: n-octanol/ water	*No Data Available*
Autoignition temperature	*Not Applicable*
Decomposition temperature	*No Data Available*
Viscosity	0.6 centipoise [@ 25 ºC]
Molecular weight	*No Data Available*
Volatile Organic Compounds	1600 g/l [*Test Method:*calculated SCAQMD rule 443.1]
Percent volatile	100 %
VOC Less H2O & Exempt Solvents	1600 g/l [*Test Method:*calculated SCAQMD rule 443.1]

SECTION 10: Stability and reactivity

10.1. Reactivity

This material may be reactive with certain agents under certain conditions - see the remaining headings in this section.

10.2. Chemical stability

Stable.

10.3. Possibility of hazardous reactions

Hazardous polymerization will not occur.

10.4. Conditions to avoid

Light

10.5. Incompatible materials
Strong bases
Amines
Alcohols

10.6. Hazardous decomposition products

Substance	**Condition**
Hydrogen Fluoride	At Elevated Temperatures - extreme conditions of heat

Refer to section 5.2 for hazardous decomposition products during combustion.

If the product is exposed to extreme condition of heat from misuse or equipment failure, toxic decomposition products that include hydrogen fluoride and perfluoroisobutylene can occur. Extreme heat arising from situations such as misuse or equipment failure can generate hydrogen fluoride as a decomposition product.

SECTION 11: Toxicological information

The information below may not be consistent with the material classification in Section 2 if specific ingredient classifications are mandated by a competent authority. In addition, toxicological data on ingredients may not be reflected in the material classification and/or the signs and symptoms of exposure, because an ingredient may be present below the threshold for labeling, an ingredient may not be available for exposure, or the data may not be relevant to the material as a whole.

11.1. Information on Toxicological effects

Signs and Symptoms of Exposure

Based on test data and/or information on the components, this material may produce the following health effects:

Inhalation:
No known health effects.

Skin Contact:
Contact with the skin during product use is not expected to result in significant irritation.

Eye Contact:
Contact with the eyes during product use is not expected to result in significant irritation.

Ingestion:
No known health effects.

Toxicological Data
If a component is disclosed in section 3 but does not appear in a table below, either no data are available for that endpoint or the data are not sufficient for classification.

Acute Toxicity

Name	Route	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Dermal	Professional judgement	LD50 estimated to be > 5,000 mg/kg
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Ingestion	Professional	LD50 estimated to be > 5,000 mg/kg

		judgement	
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Inhalation-Vapor (4 hours)	Rat	LC50 > 1,227 mg/l

ATE = acute toxicity estimate

Skin Corrosion/Irritation

Name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Rabbit	No significant irritation

Serious Eye Damage/Irritation

Name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Rabbit	No significant irritation

Skin Sensitization

Name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Guinea pig	Not classified

Respiratory Sensitization

For the component/components, either no data are currently available or the data are not sufficient for classification.

Germ Cell Mutagenicity

Name	Route	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	In Vitro	Not mutagenic
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	In vivo	Not mutagenic

Carcinogenicity

For the component/components, either no data are currently available or the data are not sufficient for classification.

Reproductive Toxicity

Reproductive and/or Developmental Effects

Name	Route	Value	Species	Test Result	Exposure Duration
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Inhalation	Not classified for female reproduction	Rat	NOAEL 3,000 ppm	premating & during gestation
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Inhalation	Not classified for male reproduction	Rat	NOAEL 3,000 ppm	premating & during gestation
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Inhalation	Not classified for development	Rat	NOAEL 3,000 ppm	premating & during gestation

Target Organ(s)

Specific Target Organ Toxicity - single exposure

Name	Route	Target Organ(s)	Value	Species	Test Result	Exposure Duration
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Inhalation	nervous system	Not classified	Rat	NOAEL 100,000 ppm	2 hours
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-	Inhalation	cardiac sensitization	Not classified	Dog	Sensitization Negative	17 minutes

pentanone						

Specific Target Organ Toxicity - repeated exposure

Name	Route	Target Organ(s)	Value	Species	Test Result	Exposure Duration
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Inhalation	liver | kidney and/or bladder | heart | endocrine system | hematopoietic system | muscles | nervous system | respiratory system | vascular system	Not classified	Rat	NOAEL 3,000 ppm	90 days

Aspiration Hazard
For the component/components, either no data are currently available or the data are not sufficient for classification.

Please contact the address or phone number listed on the first page of the SDS for additional toxicological information on this material and/or its components.

SECTION 12: Ecological information

Ecotoxicological information

Please contact the address or phone number listed on the first page of the SDS for additional ecotoxicological information on this material and/or its components.

Chemical fate information

Please contact the address or phone number listed on the first page of the SDS for additional chemical fate information on this material and/or its components.

SECTION 13: Disposal considerations

13.1. Disposal methods
Dispose of contents/ container in accordance with the local/regional/national/international regulations.

Dispose of waste product in a permitted industrial waste facility. As a disposal alternative, incinerate in a permitted waste incineration facility. Combustion products will include HF. Facility must be capable of handling halogenated materials. Empty drums/barrels/containers used for transporting and handling hazardous chemicals (chemical substances/mixtures/preparations classified as Hazardous as per applicable regulations) shall be considered, stored, treated & disposed of as hazardous wastes unless otherwise defined by applicable waste regulations. Consult with the respective regulating authorities to determine the available treatment and disposal facilities.

EPA Hazardous Waste Number (RCRA): Not regulated

SECTION 14: Transport Information

For Transport Information, please visit http://3M.com/Transportinfo or call 1-800-364-3577 or 651-737-6501.

SECTION 15: Regulatory information

15.1. US Federal Regulations
Contact 3M for more information.

EPCRA 311/312 Hazard Classifications:

Physical Hazards
Not applicable

Health Hazards
Not applicable

15.2. State Regulations
Contact 3M for more information.

15.3. Chemical Inventories
The components of this product are in compliance with the new substance notification requirements of CEPA.

The components of this material are in compliance with the China "Measures on Environmental Management of New Chemical Substance". Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of the Korean Toxic Chemical Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Japan Chemical Substance Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Philippines RA 6969 requirements. Certain restrictions may apply. Contact the selling division for additional information.

The components of this product are in compliance with the chemical notification requirements of TSCA. All required components of this product are listed on the active portion of the TSCA Inventory.

Contact 3M for more information.

15.4. International Regulations
Contact 3M for more information.

This SDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: Other information

NFPA Hazard Classification
Health: 3 **Flammability:** 0 **Instability:** 1 **Special Hazards:** None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.
The NFPA Health code of 3 is due to emergency situations where the material may thermally decompose and release Hydrogen Fluoride. During normal use conditions, please reference Section 2 and Section 11 of the SDS for additional health hazard information.

HMIS Hazard Classification
Health: 1 **Flammability:** 0 **Physical Hazard:** 1 **Personal Protection:** X - See PPE section.

Hazardous Material Identification System (HMIS® IV) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS® IV ratings are to be used with a fully implemented HMIS® IV program. HMIS® is a registered mark of the American Coatings Association (ACA).

Document Group:	16-3425-2	**Version Number:**	29.01
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Reason for Reissue
Conversion to GHS format SDS.

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Science.
Applied to Life.™

Protecting assets today with the future in mind.

3M™ Novec™ 1230 Fire Protection Fluid vs. FM-200®

FM-200® following the path of halon.

If you are looking for ways to protect your valuable electronic assets and operations, you have already made the smart decision to avoid relying on water for fire protection. Selecting a clean extinguishing agent offers the best opportunity to minimize risk to a business and its critical assets.

However, all clean agents are not the same. For example, HFC-227ea, sold under the FM-200® brand, is a hydrofluorocarbon (HFC) clean agent – which is a potent greenhouse gas. Due to their high global warming potentials (GWP), time is running out for HFCs, including FM-200.

The regulatory path taken by halon provides insight into the future for HFCs. In the past couple years there have been increasing efforts on a global basis to reduce the use of HFCs, including the European Union's implementation of an HFC phase-down under the F-gas Regulation and the U.S. EPA's advancement of regulations in an effort to reduce use of HFCs. In fact, in December 2015 a collective group of 197 countries at the 27th Meeting of the Parties to the Montreal Protocol committed to act in 2016 to put HFCs on a global phase-down schedule similar to the path taken by halon.

Unfazed by the HFC phasedown

What do these regulations mean to users of fire suppression systems? For example, in the event of an FM-200 system discharge, facility owners will face the uncertainty and risk of the future supply and costs of FM-200 to continue to protect their valued assets.

Thankfully there are system options that do not use HFCs. With 3M™ Novec™ 1230 Fire Protection Fluid, owners can avoid the uncertainty associated with HFCs like FM-200 and halons. Novec 1230 fluid is NOT an HFC. Novec 1230 fluid is a sustainable clean agent – enabling a transition from HFCs such as FM-200 and halon to a more environmentally sound solution without compromising performance. In its approval of Novec 1230 fluid, the U.S. EPA noted that Novec 1230 fluid "*is acceptable because it reduces overall risk to public health and the environment in the end use listed.*" In fact, 3M is so confident that Novec 1230 fluid will continue to meet environmental standards far into the future that 3M backs Novec 1230 fluid with 20-year protection: the 3M™ Blue Sky℠ Warranty.

Novec 1230 fluid revolutionized the clean agent market in 2001 and now sets a new standard for sustainable clean agent fire suppression. Its unique dielectric properties and low vapor pressure yields design advantages to satisfy your top priority – protecting your assets. These advantages include ease of handling and the flexibility for higher pressure system innovation that is not practical for halons and HFCs. Specifying Novec 1230 fluid leverages these advances in fire suppression to protect your operations while eliminating future risks associated HFCs such as FM-200.

3M™ Novec™ 1230 Fire Protection Fluid vs. FM-200®

Typical Environmental Properties (Not for specification purposes)

Properties	3M™ Novec™ 1230 Fire Protection Fluid	Chemours FM-200® (HFC-227ea)
Fire Performance vs. Health and Extinguishment Safety (NOAEL)	**Class A, B & C[3]** Class A: 4.5% - NOAEL 10% | Safety Margin 122% Class B: 5.9% - NOAEL 10% | Safety Margin 70% Class C: 4.5% - NOAEL 10% | Safety Margin 122%	**Class A, B & C[3]** Class A: 6.7% - NOAEL 9% | Safety Margin 34% Class B: 8.7% - NOAEL 9% | Safety Margin 3% Class C: 7.0% - NOAEL 9% | Safety Margin 29%
ODP - Ozone Depletion Potential[1]	0	0
GWP - Global Warming Potential[2]	<1	3,350
Atmospheric Lifetime – Years	0.019	38.9
Global Environmental Warranty on Agent (Years)	Yes 3M™ Blue Sky℠ Warranty (20 Years)	None
Subject to Phase-Down under EU F-Gas Regulation	No	Yes
Subject to U.S. Proposals for Global Phase-Down under Montreal Protocol	No	Yes
Subject to Potential U.S. EPA SNAP Status Change Proposals Directed at HFCs	No	Yes
Manufacturer Advocating for Global HFC Phase-Down	Yes	Yes

[1] World Meteorological Organization (WMO) 1998, Model-Derived Method
[2] Intergovernmental Panel on Climate Change (IPCC) 2013 Method, 100-year ITH
[3] NFPA 2001

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3M™ Novec™ Engineered Fluids • 3M™ Novec™ Aerosol Cleaners • 3M™ Novec™ 1230 Fire Protection Fluid • 3M™ Novec™ Electronic Grade Coatings • 3M™ Novec™ Electronic Surfactants • 3M™ Novec™ Dielectric Fluids

Regulatory: For regulatory information about this product, contact your 3M representative.

Technical Information: The technical information, recommendations and other statements contained in this document are based upon tests or experience that 3M believes are reliable, but the accuracy or completeness of such information is not guaranteed.

Product Use: Many factors beyond 3M's control and uniquely within user's knowledge and control can affect the use and performance of a 3M product in a particular application. Given the variety of factors that can affect the use and performance of a 3M product, user is solely responsible for evaluating the 3M product and determining whether it is fit for a particular purpose and suitable for user's method of application.

Warranty, Limited Remedy, and Disclaimer: Unless an additional warranty is specifically stated on the applicable 3M product packaging or product literature, 3M warrants that each 3M product meets the applicable 3M product specification at the time 3M ships the product. 3M MAKES NO OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY IMPLIED WARRANTY OR CONDITION ARISING OUT OF A COURSE OF DEALING, CUSTOM OR USAGE OF TRADE. If the 3M product does not conform to this warranty, then the sole and exclusive remedy is, at 3M's option, replacement of the 3M product or refund of the purchase price.

Limitation of Liability: Except where prohibited by law, 3M will not be liable for any loss or damage arising from the 3M product, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, including warranty, contract, negligence or strict liability.

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60-5002-0920-4

3M

Novec™

Brand

3M™ Novec™ 1230 Fire Protection Fluid

Frequently Asked Questions (FAQs)

Smart Performance FAQs

Q: What is 3M™ Novec™ 1230 Fire Protection Fluid?

A: Novec 1230 fluid is a sustainable fire extinguishing clean agent that helps protect continuity of operations and high value assets. It is a waterless fire suppressant designed to replace high global warming potential (GWP) hydrofluorocarbons (HFCs) like FM-200®.

Novec 1230 fluid is a clean agent included in the NFPA 2001 standard. It is non-conductive and leaves no residue, putting out fires while preserving both assets and operations. Novec 1230 fluid has been sold into clean agent fire suppression for 15 years and into more than a 100 countries. Its proven quality and reliability have provided specifiers and end-users with a smart solution for their clean agent needs.

Download the 3M™ Novec™ 1230 Fire Protection Fluid brochure (PDF, 1.4 mb), the technical data sheet (PDF, 510 kb), or visit the Fire Suppression - Novec 1230 webpage to learn more.

Q: What operations and valued assets is 3M™ Novec™ 1230 Fire Protection Fluid used to protect?

A: Novec 1230 fluid is designed to help protect continuity of operations because, unlike water, it does not damage electronic equipment and the critical data stored on it—to keep your business up and running. It also protects valuable assets including everything from paper archives and historical documents to priceless works of art and antiquities. To learn more about specific industry applications, download one of our brochures.

- 3M™ Novec™ 1230 Fire Protection Fluid for Telecomm & Data Centers 1464.0 kB
- 3M™ Novec™ 1230 Fire Protection Fluid Oil & Gas 923.0 kB
- 3M™ Novec™ 1230 Fire Protection Fluid Flightline Applications 699.25 kB
- 3M™ Novec™ 1230 Fire Protection Fluid Marine Application 1086.0 kB
- 3M™ Novec™ 1230 Fire Protection Fluid Museums & Archives 765.0 kB

Continue on the next page.

Q: Can I purchase a Novec 1230 fluid fire suppression system from 3M?

A: No. 3M manufactures Novec 1230 fluid but the actual sales and installations of the systems are through our OEM partners and their global distribution networks. Novec 1230 fluid is a recognized component of a listed or approved system, e.g. UL and Factory Mutual.

Click here for our full list of approved system manufacturers.

Q: How do I purchase a fire suppression system using 3M Novec 1230 fluid?

A: 3M produces Novec 1230 fluid and sells it to original equipment manufacturers (OEMs). Our OEM partners have third party approvals (such as UL and/or FM) for the fire suppression system, including both hardware and software. Systems can be customized to match the needs of the area being protected. Contact a system manufacturer.

Click here for our full list of approved system manufacturers.

Q: How do I specify Novec 1230 fluid for my fire suppression system?

A: When designing a new system, it's important that you specify an agent that's clean, sustainable and reliable. In fire suppression, there are no "equals". To ensure clean, specifications should exclude dry chemicals and water mist. To ensure sustainability, specifications should exclude HFCs, including FM-200® and ECARO-25®. To ensure quality, reliability and safety, specify 3M™ Novec™ 1230 Fire Protection Fluid and not generic descriptions of this agent.

Download this template (DOC, 85 kb) for help in specifying 3M™ Novec™ 1230 Fire Protection Fluid in a total flooding fire protection system.

Q: Where is 3M Novec 1230 fluid typically installed?

A: Systems are installed to protect critical operations and high value assets such as data centers, computer rooms, control rooms, museums, archives or any other location where the use of water to control a fire would damage the asset being protected and critical operations.

Q: How is 3M Novec 1230 fluid applied to a fire?

A: Upon activation from an automatic detection system, Novec 1230 fluid is released into the room and puts out the fire.

Q: How does 3M Novec 1230 fluid extinguish a fire?

A: Novec 1230 fluid stops the combustion process by absorbing heat. As part of an advanced fire suppression system, it quickly extinguishes the fire. Unlike CO_2 and inert gases, Novec 1230 fluid does not extinguish a fire by displacing the oxygen in an enclosure.

Q: Is there a requirement to have a dedicated ventilation system to remove Novec 1230 fluid after a discharge?

A: An active mechanical process that is designed to remove Novec 1230 fluid/gas from the protected space is not required by the industry standard, NFPA 2001. That said, the designer of a system using Novec 1230 fluid may consider use of such a ventilation system on a case-by-case basis if conditions warrant, similar to what has been done in the past with halon.

Continue on the next page.

Q: Is 3M Novec 1230 fluid a liquid or a gas?

A: Actually, it is both. Novec 1230 fluid is produced and stored as a liquid. However, upon discharge from a properly designed spray nozzle, it floods the protected space as a gas. This fire suppressant evaporates 50 times faster than water, so the energy of the discharge is more than sufficient to convert it to a gas. The gas extinguishes the fire and prevents re-ignition of the potential fire incident. (Note: the term "fluid" can be used to describe either a liquid or a gas.)

Learn more about the science behind 3M Novec 1230 fluid's transformation from liquid to gas (PDF, 51 kb).

Q: What is the shelf life of 3M Novec 1230 fluid?

A: Novec 1230 fluid has at least a 30 year shelf life in an installed system when purchased from one of our authorized manufacturers. This means the effectiveness of the fluid in a listed and approved system will not diminish during that time span.

Q: Does the noise from a system discharging Novec 1230 fluid cause damage to hard disc drives?

A: Damage to hard disc drives has not been observed as a result of a discharge of a system using Novec 1230 fluid.

For inert gas systems, noise at specific decibel levels and frequencies has been tied to HDD damage. Volume, tone and duration of the noise are all important factors. The duration of discharge for inert gas systems is up to 12 times longer than halocarbon systems, such as those that use Novec 1230 fluid. Efforts are now underway to design inert gas systems to minimize noise at the nozzle.

Learn more in the Clean Extinguishing Agent System Noise and Hard Disk Drive (HDD) Failure FAQs (PDF, 111 kb).

Q: What are the advantages of using 3M Novec 1230 fluid compared to inert gas?

A: Owners of inert gas systems have become keenly aware of the hidden costs of installing, housing, maintaining and recharging inert gas systems.

On a volume basis, inert gas systems must deliver more agent into a room to displace as much as 40% of the air in a protected space—compared to approximately 5% with a system using 3M Novec 1230 fluid. This translates into many more cylinders of inert gas required to protect a given space. In addition, the cylinders store gas at much higher pressures.

Both the greater number of cylinders and the high pressures at which these systems operate represent additional expenses, or "extra" installation costs that may not be readily apparent in the initial bid. For example, the added construction costs associated with over-pressurization may not be included in the cost of system installation, but are necessary expenses associated with installation. In addition, the larger amount of space required for the higher quantity of inert gas cylinders translates to higher real estate or space costs.

The high pressure at which inert gas systems operate also requires more frequent and rigorous maintenance to ensure that it can withstand the high discharge pressures. At regular intervals, maintenance teams validate system pressure and the integrity of the hoses, pressure vents, and cylinders.

Learn more about how 3M Novec 1230 fluid compares to inert gas.

Q: Can I air ship Novec 1230 fluid in bulk?

A: Yes. Unlike other clean agents, Novec 1230 fluid is stored as a liquid in unpressurized containers and can be shipped in bulk quantities by air.

Continue on the next page.

Safety FAQs

Q: Is this product safe for human occupancy?

A: Yes. 3M Novec 1230 fluid currently provides the largest margin of safety of any clean agent and is approved for use in occupied spaces by the U.S. Environmental Protection Agency (EPA). In its approval of 3M™ Novec™ 1230 Fire Protection Fluid, the EPA noted that the fluid "provides an improvement over use of halon 1301, hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) in fire protection. .... because it reduces overall risk to public health and the environment..."

Learn more about our margin of safety compared to other clean agents in the Novec 1230 Fluid brochure (PDF, 1.4 mb).

Q: When designing a fire suppression system using 3M Novec 1230 fluid, how are agent concentrations maintained after discharge?

A: Systems using Novec 1230 fluid are designed to flood a space with the gas to a design concentration. This design concentration is maintained by ensuring that the space has integrity (no leaks or minimal leaks) to maintain the required concentration for the required hold time, usually 10 minutes as a minimum. According to the 2015 edition of NFPA 2001, paragraph 5.6, "A minimum concentration of 85 percent of the adjusted minimum design concentration shall be held at the highest height of protected content within the hazard for a period of 10 minutes or for a time period sufficient to allow for response by trained personnel." This requirement also exists in other, similar standards.

Sustainability FAQs

Q: Why should I choose 3M Novec 1230 fluid rather than an HFC fire suppression systems?

A: As of October 2016, HFCs like Chemours' FM-200® (HFC-227ea) and FE-25™ (HFC-125), as well as Fike's ECARO-25® (HFC-125), are scheduled for global production phasedown under the Montreal Protocol. FM-200® and other hydrofluorocarbons (HFCs) are following the path of halon. Although these HFCs are clean agents that do not deplete the ozone layer, they are potent greenhouse gases—more than 3000 times more potent than CO_2. The European Union's HFC phasedown started in 2015 under the F-Gas regulations and the HFC phasedown in the United States and other developed countries begins in 2019 under the Montreal Protocol.

Because fire suppression systems are often intended to last for 30 years or more, FM-200® and other HFCs have become unsustainable clean agents. Novec 1230 fluid provides the fire protection industry with an agent that will stand the test of time based on its safety, performance and environmental properties. Novec 1230 fluid has no ozone depletion potential and a climate impact less than CO_2 and it's not targeted for phasedown or phase-out.

Learn more about how 3M™ Novec 1230™ Fire Protection Fluid stacks up against the competition.

Q: How can I stay up to date on environmental regulations impacting the fire suppression industry?

A: Visit 3M.com/NovecHotTopics to access our insights on the latest developments from around the world. Written by the makers of 3M Novec products to enhance the knowledge and insight of experts like you, this is the place to learn about the forces shaping your business and get the help you need to make informed choices about your fire protection, cleaning or other industrial applications.

Continue on the next page.

Q: Can 3M guarantee that Novec 1230 fluid will not be subject to environmental restrictions in the future?

A: While no one can accurately predict what the future will bring, 3M is so confident that Novec 1230 fluid will not be affected by any environmental mandates that it offers the 3M™ Blue Sky℠ Warranty.

Read the Blue Sky Warranty flyer (PDF, 248 kb) for more information.

Q: What is the 3M™ Blue Sky℠ Warranty?

A: The 3M™ Blue Sky℠ Warranty states, for a period of 20 years after original installation and subject to noted requirements, that 3M™ Novec™ 1230 Fire Protection Fluid, installed in an approved fire suppression system, will not be restricted for use in fire protection due to its Ozone Depletion Potential (ODP) or Global Warming Potential (GWP) and is not targeted for phasedown by the Montreal Protocol, nor subject to the European F-Gas Regulations targeting the phasedown of production and import of HFCs into Europe; and will not be affected by U.S. EPA SNAP regulations which would render it either unacceptable or acceptable subject to narrow use limits.

Read the 3M Blue Sky Warranty (PDF, 223 kb) complete terms and conditions.

Q: How much will it cost to receive this reassurance?

A: There is no cost for this warranty and it is in effect for 20 years after installation.

To apply, an end user who purchased a newly installed system simply registers it on the 3M Novec website within 30 days of system installation.

Q: Why is 3M Novec 1230 fluid considered a "third" generation fire suppression clean agent?

A: The halon family of fire protection products was widely utilized as the first of the new clean agents. These products were popular because they would extinguish a fire without damaging the contents of the space being protected, such as the early computer server rooms. However, in 1987, halons were regulated by the Montreal Protocol because they contributed to the depletion of the ozone layer. In response to the mandates of the Montreal Protocol, manufacturers developed replacement products for halons known as HFCs including FM-200®, the second generation of clean agents. While none of these products contributed to ozone depletion, they do have other environmental concerns such as high global warming potential (GWP) and the resulting regulatory consequences addressed above.

Novec 1230 fluid is a third generation clean agent because it was developed to provide high performance and a large margin of safety without harming the environment.

Q: Water is sustainable too. Why would Novec 1230 fluid be used rather than water mist?

A: Water mist is still water. It is wet and messy, electrically conductive and can require costly clean-up. It can destroy the critical assets that keep businesses running. Because water mist is not a clean agent, it is not covered by NFPA 2001. Instead, it is covered by another standard: NFPA 750 which notes, "The standard does not provide definitive fire performance criteria, nor does it offer specific guidance on how to design a system to control, suppress, or extinguish a fire."

FM Global's Data Sheet 5-32 states: "When it is essential to reduce equipment damage from an incipient fire to minimum possible levels, or to facilitate the return to service, provide an FM Approved clean agent fire extinguishing system with detection to protect the data equipment within the data processing equipment room. This is to supplement the automatic sprinkler or water mist system protecting the facility or raised floor."

Q: Where can I learn more about Novec 1230 fluid?

A: The quickest way to find accurate and informative material regarding Novec 1230 fluid is on our Fire Suppression - Novec 1230 Fluid webpage.

Continue on the next page.

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Envirotemp™ FR3™ fluid Formulated for performance.

FR3™

ENVIROTEMP™ NATURAL ESTER FLUID

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Envirotemp™ FR3™ fluid. Trusted worldwide a million times over.

With over one million installations across six continents and validated in over 250 tests, Cargill's Envirotemp™ FR3™ natural ester fluid is trusted by our customers to deliver cost-effective solutions that help improve transformer performance reliably and safely.

Our team of dielectric experts is active in the standards community globally and has extensive knowledge of not only dielectric fluid properties but also fluid performance in application. And they have transformer design experience, too. This means our customers adopting FR3 natural ester technology have comprehensive dielectric fluids support from initial planning stages through best practices implementation and beyond.

Backed by Cargill's global supply chain network, our customers can rely on us to deliver the best solution for their application - when they need it, anywhere in the world.

With FR3 fluid, our customers can:

- Gain cost efficiencies either on initial cost or total cost of ownership without sacrificing reliability.
- Extend transformer insulation and asset life.
- Optimize load capacity.
- Significantly improve fire safety.
- Enhance their environmental footprint and sustainable supply chain initiatives.

Improve performance with life extension and loading flexibility.

Protect insulation life to extend asset life.

Insulation paper is one of the primary factors that determines the life of a transformer. FR3™ fluid's unique chemistry absorbs free water and essentially wicks it away from the insulation paper. FR3 fluid has 10 times the water saturation level of mineral oil. This results in extending the insulation life 5-8 times longer than mineral oil.

Insulation aging study comparing thermally upgraded paper using FR3 fluid vs. mineral oil.

- Save significantly on replacement costs by extending the asset life with FR3 fluid.
- Reduce the risk of failure to improve reliability of the transformer.
- Reduce processing maintenance costs, since FR3 fluid does not sludge like mineral oil.

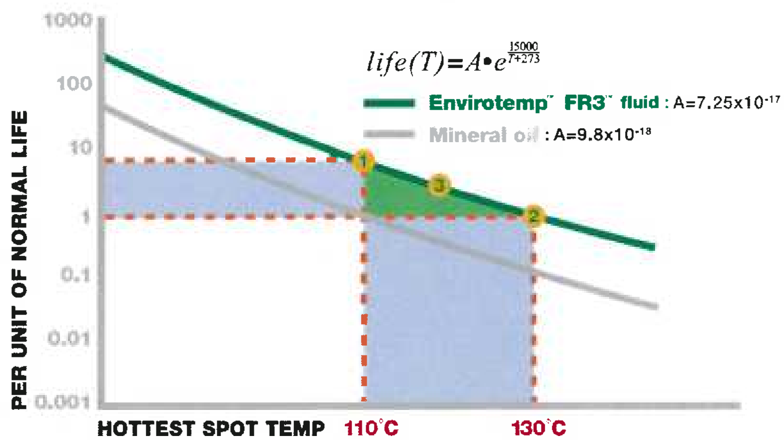
With FR3™ fluid's unique capabilities to extend insulation life and increase load capacity, organizations now have the flexibility to optimize their transformer fleet loading profiles in order to gain cost savings without sacrificing reliability.

Leverage higher thermal capability with FR3 fluid.

Historically, standards were written to accommodate a 95°C or 110°C hot spot for cellulose and Thermally Upgraded Kraft (TUK), respectively. However, published high temperature insulation system standards - IEC (60076-14) and IEEE (C157.154) – accommodate a 15°C or 20°C increase in hot spot without sacrificing the life or reliability of the transformer, when immersed in natural ester fluid.

Paper	Dielectric Fluid	Thermal Class	Hot spot	IEEE AWR	IEC AWR
TUK	Mineral Oil	120	110°C	65°C	75K
TUK	Natural Ester	140	130°C	85°C	95K

TUK life curves



OPTION 1: Extend asset life at current 110° hotspot.

OPTION 2: Increase load capability up to 20% with 130°C hotspot.

OPTION 3: Incrementally extend asset life and increase load capability with 120°C hotspot.

IEC 60076-14 Part 14: Liquid-immersed power transformers using high-temperature insulation materials. Edition 1.0 September 2013.
IEEE C57.154 Standard for the Design, Testing, and Application of Liquid-Immersed Distribution, Power, and Regulating Transformers Using High-Temperature Insulation Systems and Operating at Elevated Temperature. Published October 30, 2012.

Improve fire safety.

Add more sustainability to your sustainable supply chain.

Reduce costs while increasing fire safety.

FR3™ fluid has the highest fire point of any dielectric fluid (360°C compared to 160°C for mineral oil) making it the ideal choice for densely populated areas where transformers are positioned indoors, underground or in close proximity to buildings and other equipment. FR3 fluid is a K-class, less flammable fluid as certified by Underwriters Laboratory and approved by FM Global.

- Reduce clearance to buildings which saves precious real estate, particularly in space-constrained areas.
- Retrofill older transformers with FR3 fluid instead of replacing or moving them to help comply with current fire code regulations.
- For power transformers, potentially eliminate the need for expensive fire walls and deluge systems (and their ongoing maintenance costs).

"Being green" also benefits your bottom line.

FR3 fluid not only has best-in-class environmental properties, but with its enhanced thermal capabilities enabling smaller transformer designs, your supply chain just got a whole lot more sustainable.

- Smaller, more efficient transformer designs:
    1. Use less fluid and construction materials.
    2. Are typically lighter which could make installations easier for work crews and could reduce transportation costs.

Envirotemp™ FR3™ fluid properties: standard acceptance values and typical values

	Standard test methods		ASTM D6871/IEEE C57.147	IEC 62770	Envirotemp FR3 fluid
PROPERTY	**ASTM**	**ISO/IEC**	**As-received new fluid property requirements**	**Unused new fluid property requirements**	**TYPICAL**
Physical					
Color	D1500	ISO 2211	≤1.0	–	0.5
Flash Point PMCC (°C)	D93	ISO 2719	–	≥250	255
Flash Point COC (°C)	D92	ISO 2592	≥275	–	320-330
Fire Point (°C)	D92	ISO 2592	≥300	>300	350-360
Pour Point (°C)	D97	ISO 3016	<-10	≤-10	-18 - -23
Density at 20°C (g/cm³)	–	ISO 3675	–	≤1.0	0.92
Relative Density (Specific Gravity) 15°C	D1298	–	≤0.96	–	0.92
Viscosity (mm²/sec)					
100°C	D445	ISO 3104	≤15	≤15	7.7 - 8.3
40°C			≤50	≤50	32 - 34
0°C			≤500	–	190
Visual Examination	D1524	IEC 62770 4.2.1	bright and clear	clear, free from sediment and suspended matter	clear, light green
Biodegradation	OECD 301		readily biodegradable	readily biodegradable	readily biodegradable
Electrical					
Dielectric Breakdown (kV)	D877	–	≥30	–	47
Dielectric Breakdown (kV)					
1mm gap	D1816	–	≥20	–	28
2mm gap	D1816	–	≥35	–	48-75
2.5mm gap	–	IEC 60156	–	≥35	73
Gassing Tendency (mm/min)	D2300	–	≤0	–	-79
Dissipation Factor					
25°C (%)	D924	–	≤0.20	–	0.010 - 0.15
90°C (tanδ)	–	IEC 60247	–	≤0.05	0.02
100°C (%)	D924	–	≤4.0	–	0.41 - 3.85
Chemical					
Corrosive Sulfur	D1275	IEC 62697	non-corrosive	non-corrosive	non-corrosive
Water Content (mg/kg)	D1533	IEC 60814	≤200	≤200	4 - 50
Acid Number (mg KOH/g)	D974	IEC 62021.3	≤0.06	≤0.06	0.013 - 0.042
PCB Content (mg/kg)	D4059	IEC 61619	not detectable	free from PCBs	not detectable
Total Additives	–	IEC 60666	–	Max weight fraction 5%	<2%
Oxidation Stability (48 hrs, 120°C)	–	IEC 61125C			
Total Acidity (mg KOH/g)	–	IEC 62621.3	–	≤0.6	0.1
Viscosity at 40°C (mm²/sec)	–	ISO 3104	–	≤30% increase over initial	17.1% increase
Dissipation Factor at 90°C (tanδ)	–	IEC 60247	–	≤0.5	0.1

NOTE: Specifications should be written referencing only the defined ASTM or IEC industry standard acceptance values and test methods. The listed 'typical' values are average values summarized from a significant number of data points over many years; they are not to be identified as acceptance values.

ASTM D6871 Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus.

IEC 62770: Fluids for electrotechnical applications – Unused natural esters liquids for transformers and similar electrical equipment.

A transformer filled with FR3™ fluid complies with the transformer temperature operating range requirements defined in IEEE C57.12.00 and IEC 60076-1.

- Made from a renewable source with global, reliable supply.
- Carbon neutral (according to BEES 4.0 lifecycle analysis).
- Non-toxic and non-hazardous in soil and water.
- Readily Biodegradable per OECD 301.
- Contains no petroleum, halogens, silicones or sulfurs.
- Recyclable.









envirotemp™
ester dielectric fluids

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Cargill

Safety Data Sheet
acc. to ISO and GHS

Printing date: 03.04.2014

Reviewed on: 03.04.2014

1 Identification

Product identifier

Trade name: **ENVIROTEMP™ FR3™ Fluid**
SAP Material Numbers: 100088941; 100089128; 100089127; 100089129
CAS Number: 8001-22-7

Application of the substance / the mixture: Dielectric coolant

Details of the supplier of the Safety Data Sheet

Manufacturer/Supplier:

Cargill, Incorporated
Cargill Industrial Specialties
9320 Excelsior Blvd.
Hopkins, Minnesota 55343
Tel: 1-952-984-9122
E-mail: CIS_CustomerService@Cargill.com

Emergency telephone number: 1-800-255-3924 (ChemTel)

2 Hazard(s) identification

Classification of the substance or mixture:
The product is not classified as hazardous according to the Globally Harmonized System (GHS).

Label elements
GHS label elements: Not Regulated.
Hazard pictograms: Not Regulated.
Signal word: Not Regulated.
Hazard-determining components of labeling: None.
Hazard statements: Not Regulated.

Hazard description
WHMIS-symbols: Not hazardous under WHMIS.

Classification system:
NFPA ratings (scale 0 - 4)

Health = 0
Fire = 1
Reactivity = 0

HMIS ratings (scale 0 - 4)

Health = 0
Fire = 1
Reactivity = 0

Other hazards
Results of PBT and vPvB assessment
PBT: Not applicable.
vPvB: Not applicable.

3 Composition/information on ingredients

Chemical characterization: Mixture.
CAS No.: 8001-22-7
Description: Soybean Oil with nonhazardous additives.
Hazardous components: None.

4 First-aid measures

Description of first aid measures

General information:
No special measures required.

After inhalation:
Supply fresh air; consult doctor in case of complaints.

After skin contact:
Generally the product does not irritate the skin.
Clean with water and soap.
If skin irritation continues, consult a doctor.

After eye contact:
Remove contact lenses if worn.
Rinse opened eye for several minutes under running water. If symptoms persist, consult a doctor.

After swallowing:
Rinse out mouth and then drink plenty of water.
Do not induce vomiting; immediately call for medical help.

Most important symptoms and effects, both acute and delayed:
Gastric or intestinal distress when ingested.

Danger: None

Indication of any immediate medical attention and special treatment needed:
No additional information.

5 Fire-fighting measures

Extinguishing media

Suitable extinguishing agents:
Foam.
Fire-extinguishing powder.
Carbon dioxide.
Gaseous extinguishing agents.

For safety reasons unsuitable extinguishing agents: Water

Special hazards arising from the substance or mixture:
In case of fire, the following can be released: Carbon monoxide (CO)

Advice for firefighters

Protective equipment:
Wear self-contained respiratory protective device.
Wear fully protective suit.

Additional information: No additional information.

6 Accidental release measures

Personal precautions, protective equipment and emergency procedures:
Particular danger of slipping on leaked/spilled product.
Wear protective equipment.

Environmental precautions: Do not allow to enter sewers/ surface or ground water.

Printing date: 03.04.2014 **Reviewed on:** 03.04.2014

Trade name: ENVIROTEMP™ FR3™ Fluid

Methods and material for containment and cleaning up:
Send for suitable recovery and/or disposal authorities.
Contain and control the leaks or spills with non-combustible absorbent materials such as sand, earth, vermiculite, or diatomaceous earth in drums for waste disposal.
Clay materials (Fuller's earth, oil dry products) saturated with Envirotemp FR3 fluid can, under certain conditions, undergo a slow oxidation that releases heat. If the heat so released cannot escape, it is possible that the temperature may increase.
Reference to other sections:
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

7 Handling and storage

Precautions for safe handling: None
Information about protection against explosions and fires: No special measures required.

Conditions for safe storage, including any incompatibilities
Storage
Requirements to be met by storerooms and receptacles:
Avoid storage near extreme heat, ignition sources or open flame.
Protect from humidity and water.
Information about storage in one common storage facility: Store away from oxidizing agents.
Further information about storage conditions: Store in cool, dry conditions in well sealed receptacles.
Specific end use(s): No additional information.

8 Exposure controls/personal protection

Additional information about design of technical systems: No additional information.
Control parameters
Components with limit values that require monitoring at the workplace: Not required.
Additional information: The lists that were valid during the creation were used as basis.

Exposure controls
Personal protective equipment:
General protective and hygienic measures: No additional information.
Breathing equipment:
Not required under normal conditions of use.
Protection of hands:
Wash hands after use. For extended skin contact, gloves are recommended.


Protective gloves

The glove material has to be impermeable and resistant to the product. Selection of the glove material should be based on the penetration time, rates of diffusion and the degradation of the glove material. Wear protective gloves to handle contents of damaged or leaking units.
Material of gloves:
The selection of a suitable gloves does not only depend on the material, but also on the quality, and varies from manufacturer to manufacturer.
Penetration time of glove material:
The exact break through time has to be determined by the manufacturer of the protective gloves. DO NOT exceed the breakthrough time set by the Manufacturer.

Eye protection:

Safety glasses

Body protection:
Protective work clothing may be required for spills.
Not required under normal conditions of use.

Limitation and supervision of exposure into the environment: No special requirements.

9 Physical and chemical properties

Information on basic physical and chemical properties	
General Information	
Appearance	
Form:	Liquid
Color:	Light green
Odor:	Slight
Odor threshold:	Not determined.
pH-value:	Not applicable.
Change in condition	
Melting point/Melting range:	Not determined.
Boiling point/Boiling range:	>360 °C / >680 °F /
Flash point:	>240 °C / >464 °F / (Closed Cup)
Flammability (solid, gaseous):	Not applicable.
Ignition temperature:	Not applicable.
Decomposition temperature:	Not determined.
Autoignition:	401 - 404°C (ASTM E659)
Danger of explosion:	Product does not present an explosion hazard.
Explosion limits	
Lower:	Not determined.
Upper:	Not determined.
Oxidizing properties:	Non-oxidizing.

Vapor pressure at 20 °C (68 °F):	< 1.3 Pa (< 0.01 mm Hg)
Density at 20 °C (68 °F):	0.92 g/cm³ (7.677 lbs/gal)
Relative density at 20 °C (68 °F):	Not applicable
Vapor density:	Not determined.
Evaporation rate:	Nil.
Solubility in / Miscibility with	
Water:	Insoluble.
Partition coefficient (n-octanol/water):	Not determined.
Viscosity	
Dynamic:	Not determined.
Kinematic at 40 °C (104 °F):	33 - 35 mm²/s
Other information:	No additional information.

10 Stability and reactivity

Reactivity
Chemical stability
Thermal decomposition / conditions to be avoided:
To avoid thermal decomposition, avoid temperatures > 250C.
Possibility of hazardous reactions:
Reacts with strong oxidizing agents.
Reacts with strong alkali.
Conditions to avoid: Store away from oxidizing agents.
Incompatible materials: No additional information.
Hazardous decomposition products: None.

11 Toxicological information

Information on toxicological effects
Acute toxicity: Not acutely toxic (OECD 420)

Primary irritant effect
On the skin: No irritant effect.
On the eye: No irritating effect.
Sensitization: No sensitizing effects known.
Additional toxicological information:
When used and handled according to specifications, the product does not have any harmful effects according to our experience and the information provided to us.
The substance is not subject to classification.

Printing date: 03.04.2014 Reviewed on: 03.04.2014

Trade name: ENVIROTEMP™ FR3™ Fluid

Carcinogenic categories

NTP (National Toxicology Program):
None of the ingredients are listed.

Repeated Dose Toxicity: None.

12 Ecological information

Toxicity

Aquatic toxicity: No Observable Adverse Effect > 10 000 mg/L (ASTM D608, OECD 203).
Oral toxicity: No Observable Adverse Effect > 2 000 mg/kg (OECD 420).
Persistence and degradability: Readily biodegradable.
Bioaccumulative potential: No potential for bioaccumulation.
Mobility in soil: Product has low mobility in soil.
Additional ecological information

Results of PBT and vPvB assessment
PBT: Not applicable.
vPvB: Not applicable.
Other adverse effects: No additional information.

13 Disposal considerations

Waste treatment methods
Recommendation:
Product and packaging must be disposed of in accordance with relevant national and local regulations. May be incinerated. Unopened product may be returned for reclamation.

Uncleaned packagings:
Recommendation: Disposal must be made according to the applicable regulations.
Recommended cleansing agent: Water. Use cleansing agents, if necessary.

14 Transport information

UN-Number	
DOT, ADR, ADN, IMDG, IATA:	Not Regulated
UN proper shipping name	
DOT, ADR, ADN, IMDG, IATA:	Not Regulated

Transport hazard class(es) **DOT, ADR, ADN, IMDG, IATA** **Class:**	Not applicable
Packing group **DOT, ADR, IMDG, IATA:**	Not applicable
Environmental hazards: **Marine pollutant:**	No
Special precautions for user:	Not applicable.
Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code:	Not applicable.
UN "Model Regulation":	-

15 Regulatory information

Safety, health and environmental regulations/legislation specific for the substance or mixture.

SARA

Section 355 (extremely hazardous substances):
None of the ingredient is listed.

Section 313 (Specific toxic chemical listings):
None of the ingredient is listed.

TSCA (Toxic Substances Control Act):
All ingredients are listed.

Proposition 65 (California)

Chemicals known to cause cancer:
None of the ingredient is listed.

Chemicals known to cause reproductive toxicity for females:
None of the ingredient is listed.

Chemicals known to cause reproductive toxicity for males:
None of the ingredient is listed.

Chemicals known to cause developmental toxicity:
None of the ingredient is listed.

Carcinogenic categories

EPA (Environmental Protection Agency):
None of the ingredient is listed.

IARC (International Agency for Research on Cancer):
None of the ingredient is listed.

TLV (Threshold Limit Value established by ACGIH):
None of the ingredient is listed.

MAK (German Maximum Workplace Concentration):
None of the ingredient is listed.

NIOSH-Ca (National Institute for Occupational Safety and Health):
None of the ingredient is listed.

OSHA-Ca (Occupational Safety & Health Administration):
None of the ingredient is listed.

State Right to Know Listings:
None of the ingredient is listed.

Canadian substance listings:

Canadian Domestic Substances List (DSL):
All ingredients are listed.

Canadian Ingredient Disclosure list (limit 0.1%):
None of the ingredient is listed.

Canadian Ingredient Disclosure list (limit 1%):
None of the ingredient is listed.

16 Other information

Date of preparation / last revision: 03/04/2014

Abbreviations and Acronyms:

ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road).
IMDG: International Maritime Code for Dangerous Goods.
DOT: US Department of Transportation.
IATA: International Air Transport Association.
GHS: Globally Harmonized System of Classification and Labelling of Chemicals.
ACGIH: American Conference of Governmental Industrial Hygienists.
EINECS: European Inventory of Existing Commercial Chemical Substances.
ELINCS: European List of Notified Chemical Substances.
CAS: Chemical Abstracts Service (division of the American Chemical Society).
DNEL: Derived No-Effect Level (REACH).
PNEC: Predicted No-Effect Concentration (REACH).

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DAVID Y. IGE
GOVERNOR OF HAWAII

BRUCE S. ANDERSON, Ph.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:
File: SDWB
Fronda01.docx

March 28, 2019

Mr. R. Kalani Fronda
Senior Land Assets Manager, CCIM
Kamehameha Schools
567 South King Street, Suite 200
Honolulu, Hawaii 96813
[via kafronda@ksbe.edu only]

Dear Mr. Fronda:

SUBJECT: KAMEHAMEHA SCHOOLS WAIAWA PROPERTY
CLEARWAY ENERGY GROUP LLC
LAND USE COMMISSION CONDITION DOCKET NO. A87-610
TMKS: (1) 9-4-006: 034, 035, 036, & 037; (1) 9-6-004: 024, 025, & 026; AND (1) 9-6-005: 003
WAIAWA, WAIPIO, EWA, O`AHU, HAWAII

The Department of Health (DOH), Environmental Management Division (EMD) and Hazard Evaluation and Emergency Response (HEER) Office have reviewed the March 20, 2019 Kamehameha Schools (KS) letter which included the May 16, 2014 DOH-EMD letter commenting on the April 9, 2014 KS letter, Solar farm site plan, and technical information.

Based on the reviews by the EMD Branches and HEER Office and the understanding that Clearway will comply with all applicable regulations, the proposed solar farm should have minimal or no impact on ground water. The operation and construction of the proposed solar farm is acceptable to the DOH-EMD and HEER Office, subject to the standard conditions for each program (available online) and specific conditions as listed below and as identified for the solar farm construction and/or operation.

Safe Drinking Water Branch (SDWB)
SDWB reviewed the materials provided by Clearway and saw no increased contamination risk relative to currently zoned use. However, the proposed project is over the zone of contribution to a drinking water source that draws water from an infiltration gallery excavated along the water table. This type of drinking water source is more susceptible to contamination than traditional wells. Clearway shall install and operate the proposed solar farm within the Waiawa Shaft zone of contribution with

sufficient mitigation measures that will prevent the introduction of contamination to the source water shaft. Clearway shall obtain approval of the proposed contamination mitigation measures from the owner of the Waiawa Shaft and continue consultation with the SDWB.

Clean Water Branch (CWB)
Clearway shall obtain the necessary National Pollutant Discharge Elimination System (NPDES) permits for potential discharges of pollutants due to construction activities and Section 401 Water Quality Certifications (WQC), as applicable, during the construction of the proposed solar farm.

Wastewater Branch (WWB)
The WWB has no objection to the construction and operation of the proposed solar farm.

Clean Air Branch (CAB)
Please see the CAB standard comments for land use reviews at:
https://health.hawaii.gov/cab/files/2018/12/Standard-Comments-Clean-Air-Branch-2018-c.pdf.
While the comments provide guidance, it is the responsibility of the contractor to comply will all air regulations for the duration of the construction and operation of the solar farm.

Solid and Hazardous Waste Branch (SHWB)
Clearway shall properly manage the wastes from the construction and operation of the solar farm.

Hazard Evaluation & Emergency Response (HEER) Office
The Clearway solar farm facility may be subject to Tier II reporting and therefore may need an emergency response plan. Please contact Ms. Liz Galvez of the HEER Office at 586-4249 for more information.

If there are any questions, please call Ms. Joanna L. Seto, P.E., SDWB Chief, at 586-4258.

Sincerely,

Keith E. Kawaoka

KEITH E. KAWAOKA, D.Env.
Deputy Director for Environmental Health

JS:mc

c: Mr. Larry Sumida, KS [via lsumida@ksbe.edu only]
Ms. Michelle Swartman, KS [via miswartm@ksbe.edu only]
Ms. Nicola Park, Clearway Energy Group LLC [via Nicola.Park@clearwayenergy.com only]
Ms. Naomi Kuwaye, Esq., Ashford & Wriston [via nkuwaye@awlaw.com only]
Ms. Jennifer A. Lim, Esq., Carlsmith Ball LLP [via jlim@carlsmith.com only]
CAB [via Cab.General@doh.hawaii.gov only]
CWB [via cleanwaterbranch@doh.hawaii.gov only]
SHWB [via lene.ichinotsubo@doh.hawaii.gov only]
WWB [via DOH.wwb@doh.hawaii.gov only]
HEER Office [via MaeRose.Bento@doh.hawaii.gov only]

Waiawa Solar Farm

Waiawa, ‘Ewa, Island of O‘ahu
Tax Map Key: (1) 9-6-004:024 por.

Preliminary Civil Engineering Considerations

Prepared for:
Clearway Energy Group, LLC
4900N Scottsdale Road Suite 5000
Scottsdale, AZ 85251

Prepared by:
G70
111 South King Street, Suite 170
Honolulu, Hawai‘i 96813

July 19, 2019

KS Exhibit 14

1 Project Description

The proposed Waiawa Solar Farm Project will be located on a portion of Kamehameha Schools (KS) property in Waiawa, ‘Ewa, O‘ahu identified as Tax Map Key No. (1) 9-6-004: 024. The solar farm project will be developed by Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC and is planned to generate approximately 36-MW of power (the "Project"). The Project will be constructed within an approximately 200-acre easement area (the "Project Site") as shown on [Figure 1 – Site Plan]. The Project Site is within the 1,395-acre area that was reclassified by the State of Hawai‘i Land Use Commission from the Agricultural District to the Urban District by action taken in 1988 (the entire 1,395-acre area being referred to as the KS Property) The actual solar farm footprint will vary in size, depending on existing topography and system design and layout, but will be contained within the easement area within the State Land Use Urban District, and located over the area designated as the Waiawa Shaft Zone of Contribution ("ZOC").

Photovoltaic modules (PV Panels) will be mounted on steel racks which are anchored to the ground on piers. The racks will be fixed to the piers and will rotate from east to west throughout the day to follow movement of the sun across the sky. Groups of racks will be arranged and combined to deliver power to inverters which will be mounted on concrete pads. Power will be transmitted from inverters to a dedicated Project substation and battery storage system located near the north edge of the Project Site. A 46kV overhead electrical line will transmit power from the substation and battery storage to the point of interconnection (POI) into HECO’s existing 46kv transmission line. The POI is proposed to be directly west, across the gulch near the Ka Uka Blvd exit of H-2 Freeway. The gentie alignment crosses the gulch immediately north of the Project Site and follows the top-of-bank westward to the POI.

Infrastructure improvements required for the solar farm include: substation with a building area under 500 square feet, transformers, battery storage system (fully contained, modular enclosures on roughly 1.5 acres of land within the Project Site), approximately 110,000 to 134,400 PV panels, pad mounted inverters and electrical equipment, access driveways, perimeter fencing, security systems, and drainage and vegetation improvements.

2 Access

The proposed access point for construction traffic, including trucks and employees’ personal vehicles, is at Ka Uka Boulevard-Mililani Cemetery Road, mauka of the H-2 Freeway, which connects to Waiawa Prison Road. Figure 1 shows the access roads to the Project Site. The Project Site is within 1,395 acres of Urban District lands that are owned by Kamehameha Schools (KS Property). Access to the KS Property is over existing roads and through an existing driveway. As shown, minor road improvements are proposed south of Waiawa Prison Road west of the Project Site that would provide two points of connection to the Project. The primary entrance and gate will be located on the southern end of the Project Site, approximately three (3) miles from the Ka Uka Boulevard interchange. A secondary access point to the Project Site is along an existing 20-foot wide road, approximately 3,000 feet north of the primary entrance and gate. Once operational, employee and maintenance vehicles may access the KS Property and Project Site from a private road connection on Waihona Street via Kamehameha Highway.

3 Grading and Drainage

In general, the solar farm will be located on the ridgelines where the former tilled sugar cane fields were located. Based on available topographic information, the Project Site generally slopes mauka to makai. Elevations range from 550 feet to 240 feet above mean sea level (MSL). Optimal placement of the PV panels will be on the flatter, more gradually sloped areas on the ridgelines and away from the steep ravines that slope into to the adjacent gulches.

Clearing, grubbing and grading will be needed on the Project Site for placement of the solar panels, equipment, facilities, access driveways, fence and vegetated buffer. In general, the steeper areas of the Project Site will be avoided, and PV racks will be concentrated in areas of more gradual slopes. The initial rough estimates of potential earthwork volumes for the Project contemplated roughly 350,000-400,000 cubic yards of balanced cut/fill across the Project Site in order to construct access driveways, equipment pads, substation/battery storage pads and to install the tracking-type PV racks on relatively consistent slopes. It is anticipated that the earthwork volumes and related construction costs will be minimized by optimal placement of the PV racks by following the existing grades and elevations. Where possible, the existing agricultural roads will continue to be utilized for access. All grubbed material not reused on the site will be hauled off-site. No foreign or organic material will be used as fill material.

Grading at the Project Site will be in accordance with the Revised Ordinances of Honolulu (ROH) Chapter 14, Articles 13-16. Pursuant to the grading ordinance, a geotechnical engineer will provide cut and fill recommendations prior to design and testing/observation during construction.

Permits and approvals will be required from the State of Hawai'i and the City and County of Honolulu (C&C) to allow grading and grubbing of the site including:

- State of Hawai'i Department of Health (DOH) - NPDES General Permit for Construction Activities, Notice of Intent (NOI-C)
- City and County of Honolulu - Grading, Grubbing and Stockpiling Permit

The applications for both State and C&C grading and erosion control permits identified above require agency review and approval of Grading Plans, Erosion and Sediment Control Plans with temporary Best Management Practices (BMPs), a Storm Water Pollution Prevention Plan, and Drainage Reports that discuss permanent BMPs.

4 Stormwater Quantity Management

Since the solar farm is located on the ridgelines, the Project Site is generally not subject to runoff from offsite areas mauka of the site. Existing runoff currently exhibits sheet flow or shallow concentrated flow into swales that discharge toward adjacent, downstream areas. Existing drainage patterns will not be altered in this Project and earthwork will be limited to leveling for access driveways, equipment pads, substation/battery storage and for smoothing of contours as necessary for installation of the PV racks.

Addition of impervious area from concrete equipment pads, equipment buildings and micro-pile/pier foundations will be minimal. Due to the even distribution of impervious area throughout the Project Site, slight leveling of driveway areas, and use of gravel driveways, the increase in impervious area is not anticipated to increase runoff rates. As a result, there will not be a significant pre-development to post-development increase in stormwater flows due to the construction of the Project. Any increase of stormwater generated within the Project Site will be detained within the Project Site. If required, diversion channels will be constructed with check dams, drop structures or other velocity reducing controls prior to discharge back into the natural drainage features.

Onsite stormwater will be properly directed away from equipment pads and any other structures to minimize erosion. Drainage channels with velocity reduction controls will be constructed in which water will flow through stormwater basin(s) and/or other volume control facilities. The volume control facilities will be situated at the proper downstream locations and will discharge back into the natural drainage features with non-erosive velocities.

5 Stormwater Quality Management

BMPs are required to be implemented for the Project through the grading and erosion control regulations and permits required by the State and C&C agencies. Temporary BMPs are required during construction activities and will remain in place until permanent BMPs can be established. Temporary erosion control measures will be incorporated during the construction period to minimize soil loss and erosion hazards. It is anticipated that the erosion control BMPs to be used on-site may include the following (pending final design):

- Preservation of natural vegetation
- Minimizing areas of clearing and grubbing
- Utilization of vegetated buffers
- Temporary soil stabilization with grass and/or mulch
- Silt fences/fiber filtration tubes
- Gravel bag berms/check dams
- Stabilized construction entrances
- Sediment traps and basins
- Temporary diversion swales and ditches
- Dust control – water application and/or dust screens

Due to the size of the Project, the above temporary BMPs will be implemented in a phased manner through grading increments as required by the regulatory agencies. Details on the grading increments and related BMPs will be shown on the Grading Plans and Erosion and Sediment Control Plans.

Permanent erosion control BMPs will also be incorporated into the design and are required to close out grading and erosion control permits. Typically, permanent BMPs primarily include final stabilization of exposed soils through landscaping or installation of impervious surfaces including pavement and buildings. Additional BMPs are also typically required to provide treatment of stormwater runoff to remove pollutants. For solar farm projects, the total additional impervious surface is minimal, and the PV panels and project components are not pollution-generating surfaces. However, C&C regulations include minimum thresholds for requirements related to installation of BMPs for stormwater quality based on total disturbed area regardless of the added impervious area or pollutant generation from a project.

C&C Civil Engineering Branch (CEB) is responsible for interpreting and approving BMP and drainage system designs. For solar farms, CEB has been defining the project's disturbed area as all the area within the project fence line, regardless of actual ground disturbance. This determination results in the solar farm project being classified as a Priority A project that triggers the low impact development (LID) requirements defined in the Department of Planning and Permitting Administrative Rules Title 20, Chapter 3. The City, however, treats solar farms on a case-by-case basis and will not impose LID requirements if adequately demonstrated that the proposed condition does not adversely impact onsite stormwater quality. The Project is not anticipated to adversely impact stormwater quality because the Project Site will continue to be mostly grass following construction.

6 PV Panel Maintenance

During operations, the Project Site would be largely unoccupied. Panel cleaning will typically occur a couple of times per year, depending on rainfall. It is anticipated that the panels will be cleaned with water delivered by truck to the Project Site unless a closer source of water is later made available. Cleaning solutions and other chemicals will not be used to clean the panels.

A variety of easily controlled grasses are anticipated to be used as a vegetated groundcover. The vegetated groundcover will be maintained through mechanical means, by utilizing zero-turn mowers and weed trimmers. Animals will not be used for grass control.

7 Noise Impacts

Noise impacts are regulated based on HAR Title 11, Chapter 46, which sets decibel limits to noise emanating beyond the property line. Allowable limits are based on time of day and zoning district of the Project Site.

The solar farm is a relatively passive operation. Although the racking systems are a tracking-type system, motors are small and will not generate noise that exceeds acceptable noise levels as limited in HAR Chapter 11-46. The electrical equipment does not include any mechanical or motorized equipment that will generate noise. There will be some minimal corona noise coming from the electrical equipment and battery storage equipment. Operation and maintenance activities may result in minimal vehicular noise from maintenance staff. It is not anticipated that operations at the site would generate noise that exceeds acceptable noise levels.

During construction, noise levels are likely to increase as a result of earth moving equipment, installation of solar panels, construction vehicles and other construction activities. Noise generated from construction activities will comply with the regulations for community noise control in HAR Chapter 11-46. Due to the remote location of the Project and distance from communities it is anticipated that any impacts would be minimal. If necessary, noise permits will be obtained through DOH.

8 Air Quality

There are no direct air emissions from operating the solar farm. Operation and maintenance activities may result in fugitive dust or tailpipe emissions from vehicular traffic and landscape maintenance. However, it is not anticipated that the operations at the Project Site would adversely affect air quality.

During construction, there will be short-term impacts in the form of exhaust from increased traffic and fugitive dust generated by the construction activity. Temporary BMPs will be used to mitigate impact from fugitive dust during construction. These BMPs may include dust fences, windbreaks, watering of disturbed areas and other soil management measures. BMPs will be identified and included on the erosion and sediment control plans that are required for both C&C and State grading and erosion control permit approvals. Construction activities at the Project Site will comply with the regulations for fugitive dust control in HAR, Section 11-60.1.

July 19, 2019

Mr. Jeff Overton
Principal
Group 70
111 S. King Street, Suite 170
Honolulu, HI 96813

Subject: ***Construction Traffic Assessment for the Proposed Waiawa Solar Farm (Oahu, HI)***

Dear Mr. Overton:

Fehr & Peers has prepared a traffic assessment for a proposed solar farm to be constructed by Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC, in the Waiawa area on the island of O'ahu. This letter includes an assessment of the vehicle trip generation anticipated during both project construction and typical project operations, as well as an analysis of intersection operations to determine any traffic-related impacts from the project.

PROJECT DESCRIPTION

The proposed project is a new solar farm installation located in the Waiawa area, generally east of the H-2 Freeway/Ka Uka Boulevard interchange in Waipio and mauka of Waihona Street in Pearl City. Construction of the site will consist of a 36-megawatt (MW) installation within an area of approximately 200 acres of land. Accordingly, this assessment focuses on traffic impacts related to the construction and operations of the proposed facility. **Figure 1** shows the proposed site plan.

Once operational, the site will be primarily self-sustaining with minimal periodic maintenance required. The solar farm is anticipated to have no more than five employees on-site at any given time. No permanent employees will be on-site; however, employees will visit the site over the course of the year to conduct maintenance such as mowing and/or panel washing. As a result, the number of employee vehicle trips generated by the proposed project during typical operations is considered negligible (i.e. less than the standard daily variation in traffic during peak hours). The primary traffic concerns for the proposed project are associated with potential temporary construction traffic impacts.

Construction is expected to begin in the fourth quarter 2020 and continue into late 2021. Construction is anticipated to require a maximum of 175 workers on-site at a given time. Construction workers will be encouraged to carpool. Construction staff will be on-site between 6:00 AM to 5:00 PM Monday through Saturday. The construction work period will be from 7:00 AM to 5:00 PM. Similar to the construction of solar

KS Exhibit 15

facilities in other locations, the number of employees for the first three months and the last three months of construction will be lower with peak on-site employment occurring for the five to six months in the middle of the project schedule.

The number and types of vehicles planned to be involved during peak construction are described as follows:

- 20 heavy haul trucks (ex: 18-wheelers, water trucks, garbage trucks) per day
- 30 work trucks (ex: crew, foreman, superintendents) per day
- 100 worker personal vehicles per day

Because the project is scheduled to be completed by late 2021, the transportation analysis examines impacts using a Year 2021 baseline.

STUDY AREA

The proposed project is located just west of Pearl City, mauka of the H-1 freeway and east of the H-2 freeway/Ka Uka Boulevard interchange. The site is currently undeveloped. Surrounding roadways include Ka Uka Boulevard-Mililani Cemetery Road from the H2 freeway and Waihona Street. The traffic assessment evaluated the operations at the following four (4) intersections near the site:

1. Ka Uka Boulevard/H-2 SB Off-Ramp
2. Ka Uka Boulevard/H-2 SB On-Ramp
3. Ka Uka Boulevard/H-2 NB Off-Ramp
4. Kamehameha Highway/Waihona Street

STUDY SCENARIOS

The operations of the study intersections were evaluated during the busiest peak (one) hour in the morning (between 7:00 and 9:00 AM) and in the afternoon (between 4:00 and 6:00 PM). The peak hour for each intersection was determined by existing traffic count data. Traffic operations were evaluated for the following scenarios:

- **Existing (2019) Conditions** – The analysis of existing traffic conditions was based on 2019 intersection turning movement counts collected for the project during peak hours.
- **Construction Year (2020) Plus Project Construction Traffic Conditions** – Existing peak-hour volumes increased to account for growth in the area to the year of anticipated project construction in 2020. Traffic growth was estimated based on an annual one percent growth factor to account for

ambient growth. Analysis of Construction Year (2020) traffic conditions includes the addition of forecasted traffic from construction of the proposed project, inclusive of construction trucks and employee vehicles. Note that while construction staff will be on site starting at 6:00 AM, all project commute traffic was conservatively added to the AM peak hour count, which occurred between 7:00 and 9:00 AM.

- **Baseline (2021) No Project Conditions** – Existing peak-hour volumes increased to account for growth in the area to the year of anticipated project operations beginning in 2021. Traffic growth was estimated based on an annual one percent per year growth factor to account for ambient growth.
- **Baseline (2021) Plus Project Conditions** – Baseline (2021) Conditions plus the addition of project-generated traffic once the project is fully operational. Once operational, project-generated traffic from the solar site is anticipated to be no more than five (5) trips per day.

VEHICLE ACCESS

The proposed access point for construction traffic, including trucks and employees' personal vehicles, is at Ka Uka Boulevard-Mililani Cemetery Road, mauka of the H-2 Freeway, which connects to Waiawa Prison Road. **Figure 2** shows the access roads to the Waiawa solar site. The proposed solar site is within 1,395 acres of Urban District lands that are owned by Kamehameha Schools (KS Property). Access to the KS Property is over existing roads and through an existing driveway. As shown, minor road improvements are proposed south of Waiawa Prison Road west of the proposed solar site that would provide two points of connection to the project. The primary entrance and gate will be located on the southern end of the project boundary. This location is approximately three (3) miles from the Ka Uka Boulevard interchange and any temporary queuing at the project driveway would not impact freeway interchange operations. A secondary access point is along an existing 20-foot wide road, approximately 3,000 feet north of the primary entrance and gate. Once operational, employee and maintenance vehicles may access the site from a private road connection on Waihona Street via Kamehameha Highway.

Regional connections are provided to the H-2 freeway via Ka Uka Boulevard-Mililani Cemetery Road. Regional traffic would approach from either Ka Uka Boulevard (from the west) or from either direction on the H-2 Freeway and would turn onto Mililani Cemetery Road. Traveling north, vehicles on Mililani Cemetery Road would negotiate several curves before reaching the Waiawa Prison Road intersection where they would turn right (south) onto the existing road to the KS Property. Waiawa Prison Road is narrower than Mililani Cemetery Road but both facilities serve a limited amount of traffic. Construction employees will park within the KS Property along a temporary laydown yard within the project site to be accessed off the private road south of Waiawa Prison Road.

From a jurisdictional perspective, Ka Uka Boulevard in the immediate vicinity of the H-2 freeway is maintained and operated by the Hawaii Department of Transportation – Highways Division (HDOT). Mililani Cemetery Road is maintained by the City & County of Honolulu Department of Transportation Services (DTS), while Waiawa Prison Road is a private street with multiple owners.

Alternate access was considered from Waihona Street approximately 1,780 feet mauka of Kamehameha Highway. The intersection of Waihona Street and Kamehameha Highway was included in this traffic assessment. However, due to existing conditions and potential constraints, such as sight distance requirements and potential loss of on-street parking, consideration for this access point for construction was eliminated. However, this route may provide access to employee or maintenance vehicles once the site is operational.

ALTERNATIVE MODE ACCESS

The City and County of Honolulu and HDOT do not specify impact criteria for pedestrian, bicycle, and transit impacts. However, these impacts are generally evaluated based on whether a proposed project would: 1) conflict with existing or planned pedestrian, bicycle, or transit facilities, or 2) create walking, bicycling, or transit use demand without providing adequate and appropriate facilities for non-motorized mobility.

BICYCLE AND PEDESTRIAN TRAVEL

Given the undeveloped nature of the site and the low-density development of the immediate surrounding area, the potential conflict is low between site-generated traffic and non-automobile modes including walking and biking. North of the site at Ka Uka Boulevard east of the H-2 freeway, the amount of pedestrian and bicycle activity is negligible. Mililani Cemetery Road and Waiawa Prison Road both include vehicle travel lanes only and are not intended to accommodate separate bicycle and pedestrian travel. Given the long distances between the H-2 interchange and both the cemetery (approximately 1.2 miles) and the correctional facility (approximately 2.9 miles), significant use of non-automobile modes is not anticipated. In addition, no sidewalks or bike lanes are provided on the Ka Uka Boulevard overcrossing over H-2.

TRANSIT

Transit service in the study area consists of one route makai of H-2; no transit service is currently provided mauka of the freeway. The nearest existing transit stop to the site is the Moaniani Street/Ka Uka Boulevard bus stop served by TheBus route 433, which provides access between Waipahu and Waikele. Route 433 operates with 30-minute headways during the AM and PM peak hours. The planned Honolulu High Capacity Transit Corridor extends from Kapolei to Ala Moana Shopping Center and is expected to initiate service in late 2020, with full operations anticipated in 2025. The closest stop to the site will be the Pearl Highlands station, located makai of Kamehameha Highway opposite Waihona Street. The Pearl Highlands station will serve as a regional transit hub and will include a park and ride facility, as well as a transfer station for buses from Central Oahu. The existing stop-controlled Waihona Street/Kamehameha Highway intersection will be signalized as part of the rail project and will improve overall access to the uses on Waihona Street.

While separate bicycle, pedestrian, and transit facilities are typically encouraged to reduce vehicle traffic, the rural circulation system, distant land uses in the vicinity of the site, and nature of the proposed project are typically not conducive to multi-modal travel.

EXISTING TRAFFIC VOLUMES

The addition of traffic from the proposed project may impact operations of intersections near the site during the anticipated 12-month construction period. To determine potential impacts, the operations of the four (4) study intersections were evaluated during weekday AM and PM peak hour conditions. Traffic counts were collected at the study intersections in February 2019. **Figure 3** illustrates the study intersections. Existing land configuration and signal controls were obtained through field observations. **Figure 4** presents the existing weekday AM and PM peak hour turning movement volumes.

CONSTRUCTION YEAR 2020 TRAFFIC VOLUMES

Project construction is expected to begin during the last quarter of year 2020. Forecasted construction traffic generated by the proposed project was added to the Construction Year 2020 volumes to determine the potential impacts. For the purpose of this analysis, existing (2019) traffic volumes were increased by an average growth factor of one percent and rounded to the nearest tenth to forecast the Construction Year 2020 traffic volumes. This methodology is consistent with other traffic studies completed for local and regional projects on Oahu. Given the limited existing traffic mauka of the H2 freeway, this approach to forecasting 2020 volumes is considered extremely conservative. For instance, at the intersection of H2 Northbound Ramps/Ka-Uka Boulevard, the existing westbound right turn traffic volume is four (4) vehicles in the AM peak hour. The forecast Construction Year (2020) traffic volume for the same movement, increased by one percent (or 0.4 trips) and rounded to the nearest tenth, brings the forecasted volume to 10 vehicles.

BASELINE YEAR 2021 TRAFFIC VOLUMES

The solar project is expected to be operational in year 2021. For the purpose of this analysis, existing (2019) traffic volumes were increased by an average growth factor of one percent per year and rounded to the nearest tenth to forecast the Baseline Year 2021 traffic volumes. Forecasted trip generation from the project during typical operations was added to the Baseline Year 2021 traffic volumes to determine if any impacts are anticipated. This methodology is consistent with other traffic studies completed for local and regional projects on Oahu. As explained previously, this approach to forecasting 2021 volumes is considered extremely conservative.

FORECAST PROJECT TRIP GENERATION

The primary traffic issue for solar farm projects is associated with the temporary construction traffic. Construction traffic comprises private vehicles driven by construction workers plus trips made by trucks delivering materials, hauling earth and debris, and providing other services (e.g., water trucks). In general, workers are assumed to make one inbound trip and one outbound trip for a total of two daily trips. Detailed information on construction activities was provided by Waiawa Solar Power LLC and included the number of trucks needed to deliver the photovoltaic panels, steel piles for mounting the panels, gravel for on-site roadways, etc. This information was used to estimate the total number of truck trips during the planned construction period of 12 months. It is important to note that this information is preliminary and will be refined once a specific contractor is selected to construct the project. At that time, a construction traffic management plan must be prepared for the City and County of Honolulu.

This traffic assessment report considered two scenarios. The first scenario represents Construction Year 2020 traffic volumes plus forecasted construction-related traffic with the assumption that 100 construction worker vehicles drive to and from the site within the KS Property. This analysis assumes all worker vehicles arrive during the AM peak hour and depart during the PM peak hour. Construction truck traffic was spread equitably throughout the hours of operation to reflect the rotation of trips typical for construction activity. Forecasted trip generation for the construction portion of the project is summarized in **Table 1** below.

Table 1-Project Construction Trip Generation

Trip Type	Daily Trips	AM Peak Hour			PM Peak Hour		
		Total	In	Out	Total	In	Out
Auto[1]	200	100	100	0	100	0	100
Trucks[2,3]	100	10	5	5	10	5	5
Total	**300**	**110**	**105**	**5**	**110**	**5**	**105**

[1] Assumes construction employees will be encouraged to carpool
[2] Assumes equipment, debris, hauling, excavation, etc. trucks arrive and depart during peak hours as well as off peak hours
[3] This table reflects an estimated sum of 100 daily construction and work trucks. In the analysis (see Attachment A), a PCE factor of 2.5 per truck was applied to all truck trips assigned to the roadway network. The resulting PCE trip generation is 250 daily truck trips.

A Passenger Car Equivalent (PCE) factor of 2.5 vehicle trips per construction or work truck was applied to account for the larger impact and slower speeds of construction vehicles on the roadway network. As shown, the forecasted trip generation during construction is 300 daily trips, including 110 trips during the AM and 110 trips during the PM peak hour conditions.

The second scenario represents Baseline Year 2021 traffic volumes plus the addition of project-generated traffic once the solar site is fully constructed and operational. Once operational, the solar farm is anticipated to have a maximum of five (5) employees on site at any given time. As a result, the employee trips generated by the proposed project are nominal. The trip generation summary for the 2021 Plus Project scenario is presented in **Table 2** below.

Table 2-Project Operations Trip Generation

Trip Type	Daily Trips	AM Peak Hour			PM Peak Hour		
		Total	In	Out	Total	In	Out
Employees[1]	10	5	5	0	5	0	5

[1] Assumes five (5) employees on-site once project is operational

PROJECT TRIP DISTRIBUTION

Based on the available regional access points/interchanges and the fact that materials will be transported between the KS Property and the Grace Pacific Makakilo or Ameron Kapa'a quarries, all heavy trucks are expected to use the H-2 Freeway and turn right onto Ka Uka Boulevard from the H-2 Northbound Off-Ramp to access the site. Construction workers and employees are expected to come from throughout the island to travel to the proposed solar farm. The estimated trip distribution for construction worker vehicle trips is listed below:

- To/From the north—20%
- To/From the west—40%
- To/From the east—40%

Figure 5 illustrates the project trip distribution. Trip distribution percentages were applied to the forecasted trip generation for each scenario and assigned to the surrounding roadway network to assess potential traffic impacts in the area. The assignment of the project construction-related trips generated is shown on **Figure 6**.

INTERSECTION OPERATIONS ANALYSIS

The analysis of roadway operations performed for this study is based upon procedures presented in the *Highway Capacity Manual* (HCM), published by the Transportation Research Board. The operations of roadway facilities are described with the term level of service (LOS). LOS is a qualitative description of traffic flow based on such factors as speed, travel time, delay, and freedom to maneuver. Six levels are defined from LOS A, with the least congested operating conditions, to LOS F, with the most congested operating conditions. LOS E represents "at-capacity" operations. Operations are designated as LOS F when volumes exceed capacity, resulting in stop-and-go conditions. The computerized analysis of intersection operations was performed utilizing the SYNCHRO 10 traffic analysis software.

SIGNALIZED INTERSECTION ANALYSIS

HCM methodology defines LOS for signalized intersections in terms of delay, or more specifically, average stopped delay per vehicle. Delay is a measure of driver and/or passenger discomfort, frustration, fuel consumption and lost travel time. This technique uses 1,900 vehicles per hour per lane (VPHPL) as the maximum saturation volume of an intersection. This saturation volume is adjusted to account for lane width, on-street parking, pedestrians, traffic composition (i.e., percentage trucks) and shared lane movements (i.e. through and right-turn movements originating from the same lane). The LOS criteria used for this technique are described in **Table 3.**

Table 3 – Signalized Intersection Level of Service Criteria	
Average Stopped Delay Per Vehicle (seconds)	**Level of Service (LOS) Characteristics**
<10.0	*LOS A* describes operations with very low delay. This occurs when progression is extremely favorable, and most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.
10.1 – 20.0	*LOS B* describes operations with generally good progression and/or short cycle lengths. More vehicles stop than for LOS A, causing higher levels of average delay.
20.1 – 35.0	*LOS C* describes operations with higher delays, which may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
35.1 – 55.0	*LOS D* describes operations with high delay, resulting from some combination of unfavorable progression, long cycle lengths, or high volumes. The influence of congestion becomes more noticeable, and individual cycle failures are noticeable.
55.1 – 80.0	*LOS E* is considered the limit of acceptable delay. Individual cycle failures are frequent occurrences.
>80.0	*LOS F* describes a condition of excessively high delay, considered unacceptable to most drivers. This condition often occurs when arrival flow rates exceed the LOS D capacity of the intersection. Poor progression and long cycle lengths may also be major contributing causes to such delay.

UNSIGNALIZED INTERSECTION ANALYSIS

The HCM outlines methodology for unsignalized intersections, including two-way and all-way stop controlled intersections. The SYNCHRO 10 software supports this methodology and was utilized to produce LOS results. The LOS for a two-way stop controlled (TWSC) intersection is determined by the computed control delay and is defined for each minor movement. **Table 4** summarizes the LOS criteria for unsignalized intersections.

Table 4 – Unsignalized Intersection Level of Service Criteria	
Average Control Delay (sec/veh)	**Level of Service (LOS)**
<10	A
>10 and ≤15	B
>15 and ≤25	C
>25 and ≤35	D
>35 and ≤50	E
>50	F

INTERSECTION IMPACT CRITERIA

The analysis compares existing traffic conditions to the Construction Year (2020) with project construction traffic scenario to determine if the addition of construction traffic to existing roadways is expected to result in a significant impact on the surrounding area. Similarly, the analysis of Baseline Year (2021) conditions compares future no-project operations with conditions when the project is fully built and operational to determine whether or not project implementation is expected to result in significant impacts. Based on previous studies conducted for both the City & County of Honolulu and HDOT, the minimum acceptable operating standard for a signalized intersection is LOS D. If the addition of project traffic is expected to degrade desirable service levels (LOS D or better) to lower than desirable service levels (LOS E or F) then the project is considered to have a project-specific impact. Impacts are also defined to occur when the addition of project traffic exacerbates locations already operating or projected to operate at LOS E or F. When evaluating intersection operations at any location, other factors are considered in the analysis, such as traffic volumes, volume-to-capacity (V/C) ratios, and potential secondary impacts to pedestrian, bicycle, and transit travel.

Significant impacts are categorized as either a project-specific or cumulative impact. For unsignalized intersections, the project is determined to have a significant *project-specific* impact if the addition of project traffic causes an unsignalized intersection to degrade from LOS D or better to LOS E or F during peak hours and if the peak hour traffic signal warrant is satisfied. An impact is considered a *cumulative* impact when it adds traffic to a study location that includes a controlled approach that operates at an undesired level (i.e., LOS E or F) and if the peak hour traffic signal warrant is satisfied. The use of the peak hour traffic signal warrant is one indication that an alternate traffic control device may be needed at a study location. Significant impacts typically apply to traffic operations after a project is developed and operative. Construction-related impacts are considered temporary and are addressed with provisional mitigation measures during construction.

INTERSECTION LEVEL OF SERVICE (LOS) RESULTS

The analysis of intersection turning movement volumes was completed for all scenarios, including Existing (2019) Conditions, Construction Year (2020) with Project Construction Conditions, Baseline (2021) No Project Conditions, and Baseline (2021) Plus Project Conditions. The results of the intersection LOS analysis are summarized in **Table 5**. **Attachment A** includes the detailed LOS calculation worksheets. Volumes for Baseline (2021) Plus Project Conditions are shown on **Figure 7**.

Table 5 – Summary of Intersection Operations										
Intersection	**Peak Hour**	**Existing 2019 Conditions**		**2020 Plus Project Construction**		**2021 No Project**		**2021 Plus Project**		
		Delay[1]	**LOS[2]**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	
Ka Uka Blvd/ H-2 SB Off Ramp	AM	14.3	B	15.1	B	14.5	B	14.6	B	
	PM	49.6	D	51.3	D	51.3	D	51.3	D	
Ka Uka Blvd/ H-2 SB On Ramp*	AM	8.2	A	8.3	A	8.2	A	8.2	A	
	PM	9.6	A	10.1	B	9.7	A	9.7	A	
Ka Uka Blvd/ H-2 NB Off Ramp	AM	8.1	A	8.7	A	8.4	A	8.4	A	
	PM	47.5	D	**55.2**	**E**	49.2	D	49.4	D	
Kamehameha Hwy/ Waihona St*[3]	AM	18.9	C	19.3	C	21.0	C	21.0	C	
	PM	**79.5**	**F**	**110.9**	**F**	**130.7**	**F**	**130.7**	**F**	

Source: Fehr & Peers, March 2019 * indicates unsignalized intersection

[1] Whole intersection weighted average stopped delay expressed in seconds per vehicle for signalized intersections. The worst movement is presented for unsignalized intersections.
[2] LOS calculations performed using the *Highway Capacity Manual (HCM) 6th Edition* method.
[3] The intersection of Kamehameha Hwy/Waihona Street was initially considered but then excluded as a construction access point; no construction-related traffic is assigned at this intersection.
LOS E or F operations highlighted in **bold.**

Currently, all study intersections operate at Level of Service (LOS) D or better during the peak hours, with the exception of Kamehameha Highway/Waihona Street, which is unsignalized and operates at LOS F during the PM peak hour. The intersection of Kamehameha Highway/Waihona Street was included in this traffic assessment. However, due to existing conditions and potential constraints, such as sight distance requirements and potential loss of on-street parking, consideration for this access point during project construction was eliminated. Therefore, the LOS F operations do not reflect any traffic impacts caused or influenced by the construction of the proposed solar project.

All intersections through which construction traffic is routed are forecast to operate at desirable LOS D or better during both peak hours under the construction traffic scenario with the exception of the Ka Uka Boulevard/H-2 Northbound Off-Ramp intersection, which is forecast to operate at LOS E during the PM peak hour under Construction Year (2020) plus Construction conditions. The forecasted delay is 0.2 seconds above the LOS D threshold during the PM peak hour. As discussed previously, ambient 2020 volumes are considered extremely conservative based on the forecast methodology of a one percent per year annual growth adjustment and rounded to the nearest tenth value. Some movements, such as the northbound through movement at the off-ramp, are expected to have negligible volumes but were analyzed with at least 10 trips during the peak hour based on the forecast methodology. Therefore, the LOS results are considered exacerbated. Based on the trip generation projects for construction traffic, the intersection is anticipated to operate similarly to existing (LOS D) operations and any noticeable impacts will be temporary.

POTENTIAL CONSTRUCTION IMPACTS AND IMPROVEMENT OPTIONS

It is recommended that at least one of the following actions be included in the project's construction traffic management plan to maintain desirable intersection operations at the Ka Uka Boulevard interchange:

- Adjust work schedule shifts slightly so that worker trips are reduced during the PM peak hour. Existing traffic counts show that the PM peak hour at the H-2 southbound ramps occurs at 4:30 to 5:30 PM. Therefore, it is recommended that the volume of departures be reduced between 4:30 PM and 5:30 PM to avoid the busiest or peak traffic time.
- Encourage more carpooling greater than the currently proposed rate (1.75 workers per car) for workers
- Implement an employee shuttle service to bring workers to/from an off-site location

After construction, the operational solar site is anticipated to have a maximum of five (5) trips during each peak hour. This additional traffic would have a negligible effect on intersection turning movement operations at all study locations and the Baseline Year 2021 intersection delay and LOS would be imperceptible.

ROADWAY SEGMENT OPERATIONS

In addition to evaluating peak hour intersection operations, it is important to assess the potential impact of construction traffic on all of the access roadway segments leading to the KS Property. H-2 and Ka Uka Boulevard are higher capacity roadways that include typical lane widths and are built to higher standards than other roadways. Mililani Cemetery Road is a two-lane roadway with lane widths of approximately 12 feet plus shoulder areas along most of the segment between Ka Uka Boulevard and Waiawa Prison Road. Although the prison does not generate a significant amount of existing traffic, the addition of truck traffic to all of these facilities is not anticipated to result in any operational or apparent safety issues.

A potential issue is the relatively narrow width and alignment of Waiawa Prison Road, particularly for heavy vehicles transporting construction equipment and materials. The width of this roadway varies but is roughly 20 feet along several sections between Mililani Cemetery Road and the KS Property access driveway. In addition, there are several curves where sight distance and the adjacent shoulder width are limited. While this is not an issue for typical passenger vehicles or light duty trucks, it is possible that large trucks may conflict with opposing traffic on this roadway by reducing the available width. While the estimated volume of project-generated truck traffic is 100 trips over the course of a day (i.e., 50 trucks traveling in and out of the site), this activity would occur over an extended period and there would be some new drivers on this road where driving conditions may not be familiar to them.

It is important to note that construction activities have previously occurred in the area that added heavy truck traffic to Waiawa Prison Road and Mililani Cemetery Road. This activity included the decommissioning of several reservoirs that required trucks to transport heavy material and water along these roadways. For a four-month period, at least two heavy trucks would make daily rounds on and off Waiawa Prison Road without incident. No significant operational or safety issues were identified by Kamehameha Schools' representatives who monitored the construction activities. In addition, Hawaiian Electric (HECO) recently used Kamehameha School lands as a laydown area for 138kV pole replacements with no known complaints during construction activity.

To minimize the potential for conflicts and to maintain adequate traffic operations, the contractor should prepare a construction traffic management plan that includes the following:

- Signage between the Ka Uka Boulevard interchange and the KS Property driveway on Waiawa Prison Road that trucks are traveling and entering/exiting the roadway.
- Ensure that adequate sight distance is provided for drivers on Waiawa Prison Road approaching and departing the KS Property driveway. Measures may include traffic control signage (ex. stop or yield signs) and removal of vegetation that impede standard approach, departure, and height sight distances.
- If needed, coordinate with the City and County of Honolulu to remove vegetation in the public right of way that might impede large construction vehicles on both Mililani Cemetery Road and Waiawa Prison Road.
- Manual traffic control on Waiawa Prison Road to manage construction and prison traffic and to minimize conflicts. This could include the use of radios, flag persons, and/or temporary signals and lighting to assist with the control of vehicles and the provision of adequate sight distance (as needed).
- Maintain access to the Waiawa Correctional Facility

CONCLUSION

The proposed project will generate a negligible amount of vehicle traffic when the solar farm is fully constructed and operational. During construction, construction-related activity is expected to generate approximately 300 daily vehicle trips, including 110 vehicle trips during each peak hour. According to the project sponsor Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC, construction activity is planned occur for a 12-month period and any construction-related traffic impacts will be temporary. A detailed construction traffic management plan will be prepared prior to the start of construction to ensure that the project has a minimal impact to the transportation system during the construction period.

Based on the evaluation presented in this report and typical City & County of Honolulu Department of Planning and Permitting (DPP) requirements for assessing traffic-related impacts, the proposed point of access is sufficient for the anticipated construction traffic required to build the solar project provided measures are implemented to mitigate the temporary impacts. These measures include a construction traffic management plan that minimizes traffic during the peak commute hours to the extent possible, ensures adequate sight distance at the driveway access point, and informs other drivers on Waiawa Prison Road of construction activities and heavy vehicle traffic.

We appreciate the opportunity to assist you with this project. Please let us know if you have any questions on the information in this report.

Sincerely,

FEHR & PEERS

D. Sohrab Rashid   Stephanie Cheng

Sohrab Rashid, TE
Principal

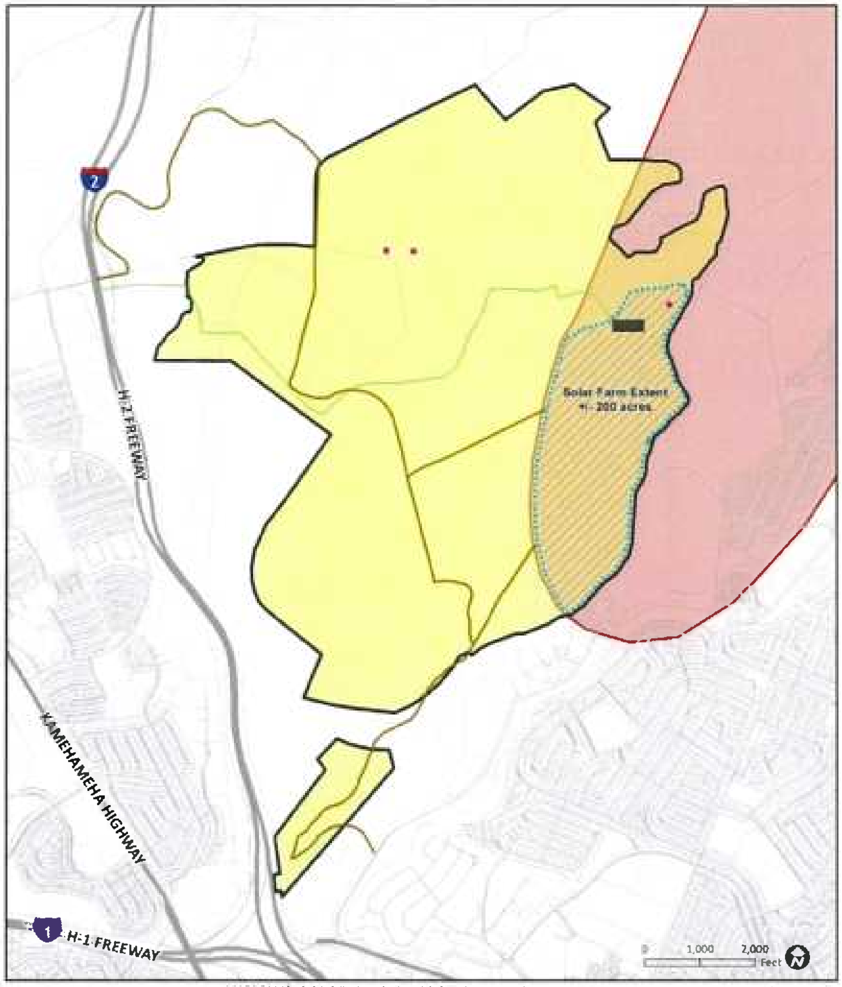
Stephanie Cheng, AICP
Associate

SD19-0299

Attachments:

Figure 1 – Vicinity Map and Site Plan
Figure 2 – Proposed Project Access Roads
Figure 3 – Study Locations
Figure 4 – Peak Hour Traffic Volumes and Lane Configurations – Existing Conditions
Figure 5 – Project Construction Traffic Trip Distribution
Figure 6 – Peak Hour Traffic Volumes and Lane Configurations – Project Construction Volumes
Figure 7 – Peak Hour Traffic Volumes and Lane Configurations – 2020 Plus Construction
Attachment A – Level of Service Analysis Worksheets

ATTACHMENT A: LEVEL OF SERVICE ANALYSIS WORKSHEETS



WAIAWA SOLAR POWER, LLC CONCEPTUAL SITE PLAN

July 19, 2019

Legend

- Solar Farm Extent, ~200 acres
- Utility Improvements Area (~ 2.5 acres)
- KS Waiawa Property (SLUD- Urban, Docket A87-610)
- Hydrologic Zone of Contribution (ZoC)
- Archaeological Preservation Area
- Gen-Tie Alignment
- Access Route

G70

Disclaimer: This Graphic has been prepared for general planning purposes only and should not be used for boundary interpretations or other spatial analysis.

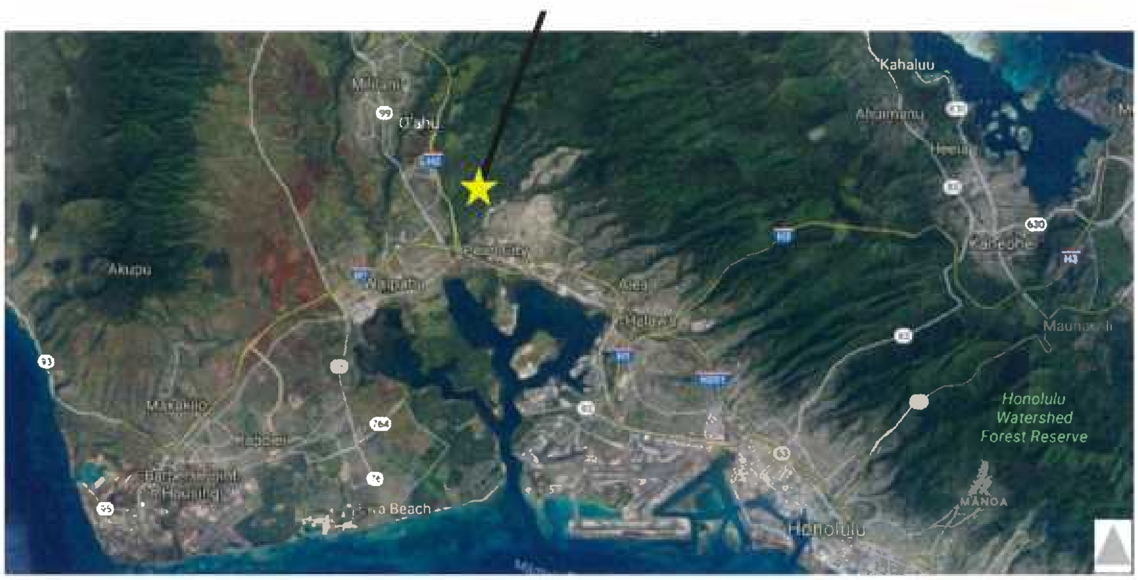


Figure 1

Vicinity Map and Site Plan

Clearway Energy - Waiawa Solar

Figure 2
Proposed Project Access Roads

Legend

- Study Intersection
- Access Road Improvements
- Waiawa Solar Site

Figure 3

Study Locations

Legend

Study Intersection — — Access Road Improvements Waiawa Solar Site

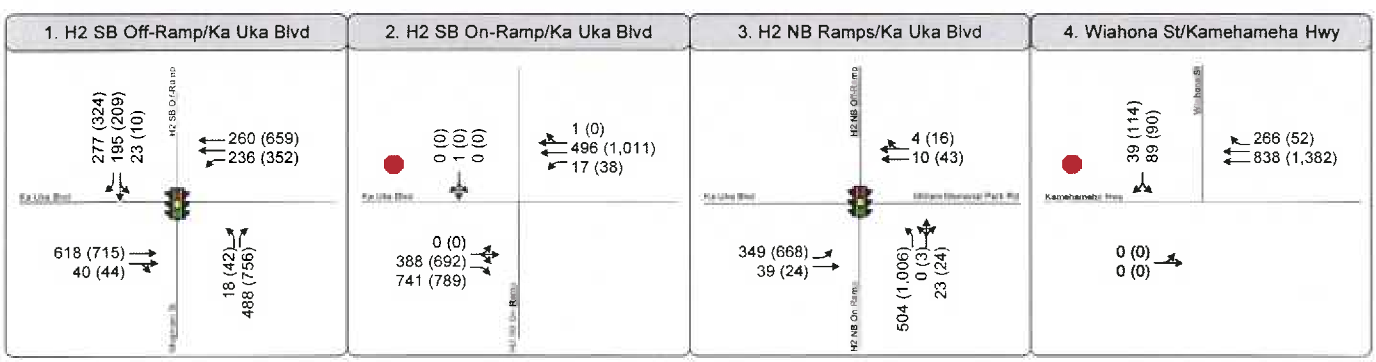


Figure 4

Peak Hour Traffic Volumes and Lane Configurations - Existing Conditions

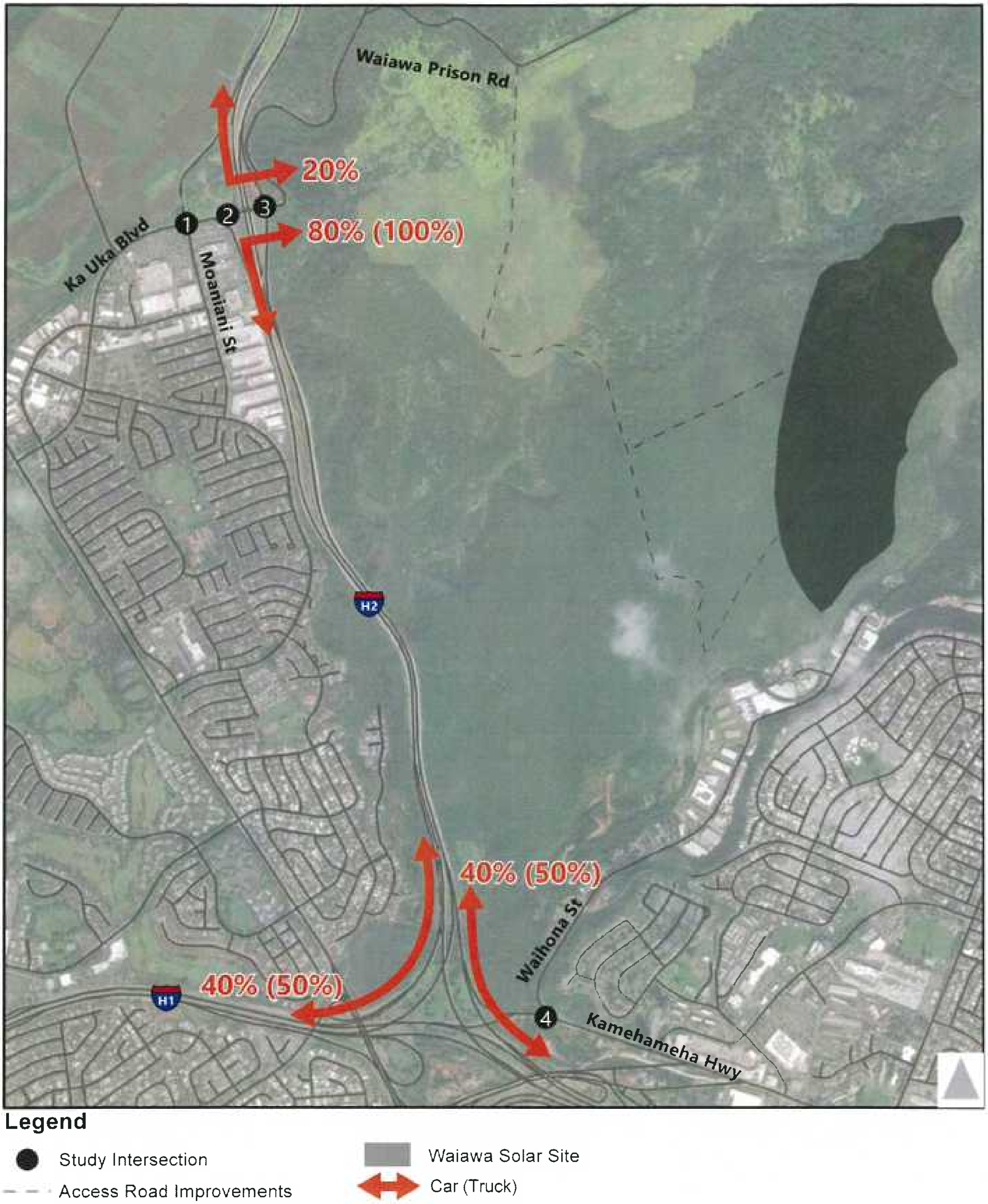


Figure 5
Project Construction Traffic Trip Distribution

Legend

Study Intersection — — Access Road Improvements Waiawa Solar Site

Note: A Passenger Car Equivalent Factor (PCE) of 2.5 was applied to all construction generated truck trips

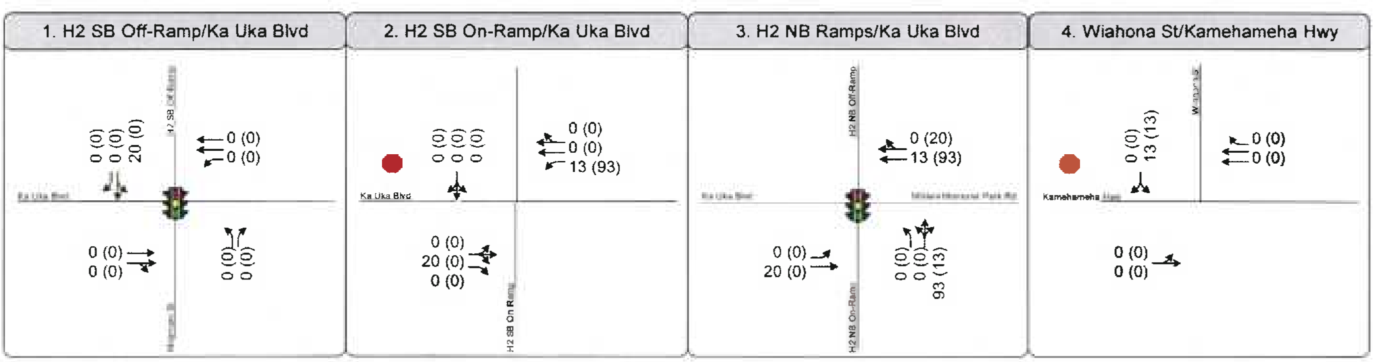


Figure 6

Peak Hour Traffic Volumes and Lane Configurations - Project Construction Volumes

Legend

Study Intersection — — Access Road Improvements Waiawa Solar Site

Note: A Passenger Car Equivalent Factor (PCE) of 2.5 was applied to all construction generated truck trips

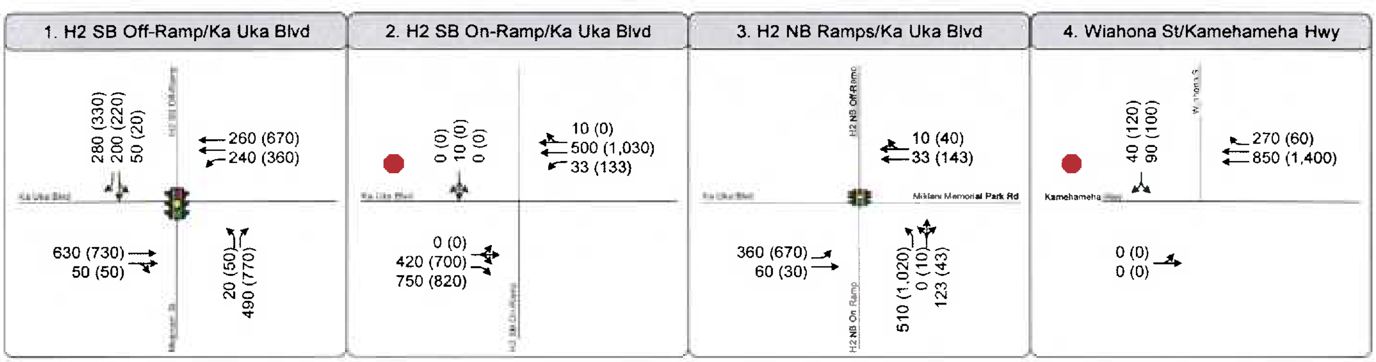


Figure 7

Peak Hour Traffic Volumes and Lane Configurations - 2020 Plus Construction

ATTACHMENT A: LEVEL OF SERVICE ANALYSIS WORKSHEETS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	618	40	236	260	0	18	0	488	23	195	277
Future Volume (veh/h)	0	618	40	236	260	0	18	0	488	23	195	277
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1841	1841	1841	1796	0	1737	0	1811	1856	1856	1870
Adj Flow Rate, veh/h	0	657	40	251	277	0	19	0	5	24	207	111
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	4	4	4	7	0	11	0	6	3	3	2
Cap, veh/h	0	1090	66	327	2084	0	0	0	0	37	319	305
Arrive On Green	0.00	0.33	0.33	0.19	0.61	0.00	0.00	0.00	0.00	0.19	0.19	0.19
Sat Flow, veh/h	0	3441	204	1753	3503	0		0		192	1654	1585
Grp Volume(v), veh/h	0	343	354	251	277	0		0.0		231	0	111
Grp Sat Flow(s),veh/h/ln	0	1749	1804	1753	1706	0				1846	0	1585
Q Serve(g_s), s	0.0	7.5	7.5	6.2	1.6	0.0				5.3	0.0	2.8
Cycle Q Clear(g_c), s	0.0	7.5	7.5	6.2	1.6	0.0				5.3	0.0	2.8
Prop In Lane	0.00		0.11	1.00		0.00				0.10		1.00
Lane Grp Cap(c), veh/h	0	569	587	327	2084	0				356	0	305
V/C Ratio(X)	0.00	0.60	0.60	0.77	0.13	0.00				0.65	0.00	0.36
Avail Cap(c_a), veh/h	0	2123	2190	978	6382	0				1030	0	884
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	12.9	12.9	17.7	3.8	0.0				17.0	0.0	16.0
Incr Delay (d2), s/veh	0.0	1.0	1.0	3.8	0.0	0.0				2.0	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	2.7	2.8	2.6	0.4	0.0				2.2	0.0	1.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	14.0	13.9	21.5	3.8	0.0				19.0	0.0	16.7
LnGrp LOS	A	B	B	C	A	A				B	A	B
Approach Vol, veh/h		697			528						342	
Approach Delay, s/veh		13.9			12.2						18.3	
Approach LOS		B			B						B	
Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			13.0	19.4		13.3		32.4				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			25.5	55.5		25.5		85.5				
Max Q Clear Time (g_c+I1), s			8.2	9.5		7.3		3.6				
Green Ext Time (p_c), s			0.7	5.4		1.6		2.1				
Intersection Summary												
HCM 6th Ctrl Delay			14.3									
HCM 6th LOS			B									

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	388	741	17	496	1	0	0	0	0	1	0
Future Vol, veh/h	0	388	741	17	496	1	0	0	0	0	1	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	2	3	5	2	5	100	2	2	2	2	100	2
Mvmt Flow	0	413	788	18	528	1	0	0	0	0	1	0

Major/Minor	Major1			Major2			Minor2		
Conflicting Flow All	529	0	-	413	0	0	978	978	265
Stage 1	-	-	-	-	-	-	565	565	-
Stage 2	-	-	-	-	-	-	413	413	-
Critical Hdwy	4.13	-	-	4.13	-	-	6.63	8	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-	5.83	7	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.43	7	-
Follow-up Hdwy	2.219	-	-	2.219	-	-	3.519	4.95	3.319
Pot Cap-1 Maneuver	1036	-	0	1144	-	-	262	151	734
Stage 1	-	-	0	-	-	-	533	349	-
Stage 2	-	-	0	-	-	-	667	427	-
Platoon blocked, %		-			-	-			
Mov Cap-1 Maneuver	1036	-	-	1144	-	-	258	0	734
Mov Cap-2 Maneuver	-	-	-	-	-	-	258	0	-
Stage 1	-	-	-	-	-	-	524	0	-
Stage 2	-	-	-	-	-	-	667	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.3	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	1036	-	1144	-	-	-
HCM Lane V/C Ratio	-	-	0.016	-	-	-
HCM Control Delay (s)	0	-	8.2	-	-	-
HCM Lane LOS	A	-	A	-	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	349	39	0	0	10	4	504	0	23	0	0	0
Future Volume (veh/h)	349	39	0	0	10	4	504	0	23	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1841	1870	0	0	1870	1870	1826	1870	1826			
Adj Flow Rate, veh/h	388	43	0	0	11	1	580	0	0			
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90			
Percent Heavy Veh, %	4	2	0	0	2	2	5	2	5			
Cap, veh/h	769	681	0	0	1202	108	1040	559	0			
Arrive On Green	0.36	0.36	0.00	0.00	0.36	0.36	0.30	0.00	0.00			
Sat Flow, veh/h	1380	1870	0	0	3392	295	3478	1870	0			
Grp Volume(v), veh/h	388	43	0	0	6	6	580	0	0			
Grp Sat Flow(s),veh/h/ln	1380	1870	0	0	1777	1817	1739	1870	0			
Q Serve(g_s), s	6.7	0.4	0.0	0.0	0.1	0.1	3.8	0.0	0.0			
Cycle Q Clear(g_c), s	6.7	0.4	0.0	0.0	0.1	0.1	3.8	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.16	1.00		0.00			
Lane Grp Cap(c), veh/h	769	681	0	0	647	662	1040	559	0			
V/C Ratio(X)	0.50	0.06	0.00	0.00	0.01	0.01	0.56	0.00	0.00			
Avail Cap(c_a), veh/h	1583	1784	0	0	1695	1734	7222	3884	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	7.6	5.5	0.0	0.0	5.4	5.4	7.9	0.0	0.0			
Incr Delay (d2), s/veh	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	1.2	0.1	0.0	0.0	0.0	0.0	1.0	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	8.1	5.6	0.0	0.0	5.4	5.4	8.4	0.0	0.0			
LnGrp LOS	A	A	A	A	A	A	A	A	A			
Approach Vol, veh/h		431			12			580				
Approach Delay, s/veh		7.8			5.4			8.4				
Approach LOS		A			A			A				

Timer - Assigned Phs		2		4				8
Phs Duration (G+Y+Rc), s		12.5		14.2				14.2
Change Period (Y+Rc), s		4.5		4.5				4.5
Max Green Setting (Gmax), s		55.5		25.5				25.5
Max Q Clear Time (g_c+I1), s		5.8		8.7				2.1
Green Ext Time (p_c), s		2.4		1.4				0.0

Intersection Summary			
HCM 6th Ctrl Delay			8.1
HCM 6th LOS			A

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Int Delay, s/veh	2.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	838	266	89	39
Future Vol, veh/h	0	0	838	266	89	39
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	4	4	20	12
Mvmt Flow	0	0	882	280	94	41

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	882	0	-	0	882	441
Stage 1	-	-	-	-	882	-
Stage 2	-	-	-	-	0	-
Critical Hdwy	4.13	-	-	-	6.9	7.08
Critical Hdwy Stg 1	-	-	-	-	6.1	-
Critical Hdwy Stg 2	-	-	-	-	5.7	-
Follow-up Hdwy	2.219	-	-	-	3.69	3.414
Pot Cap-1 Maneuver	765	-	-	0	273	542
Stage 1	-	-	-	0	333	-
Stage 2	-	-	-	0	-	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	765	-	-	-	273	542
Mov Cap-2 Maneuver	-	-	-	-	273	-
Stage 1	-	-	-	-	333	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	18.9
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	765	-	-	393
HCM Lane V/C Ratio	-	-	-	0.343
HCM Control Delay (s)	0	-	-	18.9
HCM Lane LOS	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	1.5

HCM 6th Signalized Intersection Summary
1: Moaniani St/H2 SB Off-Ramo & Ka Uka Blvd

03/11/2019

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	715	44	352	659	0	42	0	756	10	209	324
Future Volume (veh/h)	0	715	44	352	659	0	42	0	756	10	209	324
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1870	1870	1841	1870	0	1826	0	1870	1870	1870	1870
Adj Flow Rate, veh/h	0	769	44	378	709	0	45	0	219	11	225	30
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	2	2	4	2	0	5	0	2	2	2	2
Cap, veh/h	0	1246	71	402	2205	0	0	0	0	12	246	219
Arrive On Green	0.00	0.36	0.36	0.23	0.62	0.00	0.00	0.00	0.00	0.14	0.14	0.14
Sat Flow, veh/h	0	3510	195	1753	3647	0		0		87	1779	1585
Grp Volume(v), veh/h	0	400	413	378	709	0		0.0		236	0	30
Grp Sat Flow(s),veh/h/ln	0	1777	1835	1753	1777	0				1866	0	1585
Q Serve(g_s), s	0.0	31.4	31.4	36.0	16.1	0.0				21.2	0.0	2.8
Cycle Q Clear(g_c), s	0.0	31.4	31.4	36.0	16.1	0.0				21.2	0.0	2.8
Prop In Lane	0.00		0.11	1.00		0.00				0.05		1.00
Lane Grp Cap(c), veh/h	0	648	669	402	2205	0				258	0	219
V/C Ratio(X)	0.00	0.62	0.62	0.94	0.32	0.00				0.91	0.00	0.14
Avail Cap(c_a), veh/h	0	648	669	521	2205	0				280	0	238
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	44.3	44.3	64.3	15.3	0.0				72.2	0.0	64.3
Incr Delay (d2), s/veh	0.0	1.8	1.7	22.0	0.4	0.0				31.0	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	14.4	14.9	18.7	6.9	0.0				12.5	0.0	1.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	46.0	46.0	86.3	15.7	0.0				103.2	0.0	64.6
LnGrp LOS	A	D	D	F	B	A				F	A	E
Approach Vol, veh/h		813			1087						266	
Approach Delay, s/veh		46.0			40.2						98.9	
Approach LOS		D			D						F	
Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			43.5	66.5		28.0		110.0				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			50.5	50.5		25.5		105.5				
Max Q Clear Time (g_c+I1), s			38.0	33.4		23.2		18.1				
Green Ext Time (p_c), s			1.0	5.1		0.3		6.3				
Intersection Summary												
HCM 6th Ctrl Delay			49.6									
HCM 6th LOS			D									

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	692	789	38	1011	0	0	0	0	0	0	0
Future Vol, veh/h	0	692	789	38	1011	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	8	2	2	2	2	2	2	2	2
Mvmt Flow	0	744	848	41	1087	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor2		
Conflicting Flow All	1087	0	-	744	0	0	1913	1913	544
Stage 1	-	-	-	-	-	-	1169	1169	-
Stage 2	-	-	-	-	-	-	744	744	-
Critical Hdwy	4.13	-	-	4.22	-	-	6.63	6.53	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-	5.83	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.43	5.53	-
Follow-up Hdwy	2.219	-	-	2.276	-	-	3.519	4.019	3.319
Pot Cap-1 Maneuver	640	-	0	829	-	-	67	68	484
Stage 1	-	-	0	-	-	-	259	266	-
Stage 2	-	-	0	-	-	-	469	421	-
Platoon blocked, %		-			-	-			
Mov Cap-1 Maneuver	640	-	-	829	-	-	64	0	484
Mov Cap-2 Maneuver	-	-	-	-	-	-	64	0	-
Stage 1	-	-	-	-	-	-	246	0	-
Stage 2	-	-	-	-	-	-	469	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.3	0
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	640	-	829	-	-	-
HCM Lane V/C Ratio	-	-	0.049	-	-	-
HCM Control Delay (s)	0	-	9.6	-	-	0
HCM Lane LOS	A	-	A	-	-	A
HCM 95th %tile Q(veh)	0	-	0.2	-	-	-

HCM 6th Signalized Intersection Summary
3: H2 NB Off-Ramp/H2 NB On-Ramp & Ka Uka Blvd/Mililani Memorial Park Rd

03/11/2019

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	668	24	0	0	43	16	1006	3	24	0	0	0
Future Volume (veh/h)	668	24	0	0	43	16	1006	3	24	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1870	1841	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	696	25	0	0	45	10	1073	0	0			
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96			
Percent Heavy Veh, %	2	4	0	0	2	2	2	2	2			
Cap, veh/h	755	987	0	0	1559	335	1465	769	0			
Arrive On Green	0.54	0.54	0.00	0.00	0.54	0.54	0.41	0.00	0.00			
Sat Flow, veh/h	1349	1841	0	0	3003	625	3563	1870	0			
Grp Volume(v), veh/h	696	25	0	0	27	28	1073	0	0			
Grp Sat Flow(s),veh/h/ln	1349	1841	0	0	1777	1758	1781	1870	0			
Q Serve(g_s), s	85.5	1.1	0.0	0.0	1.2	1.3	43.1	0.0	0.0			
Cycle Q Clear(g_c), s	86.8	1.1	0.0	0.0	1.2	1.3	43.1	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.36	1.00		0.00			
Lane Grp Cap(c), veh/h	755	987	0	0	952	942	1465	769	0			
V/C Ratio(X)	0.92	0.03	0.00	0.00	0.03	0.03	0.73	0.00	0.00			
Avail Cap(c_a), veh/h	830	1088	0	0	1050	1039	1465	769	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	39.1	18.6	0.0	0.0	18.6	18.6	42.2	0.0	0.0			
Incr Delay (d2), s/veh	14.8	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	31.3	0.5	0.0	0.0	0.5	0.6	20.0	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.8	18.6	0.0	0.0	18.6	18.6	45.5	0.0	0.0			
LnGrp LOS	D	B	A	A	B	B	D	A	A			
Approach Vol, veh/h		721			55			1073				
Approach Delay, s/veh		52.6			18.6			45.5				
Approach LOS		D			B			D				

Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		74.4		95.6				95.6				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		60.5		100.5				100.5				
Max Q Clear Time (g_c+I1), s		45.1		88.8				3.3				
Green Ext Time (p_c), s		4.2		2.4				0.4				

Intersection Summary		
HCM 6th Ctrl Delay		47.5
HCM 6th LOS		D

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Int Delay, s/veh	10.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	1382	52	90	114
Future Vol, veh/h	0	0	1382	52	90	114
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	4	1	3
Mvmt Flow	0	0	1486	56	97	123

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1486	0	-	0	1487	744
Stage 1	-	-	-	-	1486	-
Stage 2	-	-	-	-	1	-
Critical Hdwy	4.13	-	-	-	6.615	6.945
Critical Hdwy Stg 1	-	-	-	-	5.815	-
Critical Hdwy Stg 2	-	-	-	-	5.415	-
Follow-up Hdwy	2.219	-	-	-	3.5095	3.3285
Pot Cap-1 Maneuver	450	-	-	0	126	356
Stage 1	-	-	-	0	176	-
Stage 2	-	-	-	0	1025	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	450	-	-	-	126	356
Mov Cap-2 Maneuver	-	-	-	-	126	-
Stage 1	-	-	-	-	176	-
Stage 2	-	-	-	-	1025	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	79.5
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	450	-	-	242
HCM Lane V/C Ratio	-	-	-	0.906
HCM Control Delay (s)	0	-	-	79.5
HCM Lane LOS	A	-	-	F
HCM 95th %tile Q(veh)	0	-	-	7.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	618	40	236	260	0	18	0	488	43	195	277
Future Volume (veh/h)	0	618	40	236	260	0	18	0	488	43	195	277
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1841	1841	1841	1796	0	1737	0	1811	1856	1856	1870
Adj Flow Rate, veh/h	0	657	39	251	277	0	19	0	47	46	207	46
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	4	4	4	7	0	11	0	6	3	3	2
Cap, veh/h	0	1084	64	326	2069	0	0	0	0	67	300	316
Arrive On Green	0.00	0.32	0.32	0.19	0.61	0.00	0.00	0.00	0.00	0.20	0.20	0.20
Sat Flow, veh/h	0	3447	199	1753	3503	0		0		334	1504	1585
Grp Volume(v), veh/h	0	342	354	251	277	0		0.0		253	0	46
Grp Sat Flow(s),veh/h/ln	0	1749	1805	1753	1706	0				1839	0	1585
Q Serve(g_s), s	0.0	7.6	7.7	6.3	1.6	0.0				5.9	0.0	1.1
Cycle Q Clear(g_c), s	0.0	7.6	7.7	6.3	1.6	0.0				5.9	0.0	1.1
Prop In Lane	0.00		0.11	1.00		0.00				0.18		1.00
Lane Grp Cap(c), veh/h	0	565	583	326	2069	0				367	0	316
V/C Ratio(X)	0.00	0.61	0.61	0.77	0.13	0.00				0.69	0.00	0.15
Avail Cap(c_a), veh/h	0	2092	2159	964	6290	0				1011	0	871
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	13.2	13.2	17.9	3.9	0.0				17.2	0.0	15.3
Incr Delay (d2), s/veh	0.0	1.0	1.0	3.8	0.0	0.0				2.3	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	2.7	2.8	2.6	0.4	0.0				2.5	0.0	0.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	14.3	14.2	21.8	3.9	0.0				19.5	0.0	15.5
LnGrp LOS	A	B	B	C	A	A				B	A	B
Approach Vol, veh/h		696			528						299	
Approach Delay, s/veh		14.2			12.4						18.9	
Approach LOS		B			B						B	

Timer - Assigned Phs			3	4		6		8
Phs Duration (G+Y+Rc), s			13.1	19.5		13.8		32.6
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5
Max Green Setting (Gmax), s			25.5	55.5		25.5		85.5
Max Q Clear Time (g_c+I1), s			8.3	9.7		7.9		3.6
Green Ext Time (p_c), s			0.7	5.3		1.5		2.1

Intersection Summary			
HCM 6th Ctrl Delay			14.5
HCM 6th LOS			B

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	408	741	30	496	1	0	0	0	0	1	0
Future Vol, veh/h	0	408	741	30	496	1	0	0	0	0	1	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	2	3	5	2	5	100	2	2	2	2	100	2
Mvmt Flow	0	434	788	32	528	1	0	0	0	0	1	0

Major/Minor	Major1			Major2						Minor2		
Conflicting Flow All	529	0	-	434	0	0				1027	1027	265
Stage 1	-	-	-	-	-	-				593	593	-
Stage 2	-	-	-	-	-	-				434	434	-
Critical Hdwy	4.13	-	-	4.13	-	-				6.63	8	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-				5.83	7	-
Critical Hdwy Stg 2	-	-	-	-	-	-				5.43	7	-
Follow-up Hdwy	2.219	-	-	2.219	-	-				3.519	4.95	3.319
Pot Cap-1 Maneuver	1036	-	0	1124	-	-				245	139	734
Stage 1	-	-	0	-	-	-				516	336	-
Stage 2	-	-	0	-	-	-				652	415	-
Platoon blocked, %		-			-	-						
Mov Cap-1 Maneuver	1036	-	-	1124	-	-				238	0	734
Mov Cap-2 Maneuver	-	-	-	-	-	-				238	0	-
Stage 1	-	-	-	-	-	-				502	0	-
Stage 2	-	-	-	-	-	-				652	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.5	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	1036	-	1124	-	-	-
HCM Lane V/C Ratio	-	-	0.028	-	-	-
HCM Control Delay (s)	0	-	8.3	-	-	-
HCM Lane LOS	A	-	A	-	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	349	59	0	0	23	4	504	0	116	0	0	0
Future Volume (veh/h)	349	59	0	0	23	4	504	0	116	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1841	1870	0	0	1870	1870	1826	1870	1826			
Adj Flow Rate, veh/h	388	66	0	0	26	2	636	0	0			
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90			
Percent Heavy Veh, %	4	2	0	0	2	2	5	2	5			
Cap, veh/h	751	696	0	0	1246	95	1089	586	0			
Arrive On Green	0.37	0.37	0.00	0.00	0.37	0.37	0.31	0.00	0.00			
Sat Flow, veh/h	1360	1870	0	0	3441	254	3478	1870	0			
Grp Volume(v), veh/h	388	66	0	0	14	14	636	0	0			
Grp Sat Flow(s),veh/h/ln	1360	1870	0	0	1777	1825	1739	1870	0			
Q Serve(g_s), s	7.2	0.7	0.0	0.0	0.1	0.1	4.4	0.0	0.0			
Cycle Q Clear(g_c), s	7.4	0.7	0.0	0.0	0.1	0.1	4.4	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.14	1.00		0.00			
Lane Grp Cap(c), veh/h	751	696	0	0	662	679	1089	586	0			
V/C Ratio(X)	0.52	0.09	0.00	0.00	0.02	0.02	0.58	0.00	0.00			
Avail Cap(c_a), veh/h	1457	1667	0	0	1584	1626	6746	3628	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	8.0	5.8	0.0	0.0	5.7	5.7	8.3	0.0	0.0			
Incr Delay (d2), s/veh	0.6	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	1.4	0.2	0.0	0.0	0.0	0.0	1.2	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	8.6	5.9	0.0	0.0	5.7	5.7	8.8	0.0	0.0			
LnGrp LOS	A	A	A	A	A	A	A	A	A			
Approach Vol, veh/h		454			28			636				
Approach Delay, s/veh		8.2			5.7			8.8				
Approach LOS		A			A			A				
Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		13.5		15.2				15.2				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		55.5		25.5				25.5				
Max Q Clear Time (g_c+I1), s		6.4		9.4				2.1				
Green Ext Time (p_c), s		2.6		1.5				0.1				
Intersection Summary												
HCM 6th Ctrl Delay			8.4									
HCM 6th LOS			A									

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Int Delay, s/veh	3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	838	266	102	39
Future Vol, veh/h	0	0	838	266	102	39
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	4	4	20	12
Mvmt Flow	0	0	882	280	107	41

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	882	0	-	0	882	441
Stage 1	-	-	-	-	882	-
Stage 2	-	-	-	-	0	-
Critical Hdwy	4.13	-	-	-	6.9	7.08
Critical Hdwy Stg 1	-	-	-	-	6.1	-
Critical Hdwy Stg 2	-	-	-	-	5.7	-
Follow-up Hdwy	2.219	-	-	-	3.69	3.414
Pot Cap-1 Maneuver	765	-	-	0	273	542
Stage 1	-	-	-	0	333	-
Stage 2	-	-	-	0	-	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	765	-	-	-	273	542
Mov Cap-2 Maneuver	-	-	-	-	273	-
Stage 1	-	-	-	-	333	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	20.6
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	765	-	-	377
HCM Lane V/C Ratio	-	-	-	0.394
HCM Control Delay (s)	0	-	-	20.6
HCM Lane LOS	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	1.8

HCM 6th Signalized Intersection Summary
1: Moaniani St/H2 SB Off-Ramo & Ka Uka Blvd

03/11/2019

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	715	44	352	659	0	42	0	756	10	209	324
Future Volume (veh/h)	0	715	44	352	659	0	42	0	756	10	209	324
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1870	1870	1841	1870	0	1826	0	1870	1870	1870	1870
Adj Flow Rate, veh/h	0	769	44	378	709	0	45	0	219	11	225	30
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	2	2	4	2	0	5	0	2	2	2	2
Cap, veh/h	0	1246	71	402	2205	0	0	0	0	12	246	219
Arrive On Green	0.00	0.36	0.36	0.23	0.62	0.00	0.00	0.00	0.00	0.14	0.14	0.14
Sat Flow, veh/h	0	3510	195	1753	3647	0		0		87	1779	1585
Grp Volume(v), veh/h	0	400	413	378	709	0		0.0		236	0	30
Grp Sat Flow(s),veh/h/ln	0	1777	1835	1753	1777	0				1866	0	1585
Q Serve(g_s), s	0.0	31.4	31.4	36.0	16.1	0.0				21.2	0.0	2.8
Cycle Q Clear(g_c), s	0.0	31.4	31.4	36.0	16.1	0.0				21.2	0.0	2.8
Prop In Lane	0.00		0.11	1.00		0.00				0.05		1.00
Lane Grp Cap(c), veh/h	0	648	669	402	2205	0				258	0	219
V/C Ratio(X)	0.00	0.62	0.62	0.94	0.32	0.00				0.91	0.00	0.14
Avail Cap(c_a), veh/h	0	648	669	521	2205	0				280	0	238
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	44.3	44.3	64.3	15.3	0.0				72.2	0.0	64.3
Incr Delay (d2), s/veh	0.0	1.8	1.7	22.0	0.4	0.0				31.0	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	14.4	14.9	18.7	6.9	0.0				12.5	0.0	1.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	46.0	46.0	86.3	15.7	0.0				103.2	0.0	64.6
LnGrp LOS	A	D	D	F	B	A				F	A	E
Approach Vol, veh/h		813			1087						266	
Approach Delay, s/veh		46.0			40.2						98.9	
Approach LOS		D			D						F	
Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			43.5	66.5		28.0		110.0				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			50.5	50.5		25.5		105.5				
Max Q Clear Time (g_c+I1), s			38.0	33.4		23.2		18.1				
Green Ext Time (p_c), s			1.0	5.1		0.3		6.3				
Intersection Summary												
HCM 6th Ctrl Delay			49.6									
HCM 6th LOS			D									

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	692	789	131	1011	0	0	0	0	0	0	0
Future Vol, veh/h	0	692	789	131	1011	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	744	848	141	1087	0	0	0	0	0	0	0

Major/Minor	Major1			Major2						Minor2		
Conflicting Flow All	1087	0	-	744	0	0				2113	2113	544
Stage 1	-	-	-	-	-	-				1369	1369	-
Stage 2	-	-	-	-	-	-				744	744	-
Critical Hdwy	4.13	-	-	4.13	-	-				6.63	6.53	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-				5.83	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-				5.43	5.53	-
Follow-up Hdwy	2.219	-	-	2.219	-	-				3.519	4.019	3.319
Pot Cap-1 Maneuver	640	-	0	861	-	-				49	51	484
Stage 1	-	-	0	-	-	-				202	213	-
Stage 2	-	-	0	-	-	-				469	421	-
Platoon blocked, %		-			-	-						
Mov Cap-1 Maneuver	640	-	-	861	-	-				41	0	484
Mov Cap-2 Maneuver	-	-	-	-	-	-				41	0	-
Stage 1	-	-	-	-	-	-				169	0	-
Stage 2	-	-	-	-	-	-				469	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	1.1	0
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	640	-	861	-	-	-
HCM Lane V/C Ratio	-	-	0.164	-	-	-
HCM Control Delay (s)	0	-	10	-	-	0
HCM Lane LOS	A	-	A	-	-	A
HCM 95th %tile Q(veh)	0	-	0.6	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑			↑↱		↰	✣				
Traffic Volume (veh/h)	668	24	0	0	136	36	1006	3	37	0	0	0
Future Volume (veh/h)	668	24	0	0	136	36	1006	3	37	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1870	1841	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	696	25	0	0	142	23	1085	0	0			
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96			
Percent Heavy Veh, %	2	4	0	0	2	2	2	2	2			
Cap, veh/h	739	1088	0	0	1816	289	1268	666	0			
Arrive On Green	0.59	0.59	0.00	0.00	0.59	0.59	0.36	0.00	0.00			
Sat Flow, veh/h	1221	1841	0	0	3165	488	3563	1870	0			
Grp Volume(v), veh/h	696	25	0	0	81	84	1085	0	0			
Grp Sat Flow(s),veh/h/ln	1221	1841	0	0	1777	1782	1781	1870	0			
Q Serve(g_s), s	96.8	1.0	0.0	0.0	3.3	3.4	48.0	0.0	0.0			
Cycle Q Clear(g_c), s	100.2	1.0	0.0	0.0	3.3	3.4	48.0	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.27	1.00		0.00			
Lane Grp Cap(c), veh/h	739	1088	0	0	1050	1054	1268	666	0			
V/C Ratio(X)	0.94	0.02	0.00	0.00	0.08	0.08	0.86	0.00	0.00			
Avail Cap(c_a), veh/h	739	1088	0	0	1050	1054	1268	666	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	36.4	14.4	0.0	0.0	14.9	14.9	50.7	0.0	0.0			
Incr Delay (d2), s/veh	20.1	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	32.6	0.4	0.0	0.0	1.4	1.5	23.0	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	56.5	14.4	0.0	0.0	14.9	14.9	58.3	0.0	0.0			
LnGrp LOS	E	B	A	A	B	B	E	A	A			
Approach Vol, veh/h		721			165			1085				
Approach Delay, s/veh		55.1			14.9			58.3				
Approach LOS		E			B			E				
Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		65.0		105.0				105.0				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		60.5		100.5				100.5				
Max Q Clear Time (g_c+I1), s		50.0		102.2				5.4				
Green Ext Time (p_c), s		3.6		0.0				1.1				
Intersection Summary												
HCM 6th Ctrl Delay			53.5									
HCM 6th LOS			D									

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Int Delay, s/veh	16.7

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	1382	52	103	114
Future Vol, veh/h	0	0	1382	52	103	114
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	4	1	3
Mvmt Flow	0	0	1486	56	111	123

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1486	0	-	0	1487	744
Stage 1	-	-	-	-	1486	-
Stage 2	-	-	-	-	1	-
Critical Hdwy	4.13	-	-	-	6.615	6.945
Critical Hdwy Stg 1	-	-	-	-	5.815	-
Critical Hdwy Stg 2	-	-	-	-	5.415	-
Follow-up Hdwy	2.219	-	-	-	3.5095	3.3285
Pot Cap-1 Maneuver	450	-	-	0	126	356
Stage 1	-	-	-	0	176	-
Stage 2	-	-	-	0	1025	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	450	-	-	-	126	356
Mov Cap-2 Maneuver	-	-	-	-	126	-
Stage 1	-	-	-	-	176	-
Stage 2	-	-	-	-	1025	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	122.7
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	450	-	-	221
HCM Lane V/C Ratio	-	-	-	1.056
HCM Control Delay (s)	0	-	-	122.7
HCM Lane LOS	A	-	-	F
HCM 95th %tile Q(veh)	0	-	-	10.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	630	50	240	260	0	20	0	490	30	200	280
Future Volume (veh/h)	0	630	50	240	260	0	20	0	490	30	200	280
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1841	1841	1841	1796	0	1737	0	1811	1856	1856	1870
Adj Flow Rate, veh/h	0	670	49	255	277	0	21	0	28	32	213	45
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	4	4	4	7	0	11	0	6	3	3	2
Cap, veh/h	0	1095	80	330	2100	0	0	0	0	47	310	306
Arrive On Green	0.00	0.33	0.33	0.19	0.62	0.00	0.00	0.00	0.00	0.19	0.19	0.19
Sat Flow, veh/h	0	3397	241	1753	3503	0		0		241	1603	1585
Grp Volume(v), veh/h	0	354	365	255	277	0		0.0		245	0	45
Grp Sat Flow(s),veh/h/ln	0	1749	1797	1753	1706	0				1844	0	1585
Q Serve(g_s), s	0.0	8.0	8.0	6.5	1.6	0.0				5.8	0.0	1.1
Cycle Q Clear(g_c), s	0.0	8.0	8.0	6.5	1.6	0.0				5.8	0.0	1.1
Prop In Lane	0.00		0.13	1.00		0.00				0.13		1.00
Lane Grp Cap(c), veh/h	0	579	596	330	2100	0				356	0	306
V/C Ratio(X)	0.00	0.61	0.61	0.77	0.13	0.00				0.69	0.00	0.15
Avail Cap(c_a), veh/h	0	2064	2121	951	6205	0				1000	0	859
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	13.2	13.2	18.1	3.8	0.0				17.6	0.0	15.8
Incr Delay (d2), s/veh	0.0	1.0	1.0	3.9	0.0	0.0				2.4	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	2.9	2.9	2.7	0.4	0.0				2.5	0.0	0.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	14.2	14.2	22.0	3.8	0.0				20.0	0.0	16.0
LnGrp LOS	A	B	B	C	A	A				C	A	B
Approach Vol, veh/h		719			532						290	
Approach Delay, s/veh		14.2			12.5						19.4	
Approach LOS		B			B						B	
Timer - Assigned Phs			**3**	**4**		**6**		**8**				
Phs Duration (G+Y+Rc), s			13.4	20.1		13.6		33.4				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			25.5	55.5		25.5		85.5				
Max Q Clear Time (g_c+I1), s			8.5	10.0		7.8		3.6				
Green Ext Time (p_c), s			0.7	5.6		1.5		2.1				
Intersection Summary												
HCM 6th Ctrl Delay			14.6									
HCM 6th LOS			B									

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	400	750	20	500	10	0	0	0	0	10	0
Future Vol, veh/h	0	400	750	20	500	10	0	0	0	0	10	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	2	3	5	2	5	100	2	2	2	2	100	2
Mvmt Flow	0	426	798	21	532	11	0	0	0	0	11	0

Major/Minor	Major1			Major2			Minor2		
Conflicting Flow All	543	0	-	426	0	0	1006	1006	272
Stage 1	-	-	-	-	-	-	580	580	-
Stage 2	-	-	-	-	-	-	426	426	-
Critical Hdwy	4.13	-	-	4.13	-	-	6.63	8	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-	5.83	7	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.43	7	-
Follow-up Hdwy	2.219	-	-	2.219	-	-	3.519	4.95	3.319
Pot Cap-1 Maneuver	1024	-	0	1132	-	-	252	144	726
Stage 1	-	-	0	-	-	-	524	342	-
Stage 2	-	-	0	-	-	-	658	420	-
Platoon blocked, %		-			-	-			
Mov Cap-1 Maneuver	1024	-	-	1132	-	-	247	0	726
Mov Cap-2 Maneuver	-	-	-	-	-	-	247	0	-
Stage 1	-	-	-	-	-	-	514	0	-
Stage 2	-	-	-	-	-	-	658	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.3	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	1024	-	1132	-	-	-
HCM Lane V/C Ratio	-	-	0.019	-	-	-
HCM Control Delay (s)	0	-	8.2	-	-	-
HCM Lane LOS	A	-	A	-	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	360	40	0	0	20	10	510	0	30	0	0	0
Future Volume (veh/h)	360	40	0	0	20	10	510	0	30	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1841	1870	0	0	1870	1870	1826	1870	1826			
Adj Flow Rate, veh/h	400	44	0	0	22	5	585	0	0			
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90			
Percent Heavy Veh, %	4	2	0	0	2	2	5	2	5			
Cap, veh/h	769	709	0	0	1099	241	1031	555	0			
Arrive On Green	0.38	0.38	0.00	0.00	0.38	0.38	0.30	0.00	0.00			
Sat Flow, veh/h	1361	1870	0	0	2991	635	3478	1870	0			
Grp Volume(v), veh/h	400	44	0	0	13	14	585	0	0			
Grp Sat Flow(s),veh/h/ln	1361	1870	0	0	1777	1756	1739	1870	0			
Q Serve(g_s), s	7.2	0.4	0.0	0.0	0.1	0.1	3.9	0.0	0.0			
Cycle Q Clear(g_c), s	7.4	0.4	0.0	0.0	0.1	0.1	3.9	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.36	1.00		0.00			
Lane Grp Cap(c), veh/h	769	709	0	0	674	666	1031	555	0			
V/C Ratio(X)	0.52	0.06	0.00	0.00	0.02	0.02	0.57	0.00	0.00			
Avail Cap(c_a), veh/h	1504	1718	0	0	1633	1613	6955	3740	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	7.7	5.5	0.0	0.0	5.4	5.4	8.3	0.0	0.0			
Incr Delay (d2), s/veh	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	1.3	0.1	0.0	0.0	0.0	0.0	1.0	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	8.2	5.5	0.0	0.0	5.4	5.4	8.7	0.0	0.0			
LnGrp LOS	A	A	A	A	A	A	A	A	A			
Approach Vol, veh/h		444			27			585				
Approach Delay, s/veh		8.0			5.4			8.7				
Approach LOS		A			A			A				
Timer - Assigned Phs		**2**		**4**				**8**				
Phs Duration (G+Y+Rc), s		12.7		15.0				15.0				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		55.5		25.5				25.5				
Max Q Clear Time (g_c+I1), s		5.9		9.4				2.1				
Green Ext Time (p_c), s		2.4		1.4				0.1				
Intersection Summary												
HCM 6th Ctrl Delay			8.3									
HCM 6th LOS			A									

Notes

User approved volume balancing among the lanes for turning movement.

Intersection						
Int Delay, s/veh	2.6					
Movement	**EBL**	**EBT**	**WBT**	**WBR**	**SBL**	**SBR**
Lane Configurations						
Traffic Vol, veh/h	0	0	850	270	90	40
Future Vol, veh/h	0	0	850	270	90	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	4	4	20	12
Mvmt Flow	0	0	895	284	95	42

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	895	0	-	0	895	448
Stage 1	-	-	-	-	895	-
Stage 2	-	-	-	-	0	-
Critical Hdwy	4.13	-	-	-	6.9	7.08
Critical Hdwy Stg 1	-	-	-	-	6.1	-
Critical Hdwy Stg 2	-	-	-	-	5.7	-
Follow-up Hdwy	2.219	-	-	-	3.69	3.414
Pot Cap-1 Maneuver	756	-	-	0	268	536
Stage 1	-	-	-	0	327	-
Stage 2	-	-	-	0	-	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	756	-	-	-	268	536
Mov Cap-2 Maneuver	-	-	-	-	268	-
Stage 1	-	-	-	-	327	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	19.3
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	756	-	-	387
HCM Lane V/C Ratio	-	-	-	0.354
HCM Control Delay (s)	0	-	-	19.3
HCM Lane LOS	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	1.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱		↰	↑↑		↰		↱		↰	↱
Traffic Volume (veh/h)	0	730	50	360	670	0	50	0	770	20	220	330
Future Volume (veh/h)	0	730	50	360	670	0	50	0	770	20	220	330
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1870	1870	1841	1870	0	1826	0	1870	1870	1870	1870
Adj Flow Rate, veh/h	0	785	51	387	720	0	54	0	252	22	237	52
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	2	2	4	2	0	5	0	2	2	2	2
Cap, veh/h	0	1218	79	411	2205	0	0	0	0	24	254	237
Arrive On Green	0.00	0.36	0.36	0.23	0.62	0.00	0.00	0.00	0.00	0.15	0.15	0.15
Sat Flow, veh/h	0	3481	220	1753	3647	0		0		158	1704	1585
Grp Volume(v), veh/h	0	412	424	387	720	0		0.0		259	0	52
Grp Sat Flow(s),veh/h/ln	0	1777	1831	1753	1777	0				1862	0	1585
Q Serve(g_s), s	0.0	32.8	32.8	36.9	16.4	0.0				23.4	0.0	4.9
Cycle Q Clear(g_c), s	0.0	32.8	32.8	36.9	16.4	0.0				23.4	0.0	4.9
Prop In Lane	0.00		0.12	1.00		0.00				0.08		1.00
Lane Grp Cap(c), veh/h	0	639	658	411	2205	0				278	0	237
V/C Ratio(X)	0.00	0.64	0.64	0.94	0.33	0.00				0.93	0.00	0.22
Avail Cap(c_a), veh/h	0	639	658	521	2205	0				279	0	238
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	45.4	45.4	63.9	15.3	0.0				71.4	0.0	63.6
Incr Delay (d2), s/veh	0.0	2.2	2.2	22.6	0.4	0.0				35.9	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	15.2	15.6	19.2	7.0	0.0				14.1	0.0	2.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	47.6	47.5	86.5	15.7	0.0				107.4	0.0	64.1
LnGrp LOS	A	D	D	F	B	A				F	A	E
Approach Vol, veh/h		836			1107						311	
Approach Delay, s/veh		47.6			40.5						100.1	
Approach LOS		D			D						F	
Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			44.4	65.6		29.9		110.0				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			50.5	50.5		25.5		105.5				
Max Q Clear Time (g_c+I1), s			38.9	34.8		25.4		18.4				
Green Ext Time (p_c), s			1.0	5.1		0.0		6.4				
Intersection Summary												
HCM 6th Ctrl Delay			51.3									
HCM 6th LOS			D									

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	700	820	40	1030	0	0	0	0	0	0	0
Future Vol, veh/h	0	700	820	40	1030	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	8	2	2	2	2	2	2	2	2
Mvmt Flow	0	753	882	43	1108	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor2		
Conflicting Flow All	1108	0	-	753	0	0	1947	1947	554
Stage 1	-	-	-	-	-	-	1194	1194	-
Stage 2	-	-	-	-	-	-	753	753	-
Critical Hdwy	4.13	-	-	4.22	-	-	6.63	6.53	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-	5.83	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.43	5.53	-
Follow-up Hdwy	2.219	-	-	2.276	-	-	3.519	4.019	3.319
Pot Cap-1 Maneuver	628	-	0	822	-	-	63	64	477
Stage 1	-	-	0	-	-	-	251	259	-
Stage 2	-	-	0	-	-	-	464	417	-
Platoon blocked, %		-			-	-			
Mov Cap-1 Maneuver	628	-	-	822	-	-	60	0	477
Mov Cap-2 Maneuver	-	-	-	-	-	-	60	0	-
Stage 1	-	-	-	-	-	-	238	0	-
Stage 2	-	-	-	-	-	-	464	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.4	0
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	628	-	822	-	-	-
HCM Lane V/C Ratio	-	-	0.052	-	-	-
HCM Control Delay (s)	0	-	9.6	-	-	0
HCM Lane LOS	A	-	A	-	-	A
HCM 95th %tile Q(veh)	0	-	0.2	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	670	30	0	0	50	20	1020	10	30	0	0	0
Future Volume (veh/h)	670	30	0	0	50	20	1020	10	30	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1870	1841	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	698	31	0	0	52	12	1097	0	0			
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96			
Percent Heavy Veh, %	2	4	0	0	2	2	2	2	2			
Cap, veh/h	757	999	0	0	1566	349	1441	757	0			
Arrive On Green	0.54	0.54	0.00	0.00	0.54	0.54	0.40	0.00	0.00			
Sat Flow, veh/h	1338	1841	0	0	2981	644	3563	1870	0			
Grp Volume(v), veh/h	698	31	0	0	31	33	1097	0	0			
Grp Sat Flow(s),veh/h/ln	1338	1841	0	0	1777	1754	1781	1870	0			
Q Serve(g_s), s	86.5	1.3	0.0	0.0	1.4	1.5	45.0	0.0	0.0			
Cycle Q Clear(g_c), s	87.9	1.3	0.0	0.0	1.4	1.5	45.0	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.37	1.00		0.00			
Lane Grp Cap(c), veh/h	757	999	0	0	964	952	1441	757	0			
V/C Ratio(X)	0.92	0.03	0.00	0.00	0.03	0.03	0.76	0.00	0.00			
Avail Cap(c_a), veh/h	822	1088	0	0	1050	1037	1441	757	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	38.6	18.1	0.0	0.0	18.1	18.1	43.5	0.0	0.0			
Incr Delay (d2), s/veh	15.1	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	31.4	0.6	0.0	0.0	0.6	0.6	20.9	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.7	18.1	0.0	0.0	18.1	18.1	47.4	0.0	0.0			
LnGrp LOS	D	B	A	A	B	B	D	A	A			
Approach Vol, veh/h		729			64			1097				
Approach Delay, s/veh		52.2			18.1			47.4				
Approach LOS		D			B			D				

Timer - Assigned Phs	2	4	8
Phs Duration (G+Y+Rc), s	73.3	96.7	96.7
Change Period (Y+Rc), s	4.5	4.5	4.5
Max Green Setting (Gmax), s	60.5	100.5	100.5
Max Q Clear Time (g_c+I1), s	47.0	89.9	3.5
Green Ext Time (p_c), s	4.1	2.3	0.4

Intersection Summary	
HCM 6th Ctrl Delay	48.3
HCM 6th LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Intersection						
Int Delay, s/veh	15.1					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	1400	60	100	120
Future Vol, veh/h	0	0	1400	60	100	120
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	4	1	3
Mvmt Flow	0	0	1505	65	108	129

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1505	0	-	0	1506	754
Stage 1	-	-	-	-	1505	-
Stage 2	-	-	-	-	1	-
Critical Hdwy	4.13	-	-	-	6.615	6.945
Critical Hdwy Stg 1	-	-	-	-	5.815	-
Critical Hdwy Stg 2	-	-	-	-	5.415	-
Follow-up Hdwy	2.219	-	-	-	3.5095	3.3285
Pot Cap-1 Maneuver	443	-	-	0	123	351
Stage 1	-	-	-	0	172	-
Stage 2	-	-	-	0	1025	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	443	-	-	-	123	351
Mov Cap-2 Maneuver	-	-	-	-	123	-
Stage 1	-	-	-	-	172	-
Stage 2	-	-	-	-	1025	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	110.9
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	443	-	-	231
HCM Lane V/C Ratio	-	-	-	1.024
HCM Control Delay (s)	0	-	-	110.9
HCM Lane LOS	A	-	-	F
HCM 95th %tile Q(veh)	0	-	-	9.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	630	50	240	260	0	20	0	490	50	200	280
Future Volume (veh/h)	0	630	50	240	260	0	20	0	490	50	200	280
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1841	1841	1841	1796	0	1737	0	1811	1856	1856	1870
Adj Flow Rate, veh/h	0	670	49	255	277	0	21	0	62	53	213	47
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	4	4	4	7	0	11	0	6	3	3	2
Cap, veh/h	0	1083	79	329	2076	0	0	0	0	75	303	326
Arrive On Green	0.00	0.33	0.33	0.19	0.61	0.00	0.00	0.00	0.00	0.21	0.21	0.21
Sat Flow, veh/h	0	3397	241	1753	3503	0		0		366	1471	1585
Grp Volume(v), veh/h	0	354	365	255	277	0		0.0		266	0	47
Grp Sat Flow(s),veh/h/ln	0	1749	1797	1753	1706	0				1837	0	1585
Q Serve(g_s), s	0.0	8.3	8.3	6.7	1.7	0.0				6.5	0.0	1.2
Cycle Q Clear(g_c), s	0.0	8.3	8.3	6.7	1.7	0.0				6.5	0.0	1.2
Prop In Lane	0.00		0.13	1.00		0.00				0.20		1.00
Lane Grp Cap(c), veh/h	0	573	589	329	2076	0				378	0	326
V/C Ratio(X)	0.00	0.62	0.62	0.78	0.13	0.00				0.70	0.00	0.14
Avail Cap(c_a), veh/h	0	2005	2061	924	6029	0				968	0	835
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	13.7	13.7	18.7	4.0	0.0				17.8	0.0	15.7
Incr Delay (d2), s/veh	0.0	1.1	1.1	3.9	0.0	0.0				2.4	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	3.0	3.1	2.8	0.4	0.0				2.7	0.0	0.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	14.8	14.8	22.6	4.1	0.0				20.2	0.0	15.9
LnGrp LOS	A	B	B	C	A	A				C	A	B
Approach Vol, veh/h		719			532						313	
Approach Delay, s/veh		14.8			13.0						19.6	
Approach LOS		B			B						B	

Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			13.6	20.4		14.5		33.9				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			25.5	55.5		25.5		85.5				
Max Q Clear Time (g_c+I1), s			8.7	10.3		8.5		3.7				
Green Ext Time (p_c), s			0.7	5.6		1.6		2.1				

Intersection Summary		
HCM 6th Ctrl Delay		15.1
HCM 6th LOS		B

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	420	750	33	500	10	0	0	0	0	10	0
Future Vol, veh/h	0	420	750	33	500	10	0	0	0	0	10	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	2	3	5	2	5	100	2	2	2	2	100	2
Mvmt Flow	0	447	798	35	532	11	0	0	0	0	11	0

Major/Minor	Major1			Major2						Minor2		
Conflicting Flow All	543	0	-	447	0	0				1055	1055	272
Stage 1	-	-	-	-	-	-				608	608	-
Stage 2	-	-	-	-	-	-				447	447	-
Critical Hdwy	4.13	-	-	4.13	-	-				6.63	8	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-				5.83	7	-
Critical Hdwy Stg 2	-	-	-	-	-	-				5.43	7	-
Follow-up Hdwy	2.219	-	-	2.219	-	-				3.519	4.95	3.319
Pot Cap-1 Maneuver	1024	-	0	1111	-	-				235	132	726
Stage 1	-	-	0	-	-	-				507	329	-
Stage 2	-	-	0	-	-	-				643	408	-
Platoon blocked, %		-			-	-						
Mov Cap-1 Maneuver	1024	-	-	1111	-	-				227	0	726
Mov Cap-2 Maneuver	-	-	-	-	-	-				227	0	-
Stage 1	-	-	-	-	-	-				491	0	-
Stage 2	-	-	-	-	-	-				643	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.5	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	1024	-	1111	-	-	-
HCM Lane V/C Ratio	-	-	0.032	-	-	-
HCM Control Delay (s)	0	-	8.3	-	-	-
HCM Lane LOS	A	-	A	-	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	360	60	0	0	33	10	510	0	123	0	0	0
Future Volume (veh/h)	360	60	0	0	33	10	510	0	123	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1841	1870	0	0	1870	1870	1826	1870	1826			
Adj Flow Rate, veh/h	400	67	0	0	37	4	647	0	0			
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90			
Percent Heavy Veh, %	4	2	0	0	2	2	5	2	5			
Cap, veh/h	750	720	0	0	1248	133	1087	585	0			
Arrive On Green	0.39	0.39	0.00	0.00	0.39	0.39	0.31	0.00	0.00			
Sat Flow, veh/h	1344	1870	0	0	3334	345	3478	1870	0			
Grp Volume(v), veh/h	400	67	0	0	20	21	647	0	0			
Grp Sat Flow(s),veh/h/ln	1344	1870	0	0	1777	1808	1739	1870	0			
Q Serve(g_s), s	7.8	0.7	0.0	0.0	0.2	0.2	4.7	0.0	0.0			
Cycle Q Clear(g_c), s	8.1	0.7	0.0	0.0	0.2	0.2	4.7	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.19	1.00		0.00			
Lane Grp Cap(c), veh/h	750	720	0	0	684	696	1087	585	0			
V/C Ratio(X)	0.53	0.09	0.00	0.00	0.03	0.03	0.60	0.00	0.00			
Avail Cap(c_a), veh/h	1384	1603	0	0	1522	1549	6486	3488	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	8.2	5.8	0.0	0.0	5.7	5.7	8.6	0.0	0.0			
Incr Delay (d2), s/veh	0.6	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	1.5	0.2	0.0	0.0	0.1	0.1	1.3	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	8.8	5.9	0.0	0.0	5.7	5.7	9.2	0.0	0.0			
LnGrp LOS	A	A	A	A	A	A	A	A	A			
Approach Vol, veh/h		467			41			647				
Approach Delay, s/veh		8.4			5.7			9.2				
Approach LOS		A			A			A				
Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		13.8		16.0				16.0				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		55.5		25.5				25.5				
Max Q Clear Time (g_c+I1), s		6.7		10.1				2.2				
Green Ext Time (p_c), s		2.7		1.6				0.1				
Intersection Summary												
HCM 6th Ctrl Delay			8.7									
HCM 6th LOS			A									

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Int Delay, s/veh	2.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	850	270	90	40
Future Vol, veh/h	0	0	850	270	90	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	4	4	20	12
Mvmt Flow	0	0	895	284	95	42

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	895	0	-	0	895	448
Stage 1	-	-	-	-	895	-
Stage 2	-	-	-	-	0	-
Critical Hdwy	4.13	-	-	-	6.9	7.08
Critical Hdwy Stg 1	-	-	-	-	6.1	-
Critical Hdwy Stg 2	-	-	-	-	5.7	-
Follow-up Hdwy	2.219	-	-	-	3.69	3.414
Pot Cap-1 Maneuver	756	-	-	0	268	536
Stage 1	-	-	-	0	327	-
Stage 2	-	-	-	0	-	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	756	-	-	-	268	536
Mov Cap-2 Maneuver	-	-	-	-	268	-
Stage 1	-	-	-	-	327	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	19.3
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	756	-	-	387
HCM Lane V/C Ratio	-	-	-	0.354
HCM Control Delay (s)	0	-	-	19.3
HCM Lane LOS	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	1.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	730	50	360	670	0	50	0	770	20	220	330
Future Volume (veh/h)	0	730	50	360	670	0	50	0	770	20	220	330
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1870	1870	1841	1870	0	1826	0	1870	1870	1870	1870
Adj Flow Rate, veh/h	0	785	51	387	720	0	54	0	252	22	237	52
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	2	2	4	2	0	5	0	2	2	2	2
Cap, veh/h	0	1218	79	411	2205	0	0	0	0	24	254	237
Arrive On Green	0.00	0.36	0.36	0.23	0.62	0.00	0.00	0.00	0.00	0.15	0.15	0.15
Sat Flow, veh/h	0	3481	220	1753	3647	0		0		158	1704	1585
Grp Volume(v), veh/h	0	412	424	387	720	0		0.0		259	0	52
Grp Sat Flow(s),veh/h/ln	0	1777	1831	1753	1777	0				1862	0	1585
Q Serve(g_s), s	0.0	32.8	32.8	36.9	16.4	0.0				23.4	0.0	4.9
Cycle Q Clear(g_c), s	0.0	32.8	32.8	36.9	16.4	0.0				23.4	0.0	4.9
Prop In Lane	0.00		0.12	1.00		0.00				0.08		1.00
Lane Grp Cap(c), veh/h	0	639	658	411	2205	0				278	0	237
V/C Ratio(X)	0.00	0.64	0.64	0.94	0.33	0.00				0.93	0.00	0.22
Avail Cap(c_a), veh/h	0	639	658	521	2205	0				279	0	238
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	45.4	45.4	63.9	15.3	0.0				71.4	0.0	63.6
Incr Delay (d2), s/veh	0.0	2.2	2.2	22.6	0.4	0.0				35.9	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	15.2	15.6	19.2	7.0	0.0				14.1	0.0	2.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	47.6	47.5	86.5	15.7	0.0				107.4	0.0	64.1
LnGrp LOS	A	D	D	F	B	A				F	A	E
Approach Vol, veh/h		836			1107						311	
Approach Delay, s/veh		47.6			40.5						100.1	
Approach LOS		D			D						F	

Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			44.4	65.6		29.9		110.0				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			50.5	50.5		25.5		105.5				
Max Q Clear Time (g_c+I1), s			38.9	34.8		25.4		18.4				
Green Ext Time (p_c), s			1.0	5.1		0.0		6.4				

Intersection Summary			
HCM 6th Ctrl Delay			51.3
HCM 6th LOS			D

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	700	820	133	1030	0	0	0	0	0	0	0
Future Vol, veh/h	0	700	820	133	1030	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	753	882	143	1108	0	0	0	0	0	0	0

Major/Minor	Major1			Major2						Minor2		
Conflicting Flow All	1108	0	-	753	0	0				2147	2147	554
Stage 1	-	-	-	-	-	-				1394	1394	-
Stage 2	-	-	-	-	-	-				753	753	-
Critical Hdwy	4.13	-	-	4.13	-	-				6.63	6.53	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-				5.83	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-				5.43	5.53	-
Follow-up Hdwy	2.219	-	-	2.219	-	-				3.519	4.019	3.319
Pot Cap-1 Maneuver	628	-	0	855	-	-				47	48	477
Stage 1	-	-	0	-	-	-				196	208	-
Stage 2	-	-	0	-	-	-				464	417	-
Platoon blocked, %		-			-	-						
Mov Cap-1 Maneuver	628	-	-	855	-	-				39	0	477
Mov Cap-2 Maneuver	-	-	-	-	-	-				39	0	-
Stage 1	-	-	-	-	-	-				163	0	-
Stage 2	-	-	-	-	-	-				464	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	1.1	0
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	628	-	855	-	-	-
HCM Lane V/C Ratio	-	-	0.167	-	-	-
HCM Control Delay (s)	0	-	10.1	-	-	0
HCM Lane LOS	A	-	B	-	-	A
HCM 95th %tile Q(veh)	0	-	0.6	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑			↑↱		↰	✣				
Traffic Volume (veh/h)	670	30	0	0	143	40	1020	10	43	0	0	0
Future Volume (veh/h)	670	30	0	0	143	40	1020	10	43	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1870	1841	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	698	31	0	0	149	26	1109	0	0			
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96			
Percent Heavy Veh, %	2	4	0	0	2	2	2	2	2			
Cap, veh/h	731	1088	0	0	1794	307	1268	666	0			
Arrive On Green	0.59	0.59	0.00	0.00	0.59	0.59	0.36	0.00	0.00			
Sat Flow, veh/h	1210	1841	0	0	3128	519	3563	1870	0			
Grp Volume(v), veh/h	698	31	0	0	86	89	1109	0	0			
Grp Sat Flow(s),veh/h/ln	1210	1841	0	0	1777	1777	1781	1870	0			
Q Serve(g_s), s	96.8	1.2	0.0	0.0	3.5	3.7	49.5	0.0	0.0			
Cycle Q Clear(g_c), s	100.5	1.2	0.0	0.0	3.5	3.7	49.5	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.29	1.00		0.00			
Lane Grp Cap(c), veh/h	731	1088	0	0	1050	1050	1268	666	0			
V/C Ratio(X)	0.95	0.03	0.00	0.00	0.08	0.08	0.87	0.00	0.00			
Avail Cap(c_a), veh/h	731	1088	0	0	1050	1050	1268	666	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	37.2	14.4	0.0	0.0	14.9	15.0	51.2	0.0	0.0			
Incr Delay (d2), s/veh	22.7	0.0	0.0	0.0	0.0	0.0	8.6	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	33.8	0.5	0.0	0.0	1.5	1.6	23.8	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	59.9	14.5	0.0	0.0	15.0	15.0	59.8	0.0	0.0			
LnGrp LOS	E	B	A	A	B	B	E	A	A			
Approach Vol, veh/h		729			175			1109				
Approach Delay, s/veh		58.0			15.0			59.8				
Approach LOS		E			B			E				
Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		65.0		105.0				105.0				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		60.5		100.5				100.5				
Max Q Clear Time (g_c+I1), s		51.5		102.5				5.7				
Green Ext Time (p_c), s		3.3		0.0				1.2				
Intersection Summary												
HCM 6th Ctrl Delay			55.2									
HCM 6th LOS			E									

Notes

User approved volume balancing among the lanes for turning movement.

Intersection						
Int Delay, s/veh	15.1					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	1400	60	100	120
Future Vol, veh/h	0	0	1400	60	100	120
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	4	1	3
Mvmt Flow	0	0	1505	65	108	129

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1505	0	-	0	1506	754
Stage 1	-	-	-	-	1505	-
Stage 2	-	-	-	-	1	-
Critical Hdwy	4.13	-	-	-	6.615	6.945
Critical Hdwy Stg 1	-	-	-	-	5.815	-
Critical Hdwy Stg 2	-	-	-	-	5.415	-
Follow-up Hdwy	2.219	-	-	-	3.5095	3.3285
Pot Cap-1 Maneuver	443	-	-	0	123	351
Stage 1	-	-	-	0	172	-
Stage 2	-	-	-	0	1025	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	443	-	-	-	123	351
Mov Cap-2 Maneuver	-	-	-	-	123	-
Stage 1	-	-	-	-	172	-
Stage 2	-	-	-	-	1025	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	110.9
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	443	-	-	231
HCM Lane V/C Ratio	-	-	-	1.024
HCM Control Delay (s)	0	-	-	110.9
HCM Lane LOS	A	-	-	F
HCM 95th %tile Q(veh)	0	-	-	9.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	630	50	240	270	0	20	0	500	30	200	290
Future Volume (veh/h)	0	630	50	240	270	0	20	0	500	30	200	290
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1841	1841	1841	1796	0	1737	0	1811	1856	1856	1870
Adj Flow Rate, veh/h	0	670	49	255	287	0	21	0	42	32	213	46
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	4	4	4	7	0	11	0	6	3	3	2
Cap, veh/h	0	1095	80	330	2100	0	0	0	0	47	310	306
Arrive On Green	0.00	0.33	0.33	0.19	0.62	0.00	0.00	0.00	0.00	0.19	0.19	0.19
Sat Flow, veh/h	0	3397	241	1753	3503	0		0		241	1603	1585
Grp Volume(v), veh/h	0	354	365	255	287	0		0.0		245	0	46
Grp Sat Flow(s),veh/h/ln	0	1749	1797	1753	1706	0				1844	0	1585
Q Serve(g_s), s	0.0	8.0	8.0	6.5	1.7	0.0				5.8	0.0	1.1
Cycle Q Clear(g_c), s	0.0	8.0	8.0	6.5	1.7	0.0				5.8	0.0	1.1
Prop In Lane	0.00		0.13	1.00		0.00				0.13		1.00
Lane Grp Cap(c), veh/h	0	579	596	330	2100	0				356	0	306
V/C Ratio(X)	0.00	0.61	0.61	0.77	0.14	0.00				0.69	0.00	0.15
Avail Cap(c_a), veh/h	0	2063	2121	950	6204	0				999	0	859
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	13.2	13.2	18.1	3.8	0.0				17.6	0.0	15.8
Incr Delay (d2), s/veh	0.0	1.1	1.0	3.9	0.0	0.0				2.4	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	2.9	2.9	2.7	0.4	0.0				2.5	0.0	0.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	14.2	14.2	22.0	3.8	0.0				20.0	0.0	16.0
LnGrp LOS	A	B	B	C	A	A				C	A	B
Approach Vol, veh/h		719			542						291	
Approach Delay, s/veh		14.2			12.4						19.4	
Approach LOS		B			B						B	

Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			13.4	20.1		13.6		33.4				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			25.5	55.5		25.5		85.5				
Max Q Clear Time (g_c+I1), s			8.5	10.0		7.8		3.7				
Green Ext Time (p_c), s			0.7	5.6		1.5		2.2				

Intersection Summary			
HCM 6th Ctrl Delay			14.5
HCM 6th LOS			B

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	400	760	20	510	10	0	0	0	0	10	0
Future Vol, veh/h	0	400	760	20	510	10	0	0	0	0	10	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	2	3	5	2	5	100	2	2	2	2	100	2
Mvmt Flow	0	426	809	21	543	11	0	0	0	0	11	0

Major/Minor	Major1			Major2			Minor2		
Conflicting Flow All	554	0	-	426	0	0	1017	1017	277
Stage 1	-	-	-	-	-	-	591	591	-
Stage 2	-	-	-	-	-	-	426	426	-
Critical Hdwy	4.13	-	-	4.13	-	-	6.63	8	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-	5.83	7	-
Critical Hdwy Stg 2	-	-	-	-	-	-	5.43	7	-
Follow-up Hdwy	2.219	-	-	2.219	-	-	3.519	4.95	3.319
Pot Cap-1 Maneuver	1014	-	0	1132	-	-	248	141	721
Stage 1	-	-	0	-	-	-	517	337	-
Stage 2	-	-	0	-	-	-	658	420	-
Platoon blocked, %		-			-	-			
Mov Cap-1 Maneuver	1014	-	-	1132	-	-	243	0	721
Mov Cap-2 Maneuver	-	-	-	-	-	-	243	0	-
Stage 1	-	-	-	-	-	-	507	0	-
Stage 2	-	-	-	-	-	-	658	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.3	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	1014	-	1132	-	-	-
HCM Lane V/C Ratio	-	-	0.019	-	-	-
HCM Control Delay (s)	0	-	8.2	-	-	-
HCM Lane LOS	A	-	A	-	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	360	40	0	0	20	10	520	0	30	0	0	0
Future Volume (veh/h)	360	40	0	0	20	10	520	0	30	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1841	1870	0	0	1870	1870	1826	1870	1826			
Adj Flow Rate, veh/h	400	44	0	0	22	5	596	0	0			
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90			
Percent Heavy Veh, %	4	2	0	0	2	2	5	2	5			
Cap, veh/h	766	708	0	0	1097	240	1043	561	0			
Arrive On Green	0.38	0.38	0.00	0.00	0.38	0.38	0.30	0.00	0.00			
Sat Flow, veh/h	1361	1870	0	0	2991	635	3478	1870	0			
Grp Volume(v), veh/h	400	44	0	0	13	14	596	0	0			
Grp Sat Flow(s),veh/h/ln	1361	1870	0	0	1777	1756	1739	1870	0			
Q Serve(g_s), s	7.3	0.4	0.0	0.0	0.1	0.1	4.1	0.0	0.0			
Cycle Q Clear(g_c), s	7.4	0.4	0.0	0.0	0.1	0.1	4.1	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.36	1.00		0.00			
Lane Grp Cap(c), veh/h	766	708	0	0	673	665	1043	561	0			
V/C Ratio(X)	0.52	0.06	0.00	0.00	0.02	0.02	0.57	0.00	0.00			
Avail Cap(c_a), veh/h	1491	1704	0	0	1618	1599	6895	3708	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	7.8	5.5	0.0	0.0	5.4	5.4	8.3	0.0	0.0			
Incr Delay (d2), s/veh	0.6	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	1.4	0.1	0.0	0.0	0.0	0.0	1.1	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	8.3	5.6	0.0	0.0	5.5	5.5	8.8	0.0	0.0			
LnGrp LOS	A	A	A	A	A	A	A	A	A			
Approach Vol, veh/h		444			27			596				
Approach Delay, s/veh		8.1			5.5			8.8				
Approach LOS		A			A			A				
Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		12.9		15.1				15.1				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		55.5		25.5				25.5				
Max Q Clear Time (g_c+I1), s		6.1		9.4				2.1				
Green Ext Time (p_c), s		2.4		1.4				0.1				
Intersection Summary												
HCM 6th Ctrl Delay			8.4									
HCM 6th LOS			A									

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Int Delay, s/veh	2.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	860	280	100	40
Future Vol, veh/h	0	0	860	280	100	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	4	4	20	12
Mvmt Flow	0	0	905	295	105	42

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	905	0	-	0	905	453
Stage 1	-	-	-	-	905	-
Stage 2	-	-	-	-	0	-
Critical Hdwy	4.13	-	-	-	6.9	7.08
Critical Hdwy Stg 1	-	-	-	-	6.1	-
Critical Hdwy Stg 2	-	-	-	-	5.7	-
Follow-up Hdwy	2.219	-	-	-	3.69	3.414
Pot Cap-1 Maneuver	749	-	-	0	264	532
Stage 1	-	-	-	0	323	-
Stage 2	-	-	-	0	-	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	749	-	-	-	264	532
Mov Cap-2 Maneuver	-	-	-	-	264	-
Stage 1	-	-	-	-	323	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	21
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	749	-	-	370
HCM Lane V/C Ratio	-	-	-	0.398
HCM Control Delay (s)	0	-	-	21
HCM Lane LOS	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	1.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	730	50	360	680	0	50	0	780	20	220	340
Future Volume (veh/h)	0	730	50	360	680	0	50	0	780	20	220	340
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1870	1870	1841	1870	0	1826	0	1870	1870	1870	1870
Adj Flow Rate, veh/h	0	785	51	387	731	0	54	0	263	22	237	68
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	2	2	4	2	0	5	0	2	2	2	2
Cap, veh/h	0	1218	79	411	2205	0	0	0	0	24	254	237
Arrive On Green	0.00	0.36	0.36	0.23	0.62	0.00	0.00	0.00	0.00	0.15	0.15	0.15
Sat Flow, veh/h	0	3481	220	1753	3647	0		0		158	1704	1585
Grp Volume(v), veh/h	0	412	424	387	731	0		0.0		259	0	68
Grp Sat Flow(s),veh/h/ln	0	1777	1831	1753	1777	0				1862	0	1585
Q Serve(g_s), s	0.0	32.8	32.8	36.9	16.7	0.0				23.4	0.0	6.5
Cycle Q Clear(g_c), s	0.0	32.8	32.8	36.9	16.7	0.0				23.4	0.0	6.5
Prop In Lane	0.00		0.12	1.00		0.00				0.08		1.00
Lane Grp Cap(c), veh/h	0	639	658	411	2205	0				278	0	237
V/C Ratio(X)	0.00	0.64	0.64	0.94	0.33	0.00				0.93	0.00	0.29
Avail Cap(c_a), veh/h	0	639	658	521	2205	0				279	0	238
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	45.4	45.4	63.9	15.4	0.0				71.4	0.0	64.3
Incr Delay (d2), s/veh	0.0	2.2	2.2	22.6	0.4	0.0				35.9	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	15.2	15.6	19.2	7.1	0.0				14.1	0.0	2.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	47.6	47.5	86.5	15.8	0.0				107.4	0.0	64.9
LnGrp LOS	A	D	D	F	B	A				F	A	E
Approach Vol, veh/h		836			1118						327	
Approach Delay, s/veh		47.6			40.3						98.5	
Approach LOS		D			D						F	

Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			44.4	65.6		29.9		110.0				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			50.5	50.5		25.5		105.5				
Max Q Clear Time (g_c+I1), s			38.9	34.8		25.4		18.7				
Green Ext Time (p_c), s			1.0	5.1		0.0		6.6				

Intersection Summary			
HCM 6th Ctrl Delay			51.3
HCM 6th LOS			D

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	710	820	40	1040	0	0	0	0	0	0	0
Future Vol, veh/h	0	710	820	40	1040	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	8	2	2	2	2	2	2	2	2
Mvmt Flow	0	763	882	43	1118	0	0	0	0	0	0	0

Major/Minor	Major1			Major2						Minor2		
Conflicting Flow All	1118	0	-	763	0	0				1967	1967	559
Stage 1	-	-	-	-	-	-				1204	1204	-
Stage 2	-	-	-	-	-	-				763	763	-
Critical Hdwy	4.13	-	-	4.22	-	-				6.63	6.53	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-				5.83	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-				5.43	5.53	-
Follow-up Hdwy	2.219	-	-	2.276	-	-				3.519	4.019	3.319
Pot Cap-1 Maneuver	623	-	0	815	-	-				62	62	473
Stage 1	-	-	0	-	-	-				248	256	-
Stage 2	-	-	0	-	-	-				459	412	-
Platoon blocked, %		-			-	-						
Mov Cap-1 Maneuver	623	-	-	815	-	-				59	0	473
Mov Cap-2 Maneuver	-	-	-	-	-	-				59	0	-
Stage 1	-	-	-	-	-	-				235	0	-
Stage 2	-	-	-	-	-	-				459	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.4	0
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	623	-	815	-	-	-
HCM Lane V/C Ratio	-	-	0.053	-	-	-
HCM Control Delay (s)	0	-	9.7	-	-	0
HCM Lane LOS	A	-	A	-	-	A
HCM 95th %tile Q(veh)	0	-	0.2	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	680	30	0	0	50	20	1030	10	30	0	0	0
Future Volume (veh/h)	680	30	0	0	50	20	1030	10	30	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1870	1841	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	708	31	0	0	52	12	1108	0	0			
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96			
Percent Heavy Veh, %	2	4	0	0	2	2	2	2	2			
Cap, veh/h	766	1011	0	0	1586	354	1417	744	0			
Arrive On Green	0.55	0.55	0.00	0.00	0.55	0.55	0.40	0.00	0.00			
Sat Flow, veh/h	1338	1841	0	0	2981	644	3563	1870	0			
Grp Volume(v), veh/h	708	31	0	0	31	33	1108	0	0			
Grp Sat Flow(s),veh/h/ln	1338	1841	0	0	1777	1754	1781	1870	0			
Q Serve(g_s), s	87.7	1.3	0.0	0.0	1.4	1.5	46.2	0.0	0.0			
Cycle Q Clear(g_c), s	89.2	1.3	0.0	0.0	1.4	1.5	46.2	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.37	1.00		0.00			
Lane Grp Cap(c), veh/h	766	1011	0	0	976	964	1417	744	0			
V/C Ratio(X)	0.92	0.03	0.00	0.00	0.03	0.03	0.78	0.00	0.00			
Avail Cap(c_a), veh/h	822	1088	0	0	1050	1037	1417	744	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	38.1	17.6	0.0	0.0	17.6	17.6	44.8	0.0	0.0			
Incr Delay (d2), s/veh	15.5	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	31.9	0.6	0.0	0.0	0.6	0.6	21.6	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.5	17.6	0.0	0.0	17.6	17.6	49.1	0.0	0.0			
LnGrp LOS	D	B	A	A	B	B	D	A	A			
Approach Vol, veh/h		739			64			1108				
Approach Delay, s/veh		52.0			17.6			49.1				
Approach LOS		D			B			D				
Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		72.1		97.9				97.9				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		60.5		100.5				100.5				
Max Q Clear Time (g_c+I1), s		48.2		91.2				3.5				
Green Ext Time (p_c), s		3.9		2.2				0.4				
Intersection Summary												
HCM 6th Ctrl Delay			49.2									
HCM 6th LOS			D									

Notes

User approved volume balancing among the lanes for turning movement.

Intersection						
Int Delay, s/veh	17.6					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	1410	60	100	120
Future Vol, veh/h	0	0	1410	60	100	120
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	4	1	3
Mvmt Flow	0	0	1516	65	108	129

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1516	0	-	0	1517	759
Stage 1	-	-	-	-	1516	-
Stage 2	-	-	-	-	1	-
Critical Hdwy	4.13	-	-	-	6.615	6.945
Critical Hdwy Stg 1	-	-	-	-	5.815	-
Critical Hdwy Stg 2	-	-	-	-	5.415	-
Follow-up Hdwy	2.219	-	-	-	3.5095	3.3285
Pot Cap-1 Maneuver	439	-	-	0	121	348
Stage 1	-	-	-	0	170	-
Stage 2	-	-	-	0	1025	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	439	-	-	-	121	348
Mov Cap-2 Maneuver	-	-	-	-	121	-
Stage 1	-	-	-	-	170	-
Stage 2	-	-	-	-	1025	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	130.7
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	439	-	-	219
HCM Lane V/C Ratio	-	-	-	1.08
HCM Control Delay (s)	0	-	-	130.7
HCM Lane LOS	A	-	-	F
HCM 95th %tile Q(veh)	0	-	-	10.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	630	50	240	270	0	20	0	500	31	200	290
Future Volume (veh/h)	0	630	50	240	270	0	20	0	500	31	200	290
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1841	1841	1841	1796	0	1737	0	1811	1856	1856	1870
Adj Flow Rate, veh/h	0	670	49	255	287	0	21	0	43	33	213	46
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	4	4	4	7	0	11	0	6	3	3	2
Cap, veh/h	0	1094	80	330	2099	0	0	0	0	48	310	307
Arrive On Green	0.00	0.33	0.33	0.19	0.61	0.00	0.00	0.00	0.00	0.19	0.19	0.19
Sat Flow, veh/h	0	3397	241	1753	3503	0		0		247	1596	1585
Grp Volume(v), veh/h	0	354	365	255	287	0		0.0		246	0	46
Grp Sat Flow(s),veh/h/ln	0	1749	1797	1753	1706	0				1843	0	1585
Q Serve(g_s), s	0.0	8.0	8.0	6.5	1.7	0.0				5.8	0.0	1.1
Cycle Q Clear(g_c), s	0.0	8.0	8.0	6.5	1.7	0.0				5.8	0.0	1.1
Prop In Lane	0.00		0.13	1.00		0.00				0.13		1.00
Lane Grp Cap(c), veh/h	0	579	595	330	2099	0				357	0	307
V/C Ratio(X)	0.00	0.61	0.61	0.77	0.14	0.00				0.69	0.00	0.15
Avail Cap(c_a), veh/h	0	2060	2118	949	6195	0				998	0	858
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	13.2	13.2	18.2	3.8	0.0				17.7	0.0	15.8
Incr Delay (d2), s/veh	0.0	1.1	1.0	3.9	0.0	0.0				2.4	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	2.9	3.0	2.7	0.4	0.0				2.5	0.0	0.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	14.3	14.2	22.0	3.8	0.0				20.0	0.0	16.0
LnGrp LOS	A	B	B	C	A	A				C	A	B
Approach Vol, veh/h		719			542						292	
Approach Delay, s/veh		14.3			12.4						19.4	
Approach LOS		B			B						B	
Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			13.4	20.1		13.6		33.5				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			25.5	55.5		25.5		85.5				
Max Q Clear Time (g_c+I1), s			8.5	10.0		7.8		3.7				
Green Ext Time (p_c), s			0.7	5.6		1.5		2.2				
Intersection Summary												
HCM 6th Ctrl Delay			14.6									
HCM 6th LOS			B									

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	401	760	20	510	10	0	0	0	0	10	0
Future Vol, veh/h	0	401	760	20	510	10	0	0	0	0	10	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	2	3	5	2	5	100	2	2	2	2	100	2
Mvmt Flow	0	427	809	21	543	11	0	0	0	0	11	0

Major/Minor	Major1			Major2						Minor2		
Conflicting Flow All	554	0	-	427	0	0				1018	1018	277
Stage 1	-	-	-	-	-	-				591	591	-
Stage 2	-	-	-	-	-	-				427	427	-
Critical Hdwy	4.13	-	-	4.13	-	-				6.63	8	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-				5.83	7	-
Critical Hdwy Stg 2	-	-	-	-	-	-				5.43	7	-
Follow-up Hdwy	2.219	-	-	2.219	-	-				3.519	4.95	3.319
Pot Cap-1 Maneuver	1014	-	0	1131	-	-				248	141	721
Stage 1	-	-	0	-	-	-				517	337	-
Stage 2	-	-	0	-	-	-				657	419	-
Platoon blocked, %		-			-	-						
Mov Cap-1 Maneuver	1014	-	-	1131	-	-				243	0	721
Mov Cap-2 Maneuver	-	-	-	-	-	-				243	0	-
Stage 1	-	-	-	-	-	-				507	0	-
Stage 2	-	-	-	-	-	-				657	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.3	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	1014	-	1131	-	-	-
HCM Lane V/C Ratio	-	-	0.019	-	-	-
HCM Control Delay (s)	0	-	8.2	-	-	-
HCM Lane LOS	A	-	A	-	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	360	41	0	0	20	10	520	0	34	0	0	0
Future Volume (veh/h)	360	41	0	0	20	10	520	0	34	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1841	1870	0	0	1870	1870	1826	1870	1826			
Adj Flow Rate, veh/h	400	46	0	0	22	5	601	0	0			
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90			
Percent Heavy Veh, %	4	2	0	0	2	2	5	2	5			
Cap, veh/h	765	708	0	0	1097	241	1048	564	0			
Arrive On Green	0.38	0.38	0.00	0.00	0.38	0.38	0.30	0.00	0.00			
Sat Flow, veh/h	1361	1870	0	0	2991	635	3478	1870	0			
Grp Volume(v), veh/h	400	46	0	0	13	14	601	0	0			
Grp Sat Flow(s),veh/h/ln	1361	1870	0	0	1777	1756	1739	1870	0			
Q Serve(g_s), s	7.3	0.4	0.0	0.0	0.1	0.1	4.1	0.0	0.0			
Cycle Q Clear(g_c), s	7.5	0.4	0.0	0.0	0.1	0.1	4.1	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.36	1.00		0.00			
Lane Grp Cap(c), veh/h	765	708	0	0	673	665	1048	564	0			
V/C Ratio(X)	0.52	0.06	0.00	0.00	0.02	0.02	0.57	0.00	0.00			
Avail Cap(c_a), veh/h	1484	1696	0	0	1611	1592	6862	3690	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	7.8	5.6	0.0	0.0	5.5	5.5	8.3	0.0	0.0			
Incr Delay (d2), s/veh	0.6	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	1.4	0.1	0.0	0.0	0.0	0.0	1.1	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	8.4	5.6	0.0	0.0	5.5	5.5	8.8	0.0	0.0			
LnGrp LOS	A	A	A	A	A	A	A	A	A			
Approach Vol, veh/h		446			27			601				
Approach Delay, s/veh		8.1			5.5			8.8				
Approach LOS		A			A			A				
Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		13.0		15.2				15.2				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		55.5		25.5				25.5				
Max Q Clear Time (g_c+I1), s		6.1		9.5				2.1				
Green Ext Time (p_c), s		2.5		1.5				0.1				

Intersection Summary	
HCM 6th Ctrl Delay	8.4
HCM 6th LOS	A

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Int Delay, s/veh	2.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	860	280	100	40
Future Vol, veh/h	0	0	860	280	100	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	4	4	20	12
Mvmt Flow	0	0	905	295	105	42

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	905	0	-	0	905	453
Stage 1	-	-	-	-	905	-
Stage 2	-	-	-	-	0	-
Critical Hdwy	4.13	-	-	-	6.9	7.08
Critical Hdwy Stg 1	-	-	-	-	6.1	-
Critical Hdwy Stg 2	-	-	-	-	5.7	-
Follow-up Hdwy	2.219	-	-	-	3.69	3.414
Pot Cap-1 Maneuver	749	-	-	0	264	532
Stage 1	-	-	-	0	323	-
Stage 2	-	-	-	0	-	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	749	-	-	-	264	532
Mov Cap-2 Maneuver	-	-	-	-	264	-
Stage 1	-	-	-	-	323	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	21
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	749	-	-	370
HCM Lane V/C Ratio	-	-	-	0.398
HCM Control Delay (s)	0	-	-	21
HCM Lane LOS	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	1.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	730	50	360	680	0	50	0	780	20	220	340
Future Volume (veh/h)	0	730	50	360	680	0	50	0	780	20	220	340
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	0	1870	1870	1841	1870	0	1826	0	1870	1870	1870	1870
Adj Flow Rate, veh/h	0	785	51	387	731	0	54	0	263	22	237	68
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	2	2	4	2	0	5	0	2	2	2	2
Cap, veh/h	0	1218	79	411	2205	0	0	0	0	24	254	237
Arrive On Green	0.00	0.36	0.36	0.23	0.62	0.00	0.00	0.00	0.00	0.15	0.15	0.15
Sat Flow, veh/h	0	3481	220	1753	3647	0		0		158	1704	1585
Grp Volume(v), veh/h	0	412	424	387	731	0		0.0		259	0	68
Grp Sat Flow(s),veh/h/ln	0	1777	1831	1753	1777	0				1862	0	1585
Q Serve(g_s), s	0.0	32.8	32.8	36.9	16.7	0.0				23.4	0.0	6.5
Cycle Q Clear(g_c), s	0.0	32.8	32.8	36.9	16.7	0.0				23.4	0.0	6.5
Prop In Lane	0.00		0.12	1.00		0.00				0.08		1.00
Lane Grp Cap(c), veh/h	0	639	658	411	2205	0				278	0	237
V/C Ratio(X)	0.00	0.64	0.64	0.94	0.33	0.00				0.93	0.00	0.29
Avail Cap(c_a), veh/h	0	639	658	521	2205	0				279	0	238
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	1.00	1.00	0.00				1.00	0.00	1.00
Uniform Delay (d), s/veh	0.0	45.4	45.4	63.9	15.4	0.0				71.4	0.0	64.3
Incr Delay (d2), s/veh	0.0	2.2	2.2	22.6	0.4	0.0				35.9	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	15.2	15.6	19.2	7.1	0.0				14.1	0.0	2.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	0.0	47.6	47.5	86.5	15.8	0.0				107.4	0.0	64.9
LnGrp LOS	A	D	D	F	B	A				F	A	E
Approach Vol, veh/h		836			1118						327	
Approach Delay, s/veh		47.6			40.3						98.5	
Approach LOS		D			D						F	
Timer - Assigned Phs			3	4		6		8				
Phs Duration (G+Y+Rc), s			44.4	65.6		29.9		110.0				
Change Period (Y+Rc), s			4.5	4.5		4.5		4.5				
Max Green Setting (Gmax), s			50.5	50.5		25.5		105.5				
Max Q Clear Time (g_c+I1), s			38.9	34.8		25.4		18.7				
Green Ext Time (p_c), s			1.0	5.1		0.0		6.6				
Intersection Summary												
HCM 6th Ctrl Delay			51.3									
HCM 6th LOS			D									

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	710	820	44	1040	0	0	0	0	0	0	0
Future Vol, veh/h	0	710	820	44	1040	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	Free	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	80	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	16974	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	8	2	2	2	2	2	2	2	2
Mvmt Flow	0	763	882	47	1118	0	0	0	0	0	0	0

Major/Minor	Major1			Major2						Minor2		
Conflicting Flow All	1118	0	-	763	0	0				1975	1975	559
Stage 1	-	-	-	-	-	-				1212	1212	-
Stage 2	-	-	-	-	-	-				763	763	-
Critical Hdwy	4.13	-	-	4.22	-	-				6.63	6.53	6.93
Critical Hdwy Stg 1	-	-	-	-	-	-				5.83	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-				5.43	5.53	-
Follow-up Hdwy	2.219	-	-	2.276	-	-				3.519	4.019	3.319
Pot Cap-1 Maneuver	623	-	0	815	-	-				61	62	473
Stage 1	-	-	0	-	-	-				245	254	-
Stage 2	-	-	0	-	-	-				459	412	-
Platoon blocked, %		-			-	-						
Mov Cap-1 Maneuver	623	-	-	815	-	-				57	0	473
Mov Cap-2 Maneuver	-	-	-	-	-	-				57	0	-
Stage 1	-	-	-	-	-	-				231	0	-
Stage 2	-	-	-	-	-	-				459	0	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0.4	0
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	623	-	815	-	-	-
HCM Lane V/C Ratio	-	-	0.058	-	-	-
HCM Control Delay (s)	0	-	9.7	-	-	0
HCM Lane LOS	A	-	A	-	-	A
HCM 95th %tile Q(veh)	0	-	0.2	-	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	680	30	0	0	54	21	1030	10	30	0	0	0
Future Volume (veh/h)	680	30	0	0	54	21	1030	10	30	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1870	1841	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	708	31	0	0	56	13	1108	0	0			
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96			
Percent Heavy Veh, %	2	4	0	0	2	2	2	2	2			
Cap, veh/h	766	1016	0	0	1592	357	1407	739	0			
Arrive On Green	0.55	0.55	0.00	0.00	0.55	0.55	0.39	0.00	0.00			
Sat Flow, veh/h	1332	1841	0	0	2977	647	3563	1870	0			
Grp Volume(v), veh/h	708	31	0	0	34	35	1108	0	0			
Grp Sat Flow(s),veh/h/ln	1332	1841	0	0	1777	1754	1781	1870	0			
Q Serve(g_s), s	88.2	1.3	0.0	0.0	1.5	1.6	46.4	0.0	0.0			
Cycle Q Clear(g_c), s	89.7	1.3	0.0	0.0	1.5	1.6	46.4	0.0	0.0			
Prop In Lane	1.00		0.00	0.00		0.37	1.00		0.00			
Lane Grp Cap(c), veh/h	766	1016	0	0	981	968	1407	739	0			
V/C Ratio(X)	0.92	0.03	0.00	0.00	0.03	0.04	0.79	0.00	0.00			
Avail Cap(c_a), veh/h	817	1088	0	0	1050	1037	1407	739	0			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00			
Uniform Delay (d), s/veh	37.9	17.3	0.0	0.0	17.4	17.4	45.2	0.0	0.0			
Incr Delay (d2), s/veh	15.6	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	31.9	0.6	0.0	0.0	0.6	0.7	21.7	0.0	0.0			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.5	17.3	0.0	0.0	17.4	17.4	49.7	0.0	0.0			
LnGrp LOS	D	B	A	A	B	B	D	A	A			
Approach Vol, veh/h		739			69			1108				
Approach Delay, s/veh		52.0			17.4			49.7				
Approach LOS		D			B			D				
Timer - Assigned Phs		2		4				8				
Phs Duration (G+Y+Rc), s		71.6		98.4				98.4				
Change Period (Y+Rc), s		4.5		4.5				4.5				
Max Green Setting (Gmax), s		60.5		100.5				100.5				
Max Q Clear Time (g_c+I1), s		48.4		91.7				3.6				
Green Ext Time (p_c), s		3.9		2.1				0.4				
Intersection Summary												
HCM 6th Ctrl Delay			49.4									
HCM 6th LOS			D									

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Int Delay, s/veh	17.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	0	0	1410	60	100	120
Future Vol, veh/h	0	0	1410	60	100	120
Conflicting Peds, #/hr	0	0	0	0	1	1
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	Free	-	Yield
Storage Length	-	-	-	180	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	2	2	2	4	1	3
Mvmt Flow	0	0	1516	65	108	129

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1516	0	-	0	1517	759
Stage 1	-	-	-	-	1516	-
Stage 2	-	-	-	-	1	-
Critical Hdwy	4.13	-	-	-	6.615	6.945
Critical Hdwy Stg 1	-	-	-	-	5.815	-
Critical Hdwy Stg 2	-	-	-	-	5.415	-
Follow-up Hdwy	2.219	-	-	-	3.5095	3.3285
Pot Cap-1 Maneuver	439	-	-	0	121	348
Stage 1	-	-	-	0	170	-
Stage 2	-	-	-	0	1025	-
Platoon blocked, %		-	-			
Mov Cap-1 Maneuver	439	-	-	-	121	348
Mov Cap-2 Maneuver	-	-	-	-	121	-
Stage 1	-	-	-	-	170	-
Stage 2	-	-	-	-	1025	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	130.7
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	SBLn1
Capacity (veh/h)	439	-	-	219
HCM Lane V/C Ratio	-	-	-	1.08
HCM Control Delay (s)	0	-	-	130.7
HCM Lane LOS	A	-	-	F
HCM 95th %tile Q(veh)	0	-	-	10.6

Waiawa Solar Power

VIEW STUDIES

WAIAWA, ISLAND OF O'AHU

PREPARED FOR:

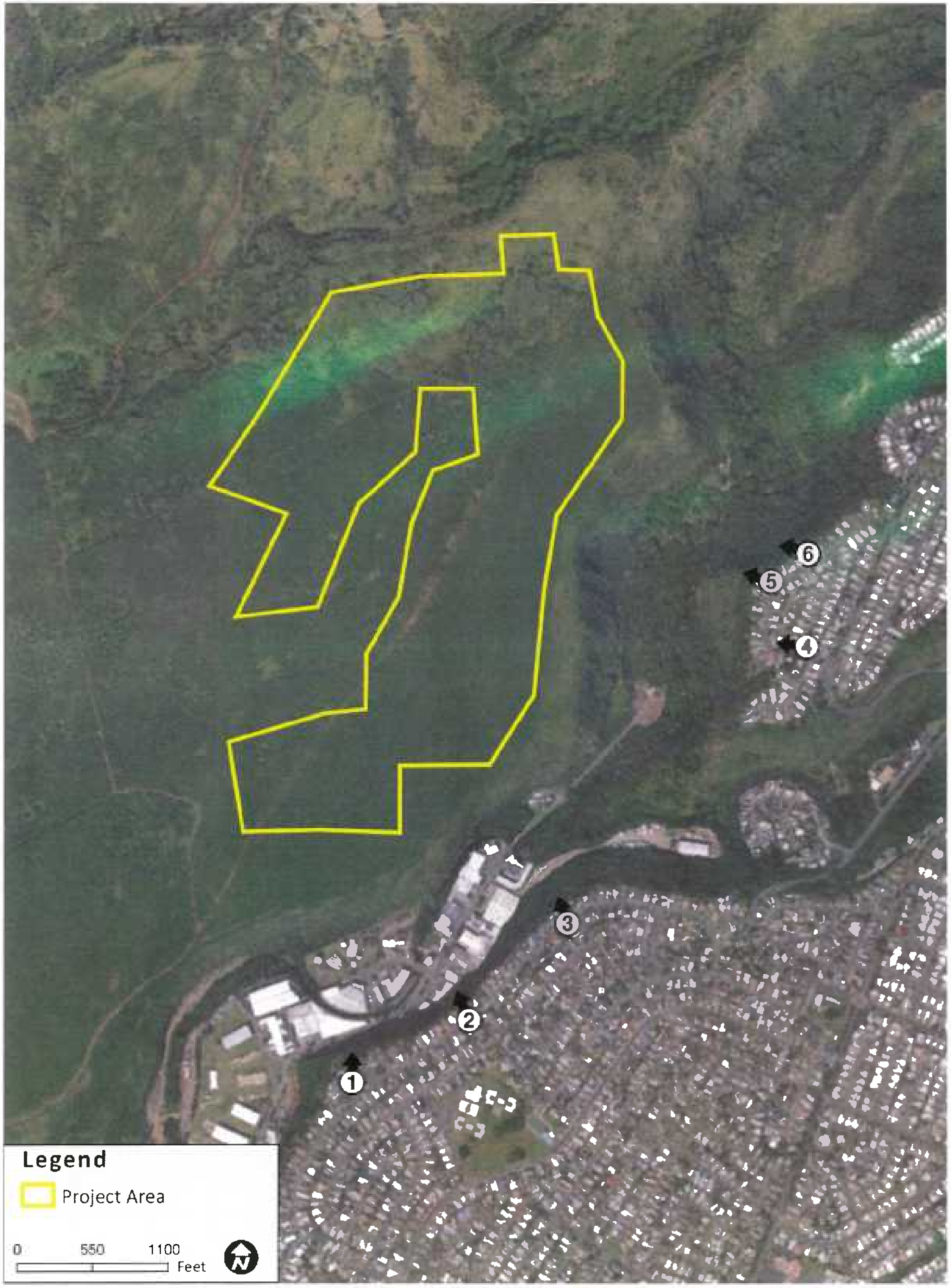
WAIAWA SOLAR POWER LLC

PREPARED BY:

G70

MARCH 2019

KS Exhibit 16



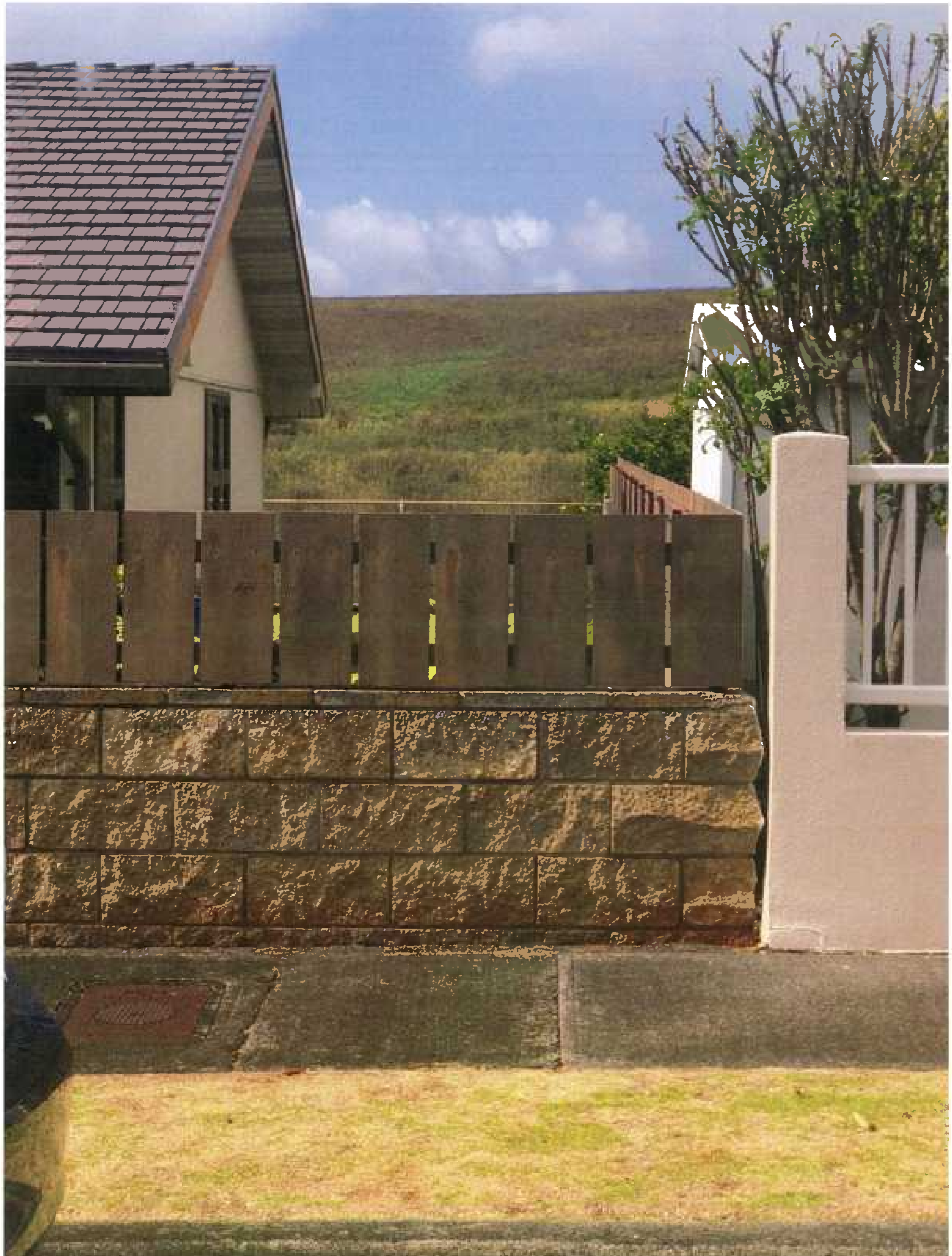
Clearway Energy Group LLC / Waiawa Solar Power LLC

View Study Key Map

G70

1 View from Kaweloka Street.

(2) View from Kaweloka Street.



3 View from Kaweloka Street.

4 View from A‘aniu Loop

5 View from A‘aniu Loop

(6) View from A‘aniu Loop

Waiawa Solar Project

Clearway Energy Group, LLC

Honolulu County, Hawaii

Glint & Glare Analysis

March 26, 2019

Capitol Airspace Group

capitolairspace.com

(703) 256 - 2485

KS Exhibit 17

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Summary

Clearway Energy Group, LLC is proposing to construct a solar array in Honolulu County, Hawaii (*Figure 1*) The Federal Aviation Administration (FAA) only requires Glint and Glare analysis for solar arrays on airports that receive federally obligated funding. The Waiawa solar array is not on an airport that receives federally obligated funding. Capitol Airspace expanded the analysis area to a 7 mile radius to include the nearest public airport receiving federally obligated funds – Daniel K. Inouye International Airport (PHNL) at 6.49 miles from the Waiawa solar project. Additionally, using this expanded analysis area, Wheeler Army Airfield (PHHI) is included in the analysis area at 4.88 miles away from the Waiawa solar project. On behalf of Clearway Energy Group, LLC, Capitol Airspace performed a Glint and Glare Analysis utilizing the Solar Glare Hazard Analysis Tool (SGHAT) in order to identify any potential impacts on Daniel K. Inouye International Airport and Wheeler Army Airfield operations. Specifically, this analysis considered the impact on aircraft approaching to land on Runways 08L/26R, 08R/26L, 04R/22L, 04L/22R, 08W/26W, and 04W/22W at Daniel K. Inouye International Airport and on Runways 06/24 at Wheeler Army Airfield. Since Daniel K. Inouye International Airport and Wheeler Army Airfield are both controlled airports, this analysis also considered the potential for impact on air traffic personnel working in the air traffic control towers (ATCT). Additionally, this analysis considered impact on residents and vehicles on Route 1, Route 2, Route 3, Route 4, Route 5, Route 6, Route 7, and Route 8.

The results of the study show that there is no predicted glare from the solar array for aircraft making approaches to Runways 08L/26R, 08R/26L, 04R/22L, 04L/22R, 08W/26W, and 04W/22W at the Daniel K. Inouye International Airport and to Runway 06/24 at Wheeler Army Airfield. In addition to modeling the effects of glare on approaching aircraft, the SGHAT model assessed the impact of potential glare on the Daniel K. Inouye International Airport ATCT and the Wheeler Army Airfield ATCT. FAA standards do not allow for any glare in the ATCT. The results of the study show that the proposed solar array will not create glare in the ATCT at either airport. These results conform to, and are in accordance with, the FAA's interim policy for Solar Energy System Projects on Federally Obligated Airports.

There was also no predicted glare for residents with an estimated single story viewing height of 8 feet or a second story viewing height of 16 feet. There is also no predicted glare from the solar array along Route 1, Route 2, Route 3, Route 4, Route 5, Route 6, Route 7, or Route 8 for cars with an estimated viewing height of 4 feet and for large trucks with an estimated viewing height of 8 feet. Capitol Airspace has applied FAA's glint and glare standards to vehicular operations due to the absence of non-aviation regulatory guidelines.

Figure 1: Location of Waiawa solar project in proximity to Daniel K. Inouye International Airport and Wheeler Army Airfield

Methodology

The results of this analysis conform to, and are in accordance with, the FAA's interim policy for Solar Energy System Projects on Federally Obligated Airports.[1] The FAA adopted this interim policy in order to enhance safety by providing standards for measuring ocular impact of proposed solar energy systems on pilots and air traffic controllers. In cooperation with the Department of Energy (DOE), the FAA developed and validated the Sandia National Laboratories' *"Solar Glare Hazard Analysis Tool"* (SGHAT), now licensed through ForgeSolar. The FAA requires the use of the SGHAT to demonstrate compliance with the standards for measuring ocular impact.

In order for the FAA to approve a revised airport layout plan depicting a solar installation and/or issue a determination of no hazard, the airport sponsor is required to show that the solar installation meets the standards set forth in the interim policy. The interim policy states that a project:

1. Must not have a potential for glint or glare in the existing or planned ATCT cab, (Green, Yellow, or Red) and
2. Must not have a potential for glare (Yellow or Red) along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). An airport may have a "low potential for after image" (Green) within these areas. The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath.
3. Ocular impact must be analyzed over the entire calendar year in one (1) minute intervals from when the sun rises above the horizon until the sun sets below the horizon.

SGHAT Assumptions:

1. Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
2. Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover, and geographic obstructions.
3. The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.
4. Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Capitol Airspace utilized the SGHAT based guidance provided in User's Manual v.3. Solar array specifications were provided by Clearway Energy Group, LLC. The Waiawa solar project array is a single axis tracking solar array. Flight path data was developed by reviewing airport's specific operations before entering it into the SGHAT tool. Each flight path has configurable parameters and observation points. One of the configurable inputs allows for limiting the downward and azimuthal angles of view from the flight path to simulate a pilot's view out the window of the cockpit. Clearway Energy Group, LLC specified that the analysis be conducted from the FAA's approved default settings in the SGHAT tool which utilizes the view from the pilot's perspective.

[1] 78 FR 63276, 10/23/2013

Data

Solar Array

Clearway Energy Group, LLC provided the data for the array (***Figure 2***), based on the input parameters defined in the SGHAT User's Manual v.3.

The data for the Waiawa Solar array are as follows:

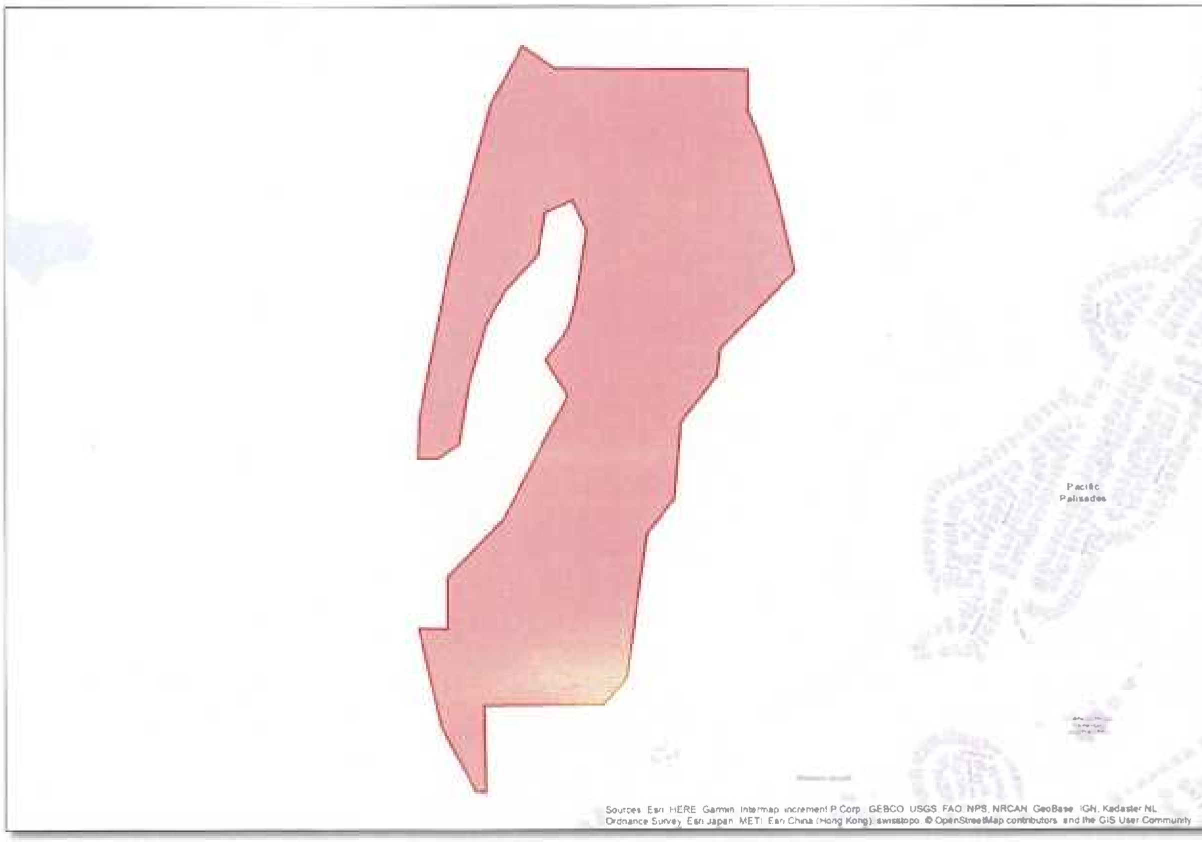

Figure 2: Waiawa Solar array overview

Parameter	Value
Axis tracking:	Single-axis rotation
Tracking axis orientation:	180.0°
Tracking axis tilt:	0.0°
Max tracking angle:	60.0°
Resting angle:	2.0°
Panel material:	Smooth glass with AR coating
Reflectivity:	Vary with sun
Slope error:	Correlate with material

Table 1: Waiawa Solar Array Inputs

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	21.427095	-157.972597	448.8	15	463.8
2	21.426655	-157.968461	527.14	15	542.14
3	21.423181	-157.967634	401.3	15	416.3
4	21.421389	-157.969075	498.39	15	513.39
5	21.41928	-157.969872	453.46	15	468.46
6	21.416205	-157.970777	397.38	15	412.38
7	21.415763	-157.971204	393.94	15	408.94
8	21.415757	-157.973402	356.11	15	371.11
9	21.414282	-157.973383	309.03	15	324.03
10	21.414295	-157.973574	303.18	15	318.18
11	21.41541	-157.9742	374.17	15	389.17
12	21.417093	-157.974596	387.84	15	402.85
13	21.417082	-157.974064	389.55	15	404.55
14	21.41798	-157.974058	395.56	15	410.56
15	21.421071	-157.971815	441.39	15	456.39
16	21.421687	-157.972217	442.93	15	457.93
17	21.424434	-157.971699	478.46	15	493.46
18	21.424229	-157.972193	454.27	15	469.27
19	21.423491	-157.972341	449.77	15	464.77
20	21.422307	-157.9733	394.04	15	409.04
21	21.42024	-157.973825	378.21	15	393.21
22	21.420012	-157.974212	368.03	15	383.03
23	21.420013	-157.974591	355.65	15	370.65
24	21.42071	-157.974554	360.8	15	375.8
25	21.423614	-157.97392	460.27	15	475.27
26	21.426096	-157.973197	479.62	15	494.62

Table 2: Waiawa Solar Array Vertices

Runway 04R/22L – Daniel K. Inouye International Airport

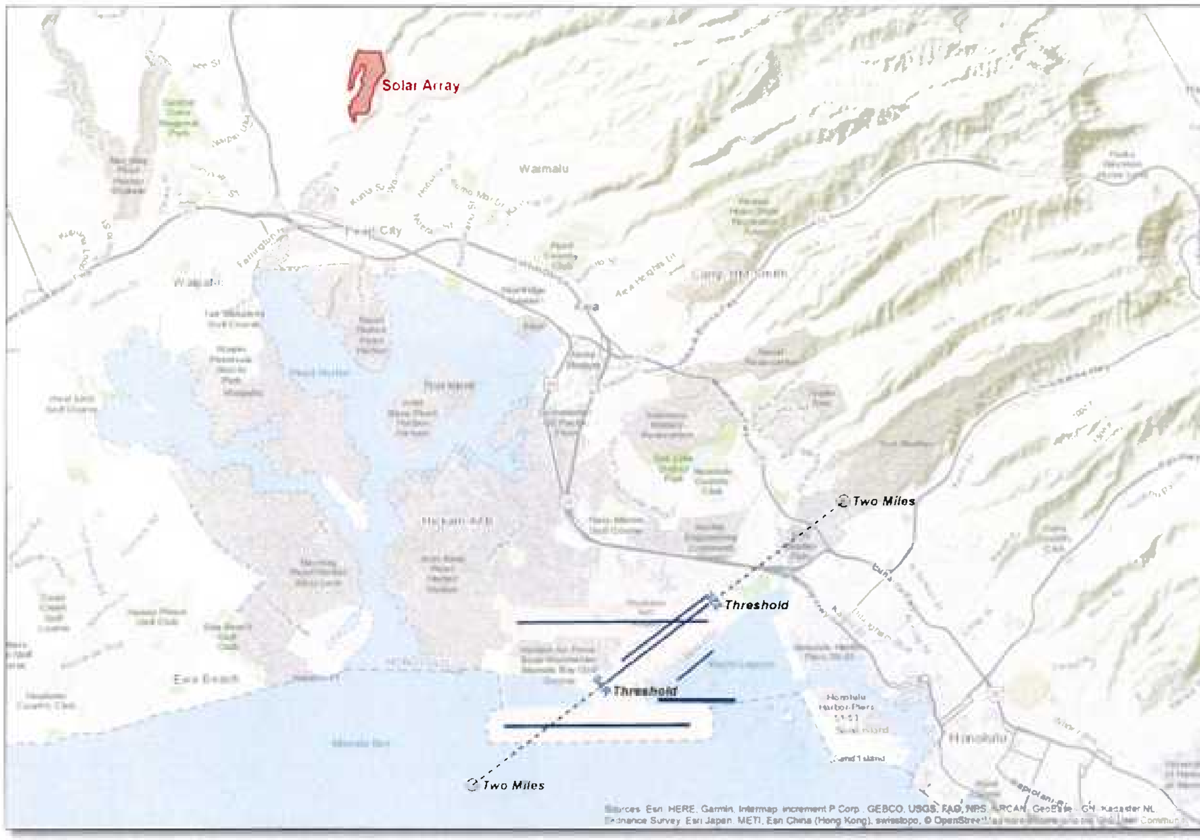

Figure 3: Runway 04R/22L SGHAT flight path and Waiawa Solar project

Parameter	Runway 04R	Runway 22L
Threshold height (ft)	50.0	50.0
Direction (deg)	53	233
Glide slope (deg)	3.0	3.0
Consider pilot visibility from cockpit	Yes	Yes

Table 3: Runway 04R/22L flight path and viewing parameters

Runway	Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
04R	Threshold	21.313921	-157.927155	8.00	50.00	58.00
	Two-mile	21.296521	-157.951970	-91.08	702.54	611.46
22L	Threshold	21.328829	-157.906018	8.30	50.00	58.30
	Two-mile	21.346229	-157.881200	110.54	501.22	611.76

Table 4: Runway 04R/22L flight path observation points

Runway 04L/22R – Daniel K. Inouye International Airport

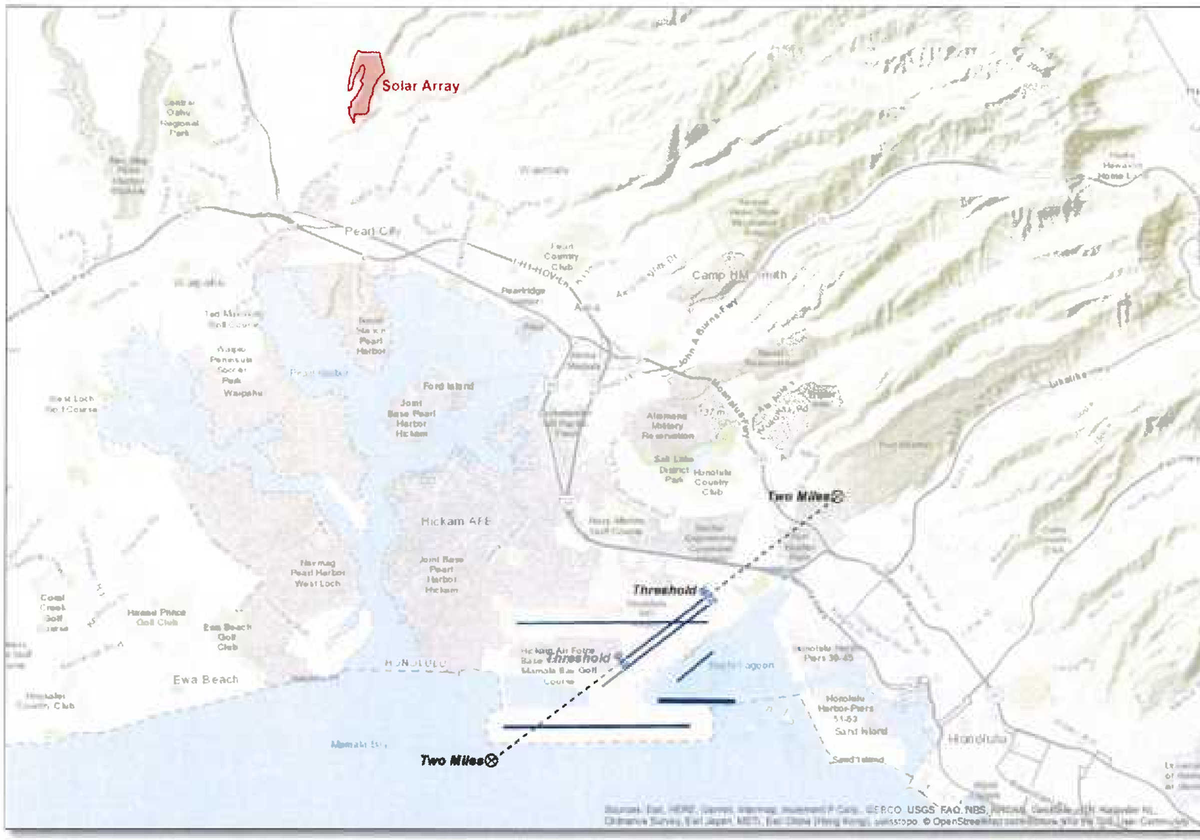

Figure 4: Runway 04L/22R SGHAT flight path and Waiawa Solar project

Parameter	Runway 04L	Runway 22R
Threshold height (ft)	50.0	50.0
Direction (deg)	53	233
Glide slope (deg)	3.0	3.0
Consider pilot visibility from cockpit	Yes	Yes

Table 5: Runway 04L/22R flight path and viewing parameters

Runway	Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
04L	Threshold	21.318335	-157.923340	9.80	50.00	59.80
	Two-mile	21.300935	-157.948156	-31.01	644.27	613.26
22R	Threshold	21.329602	-157.907366	7.40	50.00	57.40
	Two-mile	21.347002	-157.882548	116.61	494.25	610.86

Table 6: Runway 04L/22R flight path observation points

Runway 08L/26R – Daniel K. Inouye International Airport

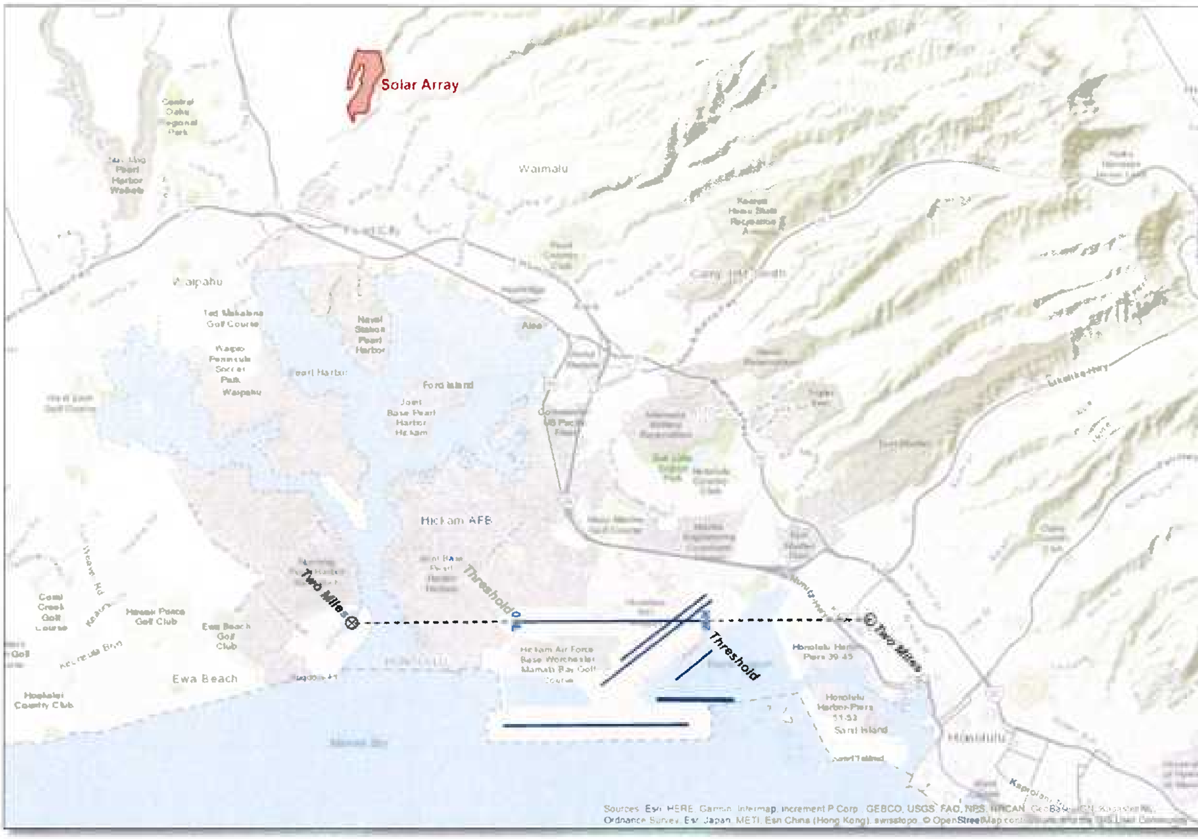

Figure 5: Runway 08L/26R SGHAT flight path and Waiawa Solar project

Parameter	Runway 08L	Runway 26R
Threshold height (ft)	50.0	50.0
Direction (deg)	90	270
Glide slope (deg)	3.0	3.0
Consider pilot visibility from cockpit	Yes	Yes

Table 7: Runway 08L/26R flight path and viewing parameters

Runway	Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
08L	Threshold	21.325256	-157.943326	11.60	50.00	61.60
	Two-mile	21.325256	-157.974400	0.00	615.06	615.06
26R	Threshold	21.325245	-157.907078	8.40	50.00	58.40
	Two-mile	21.325245	-157.876004	18.66	593.19	611.86

Table 8: Runway 08L/26R flight path observation points

Runway 08R/26L – Daniel K. Inouye International Airport

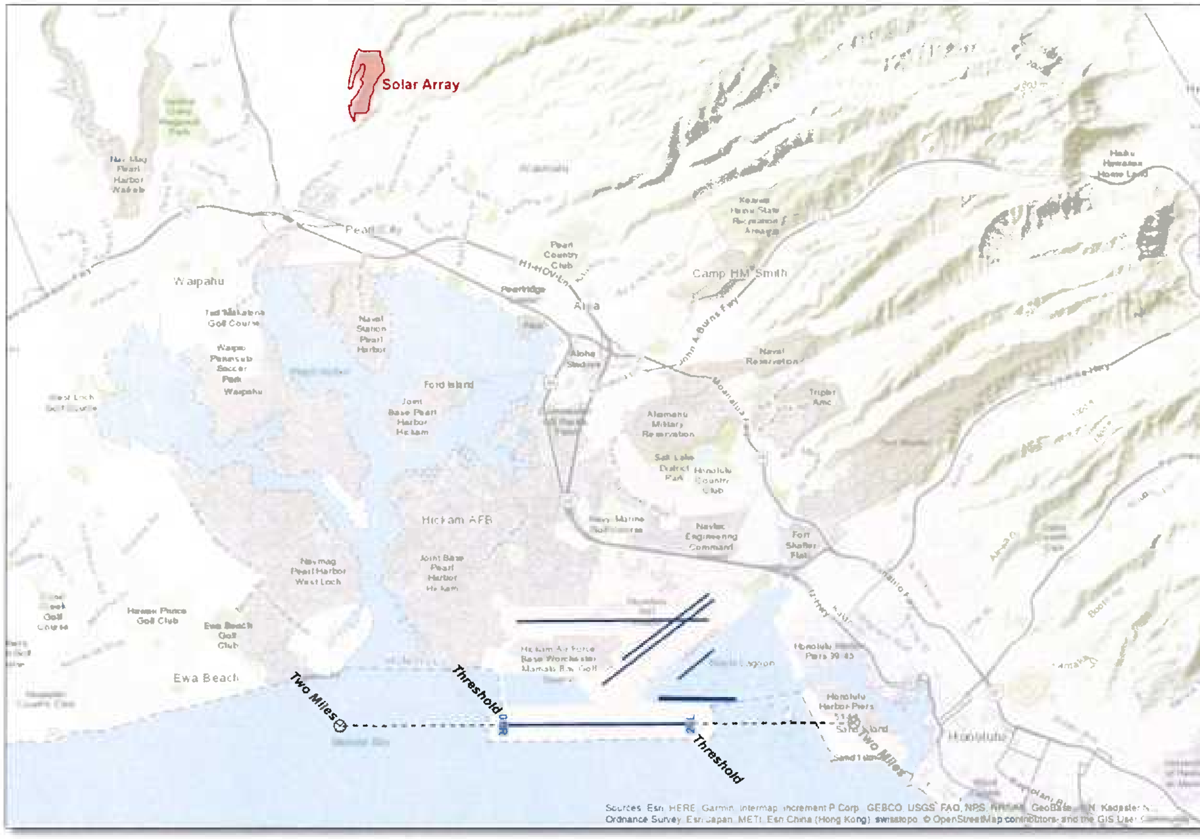

Figure 6: Runway 08R/26L SGHAT flight path and Waiawa Solar project

Parameter	Runway 08R	Runway 26L
Threshold height (ft)	50.0	50.0
Direction (deg)	90	270
Glide slope (deg)	3.0	3.0
Consider pilot visibility from cockpit	Yes	Yes

Table 9: Runway 08R/26L flight path and viewing parameters

Runway	Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
08R	Threshold	21.306809	-157.945881	10.00	50.00	60.00
	Two-mile	21.306304	-157.976946	-11.76	625.22	613.46
26L	Threshold	21.306804	-157.910604	10.00	50.00	60.00
	Two-mile	21.306804	-157.879534	7.66	605.80	613.46

Table 10: Runway 08R/26L flight path observation points

Runway 04W/22W – Daniel K. Inouye International Airport

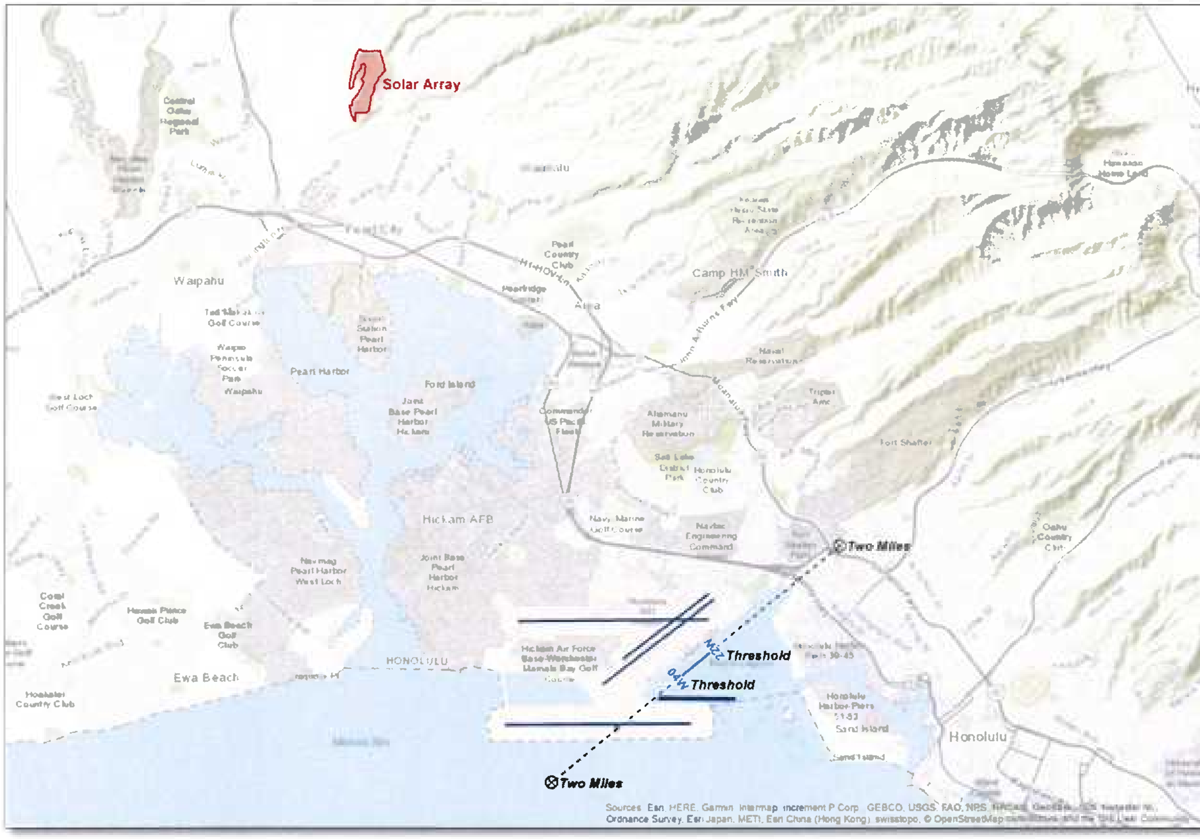

Figure 7: Runway 04W/22W SGHAT flight path and Waiawa Solar project

Parameter	Runway 04W	Runway 22W
Threshold height (ft)	50.0	50.0
Direction (deg)	53	233
Glide slope (deg)	3.0	3.0
Consider pilot visibility from cockpit	Yes	Yes

Table 11: Runway 04W/22W flight path and viewing parameters

Runway	Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
04RW	Threshold	21.314746	-157.912901	-3.73	50.00	46.27
	Two-mile	21.297346	-157.937717	-56.34	656.07	599.73
22W	Threshold	21.319944	-157.906051	-4.38	50.00	45.62
	Two-mile	21.337344	-157.881235	63.86	535.22	599.08

Table 12: Runway 04W/22W flight path observation points

Runway 08W/26W – Daniel K. Inouye International Airport

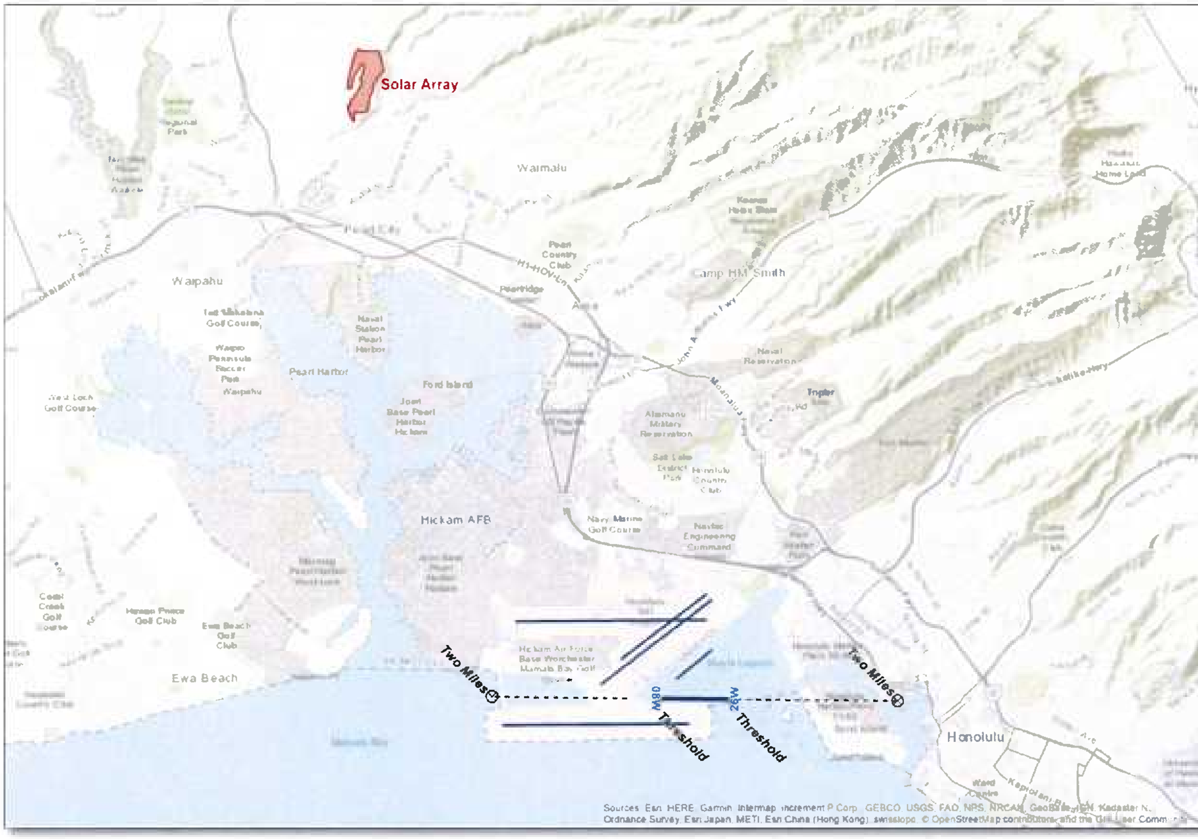

Figure 8: Runway 08W/26W SGHAT flight path and Waiawa Solar project

Parameter	Runway 08W	Runway 26W
Threshold height (ft)	50.0	50.0
Direction (deg)	91	271
Glide slope (deg)	3.0	3.0
Consider pilot visibility from cockpit	Yes	Yes

Table 13: Runway 08W/26W flight path and viewing parameters

Runway	Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
08W	Threshold	21.311347	-157.916667	-1.64	50.00	48.37
	Two-mile	21.311851	-157.947734	-2.17	603.99	601.82
26W	Threshold	21.311105	-157.901981	-9.19	50.00	40.82
	Two-mile	21.310601	-157.870915	2.32	591.96	594.27

Table 14: Runway 08W/26W flight path observation points

Air Traffic Control Tower – Daniel K. Inouye International Airport

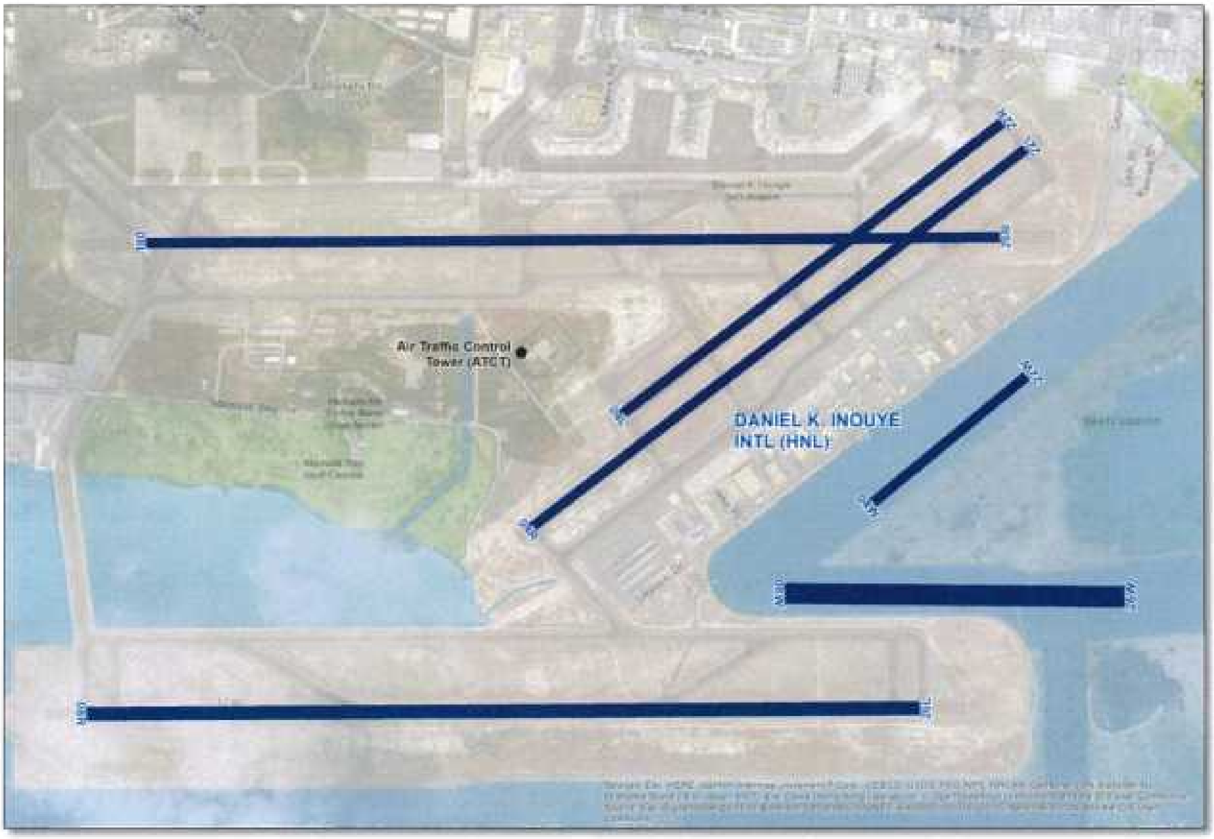

Figure 9: Air Traffic Control Tower at Daniel K. Inouye International Airport

Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
ATCT	21.320872	-157.927382	6.00	174.01	180.01

Table 15: Air Traffic Control Tower observation points

Runway 06/24 – Wheeler Army Airfield

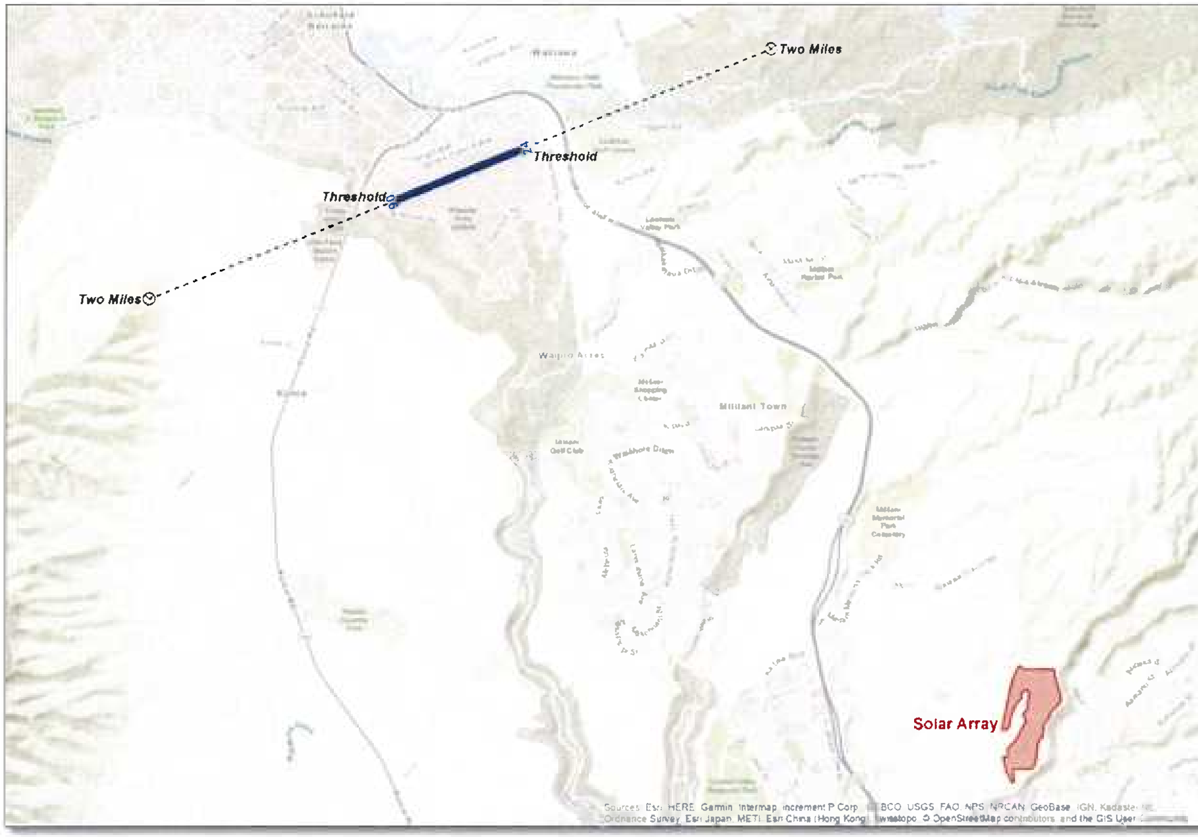

Figure 10: Runway 06/24 SGHAT flight path and Waiawa Solar project

Parameter	Runway 06	Runway 24
Threshold height (ft)	50.0	50.0
Direction (deg)	69	249
Glide slope (deg)	3.0	3.0
Consider pilot visibility from cockpit	Yes	Yes

Table 16: Runway 06/24 flight path and viewing parameters

Runway	Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
06	Threshold	21.479191	-158.043945	816.17	50.00	866.17
	2-mile point	21.468830	-158.072986	1188.83	230.80	1419.63
24	Threshold	21.484311	-158.030153	836.66	50.00	886.66
	2-mile point	21.494673	-158.001112	994.65	445.46	1440.11

Table 17: Runway 06/24 flight path observation points

Air Traffic Control Tower – Wheeler Army Airfield

Figure 11: Air Traffic Control Tower at Wheeler Army Airfield

Observation Point	Latitude	Longitude	Ground Elevation (feet)	Height above ground (feet)	Total Elevation (feet)
ATCT	21.483108	-158.038381	840.04	47.00	887.04

Table 18: Air Traffic Control Tower observation points

Waiawa Solar Discrete Observation Points - Residents

Figure 12: Location of Waiawa Solar Array Discrete Observation Points - Residents

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground - Single Story (feet)	Total Elevation - Single Story	Height Above Ground – Second Story (feet)	Total Elevation - Second Story
OP 1	21.410445	-157.977413	71.3	8	79.3	16	87.3
OP 2	21.411019	-157.976339	73.46	8	81.46	16	89.46
OP 3	21.41165	-157.974957	67.5	8	75.5	16	83.5
OP 4	21.412264	-157.973391	110.04	8	118.04	16	126.04
OP 5	21.412869	-157.972155	80.26	8	88.26	16	96.26
OP 6	21.41496	-157.970352	160.04	8	168.04	16	176.04
OP 7	21.414842	-157.965588	128.39	8	136.39	16	144.39
OP 8	21.414542	-157.965667	129.1	8	137.1	16	145.1
OP 9	21.415081	-157.965407	121.11	8	129.11	16	137.11
OP 10	21.415209	-157.965166	131.04	8	139.04	16	147.04
OP 11	21.416414	-157.96553	323.95	8	331.96	16	339.96
OP 12	21.416777	-157.965545	320.6	8	328.6	16	336.6
OP 13	21.41771	-157.965402	317.8	8	325.8	16	333.8
OP 14	21.41797	-157.965378	338.81	8	346.81	16	354.81
OP 15	21.418212	-157.965359	350.75	8	358.75	16	366.75
OP 16	21.418517	-157.965383	351.9	8	359.91	16	367.91
OP 17	21.418904	-157.965394	352.66	8	360.66	16	368.66
OP 18	21.419278	-157.96534	370	8	378	16	386
OP 19	21.419628	-157.96512	365.81	8	373.81	16	381.81
OP 20	21.419718	-157.96482	372.38	8	380.38	16	388.38
OP 21	21.422336	-157.962479	432.21	8	440.21	16	448.22
OP 22	21.42267	-157.962401	433.37	8	441.37	16	449.37
OP 23	21.422953	-157.962289	430.53	8	438.53	16	446.53
OP 24	21.420723	-157.963284	419.05	8	427.05	16	435.05
OP 25	21.424335	-157.962173	466.41	8	474.41	16	482.41
OP 26	21.424167	-157.962152	472.81	8	480.81	16	488.81
OP 27	21.424061	-157.962047	477.82	8	485.82	16	493.82

Table 19: Waiawa Solar Array Discrete Observation Receptors

Waiawa Solar Discrete Observation Points - Routes

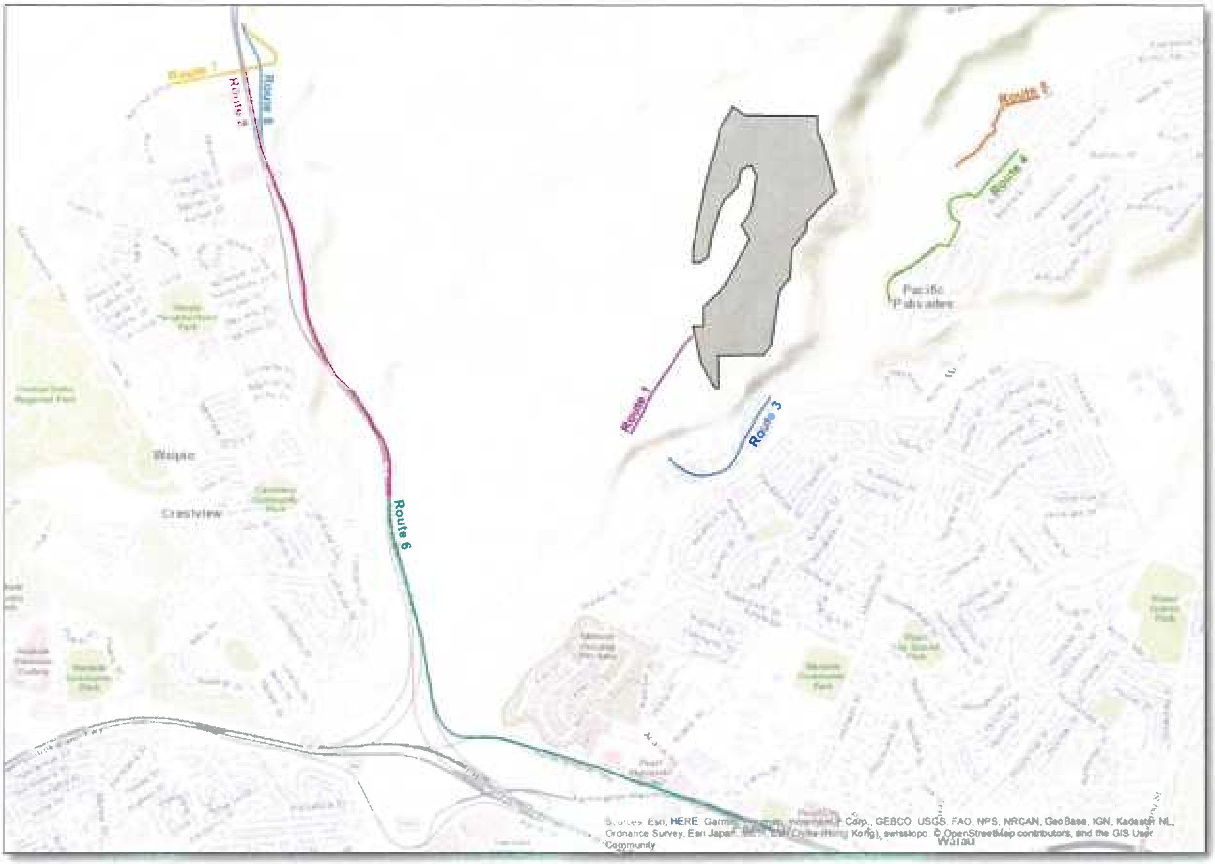

Figure 13: Location of Waiawa Solar Array Discrete Observation Points - Routes

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground – Cars (feet)	Total Elevation - Cars	Height Above Ground – Trucks (feet)	Total Elevation - Trucks
1	21.412234	-157.977661	247.92	4	251.93	8	255.93
2	21.412809	-157.977303	270.9	4	274.9	8	278.9
3	21.413091	-157.977118	283.01	4	287.01	8	291.01
4	21.413382	-157.976961	293.44	4	297.44	8	301.44
5	21.413977	-157.976651	313.3	4	317.3	8	321.3
6	21.41427	-157.97647	321.76	4	325.76	8	329.76
7	21.414528	-157.976255	329.06	4	333.06	8	337.06
8	21.415611	-157.975475	348.48	4	352.48	8	356.48
9	21.416153	-157.975083	357.14	4	361.14	8	365.14
10	21.416414	-157.974869	362.42	4	366.42	8	370.42
11	21.416662	-157.974645	366.84	4	370.84	8	374.84

Table 20: Waiawa Solar Array Observation Receptors Route 1

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground – Cars (feet)	Total Elevation - Cars	Height Above Ground – Trucks (feet)	Total Elevation - Trucks
1	21.409392	-157.989463	188.84	4	192.84	8	196.84
2	21.410836	-157.989425	249.85	4	253.85	8	257.85
3	21.411348	-157.989505	260.7	4	264.7	8	268.7
4	21.411865	-157.989666	254.09	4	258.09	8	262.09
5	21.412359	-157.99002	183.69	4	187.69	8	191.69
6	21.412549	-157.99023	151.92	4	155.92	8	159.92
7	21.413093	-157.990428	183.69	4	187.69	8	191.69
8	21.414187	-157.991185	277.12	4	281.12	8	285.12
9	21.414921	-157.992	168.38	4	172.38	8	176.38
10	21.415375	-157.992274	200.21	4	204.21	8	208.21
11	21.41569	-157.992467	242.8	4	246.8	8	250.8
12	21.416479	-157.992864	322.02	4	326.02	8	330.02
13	21.417428	-157.993293	324.94	4	328.94	8	332.94
14	21.418097	-157.993459	330.37	4	334.37	8	338.37
15	21.418916	-157.993523	370.21	4	374.21	8	378.21
16	21.420379	-157.993813	371.85	4	375.85	8	379.85
17	21.421608	-157.994055	398.92	4	402.92	8	406.92
18	21.422427	-157.994366	402.5	4	406.5	8	410.5
19	21.42392	-157.995025	403.89	4	407.89	8	411.89
20	21.425338	-157.995594	402.9	4	406.9	8	410.9
21	21.426652	-157.9959	442.59	4	446.59	8	450.59
22	21.428829	-157.996324	484.42	4	488.42	8	492.42

Table 21: Waiawa Solar Array Observation Receptors Route 2

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground – Cars (feet)	Total Elevation - Cars	Height Above Ground – Trucks (feet)	Total Elevation - Trucks
1	21.411143	-157.975835	74.65	4	78.65	8	82.65
2	21.410716	-157.975423	78.77	4	82.77	8	86.77
3	21.410698	-157.975296	77.47	4	81.47	8	85.47
4	21.410564	-157.975116	75.42	4	79.42	8	83.42
5	21.410455	-157.97493	71.22	4	75.22	8	79.22
6	21.410357	-157.974687	69.69	4	73.69	8	77.69
7	21.410281	-157.974367	70.26	4	74.26	8	78.26
8	21.410284	-157.974098	71.22	4	75.22	8	79.22
9	21.41032	-157.973769	72.37	4	76.38	8	80.38
10	21.410417	-157.973357	80.86	4	84.86	8	88.86
11	21.410576	-157.973008	87.66	4	91.66	8	95.66
12	21.410876	-157.972716	80.69	4	84.69	8	88.69
13	21.411461	-157.972374	78.35	4	82.35	8	86.35
14	21.412058	-157.972053	64.41	4	68.41	8	72.41
15	21.412258	-157.971916	65.42	4	69.42	8	73.42
16	21.412467	-157.971797	66.67	4	70.67	8	74.67
17	21.412879	-157.971549	67.66	4	71.66	8	75.66
18	21.413275	-157.971317	71.13	4	75.13	8	79.13
19	21.413596	-157.971037	72.98	4	76.98	8	80.98
20	21.413868	-157.970842	74.48	4	78.48	8	82.48

Table 22: Waiawa Solar Array Observation Receptors Route 3

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground – Cars (feet)	Total Elevation - Cars	Height Above Ground – Trucks (feet)	Total Elevation - Trucks
1	21.41814	-157.964984	366.91	4	370.91	8	374.91
2	21.418394	-157.965027	369.87	4	373.87	8	377.88
3	21.419145	-157.964967	383.7	4	387.7	8	391.7
4	21.419241	-157.96491	386.62	4	390.62	8	394.62
5	21.419354	-157.964814	390.77	4	394.77	8	398.77
6	21.419417	-157.964712	395.15	4	399.15	8	403.16
7	21.419585	-157.964297	407.56	4	411.56	8	415.56
8	21.419742	-157.964002	414.38	4	418.38	8	422.38
9	21.420042	-157.963543	422.12	4	426.12	8	430.12
10	21.42032	-157.963196	438.48	4	442.48	8	446.48
11	21.420561	-157.962887	448.43	4	452.43	8	456.43
12	21.420678	-157.962748	447.74	4	451.74	8	455.74
13	21.420717	-157.962678	447.88	4	451.88	8	455.89
14	21.420745	-157.962563	448.53	4	452.53	8	456.53
15	21.420735	-157.962444	448.95	4	452.95	8	456.95
16	21.4207	-157.962305	450.05	4	454.05	8	458.06
17	21.420645	-157.962145	451.97	4	455.97	8	459.97
18	21.421767	-157.961568	464.46	4	468.46	8	472.46
19	21.421915	-157.961874	457.25	4	461.25	8	465.25
20	21.422062	-157.961989	454.97	4	458.97	8	462.97
21	21.422289	-157.962052	454.23	4	458.23	8	462.23
22	21.422519	-157.96208	453.23	4	457.23	8	461.23
23	21.422694	-157.962043	453.29	4	457.29	8	461.29
24	21.422799	-157.96195	454.37	4	458.37	8	462.37
25	21.422864	-157.961851	455.52	4	459.52	8	463.52
26	21.422915	-157.961689	458.3	4	462.3	8	466.3
27	21.423041	-157.961179	475.63	4	479.63	8	483.63
28	21.42305	-157.961089	478.96	4	482.96	8	486.96
29	21.423033	-157.961017	481.44	4	485.44	8	489.44
30	21.4229	-157.960808	486.51	4	490.51	8	494.51
31	21.425031	-157.958682	532.24	4	536.24	8	540.24

Table 23: Waiawa Solar Array Observation Receptors Route 4

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground – Cars (feet)	Total Elevation - Cars	Height Above Ground – Trucks (feet)	Total Elevation - Trucks
1	21.424327	-157.961781	490.4	4	494.4	8	498.4
2	21.424867	-157.960852	502.08	4	506.08	8	510.08
3	21.424976	-157.960732	506.41	4	510.41	8	514.41
4	21.425292	-157.96047	517.6	4	521.6	8	525.6
5	21.425631	-157.960183	520.67	4	524.67	8	528.67
6	21.425712	-157.960057	522.42	4	526.42	8	530.42
7	21.42583	-157.959849	526.15	4	530.15	8	534.15
8	21.425855	-157.95979	526.61	4	530.61	8	534.61
9	21.426054	-157.959844	530.38	4	534.38	8	538.38
10	21.426147	-157.959852	532.51	4	536.51	8	540.51
11	21.4263	-157.959802	536.56	4	540.56	8	544.56
12	21.426789	-157.959591	542.93	4	546.93	8	550.93
13	21.426912	-157.959495	545.98	4	549.98	8	553.98
14	21.426998	-157.959406	548.57	4	552.57	8	556.57
15	21.427091	-157.959255	554.74	4	558.74	8	562.74
16	21.427148	-157.959025	564.05	4	568.05	8	572.05
17	21.427479	-157.957662	586.37	4	590.37	8	594.37

Table 24: Waiawa Solar Array Observation Receptors Route 5

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground – Cars (feet)	Total Elevation - Cars	Height Above Ground – Trucks (feet)	Total Elevation - Trucks
1	21.409157	-157.989435	181.96	4	185.96	8	189.96
2	21.407833	-157.989338	140.47	4	144.47	8	148.47
3	21.407069	-157.989107	127.3	4	131.3	8	135.3
4	21.403735	-157.988161	134.7	4	138.7	8	142.7
5	21.402911	-157.987931	127.85	4	131.85	8	135.85
6	21.40207	-157.987796	110.69	4	114.69	8	118.69
7	21.401233	-157.987623	39.65	4	43.65	8	47.65
8	21.400805	-157.987547	23.04	4	27.04	8	31.04
9	21.400392	-157.987479	24.19	4	28.2	8	32.2
10	21.399972	-157.987359	26.34	4	30.34	8	34.34
11	21.399565	-157.987224	28.18	4	32.18	8	36.19
12	21.399178	-157.987047	30.9	4	34.9	8	38.9
13	21.398838	-157.986785	31.8	4	35.8	8	39.8
14	21.398569	-157.986439	29.57	4	33.57	8	37.57
15	21.398479	-157.98618	26.92	4	30.92	8	34.92
16	21.398436	-157.985921	26.99	4	30.99	8	34.99
17	21.398429	-157.98473	21.73	4	25.73	8	29.73
18	21.398364	-157.984177	19.69	4	23.69	8	27.69
19	21.396953	-157.979118	38.87	4	42.87	8	46.87
20	21.396519	-157.978024	37.87	4	41.87	8	45.87
21	21.395275	-157.974121	58.3	4	62.3	8	66.3
22	21.393902	-157.970267	45.79	4	49.79	8	53.79

Table 25: Waiawa Solar Array Observation Receptors Route 6

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground – Cars (feet)	Total Elevation - Cars	Height Above Ground – Trucks (feet)	Total Elevation - Trucks
1	21.428272	-157.999922	475.56	4	479.56	8	483.56
2	21.428445	-157.998944	478.54	4	482.54	8	486.54
3	21.428968	-157.996138	486.26	4	490.26	8	494.26
4	21.42907	-157.995636	475.74	4	479.74	8	483.74
5	21.42922	-157.994869	456.48	4	460.48	8	464.48
6	21.429327	-157.994816	457.79	4	461.79	8	465.79
7	21.429494	-157.994843	459.24	4	463.24	8	467.24
8	21.429639	-157.994894	459.01	4	463.01	8	467.01
9	21.429769	-157.994982	460.68	4	464.68	8	468.68
10	21.429896	-157.995146	464.81	4	468.81	8	472.81
11	21.430236	-157.995621	456.96	4	460.96	8	464.96
12	21.430513	-157.996028	469.83	4	473.83	8	477.83
13	21.430762	-157.996246	471.17	4	475.17	8	479.17
14	21.430997	-157.996353	469.93	4	473.93	8	477.93

Table 26: Waiawa Solar Array Observation Receptors Route 7

ID	Latitude	Longitude	Ground Elevation (feet)	Height Above Ground – Cars (feet)	Total Elevation - Cars	Height Above Ground – Trucks (feet)	Total Elevation - Trucks
1	21.425287	-157.995422	397.66	4	401.66	8	405.66
2	21.425502	-157.995489	402.53	4	406.53	8	410.53
3	21.425684	-157.995519	409.56	4	413.56	8	417.56
4	21.425946	-157.995548	418.6	4	422.6	8	426.6
5	21.426485	-157.995599	430.86	4	434.86	8	438.86
6	21.428185	-157.995587	444.61	4	448.61	8	452.61
7	21.428661	-157.995576	459.48	4	463.48	8	467.48
8	21.428826	-157.995601	466.68	4	470.68	8	474.68
9	21.429095	-157.995625	475.02	4	479.02	8	483.02
10	21.429552	-157.995762	475.2	4	479.2	8	483.2
11	21.42981	-157.995885	471.16	4	475.16	8	479.16
12	21.430207	-157.996102	468.84	4	472.84	8	476.84
13	21.430569	-157.996309	473.82	4	477.82	8	481.82
14	21.430994	-157.996471	475.78	4	479.78	8	483.78

Table 27: Waiawa Solar Array Observation Receptors Route 8

Results

Capitol Airspace utilized the above specified inputs to analyze potential glint and glare at various points along the flight paths. Runway end coordinates were obtained from the FAA National Flight Data Center (NFDC) National Airspace System Resources (NASR) dataset. SGHAT uses this information to analyze each flight path between a two-mile final and the runway threshold.

If glare is detected, "Glare Occurrence Plots" are generated by SGHAT. The plots show when glare can occur (as viewed from the prescribed observation point) throughout the year. The color indicates the potential ocular hazard. The colors are defined as:

- Green: Low potential for temporary after-image glare
- Yellow: Potential for temporary after-image glare
- Red: Potential for permanent eye damage glare

The results of this analysis predicted no glare for any receptor (*Table 28*)

Receptor	Green Glare (minutes / year)	Yellow Glare (minutes / year)	Red Glare (minutes / year)
Runway 04R (PHNL)	0	0	0
Runway 22L (PHNL)	0	0	0
Runway 04L (PHNL)	0	0	0
Runway 22R (PHNL)	0	0	0
Runway 08L (PHNL)	0	0	0
Runway 26R (PHNL)	0	0	0
Runway 08R (PHNL)	0	0	0
Runway 26L (PHNL)	0	0	0
Runway 04W (PHNL)	0	0	0
Runway 22W (PHNL)	0	0	0
Runway 08W (PHNL)	0	0	0
Runway 26W (PHNL)	0	0	0
ATCT (PHNL)	0	0	0
Runway 06 (PHHI)	0	0	0
Runway 24 (PHHI)	0	0	0
ATCT (PHHI)	0	0	0
Residents Single Story	0	0	0
Residents Two Story	0	0	0
Route 1 Car	0	0	0
Route 2 Car	0	0	0
Route 3 Car	0	0	0
Route 4 Car	0	0	0
Route 5 Car	0	0	0
Route 6 Car	0	0	0
Route 7 Car	0	0	0
Route 8 Car	0	0	0
Route 1 Truck	0	0	0
Route 2 Truck	0	0	0
Route 3 Truck	0	0	0
Route 4 Truck	0	0	0
Route 5 Truck	0	0	0
Route 6 Truck	0	0	0
Route 7 Truck	0	0	0
Route 8 Truck	0	0	0

Table 28: Waiawa Solar project Glint and Glare summary

Conclusion

The SGHAT analyzed the expected total footprints of the Waiawa Solar project. The SGHAT finding indicated that no glare is predicted from the project array for the approaches to Runway 08L/26R, 08R/26L, 04R/22L, 04L/22R, 08W/26W, and 04W/22W for Daniel K. Inouye International Airport nor is glare predicted for the ATCT personnel in the ATCT. No glare was predicted from the project solar array for the approaches to Runway 06/24 for Wheeler Army Airbase nor is glare predicted for the ATCT personnel in the ATCT. Additionally, no glare was predicated for residents and no glare was predicted for cars or trucks on Route 1, Route 2, Route 3, Route 4, Route 5, Route 6, Route 7, and Route 8. The findings show that the project is compliant with the FAA interim policy for Solar Energy System Projects on Federally Obligated Airports. Additionally as noted in assumptions, the glint and glare analysis does not take into account vegetation, fencing, or other natural obstructions. This glint and glare report takes the most conservative approach in calculating the possibility for glint and glare.

If you have any questions regarding the findings in this analysis, please contact ***Rick Coles*** at (703) 256-2485.

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD, STE 555
KAPOLEI, HAWAII 96707

April 24, 2015

Chris Monahan, PhD, Principal
TCP Hawai'i LLC
333 Aoloa Street, #303
Kailua, HI 96734

LOG NO: 2014.04229
DOC NO: 1504GC15
Archaeology, Architecture

Dear Dr. Monahan:

SUBJECT: **Chapter 6E-42 Historic Preservation Review**
Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Lands
Waiawa and Waipi'o Ahupua'a, 'Ewa District, Island of O'ahu
TMK: (1) 9-4-006:034, 035, 036, 037; 9-6-004:024, 025, 026; 9-6-005:001

Thank-you for the opportunity to review the draft report titled *Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Land in Waiawa and Waipi'o Ahupua'a, 'Ewa District, O'ahu Island, Hawai'i* (Monahan, September 2014). We received this submittal on September 16, 2014; revised materials on January 10, 2015, and on March 23, 2015. SHPD requested an archaeological inventory survey be conducted due to the potential for proposed project plans to affect historic properties (June 12, 2014; Log No. 2014.02357, Doc. No. 1405GC14). The landowner, Kamehameha Schools (KS), proposes to develop a 50 megawatt solar facility on a portion of the property.

The archaeological inventory survey (AIS) provided surface coverage of the entire 1,395-acre project area which included two existing access roads and two proposed utility tie-ins. Subsurface testing consisted of a single hand-excavated unit placed to examine whether a small, dry-stacked terrace in Gulch C (Site 50-80-09-2273, Feature 21) was pre-Contact or plantation-era in age and association. Large-scale non-historic properties identified within the project area include recent earthen roads with low berms formed when the roads were graded or scraped; evidence of recent modification by civil engineers to control flooding of the landscape near two of the old reservoirs, Gulch C (Reservoir 3 on historic maps) and Gulch B (Reservoir 1-A on historic maps), and a long, heavily-built earthen berm in the northwest portion of the property, north of Gulch A, in an area of former workers' camp.

The AIS indicates that three previous archaeological surveys have included portions of the current project area (Barrera 1987, Goodman and Nees 1991, and Thurman et al. 2012). Portions of a data recovery project also extended into the current project area (Sinoto and Pantaleo 1994, 1995). Five historic properties (Sites 50-80-09-2262, 2270, 2271, 2272, and 2273) have been documented within or extending into the current project area. Of these, three were further documented during the current AIS (Sites 2270, 2271, and 2273); not further documented were Site 2262 (a small lithic scatter) and Site 2272 (WWII and later military concrete buildings and stock pile areas); Site 2262 was fully collected during the Goodman and Nees (1991) survey, and no evidence was found of possible Site 2272 features within the three areas previously identified in Figure 7 as having been used for military storage. Based on the current AIS documentation, Site 2270 is a network of roads and railroad right-of-ways consisting of 28 features, Site 2271 is the remains of workers' camps and other facilities represented by two extant features, and Site 2273 is an irrigation system consisting of 25 features. The most significant features of Site 2271–the Japanese cemetery (Feature 3) and the cannery (Feature 1)–were subject to data recovery work by Sinoto and Pantaleo (1994, 1995). No historic properties were newly identified during the current AIS.

Pursuant to Hawaii Administrative Rule (HAR) §13-284-6, Site 2270 is assessed as significant under Criterion d for its informational value regarding geospatial location, extent, and character of the plantation roads and temporary railroad in Waiawa built around or just after the turn of the $19^{th}/20^{th}$ century. Site 2273 is assessed as significant under Criterion c for its distinctive construction method and Criterion d for its information value. Like Site 2270, Site 2273 provides important data on geospatial location, extent, and character of the plantation irrigation infrastructure in Waiawa Uka built by the Oahu Sugar Company and its association with the nearby Waiāhole Ditch System (upslope and *mauka* of the current project area). Site 2271 Feature 1 (structural remnants) is assessed as significant under Criterion d for its information content relative to plantation working conditions in the early to middle 20^{th} century, while Site 2271 Feature 2 (camp debris) is assessed as not significant. Per HAR §13-284-7, the project effect determination is "effect, with proposed mitigation commitments." Of the three historic properties, no further work is recommended for Site 2270 and Site 2271 which are assessed as having yielded their informational and research value. The proposed mitigation is "*preservation of certain features of Site 2273*." The specific features are: (1) Feature 22, a large water-distribution and -retention basin of the plateau east of Gulch A, and one of the most formal structures in the project area; (2) a representative section of Feature 23, the cut basalt and mortar irrigation ditch leading into the Feature 22 basin; (3) Feature 19, a large dam-like retention structure in the west end of Gulch B; and (4) a representative section of Feature 14, Sub-feature 3, the cut basalt and mortar irrigation ditch draining into Gulch B and directly associated with the Feature 19 dam. We concur with the site significance assessments and the mitigation commitments.

The AIS report provides an excellent discussion of the project area, physical environs and cultural history background, previous investigations, the project methods and findings, and the site significance assessments and mitigation recommendations. The report meets the requirements of HAR §13-276-5. **It is accepted by SHPD.** Please send one hardcopy of the document, clearly marked FINAL, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office, attention SHPD Library.

As stipulated in HAR §13-284-7(e), when SHPD comments that the project will have an "effect, with agreed upon mitigation commitments," then detailed mitigation plans shall be developed for SHPD review and acceptance. Per HAR §13-284-8(a)(1)(A), the agreed-upon mitigation measure for this project is preservation of specific features of Site 2273. Pursuant to HAR §13-284-8(e)(5), we look forward to receiving an archaeological preservation plan that meets HAR §13-277.

Please contact Jessica Puff at (808) 692-8023 or at Jessica.L.Puff@hawaii.gov if you have any questions or concerns regarding architectural features. Please contact me at (808) 692-8019 or at Susan.A.Lebo@hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Susan A. Lebo

Susan A. Lebo, PhD
Oahu Lead Archaeologist
Acting Archaeology Branch Chief

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD, STE 555
KAPOLEI, HAWAII 96707

September 14, 2015

Chris Monahan, PhD, Principal
TCP Hawai'i LLC
333 Aoloa Street, #303
Kailua, HI 96734

Log No. 2015.01827
Doc. No. 1509SL01
Archaeology

Dear Dr. Monahan:

SUBJECT: **Chapter 6E-42 Historic Preservation Review**
Archaeological Preservation Plan for State Site No. 50-80-09-2273, Features 14 (portion), 19, 22, and 23 (portion), Kamehameha Schools' Land Waiawa Ahupua'a, 'Ewa District, Island of O'ahu
TMK: (1) 9-4-004:024 portion

Thank you for the opportunity to review the draft report titled *Archaeological Preservation Plan State Site No. 50-80-09-2273 Features 14 (Portion), 19, 22 & 23 (Portion) Kamehameha Schools' Land in Waiawa Ahupua'a, 'Ewa District, O'ahu Island, Hawai'i TMK (1) 9-6-004:024 (portion)* (Monahan, May 2015). We received this submittal on May 12, 2015; we apologize for the delay and thank you for your patience. SHPD requested an archaeological inventory survey be conducted due to the potential for proposed project plans to affect historic properties (June 12, 2014; Log No. 2014.02357, Doc. No. 1405GC14). The landowner, Kamehameha Schools (KS), proposes to develop a 50 megawatt solar facility on a portion of the property. The archaeological inventory survey (Monahan, September 2014) was reviewed and accepted by SHPD on April 24, 2015 (Log No. 2014.04229, Doc. No. 1504GC15).

The archaeological inventory survey (AIS) provided surface coverage of the entire 1,395-acre project area which included two existing access roads and two proposed utility tie-ins. Subsurface testing consisted of a single hand-excavated unit placed to examine whether a small, dry-stacked terrace in Gulch C (Site 50-80-09-2273, Feature 21) was pre-Contact or plantation-era in age and association. Large-scale non-historic properties identified within the project area include recent earthen roads with low berms formed when the roads were graded or scraped; evidence of recent modification by civil engineers to control flooding of the landscape near two of the old reservoirs, Gulch C (Reservoir 3 on historic maps) and Gulch B (Reservoir 1-A on historic maps), and a long, heavily-built earthen berm in the northwest portion of the property, north of Gulch A, in an area of former workers' camp.

The accepted AIS report (Monahan 2015) indicated that three previous archaeological surveys have included portions of the current project area (Barrera 1987, Goodman and Nees 1991, and Thurman et al. 2012). Portions of a data recovery project also extended into the project area (Sinoto and Pantaleo 1994, 1995). Five historic properties (Sites 50-80-09-2262, 2270, 2271, 2272, and 2273) have been documented within or extending into the current project area. Of these, three were further documented during the AIS (Sites 2270, 2271, and 2273); not further documented were Site 2262 (a small lithic scatter) and Site 2272 (WWII and later military concrete buildings and stock pile areas); Site 2262 was fully collected during the Goodman and Nees (1991) survey, and no evidence was found of possible Site 2272 features within the three areas previously identified in Figure 7 as having been used for military storage. Monahan (2015) indicates that no historic properties were newly identified. Site 2270 is a network of roads and railroad right-of-ways consisting of 28 features, Site 2271 is the remains of workers' camps and other

KS Exhibit 19

facilities represented by two extant features, and Site 2273 is an irrigation system consisting of 25 features. The most significant features of Site 2271–the Japanese cemetery (Feature 3) and the cannery (Feature 1)–were subject to data recovery work by Sinoto and Pantaleo (1994, 1995).

Pursuant to Hawaii Administrative Rule (HAR) §13-284-6, Monahan (2015) assessed Site 2270 as significant under Criterion d for its informational value regarding geospatial location, extent, and character of the plantation roads and temporary railroad in Waiawa built around or just after the turn of the 19th/20th century. Site 2273 was assessed as significant under Criterion c for its distinctive construction method and Criterion d for its information value. Like Site 2270, Site 2273 provides important data on geospatial location, extent, and character of the plantation irrigation infrastructure in Waiawa Uka built by the Oahu Sugar Company and its association with the nearby Waiāhole Ditch System (upslope and *mauka* of the current project area). Site 2271 Feature 1 (structural remnants) was assessed as significant under Criterion d for its information content relative to plantation working conditions in the early to middle 20th century, while Site 2271 Feature 2 (camp debris) was assessed as not significant. Per HAR §13-284-7, the project effect determination was "effect, with proposed mitigation commitments." Of the three historic properties, no further work was recommended for Site 2270 and Site 2271 which were assessed as having yielded their informational and research value. The proposed mitigation was "*preservation of certain features of Site 2273*." SHPD concurred with the site significance assessments and the mitigation commitments, and the development of an archaeological monitoring plan meeting the requirements of HAR §13-277.

The archaeological preservation plan (PP) indicates that preservation includes: (1) a representative section (100 ft [30 m]) of Feature 14, the cut basalt and mortar irrigation ditch draining into Gulch B and directly associated with the Feature 19 dam; (2) the entirety of Feature 19, a large dam-like retention structure in the west end of Gulch B; (3) the entirety of Feature 22, a large water-distribution and water-retention basin on the plateau east of Gulch A, and one of the most formal structures in the project area; and (4) a representative section (75 ft [25 m]) of Feature 23, the cut basalt and mortar irrigation ditch leading into the Feature 22 basin. Preservation will be in the form of "avoidance and protection" and will involve a 10-ft (3 m) buffer around all features or portions of preserved features, except one side of Feature 22 (east side). The buffers will be marked by permanent fencing. No vegetation clearance is anticipated/planned within the buffers. In addition, no signage or access is planned. Periodic monitoring of the preserves will be conducted by the landowner or their representatives.

The preservation plan meets the requirements of HAR 13-277. It is accepted by SHPD. Please send one hardcopy of the document, clearly marked FINAL, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office, attention SHPD Library.

Please contact me at (808) 692-8019 or at Susan.A.Lebo@hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Susan A. Lebo

Susan A. Lebo, PhD
Archaeology Branch Chief

FINAL

ARCHAEOLOGICAL PRESERVATION PLAN
STATE SITE NO. 50-80-09-2273
FEATURES 14 (PORTION), 19, 22 & 23 (PORTION)
KAMEHAMEHA SCHOOLS' LAND IN WAIAWA AHUPUAʻA, ʻEWA DISTRICT, OʻAHU ISLAND, HAWAIʻI

TMK (1) 9-6-004:024 (portion)

Prepared for:
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May 2015

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ABSTRACT — EXECUTIVE SUMMARY

TCP Hawai'i has developed this Archaeological Preservation Plan for four features of State Site # 50-80-09-2273, an extensive system of infrastructure built, maintained and used by plantation workers to manage, store, transport and distribute water for commercial sugarcane. Part of the system may date to as early as the late 19^{th} century, but the most formal components—and those that will be preserved as a result of this plan—date from the 1920s. This site complex and components of two other historic properties were identified in a recent Archaeological Inventory Survey by Monahan (2015). This plan includes (1) Feature 22, a large water-distribution and -retention basin of the plateau east of Gulch A, which will be preserved in its entirety; (2) a representative (75-ft. [25-m] long) section of Feature 23, a cut basalt and mortar irrigation ditch leading into the Feature 22 basin; (3) Feature 19, a large dam-like retention structure in the west end of Gulch B, which will be preserved in its entirety; and (4) a representative (100-ft. [30-m] long) section of Feature 14, a cut basalt and mortar irrigation ditch draining into Gulch B and directly associated with the Feature 19 dam. All of the components listed in HAR § 13-277 are described in this report.

INTRODUCTION

TCP Hawai'i prepared this Archaeological Preservation Plan for four features of State Site # 50-80-09-2273, an extensive system of plantation infrastructure once used to irrigate commercial sugarcane. The site and features, which were built in the early 20th century, were identified during an Archaeological Inventory Survey (AIS) (Monahan 2015) of a 1,395-acre project area in Waiawa and Waipi'o Ahupua'a, 'Ewa District, O'ahu, TMK (1) 9-4-006:034 por., 035 por., 036, 037 por.; 9-6-004:024 por., 025, 026; 9-6-005:001 por. (Figure 1 through Figure 3). The landowner is Kamehameha Schools (KS). The AIS project area is the entire parcel subject to a recent Land Use Commission (LUC) review (KS' Motion to Amend Decision and Order – Ref. No. P-14388, LUC Docket No. A87-610), plus two existing access roads into the property and two linear transects (utility tie-ins for a proposed solar farm development project). SunEdison is working with KS and Hawaiian Electric Company to develop a 50 Megawatt solar facility on a portion of the LUC project area.

The AIS project area is just west of Pearl City, mauka[1] of the H-1 freeway and east of the H-2 freeway. The Waiawa Correctional Facility is a short distance north (mauka) of the AIS project area. The Waiāhole Ditch System (State Site # 50-80-09-2268) crosses Waiawa Ahupua'a near the correctional facility. Nearly the entire project area (~90%) is in Waiawa Ahupua'a; the rest is in Waipi'o Ahupua'a. Prior to the AIS fieldwork, based on archival research and previous archaeological surveys in the project area (Barrera 1987; Goodman and Nees 1991; Thurman et al. 2012), we believed there was a low potential for identifying traditional (precontact) Hawaiian sites: nearly the entire project area was mechanically grubbed, graded, plowed, planted and harvested repeatedly for at least 80 years starting in the late 19th century by commercial agriculture (first pineapple and then sugarcane). The ahupua'a[2] of Waiawa above the H-1 was part of LCA 7713:46 to Victoria Kamāmalu, sister of Alexander Liholiho (Kamehameha IV) and Lot Kamehameha (Kamehameha V). Many small kuleana parcels were awarded makai (south) of the H-1 around Pearl Harbor. There are no other LCAs in the AIS project area.

Historic Preservation Context

As a privately-funded development on private land subject to a land use change, the project's AIS was designed to satisfy the general requirements of HRS § 6E-42 and HAR § 13-284; and the specific details in HAR § 13-276. In March, 2014, we initiated consultation with Susan Lebo, Ph.D., Lead O'ahu Archaeologist, State Historic Preservation Division (SHPD), regarding the SunEdison solar project, 99% of which consists of previously-impacted (by commercial plantation agriculture) plateau lands. We obtained a determination letter (Log No. 2014.01283, Doc No. 1404SL16) dated April 21, 2014, in which SHPD concurred with our assessment recommending an AIS of the entire (447-acre) solar project area. SHPD also requested an opportunity to review and accept a report that detailed the findings of the AIS prior to commencement of any project construction-related ground-disturbing activity. In June, 2014, while we were completing this AIS, SHPD, in a letter to the State Office of Planning, commented (Log No. 2014.02357, Doc No. 1405GC14 dated June 12) on the subject LUC motion and recommended an AIS of the entire 1,395-acre project area. On July 8, 2014, we began additional AIS fieldwork needed to satisfy SHPD's recommendation. In April, 2015, we received SHPD's acceptance letter of the final AIS report for the entire project area (see Appendix A).

Based on the final, accepted AIS, mitigation for this project consists of preparation of an Archaeological Preservation Plan, written in accordance with HAR § 13-277, that will be implemented by the landowner and lessee (SunEdison) following approval from the SHPD. The subject report includes all relevant contents described in HAR § 13-277. Readers wanting additional details on the AIS should refer to Monahan (2015).

[1] Hawaiian words are not italicized since Hawaiian is an official state language rather than a "foreign" language.
[2] We do not systematically define all Hawaiian words or provide a glossary of definitions for the same reason we do not italicize Hawaiian words (see Pukui and Elbert 1986 or http://wehewehe.org/ for Hawaiian dictionaries).

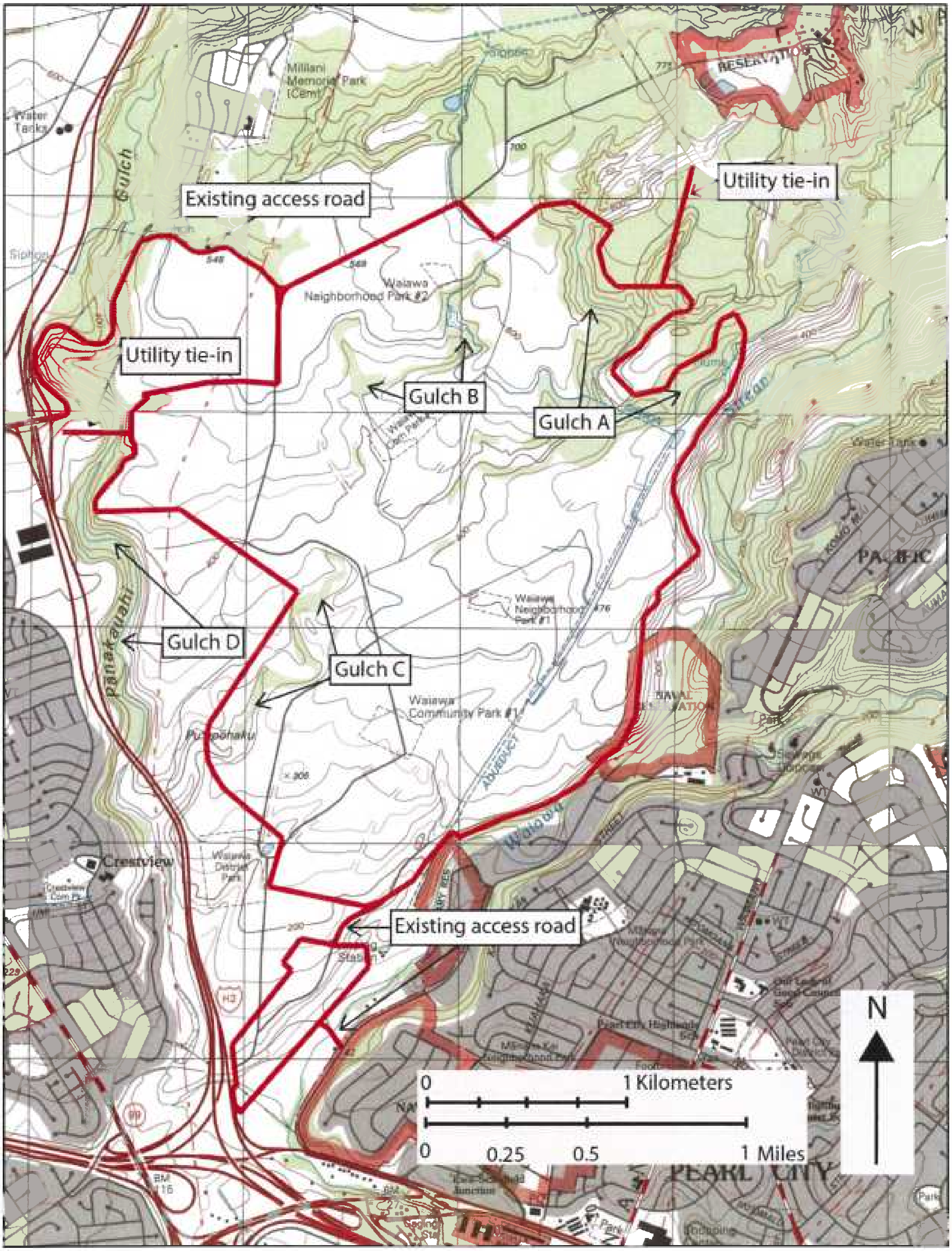

Figure 1. Project area depicted on a portion of USGS 7.5-minute series topographic map 1998 Waipahu quadrangle (base map, www.usgs.gov)

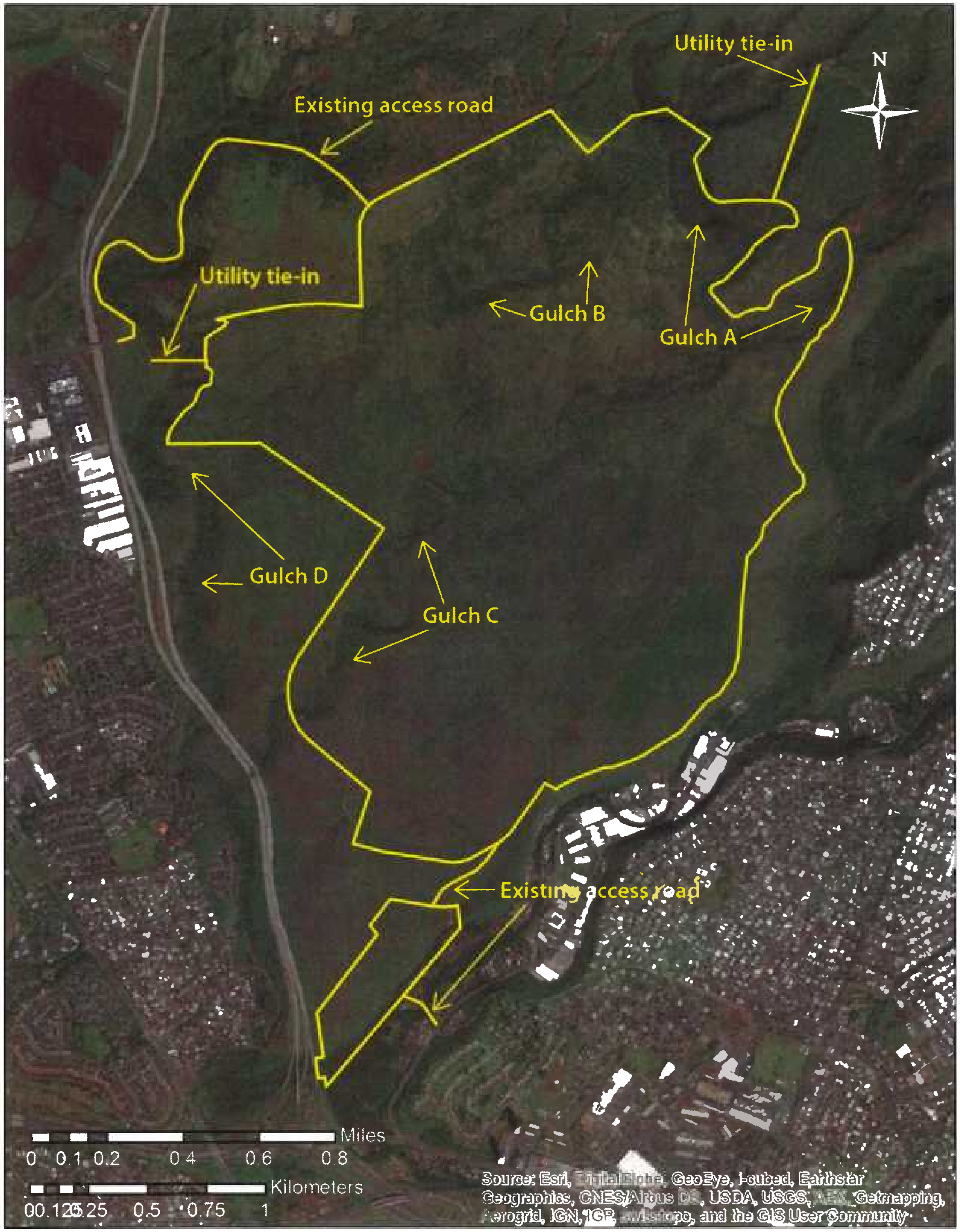

Figure 2. Project area depicted on aerial image (base map from ESRI)

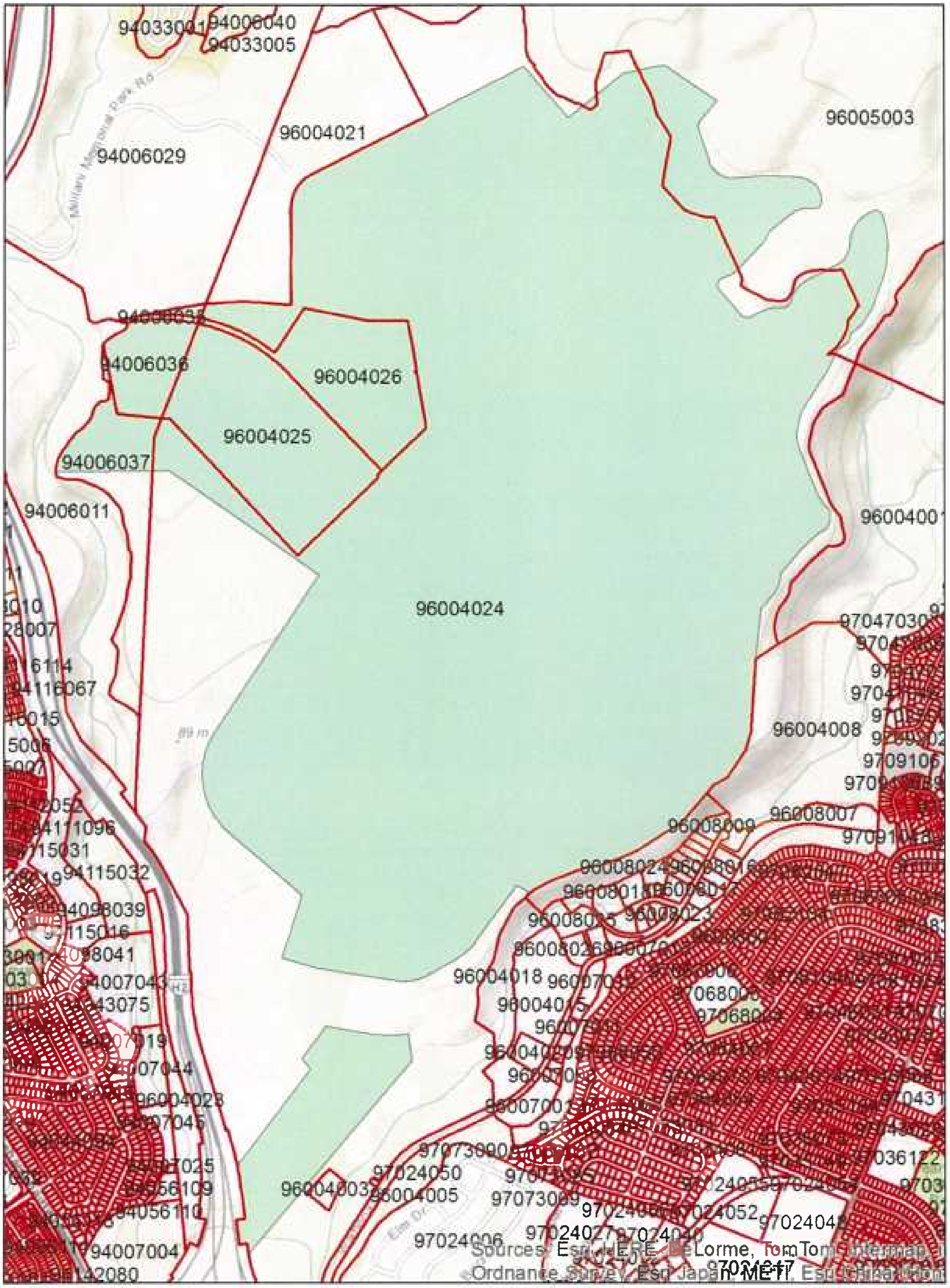

Figure 3. TMK map of the project area; data downloaded from City and County of Honolulu Office of Planning (http://planning.hawaii.gov/gis/download-gis-data/), processed using ESRI software

SITE AND FEATURE DESCRIPTIONS

This Archaeological Preservation Plan includes four features of the plantation irrigation complex, State Site # 50-80-09-2273: (1) Feature 22, a large water-distribution and -retention basin of the plateau east of Gulch A, one of the most formal structures in the project area, which will be preserved in its entirety; (2) a representative (75-ft. [25-m] long) section of Feature 23, a cut basalt and mortar irrigation ditch leading into the Feature 22 basin; (3) Feature 19, a large dam-like retention structure in the west end of Gulch B, which will be preserved in its entirety; and (4) a representative (100-ft. [30-m] long) section of Feature 14, a cut basalt and mortar irrigation ditch draining into Gulch B and directly associated with the Feature 19 dam. After describing Site 2273 in more detail, these four features are also described.

State Site # 50-80-09-2273

Site 2273 is an extensive system of infrastructure built, maintained and used by plantation workers to manage, store, transport and distribute water for commercial sugarcane. According to Goodman and Nees (1991), Site 2273 was initially built in the early 1900s by the Oahu Sugar Company as a network of ditches, flumes, siphons, reservoirs, pumping stations and a well. Based on our observations during the AIS fieldwork (Monahan 2015), the major components of Site 2273 were built after 1916, when completion of the Waiāhole Ditch made available large quantities of water from the Ko'olau Mountains. We documented inscribed dates as early as 1925 on some features of this system. Operation of this system may have been interrupted altogether or simply altered by World War II, when parts of the current project area and its environs were used for military training. After the war, sugarcane agriculture continued up to the 1970s.

Goodman and Nees (1991) identified a total of 35 features distributed over a larger (3,600-acre) project area compared with the current (1,395-acre) project area. Our survey resulted in the identification of 25 features, which extend all throughout the current project area; many of these features also continue outside of the project area to the north, west and south. We observed the following types of features: a concrete-lined retention basin; a large, dam-like feature associated with a retention basin; ferrous-metal siphons (80-cm diameter); cut basalt and mortar ditches; earthen ditches; prefabricated flumes; industrial-sized (hand-operated) valves; small culverts; and large, formally-constructed cut basalt and mortar water-distribution basins.

Because Goodman and Nees (1991:59, Figure 20) provided numbers for 35 features at Site 2273, but since it is not always clear which of these they actually observed in the field or which numbers correspond exactly to which features, we assigned new feature numbers. Wherever possible, we have also included what we believe the corresponding Goodman and Nees feature number is. Figure 4 and Figure 5 depict all sites and features identified in the AIS project area. Table 1 is a summary of Site 2273 features identified in the AIS project area.

Site 2273 was evaluated by TCP Hawai'i as significant under criteria c and d for its intrinsic informational value to research on Hawaiian history (d) and as exemplars of a distinctive construction method (c) using skillfully-shaped basalt blocks and mortar. In a letter (Log No: 2014.04229, Doc. No: 1504GC15) dated April 24, 2015, SHPD concurred with these significance assessments.

TCP Hawai'i documented 25 component features of this site, which provides important data on the geospatial location, extent and character of the plantation irrigation infrastructure in Waiawa Uka built around or shortly after 1916 by the Oahu Sugar Company; and, excluding the interruption of World War II, continued to be used into the 1970s. In the context of the nearby Waiāhole Ditch System (upslope and mauka of the current project area), Site 2273 played an important role in the early 20th century commercial development of O'ahu and the Hawaiian Islands.

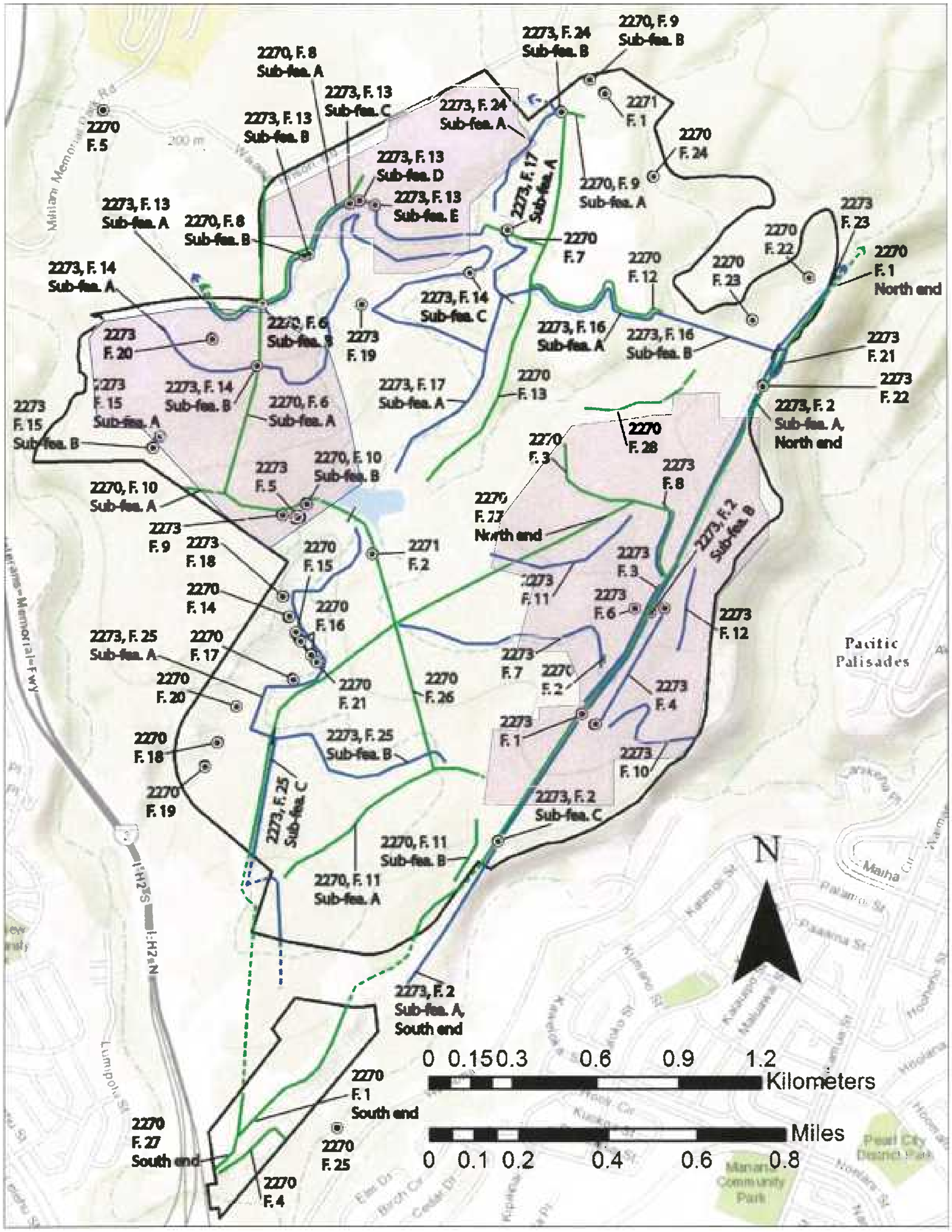

Figure 4. Historic properties and features identified in the AIS by TCP Hawai'i on a topographic map (base map from ESRI in ArcMap); LUC project area in black; SunEdison project area in light pink; roads in green; linear irrigation features in blue; dashed lines indicate feature continues out of project area

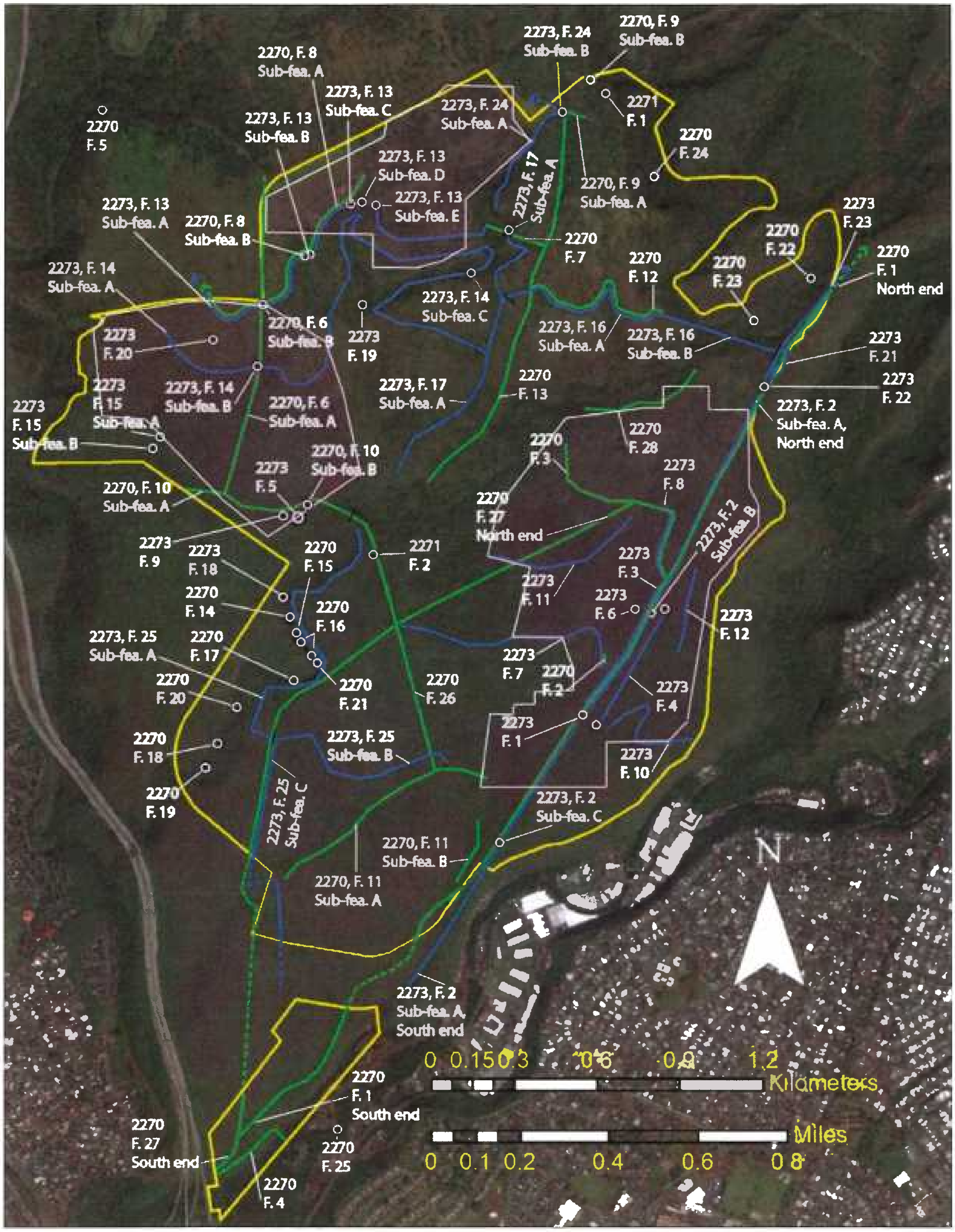

Figure 5. Historic properties and features identified in the AIS by TCP Hawai'i on aerial image (base map from ESRI in ArcMap); LUC project area in yellow; SunEdison project area in light pink; roads in green; linear irrigation features in blue; dashed lines indicate feature continues out of project area

Table 1. Site 2273 Features Identified in the Current Project Area

Fea.	Other #[1]	Description	Dimensions (Area)	Comments
1	n.a.	Cut basalt and mortar water-distribution basin	10 m (NE/SW) by 7.5 m (NW/SE)	This is one of the most complex formal structures in the project area
2	32	Siphon (80-cm diameter pipe) oriented mauka-makai	2.0 km long (in the project area)	Pipe continues a short distance out of the project area to the south
3	?32	Siphon (80-cm diameter pipe) oriented mauka-makai	600 m long	Portions of this siphon were (by design) buried under an earthen road
4	n.a.	Prefabricated concrete flume (caulked sections)	800 m long	Runs east, upslope, and parallel to main earthen road (Feature 1, Site 2270)
5	n.a.	Prefabricated concrete flume (caulked sections)	20.5 m long	Feature is complete on its west end but broken on its east end
6	n.a.	Metal pole w. marker on concrete footing	5-m tall 3-in. diameter pipe	Possibly marking location of earthen ditch (see text)
7	34	Cut basalt and mortar ditch	970 m long	Partially filled in with sediment
8	?33	Cut basalt and mortar ditch	330 m long	Partially filled in with sediment
9	n.a.	Prefabricated concrete flume (caulked sections)	5.0 m long	Feature is complete on its west end but broken on its east end
10	n.a.	Earthen ditch	530 m long	Heavily overgrown with vegetation
11	33	Earthen ditch	500 m long	Heavily overgrown with vegetation
12	n.a.	Prefabricated concrete flume (caulked sections)	420 m long	Runs parallel up the slope just east of main earthen road (Feature 1, Site 2270)
13	28/31	Cut basalt and mortar ditch	1.5 km (in the project area)	Ditch continues out of project area to the west-northwest
14	27	Cut basalt and mortar ditch	3.4 km long	Ditch disappears in heavy ground cover, possibly buried by sedimentary deposition at its west end
15	n.a.	Earthen ditch ending in a 4-way sluice gate intersection	50 m long	Earthen ditches around 3 sides of the 4-way sluice gate are difficult to identify due to soil erosion and deposition
16	2	Combination cut basalt and mortar ditch and siphon	1.2 km long (ditch is 920 m long, siphon is 300 m long)	Feature traverses east half of project area from just below Gulch A to east end of Gulch B
17	?	Cut basalt and mortar ditch	1.3 km long	Connects Reservoir 1-A w. Reservoir 3
18	n.a.	Ditch-builders lithic processing area	26 m (N/S) by 14 m (E/W)	Abundant large flakes and debitage created with metal (presumably iron) tools

Fea.	Other #[1]	Description	Dimensions (Area)	Comments
19	6	Massive slope-retaining feature in Gulch B	38.0 m (E/W) by 33.0 m (N/S)	Part of a dam-like structure at the south end of Reservoir 1-B
20	n.a.	Prefabricated concrete flume (caulked sections)	25 m long	Upper end truncated by a modern (non-historic-age) road
21	8	Cut basalt and mortar lined reservoir	110 m (N/S) by 30 m (E/W)	According to historic maps from the 1930s, this is Reservoir 2-B
22	Part of 2 or 32?	Cut basalt and mortar water-distribution basin	16.0 m (N/S) by 13.0 (E/W)	One of the most complex formal structures in the project area
23	Part of 32?	Cut basalt and mortar ditch	360 m long	Connects with Feature 22 and is damaged on its south end
24	Part of 31	Basalt and mortar ditch	550 m long	Ditch uses natural (sub-rounded), rather than cut and dressed, boulders
25	35, 22	Cut basalt and mortar ditch	2.6 km long (includes 3 sections)	Ditch begins as a cut basalt and mortar ditch, changes into two earthen ditches

[1] Other # = Goodman and Nees (1991) feature number; n.a. = newly-identified feature (not mapped or described in Goodman and Nees); ? = we were unable to determine Goodman and Nees number

Feature 22

This is a large, formally-constructed water-distribution and -retention basin built of cut basalt and mortar in the northeast corner of the project area, on the elevated plateau east of Gulch A and west of a mauka-makai road (Feature 1, Site 2270) (Figure 6). Feature 22 connects with two other major components of the historic-era irrigation system: (1) a cut basalt and mortar ditch (Feature 23) oriented north to south; and (2) a siphon (Feature 2) oriented north to south that traverses nearly the entire east side of the project area. Feature 22 is inscribed with the date "1925," and is one of the earliest large-scale irrigation features built for commercial sugarcane following completion of the Waiāhole Ditch in 1916. Feature 22 consists of three sub-features, and occupies a maximum area of 16.0 m (N/S) by 13.0 m (E/W). It is in good physical condition, exception for a few areas of minor damage by vegetation growth. Other than California grass and koa haole, vegetation at this feature includes several large Christmas berry trees.

Sub-feature A, a rectangular cut basalt and mortar basin measuring 9.0 m (N/S) by 6.0 m (E/W), is connected with a section of flume (Sub-feature C) on its east side and Feature 23—a cut basalt and mortar ditch oriented north to south—on its west side (Figure 7). The wall height is 170 cm above the ground surface. On its east and southeast sides, the wall face is vertical (plumb) and 40 cm thick. The wall flares (tapers out at the base) on the west side, where it is 90 cm thick at the top and 130 cm thick at the base. The southwest wall, where the date "1925" is inscribed in mortar, is 90 cm thick. An old section of displaced ferrous-metal siphon is on the ground surface in the southwest (interior) corner of Sub-feature A, next to an outlet at the base of the wall, now sealed with concrete, that once housed the siphon. There is a rectangular sluice-gate opening along the west wall with two sets of sluice-gate grooves (each 4 cm thick) (Figure 8). These would have controlled water flow between Sub-feature A and the adjacent ditch (Feature 23). Portions of the west wall have been damaged by Christmas berry growth into its constituent rock and mortar. Another set of larger sluice-gate grooves (each 5 cm thick) is at the north end of this sub-feature, where Sub-feature B begins.

Sub-feature B, a triangular cut basalt and mortar connector between the rectangular basin (Sub-feature A) and the adjacent ditch (Feature 23), tapers down from a height of 170 cm above the ground surface (at its south end) to 60 cm above ground surface (at its north end), where it opens into the ditch designated Feature 23 (Figure 9). The west wall of Sub-feature B is constructed in a very unique way, tapering down to a sharp point in both plan and profile perspectives. Another inscribed "1925" is located atop this west wall (Figure 10).

Sub-feature C, a relatively narrow and shallow flume section, constructed mainly of vertically-positioned sections of concrete slabs (seams caulked with mortar), is built off the southeast corner of the main retention basin (Sub-feature A), and separated from it by a pair of sluice-gate grooves (each 3 cm thick), as an overflow device. The far (east) end of this flume is not truncated or damaged by the adjacent earthen road, but, rather, there is a constructed end to this flume. This east end, and the west end around the sluice gate, is partially constructed of cut basalt and mortar as well as the concrete slabs. This sub-feature has a concrete slab bottom; thus, it has a "U"-shaped cross section.

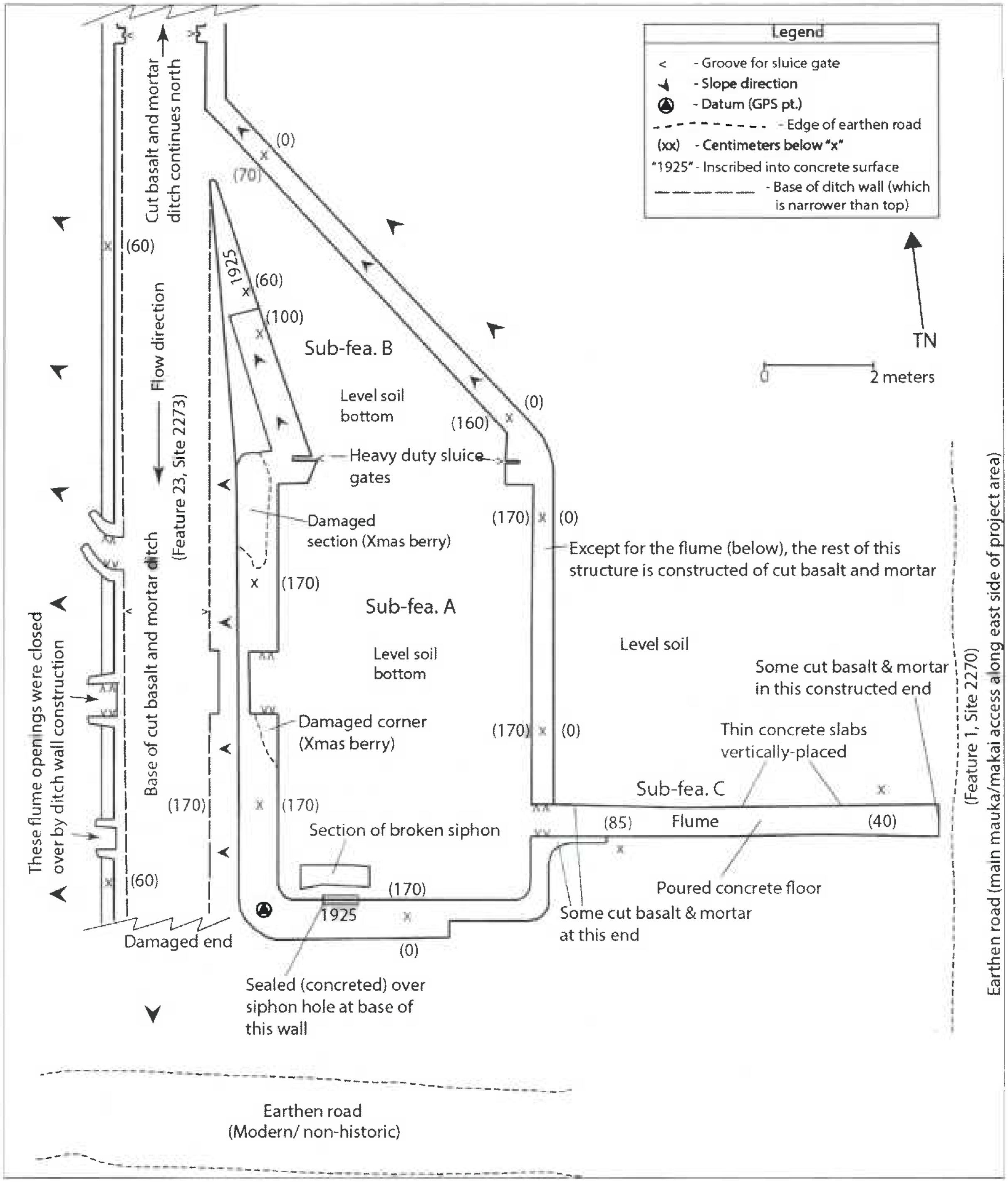

Figure 6. Plan view Feature 22, Site 2273

Figure 7. Cut basalt and mortar ditch (Feature 23, Site 2273) running parallel to Feature 22 and connecting with it by way of the sluice gate at Sub-feature A and the large opening to the left (tall grass) into Sub-feature B, view south; vertical scale bar is 80

Figure 8. Portion of the west wall, Feature 22, Sub-feature A, Site 2273, view northwest; measuring tape is 170 cm high

Figure 9. Opening to the north end of Feature 22, Sub-feature B, view south-southwest; vertical scale is 80 cm high

Figure 10. Inscription on the top of the south wall at Feature 22, Sub-feature A

Feature 23

Feature 23 (Figure 11, and see Figure 7), a typical cut basalt and mortar ditch, is approximately 360 m long from its south end at the large retention basin described above (Feature 22) to where it continues out of the project area to the north. This ditch is relatively narrow, compared with others in the project area; it is approximately 100 cm wide at its interior base, increasing to 130 cm at its interior top. It is currently approximately 80 cm deep, from the top of its structural work to the ground surface in the ditch. When originally constructed, it was about 1.0 m deep. The plan view of its south end shows it has been damaged and truncated by a modern earthen road to the south. The plan view also depicts three small flume openings that would have sent water over the ground surface to the west. Two of these flume openings were constructed over (sealed up) by rock work and mortar in the past.

Figure 11. Representative portion of Feature 23, Site 2273, view north; vertical scale bar is 80 cm high, horizontal measuring tape is 100 cm long

Feature 19

Feature 19 is a massive rock retaining structure with a culvert underneath leading to a hand-operated valve and siphon built and used by plantation workers along the south bank of Gulch B, near its west end. The location of this feature corresponds with the south edge of Reservoir 1-B, suggesting it functioned as a type of dam that could be used to control the level of water in the reservoir with an outlet on the south side (i.e., the siphon valve) to send water over the ground surface in that direction. This is one of the most impressive plantation structures in the project area, and certainly *the* most impressive dry-stacked feature.

This feature, which occupies an area of approximately 38.0 m (E/W) by 33.0 m (N/S) and has portions that are 5.0–6.0 m above the ground surface, consists of three sub-features that collectively represent the remnants of a heavy-duty water diversion, collection and redistribution structure (Figure 12 and Figure 13). In general, this feature is in good to fair physical condition with some naturally-collapsed sections. Numerous, large Christmas berry trees growing into the top of the main retaining structure (Sub-feature A) have caused significant damage, which is ongoing. Compared with most other features in the project area, the vegetation at Feature 19 is relatively sparse and ground visibility is good.

Sub-feature A, the main slope-retaining structure and dam, is constructed of large, cut and dressed basalt boulders fitted onto the steep, natural gulch slope as a kind of heavy-duty veneer; our inspection of this feature, which was relatively difficult and dangerous to accomplish given the steep, slippery slope, indicates there is only one layer of fitted boulders directly over the earthen slope. No mortar was used during construction of this sub-feature. Sub-feature A measures approximately 38.0 m (E/W) by 11.0 m (N/S) by 5.0–6.0 m high (Figure 14). As depicted in the schematic profile below, there is a constructed low ridge between the longer, western portion of this structure and the eastern portion. The culvert travels under this low ridge to the south where it eventually emerges near the siphon valve (Sub-feature C).

Sub-feature B, a culvert passing under Sub-feature A from north to south, has an intake/ opening constructed of shaped basalt slabs and a water conduit constructed of a ferrous-metal siphon (pipe) measuring 80 cm in diameter and 22.5 m long (N/S) (Figure 15). The opening of the culvert on the north side of Sub-feature A is a semi-circular, earthen depression measuring approximately 150 cm in diameter and 140 cm deep. This was once a water catchment where excess gulch water drained through the culvert to the other side of the retaining structure where it collected in a small earthen pool to be siphoned further down the plateau south of Feature 19.

Sub-feature C is a large, hand-operated valve that appears to be made of iron (Figure 16). A manufacturer's stamp on this valve reads as follows: "CHAPMAN VALVE M.F.G. CO., BOSTON, U.S.A." The area between this valve and the back (south) side of Sub-feature A is heavily eroded and channelized. A gently-sloping, partially level soil area immediately west of this valve appears to be the remnants of an old bulldozed access road. The area in and around this possible road is heavily eroded and difficult to definitively describe. We did not find the other (south) end of the siphon that goes through this valve; we presume its other end is buried downslope under modern sedimentary deposition in heavy vegetation.

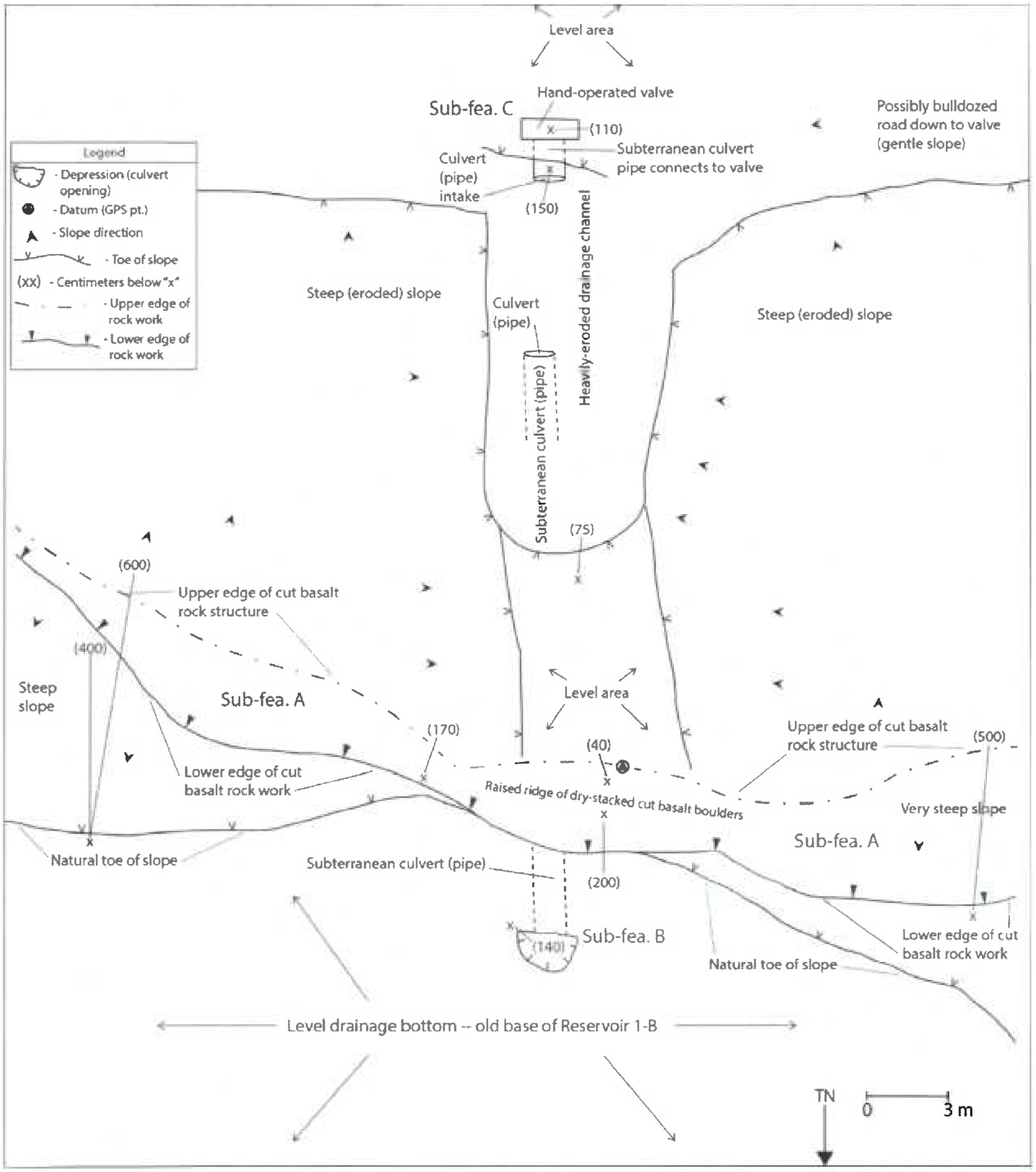

Figure 12. Plan view Feature 19, Site 2273

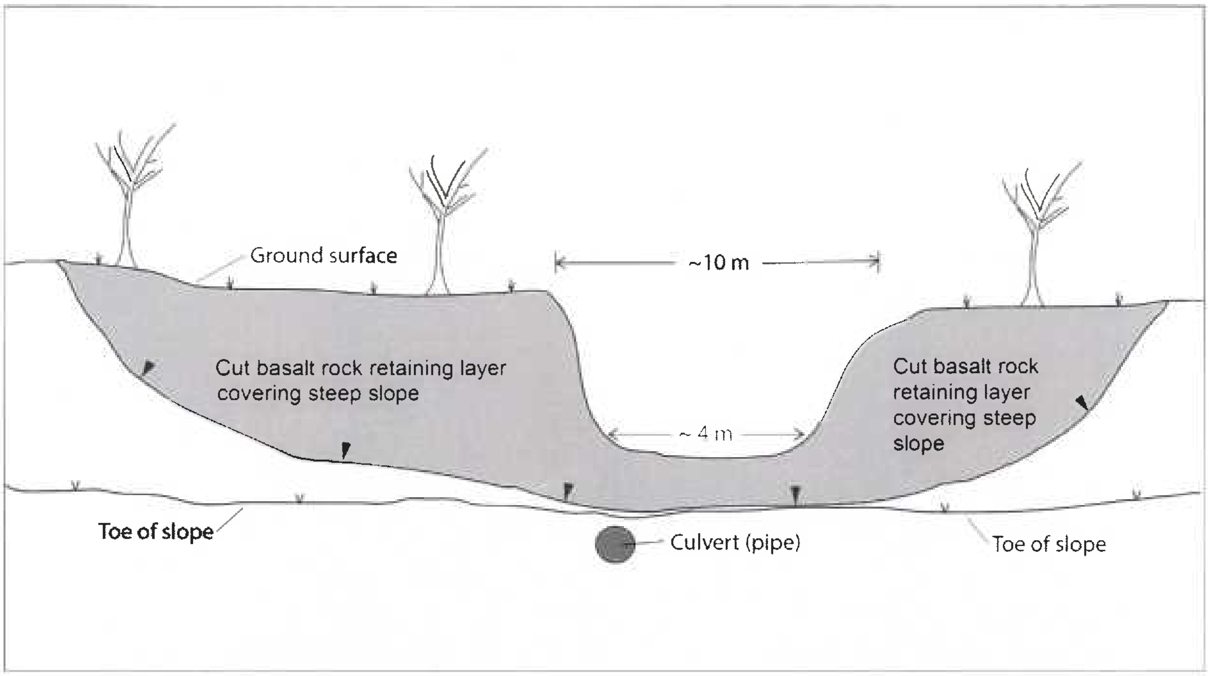

Figure 13. Schematic--not to scale--profile of Feature 19, Site 2273, view south

Figure 14. Portion of west half of Feature 19, Sub-feature A (main retaining structure), Site 2273, view east; scale bar is 120 cm high

Figure 15. Feature 19, Sub-feature B (constructed culvert opening), Site 2273, view south; scale bar is 80 cm high

Figure 16. Feature 19, Sub-feature C, Site 2273, view south; vertical scale bar is 80 cm high

Feature 14

Feature 14 is a very long ditch with cut basalt and mortar sides and a constructed cut basalt and mortar base. We identified three sub-features.

Sub-feature A, the main ditch, is oriented (like Feature 13, which is just upslope) generally east to west across the project area, starting from Reservoir 1-A in the east and eventually exiting the project area in the west. Unlike Feature 13, the east end of Feature 14 is more complex as it makes one large "switch back" between Reservoir 1-A and Reservoir 1-B. The eastern portion of Feature 14, from the south end of Reservoir 1-A, then passing by the east side of Reservoir 1-B, eventually meets up with a mauka-makai oriented irrigation ditch (Feature 17) heading down to Reservoir 3. The west end of Feature 14, as it nears the project area boundary, disappears and may be buried under sedimentary deposition. The entire length of Feature 14, as can be currently identified on the landscape, is approximately 3.4 km (0.8 km on the west side of road Feature 6, and 2.6 km on the east side of this road). Portions of Feature 14 follow along parts of the upper (north) edge of Gulch B. When in operation, the Feature 14 ditch connected with both Reservoir 1-A and Reservoir 1-B. Its maximum exterior width is 185 cm; the interior top of the feature measures 160 cm across; the interior base is 130 cm wide. Depending on the amount of post-abandonment sedimentary deposition within the ditch, its interior height ranges from 60–80 cm. Its depth was originally approximately 1.0 m (Figure 17). Other than being partially buried by sediment in some places, this sub-feature is generally in good physical condition.

Sub-feature B is a culvert under the road Feature 6 (Site 2270) and a cut basalt and mortar sluice gate on the south side of the main ditch (Figure 18). The 80-cm (diameter) concrete pipe underneath the road is nearly completely filled in with sediment. The constructed sluice gate heading south extends for approximately 3.0 m then transitions into an earthen ditch. Both the formal sluice gate and the earthen ditch parallel the road (Feature 6, Site 2270). From the main ditch (Sub-feature A) to the end of the cut basalt and mortar sluice gate, Sub-feature B is approximately 3.0 m long, 65–70 cm wide and 80–85 cm high. This sub-feature is in good physical condition. A pair of sluice-gate grooves are located on either side of the north end of the Sub-feature B sluice gate, and the main ditch (Sub-feature A) also has a set of sluice-gate grooves on either side of the opening to the sluice gate.

Sub-feature C is a sluice gate along a "switch back" section of the main ditch traversing the southern edge of Gulch B. This sluice gate structure is unusual in the project area as it diverts water from the main ditch to the *north*, rather than the south; in this case, it empties water into the Gulch B drainage which eventually flowed west-southwest into Reservoir 1-B (Figure 19). This sub-feature is in poor physical condition, having sustained extensive damage from being located on a steep slope (down to the north into Gulch B) that has eroded over time.

Sub-feature C consists of three main components. A cut basalt and mortar sluice gate with wooden sluice gates still in place is located at the top of the slope, built off the main ditch (Figure 20). This upper sluice gate is oriented to north to south. It is approximately 1.5 m long, 50 cm wide and 50 cm high. The west side of this constructed sluice gate is badly damaged and falling down the slope. At the bottom of the slope, a lower sluice gate constructed of relatively thin concrete slabs empties into the gulch bottom (Figure 21). This lower sluice gate is approximately 1.5 m long, 75 cm wide and 40 cm high. Between these two sluice gates, there is a concrete deflection wall that functioned to slow down the water pouring out of the upper sluice gate. Some of this water diverted to the west, as evidenced by an earthen erosional ditch, and some of it flowed down to the next (lower) sluice gate. This heavily-damaged deflection wall is approximately 2.5 m long (E/W) by 30–90 cm thick by 160 cm high.

Figure 17. Representative section of Feature 14, Sub-feature A, Site 2273; view southeast; scale bar is 80 cm high

Figure 18. Feature 14, Sub-feature B, Site 2273, view southeast; culvert under road Feature 6 (Site 2270) is to the left, downslope sluice gate (paralleling the road) is to the right; main ditch (Sub-feature A) continues to the west (lower right in this image); scale bar is 120 cm high

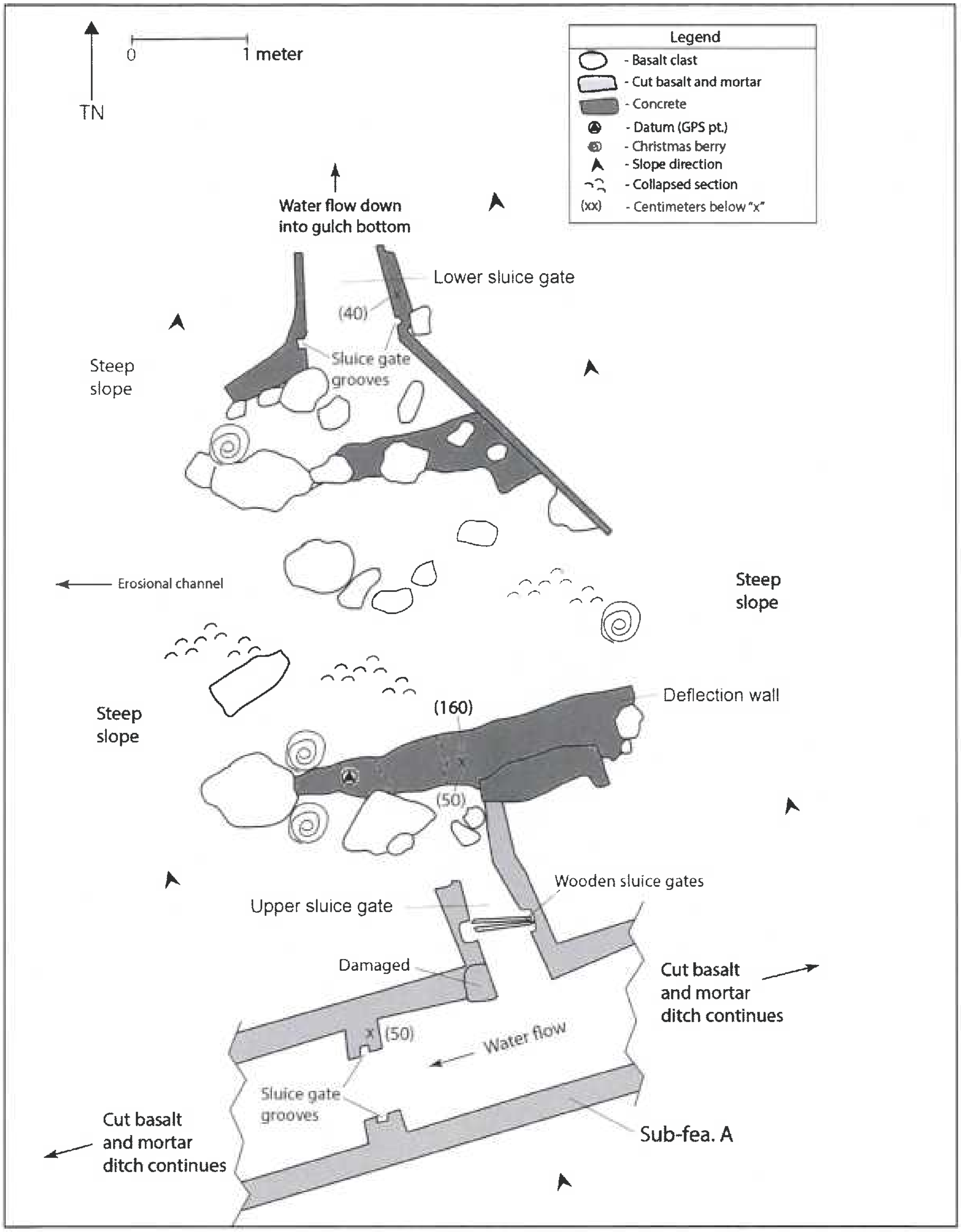

Figure 19. Plan view Feature 14, Sub-feature C, Site 2273

Figure 20. Main ditch (Sub-feature A) and upper (south) portion of Feature 14, Sub-feature C (damaged sluice gate), Site 2273, view east; horizontal scale bar is 120 cm long

Figure 21. Lower (north) portion Feature 14, Sub-feature C, Site 2273, view south; vertical scale bar is 120 cm high; damaged deflection wall is in the middle ground (directly behind the vertical scale bar)

PRESERVATION MEASURES

This section is based on HAR § 13-277. Features 19 and 22 will be preserved in their entirety; a 75 ft. (25 m) long section of Feature 23 (ditch extending 1,180 ft. [360 m] overall) will be preserved; and, a 100 ft. (30 m) long section of Feature 14 (ditch extending 2.1 miles [3.4 km] overall) will be preserved.

Form of Preservation (HAR § 13-277-3)

A Preservation Plan shall identify for each significant historic property which forms of preservation will be implemented. For all four of the features in this plan, we propose "avoidance and protection" as the only form of preservation.

Buffer Zones (HAR § 13-277-4)

According to the preservation rule, each significant historic property buffer zones and depict them on a map of sufficient scale. With the exception of one side of one feature (i.e., a small portion of the east side of Feature 22), all preserved features, or portions of preserved features (as with the two cut basalt and mortar ditches [Features 14 and 23] for which a representative section only will be preserved), shall be surrounded on all sides by a buffer of at least 10 ft. (3 m). We prefer to use English, rather than metric, measurements for the buffers because they will most likely be marked in the field by contractors who are more familiar with feet than meters. Buffers of 10 feet are more than adequate for these features, which are neither fragile—compared with traditional, dry-stacked Hawaiian features, for example—nor difficult to see or avoid on the landscape. As described below (see "Long-term preservation measures"), these buffers will be physically marked on the landscape by permanent fencing. Map depictions of the buffers and specifications for the fencing are described in the section on long-term preservation.

Interim (Short-term) Protection Measures (HAR § 13-277-5)

The rule also states that short-term protection measures are required for significant historic properties that will be near a construction area. None of the four features described in this plan are within the construction footprint for the proposed solar project. However, in March, 2015, while the AIS for this project was still under review, we decided to proactively protect Feature 19 because it is somewhat close to both Phase I construction footprints; and because of the nature of the construction activity we were protecting it against: tree cutting of large trees whose limbs may extend a long distance laterally.[3] To prevent any inadvertent damage to the significant historic property, we installed orange construction fencing around the south and west sides of Feature 19, even though the proposed construction footprint was more than 125 meters away. The fencing (short-term buffer) was established at least 10 ft. (3 m) away from any portion of Feature 19.

On March 9, 2015, Chris Monahan walked to Feature 19 with land surveyors from Sam O. Hirota, Inc. Monahan selected three points that were then staked, flagged and mapped in by Hirota staff using a surveyor-grade GPS (Trimble) device. On March 18, a crew under contract with SunEdison, armed with the GPS data from Hirota and a graphic depiction of how the fencing should be installed (Figure 22), erected approximately 230 feet of orange construction fencing using standard metal stakes, connecting the three points that were previously staked, flagged and recorded with GPS (Figure 23 and Figure 24). Feature 19 only needed to be fenced on two sides (the south and west) because the other sides drop into a deep gulch that will not be impacted in any way by proposed construction.

SunEdison shall ensure the orange construction fencing is intact and in good working order throughout the course of construction activities; shall place avoidance instructions on construction plans and specifications; and shall conduct a pre-construction briefing of the hired construction firms to make them aware of the preservation buffer.

[3] SunEdison needed to conduct tree cutting (leaving intact the lower 5 feet of the trees) by March in order to avoid adverse impacts to bat pupping.

Long-term Preservation Measures (HAR § 13-277-6)

The preservation rule lists eight measures that need to be addressed:

(1) Maintenance measures to be followed – The fencing that marks the permanent buffer shall be maintained in good working order by the landowner, who shall conduct periodic inspections of the preservation fencing and make repairs as needed. As described above, the permanent buffer shall be placed at a minimum of 10 ft. from the structural boundaries of each preserved feature or portion thereof. The one exception to this "10-foot rule" is a small portion of the east side of Feature 22, where the main mauka-makai road, an important fire-break access road within the project area, is just a few feet from the end of the feature. The road cannot be moved to the east, because it is located along the top of the plateau edge (i.e., the terrain east of the road drops precipitously into the steep and deep Waiawa Stream gorge). Figure 25 to Figure 27 depict the permanent (long-term) buffers for the features or portions thereof described in this plan. As stated above, and depicted in the figures below, a 75 ft. (25 m) section of Feature 23 will be preserved; and, a 100 ft. (30 m) section of Feature 14 will be preserved. The permanent fencing shall be constructed of durable materials whose appearance is consistent with the early 20th century features it surrounds. For example, it should not consist of chain link fencing. It should consist of t-post or wood post with barbed wire or hog wire.

(2) Methods for clearing vegetation – As long as the fencing is installed and maintained as described above, there is no need for vegetation maintenance at the preservation features.

(3) The manner in which litter is controlled – As long as the fencing is installed and maintained as described above, there is no need for a litter control plan at the preservation features. The project area, in general, is remote and access is very limited with both of the vehicular entrances controlled by locked gates.

(4) Access to the site and possible use of the site for cultural practices, if appropriate – There are no ongoing cultural practices associated with these features.

(5) Approaches to interpret and inform the public about the site, if appropriate – There is no public access to this project area, and no interpretative programs or signage is planned.

(6) Permanent marked markers, if appropriate – No markers are planned at these preservation features. The fenced buffers shall be recorded internally by the landowner and communicated to their lessees.

(7) If appropriate, provisions to address potential future impacts and site stability – As long as the fencing is installed and maintained as described above, there is no need to mitigate future impacts and site stability.

(8) Provisions for reasonable monitoring of site integrity by the person or agency, and SHPD inspection to assure compliance – As part of its periodic inspection of the fencing marking the permanent buffers, the landowner shall report to SHPD any new damage or impacts to the preservation features; in consultation with SHPD, corrective measures may be taken.

Penalties due to non-compliance are discussed in HAR § 13-277-8, and apply to the implementation of the preservation measures described in this plan.

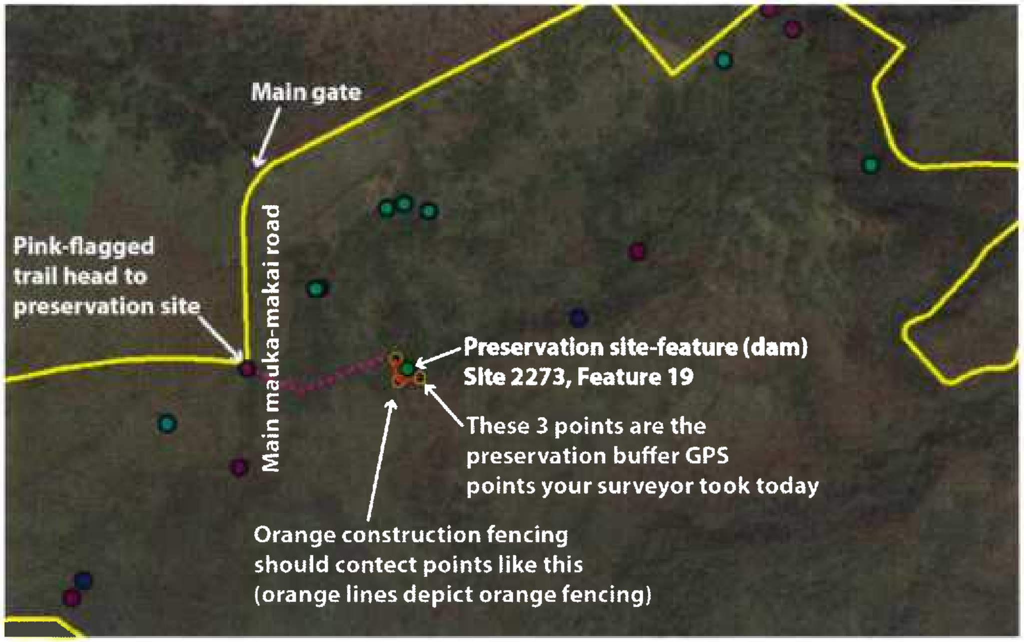

Figure 22. Simplified graphic depiction of how the interim (short-term) buffer at Feature 19 was installed using orange construction fencing between the three GPS points

Figure 23. Top (east) end of the south section of fencing installed as a temporary buffer at Feature 19 on March 18, 2015; facing northeast

Figure 24. Looking down the installed fencing at Feature 19 from the east end of the south section (same as above, from a different angle); facing west-southwest

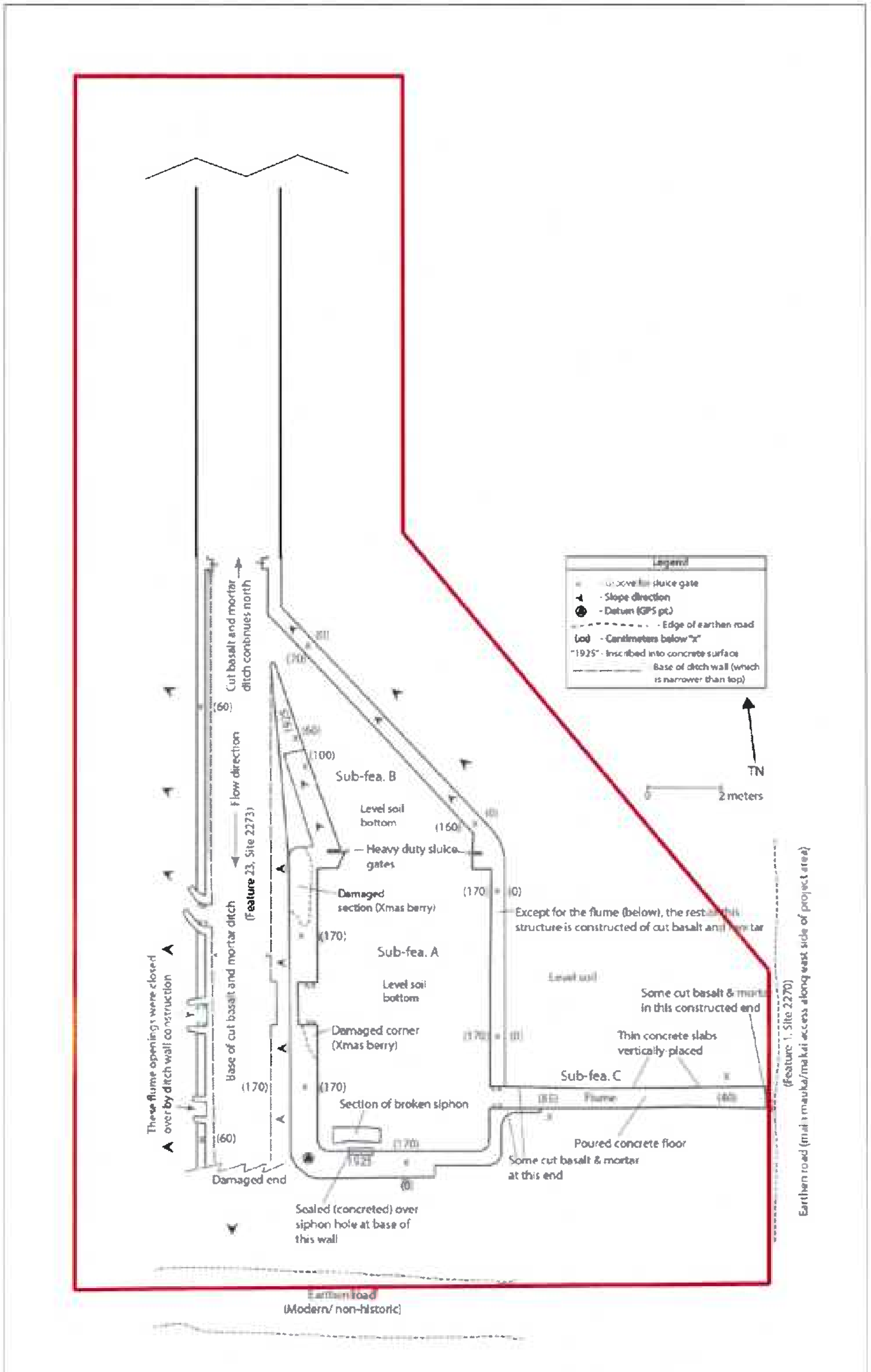

Figure 25. Long-term preservation buffer (red line) around Feature 22 and a portion of Feature 23; buffer measures a minimum of 10 ft. (3 m) from the structural edges of the features

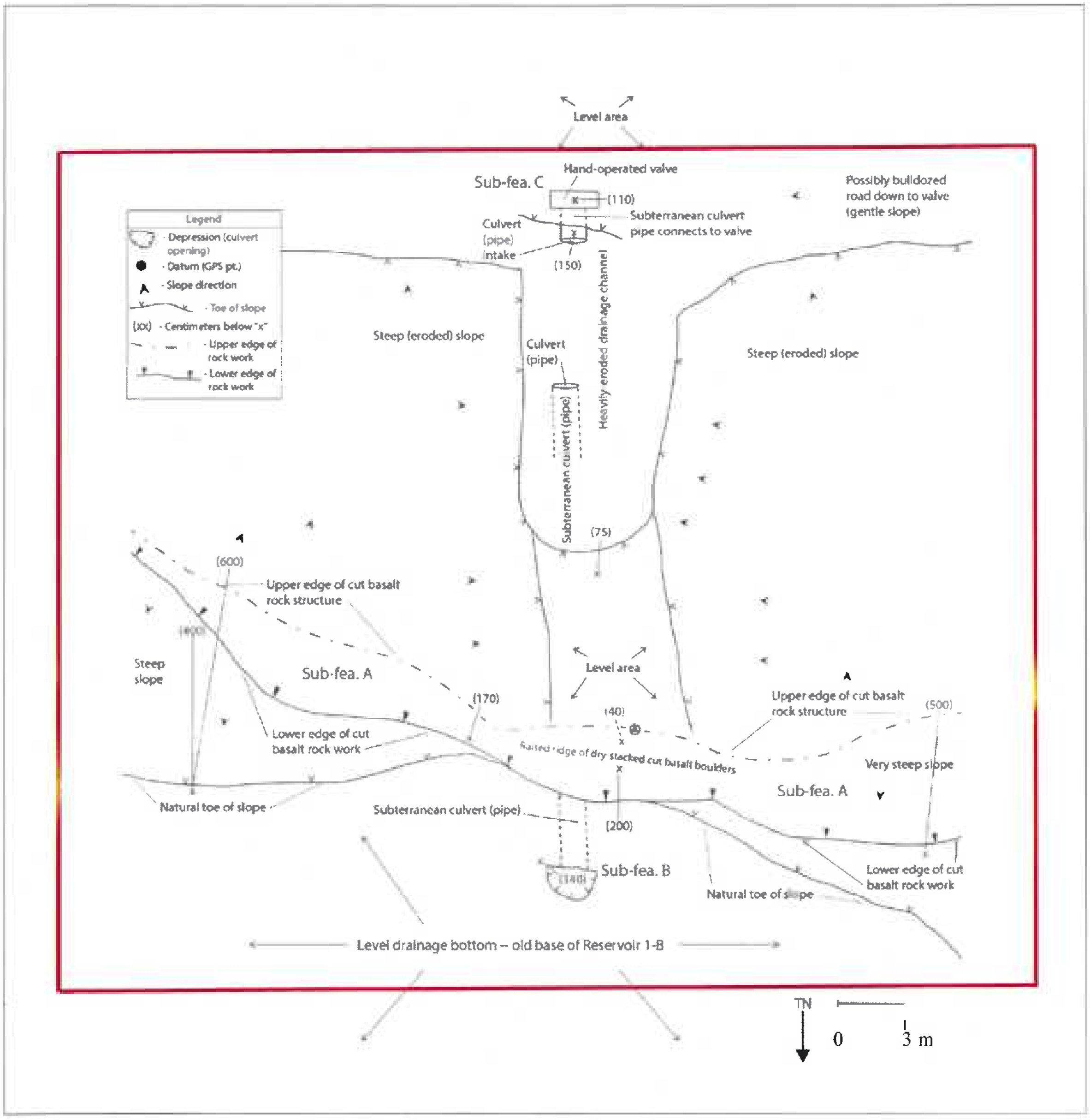

Figure 26. Long-term preservation buffer (red line) around Feature 19; buffers measures a minimum of 10 ft. (3 m) from the structural edges of the feature

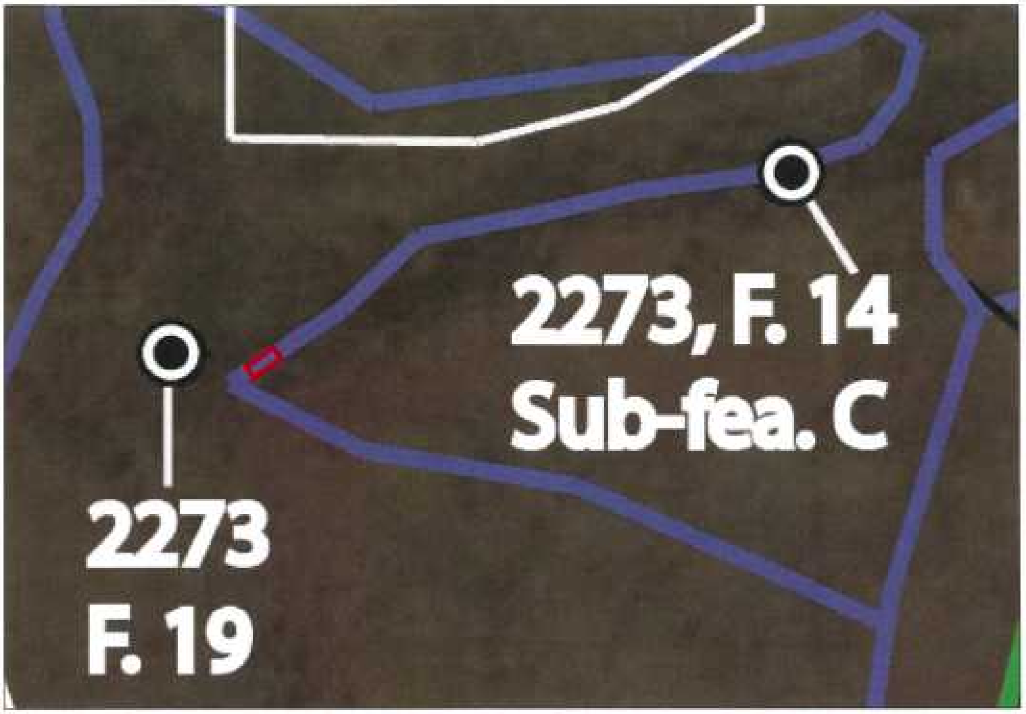

Figure 27. Long-term preservation buffer (red line) around a section of cut basalt and mortar ditch, Feature 14, just east of Feature 19 (dam-like retention structure); buffer measures 100 feet (30 m) long and extends 10 ft. (3 m) beyond the sides of the ditch (to the NW and SE)

CONCLUSION

TCP Hawai'i has developed this Archaeological Preservation Plan for four features of State Site # 50-80-09-2273, an extensive system of infrastructure built, maintained and used by plantation workers to manage, store, transport and distribute water for commercial sugarcane. Part of the system may date to as early as the late 19th century, but the most formal components—and those that will be preserved as a result of this plan—date from the 1920s. This site complex and components of two other historic properties were identified in a recent Archaeological Inventory Survey (AIS) by Monahan (2015). SHPD's acceptance letter of the AIS is in Appendix A.

This plan includes the following four features: (1) Feature 22, a large water-distribution and -retention basin of the plateau east of Gulch A, and one of the most formal structures in the project area, which will be preserved in its entirety; (2) a representative (75-ft. [25-m] long) section of Feature 23, a cut basalt and mortar irrigation ditch leading into the Feature 22 basin; (3) Feature 19, a large dam-like retention structure in the west end of Gulch B, which will be preserved in its entirety; and (4) a representative (100-ft. [30-m] long) section of Feature 14, a cut basalt and mortar irrigation ditch draining into Gulch B and directly associated with the Feature 19 dam.

As described in detail on pp. 23–24 and graphically depicted on pp. 25–29, we propose "avoidance and protection" as the only form of preservation. With one exception (a short section along the east side of Feature 22, where there is no room for an expanded buffer), permanent buffers of at least 10 ft. (3 m) are described, justified and depicted (see Figure 25, Figure 26 and Figure 27). In March, 2015, as discussed on p. 23, SunEdison (with our assistance) proactively installed a temporary (short-term) buffer (orange construction fencing) at Feature 19 in advance of tree cutting. We propose the installation of permanent fencing, built with materials and methods that are consistent with the early 20th century features it surrounds; and, periodic inspections by the landowner, who shall insure the fencing is maintained in good working order, and report to SHPD any new damage or impacts to the preservation features. Other long-term preservation measures listed in HAR § 13-277, as applicable, are described on p. 24.

REFERENCES CITED

Barrera, W.
1987 Waiawa Ridge, Oahu: Archaeological Survey of Proposed Golf Course. Chiniago, Inc., Honolulu.

Goodman, W., and R. Nees
1991 *Archaeological Reconnaissance and Inventory Surveys of 3,600 Acres in Waiawa Ahupua'a, 'Ewa, O'ahu*, manuscript 022892. Public Archaeology Section, Applied Research Group, Bishop Museum, Honolulu.

Monahan, C.M.
2015 Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Land in Waiawa and Waipi'o Ahupua'a, 'Ewa District, O'ahu Island, Hawai'i, TMK (1) 9-4-006:034 por., 035 por., 036, 037 por.; 9-6-004:024 por., 025, 026; 9-6-005:001 por. TCP Hawai'i, Kailua, Hawai'i.

Thurman, D.W., C.R. O'Hare, and C.M. Monahan
2012 Archaeological Reconnaissance Survey of 1,680 Acres of Kamehameha School Lands in Waiawa Ahupua'a, 'Ewa District, Island of O'ahu, TMK [1] 9-4-006:034, 036, 037, 9-6-004:024 & 025. Cultural Surveys Hawai'i, Kailua, Hawai'i.

APPENDIX A: SHPD'S ACCEPTANCE LETTER OF THE AIS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD, STE 555
KAPOLEI, HAWAII 96707

April 24, 2015

Chris Monahan, PhD, Principal
TCP Hawai'i LLC
333 Aoloa Street, #303
Kailua, HI 96734

LOG NO: 2014.04229
DOC NO: 1504GC15
Archaeology, Architecture

Dear Dr. Monahan:

SUBJECT: **Chapter 6E-42 Historic Preservation Review**
Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Lands
Waiawa and Waipi'o Ahupua'a, 'Ewa District, Island of O'ahu
TMK: (1) 9-4-006:034, 035, 036, 037; 9-6-004:024, 025, 026; 9-6-005:001

Thank-you for the opportunity to review the draft report titled *Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Land in Waiawa and Waipi'o Ahupua'a, 'Ewa District, O'ahu Island, Hawai'i* (Monahan, September 2014). We received this submittal on September 16, 2014; revised materials on January 10, 2015, and on March 23, 2015. SHPD requested an archaeological inventory survey be conducted due to the potential for proposed project plans to affect historic properties (June 12, 2014; Log No. 2014.02357, Doc. No. 1405GC14). The landowner, Kamehameha Schools (KS), proposes to develop a 50 megawatt solar facility on a portion of the property.

The archaeological inventory survey (AIS) provided surface coverage of the entire 1,395-acre project area which included two existing access roads and two proposed utility tie-ins. Subsurface testing consisted of a single hand-excavated unit placed to examine whether a small, dry-stacked terrace in Gulch C (Site 50-80-09-2273, Feature 21) was pre-Contact or plantation-era in age and association. Large-scale non-historic properties identified within the project area include recent earthen roads with low berms formed when the roads were graded or scraped; evidence of recent modification by civil engineers to control flooding of the landscape near two of the old reservoirs, Gulch C (Reservoir 3 on historic maps) and Gulch B (Reservoir 1-A on historic maps), and a long, heavily-built earthen berm in the northwest portion of the property, north of Gulch A, in an area of former workers' camp.

The AIS indicates that three previous archaeological surveys have included portions of the current project area (Barrera 1987, Goodman and Nees 1991, and Thurman et al. 2012). Portions of a data recovery project also extended into the current project area (Sinoto and Pantaleo 1994, 1995). Five historic properties (Sites 50-80-09-2262, 2270, 2271, 2272, and 2273) have been documented within or extending into the current project area. Of these, three were further documented during the current AIS (Sites 2270, 2271, and 2273); not further documented were Site 2262 (a small lithic scatter) and Site 2272 (WWII and later military concrete buildings and stock pile areas); Site 2262 was fully collected during the Goodman and Nees (1991) survey, and no evidence was found of possible Site 2272 features within the three areas previously identified in Figure 7 as having been used for military storage. Based on the current AIS documentation, Site 2270 is a network of roads and railroad right-of-ways consisting of 28 features, Site 2271 is the remains of workers' camps and other facilities represented by two extant features, and Site 2273 is an irrigation system consisting of 25 features. The most significant features of Site 2271–the Japanese cemetery (Feature 3) and the cannery (Feature 1)–were subject to data recovery work by Sinoto and Pantaleo (1994, 1995). No historic properties were newly identified during the current AIS.

Dr. Monahan
April 24, 2015
Page 2

Pursuant to Hawaii Administrative Rule (HAR) §13-284-6, Site 2270 is assessed as significant under Criterion d for its informational value regarding geospatial location, extent, and character of the plantation roads and temporary railroad in Waiawa built around or just after the turn of the 19th/20th century. Site 2273 is assessed as significant under Criterion c for its distinctive construction method and Criterion d for its information value. Like Site 2270, Site 2273 provides important data on geospatial location, extent, and character of the plantation irrigation infrastructure in Waiawa Uka built by the Oahu Sugar Company and its association with the nearby Waiāhole Ditch System (upslope and *mauka* of the current project area). Site 2271 Feature 1 (structural remnants) is assessed as significant under Criterion d for its information content relative to plantation working conditions in the early to middle 20th century, while Site 2271 Feature 2 (camp debris) is assessed as not significant. Per HAR §13-284-7, the project effect determination is "effect, with proposed mitigation commitments." Of the three historic properties, no further work is recommended for Site 2270 and Site 2271 which are assessed as having yielded their informational and research value. The proposed mitigation is "*preservation of certain features of Site 2273*." The specific features are: (1) Feature 22, a large water-distribution and -retention basin of the plateau east of Gulch A, and one of the most formal structures in the project area; (2) a representative section of Feature 23, the cut basalt and mortar irrigation ditch leading into the Feature 22 basin; (3) Feature 19, a large dam-like retention structure in the west end of Gulch B; and (4) a representative section of Feature 14, Sub-feature 3, the cut basalt and mortar irrigation ditch draining into Gulch B and directly associated with the Feature 19 dam. We concur with the site significance assessments and the mitigation commitments.

The AIS report provides an excellent discussion of the project area, physical environs and cultural history background, previous investigations, the project methods and findings, and the site significance assessments and mitigation recommendations. The report meets the requirements of HAR §13-276-5. **It is accepted by SHPD.** Please send one hardcopy of the document, clearly marked FINAL, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office, attention SHPD Library.

As stipulated in HAR §13-284-7(e), when SHPD comments that the project will have an "effect, with agreed upon mitigation commitments," then detailed mitigation plans shall be developed for SHPD review and acceptance. Per HAR §13-284-8(a)(1)(A), the agreed-upon mitigation measure for this project is preservation of specific features of Site 2273. Pursuant to HAR §13-284-8(e)(5), we look forward to receiving an archaeological preservation plan that meets HAR §13-277.

Please contact Jessica Puff at (808) 692-8023 or at Jessica.L.Puff@hawaii.gov if you have any questions or concerns regarding architectural features. Please contact me at (808) 692-8019 or at Susan.A.Lebo@hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Susan A. Lebo

Susan A. Lebo, PhD
Oahu Lead Archaeologist
Acting Archaeology Branch Chief

Jeannie A. Hirabara

From: Chris Monahan <mookahan@gmail.com>
Sent: Friday, July 19, 2019 3:36 PM
To: DLNR.Intake.SHPD; Lebo, Susan A
Cc: Tracy Camuso; kafronda@ksbe.edu; Joshi, Aarty; Park, Nicola
Subject: SHPD 6E form submittal Waiawa PV Solar project TMK (1) 9-6-004:024 (por.), 025 (por.) & 026 (por.)
Attachments: 19 July 2019 SHPD 6E form.pdf

Aloha Susan,

On March 12, 2019, we emailed you this message with an earlier version of the subject SHPD 6E form submittal. At that time, we wrote (bold text):

Attached here for your review is a request for SHPD concurrence of determination of effect for the Waiawa Solar Power project. As you may recall, we met at Kalanimoku about this project and process last month (2/14/19). There is a pair of plantation-era features in the current proposed project area that are subject to preservation, based on AIS work (and a subsequent Preservation Plan following from it) TCP Hawai`i completed for KS (landowner) in 2015.

Based on our discussion last month, the attachment consists of:
1. Cover letter requesting SHPD concurrence
2. Completed SHPD HRS 6E Submittal Form
3. Attachments to the submittal form with map figures, prior relevant SHPD review letters, and a letter of commitment from the project proponent (Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC) regarding the installation of preservation site buffer fencing. For your information, we (TCP Hawaii) are currently under contract to install the preservation buffer fencing.

The Waiawa Solar Power project will soon be the subject of Land Use Commission proceedings, and we have included the Docket # for the LUC in the attached SHPD HRS 6E Submittal Form.

Please let me know if you have any questions, or if you need any additional information or revisions to complete this request for SHPD concurrence.

The purpose of the current email is to provide you with an updated/revised submission that has more details and a final site plan map that was not included in the original attachment to the form. Also, the overall project acreage has been changed from (previous) 185 acres, to 200 acres (current) to reflect the access roads needed to complete the PV solar project.

After the March, 2019, submission, we went out and installed the preservation buffer fencing around the preservation site-features in April, 2019. Documentation of this effort is also included in the attachment to the form.

With this submittal, we seek SHPD's concurrence of determination of effect for this project.

Please let me know if you have questions or need more information.

Chris

KS Exhibit 20

TCP Hawaii, LLC
150 Hamakua Dr., #810
Kailua, HI 96734
(808) 754-0304

TCP Hawai'i, LLC

Documenting Traditional Cultural Properties of Hawai'i
Preserving and Restoring Cultural and Natural Resources of Hawai'i

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July 19, 2019

To: **Susan Lebo, Ph.D., Archaeology Branch Chief, State Historic Preservation Division (SHPD)**
Re: **Request for Concurrence on HRS § 6E-42 Effect Determination for Waiawa Solar Power Project, Waiawa Ahupua'a, O'ahu, TMK (1) 9-6-004:024 (por.), 025 (por.) & 026 (por.)**

Aloha Dr. Lebo,

On behalf of the project proponent (Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC [Applicant]) and landowner (Kamehameha Schools [KS]), and in anticipation of the proposed project's Land Use Commission review (LUC's Order in Docket # A87-610), we formally request your HRS § 6E-42 concurrence with the effect determination for the Waiawa Solar Power Project.

Enclosed for your reference is HRS 6E Submittal Form (with map figures and other attachments) stating the proposed project will have an "Effect, with agreed upon mitigation commitments," and that the mitigation will be the preservation of State Inventory of Historic Places (SIHP) # 50-80-09-2273, Features 22 and 23 (portion).

The proposed project is restricted to a 200-acre area (see map figures attached to HRS 6E Submittal Form), plus improved "cane haul" access roads, within a larger (1,395-acre) area that was subject to a formal HAR § 13-276 Archaeological Inventory Survey (AIS) accepted by SHPD in a letter (Log No: 2014.04229, Doc No: 1504GC15) dated April 24, 2015. The AIS project area included and subsumes the subject project area. In fulfillment of historic-preservation mitigation for the AIS project area, the SHPD accepted a formal HAR § 13-277 Archaeological Preservation Plan (PP) in a letter (Log No: 2015.01827, Doc No: 1509SL01) dated September 14, 2015. Both the AIS report and PP were completed by TCP Hawai'i on behalf of the landowner (KS).

In a letter dated March 12, 2019, submitted to SHPD with the attached HRS 6E Submittal Form, the Applicant formally committed to the following actions: (1) install preservation buffer fencing around SIHP # 50-80-09-2273, Features 22 and a portion of Feature 23, in accordance with the specifications in the PP; (2) notify SHPD in a letter memo with photographic documentation once the fencing has been installed; and (3) maintain the preservation fencing in good working order throughout the duration of the proposed construction. Since that submittal, TCP Hawai'i (Chris Monahan) completed installation of the preservation buffer fencing in April, 2019 (per item #1) and with this submittal, is providing photographic documentation (per item #2; see letter documentation attached).

With these conditions, we hereby request the SHPD's formal (in writing) concurrence on the aforementioned effect determination, and thank you for your assistance.

With aloha,

Chml

Christopher M. Monahan, Ph.D.
TCP Hawai'i, 150 Hamakua Dr., #810, Kailua, HI 96734
(808) 754-0304 mookahan@gmail.com

c: Aarty Joshi, Clearway Energy Group LLC
Nicola Park, Clearway Energy Group LLC
Kalani Fronda, Kamehameha Schools
Tracy Camuso, G70

State Historic Preservation Division
HRS 6E Submittal Form

Per §6E, Hawai'i Revised Statutes, if the Project requires review by the State Historic Preservation Division (SHPD), please review and fill out this form and submit all requested information to SHPD. Please submit this form and project documentation **electronically** to:

dlnr.intake.shpd@hawaii.gov

If you are unable to submit electronically, please contact SHPD at (808) 692-8015. Mahalo.

The submission date of this form is:

1. APPLICANT (select one)

☑ Property Owner ☐ Government Agency

2. AGENCY (select one)

☐ Planning Department ☐ Department of Public Works ☑ Other (specify): Land Use Commission

Type of Permit Applied For: LUC Application for Waiawa Solar Power Project

3. APPLICANT CONTACT

3.1) Name: Kalani Fronda 3.2) Title: Sr. Land Assets Manager, Kamehameha Schools

3.3) Street Address: 567 S. King St., Ste. 200, Honolulu

3.4) County: Honolulu 3.5) State: Hawaii 3.6) Zip Code: 96813

3.7) Phone: (808) 523-6244 3.8) Email: kafronda@ksbe.edu

4. PROJECT DATA

4.1) Permit Number (if applicable): LUC's Order in Docket # A87-610

4.2) TMK [e.g. (3) 1-2-003:004]: (1) 9-6-004:024 (por.), 025 (por.) & 026 (por.)

4.3) Street Address: not applicable - undeveloped land

4.4) County: Honolulu 4.5) State: Hawaii 4.6) Zip Code: not applicable

4.7) Total Property Acreage: 1,395 acres

4.8) Project Area (acreage, square feet): 200 acres

4.9) List any previous SHPD correspondence (LOG Number & DOC Number, if applicable): **See attachment for these letters**

LOG NO. 2014.04229 (AIS acceptance) DOC NO. 1504GC15 (AIS acceptance)
2015.01827 (Pres. Plan accept.) 1509SL01 (Pres. Plan accept.)

5. PROJECT INFORMATION

5.1) Does the Project involve a Historic Property? A Historic Property is any building, structure, object, district, area, or site, including heiau and underwater site, **which is over 50 years old** (*HRS §6E-2*).

☑ Yes ☐ No

5.2) The date(s) of construction for the historic property (building, structure, object, district, area, or site, including heiau and underwater site) is Circa 1925

5.3) Is the Property listed on the Hawai'i and or National Register of Historic Places? To check: http://dlnr.hawaii.gov/shpd/

☐ Yes ☑ No

5.4) Detailed Project Description and Scope of Work:

The proposed project will involve improving several existing "cane haul" roads, and installing hundreds of solar panels mounted on frames and posts that will be driven into the subsurface using "pile driver" technology; there will also be concrete footings built at or just below grade.

5.5) Description of **previous** ground disturbance (e.g. previous grading and grubbing):

As documented in a 2015 AIS report by Monahan (accepted by the SHPD on April 24, 2015), the entire Project Area has been severely impacted/altered by commercial agriculture (sugar cane), including not only chain-dragging/grubbing but also a century of mechanized plowing.

5.6) Description of **proposed** ground disturbance (e.g. # of trenches, Length x Width x Depth):

There are no specific civil engineering (ground-disturbance) plans at this time; however, the entire Project Area was included in the 2015 AIS that was accepted by the SHPD. According to the AIS, and a subsequent Preservation Plan (also accepted by the SHPD), sufficient data has been obtained for all historic properties and component features in the Project Area.

5.7) The Agency shall ensure whether historic properties are present in the project area, and, if so, it shall ensure that these properties are properly identified and inventoried. Identify all known historic properties:

This work has already been completed, and accepted by SHPD. Project area includes component features of plantation-era SIHP #s 50-80-09-2270 ("cane haul" roads) and -2273 (irrigation complex)

5.8) Once a historic property is identified, then an assessment of significance shall occur.

Integrity (check all that apply):

☑ Location ☑ Design ☑ Setting ☑ Materials ☑ Workmanship ☑ Feeling ☑ Association

Criteria (check all that apply):

☐ a – associated with events that have made an important contribution to the broad patterns of our history
☐ b – associated with the lives of persons important in our past
☑ c – embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value
☑ d – have yielded, or is likely to yield, information important for research on prehistory or history
☐ e – have an important value to the Native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out or still carried out, at the property or due to associations with traditional beliefs, events, or oral accounts - - these associations being important to the group's history and cultural identity

5.9) The effects or impacts of a project on significant historic properties shall be determined by the agency.

Effect Determination (select one): **Note: The result of the AIS was that 4 features of SIHP # -2273 (i.e., 14 [por.], 19, 22 & 23 [por.]) would be preserved. These 4 features were the subject of 2015 Preservation Plan, accepted by SHPD on 9/14/2015**

☐ No Historic Properties Affected

☑ Effect, with Agreed Upon Mitigation Commitments (§6E-42, HRS)

☐ Effect, with Proposed Mitigation Commitments (§6E-8, HRS)

5.10) This project is (check all that apply, if applicable): **None of these**

☐ an activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency;

☐ carried out with Federal financial assistance; and or

☐ requiring a Federal permit, license or approval.

If any of these boxes are checked, then the Project may also be subject to compliance with Section 106 of the National Historic Preservation Act (NHPA).

6. PROJECT SUBMITTALS

6.1) Please submit a copy of the Tax Map Key (TMK) map **See Attachment (Figure 1)**

6.2) Please submit a copy of the property map showing the project area and indicate if the project area is smaller than the property area. **See Attachment (Figure 1)**

6.3) Please submit a permit set of drawings. A permit set is a set of drawings prepared and signed by a licensed architect or engineer and is at least 65% complete. **Not currently available**

6.4) Are you submitting a survey?

☑ Yes ☐ No

Specify Survey: AIS for entire (1,395-acre) property (landowner KS) completed/accepted in 2015

6.5) Did SHPD request the survey?

☐ Yes ☐ No **AIS was completed in 2015 in anticipation of the need for an LUC application**

If 'Yes', then please provide the date, SHPD LOG NO, and DOC NO:

Date: April 24, 2015 LOG NO. 2014.04229 DOC NO. 1504GC15

6.6) **SURVEY REVIEW FEES**. Fee for Review of Reports and Plans (§§13-275-4 and 284-4). A filing fee will be charged for all reports and plans submitted to our office for review. Please go to:

http://dlnr.hawaii.gov/shpd/about/branches/archaeology/filing-fee-schedule/

A check payable to the Hawaii Historic Preservation Special Fund should accompany all reports or plans submitted. **This was all completed in 2015**

6.7) Please submit color photos/images of the Historic Property (any building, structure, object, district, area, or site, including heiau and underwater site) that will be affected by the Project. **Previously documented in SHPD-approved Preservation Plan (Monahan 2015)**

The following are the minimum number and type of color photographs required:

Quantity	Description
1-2	Street view(s) of the resource and surrounding area
1-2	Over view of exterior work area
1	exterior photo of the North elevation (if applicable)
1	exterior photo of the South elevation (if applicable)
1	exterior photo of the East elevation (if applicable)
1	exterior photo of the West elevation (if applicable)
1-2	interior photos(s) of areas affected (if applicable)

CHECKLIST

- [x] **SHPD FORM 6E** (this form)
- [x] **PROJECT SUBMITTALS** (any requested documentation for items 6.1 - 6.7 of this form)
- [ ] **FILING FEE FORM** (if applicable)

ATTACHMENT – WAIAWA SOLAR POWER PROJECT

This attachment includes:

(1) TMK map of the current Project Area (Figure 1, p. 2);

(2) Detail map of archaeological preservation sites in relation to current Project Area (Figure 2, p. 3);

(3) SHPD acceptance letter of the 2015 AIS that included the current Project Area (pp. 4-5);

(4) SHPD acceptance letter of the 2015 Preservation Plan that included the current Project Area (pp. 6-7);

(5) Formal written commitment letter (pp. 8-9) dated March 12, 2019, from Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC (Applicant), to install temporary preservation buffer fencing around State Inventory of Historic Places (SIHP) # 2273, Features 22 and 23 (portion) prior to the start of ground disturbing activities, and to maintain the temporary preservation buffer fencing around SIHP # 2273, Features 22 and 23 (portion) throughout the duration of construction activities in the current Project Area.

(6) Final overall site plan map showing current Project Area, proposed access roads, and utility tie-ins. (Figure 3, p. 10)

(7) 16 April 2019 letter memorializing installation of preservation buffer fencing around the preservation sites (p 11-14).

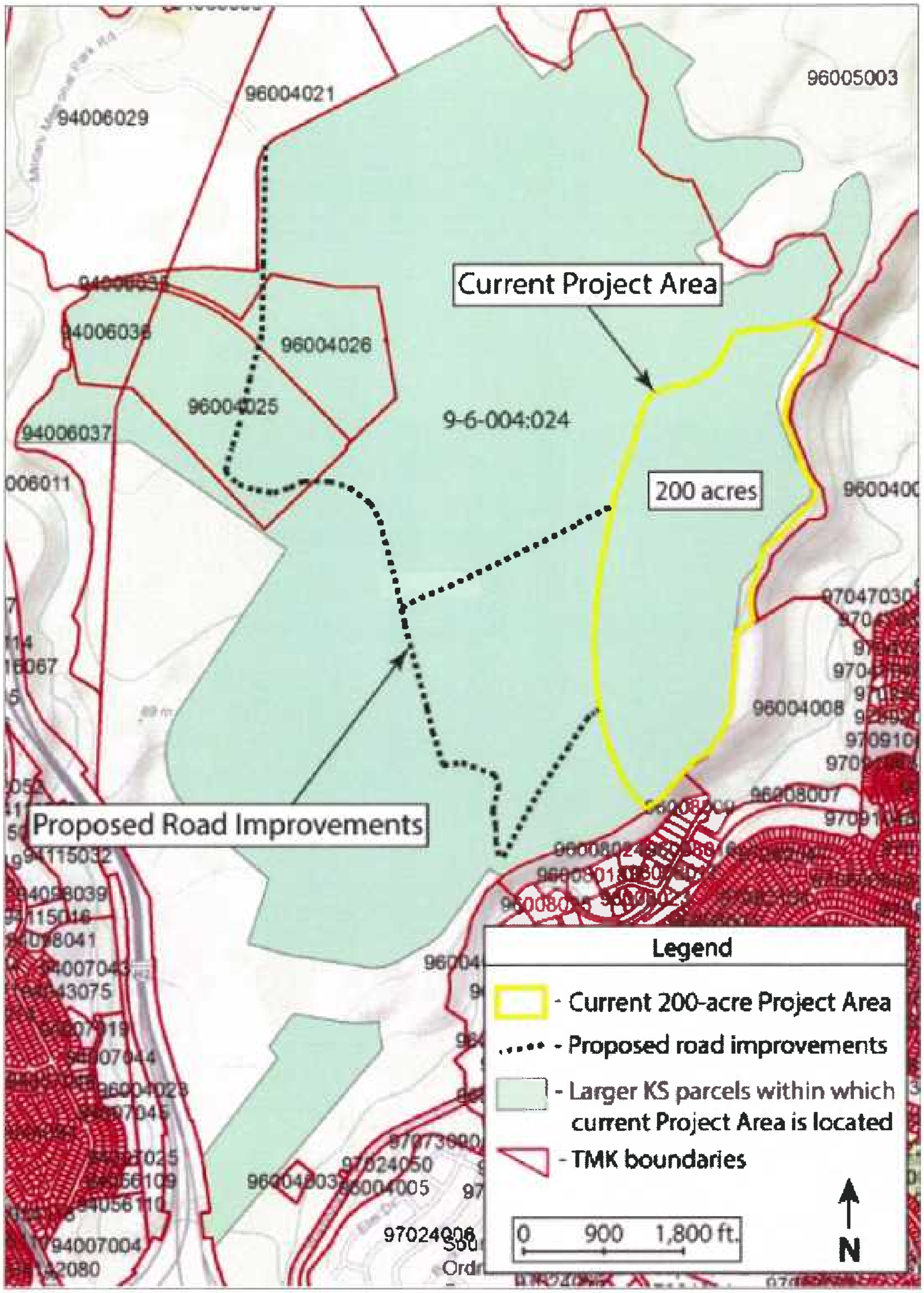

Figure 1. TMK map of the Current Project Area (200-acre yellow polygon) with proposed road improvements (black dashed line) in relation to larger (1,395-acre) Kamehameha Schools property (green)

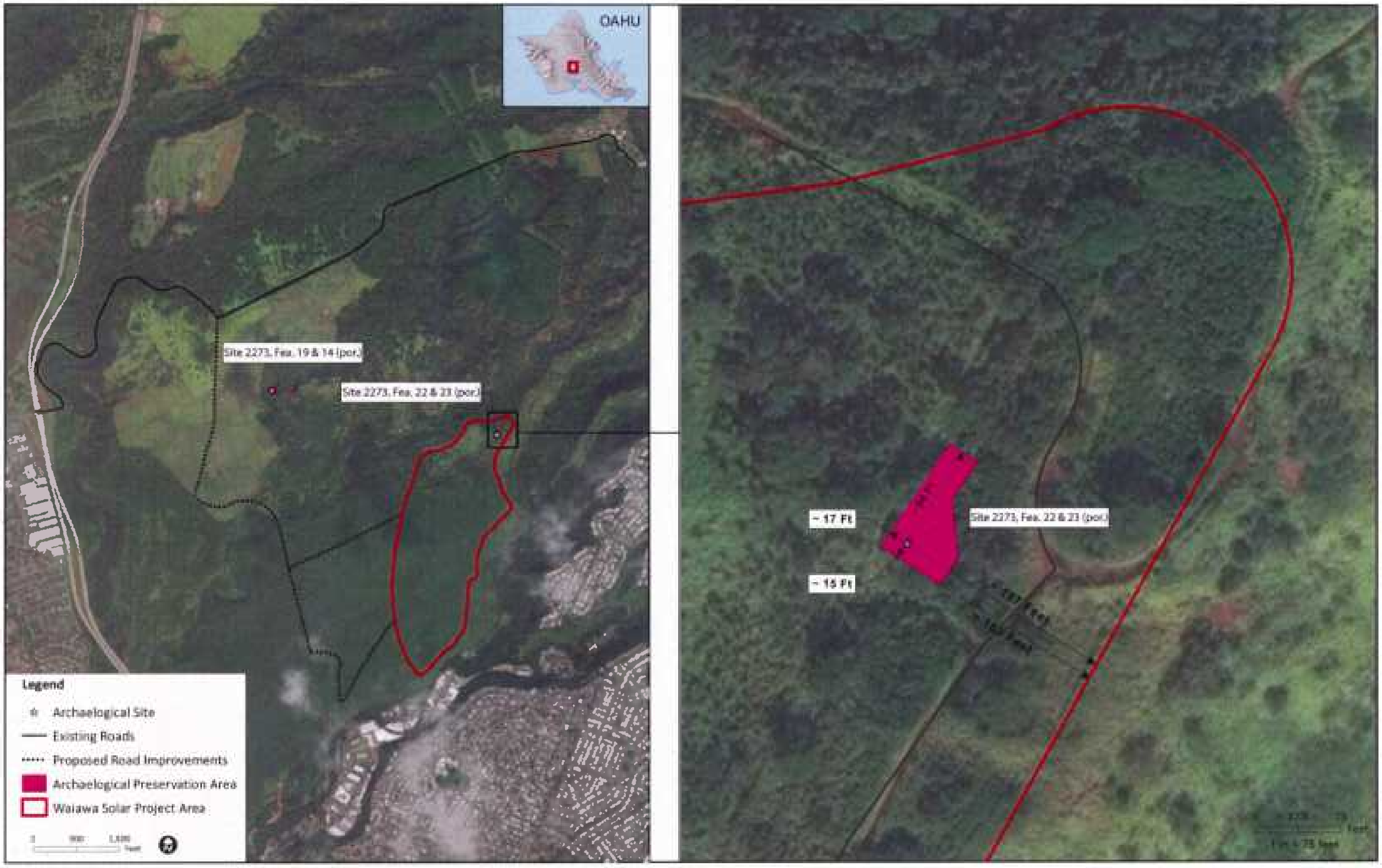

Figure 2. Detail view of the site-features subject to preservation according to the 2015 Archaeological Preservation Plan; the current Project Area is represented by the red polygon

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD, STE 555
KAPOLEI, HAWAII 96707

April 24, 2015

Chris Monahan, PhD, Principal
TCP Hawai'i LLC
333 Aoloa Street, #303
Kailua, HI 96734

LOG NO: 2014.04229
DOC NO: 1504GC15
Archaeology, Architecture

Dear Dr. Monahan:

SUBJECT: **Chapter 6E-42 Historic Preservation Review**
Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Lands
Waiawa and Waipi'o Ahupua'a, 'Ewa District, Island of O'ahu
TMK: (1) 9-4-006:034, 035, 036, 037; 9-6-004:024, 025, 026; 9-6-005:001

Thank-you for the opportunity to review the draft report titled *Archaeological Inventory Survey of 1,395 Acres of Kamehameha Schools' Land in Waiawa and Waipi'o Ahupua'a, 'Ewa District, O'ahu Island, Hawai'i* (Monahan, September 2014). We received this submittal on September 16, 2014; revised materials on January 10, 2015, and on March 23, 2015. SHPD requested an archaeological inventory survey be conducted due to the potential for proposed project plans to affect historic properties (June 12, 2014; Log No. 2014.02357, Doc. No. 1405GC14). The landowner, Kamehameha Schools (KS), proposes to develop a 50 megawatt solar facility on a portion of the property.

The archaeological inventory survey (AIS) provided surface coverage of the entire 1,395-acre project area which included two existing access roads and two proposed utility tie-ins. Subsurface testing consisted of a single hand-excavated unit placed to examine whether a small, dry-stacked terrace in Gulch C (Site 50-80-09-2273, Feature 21) was pre-Contact or plantation-era in age and association. Large-scale non-historic properties identified within the project area include recent earthen roads with low berms formed when the roads were graded or scraped; evidence of recent modification by civil engineers to control flooding of the landscape near two of the old reservoirs, Gulch C (Reservoir 3 on historic maps) and Gulch B (Reservoir 1-A on historic maps), and a long, heavily-built earthen berm in the northwest portion of the property, north of Gulch A, in an area of former workers' camp.

The AIS indicates that three previous archaeological surveys have included portions of the current project area (Barrera 1987, Goodman and Nees 1991, and Thurman et al. 2012). Portions of a data recovery project also extended into the current project area (Sinoto and Pantaleo 1994, 1995). Five historic properties (Sites 50-80-09-2262, 2270, 2271, 2272, and 2273) have been documented within or extending into the current project area. Of these, three were further documented during the current AIS (Sites 2270, 2271, and 2273); not further documented were Site 2262 (a small lithic scatter) and Site 2272 (WWII and later military concrete buildings and stock pile areas); Site 2262 was fully collected during the Goodman and Nees (1991) survey, and no evidence was found of possible Site 2272 features within the three areas previously identified in Figure 7 as having been used for military storage. Based on the current AIS documentation, Site 2270 is a network of roads and railroad right-of-ways consisting of 28 features, Site 2271 is the remains of workers' camps and other facilities represented by two extant features, and Site 2273 is an irrigation system consisting of 25 features. The most significant features of Site 2271–the Japanese cemetery (Feature 3) and the cannery (Feature 1)–were subject to data recovery work by Sinoto and Pantaleo (1994, 1995). No historic properties were newly identified during the current AIS.

Dr. Monahan
April 24, 2015
Page 2

Pursuant to Hawaii Administrative Rule (HAR) §13-284-6, Site 2270 is assessed as significant under Criterion d for its informational value regarding geospatial location, extent, and character of the plantation roads and temporary railroad in Waiawa built around or just after the turn of the $19^{th}/20^{th}$ century. Site 2273 is assessed as significant under Criterion c for its distinctive construction method and Criterion d for its information value. Like Site 2270, Site 2273 provides important data on geospatial location, extent, and character of the plantation irrigation infrastructure in Waiawa Uka built by the Oahu Sugar Company and its association with the nearby Waiāhole Ditch System (upslope and *mauka* of the current project area). Site 2271 Feature 1 (structural remnants) is assessed as significant under Criterion d for its information content relative to plantation working conditions in the early to middle 20^{th} century, while Site 2271 Feature 2 (camp debris) is assessed as not significant. Per HAR §13-284-7, the project effect determination is "effect, with proposed mitigation commitments." Of the three historic properties, no further work is recommended for Site 2270 and Site 2271 which are assessed as having yielded their informational and research value. The proposed mitigation is "*preservation of certain features of Site 2273*." The specific features are: (1) Feature 22, a large water-distribution and -retention basin of the plateau east of Gulch A, and one of the most formal structures in the project area; (2) a representative section of Feature 23, the cut basalt and mortar irrigation ditch leading into the Feature 22 basin; (3) Feature 19, a large dam-like retention structure in the west end of Gulch B; and (4) a representative section of Feature 14, Sub-feature 3, the cut basalt and mortar irrigation ditch draining into Gulch B and directly associated with the Feature 19 dam. We concur with the site significance assessments and the mitigation commitments.

The AIS report provides an excellent discussion of the project area, physical environs and cultural history background, previous investigations, the project methods and findings, and the site significance assessments and mitigation recommendations. The report meets the requirements of HAR §13-276-5. **It is accepted by SHPD**. Please send one hardcopy of the document, clearly marked FINAL, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office, attention SHPD Library.

As stipulated in HAR §13-284-7(e), when SHPD comments that the project will have an "effect, with agreed upon mitigation commitments," then detailed mitigation plans shall be developed for SHPD review and acceptance. Per HAR §13-284-8(a)(1)(A), the agreed-upon mitigation measure for this project is preservation of specific features of Site 2273. Pursuant to HAR §13-284-8(e)(5), we look forward to receiving an archaeological preservation plan that meets HAR §13-277.

Please contact Jessica Puff at (808) 692-8023 or at Jessica.L.Puff@hawaii.gov if you have any questions or concerns regarding architectural features. Please contact me at (808) 692-8019 or at Susan.A.Lebo@hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Susan A. Lebo

Susan A. Lebo, PhD
Oahu Lead Archaeologist
Acting Archaeology Branch Chief

DAVID Y. IGE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING
601 KAMOKILA BLVD, STE 555
KAPOLEI, HAWAII 96707

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

KEKOA KALUHIWA
FIRST DEPUTY

JEFFREY T. PEARSON
DEPUTY DIRECTOR - WATER

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

September 14, 2015

Chris Monahan, PhD, Principal
TCP Hawai'i LLC
333 Aoloa Street, #303
Kailua, HI 96734

Log No. 2015.01827
Doc. No. 1509SL01
Archaeology

Dear Dr. Monahan:

SUBJECT: **Chapter 6E-42 Historic Preservation Review**
Archaeological Preservation Plan for State Site No. 50-80-09-2273, Features 14 (portion), 19, 22, and 23 (portion), Kamehameha Schools' Land Waiawa Ahupua'a, 'Ewa District, Island of O'ahu
TMK: (1) 9-4-004:024 portion

Thank you for the opportunity to review the draft report titled *Archaeological Preservation Plan State Site No. 50-80-09-2273 Features 14 (Portion), 19, 22 & 23 (Portion) Kamehameha Schools' Land in Waiawa Ahupua'a, 'Ewa District, O'ahu Island, Hawai'i TMK (1) 9-6-004:024 (portion)* (Monahan, May 2015). We received this submittal on May 12, 2015; we apologize for the delay and thank you for your patience. SHPD requested an archaeological inventory survey be conducted due to the potential for proposed project plans to affect historic properties (June 12, 2014; Log No. 2014.02357, Doc. No. 1405GC14). The landowner, Kamehameha Schools (KS), proposes to develop a 50 megawatt solar facility on a portion of the property. The archaeological inventory survey (Monahan, September 2014) was reviewed and accepted by SHPD on April 24, 2015 (Log No. 2014.04229, Doc. No. 1504GC15).

The archaeological inventory survey (AIS) provided surface coverage of the entire 1,395-acre project area which included two existing access roads and two proposed utility tie-ins. Subsurface testing consisted of a single hand-excavated unit placed to examine whether a small, dry-stacked terrace in Gulch C (Site 50-80-09-2273, Feature 21) was pre-Contact or plantation-era in age and association. Large-scale non-historic properties identified within the project area include recent earthen roads with low berms formed when the roads were graded or scraped; evidence of recent modification by civil engineers to control flooding of the landscape near two of the old reservoirs, Gulch C (Reservoir 3 on historic maps) and Gulch B (Reservoir 1-A on historic maps), and a long, heavily-built earthen berm in the northwest portion of the property, north of Gulch A, in an area of former workers' camp.

The accepted AIS report (Monahan 2015) indicated that three previous archaeological surveys have included portions of the current project area (Barrera 1987, Goodman and Nees 1991, and Thurman et al. 2012). Portions of a data recovery project also extended into the project area (Sinoto and Pantaleo 1994, 1995). Five historic properties (Sites 50-80-09-2262, 2270, 2271, 2272, and 2273) have been documented within or extending into the current project area. Of these, three were further documented during the AIS (Sites 2270, 2271, and 2273); not further documented were Site 2262 (a small lithic scatter) and Site 2272 (WWII and later military concrete buildings and stock pile areas); Site 2262 was fully collected during the Goodman and Nees (1991) survey, and no evidence was found of possible Site 2272 features within the three areas previously identified in Figure 7 as having been used for military storage. Monahan (2015) indicates that no historic properties were newly identified. Site 2270 is a network of roads and railroad right-of-ways consisting of 28 features, Site 2271 is the remains of workers' camps and other facilities represented by two extant features, and Site 2273 is an irrigation system consisting of 25 features. The most significant features of Site 2271–the Japanese cemetery (Feature 3) and the cannery (Feature 1)–were subject to data recovery work by Sinoto and Pantaleo (1994, 1995).

Pursuant to Hawaii Administrative Rule (HAR) §13-284-6, Monahan (2015) assessed Site 2270 as significant under Criterion d for its informational value regarding geospatial location, extent, and character of the plantation roads and temporary railroad in Waiawa built around or just after the turn of the 19th/20th century. Site 2273 was assessed as significant under Criterion c for its distinctive construction method and Criterion d for its information value. Like Site 2270, Site 2273 provides important data on geospatial location, extent, and character of the plantation irrigation infrastructure in Waiawa Uka built by the Oahu Sugar Company and its association with the nearby Waiāhole Ditch System (upslope and ***mauka*** of the current project area). Site 2271 Feature 1 (structural remnants) was assessed as significant under Criterion d for its information content relative to plantation working conditions in the early to middle 20th century, while Site 2271 Feature 2 (camp debris) was assessed as not significant. Per HAR §13-284-7, the project effect determination was "effect, with proposed mitigation commitments." Of the three historic properties, no further work was recommended for Site 2270 and Site 2271 which were assessed as having yielded their informational and research value. The proposed mitigation was "***preservation of certain features of Site 2273.***" SHPD concurred with the site significance assessments and the mitigation commitments, and the development of an archaeological monitoring plan meeting the requirements of HAR §13-277.

The archaeological preservation plan (PP) indicates that preservation includes: (1) a representative section (100 ft [30 m]) of Feature 14, the cut basalt and mortar irrigation ditch draining into Gulch B and directly associated with the Feature 19 dam; (2) the entirety of Feature 19, a large dam-like retention structure in the west end of Gulch B; (3) the entirety of Feature 22, a large water-distribution and water-retention basin on the plateau east of Gulch A, and one of the most formal structures in the project area; and (4) a representative section (75 ft [25 m]) of Feature 23, the cut basalt and mortar irrigation ditch leading into the Feature 22 basin. Preservation will be in the form of "avoidance and protection" and will involve a 10-ft (3 m) buffer around all features or portions of preserved features, except one side of Feature 22 (east side). The buffers will be marked by permanent fencing. No vegetation clearance is anticipated/planned within the buffers. In addition, no signage or access is planned. Periodic monitoring of the preserves will be conducted by the landowner or their representatives.

The preservation plan meets the requirements of HAR 13-277. It is accepted by SHPD. Please send one hardcopy of the document, clearly marked FINAL, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office, attention SHPD Library.

Please contact me at (808) 692-8019 or at Susan.A.Lebo@hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Susan A. Lebo

Susan A. Lebo, PhD
Archaeology Branch Chief

Clearway Energy Group
100 California Street, Floor 4
San Francisco, CA 94111

clearwayenergygroup.com

Clearway

March 12, 2019

Susan Lebo, Ph.D
Archeology Branch Chief, State Historic Preservation Division
601 Kamokila Blvd. Room 555
Kapolei, Hawaii 96707

Re: Formal Commitment to Install and Maintain Preservation Buffer Fencing at State Inventory of Historic Place # 50-80-09-2273, Features 22 & 23 (portion), Waiawa Solar PV Project (TMK [1] 9-6-004:024), Waiawa Ahupua'a, O'ahu Island; HRS § 6E-42 Review

Aloha Dr. Lebo,

Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC (Applicant), is proposing to develop and operate the Waiawa Solar Project on O'ahu. The purpose of this letter is to formalize our commitment to install and maintain preservation buffer fencing at Site 2273, Features 22 & 23 (portion), in accordance with the specifications in an Archaeological Preservation Plan (Monahan 2015) completed by the landowner (Kamehameha Schools) that was accepted by the SHPD in a letter (Log No. 2015.01827, Doc No. 1509SL01) dated September 24, 2015.

The subject letter supports a request for concurrence to SHPD from the landowner, per (attached) HRS 6E Submittal Form, that the Solar PV Project by the project proponent (Applicant) will have an "Effect, with agreed upon mitigation commitments," and that the mitigation will be the preservation, in perpetuity, of SIHP # 50-80-09-2273, Features 22 and a portion of 23.

The (attached) HRS 6E Submittal Form, in turn, supports the landowner's Land Use Commission's Order in Docket # A87-610.

Although the proposed construction is not planned to begin for another two or three years, we will install temporary construction fencing to act as preservation buffer to ensure that project-related studies and investigations that are required to support project design and permitting do not disturb Features 22 and a portion of 23. We will maintain the preservation buffer fence during the study period and will re-confirm the integrity of the fence prior to the start of ground-disturbing work. We will install the preservation buffer fencing around SIHP # 50-80-09-2273, Features 22 and a portion of Feature 23, in accordance with the specifications in the aforementioned plan; and we will notify the SHPD in a letter memo with photographic documentation that the fencing has been installed. The preservation fencing will then be maintained in good working order throughout the duration of the proposed construction.

Should you have any questions, please do not hesitate to contact our cultural resources consultant Chris Monahan of TCP Hawai'i at (808) 754-0304, or myself at (415) 627-4656, Aarty.Joshi@ClearwayEnergy.com.

Sincerely,

Aarty Joshi

Senior Manager, Environmental Permitting

c: Nicola Park, Clearway Energy Group LLC
Kalani Fronda, Kamehameha Schools
Tracy Camuso, G70
Chris Monahan, TCP Hawai'i

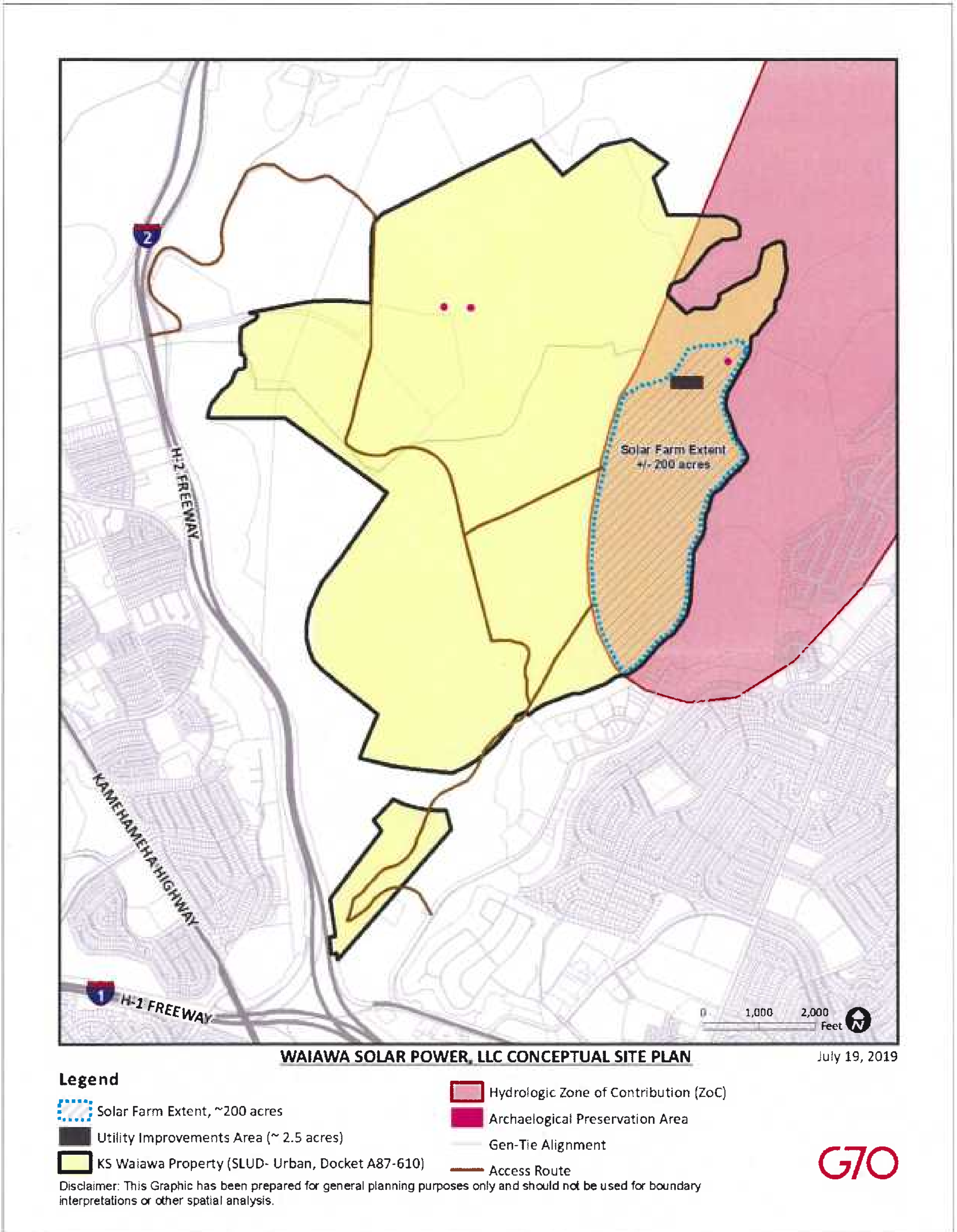

Figure 3. Final overall site plan

TCP Hawai'i, LLC

Documenting Traditional Cultural Properties of Hawai'i
Preserving and Restoring Cultural and Natural Resources of Hawai'i

April 16, 2019

To: **Tracy Camuso, G70 (via email)**
Re: **Letter Memo – Completion of Installation of Protective Fencing/Preservation Buffer around SIHP # 50-80-09-2273, Features 22 & 23 (por.) in Support of Clearway Energy Group LLC/Waiawa Solar Project**

Aloha Ms. Camuso,

This letter memo with attachments (photographs from the field) serves as notification of completion of the installation of orange construction fencing around the aforementioned site-features. The work was completed according to the specifications described in the Archaeological Preservation Plan by Monahan (2015).

This letter memo with photographs is also being sent to the SHPD, in support of the HRS 6E form that was submitted on 3/12/19 for this project.

Photographs of the installed fencing are included below.

Please let me know if you have any questions about this letter memo.

With aloha,

Christopher M. Monahan, Ph.D.
Principal Investigator, Archaeologist
TCP Hawai'i, LLC
150 Hamakua Dr., #810
Kailua, HI 96734
(808) 754-0304
mookahan@gmail.com

c: Arty Joshi, Clearway Energy Group LLC
Nicola Park, Clearway Energy Group LLC
Susan Lebo, SHPD-Archaeology Branch
Kalani Fronda, Kamehameha Schools

Figure 1. Fencing in foreground is a visual warning of the preservation buffer fencing that starts in the background, indicated by arrows; facing north-northwest

Figure 2. Section of fencing along west side of preservation buffer; portion of Feature 22 visible in background (arrow); facing south-southeast

Figure 3. Section of fencing along west side of preservation buffer; facing north

Figure 4. Northeast corner of fencing of preservation buffer; facing south

Figure 5. Section of fencing along north end of preservation buffer; portion of Feature 23 visible in lower left (arrow); facing south

Figure 6. Section of fencing along east side of preservation buffer; facing north

Biological surveys for a solar electrical generating facility in Waiawa, central O'ahu

July 22, 2019 *AECOS* No. 1579

Eric Guinther, Reginald David[1], Chad Linebaugh
AECOS, Inc.
45-939 Kamehameha Hwy, Suite 104
Kāne'ohe, Hawai'i 96744
Phone: (808) 234-7770 Fax: (808) 234-7775 Email: guinther@aecos.com

Introduction

Waiawa Solar Power LLC, a subsidiary of Clearway Energy Group LLC, is proposing to construct and operate a 36 MW solar electrical generating facility, including a substation and battery storage (the "Project") on approximately 200 ac (82 ha) of former agriculture land in Waiawa, central O'ahu (Figure 1). The site[2] is located east of the H-2 (Veterans Memorial Freeway) with proposed access from Ka Uka Boulevard, via Mililani Memorial Park Road to Waiawa Prison Road (Figure 2) or, alternatively during operation, off Waihona Street in the Pearl City Industrial Park. A gentie line will extend from the northwest side of the Project area to the west, connecting with the HECO grid near the Ka Uka Blvd H-2 freeway off-ramp.

Site Description

The Project lies within a 1,567-ac (634-ha) parcel (TMK: 9-6-004: 024) owned by Kamehameha Schools (KS) and formerly used to grow sugar cane. Ample evidence remains of this past agricultural use in the form of large irrigation pipes, ditches, and concrete field channels. The land is not presently in productive agricultural use and has not been since 1982. This parcel is part of a once proposed residential development that was proposed to be called Waiawa Ridge (see Gomes, 2009) and in 1988, a 1,395-ac (565-ha) area encompassing a

[1] Rana Biological Consulting, Inc., Kailua-Kona, Hawai'i.
[2] See glossary of terms used on page 18.

part of this parcel and other adjacent parcels was reclassified by the State Land Use Commission from the Agricultural District to the Urban District.

Figure 1. Waiawa Solar Power site (red) in central O'ahu.

Abandoned agricultural lands on O'ahu do not recover the native plant communities that characterized the location several centuries ago. Introduced naturalized plants inevitably come to dominate the landscape and it is rare for any of the native species that may have once grown here to recover even as a sparse population due to the completeness of the disturbance of the land, the long history of agrarian use, and the abilities of certain invasive species to out-compete all other species.

Figure 2. Waiawa Solar Power site (approximate, subject to refinement).

Located on the leeward slope of the Koʻolau mountain, most of the site is sloping land of the interfluve between Waiawa Stream and an unnamed gulch tributary to Pānakauahi Gulch, the latter a tributary of Waiawa Stream. Steep lands associated with bordering gulches are not included in the Project site. The land slopes down from northeast to southwest, from approximately 540 ft (165 m) above sea level (asl) at the northeast end to 240 ft (73 m) asl at the southwest end of the site itself. A few shallow swales are present within the site. Unimproved roads, developed during the sugar cane era, access various parts of the property.

Annual rainfall over the elevation range of the site varies from approximately 40 in (103 cm) at the upper (*mauka*) end to 32 in (81 cm) at the low (*makai*) end (Giambelluca, et al., 2013). Although this difference seems insignificant, the vegetation does reflect, in a subtle way, the presence of such a gradient. Rainfall over the Project area is indicative of an island leeward environment of generally mesic conditions.

Methods

Biological surveys of the site were conducted on March 12 and 13, 2019 covering the Project "Site" of some 200 ac (82 ha) as outlined in red in Figure 2, above. The surveys entailed searches for natural resources of interest or concern in or near the Project area, with particular attention paid to native plants and animals, and especially those native species protected by statutory authority administered by the U.S. Fish and Wildlife Service and the State of Hawaiʻi, Department of Land and Natural Resources. Emphasis was on vascular plants and birds, with consideration given to mammals. The location of the Project on former cane lands at low elevation on Oʻahu strongly suggests that non-vascular plants, invertebrates, fishes, amphibians, or reptiles of conservation interest or concern would not be present, although the biologists were tasked with making a final determination of this fact as part of the survey.

Prior to going into the field, the biology team members researched literature pertinent to the proposed Project area as detailed further in the Discussion Section of the report. Plant names used in the report follow *Manual of the Flowering Plants of Hawaiʻi* (Wagner, Herbst, & Sohmer, 1999) for native and naturalized flowering plants and *A Tropical Garden Flora* (Staples & Herbst, 2005) for crop and ornamental plants. More recent name changes for naturalized plants follow Imada (2012). Avian phylogenetic order and nomenclature used in this report follows the *AOU Check-List of North American Birds* (American Ornithologists' Union, 1998) and the 42nd through the 58th 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, 2014, 2015, 2016, 2017, 2018). Mammal scientific names follow *Mammal Species of the World: a Taxonomic and Geographic Reference* (Wilson and Reeder, 2005).

Plant Survey

For the botanical survey, a boundary map was loaded into Trimble GNSS units (GeoXM and GeoXH) to serve as a guide to the survey area limits. The GNSS units recorded the progress tracks of the botanists, providing real time feedback on location and adequacy of coverage of the pedestrian survey. Plant species were identified as they were encountered and notations used to develop a qualitative sense of abundance. Any plants not immediately recognized during the survey were photographed and/or a representative feature (flower, fruit) collected for later identification at the laboratory.

Avian Survey

For the avian survey, 12 avian point-count stations were sited roughly equidistant from each other within the survey area. A single eight-minute avian point count was made at each of the 12 count stations. Field observations were made with the aid of Leica 8 X 42 binoculars and by listening for vocalizations. The avian counts were conducted in the early morning hours. Time not spent counting at point-count stations was used to search the area for species and habitats not detected during the point-counts. Weather conditions were generally good, with winds of between 2 and 15 kilometers per hour (kph) during count periods and a few intermittent light showers.

Mammalian Survey

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 mammalian species detected during the survey. No survey was conducted for the only native Hawaiian land mammal, the *'ōpe'ape'a* or Hawaiian hoary bat (*Lasiurus cinereus semotus*), detection of which would require night surveys deploying special detection equipment. The population of this bat on O'ahu is sparse. Currently, no technology exists to appropriately survey for this species. Conducting a survey over multiple nights cannot guarantee that bats would be detected or preclude the possibility that the Hawaiian hoary bat utilizes resources in the area on occasion. Consequently, habitat presence is assumed and recommendations presented on page 18 will minimize impacts to this species to the maximum extent practicable.

Figure 3. Interior of *koa haole* shrub-scrub vegetation.

Results

Vegetation

The vegetation on the Project site can be divided into two major types that blend along their common edges: 1) a *koa haole* (*Leucaena leucocephala*) shrub-scrub (Figure 3, above); and 2) a dense Guinea grass (*Megathyrsus maximus*) grassland (Figure 4). Both types extend broadly over the entire parcel. Guinea grass is a subdominate species in the *koa haole* shrubland (see Fig. 3), although the stature of the grass is low and coverage can be sparse in places. *Koa haole* and other trees and shrubs occur scattered within the otherwise open grassland where the stature of the grass can reach 2 m (6 ft) and the density nearly impenetrable. Scattered trees of several species form copses at the upper elevation parts of the site. Both vegetation types can be characterized as dominating the ground to an extent that few other plant species occur within them, except where that ground has been regularly disturbed, creating an opening in the coverage by the dominant plant species.

Figure 4. An infrequently used track through the Guinea grass grassland.

Thus, a third "vegetation" type is that of the ruderal environment on and along unimproved roads in the area. Most of the plant species recorded during the survey are actually limited in occurrence to these roadways; tracks not regularly traveled by vehicles are overgrown by Guinea grass and most ruderal species disappear (Figure 4, above). The listing of plant species observed (Table 1) has 27 species (46% of total) that are described (see note <1> in Table 1) as found only along the unimproved roads. Several others are similarly distributed, although not exclusively so, and occur within the *koa haole* vegetation type in small numbers. The rainfall gradient mentioned in the Introduction appears to be an influence only on the composition of the ruderal plant assemblage and the stature of the two dominant species of the other vegetation types.

Table 1. Plant species identified present on the Waiawa Solar Power site.

Species listed by family	Common name	Status	Abundance	Notes
FLOWERING PLANTS				
DICOTYLEDONES				
ANACARDIACEAE				
Schinus terebinthefolius Raddi	Christmas berry	Nat	Oc	
ASTERACEAE (COMPOSITAE)				
Ageratum conyzoides L.	*maile hohono*	Nat	R	<1>
Bidens alba (L.) DC.	---	Nat	R	<1>
Conyza bonariensis (L.) Cronq.	hairy horseweed	Nat	R	<1><2>
Emilia fosbergii Nicolson	Flora's paintbrush, *pualele*	Nat	U	<1>
Pluchea carolinensis (Jacq.) G. Don	sourbush	Nat	U	
BORAGINACEAE				
Carmona retusa (Vahl) Masamune	Fukien-tea	Nat	R	
BIGNONIACEAE				
Spathodea campanulata P. Beauv.	African tulip tree	Nat	U	
CARICACEAE				
Carica papaya L.	papaya	Nat	R	
EUPHORBIACEAE				
Macaranga tanarius (L.) Müll. Arg.	---	Nat	R	
FABACEAE				
Acacia confusa Merr.	Formosan koa	Nat	Ou	
Chamaecrista nictitans (L.) Moench	partridge pea	Nat	Oc	<1>
Crotalaria incana L.	fuzzy rattlepod	Nat	R	
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	Nat	U	
Desmodium incanum DC.	Spanish clover	Nat	Uc	<1>
Enterolobium cyclocarpum (N. Jacq.) Grisb.	earpod tree	Nat	R	
Falcataria moluccana (Miq.) Barneby & Grimes	albizia	Nat	R	<2>
Neonotonia wightii (Wight & Arnott) Lackey	glycine vine	Nat	O	
Indigofera suffruticosa Mill.	indigo	Nat	R	<1>
Leucaena leucocephala (Lam.) deWit	*koa haole*	Nat	AA	
Pithecelobium dulce (Roxb.) Benth.	*'opiuma*	Nat	O	

Table 1 (continued).

Species listed by family

Species	Common name	Status	Abundance	Notes
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	*kiawe*	Nat	R	
MALVACEAE				
Sida ciliaris L.	---	Nat	C	<1>
Sida spinosa L.	prickly sida	Nat	C	<1>
Waltheria indica L.	*'uhaloa*	**Ind**	C	
MYRTACEAE				
Psidium guajava L.	common guava	Nat	U	
Syzigium cumini L.	Java plum	Nat	Oc	
PASSIFLORACEAE				
Passiflora foetida L.	running pop	Nat	R	<2>
PHYTOLACCACEAE				
Rivina humilis L.	coral berry	Nat	U	
PITTOSPORACEAE				
Pittosporum pentandrum (Blanco) Merr.	---	Nat	O	
PROTEACEAE				
Grevillea robusta A. Cunn. ex R. Br.	silk oak	Nat	U	
RUTACEAE				
Murraya paniculata (L.) W. Jack	mock orange	Nat	O	
SAPINDACEAE				
Dodonaea viscosa Jacq.	*'a'ali'i*	**Ind**	U	
SAPOTACEAE				
Chrysophyllum oliviforme L.	satin leaf	Nat	R	
SOLANACEAE				
Solanum seaforthianum Andr.	---	Nat	U	
VERBENACEAE				
Lantana camara L.	lantana	Nat	R	
Stachytarpheta australis Moldenke	---	Nat	U	<1>
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain	Nat	O	<1>
FLOWERING PLANTS MONOCOTYLEDONES				
POACEAE				
Megathyrsus maximus (Jacq.) B.K. Simon & W.L. Jacobs	Guinea grass	Nat	AA	

Table 1 (continued).

Legend to Table 1

STATUS = distributional status for the Hawaiian Islands:

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

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

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

ABUNDANCE = occurrence ratings for plant species:

- - -	Species not present in specified 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.

Letters (u,c, or a) following qualitative rating of abundance indicate a localized abundance that is greater than the occurrence rating. For example, Ra would be a plant encountered perhaps only once or twice, but very numerous where encountered.

NOTES: <1> – Distribution generally limited to roadway margins (ruderal).
<2> – Plant lacking key diagnostic characteristics (flower, fruit); identification, therefore, not confirmed.

Flora

A list of all the flowering plant species observed on the Project site is given above as Table 1. No ferns or conifers were found. A total of 39 species were recorded during our survey. The observations included two (2) indigenous native species: *ʻuhaloa* (*Waltheria indica*) and *ʻaʻaliʻi* (*Dodonaea viscosa*). No early Polynesian introduced or Hawaiian Islands endemics are present. With the exception of *ʻuhaloa*, these indigenous species are rare or uncommon in the survey area. *ʻUhaloa* is a common and typically ruderal plant that here is moderately common along roads in the area. The remaining 37 species (95%) are non-native species.

Avian Count Survey

A total of 408 individual birds (23 species, representing 16 separate families) were recorded during station counts (Table 2). One species detected within the site, albeit while moving between point-count locations, the Pacific Golden-Plover (*Pluvialis fulva*), is an indigenous, migratory shorebird species. The remaining 22 species recorded during the course of this survey are alien to the Hawaiian Islands. Two species—Japanese White-eye (*Zosterops japonicus*) and Red-vented Bulbul (*Pycnonotus cafer*)—accounted for 48% of all birds recorded during station counts. The most frequently recorded species was Japanese white-eye, which accounted for 25% of the total number of birds recorded during station point-counts.

Table 2. Avian species detected at the Waiawa Solar Power site in March 2019.

Common Name	Scientific Name	ST	*RA*
	GALLIFORMES		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	0.92
Chicken	*Gallus gallus*	D	0.67
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	0.42
Zebra Dove	*Geopelia striata*	A	0.50
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	**I-20**
	PELECANIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	0.08
	PSITTACIFORMES		
	PSITTACIDAE - Lories Parakeets, Macaws & Parrots		
	Psittacinae - Typical Parrots		
Rose-ringed Parakeet	*Psittacula krameri*	A	2.08
	Arinae - New World Parakeets, Macaws & Parrots		
Red-crowned Parrot	*Amazona viridigenalis*	A	1.67
	PASSERIFORMES		
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	7.67
Red-whiskered Bulbul	*Pycnonotus jocosus*	A	2.00
	CETTIIDAE - Cettia Warblers & Allies		
Japanese Bush-Warbler	*Cettia diphone*	A	2.17
	ZOSTEROPIDAE - White-eyes		
Japanese White-eye	*Zosterops japonicus*	A	8.50
	TIMALIIDAE - Babblers		
Chinese Hwamei	Garrulax canorus	A	0.08
Red-billed Leiothrix	*Leiothrix lutea*	A	0.83
	MIMIDAE - Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	A	0.08

Table 2 (continued).

Common Name	Scientific Name	ST	*RA*
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	0.33
	FRINGILLIDAE - Fringilline and Carduline Finches & Allies Carduelinae - Carduline Finches & Hawaiian Honeycreepers		
House Finch	Haemorhous mexicanus	A	1.25
	TURDIDAE - Thrushes		
White-rumped Shama	*Copsychus malabaricus*	A	0.83
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	1.67
	THRAUPIDAE - Tanagers		
Red-crested Cardinal	*Paroaria coronata*	A	0.92
	ESTRILDIDAE - Estrildid Finches		
Common Waxbill	*Estrilda astrild*	A	0.75
Java Sparrow	*Lonchura oryzivora*		
Scaly-breasted Munia	*Lonchura punctulata*	A	0.25
Chestnut Munia	*Lonchura atricapilla*	A	0.33

Key to Table 2

ST Status

- A Alien – Introduced to the Hawaiian Islands by humans
- D Domesticated – Species which has become partially feral, but is not considered to be established in the wild on O'ahu
- IM Indigenous Migrant – Native but not unique to the Hawaiian Islands, does not nest in the Islands

RA Relative Abundance – Number of birds detected divided by the number of count stations (12)

Mammalian Survey

Four terrestrial mammalian species were detected in the vicinity of the Project during the course of this survey. We saw a number of small Indian mongoose (*Herpestes auropunctatus*) within the site. We also saw three individuals of the house mouse (*Mus musculus*) and individuals, scat, tracks, trails, and other sign of pig (*Sus scrofa*) in numerous locations within the survey area. Domestic dog (*Canis familiaris*) was heard barking from locations outside of the survey area on both days that we were on the site. All four of these mammalian species are alien to the Hawaiian Islands and deleterious to native wildlife.

Discussion

Flora

The authors previously surveyed a proposed solar facility on 387 ac (157 ha) in the same general area (located approximately 0.8 mi [1500 m] to the northwest of the current Project site; *AECOS*, 2014). That earlier survey produced a plant species list of 62 species, a higher count than that of the present survey in an area of more or less identical vegetation, but where disturbed ground was a greater proportion of the survey area. Comparison of the two floras, however, shows nearly half of the species in each list did not appear on the other listing: that is, 36 species listed in 2014 are unique (not seen in the present survey) and 13 species are unique to our 2019 (this report) survey. While perhaps unexpected, the differences can be attributed in part to the fact that 66% of the species observed in 2014 were rare or uncommon and 62% were rare or uncommon in the 2019 list. As is the case with regard to the present survey, no plants of any particular interest or concern were report for the 2014 survey.

Unrelated to the current survey, the lead author surveyed the flora of a parcel adjacent on the east owned by the U.S. Navy (TMK: 9-6-004:001). The Navy property includes the rocky side wall of Waiawa Valley rising steeply some 200 ft (60 m) on the Navy side of the common property line. The following is excerpted from the *AECOS* report (2016, p. 132):

> Parallel to the west of the forested valley bottom occurs a scrub forest of *koa haole* and Guinea grass… [and partially mapped along the solar farm Project site boundary]. The scrub growth, and the similar but more open growth on the steep valley margin… dominates much of the [Navy] property. This latter vegetation type—designated "low-statured koa haole scrub" by Char… —is well described in her report, and includes five of the natives reported by Char from the [Navy] property.

These five species are: *pili* grass (*Heteropogon contortus*), *ʻaʻaliʻi*, *pōpolo*, *ʻala ʻala wai nui* (*Peperomia leptostachya*), and *ʻuhaloa* (Char, 2000). Two were recorded for the present survey on the Project site. The other three—*pili*, *pōpolo*, and *ʻalaʻala wai nui*—could potentially occur as rare or uncommon on the Project property. However, *P. leptostachya* is typically found on rock outcrops, a habitat not observed on the site. An unusual aspect of our present survey results is that only one grass species was recorded. A survey of the proposed solar farm site to the northwest (AECOS, 2014) listed a somewhat more typical 6 grass species, all common grasses, *pili* not included.

In conclusion, the Navy report stated (*AECOS*, 2016, p. 133):

> No plant species listed as threatened, endangered, or proposed for listing under federal (USFWS, 2015) or state statutes (DLNR, 1997) were found or have been reported in recent decades at the Waiawa Watershed property. Native species are sparsely distributed on the valley floor; most occur on the steep western margin of the valley [adjacent to the present Project eastern property line].

None of the plant species observed at the Project site are considered important from a natural resources perspective. No plant species currently protected or proposed for protection under either the federal or State of Hawai'i endangered species programs (HDLNR, 1998; USFWS, nd a) were detected during the course of our survey.

Fauna

Avian diversity and densities are in keeping with the highly disturbed habitats present on the study site and similar to those reported from a previous survey conducted on land to the northwest of the current survey site (*AECOS*, 2014). No vertebrate species currently protected or proposed for protection under either the federal or State of Hawai'i endangered species programs (HDLNR, 2015; USFWS, nd a) were detected during the course of this survey.

Shorebirds - As noted above, the Pacific Golden-Plover is an indigenous migratory shorebird species that nests in the high Arctic during the late spring and summer months, returning to Hawai'i and the tropical Pacific to spend the fall and winter months each year. Plover usually leave Hawai'i and return to the Arctic in late April or the very early part of May and are commonly encountered in open areas throughout the Hawaiian Islands from late summer through mid-spring.

Seabirds - Although no seabirds were detected during this survey, it is possible that the endangered Hawaiian Petrel (*Puffinus sandwichesis*) and the threatened Newell's Shearwater (*Puffinus newelli*) over-fly the project area between April and the middle of December each year in very small numbers. Newell's Shearwaters are not known to breed on the Island of O'ahu, though recent acoustical surveys conducted on the Island have recorded low numbers of this species calling over the higher reaches of the Island (Young, et al., 2019). These authors also recorded one Hawaiian Petrel over the Island.

The primary cause of mortality in Hawaiian Petrels and Newell's Shearwaters is thought to be predation by alien mammalian species at the nesting colonies

(USFWS, 1983; Simons and Hodges, 1998; Ainley et al., 2001). Collision with man-made structures is considered to be the second most significant cause of mortality of these seabird species in Hawai'i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. Disoriented seabirds may collide with man-made structures and, if not killed outright, become easy targets of opportunity for feral mammals (Hadley, 1961; Telfer, 1979; Sincock, 1981; Reed et al., 1985; Telfer et al., 1987; Cooper and Day, 1998; Podolsky et al., 1998; Ainley et al., 2001; Hue et al., 2001; Day et al., 2003).

Mammals - The findings of the mammalian survey are consistent with the location of the property and environments present on the site. It is likely that cat (*Felis catus*) and some of the other established alien Muridae found on O'ahu—roof rat (*Rattus rattus*), brown rat (*Rattus norvegicus*), and Polynesian rat (*Rattus exulans hawaiiensis*)—use various resources within the general project area on a seasonal basis. All of these introduced rodents are deleterious to native ecosystems and native faunal species within them.

Potential Impacts to Protected Species

Hawaiian hoary bat - It is possible that the Hawaiian hoary bat overflies the Project area on a seasonal basis. A potential impact that the installation and operation of a PV generating farm poses to bats is during the clearing and grubbing phase of construction when taller vegetation is being removed. The removal of vegetation may temporarily displace individual bats, which use trees for roosting. Because this bat uses multiple roosts within a home territory, the disturbance resulting from removal of trees is likely to be minimal. However, during the pupping season, a female carrying a pup may be less able to rapidly vacate a roost site when an inhabited tree is being felled. Further, an adult female may leave a pup in the roost tree while foraging. Very small pups will be unable to flee a tree that is being felled. Potential adverse effects from such disturbance can be avoided or minimized by not clearing woody vegetation taller than 15 ft (4.6 m) between June 1 and September 15, the bat pupping season. Stringing barbed wire along the top of security fences is a potential threat to flying bats.

Seabirds - A potential impact that the installation and operation of a PV generating facility poses to seabirds is the increased threat that birds will be downed after becoming disoriented by lights associated with a project during the fledging season. The two main areas that outdoor lighting could pose a threat to these nocturnally flying seabirds are: 1) during construction if it is deemed expedient or necessary to conduct night-time construction activities; and 2) following build-out, the operation of security lighting.

Other Species - The USFWS iPaC website (USFWS, nd a) was visited for a list of protected species included in a USFWS database. The website generated no ESA-listed species for the Project area, but listed two "migratory birds": Brown Booby (*Sula leucogaster*) and Oʻahu *ʻAmakihi* (*Hemignathus flavus*[3]).

Oʻahu *ʻAmakihi* is an endemic, year-round resident on the Island of Oʻahu. This species is not migratory and does not occur at the Project elevation in the Waiawa area. The Brown Booby is a pelagic seabird species that nests on offshore islands in the Hawaiian chain. The species is not found in the interior of any of the high islands. Additionally, no place exists within the Project site where a Brown Booby could land if an individual chose to explore the area.

Jurisdictional Waters

The Project site does not contain waters that would be considered jurisdictional under the Clean Water Act (CWA). All of the Project site is located on an interfluve with no perennial or intermittent streams present. Some topographic maps and the HDLNR stream shapefile (HDLNR-DAR, 2008) show partial representations of water conveyance pipes ("aqueduct)" and channels (as blue line features on USGS map, 7.5-Minute Series (Topographic), Waipahu Quadrangle (USGS, 1998). All of these features are long abandoned and no longer functional; they do not hold or convey water.

The National Wetlands Inventory (NWI) Wetlands Mapper (USFW, nd b) shows no wetlands or streams in the survey area, and no hydrology or vegetation indicative of wetlands were observed during our survey of the Project area. The nearest jurisdictional water, Waiawa Stream, is found to the east of the Project on U.S. Navy property and within the Pearl City Industrial Park along the valley bottom, separated from the site by a high valley wall.

[3] This species was elevated to a full species in 1995. The current accepted name is *Chlorodrepanis flava*.

Critical Habitat and State Conservation Districts

Federally delineated Critical Habitat is not present in the Project area (USFWS, nd a). No equivalent designation exists under state law. Conservation zoning in Hawai'i is promulgated at the state level by state Conservation Districts. No Conservation Districts occur near the Project.

Recommendations

- If night-time construction activity or equipment maintenance is conducted during construction of the Project, all associated lighting should be shielded and, if large work lights are used, these must be placed on poles that are high enough to allow the lights to be pointed directly towards the ground.

- If exterior facility lighting is installed, it is recommended that the lights be manual, timed, or motion sensor configured and downward shielded to reduce the potential for causing interactions between nocturnally flying seabirds and man-made structures (Reed et al., 1985; Telfer et al., 1987).

- To avoid deleterious impacts to roosting bats, it is recommended that no woody vegetation taller than 4.6 m (15 ft) be removed between June 1 and September 15. Any fencing erected should not utilize strands of barbed wire.

Implementing the recommendations listed above, as appropriate for construction and/or operation phases of the proposed Project, will avoid or minimize adverse impacts to any and all flora and fauna of concern associated with the Project area.

Glossary

AECOS Inc. traditionally uses the following definitions for selected terms appearing in this report:

Area – General term for a usually imprecisely bounded place including the subject Project, the bounds typically more narrowly specified as, for examples, in "survey area" or "project area", the latter meaning more generally the location of the project.

Parcel – a specific tract of land defined by meets and bounds and assigned a Tax Map Key (TMK) number by the county.

Project – A defined development, typically called the "Project" after describing and thereafter used as a proper noun.

Site - The area of disturbance to be occupied by a project and may encompass a portion, one, or several parcels and shown outlined on a figure (Figure 2 in this report).

Vicinity – Area(s) outside the project site, usually in some sense adjacent to it or the project area.

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TABLE 21-3
MASTER USE TABLE

In the event of any conflict between the text of this Chapter and the following table, the text of the Chapter shall control. The following table is not intended to cover the Waikiki Special District; please refer to Table 21-9.6(A).

KEY			
	Ac	=	Special accessory use subject to standards in Article 5
	Cm	=	Conditional Use Permit-minor subject to standards in Article 5; no public hearing required (see Article 2 for exceptions)
	C	=	Conditional Use Permit-major subject to standards in Article 5; public hearing required
	P	=	Permitted Use
	P/c	=	Permitted use subject to standards in Article 5
	PRU	=	Plan Review Use

	ZONING DISTRICTS																				
USES (Note: Certain uses are defined in Article 10.)	P-2	AG-1	AG-2	Country	R-20, R-10	R-7.5, R-5, R-3.5	A-1	A-2	A-3	AMX-1	AMX-2	AMX-3	Resort	B-1	B-2	BMX-3	BMX-4	I-1	I-2	I-3	IMX-1
Schools: Elementary, intermediate and high			Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm		P	P	P	P				
Schools, language				P/c	P/c	P/c	P/c	P/c	P/c	P/c	P/c	P/c	P/c	P	P	P	P				
Schools, vocational, technical, industrial, trade																		P	P		P
Schools, vocational, which do not involve the operation of woodwork shops, machine shops or other similar features													P	P	P	P	P				P
Theaters													P	P	P	P	P				P[2]
Universities, colleges	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU
TRANSPORTATION AND PARKING																					
Airports	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU	PRU
Automobile service stations														Cm P	P	P	P	P	P		P
Car washing, mechanized														P/c	P/c	P/c	P/c	P/c	P/c		P/c
Commercial parking lots and garages										P/c[1]	P/c[1]	P/c[1]	P	P	P	P	P	P	P		P
Heliports																			P		
Helistops		C	C										C		C	C	C	C	P	P	C
Joint use of parking facilities				Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm
Off-site parking facilities				Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm
Truck terminals																			P	P	
UTILITIES AND COMMUNICATIONS																					
Antennas, broadcasting	Cm	Cm	Cm															C	C	C	C
Antennas, receive-only	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac
Broadcasting stations													P		P	P	P	P	P	P	P
Utility installations, Type A	P/c	P/c	P/c	P	P	P	P	P/c	P/c	P	P/c	P/c	P/c	P/c	P/c	P/c	P/c	P/c	P/c	P/c	P/c
Utility installations, Type B	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm	Cm
Wind machines Up to 100 kW		Cm Ac	Cm Ac	Cm Ac	Cm	Cm								Cm	Cm			Cm	Cm		Cm

KS Exhibit 22

GOV. MSG. NO. 1197

EXECUTIVE CHAMBERS
HONOLULU

DAVID Y. IGE
GOVERNOR

June 8, 2015

The Honorable Ronald D. Kouchi,
President
and Members of the Senate
Twenty-Eighth State Legislature
State Capitol, Room 409
Honolulu, Hawai'i 96813

The Honorable Joseph M. Souki,
Speaker and Members of the
House of Representatives
Twenty-Eighth State Legislature
State Capitol, Room 431
Honolulu, Hawai'i 96813

Dear President Kouchi, Speaker Souki, and Members of the Legislature:

This is to inform you that on June 8, 2015, the following bill was signed into law:

HB623 HD2 SD2 CD1	RELATING TO RENEWABLE STANDARDS **ACT 097 (15)**

Sincerely,

DAVID Y. IGE
Governor, State of Hawai'i

Approved by the Governor

on JUN 8 2015

ORIGINAL

ACT 097

HOUSE OF REPRESENTATIVES
TWENTY-EIGHTH LEGISLATURE, 2015
STATE OF HAWAII

H.B. NO. 623 H.D. 2 S.D. 2 C.D. 1

A BILL FOR AN ACT

RELATING TO RENEWABLE STANDARDS.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. The legislature finds that Hawaii's dependency on imported fuel drains the State's economy of billions of dollars each year. A stronger local economy depends on a transition away from imported fuels and toward renewable local resources that provide a secure source of affordable energy.

The legislature further finds that alternative energy technologies have advanced significantly in recent years, leading to an explosion of new markets, jobs, and local energy sources. Due to these and other advances, Hawaii is currently ahead of its timeline in reaching its goal of becoming forty per cent renewable by 2030.

The legislature also finds that Hawaii is in a period of energy transition, with many long-term agreements soon to be executed for new forms of imported fuels that may act as temporary "bridge" fuels until local sources of renewable energy can be developed.

The purpose of this Act is to update and extend Hawaii's clean energy initiative and renewable portfolio standards to ensure maximum long-term benefit to Hawaii's economy by setting a goal of one hundred per cent renewable by 2045; provided that extending the renewable portfolio standard goals and transition to energy independence beyond 2030 shall be undertaken in a manner that benefits Hawaii's economy and all electric customers, maintains customer affordability, and does not induce renewable energy developers to artificially increase the price of renewable energy in Hawaii. This target will ensure that Hawaii moves beyond its dependence on imported fuels and continues to grow a local renewable energy industry.

SECTION 2. Section 269-92, Hawaii Revised Statutes, is amended as follows:

1. By amending subsection (a) to read:

"(a) Each electric utility company that sells electricity for consumption in the State shall establish a renewable portfolio standard of:

(1) Ten per cent of its net electricity sales by December 31, 2010;

(2) Fifteen per cent of its net electricity sales by December 31, 2015;

(3) [~~Twenty-five~~] Thirty per cent of its net electricity sales by December 31, 2020; [~~and~~]

(4) Forty per cent of its net electricity sales by December 31, 2030[~~.~~];

(5) Seventy per cent of its net electricity sales by December 31, 2040; and

(6) One hundred per cent of its net electricity sales by December 31, 2045."

2. By amending subsection (d) to read:

"(d) Events or circumstances that are outside of an electric utility company's reasonable control may include, to the extent the event or circumstance could not be reasonably foreseen and ameliorated:

(1) Weather-related damage;

(2) Natural disasters;

(3) Mechanical or resource failure;

(4) Failure of renewable electrical energy producers to meet contractual obligations to the electric utility company;

(5) Labor strikes or lockouts;

(6) Actions of governmental authorities that adversely affect the generation, transmission, or distribution of renewable electrical energy under contract to an electric utility company;

(7) Inability to acquire sufficient renewable electrical energy due to lapsing of tax credits related to renewable energy development;

(8) Inability to obtain permits or land use approvals for renewable electrical energy projects;

(9) Inability to acquire sufficient cost-effective renewable electrical energy;

(10) Inability to acquire sufficient renewable electrical energy to meet the renewable portfolio standard goals beyond 2030 in a manner that is beneficial to Hawaii's economy in relation to comparable fossil fuel resources;

[~~(10)~~] (11) Substantial limitations, restrictions, or prohibitions on utility renewable electrical energy projects; and

[~~(11)~~] (12) Other events and circumstances of a similar nature."

SECTION 3. Section 269-95, Hawaii Revised Statutes, is amended to read as follows:

"**§269-95 Renewable portfolio standards study.** The public utilities commission shall:

(1) By December 31, 2007, develop and implement a utility ratemaking structure, which may include performance-based ratemaking, to provide incentives that encourage Hawaii's electric utility companies to use cost-effective renewable energy resources found in Hawaii to meet the renewable portfolio standards established in section 269-92, while allowing for deviation from the standards in the event that the standards cannot be met in a cost-effective manner or as a result of events or circumstances, such as described in section 269-92(d), beyond the control of the electric utility company that could not have been reasonably anticipated or ameliorated;

(2) Gather, review, and analyze empirical data to:

(A) Determine the extent to which any proposed utility ratemaking structure would impact electric utility companies' profit margins; and

(B) Ensure that the electric utility companies' opportunity to earn a fair rate of return is not diminished;

(3) Use funds from the public utilities special fund to contract with the Hawaii natural energy institute of the University of Hawaii to conduct independent studies to be reviewed by a panel of experts from entities such as the United States Department of Energy, National Renewable Energy Laboratory, Electric Power Research Institute, Hawaii electric utility companies, environmental groups, and other similar institutions with the required expertise. These studies shall include findings and recommendations regarding:

(A) The capability of Hawaii's electric utility companies to achieve renewable portfolio standards in a cost-effective manner and shall assess factors such as:

(i) The impact on consumer rates;

(ii) Utility system reliability and stability;

(iii) Costs and availability of appropriate renewable energy resources and technologies[~~;~~], including the impact of renewable portfolio standards, if any, on the energy prices offered by renewable energy developers;

(iv) Permitting approvals;

(v) Effects on the economy;

(vi) Balance of trade, culture, community, environment, land, and water;

(vii) Climate change policies;

(viii) Demographics; [~~and~~]

(ix) Cost of fossil fuel volatility; and

[~~(ix)~~] (x) Other factors deemed appropriate by the commission; and

(B) Projected renewable portfolio standards to be set five and ten years beyond the then current standards;

(4) Evaluate the renewable portfolio standards every five years, beginning in 2013, and may revise the standards based on the best information available at the time to determine if the standards established by section 269-92 remain effective and achievable; and

(5) Report its findings and revisions to the renewable portfolio standards, based on its own studies and

other information, to the legislature no later than twenty days before the convening of the regular session of 2014, and every five years thereafter."

SECTION 4. Statutory material to be repealed is bracketed and stricken. New statutory material is underscored.

SECTION 5. This Act shall take effect on July 1, 2015.

APPROVED this 8 day of JUN , 2015

GOVERNOR OF THE STATE OF HAWAII

Home » **Latest News**, **Newsroom**, **Press Releases** » PRESS RELEASE: Governor Ige signs bill setting 100 percent renewable energy goal in power sector

PRESS RELEASE: GOVERNOR IGE SIGNS BILL SETTING 100 PERCENT RENEWABLE ENERGY GOAL IN POWER SECTOR

Posted on Jun 8, 2015 in Latest News, Newsroom, Press Releases

HONOLULU – Gov. David Ige today signed into law four energy bills, including one that strengthens Hawaii's commitment to clean energy by directing the state's utilities to generate 100 percent of their electricity sales from renewable energy resources by 2045.

The bold step taken by the Hawai'i State Legislature in passing the landmark legislation (HB623 (http://www.capitol.hawaii.gov/session2015/bills/HB623_CD1_.pdf)) fulfills one of Ige's policy objectives by making Hawai'i the first state in the nation to set a 100 percent renewable portfolio standard (RPS) for the electricity sector.

"As the most oil dependent state in the nation, Hawai'i spends roughly $5 billion a year on foreign oil to meet its energy needs. Making the transition to renewable, indigenous resources for power generation will allow us to keep more of that money at home, thereby improving our economy, environment and energy security," Ige said. "I'd like to thank the senate and house energy committee chairs for championing HB623 and ensuring that Hawai'i remains a national leader in clean energy."

KS Exhibit 24

"Setting a 100 percent renewable portfolio standard will help drive investment in Hawai'i's growing clean energy sector," said Luis Salaveria, director of the Department of Business, Economic Development and Tourism. "Our commitment to clean energy has already attracted entrepreneurs and businesses from around the world, looking to develop, test and prove emerging technologies and strategies right here in Hawai'i."

"Raising the bar for renewable energy in Hawai'i will also push the state to stay out in front on innovation," said Mark Glick, administrator, State Energy Office. "We are finding ways to be innovative both with technical solutions and financing structures that will help us meet our ambitious renewable energy goals."

"Renewable energy projects are already producing cheaper power than new fossil fuel projects in Hawai'i, and it's only going to get cheaper as renewable technology advances, unlike fossil fuels which will only grow more expensive as they become more difficult to extract from a shrinking supply," added Rep. Chris Lee, Chair of the House Energy and Environmental Protection Committee. "The faster we move toward renewable energy the faster we can stop exporting billions from our local economy to import expensive fossil fuels."

Another measure signed by Ige (SB1050 (http://www.capitol.hawaii.gov/session2015/bills/SB1050_CD1_.pdf)) will help democratize renewable energy by creating a structure that will allow renters, condominium owners and others who have been largely shut out of Hawai'i's clean energy transformation, to purchase electricity generated at an off-site renewable energy facility, such as a large-scale solar farm.

The bill establishing a community-based renewable energy program will be particularly valuable on O'ahu where there is a high concentration of high-rise condominiums that lack sufficient roof space to support on-site solar panels. The law is also expected to provide relief to homeowners and businesses who are located on highly saturated circuits that cannot accommodate additional PV installations.

"As of March 2015, there are about 56,000 PV/Solar systems on rooftops. These folks are saving tremendously on their electricity bills. That's great, but what about the 44 percent of Hawai'i residents who don't own their homes? And those without roof space? SB 1050 allows people to form a hui, find a piece of land, and purchase or lease however many PV panels they want and then get a credit on their electricity bill for the energy they produce. We spend $3-5 billion annually buying fossil fuels; this is an awesome concept that will help keep some of that money here to help our economy," said Sen. Mike Gabbard, who co-authored the bill while serving as chair of the Energy and Environment Committee.

In addition to the 100 percent RPS and community-based renewable energy bills, Ige signed into law a measure that sets a net-zero energy goal for the University of Hawai'i System (HB1509 (http://www.capitol.hawaii.gov/session2015/bills/HB1509_CD1_.pdf)) and another that designates a state hydrogen implementation coordinator (HB1296 (http://www.capitol.hawaii.gov/session2015/bills/HB1296_CD1_.pdf)).

Photos on our Flickr account: https://www.flickr.com/gp/govhawaii/Y7QuY6

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KS -Waiawa

LUC Motion to Amend Service of Process Checklist

July 24, 2019

HAR § 15-15-94(a) requires service of a Motion to Amend to be made "on all parties to the boundary amendment proceeding in which the condition was imposed or in which the order was issued, and to any person that may have a property interest in the subject property as recorded in the county's real property tax records at the time the motion is filed."

On behalf of the Trustees of the Estate of Bernice Pauahi Bishop, dba Kamehameha Schools ("**KS**"), we filed a Motion to Amend with the State Land Use Commission on July 24, 2019 in LUC Docket A87-610. Under said Docket, in 1988, the Land Use Commission granted the reclassification of 1,395 acres of land from the Agricultural District to the Urban District (the "**Petition Area**"). KS owns the Petition area. In order to comply with HAR § 15-15-94(a), KS obtained title reports for the parcels within the Petition Area in order to determine the identify of any persons that may have a recorded property interest in any portion of the Petition Area, so that KS could serve such persons with copies of the Motion. The persons served are listed on the Certificate of Service that was filed with the LUC on July ___, 2019. This chart identifies the recorded encumbrances within the Petition Area. The 8 TMK Nos. are:

1. 9-4-006: 034 (aka Land Court Lot 16461), consisting of 1.165 acres. Title Report Order No. 4600061 dated 4/18/2014.
2. 9-4-006: 035 (Lot 16462), consisting of 2.564 acres. Title Report Order No. 4600062 dated 5/2/2014.
3. 9-4-006: 036 (Lot 16463), consisting of 21.345 acres. Title Report Order No. 4600066 dated 5/2/2014.
4. 9-4-006: 037 (Lot 16464), consisting of 36.330 acres (only a portion of Parcel 37 in Petition Area). Title Report Order No. 4600064 dated 4/18/2014.
5. 9-6-004: 024, consisting of 1,566.977 acres. Title Report Order No. 4600068 dated 5/2/2014.
6. 9-6-004: 025, consisting of 76.241 acres. Title Report Order No. 4600070 dated 5/2/2014.
7. 9-6-004: 026, consisting of 47.036 acres. Title Report Order No. 4600067 dated 5/2/2014.
8. 9-6-005: 003, consisting of 1,831.445 acres (only a portion in Petition Area). Title Report Order No. 4900786 dated 6/1/2015.

KS Exhibit 25

Tab	Document/Encumbrance for LUC Motion Service of Process Only	Affected TMK(s) Per Tittle Reports	Party or Parties to Serve
1	Declaration of Conditions Imposed by the LUC in Docket No. A87-610, recorded in Liber 22151 Page 250, filed July 19, 1988 as Land Court Document No. 1565292. As amended by Amendment to Declaration of Conditions Imposed by the Land Use Commission, recorded Nov. 10, 1992, Doc. No. 92-182606, Land Court Document No. 1969166. A new Declaration of Conditions Imposed by the State Land Use Commission was recorded January 21, 2015, as Document No. A-54991338.	<u>All</u>: 9-4-006: 034, 035, 036, and 037 9-6-004: 024, 025, and 026 9-6-005: 003	N/A This Declaration does not give anyone a recorded property interest in the Petition Area. However, under HAR §15-15-94(a), when filing a Motion to Amend with the LUC, the moving party must serve all parties to the original boundary amendment proceeding. Those parties were Tom Gentry and Gentry Pacific, Ltd. Tom Gentry, died in 1998. No service of Motion necessary. Gentry-Pacific, Ltd. Attn: Victoria Slovak 733 Bishop Street, Suite 1400 Honolulu, HI 96813
2, 3	Unilateral Agreement and Declaration for Conditional Zoning. KS as Fee Owner, and GIP, as Declarant, recorded Dec. 3, 1997 as Regular System Doc. No. 97-168626 and Land Court Doc. No. 2423720. The foregoing document was amended by Ordinance No. 98-69 and the Amendment to Unilateral Agreement and Declaration for Conditional Zoning recorded on Nov. 24, 1998 as Regular System Doc. No. 98-176077.	<u>All</u>: 9-4-006: 034, 035, 036, and 037 9-6-004: 024, 025, 026 9-6-005: 003	N/A GIP was the Declarant, due to holding the rights of the Buyer under the Agreement of Sale, Master Lease and Development Agreement. That agreement has been terminated and GIP has no rights as Declarant under this UA.

4	Unilateral Agreement and Declaration for Conditional Zoning re Ordinance No. 03-01. GIP, as Declarant, and KS as fee owner, recorded Jan. 28, 2003 as Regular System Doc. No. 2003-015986.	9-6-04: 024(por.)	N/A GIP was the Declarant, due to holding the rights of the Buyer under the Agreement of Sale, Master Lease and Development Agreement. That agreement has been terminated and GIP has no rights as Declarant under this UA.
5	Notice of Termination (and of Rights and Obligations that Survive Termination) and Quitclaim, between KS, GIP, and WRD.[1] Dated 1/1/09, recorded 8/25/09 as Regular System Doc. No. 2009-129931 and Land Court Doc. No. 3891022.	<u>All</u>: 9-4-006: 034, 035, 036, 037 9-6-004: 024, 025, 026 9-6-005: 003	N/A Per the 2012 Notice of Surrender, GIP terminated and surrendered all of its rights under the "Restated Agreement" thus, no rights should remain under this Notice of Termination.
6	Notice of Surrender, executed by WRD, GIP, and KS, recorded Aug. 31, 2012 as Regular System Doc. No. A-46260711 and Land Court Doc. No. T-8278443	<u>All</u>: 9-4-006: 034, 035, 036, 037 9-6-004: 024, 025, 026 9-6-005: 003	N/A Notice of Surrender surrendered and terminated all agreements, rights and obligations that survived termination of the Restated Agreement.
7	Deed and Agreement. WRD as Grantor. KS as Grantee. Additional Parties: GIP, Waiawa Development LLC, and A&B Waiawa, LLC. Recorded Aug. 31, 2012 as Regular System Doc. No. A-46260713A thru A-46260713B and Land Court Doc. No. T-8278445A thru T-827844B.	9-4-006: 035 9-6-004: 026	No service necessary. All rights in favor of KS.
8	Land Court Order No. 144521, recorded Jan. 10, 2002 noting KS' and GIP's petition for subdivision, and designating Easements 6373 and 6374.	9-4-006: 034, 035, 036, and 037	N/A Land Court Order does not give rights to any party.

[1] Waiawa Ridge Development LLC.

9, 10	The rights to all ground irrigation systems above the 650 foot elevation, including all ditches, siphons, dams, reservoirs, intake adits, pumps and pipelines conveyed to Waiahole Water Company, Ltd. as set forth in the Bill of Sale dated 6/10/1915, recorded as Book 426 Page 294. These rights were later conveyed to Waiahole Irrigation Company, Ltd, by Deed, Grant and Assignment, dated 9/18/70, recorded in Book 7213, Page 338.	9-6-004: 026 9-6-005: 003	Waiahole Irrigation Company, Ltd merged with AMFAC Land Company, Ltd.; AMFAC Land Company, Ltd. then merged with KLC Holding Corp. in 2002. KLC Holding Corp. Attn: Kaanapali Land, LLC 1100 Alakea Street, Suite 2100 Honolulu, HI 96813
11	Grant of Easement for underground communication cable and incidental purposes, in favor of USA, dated May 16, 1946, recorded as Book 2026 Page 182	9-6-004: 024 9-6-005: 003	USA U.S. Department of Justice 950 Pennsylvania Avenue, NW Washington, DC 20530-0001
12, 13	Grant of Easement for underground communication cable and incidental purposes, from KS in favor of USA, acting through the Secretary of the Army, dated Dec. 24, 1956, recorded as Book 3240 Page 149. Partially reconveyed to KS by Quitclaim Deed dated Sept. 30, 1965, recorded as Book 5173 Page 246.	9-6-004: 024 9-6-005: 003	USA U.S. Secretary of the Army Attn: John McHugh 1500 Army Pentagon Washington, D.C. 20310-1500 U.S. Department of Justice 950 Pennsylvania Avenue, NW Washington, DC 20530-0001
14, 15	Easement Tract WR-8 (5.29 acres), described in the Declaration of Taking, Civil No. 705, recorded as Book 1973 Page 206. Easement conveyed to the State of Hawai'i, BLNR by Quitclaim Deed recorded June 20, 1985 as Book 18721 Page 536.	9-6-004: 024 9-6-005: 003	State of Hawai'i, Board of Land and Natural Resources 1151 Punchbowl Street, Room 220 Honolulu, HI 96813

16	Grant of perpetual easement for utility and incidental purposes from KS to HECO,[2] dated 6/17/61, recorded as Book 4091 Page 428.	9-6-004: 024 9-6-005: 003	HECO Hawaiian Electric Company, Inc. Attn: Susan A. Li 900 Richards Street, Room 404 Honolulu, HI 96813
17	Grant of Easement Noy(R)-68088, from KS to of USA, acting through the Department of the Navy, for an infiltration tunnel to collect, take and remove water from the property, and incidental purposes, dated 10/11/65, recorded as Book 5192 Page 423.	9-6-004: 024	USA, Department of the Navy 1200 Navy Pentagon Washington, D.C. 20350-1200 U.S. Department of Justice 950 Pennsylvania Avenue, NW Washington, DC 20530-0001
18	Grant of Easement from Tom Gentry to State of Hawaii (DOT) for slope purposes for Highway, dated 2/18/90, recorded as Land Court Doc. No. 1708437.	9-4-006: 036 (Easement 4760 as shown on Map 731, L. C. App. 1000)	State of Hawai‘i, Department of Transportation Aliiaimoku Building 869 Punchbowl Street Honolulu, HI 96813
19	Any and all access rights in favor of the owners of TMK No. 9-6-004: 003 over and across the land herein described, to a public road, if any, which parcel is landlocked.	9-6-004: 024	The fee owners of Parcel 003 are the Dorothy Y. Yoshimura Trust and Yoshimasa I. Yoshimura Trust. 94-306 Kahualena Street Waipahu, HI 96797
20, 21	Grant of Easement from KS to HECO, dated 7/31/70, recorded at Book 7153 Page 358. Partial Cancellation of Easement, dated 6/18/97, recorded as Regular System document No. 97-089976.	9-6-004: 024	HECO Hawaiian Electric Company, Inc. Attn: Susan A. Li 900 Richards Street, Room 404 Honolulu, HI 96813

[2] Hawaiian Electric Company.

22	Grant of Easement (for slope maintenance) from KS in favor of City & County, dated 8/24/76 recorded as Book 13472 Page 230	9-6-004: 024	City & County of Honolulu Acting Corporation Counsel Paul S. Aoki, Corporation Counsel 530 S. King Street, Room 110 Honolulu, HI 96813
23	Grant of Easement (for water pipeline and incidental purposes), from KS to City & County and the Board of Water Supply, dated 2/14/83, recorded as Book 16964 Page 83.	9-6-004: 024	Board of Water Supply, City & County of Honolulu 630 S. Beretania Street, Honolulu, HI 96843
24	Grant of Easement (for utility purposes) from KS to HECO, dated 11/7/96, recorded as Regular System Doc. No. 96-175593.	9-6-004: 024	HECO Hawaiian Electric Company, Inc. Attn: Susan A. Li Hawaiian Electric Company, Inc. 900 Richards Street, Room 404 Honolulu, HI 96813
25	Lease No. 14,748, dated 12/2/64, from KS to Hawaiian Telephone Company (now Hawaiian Telcom, Inc.), and AT&T,[3] recorded as Book 5117 Page 381. 65-year lease beginning Sept. 1, 1964 and ending in 2029.	9-6-004: 024	Hawaiian Telcom, Inc. Attn: Gwen Massiah Legal Department 1177 Bishop Street Honolulu, HI 96813 AT&T Corp. Attn: The Corporation Company, Inc. 1136 Union Mall, Suite 301 Honolulu, HI 96813

[3] American Telephone and Telegraph Company; name changed to AT&T Corp. 4/20/1994

26	Lease of Easement No. 28,889, from KS to GTE Hawaiian Telephone Company Incorporated (now Hawaiian Telecom, Inc.) as lessee, dated 6/8/99, recorded as Doc. No. 99-102567. Amendment of Lease of Easement (nka Easement T-1), recorded as Doc. No. 2000-164469.	9-6-04: 024 9-6-005: 003	Hawaiian Telcom, Inc. Attn: Gwen Massiah Legal Department 1177 Bishop Street Honolulu, HI 96813
27, 10, 28	Grant of Easement in the ahupua'a of Waiawa for the construction and use of a tunnel, conduit, water course, shafts, etc. from KS in favor of Waiahole Water Company, Ltd., dated 1/1/1913, recorded at Book 388 Page 460. Waiahole Water Company, Ltd. conveyed these rights to Waiahole Irrigation Company, Ltd., by Deed, Grant and Assignment dated 9/18/70, recorded at Book 7213 Page 338. Waiahole Irrigation Company, Ltd. later assigned these rights to Agribusiness Development Company, Limited, an instrumentality of the State of Hawai'i, Department of Agriculture, by Quitclaim Assignment dated 7/9/99, recorded as Regular System Doc. No. 99-109934 and Land Court Doc. No. 2558831.	9-6-005: 003	Agribusiness Development Corporation State Office Tower 235 S. Beretania Street, Room 205 Honolulu, HI 96813
29	Grant of Easement for pole and wire lines, from KS to The Hawaiian Electric Company, Limited, dated 6/12/1962, recorded at Book 4406 Page 189.	9-6-005: 003	HECO
30	Supplemental Grants of Easement, from KS to Hawaiian Electric Company, Inc., dated 1/30/1979, recorded at Book 13673 Page 733.	9-6-005: 003	HECO

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAIʻI

In the Matter of the Petition of TOM GENTRY AND GENTRY-PACIFIC, LTD. To Amend the Agricultural Land Use District Boundary into the Urban Land Use District for Approximately 1,395 Acres at Waiawa, Ewa, Oahu, State of Hawaii, Tax Map Key Nos.: 9-4-06: Portion of 26; 9-6-04: Portion of 1 and Portion of 16; and 9-6-05: Portion of 1, Portion of 7 and Portion of 14	DOCKET NO. A87-610 CERTIFICATE OF SERVICE

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing document was served upon the parties listed below, at their respective addresses on this date, by the manner indicated below:

Mary Alice Evans, Director State of Hawaii, Office of Planning Leiopapa A Kamehameha Building 235 South Beretania Street, 6th Floor Honolulu, HI 96813	HAND-DELIVERED
Kathy K. Sokugawa, Director Department of Planning and Permitting City and County of Honolulu Frank F. Fasi Municipal Building 650 South King Street Honolulu, HI 96813	HAND-DELIVERED
Paul S. Aoki, Acting Corporation Counsel Department of the Corporation Counsel 530 South King Street, Room 110 Honolulu, HI 96813	HAND-DELIVERED

Clare E. Connors, Esq. Attorney General Dawn Takeuchi-Apuna, Esq. Deputy Attorney General Department of the Attorney General State of Hawaii 425 Queen Street Honolulu, HI 96813	HAND-DELIVERED
State of Hawai'i, Department of Transportation Aliiaimoku Building 869 Punchbowl Street Honolulu, HI 96813	HAND-DELIVERED
Land Division Board of Land and Natural Resources State of Hawai'i 1151 Punchbowl Street, Room 220 Honolulu, HI 96813	U.S. MAIL, POSTAGE PREPAID
Board of Water Supply, City & County of Honolulu 630 S. Beretania Street Honolulu, HI 96843	U.S. MAIL, POSTAGE PREPAID
Gentry-Pacific, Ltd. Attn: Victoria Slovak 733 Bishop Street, Suite 1400 Honolulu, HI 96813	U.S. MAIL, POSTAGE PREPAID
KLC Holding Corp. Attn: Kaanapali Land, LLC 1100 Alakea Street, Suite 2100 Honolulu, HI 96813	U.S. MAIL, POSTAGE PREPAID
U.S. Department of Justice 950 Pennsylvania Avenue, NW Washington, DC 20530-0001	U.S. MAIL, POSTAGE PREPAID
U.S. Secretary of the Army Attn: John McHugh 1500 Army Pentagon Washington, D.C. 20310-1500	U.S. MAIL, POSTAGE PREPAID

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Dated at Honolulu, Hawaii, July 24, 2019.

JENNIFER A. LIM
PUANANIONAONA P. THOENE

Attorney for Successor Petitioner
KAMEHAMEHA SCHOOLS