Draft Environmental Assessment for Photovoltaic Systems

Joint Base Pearl Harbor-Hickam,
Oahu, Hawaii

April 2015

COMMANDER NAVY REGION HAWAII

NAVFAC Naval Facilities Engineering Command PACIFIC DIVISION

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Joint Base Pearl Harbor-Hickam, Oahu, Hawaii

Prepared for:

Joint Base Pearl Harbor-Hickam

Prepared By:

Naval Facilities Engineering Command Pacific

April 2015

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COVER SHEET

Proposed Action: The Department of the Navy (DoN) proposes to lease approximately 380 acres of land at Joint Base Pearl Harbor-Hickam (JBPHH), Oahu, Hawaii to Hawaiian Electric (HE) for the construction, operation, and decommissioning of a 50 megawatt (MW) photovoltaic (PV) system.

Type of Document: Environmental Assessment (EA)

Lead Agency: U.S. Department of the Navy
Joint Base Pearl Harbor-Hickam

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This EA has been developed in accordance with the National Environmental Policy Act (NEPA) of 1969 codified in Title 42 of the United States Code (U.S.C.), Section (§) 4321 et seq.; Council on Environmental Quality (CEQ) procedures for implementing NEPA codified in Title 40 of the Code of Federal Regulations (CFR), Parts 1500-1508; Department of Defense (DoD) Directive 6050.1(D), titled *Environmental Effects in the United States of DoD Actions* (July 30, 1979); DoD Instruction 4715.9, titled *Environmental Planning and Analysis* (May 3, 1996); DoN procedures for implementing NEPA (32 CFR §775), and Office of the Chief of Naval Operations M-5090.1, titled *Environmental Readiness Program Manual* (January 10, 2014).

The PV system would be developed in two phases. Phase I would cover up to 169 acres and produce up to 20 MW of power, while Phase II would cover up to 211 acres and generate up to 30 MW of power. The electrical power generated by both phases of the project would be conveyed to HE's electrical grid for public use. The land for the PV site would be leased to HE for up to 37 years after which time the lease may be renewed or the facility could be decommissioned.

The proposed action would provide clean, renewable energy and would help decrease energy costs, reduce dependency on fossil fuel, and increase energy independence. The proposed action is not expected to have an adverse effect upon air quality; noise; topography and soils; water resources; biological resources; cultural resources; visual resources; land use; roadways; electrical and water utilities; and socioeconomic conditions. Consultations with the Hawaii State Historic Preservation Officer (SHPO), native Hawaiian Organizations, and interested parties are underway, and the SHPO is reviewing the DoN finding of "no historic properties affected" for the proposed action.

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List of Acronyms

ABCD	Advance Base Construction Depot
appr.	approximately
AC	alternating current
BESS	Battery Energy Storage System
BCS	Battery Container System
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CONUS	Continental United States
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DBEDT	Hawaii Department of Business, Economic Development, and Tourism
DC	direct current
DoD	U.S. Department of Defense
DoE	U.S. Department of Energy
DoN	U.S. Department of the Navy
EA	Environmental Assessment
EDP	Ewa Development Plan
EO	Executive Order
EPAct	Energy Policy Act of 2005
FPPA	Farmland Protection Policy Act
FY	fiscal year
GHG	greenhouse gas
GW	gigawatt
HE	Hawaiian Electric
HIA	Honolulu International Airport
JBPHH	Joint Base Pearl Harbor-Hickam
kV	kilovolt
LEED	Leadership in Energy and Environmental Design
MW	megawatt
NAVFAC	Naval Facilities Engineering Command
n.d.	not dated
NEPA	National Environmental Policy Act of 1969

NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
POC	point of connection
PV	photovoltaic
REPO	Renewable Energy Program Office
SCADA	supervisory communications and data acquisition
SHPO	State of Hawaii Historic Preservation Office
SECNAV	Secretary of the Navy
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service

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Chapter 1 Purpose and Need for the Proposed Action

1.1 Introduction

The U.S. Department of the Navy (DoN) has prepared this Environmental Assessment (EA) to evaluate the potential environmental effects of the construction, operation, and decommissioning of a ground-mounted, solar photovoltaic (PV) system at Joint Base Pearl Harbor-Hickam (JBPHH), Oahu, Hawaii.

The DoN proposes to lease approximately 380 acres of land to Hawaiian Electric (HE), the local electric utility company, who would engage renewable energy contractors to build and operate the solar PV system. HE is exploring the feasibility of operating the leased parcel as a community shared solar program which would allow HE's individual customers to directly invest in, and receive benefits from, construction and operation of a commercial-scale PV facility. The PV system would utilize solar panels and electrical equipment to convert sunlight into electrical energy and feed into HE's electrical grid for Oahu. The land underlying the PV site would be leased to HE for 37 years after which time the lease may be renewed or the facility could be decommissioned.

This EA has been developed in accordance with the National Environmental Policy Act (NEPA) of 1969 codified in Title 42 of the United States Code (U.S.C.), Section (§) 4321 et seq.; Council on Environmental Quality (CEQ) procedures for implementing NEPA codified in Title 40 of the Code of Federal Regulations (CFR), Parts 1500-1508; Department of Defense (DoD) Directive 6050.1(D), titled *Environmental Effects in the United States of DoD Actions* (July 30, 1979); DoD Instruction 4715.9, titled *Environmental Planning and Analysis* (May 3, 1996); DoN procedures for implementing NEPA (32 CFR §775), and Office of the Chief of Naval Operations M-5090.1, titled *Environmental Readiness Program Manual* (January 10, 2014).

The DoN is the lead agency for the Proposed Action, and JBPHH is the action proponent.

1.2 Background

The DoN's energy strategy is centered on energy security, energy efficiency, and sustainability while remaining the pre-eminent maritime power.

- Energy efficiency increases mission effectiveness. Efficiency improvements minimize operational risks while saving time, money, and lives.
- Energy security is critical to mission success. Energy security safeguards our energy infrastructure and shields the DoN from a volatile energy supply.
- Sustainable energy efforts protect mission capabilities. Investment in environmentally responsible technologies afloat and ashore reduces greenhouse gas (GHG) emissions and lessens dependence on fossil fuels (DoN, 2012).

In October 2009, the Secretary of the Navy (SECNAV) established renewable energy goals for the DoN's shore-based installations to meet by 2015. These goals include:

1. The DoN will produce or procure at least 50 percent of the total quantity of electric energy consumed by shore-based facilities and activities each fiscal year (FY) from alternative energy sources;

2. 50 percent of DoN installations will be net zero (i.e., over the course of a FY, an installation matches or exceeds the electrical energy it consumes ashore with electrical energy generated from alternative energy sources) (DoN, 2011).

The DoN's goals and energy strategy are in sync with renewable energy policies being developed throughout the Federal Government and contained in the following executive order and statutes:

- Executive Order (EO) 13514, Federal Leadership in Environmental, Energy, and Economic Performance (2009): This EO requires federal agencies to set percentage reduction targets for GHG emissions for FY 2020. Agencies are instructed to consider measures for the targets by increasing energy efficiency, reducing use of fossil fuels, and increasing use of renewable energy and implementing renewable energy generation projects on agency property.

- Energy Policy Act of 2005 (EPAct) (42 U.S.C. 15852): Section 203 of the EPAct requires that the federal government consume not less than 7.5 percent of its electricity from renewable sources after FY 2013.

- Title 10 U.S.C. 2911(e): This statute requires the submission of an energy performance master plan and performance goals, including the goal to produce or procure 25 percent of the total quantity of energy consumed within its facilities from renewable sources by 2025 and each FY thereafter.

In December 2013, President Obama signed a presidential memorandum that requires federal agencies to produce or procure from renewable sources 20 percent of electricity consumed by facilities by FY 2020 and each FY thereafter, an amount that represents a more aggressive goal than under the EPAct or 10 U.S.C. 2911(e). The memorandum also establishes interim goals of 10 percent by 2015, 15 percent by 2016, and 17.5 percent by 2018. The memorandum states that the renewable energy consumption target be achieved by: 1) installing agency-funded renewable energy on-site at federal facilities, or 2) contracting for energy that includes the installation of a renewable energy project on-site at a federal facility. The memorandum implements the goal outlined by President Obama in the June 2013 Climate Action Plan. As part of this effort, agencies are instructed "to consider opportunities to the extent economically feasible and technically practical, to install or contract for energy installed on current or formerly contaminated lands, landfills, and mine sites." The DoD is currently working with the CEQ, the U.S. Office of Management and Budget, and the Department of Energy (DoE) to provide guidance on the 20-percent renewable energy goal under the presidential memorandum (DoD, 2014).

In support of the EPAct and 10 U.S.C. 2911(e) renewable energy goals, SECNAV created the 1 Gigawatt (GW) Initiative—named for the amount of renewable energy generation capacity to be deployed in 2015 (DoN, 2012), either on or near DoN installations. This goal was initially stated in the President's 2012 State of the Union Address and is consistent with SECNAVs 2009 alternative energy goal and the 2013 presidential memorandum.

With the 1 GW Initiative, the DoN took a more aggressive approach to implement cost-effective and mission-compatible projects at its shore facilities. To achieve 1 GW of renewable energy generation capacity in 2015, the DoN recognized the need to develop opportunities for large-scale projects that would be attractive to local commercial utilities. The DoN established the Renewable Energy Program Office (REPO) specifically to work with local commercial utilities to use private-sector funds to construct renewable energy facilities on DoN land. The DoN established three Regional Program Offices to implement the projects at shore facilities across the country and abroad, including the Naval Facilities Engineering Command (NAVFAC) Pacific Office.

1.3 Purpose and Need

The purpose of the proposed action is to reduce energy costs and fuel oil dependency, and increase the energy security, operational capability, strategic flexibility and resource availability of DoN installations through the development of renewable energy generating assets on JBPHH. The proposed action is required to meet the renewable energy standards put forth by the 1 GW Initiative, EPAct, 10 U.S.C. 2911(e), the 2013 presidential memorandum, and SECNAV, to include the requirement to produce 50 percent of the DoN's shore-based energy requirements from alternative sources.

1.4 Project Location

JBPHH encompasses approximately (appr.) 28,000 acres of land and water, and includes significant land holdings at the main base, West Loch Annex, Pearl City Peninsula, Waipio Peninsula, and other outlying areas. In 2010, Naval Station Pearl Harbor joined with Hickam Air Force Base to become JBPHH combining the two bases into a single joint installation to support both Air Force and DoN missions in the Pacific. JBPHH serves as the home base for U.S. Air Force air wings and DoN surface ship and submarine squadrons, and is a regional maintenance center for ships and submarines. The main base is host to Commander U.S. Pacific Fleet and the Headquarters Pacific Air Forces. In addition there are over 100 tenant commands that support the DoN, Air Force, and other missions in Hawaii and the Pacific.

The solar PV system would be located at the West Loch Annex on approximately 380 acres of land in the Ewa district of south-central Oahu (Figure 1-1). The PV site is partially vacant and partially under agricultural use and proximate to public roads and utilities. Access to the PV site would be provided by Fort Weaver Road, a divided four-lane State highway, and Iroquois Road, a two-lane County roadway. The PV site is bordered by farmland on the north, and a DoN munitions storage area on the east. Land uses to the south and west of the PV site are characterized by large residential communities (Iroquois Point, Ewa Beach, Ewa Gentry, Ewa Villages) and various parks, schools, golf courses, and shopping centers.

1.5 Scope of the EA

This EA evaluates the reasonably foreseeable potential environmental effects of the DoN's plan to construct, operate, and decommission the proposed West Loch PV system and associated facilities. The project site was previously part of a potential 685-acre PV system at West Loch that was fully analyzed in an EA/FONSI published in 2013 but was not proposed for development (DoN, May 2013).

Resource areas that could be potentially affected by the Proposed Action include the following.

- Air Quality
- Noise
- Topography and Soils
- Water Resources
- Biological Resources
- Cultural Resources
- Visual Resources
- Glint and Glare Effects
- Utilities
- Land Use
- Socioeconomic Conditions

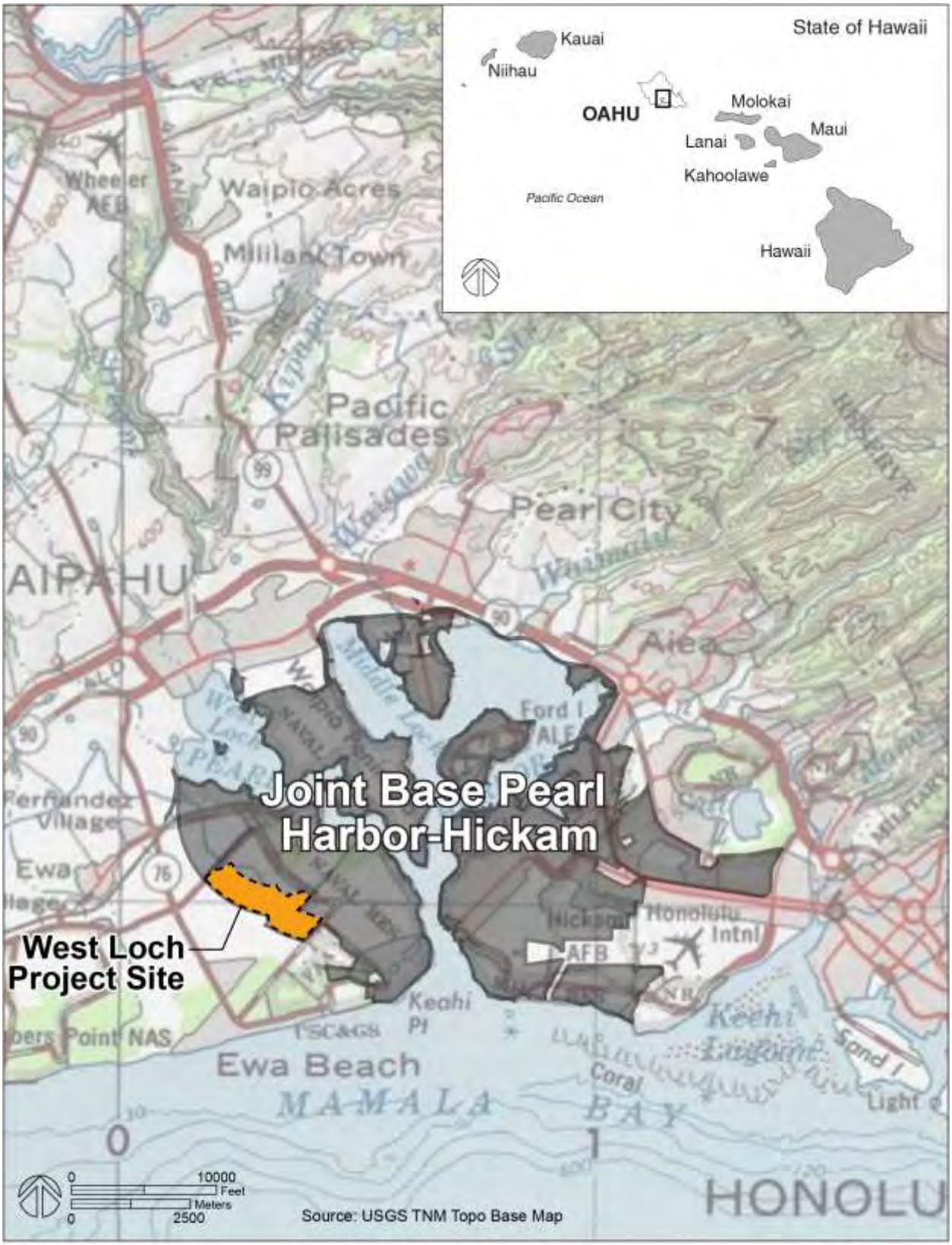
1.6 Agency Coordination and Permit Requirements

As part of the NEPA compliance process, the DoN has engaged in coordination, consultation, and permitting with regulatory agencies to ensure that all applicable laws, rules, regulations, and policies have been satisfied with respect to the proposed action. Table 1-1 summarizes the permits and consultation processes required for the proposed action.

Table 1-1: Agency Coordination and Permit Requirements

Permit or Consultation	Agency/Stakeholders
National Historic Preservation Act Section 106 Consultation	State of Hawaii Historic Preservation Officer, Advisory Council on Historic Preservation, Native Hawaiian organizations, interested parties
National Pollutant Discharge Elimination System (NPDES) Permit	Hawaii Department of Health, State of Hawaii
Coastal Zone Management Act (CZMA) *De minimis* acknowledgment	Coastal Zone Management (CZM) Program, State of Hawaii

In accordance with DoD and DoN policies and instructions for implementing NEPA, comments from the public will be solicited for the Draft EA. Copies of the Draft EA will be provided to public libraries on Oahu and will be available over the Internet. A Notice of Availability of the Draft EA will be published in local newspapers of general distribution and in the *Environmental Notice*, the bi-monthly publication of the State of Hawaii, Office of Environmental Quality Control. All comments received during the Draft EA comment period will be fully considered by the DoN prior to rendering a decision on the Proposed Action.



Regional Location Map
Environmental Assessment for PV Systems
JBPHH, Oahu, Hawaii

Figure 1-1

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Chapter 2 Proposed Action and Alternatives

The DoN established REPO to spearhead its efforts to secure 1 GW of renewable energy generation capacity by 2015. In July 2014, REPO asked DoN regions and installations to identify suitable sites on DoN-owned land that could support a renewable energy facility of 10 megawatts (MW) or more. For a solar PV facility, a 10 MW system is considered a utility-scale project which would typically require about 50 acres of land (appr. five acres per MW). The availability of suitable DoN land for the development of a utility-scale solar PV system on Oahu is very limited. Due to the efforts of JBPHH, REPO and NAVFAC personnel, an appropriate location for a utility-scale solar PV system was identified on DoN property at the West Loch Annex.

2.1 Proposed Action

2.1.1 Overview of the Proposed Action

JBPHH proposes to lease approximately 380 acres of DoN land to HE for the construction and operation of a solar PV system at West Loch. The PV system would be developed in two phases with Phase I covering approximately 169 acres and producing up to 20 MW of electric power and Phase II covering the remaining acreage (appr. 211 acres) and generating approximately an additional 30 MW of power. The electricity generated by both phases of the West Loch PV system would be conveyed to HE's electrical grid for public use. The proposed 20 MW of power generated from Phase I could be accommodated by HE's existing 46 kilovolt (kV) overhead transmission line that runs adjacent to the proposed action site along Iroquois Road and the west boundary of the site. The additional 30MW of power generation proposed for Phase II would require substantial upgrades to HE's transmission infrastructure.

2.1.2 Solar PV Technology

Solar PV technology converts solar radiation (sunlight) into an electrical current by means of photovoltaics. Solar PV systems generate direct current (DC) electricity, which is converted to alternating current (AC) for transmission on the electrical grid and ultimate end-use in AC form. The conversion from DC to AC occurs at inverters mounted on concrete pads located strategically throughout the PV array. Each inverter would have its own medium voltage transformer, and the medium voltage power output from each of these inverter/transformer locations would be carried through electrical cables to the projects substation. The system typically includes some form of battery energy storage system (BESS) to provide dispatchable energy to balance fluctuations caused by weather, seasons, and nighttime darkness. BESS represents a method of energy storage where the storage needs are met through the connection of large scale battery systems. Battery technology is advancing rapidly, and several types of batteries are now commercially available for BESS application. Lead-acid, sodium sulfur, and lithium-ion batteries represent the more robust technologies available, however, the specific battery technology used for the proposed system would be decided during the project design process. Batteries are typically housed entirely within a battery container system (BCS), and multiple BCS would be located within the BESS main building, adjacent to the projects substation. Once all electricity is collected, the power is then transferred via a transmission line from the project substation to the nearest point of connection (POC) to the utility grid.

2.1.3 Description of the Proposed Action

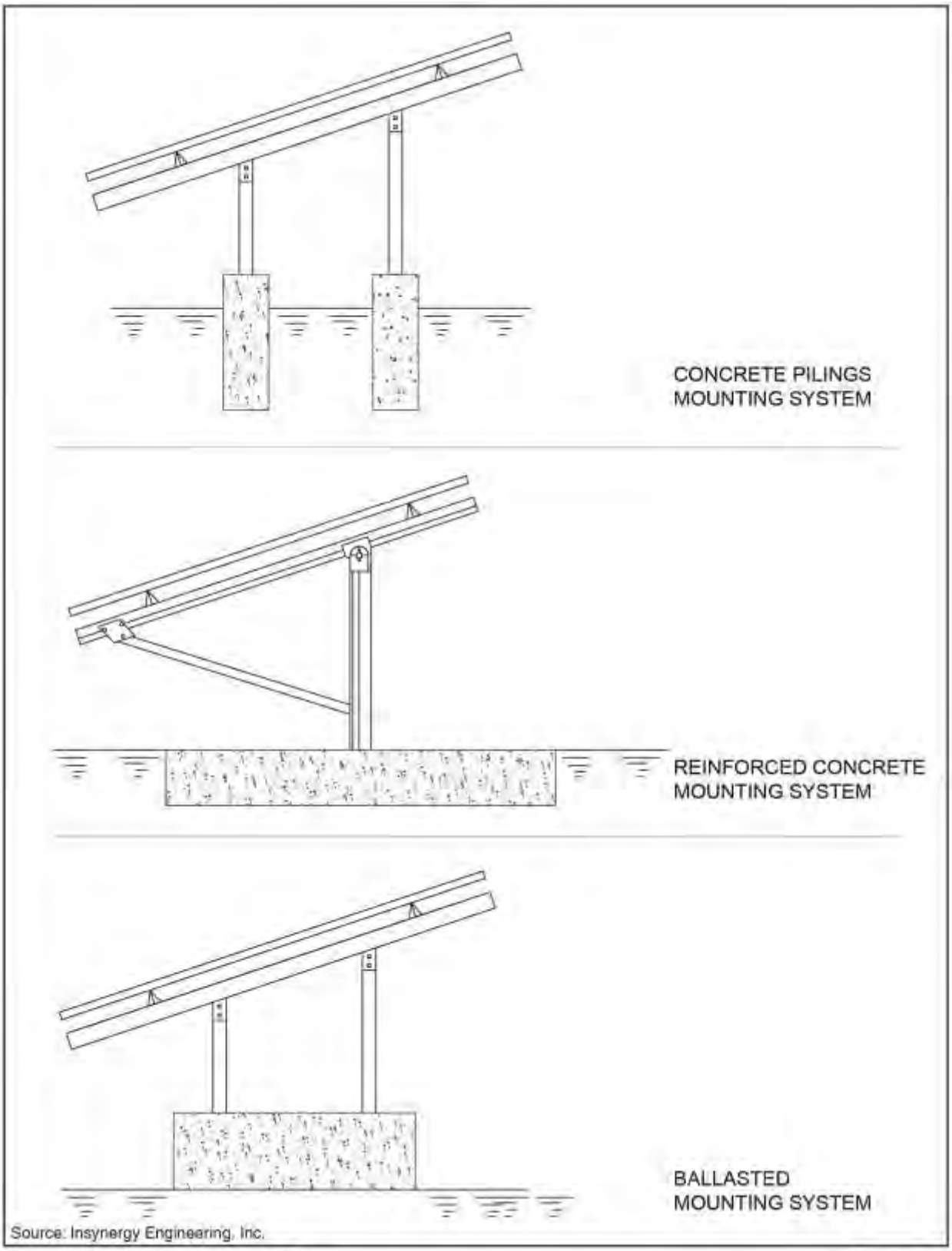
The proposed action involves the construction of a solar PV system at West Loch. A description of the project characteristics follows below.

Glass-cased PV panels would be used for the PV array. The panels would be darkly colored to minimize light reflection and would be approximately 3.5 feet wide and five feet long. The PV panels would be attached to metal racking structures before being placed upon foundations. The type of racking structure (stationary versus adjustable) would be determined by HE's PV contractor during the final engineering design. A stationary racking structure is one in which the PV panels are attached to a fixed assembly which locks the tilt and orientation of the panels. The optimal tilt for a stationary racking structure in Honolulu is 21.3 degrees pointing due south. To maximize density and accommodate the shape and topography of the site, the PV arrays may be oriented in the south-easterly direction. The actual tilt and orientation of the panels would be established during the final design. An adjustable racking structure is one in which the panels are attached to solar tracking assembly which allows the panels to follow the path of the sun throughout the day in a vertical and/or horizontal direction – which increases the efficiency of the system but also increases cost. The installed top edge height of the ground-mounted PV panels (regardless of the racking structure) is projected to be approximately four feet above ground level.

Foundations constructed of concrete pilings, poured reinforced concrete, or concrete ballasted systems would be used to support the racking structures (Figure 2-1). The racking structures would be designed to comply with all applicable wind load criteria. Where possible, the racking structures would adapt to ground contours to minimize site work and ground disturbance. The racking systems would also be designed to facilitate the efficient placement, replacement, maintenance, and cleaning of the PV panels.

Electrical cabling would be used to connect the individual PV modules and the larger electrical system. Where practical, cabling would be placed in trays above ground. In the event cable routing requires underground installation, cables (in conduits) would be buried directly in excavations of minimal cross section with a required depth per UFC and NFPA 70 (typically 36 inches below grade). The conduit would then be covered with backfill and tamped to the appropriate level of compaction. Where conduit would cross under on-site service roads, concrete encasement would be used around conduits for mechanical protection against vehicular traffic.

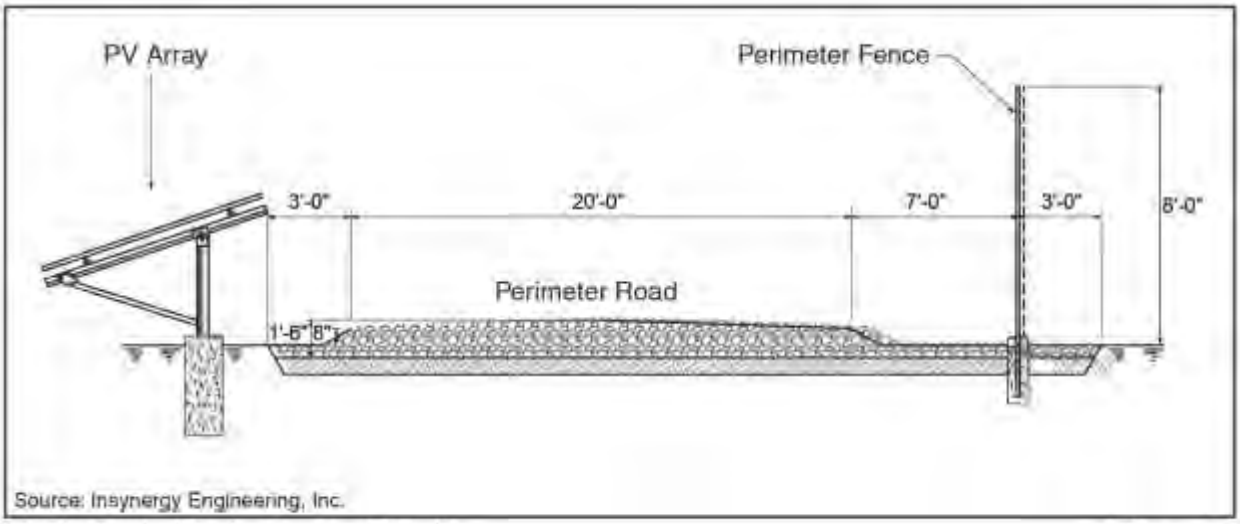
The construction of several electrical system components would require concrete slab foundations. The inverter/transformer stations located throughout the PV array would be pad mounted on concrete foundations and determined during final engineering design. For efficiency purposes, a substation complex would be located nearest to the POC for each phase. Each substation complex would include its own transformers as well as switchgear, a BESS facility, and a maintenance building, all of which would require concrete foundations. Prefabricated buildings would likely be used to house some of this equipment (i.e., maintenance building and BESS facility). A microwave communications tower would be required to connect the sites supervisory control and data acquisition (SCADA) system to the HE control center, therefore, no full time on-site personnel would be required for the proposed PV system. This communications tower would not exceed 75 feet.



Ground Mount PV Foundation Types **Figure 2-1**

For Phase I, the substation complex would be located adjacent to the POC to HE's 46kV overhead transmission line on the northwest side of the site. For Phase II, the substation complex would be located along the southwest boundary of the site, adjacent to the POC at HE's 46kV transmission line (Figure 2-4). The operations building would be designed and sized based on what is appropriate for the project. The substation complexes would serve as the operations and maintenance hubs for the PV system, but they would cover only a small percentage (appr. 2.2%) of the project site's land area. The Phase I substation is expected to cover approximately five acres, and the Phase II substation is expected to cover approximately 3.5 acres. Meanwhile the PV array is expected to cover around 350 acres, and the remaining site area would be required for the maintenance road and other site improvements (Figure 2-4).

The PV site would be contained within an eight-foot-high perimeter fence to restrict access and ensure security. The PV arrays would occupy most of the space within the fenced enclosure. A perimeter maintenance road would be located directly inside of the security fence, and would generally be 20 feet wide (Figure 2-2). Access roads within the array would typically be 10 feet wide. All roads would be constructed per final design but likely would consist of a gravel or similar base that would be trucked on site.



PV Site Typical Perimeter Road Detail **Figure 2-2**

2.1.4 Site Preparation and Construction Activities

During site preparation, surface vegetation in the areas to be developed would be cleared and grubbed (i.e., roots and stumps extracted), and the ground would be excavated and compacted where load-bearing foundations are proposed. Ground disturbance during construction would include the installation of the PV racking system and foundations, trenching for underground electrical cables, installation of overhead transmission line poles, foundation work for electrical equipment and site buildings, and miscellaneous civil works (i.e., perimeter fencing post holes and access roads). BMPs for soil erosion and sedimentation control would be implemented in accordance with a project-specific drainage and erosion control plans which would comply with applicable NPDES requirements for construction-related activities.

During construction, materials would be transported to the project sites by truck, where they would be stored, assembled (as necessary), and moved into place. Temporary construction laydown areas for materials, equipment, and parking would be provided on each site or on adjacent DoN property. Prior to construction, site boundaries or limits of disturbance would be surveyed and staked to identify areas where construction activities would occur. Dust barriers would be erected around active construction areas to minimize the effects of fugitive dust on adjacent land uses in the area.

2.1.5 PV Substations and Interconnections

The proposed substations at the project sites are where power is transformed to match the specification for interconnection with HE's electrical grid. An electrical transmission line would be installed to connect the project substations to HE's electrical system.

Phase I would connect directly to HE's existing 46kV overhead transmission line along Iroquois Road. Phase II would connect to the same transmission line route, but further to the south adjacent to the Phase II substation. However, because the energy generation from Phase II will exceed the capacity of the existing 46kV transmission line, this phase would require transmission line upgrades from the Phase II POC back to HE's Ewa Nui Substation (appr. four miles north). These upgrades would be accommodated within HE rights-of-way, and would include either additional transmission lines on existing poles, and/or the installation of new transmission lines and poles.

2.1.6 Operation and Maintenance

The solar PV system would require minimal maintenance. Cleaning with hand tools or spray washing the surfaces of the PV panels with water would be undertaken periodically to remove accumulated dust and dirt. Water trucks could also be used for cleaning purposes.

Periodic maintenance of the PV system electrical equipment would involve checking the equipment and testing the connections, replacing air filters in the inverters, and sampling the oil in the transformers. Maintenance for the BESS facility would involve checking the batteries and electrical equipment and testing the connections.

Surface vegetation lying beneath, and adjacent to the panels, would be regularly trimmed to ensure that grass, plants, and weeds do not overhang or cast shadows upon the panels. As warranted, herbicides would be used for vegetation control in accordance with applicable government regulations and manufacturers guidelines. Maintenance roads would be maintained as needed to ensure that vehicular access and mobility are maintained.

2.1.7 Lease Agreement

The land underlying each solar PV site would be leased to HE for up to 37 years including renewal options. HE would engage renewable energy contractors to construct and operate the solar PV system. HE is exploring the feasibility of operating the leased parcel as a community shared solar program which would allow HE's individual customers to directly invest in, and receive benefits from, construction and operation of a commercial-scale PV facility. After the expiration of the lease, the lease may be renewed or the facility could be decommissioned. As a statutory requirement of the lease agreement, the Navy would receive in-kind consideration for the leased property. It is intended that this consideration would address the energy security at JBPHH through surveys, studies, repair, replacement, or upgrades (or a

combination thereof) of the existing electrical distribution systems; distribution system controls to provide JBPHH with direct access to the renewable generation asset; or other energy conservation measures and maintenance to existing infrastructure at JBPHH. While the specific scope of the in-kind consideration would be determined through lease negotiation, it is anticipated that these activities would occur within the existing infrastructure or distribution system footprints. However, once the specific considerations are identified, a new review process under Section 106 of the National Historic Preservation Act would be undertaken to consider the effect the in-kind considerations could have on historic properties.

2.1.8 Removal of Equipment

If decommissioning is required, HE would prepare a plan to decommission the PV system and supporting infrastructure. The plan would be prepared in accordance with DoN requirements and would ensure that the closure of the site would be conducted in accordance with conditions established in the lease.

In general, the decommissioning process would involve compliance with mutually agreed upon conditions for the removal of structures, restoration of topsoil, and the re-vegetation of the site. Best management practices (BMPs) would be used during the decommissioning phase to control soil erosion, sedimentation, and storm water runoff.

2.2 Alternatives Considered but Dismissed

As indicated in its *Strategy for Renewable Energy* (DoN, October 2012), the Navy will consider all sources of renewable energy to attain its goal of procuring 1 GW of renewable energy capacity in 2015.

Renewable energy can be described as energy that comes from sources which are naturally replenished on a human timescale such as sunlight, wind, geothermal heat, and ocean waves, tides, and currents. Because some renewable energy technologies may be appropriate for some locations, while others may not be well suited, each Navy installation and region must prepare an energy plan to evaluate which technology is most appropriate and cost-effective for their particular area.

Given Hawaii's remote location and its dependence on fossil fuels, it was imperative that the Navy find an appropriate, long-term renewable energy source that would be efficient, dependable, and cost-effective. The following renewable energy technologies were considered by the DoN but were subsequently dismissed.

2.2.1 Wind Energy

Wind-based power generation is a mature technology that uses airflows to run wind turbines and drive electrical generators. As the wind speed rises, power output increases up to the maximum capacity of the turbine. Areas with strong and constant winds such as offshore and high altitude locations are preferred sites for wind farms. Land-based wind farms can pose challenges for DoN installations since the height of the turbines can interfere with military/commercial aircraft operations and affect military radar systems. Additionally, DoN installations on Oahu are generally located in coastal plain areas on the leeward side of the island and do not experience the wind power density required to warrant wind energy development.

2.2.2 Geothermal Energy

Geothermal energy is generated by natural heat stored in the Earth. The temperature difference between the Earth's core and its surface drives a continuous conductive process where molten rock (magma) inside the Earth heats rock and water to produce geothermal heat. The heat produced by a geothermal source is used to generate electric power via heat exchangers and turbines. Where available, geothermal sources would produce full-time baseload power unlike the intermittent energy provided by solar and wind. Sufficient geothermal energy resources have yet to be found near Oahu, and it is not currently a feasible alternative for renewable energy development.

2.2.3 Ocean Energy

Sometimes referred to as marine energy, this renewable energy source is created by ocean waves and currents. The global movement of ocean water creates a vast store of kinetic energy which can be harnessed to generate electric power. Ocean energy conversion is a fledgling technology which is still in its infancy. The DoN recently selected a private developer to test its wave-to-energy technology in in the Pacific Ocean outside Kaneohe Bay, Oahu for at least 12 months beginning in the second half of 2016. While ocean energy conversion may provide a future source of renewable energy generation, it currently is not feasible for the large scale development that is required to meet the DoN's renewable energy goals.

2.3 No Action Alternative

In accordance with NEPA and CEQ regulations, the No Action Alternative and any associated potential impacts, must be taken into account and evaluated. Although the No Action Alternative does not address the DoN's purpose and need, the inclusion of this alternative is prescribed by CEQ regulations and is brought forward and analyzed in this EA. The No Action alternative also serves as a baseline against which the impacts of the proposed action can be measured and evaluated.

Under the No Action Alternative, the development and use of the solar PV system at West Loch would not occur. Thus, the various near-term federal statutes and EOs that mandate changes in energy consumption and production would not be addressed as the No Action Alternative would not increase renewable energy production or use. The No Action Alternative does not address the DoN's strategy for renewable energy nor would it meet the purpose and need of the proposed action as described in Section 1.2 and Section 1.3 of this document.

2.4 Comparison of Environmental Consequences of the Alternatives

The effect the proposed action and no action alternative will have on various facets of the natural and man-made environment is summarized in Table 2-1. Potential impacts associated with the construction period and operational phase are covered separately when warranted.

Table 2-1 Summary of Potential Impacts to Resource Areas

Resource	Proposed Action	No Action
Air Quality	Construction: Temporary effects from fugitive dust and soil erosion. Operations: Vehicular emissions from occasional trips to the PV sites for system maintenance will have a minimal, temporary effect.	No impact.
Climate Change	Construction: Slight increase in GHG emissions due to use of construction equipment, machinery and vehicles. Operations: Decrease in GHG emissions due to reduction of fossil fuel used to produce electricity.	No reduction in fossil fuel use and GHG emissions would be realized under this alternative.
Noise	Construction: Temporary increase in ambient noise from activities, equipment, machinery and vehicles. Operations: Minimal noise from cooling fans and transformers.	No impact.
Topography and Soils	Construction: Temporary effects from fugitive dust and soil erosion and sedimentation. Operations: No significant impact.	No impact.
Water Resources	Construction: Hazardous materials (coolants, fluids, oils) from equipment, machinery, and vehicles could contaminate groundwater. Operations: The unmanned PV systems would only require water for fire protection and periodic cleaning of PV panels.	No impact.
Drainage	Construction: Introduction of impervious surfaces will alter existing drainage conditions and could increase stormwater runoff potential. Operations: No significant impact.	No impact.
Biological Resources	Construction: No trees taller than 15 feet will be trimmed or removed during the Hawaiian hoary bat's pupping season which occurs between June 1 and September 15 because non-volant juvenile bats (bats that cannot fly) may be roosting in the trees. Should nests of any MBTA species be found in areas where PV arrays are planned, the installation of equipment at that location will be delayed until after the nest fledges or naturally fails on its own accord.	No impact.

Resource	Proposed Action	No Action
Biological Resources (cont.)	Operations: Shaded areas below the PV panels could shelter feral animals. Birds could strike the panels if they mistake them for a body of water and try to land on them. PV arrays could displace migratory birds that use the PV sites for foraging. Seabirds could be disoriented by outdoor lighting.	
Cultural Resources	Construction: Archival research was conducted for the project area and no cultural resources were identified through that process. Archaeological inventory-level surveys and subsurface testing of the project site did not locate any cultural deposits or materials that are eligible for listing on the National Register of Historic Places (NRHP). No further archaeological work was recommended. Per Section 106 of the NHPA, the Navy has made a determination of "no historic properties affected." Operations: No significant impact (no historic properties affected).	No impact.
Visual Resources	Construction: The PV system would be visible from adjacent roads and properties. The Phase I substation would visible from Iroquois Road, while the Phase II substation would not be visible from roadways due to its remote location. The new transmission lines would blend in with the existing lines in the area. Operations: The PV site is 3.25 miles south of the H-1 Freeway. Due to its relatively low profile and distance from elevated public viewpoints (i.e., H-1 Freeway), the proposed action would not significantly impact regional views from the surrounding community.	No impact.
Glint and Glare	Construction and Operations: A glare hazard analysis reveals that the PV site will not create any adverse glint/glare effects for aircraft or residents in the surrounding area.	No impact.
Hazardous Materials	Construction: Undetected hazardous materials may be present at the PV sites; however, any unanticipated materials would be disposed in accordance with all applicable regulations. Operations: Potential exposure to hazardous materials could occur if inverters or transformers are broken and BESS components could pose a fire hazard. The project will utilize BMPs to minimize the exposure risk in accordance with all applicable regulations.	No impact.

Resource	Proposed Action	No Action
Land Use	Construction: Construction-related activities could have short-term, minor effects on surrounding land uses due to noise; however, these impacts would cease upon completion of construction. Operations: Use of DoD property for the PV systems would preclude other land uses during the term of the lease agreement (up to 37 years unless the lease is extended).	No impact.
Roadways	Construction: Vehicle trips by construction workers; deliveries of PV system components; and disposal of construction waste materials would have a short-term, non-significant effect on traffic. Operations: The PV systems will be unmanned facilities and would not generate consistent vehicle trips. Occasional vehicle trips to the PV sites for system maintenance will have little effect on traffic.	No impact.
Potable Water	Construction: Temporary construction-related impacts for the installation of new water lines; however, regional service delivery would not be affected. Operations: No significant impact.	No impact.
Electrical Power	Construction: Temporary construction-related impacts for the installation of new transmission lines; however, regional service delivery would not be affected. Operations: Operation of the PV system would decrease fossil fuel dependency, help reduce the cost of electricity, combat future fuel cost increases, and meet the renewable energy goals set by SECNAV and the Federal Government.	No impact.
Solid Waste Disposal	Construction: Surface vegetation will be removed in areas where the PV arrays, equipment pads, substation complexes, and maintenance/access roads will be built. Operations: Occasional vegetation clearing will keep areas around the PV system and maintenance/access roads from becoming overgrown.	No impact.
Socio-economic Conditions	Construction: Construction-related employment and spending will benefit the economy. Operations: Wages and the purchase of goods and services for PV system operations and maintenance will benefit the economy.	No impact.

Figure 2-3

Project Location Map
Environmental Assessment for PV Systems
JBPHH, Oahu, Hawaii

Figure 2-4

West Loch Project Site Map
Environmental Assessment for PV Systems
JBPHH, Oahu, Hawaii

Chapter 3 Affected Environment and Environmental Consequences

This chapter describes the existing environmental setting and establishes baseline conditions for the environmental resources with the potential to be directly or indirectly affected by the proposed action.

This chapter also evaluates potential environmental consequences of the proposed action including the potential direct, indirect, short-term, long-term, and cumulative impacts on relevant environmental resources. The chapter is organized by resource topic (e.g., air quality, noise, geology and soils, etc.). The discussion under each topic begins with an overview of existing conditions related to that topic. Where appropriate, the discussion encompasses a larger environmental setting (e.g., the proposed action site and surrounding area). In other cases the discussion is focused on the environmental setting and potential impacts associated with the specific phase of the West Loch PV System.

In accordance with CEQ guidance 40 CFR 1501.7(3), only resources/areas that have the potential to be affected are discussed in this EA. Therefore, the following resources/areas will not be evaluated:

Flood Hazard Areas. The PV system will not be built in an area that is subject to coastal or inland flooding nor will it affect flood hazard parameters or increase flood hazard potential.

Wetlands. The PV system will be constructed in an upland, dry area. The site does not intersect with any wetlands identified by the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory, and the proposed action will not affect any wetlands in the vicinity of the project area.

Marine Resources. The proposed action will not involve any work in the shoreline area or within the nearshore marine environment.

Public Health and Safety. The proposed action does not pose a risk to public health and safety. Access to the PV site will be restricted and security fencing and lighting have been incorporated into the design of the project.

Public Services. The PV sites will be unmanned facilities and would not increase the workload or service area limits for police or fire protection nor would it generate a demand for health, educational, or recreational services or facilities. Construction of the PV systems will generate a relatively small amount of solid waste. What little construction waste is generated will be sold to a recycling facility or disposed of at an approved offsite location.

Transportation. The proposed action will not directly affect air or ocean transportation facilities. Most of the materials to be used for the project would be imported by sea. However, the volume of cargo passing through these facilities amounts to a fraction of their capacity and is well within their capabilities. Roadway traffic is covered below in Section 3.10 (Utilities).

Wastewater and Telecommunications. The proposed action will not disrupt existing services nor would it require that any new wastewater or telecommunications utility lines be installed.

Resources that could be potentially affected by the proposed action include: air quality; noise; topography and soils; water resources; biological resources; cultural resources; visual resources; land use; electrical and water utilities; and socioeconomic conditions. Potential effects from glint and glare and hazardous materials and waste are also discussed in this EA.

3.1 Air Quality

3.1.1 Affected Environment

The U.S. Environmental Protection Agency (EPA) characterizes air quality by comparing concentrations of criteria pollutants to established National Ambient Air Quality Standards (NAAQS). The Hawaii Department of Health has established ambient air quality standards similar to the NAAQS. Criteria pollutants at the national level include carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter less than ten microns in aerodynamic diameter, ozone, and lead. Based on ambient air monitoring data, EPA has classified the State of Hawaii as being in attainment of the federal standards. In addition, pollutant concentrations within the state comply with State standards, which are more stringent than NAAQS. The proposed action is located in attainment areas.

3.1.2 Potential Impacts

The ambient air quality at the proposed project site is within the Hawaii and NAAQS. The construction and operation of the PV systems would have minimal impact on air quality. Emissions from heavy equipment (e.g., bulldozers, excavators, dump trucks, etc.) will temporarily affect ambient air quality during the construction phase. In addition, ground disturbing activities such as site clearing; grading for the foundations of the PV arrays, substation complexes, and maintenance roads; and trenching for fence posts, utility poles, and underground utility lines would temporarily generate fugitive dust. To minimize the effects of fugitive dust during construction, dust suppression methods using water trucks and dust screens would be implemented in accordance with all applicable regulatory requirements.

A slight increase in GHG emissions is anticipated during construction. This increase would be attributed primarily to diesel-powered equipment and trucks, along with fossil fuel-powered delivery trucks and vehicles of workers and visitors traveling to and from the project sites. However, the short-term increase in GHG emissions during construction would be compensated by the generation of electricity from solar energy and the associated fossil fuel it will offset once the PV system is in operation.

During the operational period, none of the PV system components emit air pollutants of any kind. Some emissions will result from vehicles to and from the PV sites for periodic maintenance but these effects would involve relatively short distances and brief periods of time. The proposed action would provide long-term beneficial effects on air quality and GHG emissions, since the use of fossil fuels would be reduced. The use of PV systems to generate electricity reduces dependence on fossil fuels that emit GHG (See Section 3.13 for a discussion of the cumulative effects of GHG and climate change).

No adverse impacts are anticipated during the decommissioning process. Dust from the removal of structures and improvements, and emissions from vehicles and equipment used to perform this work will be temporary in duration. BMPs will be implemented during decommissioning to control fugitive dust.

No Action Alternative. No impacts to air quality would occur because no construction activities would take place and existing site conditions would continue to be maintained. The No Action Alternative would not realize the benefit of reducing fossil fuel consumption and GHG emissions.

3.2 Noise

3.2.1 Affected Environment

The level of ambient noise is an important indicator of environmental quality. Noise from vehicle traffic, aircraft flights, and industrial land uses, and construction activities can impact ambient noise levels based on their proximity to noise-sensitive receptors (e.g., occupied structures). Chronically high noise levels can impact personal health and quality of life in an area.

Noise-sensitive receptors in the vicinity of the proposed action include the single family homes that border the site to the southwest, and Holomua Elementary School which is located approximately 1000 ft. (300 m) to the north northwest of the site at its closest point.

Noise in the vicinity of the West Loch Annex PV site is primarily attributable to vehicles along adjacent roadways, farm equipment, or aircraft transiting the area. The site is adjacent to the main approach to Honolulu International Airport (HIA) with aircraft passing overhead at approximately 1,000 feet elevation on approach to Runways 8L and 8R, which generates a significant amount of noise.

3.2.2 Potential Impacts

The proposed action would have minor, short-term impacts on ambient noise levels during the construction period. Under the proposed action, site preparation and construction activities would be expected to create short-term noise impacts.

Construction noise may temporarily affect the occupants of any noise-sensitive receptors in the vicinity of the PV site. Noise from construction vehicles, machinery, equipment, and power tools would be the dominant source of construction noise, and the single-family homes directly bordering the proposed site would be the most susceptible to noise impacts. However, measures would be implemented to minimize noise including the use of sound-dampening devices (e.g., baffles, mufflers) and properly maintaining all equipment, vehicles, and machinery. The Contractor would be responsible for compliance with all applicable regulatory requirements for noise control, including the Hawaii Administrative Rules Chapter 46 regarding Community Noise Control. To minimize noise impacts, construction activities will be limited to normal daylight hours.

Holomua Elementary School is located at approximately 1000 ft. (300 m) from the nearest edge of the proposed PV site, but several rows of single family homes lie between the school and the proposed site. Given the distance from the proposed PV site, and the noise buffer that the single family homes provide, it is not expected that Holomua Elementary School will experience adverse short-term noise impacts during the construction process

From a long-term perspective, the proposed action is not expected to result in any adverse noise impacts. The PV system components will make little or no sound except for noise from cooling fans in the inverters and a low hum from transformers mounted on each equipment pad. Vehicles used for periodic maintenance activities will generate noise on a limited, temporary basis.

No long-term adverse impacts are anticipated during the decommissioning process. Noise from the removal of structures and improvements, and emissions from vehicles and equipment used to perform this work will be temporary in duration. BMPs will be implemented during decommissioning to minimize work-related noise.

No Action Alternative. No impacts to ambient noise levels would occur because no construction activities would take place and existing site conditions would continue to be maintained.

3.3 Topography and Soils

3.3.1 Affected Environment

The West Loch Annex site is predominately classified as Mamala Stony Silty Clay Loam. This soil was formed in alluvium deposited over coral limestone and consolidated calcerous sand. The area also contains areas of Fill Land, Ewa Silty Clay Loam (soils developed in alluvium derived from basic igneous rock) and Waipahu Silty Clay (soils developed in old alluvium derived from basic igneous rock) and Coral Outcrop (DoN 2008).

The proposed PV site is generally flat and gently sloping towards the southeast. The elevation of the site ranges from approximately 40 feet above mean sea level (MSL) in the northwest corner of the site to approximately 18 feet above MSL in along the southeast boundary. However, one depression located in the undeveloped portion of the site drops to an elevation of approximately six feet above MSL. Two prominent berms are located on the parcel. The first berm runs along the most of the southwest boundary of the site. It buffers the site from the single family homes and the golf course that border to the southwest. The second berm runs generally parallel to the first but is located more centrally in the site, acting as the southwest boundary to the existing agricultural fields located at the site. Both berms were constructed by bulldozing topsoil from both sides. Scars from this process, exposing the limestone bedrock, are still present on the landscape.

3.3.2 Potential Impacts

No significant impacts to topography and soils would occur at the proposed PV site. Site preparation would involve selective grading, grubbing, and vegetation removal in areas where the foundations for the PV arrays, substation complexes, and maintenance roads would be located. It is likely that the berm located centrally in the site would require grading to make the area suitable for the ground mount racking systems. Earthwork for maintenance roads, fence posts, utility poles, and underground utility lines is expected to be minimal.

Phase II of the West Loch PV System would require an upgrade to the existing HE 46kV transmission line and the associated transmission line poles. The installation of the new transmission line poles would require ground disturbance along the four-mile pole line, but the poles would be located within the existing utility right of way and is not expected to cause significant impacts to topography or soils. Cut and fill quantities will be balanced on site to make use of excavated earth although not all of this material may be suitable for structural fill. As necessary, the Contractor may need to import appropriate fill material (e.g., gravel, rock, sand) to create a strong and stable foundation for PV system components.

Ground-altering construction activities will comply with all applicable regulatory requirements. An NPDES Permit would be obtained from the Hawaii Department of Health for the discharge of stormwater associated with construction activities such as grubbing and grading. To the extent possible, earthwork will be balanced to maintain existing drainage patterns and bare ground shall be hydro mulched or planted with ground cover to minimize erosion and runoff. If necessary, water trucks or temporary irrigation systems would be utilized to facilitate plant growth. Green waste from the site clearing process will be transported to a composting facility and excavated earth from site work shall not be transported off base for use on non-DoD properties. The Contractor will be responsible for implementing BMPs to control soil erosion and sedimentation during construction activities.

During the operational period, the PV systems are not expected to have an adverse impact upon topography and soils.

No adverse impacts are anticipated during the decommissioning process. Dust from the removal of structures and improvements, and emissions from vehicles and equipment used to perform this work will be temporary in duration. BMPs will be implemented during decommissioning to control soil erosion, sedimentation, and stormwater runoff.

No Action Alternative. No impacts to topography and soils would occur because no construction activities would take place and existing site conditions would continue to be maintained.

3.4 Water Resources

3.4.1 Affected Environment

Hydrology. The project site is located in the Honouliuli Subwatershed of the larger Pearl Harbor Watershed (Figure 3-1). Honouliuli is the westernmost subwatershed within the Pearl Harbor Watershed. Annual rainfall ranges from an average of 47 inches at the Waianae Mountain Peaks to 24 inches near the H-1 Freeway (Oahu Resource Conservation and Development Council 2013). The proposed PV system is located in the coastal plain to the south of the Honouliuli Stream and within the Pearl Harbor aquifer sector. Most of the Ewa Plain, including West Loch Annex, overlies the Ewa caprock aquifer that is not connected to the deeper Pearl Harbor aquifer, a major potable water source for Oahu. The caprock aquifer is relatively shallow and brackish.

Drainage. The proposed PV system is located in an area with minimal slope and is currently either undeveloped or used for agricultural production. Surface runoff at the proposed site is generally absorbed by the surrounding ground area due to the low slope and permeable ground cover.

3.4.2 Potential Impacts

Hydrology. During construction, water will be dispensed by water trucks or temporary irrigation systems to control fugitive dust and wet down any exposed ground. During the operational period, PV system operations will not require significant water use nor would it affect ground water withdrawals or infiltration. The PV systems would be unmanned facilities and would not generate a regular demand for water use. The PV systems will require minimal maintenance which would involve periodically washing the PV panels with water to remove accumulated dust and dirt. Water would also be required to provide fire protection for the substation complexes. To provide water for PV system maintenance and fire suppression, connection to a water line within the adjacent roadway right-of-way is proposed.

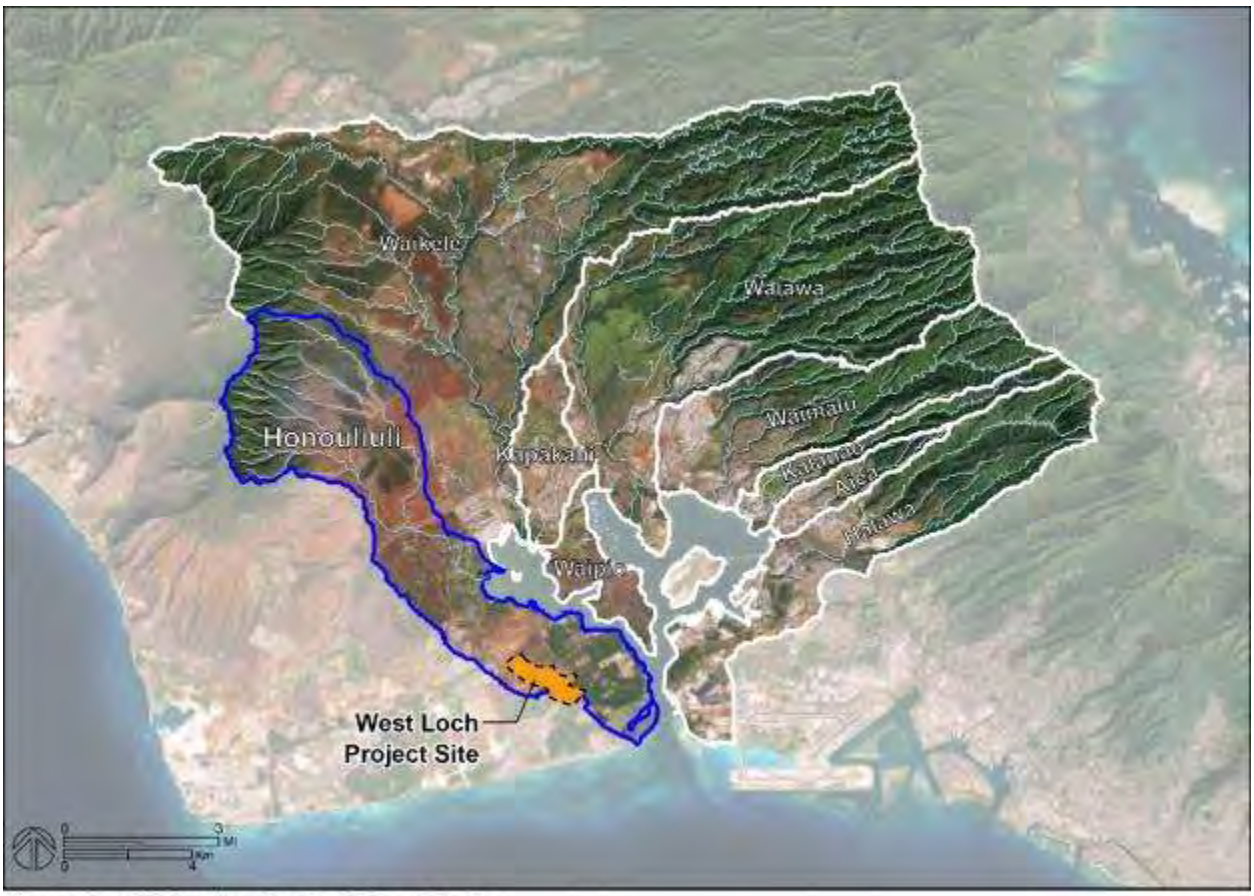


Figure 3-1: Subwatersheds of Pearl Harbor

The proposed PV system would not impact ground water resources as it would have a negligible effect on groundwater recharge and the West Loch Annex site is located over Ewa caprock aquifer which is insulated from the underlying Pearl Harbor aquifer, Oahu's major source of potable water. While small amounts of hazardous materials are contained within equipment like the inverters, transformers, and BESS, they are housed in closed, properly-maintained systems (see Section 2.12). During construction, BMPs such as proper storage of hazardous materials and immediate cleanup of any leaks or spills will be implemented to prevent contamination of groundwater resources.

Drainage. Section 438 of the Energy Independence and Security Act of 2007 established strict stormwater runoff requirements for federal development and redevelopment projects. The provision requires that "The sponsor of any development or redevelopment project involving federal facility with a footprint that exceeds 5,000 square feet (465 m^2) shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow." These requirements will be followed for the proposed PV System.

The proposed action site is currently covered with vegetation. Installation of PV ground mount system at this site would increase the amount of impervious surface. However, the increase in runoff would be minor as the increase in impervious surface would be limited to the ground-mounted PV footings, and equipment foundations, estimated at less than 10% of the total site area. As appropriate, the project would implement best management practices (BMPs) to capture and retain stormwater on site and allow it to infiltrate into the soil or to be discharged at a rate that would not exceed the predevelopment hydrology to adjacent surface waters. An NPDES permit would be obtained for the project.

No long-term adverse impacts are anticipated during the decommissioning process which will be limited in duration. BMPs will be implemented during decommissioning to ensure that the removal of structures and improvements does not impact surface and ground water.

No Action Alternative. No impacts to hydrology or drainage would occur because no construction activities would take place and existing site conditions would continue to be maintained.

3.5 Biological Resources

3.5.1 Affected Environment

Biological resource surveys of the proposed PV site were conducted in November 2014 to document potential impacts that the proposed action could have on biological resources, including Endangered Species Act (ESA)-listed species and candidate species (SWCA Environmental Consultants, January 2015). Prior to the surveys, a review of the relevant literature for the proposed site was also undertaken. During the surveys, no State or federally-listed threatened, endangered, or candidate plant or animal species were recorded in the survey area and no critical habitat was found near the proposed site. A summary of the literature review and the findings from the biological surveys are provided below.

Flora. Approximately one quarter (1,025 acres) of the West Loch Annex is leased under JBPHH's agricultural outlease program, although only a portion of that lease area is actually farmed (DoN 2011). The project site mostly consists of current and former agricultural land (312 acres) that has been previously cleared. A small portion of the site is undeveloped (77 acres). Approximately 150 acres of the cleared acreage is currently leased under the Navy's agricultural out-leasing program for farming watermelon, tomatoes, and corn. On the undeveloped portions of the site, the most common plant species include kiawe (*Prosopis pallida*) and koa haole (*Leucena leucocephala*). Guinea grass (*Urochloa maxima*) is the most common understory plant and is often quite dense.

Three (3) main vegetation types were identified during the 2014 survey: Kiawe-Koa Haole Forest, Strangler Fig- Opiuma Closed Forest, and Agricultural. No State or federally listed threatened, endangered, or candidate plant species were recorded in the survey area. In all, 44 plant species were recorded at the site during the survey. Of these, six are native to the Hawaiian Islands: kou (*Cordia subcordata*), koaliawa (*Ipomoea indica*), pau o hiiaka (*Jacquemontia sandwicensis*), ilima (*Sida fallax*), uhaloa (*Waltheria indica*), and milo (*Thespesia populnea*). Only one of the aforementioned species is endemic to the Hawaiian Islands—pau o hiiaka— the others are indigenous. One additional species observed is considered a Polynesian introduction—noni (*Morinda citrifolia*)—but is not classified as native. None of the native species observed are considered rare throughout the Hawaiian Islands.

Fauna. No State or federally-listed, threatened, endangered, or candidate avian species were recorded in the project area during the 2014 survey. Additionally, the project site does not overlap with any federally-identified critical habitat for avian species. In all, eight non-native species were recorded: strawberry finch (*Amandava amandava*), cattle egret (*Bubulcus ibis*), Japanese bush warbler (*Cettia diphone*), common myna (*Acridotheres tristis*), red-crested cardinal (*Paroaria coronata*), rock dove (*Columba livia*), white-rumped shama (*Copsychus malabaricus*), and zebra dove (*Geopelia striata*).
The 37-acre Honouliuli unit of the Pearl Harbor National Wildlife Refuge is located approximately one mile north of the proposed PV site. The refuge is primarily devoted to the recovery of four of Hawaii's six endemic waterbirds: Hawaiian Stilt (*Himantopus mexicanus knudseni*), Hawaiian Coot (*Fulica alai*), Hawaiian Moorhen (*Gallinula chloropus sandvicensis*), and Hawaiian Duck (*Anas wyvilliana*), as well as a variety of migratory shorebirds and waterfowl. The federally-listed endangered Hawaiian stilt has been recorded in the West Loch area. However, since the Hawaiian stilt is a wading bird that uses a variety of aquatic habitats, it would not be present at the project site since it does not contain suitable habitat.
Two State-listed endangered birds, the white fairy tern (*Gyptis alba*) and the *pueo* or Hawaiian short-eared owl (*Asio flammeus sandwichensis*) have been observed on the Waipio Peninsula which is located approximately one-mile from the project site. While the white fairy tern is protected by the Migratory Bird Treaty Act (MBTA), the project site does not contain suitable habitat for this species. However, the close proximity of Waipio Peninsula makes it possible that the *pueo* could be present at the project site.

Mammals. Feral mammals common to the area include the small Indian mongoose (*Herpestes javanicus*), rats (*Rattus rattus*), and mice (*Mus muscullus*). The ESA-listed Hawaiian hoary bat (*Lasiurus cinereus semotus*) typically roosts in trees that provide thick vegetation. The project site lies in a lowland area and contains a large number of kiawe where roosting is known to occur. During their breeding period (May-October), Hawaiian hoary bat occurrences increase in the lowlands. During the non-breeding period (November-April), bat occurrences increase at higher elevations (above 5,000 feet). Surveys for the detection of the Hawaiian hoary bat were not conducted so it is not known if the species is present on the site; however, the project site contains suitable habitat that could potentially be used by this species.

3.5.2 Potential Impacts

The proposed action will not have a significant impact upon biological resources during the construction period. However, since the project site contains suitable habitat for the State-listed *pueo*, it is possible *pueo* could occur on the site. Measures to reduce disturbance to *pueo* during construction activities include suspending construction work (particularly machinery or vehicle use) within 300 feet of any area where distraction displays, vocalizations, or other indications of nesting by adult *pueo* are seen or heard and only resume activity when it is apparent that the young have fledged or there is other confirmation that *pueo* nesting is no longer occurring. Through implementation of these measures, no adverse effects to the *pueo* are likely to occur during construction. While the project site contains habitat that could potentially support the Hawaiian hoary bat, habitat destruction during the construction phase could impact the bat; however, the following measures can be taken to minimize impacts:

- No trees taller than 15 feet should be trimmed or removed during the Hawaiian hoary bat's pupping season which occurs between June 1 and September 15 because non-volant juvenile bats (bats that cannot fly) may be roosting in the trees.

- Any fences erected at the project site should have a barbless top-strand wire to prevent the Hawaiian hoary bats from getting entangled on the barbed wire.

The implementation of the preceding guidelines, which are promulgated by the USFWS (1998), are expected to avoid all direct impacts to the Hawaiian hoary bat.

Should nests of any MBTA species be found in areas where PV arrays are planned, the installation of equipment at that location will be delayed until after the nest fledges or naturally fails on its own accord. To ensure that all parties are aware of this procedure, a coordination meeting with the PV contractor, construction workers, and USFWS resource specialist shall be held prior to the start of construction for instructional purposes.

During the operational period, the proposed action will not have an adverse effect on biological resources. There are no state or federally-listed threatened or endangered species or important habitat that would be affected by the proposed action. As necessary, skirting would be placed around the PV arrays to prevent the shaded area underneath the panels from becoming a habitat for feral animals.

Recent reports suggest that solar arrays may pose a danger to some bird species. Many of these reports refer to concentrated solar technology which uses mirrors to concentrate solar energy, this technology is not being considered for the proposed action. It is also suggested that birds may mistake solar PV arrays for bodies of water and attempt to land or fly into the panels (Upton 2014). However, the proposed PV array is not expected to pose a threat to water birds in the project vicinity. The PV array will consist of panels that are placed at an angle instead of a horizontal position and rows of PV panels will be spaced apart for vehicular maintenance, making it less likely to be mistaken for a body of water. Therefore, it is unlikely that the possibility of birds attempting to land on or fly into the panels would be a problem. To minimize the potential for bird strikes, the design of the PV systems will not include any guy wires that would create a strike hazard.

Federally-protected migratory birds that may pass through or use the PV site for foraging or loafing could be displaced by the installation of the PV arrays. This would not have an adverse effect on these species since they would relocate to adjacent areas with suitable habitat. Anecdotal information indicates that PV arrays can become a haven for a variety of bird species which are attracted to the relatively open areas foraging areas.

To minimize the potential of seabird fallout or disorientation, permanent outdoor lighting shall be fully shielded, utilize light-emitting diodes, and comply with International Dark-Sky Association standards.

The decommissioning of the PV systems is not expected to result in any adverse impacts. BMPs such as those utilized during the construction and operational phases will be implemented as necessary.

No Action Alternative. No impacts to biological resources would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

3.6 Cultural Resources

3.6.1 Affected Environment

The proposed PV site encompasses 380 acres and constitutes the area of potential effect for the proposed action. The site lies in the Ewa Plain. It is located beyond the limits of the West Loch Naval Magazine Historic Management Zone and is adjacent to the boundary of the Pearl Harbor National Historic Landmark (NHL).

The project site and surrounding area was planted in sugarcane until 1995 when Oahu Sugar closed and ended over 100 years of commercial sugar cultivation on the Ewa Plain (Filimoehala et al. 2015:15). The area includes no extant structures and has been identified as an area with no and/or low archaeological probability (DoN 2008).

In October and November 2014, an archaeological inventory survey and subsurface testing was conducted at the proposed action site to document existing conditions and the potential for impacts the proposed action could have on cultural resources, including NRHP-eligible sites. Prior to this field work, archival research was completed to assist in identifying cultural resources in the project area (Filimoehala et al. 2015:9). A summary of the findings is provided below.

The Ewa area was associated with chiefs and activities important to them during the 14th through 18th centuries (Filimoehala et al. 2015:6). However, the portion of the Ewa Plain where the proposed PV site is located, "always had limited occupation and it was seen traditionally as a forbidding place. Known by the Hawaiian place name of Kaupea, this was a place where the souls of dead who had no *aumakua* (family god or deified ancestors) wandered endlessly, and this belief continued through the 19th century (Tuggle and Tomonari-Tuggle 2004:50-51)." By 1825, historical maps depict the area containing the proposed site as a "low uncultivated plain". Small clusters of houses, presumably fishing camps, dotted the southern shore of the plain and trails in the area were well to west and south of the project area. No cultural resources associated with these activities were identified in the vicinity of the project area (Filimoehala et al. 2015:79).

During the late 19th century and the first half of the 20th century, the landscape of the Ewa Plain was dominated by commercial industry, including salt works, ranching, and sugar. The Oahu Rail and Land Company provided a transportation link from rural Ewa to the shipping center in Honolulu (Filimoehala et al. 2015:11). In the 1920's, West Loch was chosen as one of two sites that would replace the Navy's ammunition depot. The West Loch Branch of the Naval Ammunition Depot, Oahu was officially commissioned in 1934, and military expansion into the Ewa Plain continued through World War II (DoN 2008). Much of this expansion was associated with the construction of the Advance Base Construction Depot (ABCD) Annex (Filimoehala et al. 2015:18).

No traditional Hawaiian features or deposits have been identified at the project site (Filimoehala et al. 2015:18). The extensive agricultural and military activities of the 20th century had a substantial impact across the project area. These impacts are documented through a review of historical photographs and maps; the large and extensive push piles, graded areas, and 20th century military foundations; the subsurface testing; and extant agricultural fields. Any pre-Contact or early post-Contact cultural properties that may have been present would have apparently been destroyed as a result (Filimoehala et al. 2015:18).

Six (6) archaeological sites were identified including five which had been previously recorded (Filimoehala et al. 2015:81-82). These sites consist of concrete foundations, a metal container and historical roads. Sites 50-80-13-5040, 50-80-13-5080, 50-80-13-5133, and 50-80-13-5134 are concrete foundations associated with the former Navy ABCD Annex constructed in 1943 and demolished in 1951. Site 50-80-13-5047 is a partially buried metal container that is also associated with the former ABCD Annex. Site 50-80-13-7735 is a complex of roads created during the first half of the 20th century for agriculture and military. The National Register Bulletin 16A (Anonymous 1997:1) indicates that, "Properties listed in the National Register of Historic Places (NRHP) possess historic significance and integrity" (emphasis added in original). Although each of the sites retains some integrity characteristics, none of them are considered to retain a combination of significance under the NHRP criteria and integrity. None of the sites are eligible for listing on the NRHP.

3.6.2 Potential Impacts

Late 19th and 20th century activities have had a substantial effect on the landscape in this part of the Ewa Plain. Evidence for presumed traditional activities, such as temporary habitation and dryland agricultural practices, were replaced with large-scale commercial agriculture and military infrastructure. Any archaeological evidence relating to these possible pre-Contact or early post-Contact periods is likely long destroyed. However, some of the historic agricultural and military infrastructure has become part of the archaeological record (Filimoehala et al. 2015:81). None are considered eligible for inclusion in the NRHP. There are no known December 7, 1941 attack sites or World War II features within the proposed site and the site is outside the boundary of the Pearl Harbor National Historic Landmark.

The Section 106 Consultation Process is ongoing with the SHPO, native Hawaiian Organizations, and interested parties. The SHPO is reviewing the DoN determination that the proposed action would result in "no historic properties affected." This determination is based on the following: (1) it is located in an area extensively disturbed by former agricultural land uses, designated by the Commander Navy Region Hawaii Integrated Cultural Resource Management Plan (DoN 2008) as having no and/or low archaeological potential; (2) it is outside of (adjacent to) the West Loch Historic Management Zone, and (3) construction and operation would not affect any NRHP-eligible properties. The proposed site lies beyond the boundaries of the Pearl Harbor NHL and would not have any impact on the NHL.

Table 3-1: Archaeological Sites Identified within the project area

Site #	Form	NRHP Evaluation	Recommended Action
50-80-13-5040	Military concrete pad foundation	Not eligible	No further work
50-80-13-5047	Military metal container	Not eligible	No further work
50-80-13-5080	Military concrete pad foundation	Not eligible	No further work
50-80-13-5133	Military concrete pad foundation	Not eligible	No further work
50-80-13-5134	Military concrete pad foundation	Not eligible	No further work
50-80-13-7735	Roads	Not eligible	No further work

Because none of the six archaeological sites located by Filimoehala et al. 2015 were determined to be NRHP eligible, and since no other types of cultural resources were identified at the project site, the proposed action would not negatively impact cultural resources.

As discussed in Section 2.1.7, once the specific in-kind considerations are identified, a new Section 106 review process would be undertaken to consider the effect the in-kind considerations could have on historic properties.

No Action Alternative. No impacts to cultural resources would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

3.7 Visual Resources

3.7.1 Affected Environment

The project site lies in the relatively flat Ewa Plain to the west of Pearl Harbor. It is located entirely on DoN property, but it is surrounded on three sides by publicly accessible roadways, and on the other by private residences and two private golf courses. Public views into the proposed PV site are limited to those attained from adjacent roadways, including: (1) Iroquois Road looking southeast (Figure 3-2); (2) West Loch Drive looking southwest (Figure 3-3); (3) and North Road looking northwest (Figure 3-4). West Loch Drive and North Road are DoN-owned roadways, but the general public is allowed access.

Residential homes along the southwest border of the site may be able to see the site from their second floor windows, but the existing berm along the site boundary generally obstructs any view of the site from ground level. The views from the terminus of Hoomalie Place (Figure 3-5) and Kuanoo Street (Figure 3-6) generally represent this view towards the site from the residential area.

The City and County of Honolulu's Ewa Development Plan (EDP) has identified that utilizing open space to protect scenic views is a general policy for the Ewa Community. It has specified several views which are considered particularly significant views and vistas which should be preserved including, "*Distant vistas of the shoreline from the H-1 Freeway above the Ewa Plain (EDP 2013).*" The project site lies between the H-1 Freeway and the Ewa shoreline (Figure 3-7), approximately 3.25 miles south of the H-1 Freeway at the Fort Weaver interchange. The elevation of the freeway is about 174 feet MSL, while the elevation at the mauka boundary of the project site is about 40 feet MSL. The landform of the intervening area is characterized by gently sloping terrain, vacant land, cultivated fields, and residential and golf course development.

Figure 3-2: View into the site from the existing gate entrance at Iroquois.

Figure 3-3: View into the site from West Loch Drive.

Figure 3-4: View into the site from North Road.

Figure 3-5: View into the site from the terminus of Hoomalie Place.

Figure 3-6: View into the site from the terminus of Kuanoo Street.

Figure 3-7: View towards the site from H-1.

3.7.2 Potential Impacts

Due to its large footprint and location, the PV system would be visible from public roadways and areas adjacent to the site (see artist rendering of proposed substation complex in Figure 3-8). However, the vast majority of the site (approx. 90%) would be covered by the low profile PV array, with panels no higher than four feet above grade. The perimeter/security fencing (8 feet) would surround the entire site, but the fencing would be set back from the roadway right-of-way to minimize streetscape impacts. Approximately 50 pad-mounted inverter/transformer blocks (10 feet square by 10 feet high) are distributed throughout the PV array (appr. one per eight acres). Permanent outdoor lighting would be fully shielded and downward directed in compliance with the International Dark Sky Association standards.

The approximately seven-acre Phase I substation complex would be quite visible to motorists traveling along Iroquois Road given its location at the Iroquois Road entrance to the site (Figure 3-8). The site would include medium voltage switchgear and transformers, as well as a two-story warehouse-type building to house the BESS, SCADA, and maintenance facilities. A microwave communications tower, not to exceed 75 feet high, would be located adjacent to the building. While these facilities would be visible to motorists along a several block segment of Iroquois Road, they would be no more intrusive than existing utility substations located in residential areas and along main thoroughfares throughout Oahu. The vast majority of the site is comprised of the relatively low lying PV arrays. The Phase II substation is proposed at an interior location away from public roadways along the southwest project boundary and would not be visible from nearby roads (Figure 2-4).

Figure 3-8: Artist rendering showing the view of the proposed Phase I Substation Complex from Iroquois Road (proposed substation and BESS facility in foreground near project entrance, PV arrays on the left, fencing along roadway).

Based upon final engineering design, any additional (new) transmission lines required for Phase II of the proposed PV systems would be installed overhead along the existing HE transmission line right-of- way to the Ewa Nui Substation, suspended on approximately 40-foot tall utility poles spaced at approximately 200-foot intervals. Any new overhead transmission lines are not expected to result in any adverse visual effects since their appearance would blend in and be consistent with those of pre-existing transmission lines in the area.

As noted, the proposed action may be visible from second floor windows of private homes along the southwest border of the site, but the existing berm along the site boundary would mitigate any significant impacts (Figures 3-5 and 3-6). Glint and glare could also potentially have an effect on these homes. However, PV panels are designed to maximize light absorption and will be covered with an anti-reflective coating which reflects as little as 2% of the incoming sunlight depending on the angle of the sun (FAA November 2010).

The proposed action will alter open space views from bordering roadways and adjacent areas, but the PV system is generally consistent with DoN land uses at the West Loch Annex and is not expected to significantly impact visual resources. Due to its relatively low profile and distance from elevated public viewpoints (i.e., H-1 Freeway), the proposed action would not significantly impact regional views from the surrounding community (Figure 3-7). Therefore, the proposed action is determined to be generally consistent with the EDP's goal to preserve regionally significant views and vistas.

The decommissioning process would remove all proposed action structures and improvements, and will not have an adverse effect on visual resources.

No Action Alternative. No impacts to visual resources would occur because the PV system would not be built and existing site conditions would continue to be maintained.

3.8 Land Use

3.8.1 Affected Environment

The proposed ground mount site is located within the 4,000-acre JBPHH West Loch Annex that includes ammunition wharves on the West Loch frontage, ammunition storage areas, and the associated safety clearance zones in which the proposed action is located. The proposed PV site is constrained by ESQD arcs (land use hazard zones regulated by DoD Explosives Safety Board (DDESB) which establishes guidelines for various quantities and types of ammunition and explosives). Since the proposed PV system is located within the ESQD arc, it would need to be approved by DDESB.

While the proposed PV system is located entirely within DoD property, it does border private residential areas and two private golf courses to the south west. This surrounding area is located within the City and County of Honolulu's fast growing Ewa District regulated under the City's EDP. Amongst other provisions, the EDP "Promotes diversified agriculture on prime agricultural lands along Kunia Road and surrounding the West Loch Naval Magazine (EDP 2013)." Approximately one quarter (1,025 acres) of West Loch Annex is leased under JBPHH's agricultural outlease program. Only a portion of that lease area is being actively farmed, including approximately 150 acres of row crops located within the proposed action site.

The surrounding communities of Ewa Gentry, Ewa Villages, and Ewa Beach are characterized mainly by single family residential areas. Commercial areas serving these communities are focused along Fort Weaver Road, approximately one mile southwest of the project area. There are several schools located in the region including, James Campbell High School, Ilima Intermediate School, Ewa Beach Elementary School, Pohakea Elementary School, Keoneula Elementary School, Ewa Makai Middle School, and Holomua Elementary School. The closest of these schools, Holomua Elementary, is located approximately 1,000 feet away from the site. Golf Courses represent the other major land use in the area. The Hawaii Prince Golf Club and the Ewa Beach Golf Club are both located directly south of the project site.

3.8.2 Potential Impacts

The proposed action would remain compatible with existing and foreseeable land uses, as activities associated with the PV ground mount systems are considered largely benign and not expected to have any impacts on surrounding areas or uses. The proposed site is on federal land encumbered by an ESQD arc; therefore, use is restricted to activities that do not have full-time personnel. Since the proposed PV system would only require personnel for installation, operation, maintenance, and repair of PV ground mount systems, it would not introduce additional full-time personnel working inside the ESQD arcs. Maintenance requirements are expected to require monthly visits to the site and PV operation will be monitored remotely. Appropriate precautions for working within the ESQD arcs would be taken during both construction and maintenance. Given their locations within ESQD arcs, the proposed action will need to be reviewed and approved by DDESB to ensure land use compatibility.

The proposed PV site would replace an area that is currently under agricultural production with a non-agricultural use. The Farmland Protection Policy Act (FPPA) is intended to minimize the impact of federal programs have on the conversion of farmland to non-agricultural uses. While both the FPPA and the EDP support the preservation of farmland, one specific exemption to the FPPA is construction for national defense purposes. In this case, DoN has recognized renewable energy development and energy security as critical to national defense, prioritizing the use of DoN property to support energy security. The proposed action will displace approximately 150 acres of active farmland, less than 0.5% of farmland on Oahu. Also, like other PV farms planned for Oahu, it is considered an interim use (e.g., 37-year lease), after which land use may be reassessed.

The decommissioning process will not have an adverse effect on land use. Because decommissioning would involve the removal of all applicable structures and improvements, the sites are expected to revert to their pre-development, open space condition.

No Action Alternative. No impacts to land use would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

3.9 Glint and Glare Effects

3.9.1 Affected Environment

The proposed action site is located approximately 3.5 miles west northwest from the nearest runway (8L) at JBPHH and HIA. The site is located adjacent to existing flight tracks, including the typical approach to HIA. Currently the site consists of agricultural and undeveloped vegetated land, and does not create glint or glare effects for aircraft or residents in the surrounding area.

3.9.2 Potential Impacts

The proposed PV system introduces the possibility of light being reflected off the surface of the PV panels into the eyes of individuals (e.g., pilots) which can cause disorientation and a brief loss of vision also known as flash blindness (FAA November 2010). However, solar PV systems employ glass panels that are designed to maximize light absorption and minimize reflection. The panels are constructed with dark, light-absorbing materials and covered with an anti-reflective coating which reflect as little as 2% of the incoming sunlight depending on the angle of the sun (FAA, November 2010).

In order to assess the potential for glint and glare effects from proposed PV systems near airports, the Sandia National Laboratories has developed the Solar Glare Hazard Analysis Tool (SGHAT). This tool determines when and where solar glare can occur throughout the year from a proposed PV system as viewed from user-specified observation points (e.g., flight tracks) (SGHAT User Manual, 2014). The tool accounts for PV system configurations (e.g., tilt, orientation, height, etc.) to determine the potential glare impacts.

In October 2013, the Federal Aviation Administration (FAA) released an interim policy for solar energy system projects on federally-obligated airports. Under this policy, the FAA specifies that glint and glare impacts to airport facilities must be limited to "no potential" for glint glare impacts at air traffic control towers, and "no potential" for glare or "low potential for after image" along the final approach path for any existing or planned landing threshold (FAA, 2013). The FAA also identified the SGHAT as the acceptable tool to be used to determine glare impacts and requires that it be used to demonstrate compliance with the standards for measuring ocular impact for any solar energy system proposed at a federally-obligated airport.

Although the proposed action does not involve a solar energy system for a federally-obligated airport, SGHAT was used to assess potential glare hazard associated with the proposed action (Appendix E). The glare analysis was conducted for all applicable runway flight tracks. Also, the contractor will be selecting the final layout and panel orientation of the proposed PV system, so the analysis incorporated a range of panel orientation from due south (180 degrees) to southwest (220 degrees). An orientation of due south would provide for the greatest panel efficiency, and an orientation of southwest would allow the panel layout to best fit the shape of the site. With an orientation of due south, glare impacts along the landing approach were found to be at a level of "low potential for after image," which is acceptable under current FAA policy. With a southwest orientation, no glare impacts were found. For both orientations, no glare impacts were found to the air traffic control tower.

The SGHAT analysis shows that potential impacts from glint and glare will not be significant and are within the approved standards set forth by the FAA.

The decommissioning of the PV systems will remove any potential effects from glint and glare. After completion, the sites are expected to revert to their pre-development, open space condition.

No Action Alternative. No impacts from glint and glare would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

3.10 Utilities

3.10.1 Affected Environment

Utilities are basic services that are provided to the general public and include roadways, potable water, electrical power, telecommunications, and wastewater. These utilities largely lie within or utilize Oahu's roadway rights-of-way. The West Loch Annex also includes-DoD owned utilities that provide service on base. The proposed action will require connections to existing electrical and water lines within the roadway rights-of-way. As previously noted, the proposed action will not require any wastewater and telecommunications connections or service. As such, a discussion of these utility systems is not included in this section. A summary description of the utilities that are affected or required for the project follows below.

Roadways. The proposed action site is bordered by roads on three sides: Iroquois Road to the north, West Loch Drive to the East, and North Road to the South. Residential (Ewa Gentry) and recreational (Hawai`i Prince Golf Club and Ewa Beach Golf Club) development border the site on to the West. Access to the site will be provided off of Iroquois Drive for Phase I, and North Road for Phase II.

Potable Water. Water service is currently provided to the 150-acre agricultural outlease portion of the site. Service is provided via an existing 12" distribution main running along Iroquois Road.

Electrical Power. There is presently no electrical power service to the project site, however existing HE transmission lines run adjacent to the site along Iroquois Road, and along the site's southwest boundary.

3.10.2 Potential Impacts

The proposed action will require the use of local roadways to transport construction materials; provide construction and maintenance workers with access to and from the PV sites; and haul green waste and construction waste materials away for disposal BMPs will be implemented for the installation of water and electrical lines to control soil erosion and surface runoff during work within the roadway right-of-way. The PV Contractor will be responsible for ensuring that water and electrical services in the area is not disrupted and that utility lines in the roadway right-of-way are not disturbed. Water service for the project will be coordinated with the potable water provider to ensure that all applicable design criteria are addressed. Phase II of the proposed PV system would include an upgrade to the adjacent HE transmission line, however this upgrade would not impact electrical service to the area. The proposed action would not require additional full-time operational or maintenance personnel and would not increase water use or place any additional demand on the existing electric power or water supply.

The decommissioning of the PV systems is not expected to result in any adverse impacts. For roadways, traffic management measures will be implemented to ensure that local roadways and traffic are not impacted during this process. Solid waste disposal will be the responsibility of the PV Contractor who would hire a commercial waste service to transport the waste to an appropriate disposal facility. For potable water, and electrical power, BMPs will be implemented to control soil erosion, sedimentation, and stormwater runoff. The PV Contractor will be responsible for ensuring that water, and power services to others are not disrupted and that other utility lines in the roadway right-of-way are not disturbed.

No Action Alternative. No impacts to roadways, potable water, electrical power, telecommunications, and solid waste disposal would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

3.11 Socioeconomic Conditions

3.11.1 Affected Environment

Hawaii had an estimated resident population of 1,404,054 persons in 2013, of which 47,114 were military and 60,490 were dependents representing a military population of 107,604 or 7.7% of the total population. Over 99% of the military population is on Oahu (DBEDT 2013).

On October 1, 2010, Naval Station Pearl Harbor combined with Hickam Air Force Base to become JBPHH. The base has a total population of 84,000 of which 35,000 are combined military/civilian and 49,000 are combined family members/retired military personnel. Total land area is 27,694 acres (11,200 ha).

While the proposed PV site is located within DoD Property and encumbered by an ESQD arc, the adjacent Ewa Plain is an area of planned growth for the island of Oahu. The EDP calls for the construction of an additional 35,000 new homes from the year 2000 to 2035. Population is expected to grow by approximately 96,000 residents (EDP 2013).

3.11.2 Potential Impacts

The proposed action is not expected to result in any adverse socioeconomic impacts because it will not alter population and demographic characteristics nor would it result in inconsistent population growth or have any disproportionate impacts upon housing and employment markets. Construction-related employment would have a positive impact on the local economy due to spending by those employed in construction jobs and businesses providing goods and services to the construction industry. Construction-related spending would also benefit businesses in other commercial sectors (e.g., stores, restaurants), while construction-related tax revenues would benefit the local economy. During the operational period, the PV systems would continue contributing to the local economy through the payment of wages and the purchase of goods and services for the operation and maintenance of the system. However, given the limited project scope, these benefits would not significantly affect the State's overall socioeconomic status.

No adverse impacts are anticipated from the decommissioning of the PV systems. The decommissioning work will provide employment opportunities and contribute to the local economy through direct and indirect spending.

No Action Alternative. No impacts to socioeconomic conditions would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

3.12 Hazardous Materials and Wastes

3.12.1 Affected Environment

There are no hazardous materials or waste stored or handled at the proposed action site. However, it is noted that the site is adjacent to ammunition storage areas and encumbered by ESQD arcs.

Portions of JBPHH, including the proposed action site have been placed on the National Priorities List, regulated under the Comprehensive Environmental Response, Compensation, and Liability Act, commonly referred to as Superfund. Petroleum contaminated soil and groundwater is likely to be encountered in these areas and excavation in these areas must be handled in accordance with procedures established by the Commander Naval Base Pearl Harbor (1996).

3.12.2 Potential Impacts

No impacts are anticipated to hazardous materials and wastes at the proposed action site. As noted above, excavation work will be handled in accordance with established procedures, and all ESQD arc requirements will be followed. Generally, the equipment associated with PV systems do not pose a threat of hazardous waste. However, coolant used in inverters, mineral oil used in transformers, and substances (e.g., anti-freeze, petroleum, oils, lubricants) used by construction vehicles are considered hazardous substances. Both the inverters and transformers utilize closed systems, and the hazardous materials could only be spilled if there was physical damage to the equipment.

During the construction phase, the Contractor shall be responsible for ensuring that temporary, secondary containment measures are employed, to ensure that any accidental releases of hazardous substances (e.g., anti-freeze, petroleum, oils, lubricants) are prevented or limited in scope. Portable catch basins, portable containment berms, and other similar measures would be used for refueling equipment. The Contractor would ensure that spill kits are kept on site to ensure that response and cleanup actions are promptly undertaken should a spill occur. All construction workers will be trained on spill prevention and notification measures in accordance with DoD pollution control requirements to reduce the potential for accidental spills.

Additionally, the batteries used in the BESS will contain hazardous substances. Lead-acid, sodium sulfur, and lithium-ion batteries represent the more robust technologies available, however, the specific battery technology used for the proposed system would be decided during the project design process. Batteries are typically housed entirely within a BCS, and multiple BCS would be located within the BESS main building. The BCS will include the container, battery enclosures, control system, internal wiring, cooling system, fire suppression system, battery rack system and interfaces for battery management system. Fire risk presents the main safety concern with respect to BESS.

In response to the growing demand for energy storage systems, including BESS, the DoE has recently released, December 2014, an Energy Storage Safety Strategic Plan. In the plan they outline two basic sets of controls that should be used to minimize the risk of BESS. Engineered controls provide the first step in ensuring the safety of a BESS and include designing the system to the highest possible level of safety. Administrative controls includes the implementation of emergency preparedness plans and the appropriate facility signage, processes, and procedures (DoE 2014).

During the design, construction, and operation of the PV system, including the BESS, the contractor will be required to implement both engineering and administrative controls to minimize the risk of hazardous substance release.

No adverse impacts are anticipated during the decommissioning process. Appropriate measures will be implemented during decommissioning to control any hazardous materials or waste, including the proper disposal or recycling of batteries.

No Action Alternative. Because no construction activities would take place and existing site conditions would continue to be maintained, there would be no impacts to hazardous materials or wastes.

3.13 Cumulative Impacts

Cumulative impacts on environmental resources are the result of two or more individual impacts that, when considered together, compound or increase the overall impact of a particular action. Cumulative impacts can arise from the individual effects of a single action or from the combined effects of past, present and reasonably foreseeable future actions. Cumulative impacts can result from individually minor actions that collectively amount to significant impacts over time.

The proposed PV system is part of a worldwide shift toward renewable energy sources. This growth is attributable to rising fossil fuel costs, an awareness of fossil fuel dependency and energy independence, and energy efficient improvements in PV technology (i.e., improved kilowatt hours per square foot), as well as federal renewable energy policies and the availability of federal tax credits.

Hawaii is somewhat unique from the continental U.S. (CONUS) due to its geographic location and heavy reliance on fossil fuel. Hawaii is also different from CONUS in that it cannot benefit from redundant and oftentimes competitive electrical grids, accessibility to natural gas, and availability of other types of fuel (e.g., coal, hydro, large scale geothermal, etc.).

The proposed action would utilize approximately 380 acres of DoD land to construct and operate a PV system with a combined energy potential of 50 MW. For purposes of the cumulative impacts analysis, this section assesses the effects of the proposed action when considered within the context of past, present, and reasonably foreseeable future actions that may affect environmental resources in the project area. For the purposes of this analysis, the geographic scope will include the lands of JBPHH and the adjacent lands of the Ewa Plain.

Table 3-2 lists past, present, and reasonably foreseeable future projects on Oahu that are located in the vicinity of the proposed action.

Table 3-2: Past, Present, and Reasonably Foreseeable Projects

Location	Project Name	Description	Status
JBPHH	Waterfront recapitalization projects	Ongoing repairs and recapitalization of waterfront berths throughout Pearl Harbor	ongoing
	National Oceanic and Atmospheric Administration (NOAA) Pacific Regional Center	Consolidate NOAA offices and facilities scattered on Oahu by constructing a new 30-acre (12-ha) facility on Ford Island.	Completed
	Production Services Support Facility	Consolidate PHNSY & IMF production shops and engineering teams in one building on the waterfront for better working efficiency and cost savings.	Completion estimated by FY15.
	Hawaii Air National Guard (HIANG) Munitions Storage Area	Construct a munitions storage area adjacent to the existing 647th Air Base Group munitions storage area south of the hot cargo loading area. After the new F-22A aircraft parking apron is constructed, munitions cannot be stored at the existing HIANG munitions area due to the ESQD arcs around the loaded aircraft.	Unknown
Ewa District	Ewa Development Plan	Comprehensive City plan identifies the Ewa Plain as a major Oahu growth area where it envisions 16% of Oahu's population will live by 2030	In process of being implemented
	HCDA solar farm	The Hawaii Community Development Authority is negotiating with Sunetric to design and develop a 5 MW solar farm in Kalaeloa in West Oahu.	Planning
	Kalaeloa Renewable Energy Park (KREP)	The recently completed 5 MW system provides enough power for up to 1,000 Oahu homes for 20 years.	Completed
	DR Horton –Solar Farm (Hoopili)	Plans to construct a 5 to 7 MW solar farm (adjacent to its planned 11,750-home Hoopili subdivision) in 2015.	Planning
Oahu	Forest City Military Community Rooftop PV Projects	Forest City has installed rooftop PV systems on the Navy and Marine Corps privatized family housing around Oahu.	Ongoing
	HE Renewable Energy Projects	HE is pursuing a range of renewable energy projects on Oahu starting with the 24-MW Kahuku Wind Farm in 2006. Recent projects include the 69 MW Kawailoa Windfarm on the North Shore (2012) and several privately-funded solar PV farms in Kalaeloa which became operational in the last couple of years. HE is currently pursuing an additional 222 MW of PV solar farms spread over eight Oahu projects it hopes to have operational by the end of 2016. This is in addition to over 220 MW of rooftop PV systems using HE's Net Energy Meters already in place.	Past, Present, Future

3.13.1 Air Quality

Renewable energy technologies, by definition, replace fossil-fuel generated power. These technologies require fossil fuels to support the manufacture, transport, construction and servicing of the equipment, but during the operational period, the technologies generate clean power. According to researchers at the Brookhaven National Laboratory, regardless of the specific technology, PV systems generate significantly fewer harmful air emissions (at least 89% less per kW) than conventional fossil fuel fired technologies (Good Company, n.d.).

Long term, cumulative impacts on climate change are expected to be slightly positive as a result of implementing PV energy generation. The earth's climate is affected by energy entering and leaving its atmosphere, which can be affected by both natural and human factors, including variations in the sun's energy reaching the planet, changes in the reflectivity of its atmosphere and surface, and changes in the amount of heat retained by its atmosphere. When energy from the sun reaches the earth's surface, it can either be reflected back into space or absorbed by the earth. After it is absorbed, the energy can be released back into the atmosphere as heat (i.e., infrared radiation) (EPA, ND). GHG emissions absorb energy, resulting in the slowing or prevention of heat loss back into space. The key GHGs emitted by human activities include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases. In 2004, energy supply (i.e., the burning of coal, natural gas, and oil for electricity and heat) was the largest source of global GHG emissions (26%), followed by industry (19%), land use change and forestry (17%), agriculture (14%), transportation (13%), commercial and residential buildings (8%), and waste/wastewater (3%) (EPA, n.d.).

Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance (October, 2009), makes reductions of GHG emissions a priority of the federal government by requiring federal agencies to develop sustainability plans focused on cost- effective projects and programs. The EOs goal is to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of GHG emissions a priority for federal agencies. Under this EO, agencies are required to measure, manage, and reduce GHG emissions toward agency-defined targets, and meet a number of energy, water, and waste reduction targets and sustainability requirements.

Though individual projects are unlikely to have significant impacts on global climate change, they collectively may have cumulative effects when their individual GHG emissions are combined over time. The proposed and potential future PV systems would generate GHG emissions in the manufacture, assembly, transport, and installation of the PV systems and energy transmission networks. However, most of the GHG emissions associated with the PV systems would be temporary in nature. Once they are installed, the operation of these PV systems is not expected to generate levels of GHGs that would significantly impact global, regional or local climate conditions when considered together with other local or regional projects (operations and maintenance activities will involve the use of fossil-fueled vehicles and equipment).

The development of renewable energy generation, including PV systems, has been identified by the State of Hawaii as a critical step towards environmental sustainability and reducing the state's vulnerability to fluctuations in fossil fuel prices and availability (HCEI 2014). Similarly, the DoN has prioritized renewable energy generation as paramount to their strategy to increase energy efficiency, security, and sustainability.

PV systems have the potential offset the future demand for fossil fuel based energy, and to ultimately contribute to the reduction of regional and overall GHG emissions in the future. The development of PV systems represent an important step towards reaching state, federal, and DoD renewable energy goals that, from a cumulative impact perspective, represent a modest, positive impact on the environment in conjunction with other past, present, and reasonably foreseeable future actions.

3.13.2 Topography and Soils

The proposed PV systems could potentially alter storm drainage and cause erosion if the PV panels are not properly spaced and new impervious surfaces are not mitigated by engineered drainage improvements. For operational efficiency, the PV systems are generally built in areas that are relatively flat or with minimal slope, thus avoiding areas that have steep slopes and are more erosion prone. Similarly, PV installations tend to avoid areas with significant topography that would incur substantial grading and earthwork costs. Given these general siting criteria for PV ground mount systems, it is not likely that the proposed action coupled with other past, present and reasonably foreseeable future actions would have a significant cumulative impact to topography and soils.

3.13.3 Water Resources

The proposed action, in combination with past, present, and reasonably foreseeable future projects could increase the potential of polluting or otherwise impairing surface and groundwater resources by altering site drainage and groundwater recharge. However, federal renewable energy systems are required to maintain pre-development onsite hydrology to the maximum extent possible. The proposed action will meet this requirement, and therefore will not contribute to a cumulative effect on groundwater recharge or stormwater quality. The proposed action, as well as the other past, present, and reasonably foreseeable PV systems, is not a water intensive land use. They draw water from the potable water system, but only for fire protection and periodic cleaning/maintenance. As such, these PV systems would not contribute to a cumulative effect on public drinking water sources.

Global sea levels are expected to rise over the coming century due to the effects of global warming. The projected sea level rise from the Pacific Islands Regional Assessment Group report for the Hawaiian Islands for 2020 to 2040 (relative to 1980-2000) is approximately four to five inches, while the increase for 2080 to 2099 (relative to 1980-2000) is between 14 to 15 inches (SOEST, n.d.). The proposed PV system (40 feet above appr. ground elevation) would be located well above the 18- to 20-inch projected sea level rise projected for 2099 and would therefore not be affected. As such, there would be no significant cumulative impact from global sea level rise from the proposed action in conjunction with other past, present and reasonably foreseeable future actions.

3.13.4 Biological Resources

The proposed PV site at West Loch, like other proposed PV sites on Oahu, are generally located on previously disturbed farmland, and no significant impact to biological resources is expected. Ground mount PV systems tend to take advantage of previously disturbed or marginalized areas where biological resources are not likely to be impacted. Similarly, the projects identified in Table 3-2 are generally located on previously developed sites or former agricultural land, which will likely not pose a significant threat to biological resources. Therefore, the proposed action, in conjunction with the past, present and reasonably foreseeable future actions, is not expected have a significant cumulative impact on biological resources.

3.13.5 Cultural Resources

The 380 acres encompassed by the PV site constitutes the area of potential effect for the proposed action. As was previously discussed, siting criteria for PV ground mount development favors flatter sites that have therefore been previously disturbed by plantation agricultural practices. As is the case with the proposed site at West Loch, these previously disturbed sites often have a lower probability of encountering historic properties as a result of the previous land disturbance. Still, the proliferation of ground mount PV systems has the potential to have cumulative impacts on historic properties. Because the NHPA Section 106 process requires federal agencies to consider the effect their projects could have on historic properties, it helps reduce the potential for cumulative impacts since agencies are required to explore measures to avoid or reduce harm to historic properties. The proposed action does not involve any NRHP-eligible properties nor would it affect cultural resources such as traditional Hawaiian features or deposits. Therefore, the proposed action does not have the potential to contribute any cumulative impacts to historic properties or cultural resources.

3.13.6 Land Use Compatibility and Visual Resources

West Loch Annex is located on the eastern edge of Oahu's vast Ewa Plain, referred to by the City and County of Honolulu as the EDP area. The region was under extensive sugar cane cultivation until the mid-1990s and the closure of the Oahu Sugar Company plantation. Under City policy, the region is targeted to accommodate approximately 16% of Oahu's population by 2030 (up from 5% in 1980). New suburban communities, commercial centers and major new public facilities have been constructed on former sugar cane lands over the past 20 years and a number of new developments are planned or under construction. The western end of the City's $5.3 billion rail project is now under construction several miles to the north of the proposed action which will connect the growing Ewa District to metropolitan Honolulu.

PV systems are land-use intensive and are seen by some as competing with agricultural uses in that they require exposure to the sun, as well as flat, open areas suitable for farming or ranching. Windfarms are perhaps the most visible form of alternative energy projects while PV farms are relatively low lying and less visible from a regional perspective. Windfarms can co-exist with some agricultural operations whereas PV farms, which are a more intensive use, cannot typically with co-exist with agricultural uses. Another potential land use incompatibility arises from the general loss of open space or perceived open space to these renewable energy facilities.

The proposed action, coupled with past, present, and reasonably foreseeable future renewable energy projects on Oahu has/will continue to change Oahu's open space landscape. Windfarms are far more visible and more are planned for the North Shore of Oahu which will increase community concerns about loss of viewscapes and apparent open space. The PV farms are planned for Central Oahu, the Ewa plain, and the Waianae regions of Oahu. The total footprint (appr. 1,400 acres) of these solar PV energy facilities represents less than 1% of the 285,000 acres of non-urban land on Oahu, so the actual loss of open space is insignificant. Because they are low lying and relatively compact, PV farms are largely invisible from a regional perspective, although some of the new planned PV farm locations on the lower elevations of Central Oahu and Kunia could be visible from communities and vantage points on Oahu's coastal plain – but still at an insignificant level.

While the planned PV farms on Oahu will displace some existing agricultural production, including approximately 150 acres under cultivation at the West Loch Annex, they do not represent a significant impact to the amount of available farmland. The total land area of the proposed action and the planned PV farms on Oahu is approximately 1,800 acres representing less than 1.5% of agricultural district lands on Oahu (appr. 128,000 acres) (DBEDT 2013). As of 2011, only approximately one quarter of the 42,600 acres of high quality farm land on Oahu was being farmed (Plasch, 2011). The proposed action, coupled with past, present, and reasonably foreseeable future renewable energy projects will have only minimal cumulative effects on agriculture as a large stock of underutilized high quality farmland that will remain available to farmers.

3.13.7 Socioeconomics

The proposed action, in combination with past, present, and reasonably foreseeable future projects has the potential to impact Oahu or the Ewa District's socio-economic environment. From a regional perspective and in accordance with the City's growth policy, the Ewa District is undergoing a dramatic change from an agricultural community to a major urban center. This has, and will continue to have, vast effects on the region's socioeconomic environment associated with the influx of approximately 150,000 new residents and creation of thousands of new jobs over a 40-50 year period. This population increase will create significant economic growth and influence socioeconomic conditions.

The proposed action in itself is not expected to significantly contribute to this socioeconomic change. PV projects do not influence population growth and are relatively limited in their economic contributions. The construction of the PV project would provide temporary boosts to the local construction industry, and the construction and maintenance of the PV system may help to stimulate growth in the renewable energy industry (so called "green jobs"). However, this effect on local industry and labor will be temporary and relatively small.

Hawaii's focus on transitioning towards renewable sources for energy production also has the potential to influence socioeconomic conditions. Continued growth in the renewable energy industry, including the proposed PV systems, would result in continued job growth and increased disposable income due to attendant energy savings. However, other energy sources, such as natural gas, could raise the cost of solar-generated power due to their lower costs, which would make solar energy pricing less competitive. Overall, the proposed PV system, in conjunction with other past, present, and reasonably foreseeable future actions, would have a beneficial cumulative effect on Oahu's economy.

Additional economic benefits will likely be gained through the development of PV energy generation as part of an overall strategy to increase the reliability of the electrical grid and reduce consumer's electrical bills. In their 2014 Power Supply Improvement Plan, HE has identified utility scale solar power as a key energy generation source that will contribute to a total renewable energy generation share of 65% of Hawaii's electrical generating capacity by 2030. HE's plan anticipates that over this time period the average customers' bill would decrease by 23 – 28% and provide a lower cost energy alternative. While the proposed action, and solar PV in general, only represent a part of this future energy strategy, the overall cumulative effect, when combined with the past, present, and reasonably foreseeable future actions, is expected to have a significant positive effect on the economy.

3.13.8 Hazardous Materials and Waste

The proposed action in conjunction with past, present, and reasonably foreseeable actions are not expected to generate cumulative impacts with regards to hazardous materials and waste. These projects do represent a significant amount of construction, and present the potential for cumulative impacts from construction related hazardous substance release. However, state and federal requirements for BMPs help to ensure that hazardous substance releases are kept to a minimum, and that cleanup actions are prompt should a spill occur.

From a cumulative perspective, the use of hazardous chemicals in the manufacture of PV panels poses a potential biological impact. Extracting raw materials such as crystalline silica to manufacture the panels, can also pose a hazard. The proposed PV system will not require the extraction of materials or manufacture of panels on Oahu. With effective regulation, enforcement, and vigilance by manufacturers and operators, any danger to workers, the public, and the environment can be minimized. The benefits of PV systems tend to far outweigh risks especially when compared to conventional fossil fuel technologies (Good Company, n.d.).

During the operational period, PV systems are generally inert. Similarly the past, present, and reasonably foreseeable projects do not present a significant risk to hazardous substance release during their operations. At decommissioning, there is the potential for a large amount of solid waste to be generated, but solar panel recycling programs are developing and are expected to be more robust as the current boom in solar panel production reaches the end of their useful lives (SEIA, 2014). Overall, the proposed PV system in conjunction with other past, present and reasonably foreseeable future actions is not expected to cause significant cumulative impacts with regards to hazardous substances and waste.

3.13.9 Cumulative Impacts Summary

The construction, operation, and decommissioning of the proposed action, in combination with past, present and reasonably foreseeable future projects in the vicinity of the project site, are not expected to result in any significant cumulative impacts upon air quality; noise; topography and soils; water resources; biological resources; cultural resources; visual resources; land use; electrical and water utilities; and socioeconomic conditions. Potential adverse effects from hazardous materials are not expected and are capable of being mitigated through the use of BMPs and compliance with applicable regulatory requirements and protocols.

The proposed action, in connection with past, present and reasonably foreseeable future projects in the vicinity of the project site, would have minor, short-term cumulative impacts on air quality and ambient noise levels from construction-related vehicles, equipment, and activities. During the operational period, beneficial cumulative effects upon air quality would be realized as more renewable energy projects are developed on Oahu.

No Action Alternative. No adverse cumulative impacts to the natural or manmade environment in the area around the proposed and potential future PV systems would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

3.14 Relationship between Short-Term Use and Long-Term Productivity

This section lists the trade-offs between short-term and long-term gains and losses due to the proposed action. "Short-term" refers to the construction period; "long-term" refers to the post-construction (operation and potential decommissioning) period.

The proposed action would have the following short- and long-term gains and losses:

Short-term:

- Short-term construction period impacts on air quality, noise, traffic, and stormwater runoff.
- Short-term economic benefits associated with the employment created by construction contracts.

Long-term:

- Long-term improvements in energy efficiency and reduction of fossil fuel use and GHG emissions.

The proposed action would have the long-term benefit of producing 50 MW of clean, renewable energy for the island of Oahu. Additional long-term benefits include increasing the energy security, operational capability, strategic flexibility and resource availability for DoD installations through the development of renewable-energy on Oahu. In addition, the proposed action would also help meet the renewable energy standards set forth by the Federal Government and SECNAV's 1 GW Initiative and goal to produce 50 percent of the DoN's shore-based energy requirements from alternative sources.

Although the proposed action would result in short term, construction-related impacts in the short term, the beneficial, long-term environmental effects of the action greatly outweigh any limited, transient effects incurred during the construction phase. In this light, the proposed action represents a viable, productive use of DoD land with beneficial long-term results.

No Action Alternative. Under this scenario, the PV systems would not be built and existing site conditions would continue to be maintained.

3.15 Irreversible and Irretrievable Commitments of Resources

Irreversible and irretrievable resource commitments are defined as the use of non-renewable resources and the effects the use of these resources have on future generations. Irreversible effects result from the use or destruction of a specific resource, such as fossil fuels or minerals that cannot be replaced within a reasonable period. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the proposed action, such as a significant archaeological site.

Irreversible resources that would be consumed by the proposed action include energy needed to manufacture the PV system components (e.g., PV panels, cables, batteries, and inverters); transport the components from the manufacturer to the PV sites; and operate the construction equipment to install the PV systems. Other irreversible resource commitments include materials needed to manufacture the PV components. Construction and operation of the PV arrays and the placement of associated electrical equipment and cables would be an irretrievable commitment of various resources, such as labor, capital, energy, and land, by the Contractor. Use of the land for the PV systems is not an irreversible or irretrievable resource commitment because the systems can be removed at the end of the lease period.

No-Action Alternative. There would be no irreversible and irretrievable resource commitments. However, DoD installations on Oahu would continue to use non-renewable energy and, during the operational period, would consume a greater amount of irreversible resources by using energy produced by fossil fuels.

3.16 Compliance with Executive Orders

3.16.1 Executive Order 12898, Environmental Justice in Minority Populations and Income Populations

Executive Order 12898 (February 11, 1994), and SECNAVs Notice 5090 (May 27, 1994) requires the DoN to identify and address the potential for disproportionately high and adverse human health and environmental effects of their actions on minority and low-income populations. Because the PV systems will be located on DoD property, exposure and risk to the general public would be limited. In addition, since the proposed action is not expected to have an adverse effect upon environmental resources, it would not create any environmental health or safety risks that would disproportionately affect minorities or disadvantaged populations. The construction and operation of the PV systems would not disrupt the structure or cohesion of the community since the proposed action would occur on DoD lands.

As such, no adverse environmental justice impacts are anticipated because there would be no significant changes in land use or aesthetics and there would be no disproportionate human health or environmental impacts to low income or minority populations.

No Action Alternative. No construction activities would take place and existing site conditions would continue to be maintained.

3.16.2 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

Executive Order 13045 (April 21,1997) requires federal agencies to make it a high priority to identify and its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health or safety risks. Because the proposed PV systems will be mounted on the ground, it could be accessible to children who live in the area. Residential areas and schools including Holomua Elementary School are located in the vicinity of the proposed West Loch PV site.

During construction, access to the PV site would be restricted to authorized personnel. Temporary fences and other access control measures would be utilized to prevent accidental entry by children or other individuals who reside or work on or near military installations or DoD lands. Noise generated by construction activities near their homes would have a temporary effect on children due to their limited duration. Safety precautions employed during construction to minimize construction noise, would not be hazardous to the safety and health of children. After their completion, the PV systems would be screened from children living in nearby homes by fences and locked gates to prevent accidental entry and exposure to electrocution or other safety and health hazards. No long-term adverse impacts on children living near the PV sites are anticipated.

No Action Alternative. No construction activities would take place and existing site conditions would continue to be maintained.

3.16.3 Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management

Executive Order 13423 (January 24, 2007) consolidates and strengthens a number of prior EOs (13101, 13123, 13134, 13148 and 13149) by establishing new and updated goals, practices, and reporting requirements for environmental, energy and transportation performance and accountability. EO 13423 establishes goals for federal agencies to implement the policy of conducting environmental, transportation, and energy-related activities in support of their respective missions in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient and sustainable manner. Goals relevant to the proposed action include:

- Improving baseline energy efficiency and reducing GHG emissions by certain numerical targets and timelines.

- Ensuring that at least half of the statutorily required renewable energy consumed by the agency in a fiscal year comes from new renewable sources, and to the extent feasible, implements renewable energy generation projects on agency property for agency use.

In accordance with NAVFACINST 9830.1, current DoN policy is for new construction to meet Leadership in Energy and Environmental Design (LEED) certification levels set forth by the U.S. Green Building Council. As such, the proposed action will be guided by LEED standards and directives to employ efficient and environmentally-sensitive sustainable design standards and minimize energy use and water consumption during PV system operations.

Under the No Action Alternative, no construction activities would take place and existing site conditions would continue to be maintained.

3.16.4 Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance

Executive Order 13514 (October 5, 2009) builds on and expands the energy reduction and environmental requirements of EO 13423 by making GHG reductions a federal priority, setting targets for the reduction of GHG emissions by FY 2020, and requiring federal agencies to develop plans focused on cost-effective projects and programs. Under this EO, agencies are required to measure, manage, and reduce GHG emissions toward agency-defined targets, and meet a number of energy, water, and waste reduction targets and sustainability requirements. The proposed action will increase renewable energy and renewable energy generation on federal land, thereby helping to meet sustainability requirements and reduce GHG emissions.

No Action Alternative. No construction activities would take place and existing site conditions would continue to be maintained.

3.17 Coastal Zone Management Act

The Navy/Marine Corps and the State of Hawaii Department of Business, Economic Development and DBEDT, Office of Planning have come to an agreement that certain activities listed on the "Navy/Marine Corps De Minimis Activities under CZMA" (*De Minimis* Activity List) were not subject to further review by the Hawaii CZM Program when such an activity was conducted in compliance with the corresponding "Project Mitigation/General Conditions." (DBEDT, July 9, 2009).

The Proposed Action to install PV systems at the West Loch Annex falls within Items 1 and 2 on the De Minimis Activity List. The relevant mitigation/conditions are as follows:

(1) All activities will occur on DoD property.

(6) No project-related materials will be stockpiled in the water.

(9) Fueling of project-related vehicles and equipment will take place away from the water. A contingency plan will be established to control accidental petroleum releases during project construction.

(10) All fill material will be protected from erosion as soon as practicable.

(11) All exposed soil will be protected from erosion and stabilized as soon as practicable.

(12) Consultation pursuant to Section 106 of the NHPA will be completed.

(13) No species or habitats protected under ESA will be affected by the Proposed Action.

(14) NEPA EA process will be completed.

(16) State CZM office notified on use of *De Minimis* List for an EA.

The State CZM office acknowledged receipt of notification on March 20, 2015 of usage of the *De Minimis* Activity List and the preparation of this environmental assessment.

No-Action Alternative. PV systems would not be installed; therefore, there would be no impacts to coastal resources.

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Appendix A

NHPA Section 106

Consultation Correspondence

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DEPARTMENT OF THE NAVY
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5750
Ser N45/186
March 10, 2015

CERTIFIED NO: 7014 1200 0000 9858 6414

Dr. Alan Downer, PhD
Administrator
Department of Land and Natural Resources
State Historic Preservation Officer
State Historic Preservation Division
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, HI 96707

Dear Dr. Downer:

SUBJECT: SECTION 106 CONSULTATION FOR PROPOSED SOLAR PHOTOVOLTAIC (PV) ARRAY, WEST LOCH ANNEX, JOINT BASE PEARL HARBOR-HICKAM, O'AHU, HAWAI'I TMK: 1-9-1-011; 1-9 1-016; 1-9-1-031: ENCLOSURE

Pursuant to Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, and in accordance with 36 CFR Part 800, the U.S. Department of the Navy (DoN) is initiating consultation regarding a proposal to develop renewable energy via a solar photovoltaic system at the West Loch Annex on Joint Base Pearl Harbor-Hickam (JBPHH), Oahu, Hawaii (TMK: 1-9-1-011; 1-9-1-016; 1-9-1-031). We have determined that the proposed project is an undertaking as defined in Part 800.16(y).

Project Description

The DoN proposes to lease approximately 389 acres of land to Hawaiian Electric Company (HECO), the local electric utility provider, who will engage renewable energy contractors to build and operate a solar photovoltaic (PV) array. The proposed PV system will utilize solar panels and electrical equipment to convert natural sunlight into electrical energy and feed into HECO's electrical grid for Oahu. The utility-sized solar array will be constructed in two phases. Phase one will consist of a 20 MW solar array on a 160 acre site; Phase two will be a 30 MW solar array on 229 acres. The land will be leased for up to 37 years, after which time the lease would be renewed or the facility would be decommissioned and all equipment and support facilities removed and the land restored back to an open field condition.

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March 10, 2015

As a statutory requirement of the lease agreement, the Navy will receive an in-kind consideration for the leased property. It is intended that this consideration will address the energy security of JBPHH through surveys, studies, repair, replacement, or upgrades (or a combination thereof) of the existing electrical distribution systems or other energy conservation measures and maintenance to existing infrastructure on JBPHH. While the specific scope of the in-kind consideration will be determined through lease negotiation, it is anticipated that these activities would occur within the existing JBPHH infrastructure footprint. Nonetheless, once the specific consideration(s) are identified, a new Section 106 review will be undertaken for those activities, and as such are not addressed in the determination of effect as outlined by this letter.

The proposed undertaking will assist the DoN in achieving its renewable energy goals, including the Navy's 1 gigawatt (GW) initiative to produce or procure 1 GW of renewable energy before the end of the 2015 calendar year (31 December 2015), and are supported by the requirements of Executive Order (EO) 13514: Federal Leadership in Environmental, Energy, and Economic 11 Performance (2009), the Energy Policy Act of 2005, Title 10 U.S.C. 2911(e).

During site preparation, surface vegetation in the areas to be developed would be cleared and grubbed, and where load-bearing foundations are proposed the ground would be excavated and compacted. Ground disturbance required during construction at the proposed project sites would include the installation of the PV racking system on foundations or piers, trenching for underground electrical cables, power centers with inverters, substations constructed during each construction phase, installation of 46 kv overhead transmission line poles for connection to the existing HECO transmission lines immediately adjacent to the property, foundation work for electrical equipment, and site buildings, and miscellaneous civil works (i.e., perimeter fencing post holes, typically 4' deep, to support a 8-foot high chain link fence enclosure and gates.)

Former roads in the area will be abandoned and a new perimeter road and smaller access roads will be constructed to access the solar array in order to maintain the elevated and sloped photovoltaic panels. In the second phase of construction, a new 46 kv line would be installed along the southern boundary of the project to connect the Phase II

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Substation to the existing HECO utility system immediately adjacent to the project area.

All structures and equipment within the PV site will be contained within an 8-foot-high perimeter fence enclosure in order to restrict access and ensure site security. The ground-mounted PV arrays will occupy most of the space within the fenced area. The perimeter maintenance road will be located directly inside of the security fence, and generally be 20 feet wide plus shoulders.

Access roads within the array will typically be 10-feet wide plus shoulders. All site roads will more than likely consist of compacted gravel or similar base that would be trucked on site. Enclosures 1 and 2 depict PV mounting systems alternatives being proposed and typical field layout.

Identification of Archaeological Historic Properties

Several archaeological investigations have been completed in the area: Filimoehala et al. (2014); Jensen and Head (1997); Davis (1988); Kennedy (1988); and Davis and Burtchard (1991). Enclosure 4 depicts the coverage of previous archaeological investigations. Archival research was also conducted to gather traditional information about the area (Filimoehala et al. 2014). In addition, Native Hawaiian organizations have been included in this consultation for an opportunity to comment on the identification of historic properties per 36 CFR Part 800.4(b).

Filimoehala et al. (2014:6) relates that the 'Ewa area was associated with chiefs and activities important to them during the 14th through 18th centuries. However, the portion of the 'Ewa Plain where the APE is located "always had limited occupation and it was seen traditionally as a forbidding place. Known by the Hawaiian place name of Kaupe'a, this was a place where the souls of dead who had no *'aumakua* (family god or deified ancestors) wandered endlessly, and this belief continued through the 19th century" (Filimoehala et al. 2014:9 citing Tuggle and Tomonari-Tuggle 2004:50-51). By 1825, historical maps depict the area containing the APE as a "low uncultivated plain" (Filimoehala et al. 2014:9). Filimoehala et al. (2014) conducted pedestrian survey and subsurface survey of the APE. Jensen and Head (1997) completed a reconnaissance-level survey

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including a majority of the APE. Earlier, Davis (1988) and Kennedy (1988) conducted projects that included the western portion of the APE and the northwestern portion of the narrow strip of the 116-acre parcel. Kennedy (1988) completed a cursory reconnaissance survey while Davis (1988) excavated trenches but none were within the APE. Davis and Burtchard (1991) completed an archaeological inventory survey of the southwestern portion of the APE. Jensen and Head (1997) recorded sites within the APE. All other investigations described resulted in no significant findings. The study conducted in support of this undertaking (Filimoehala et al. 2014) recorded sites identified to sufficiently determine eligibility of properties for listing on the National Register of Historic Places (NRHP).

The most recent study (Filimoehala et al. 2014:81) concluded that:

> Late 19th and 20th century activities have had a substantial effect on the landscape in this part of the 'Ewa Plain. Evidence for presumed traditional activities, such as temporary habitation and dryland agricultural practices, were replaced with large-scale commercial agriculture and military infrastructure. Any archaeological evidence relating to these possible pre Contact or early post-Contact periods is likely long destroyed. However, some of the historic agricultural and military infrastructure has become aspects of the archaeological record.

Five of the six sites identified within the APE were first recorded by Jensen and Head (1997), with the sixth having been identified by Filimoehala et al. (2014). All were 20th century remnants, most of military development. These Sites 50-80-13-5040, 50-80-13-5080, 50-80-13-5133, and 50-80-13-5134 include concrete foundations, Site 50-80-13-5047 is a metal container, and Site 50-80-13-7735 is a complex of roads and a fence that includes agricultural roads that pre- and post-date WWII.

None of the identified sites are recommended as eligible for listing on the National Register of Historic Places (NRHP) by either Filimoehala et al. (2014:82) or Jensen and Head (1997).

The DoN is concurrently requesting a thirty (30) day review of the attached 2014 draft report by Filimoehala et al.

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(Enclosure 7), and consulting on the eligibility of properties for inclusion in NRHP with the State Historic Preservation Division. The National Register Bulletin 16A (Anonymous 1997:1) indicates that, "Properties listed in the National Register of Historic Places (NRHP) possess historic significance and integrity" (emphasis added in original). Although each of the sites retains some integrity characteristics, none of them are considered to retain a combination of significance under the NHRP criteria and integrity. In agreement with the findings of (2014), we have determined that none of the sites are eligible for listing in the NRHP, and are requesting your concurrence on this matter.

Area of Potential Effects

The proposed location for the solar PV system is on JBPPH. The joint base encompasses approximately 28,000 acres of land and water, and includes significant land holdings at the main base, West Loch Annex, Pearl City Peninsula, Waipio Peninsula, and other outlying areas. The solar PV system will be located at the West Loch Annex in the 'Ewa district of south-central O'ahu, with the Area of Potential Effect (APE) measuring approximately 389 acres. The PV site is partially vacant and partially under agricultural use and proximate to public roads and utilities.

Most of the land is former Ewa Plantation Co. land in the Ewa Plain. The western parcels of land have been in continuous use for agriculture since the early plantation development. The eastern parcels and land associated with the Pu'uloa District were used by the military during and immediately after World War II for open storage of military equipment. This area is illustrated in Enclosures 5 and 6. Some of the land used by the military for open storage during World War II was later converted back to agricultural use after the war. There are no known World War II sites within the proposed PV site area considered significant.

Access to the PV site would be provided by Fort Weaver Road, a divided four-lane State highway, and Iroquois Road, a two-lane County roadway. The PV site is bordered by farmland on the north, and a DoN munitions storage area on the east. Land uses to the south and west of the proposed site are characterized by large residential communities and various parks, schools, golf courses, and shopping centers. The southern boundary of the

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proposed project is adjacent to residential areas of Ewa Gentry and Ewa Beach, as well as, the Hawaii Prince Golf Course and Ewa Beach Golf Course. The project area is contained within the APE boundary as depicted in Enclosure 3.

Determination of Effect

No traces of traditional Hawaiian activities are known to remain in the proposed project area based on extensive land modifications throughout the APE and no evidence of findings. There has also been numerous archaeological investigations throughout the APE.. Historical agriculture and military structures are present within the APE, but none are considered eligible for inclusion in the NRHP. There are no known December 7, 1941 attack sites or World War II features identified within the APE. The area is outside the boundary identified as the Pearl Harbor National Historic Landmark. Given the information presented here, the DoN has determined there would be "no historic properties affected" by the undertaking.

Per 36 CFR Part 800.11(d), the provided information supports the DoN's determination that no historic properties will be affected by this undertaking. This document has condensed multiple consultation steps as referenced in Part 800.3(g).

The DoN is providing SHPD notification of our finding of effect per 36 CFR Part 800.4(d)(1), and request that any objection be made within 30 days of receipt of this letter per Part 800.4(d)(1)(i). If you or your staff have any questions concerning this matter, please contact Mr. John Lohr, NAVFAC Hawaii Historic Preservation Officer, at (808) 474-9019, or email john.r.lohr@navy.mil.

Sincerely,

G. N. SUTHER
Captain, CEC, U.S. Navy
Executive Officer
By direction of the
Commanding Officer

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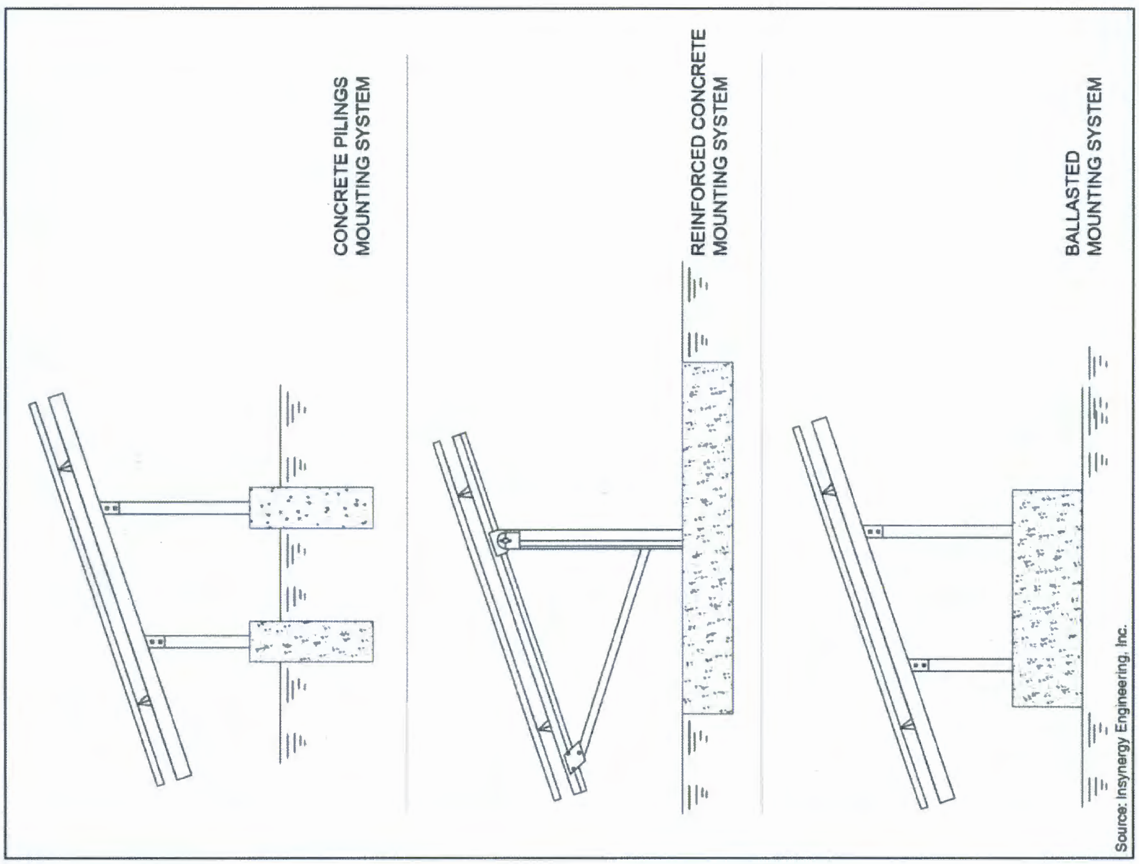
March 10, 2015

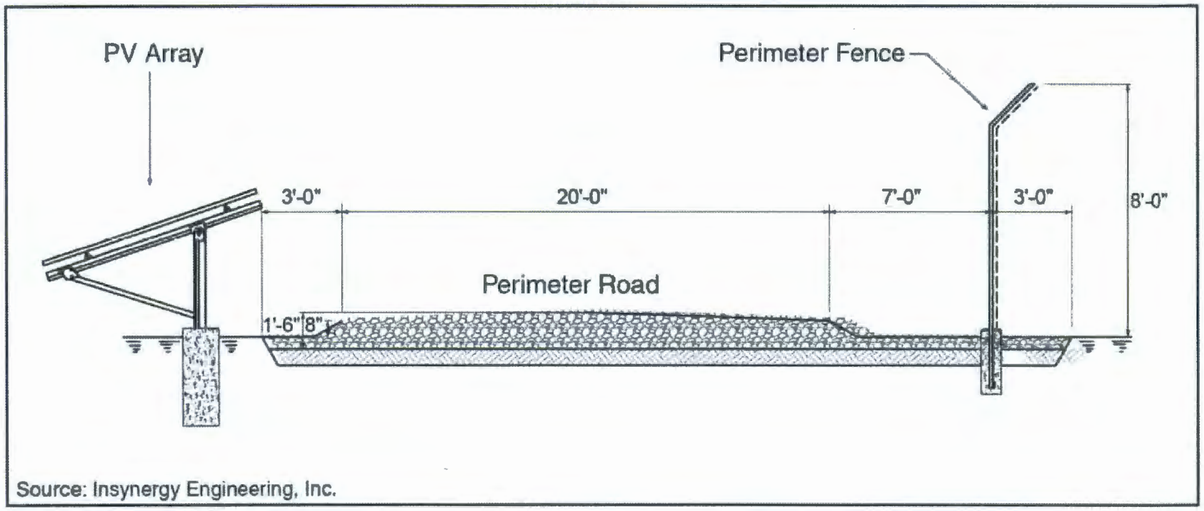
Enclosures:
1. PV Panel Mounting Systems
2. Perimeter Road Layout in PV Field
3. West Loch Annex Solar PV Area of Potential Effect
4. Previous Archaeological Investigations
5. Map of 1946 ABCD area with overlay of proposed project area
6. World War II Aerial Photograph of the ABCD area

Copy to:
Dr. Kamana'opono M. Crabbe
Ka Pouhana, Chief Executive Officer
Office of Hawaiian Affairs
Mr. Shad Kane
O'ahu Council of Hawaiian Civic Clubs
Ms. Kiersten Faulkner and Megan Borthwick
Historic Hawaii Foundation (PDF Format)
Ms. Betsy Merritt and Brian Turner
National Trust for Historic Preservation (PDF Format)
Dr. Elaine Jackson-Retondo
National Park Service (PDF Format)
Ms. Katharine Kerr
Advisory Council on Historic Preservation (PDF Format)



PROPOSED SOLAR PHOTOVOLTAIC ARRAY
WEST LOCH ANNEX, OAHU, HAWAII
JOINT BASE PEARL HARBOR-HICKAM

Enclosure 1: Photovoltaic Mounting Systems

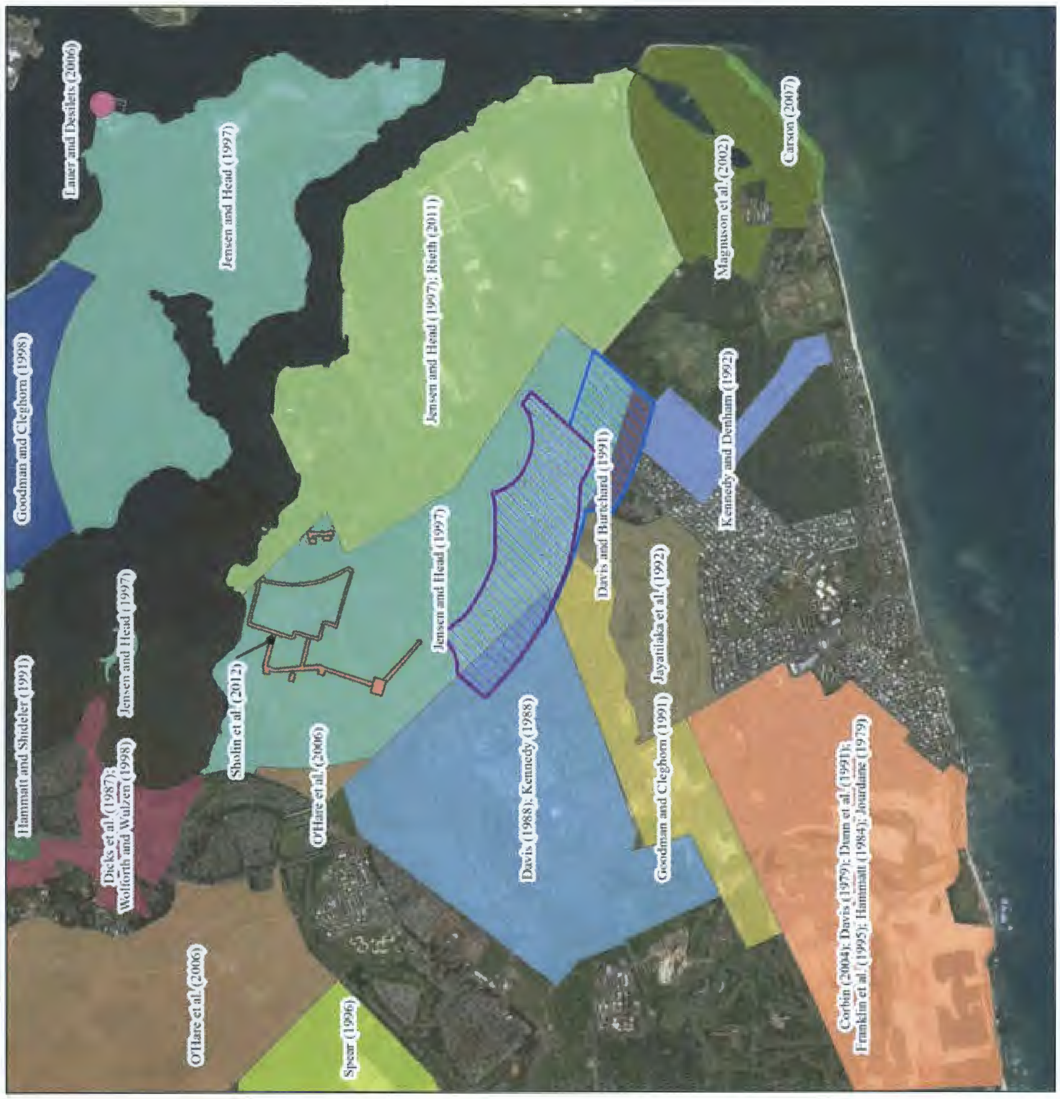


PROPOSED SOLAR PHOTOVOLTAIC ARRAY
WEST LOCH ANNEX, OAHU, HAWAII
JOINT BASE PEARL HARBOR-HICKAM

Enclosure 2: Typical Perimeter Road Layout in PV Field

Enclosure 3: West Loch Annex Solar PV Area of Potential Effects

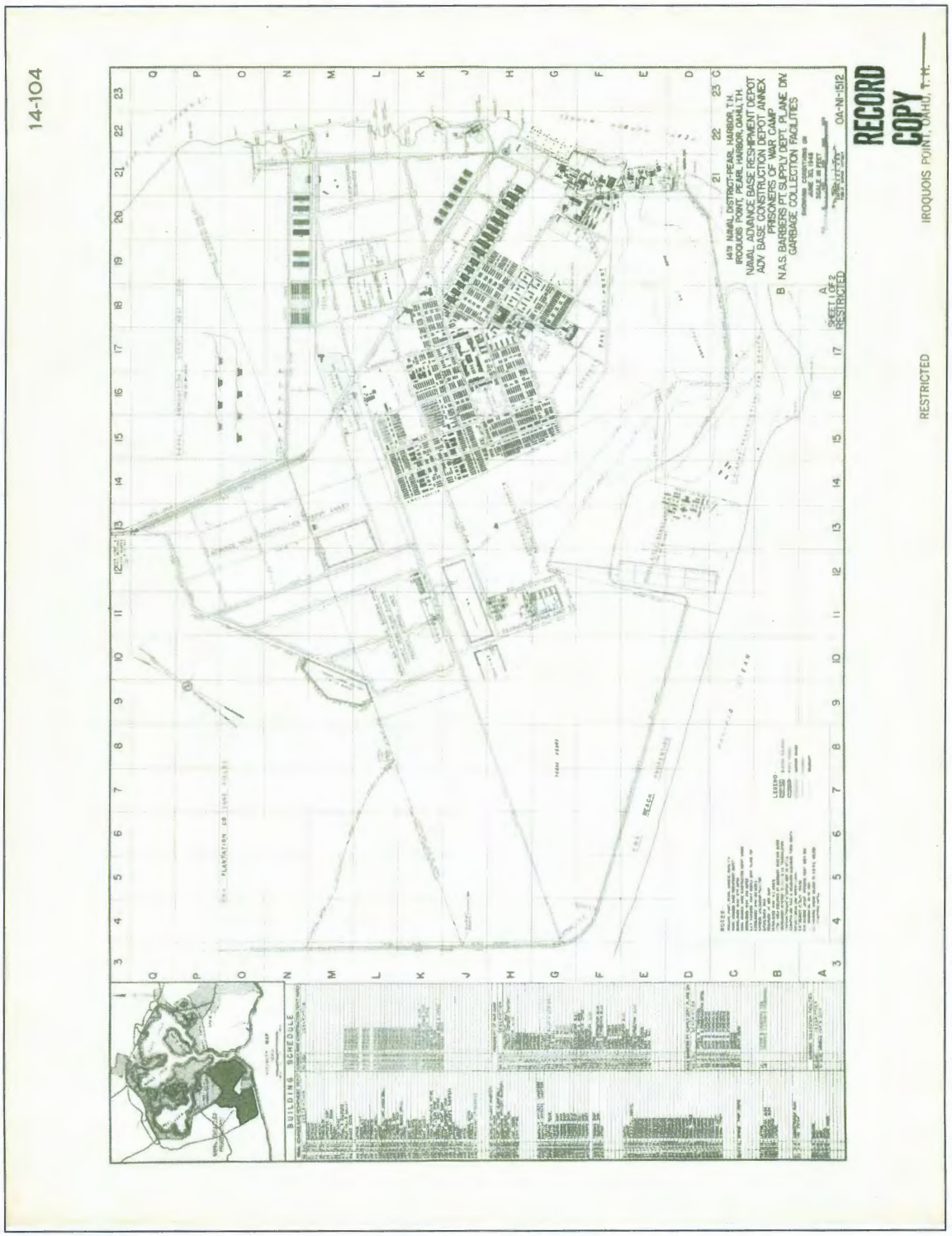
PROPOSED SOLAR PHOTOVOLTAIC ARRAY
WEST LOCH ANNEX, OAHU, HAWAII
JOINT BASE PEARL HARBOR-HICKAM



Previous archaeological investigations in the vicinity of the APE. The most recent study area, (Filimoehala et al. 2014), is identical to the APE (depicted by the hatched areas).

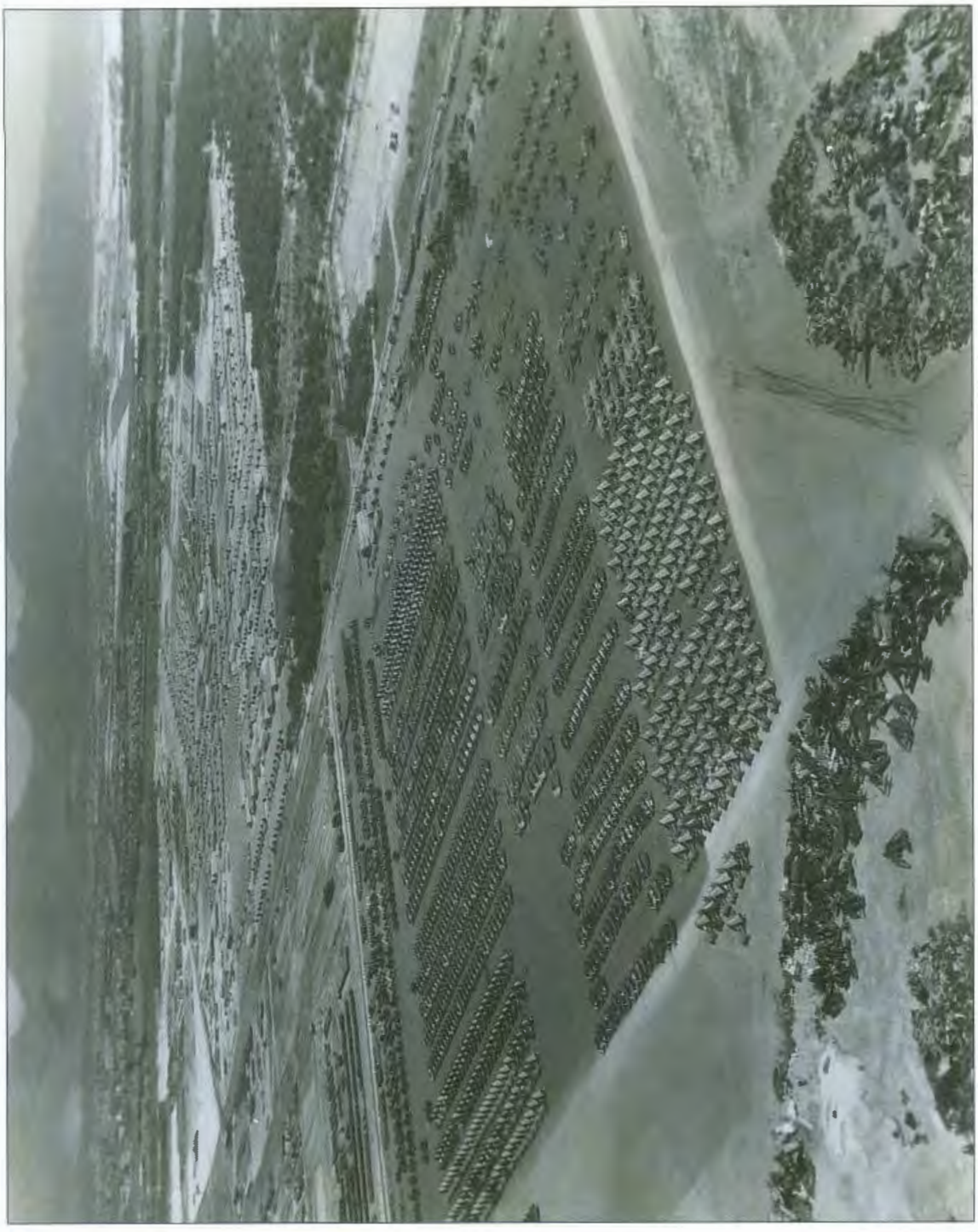
PROPOSED SOLAR PHOTOVOLTAIC ARRAY
WEST LOCH ANNEX, OAHU, HAWAII
JOINT BASE PEARL HARBOR-HICKAM

Enclosure 4: Previous Archaeological Investigations



Enclosure 5: Map of 1946 ABCD at Iroquois Point

PROPOSED SOLAR PHOTOVOLTAIC ARRAY
WEST LOCH ANNEX, OAHU, HAWAII
JOINT BASE PEARL HARBOR-HICKAM



PROPOSED SOLAR PHOTOVOLTAIC ARRAY
WEST LOCH ANNEX, OAHU, HAWAII
JOINT BASE PEARL HARBOR-HICKAM

Enclosure 6: World War II Aerial Photograph of the ABCD Area

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Appendix B

CZMA Correspondence

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From: John Nakagawa [mailto:JNakagaw@dbedt.hawaii.gov]
Sent: Friday, March 20, 2015 2:39 PM
To: Chang, Connie M CIV NAVFAC PAC
Subject: Re: Use of De Minimis List for Photovoltaic Systems EA, JBPHH, West Loch Annex

Connie,

This acknowledges receipt, on March 20, 2015, of the notification of the use of the Navy/Marine Corps CZMA De Minimis List to the subject activity.

Thank you.

John Nakagawa
Hawaii Coastal Zone Management Program
(808) 587-2878

From: "Chang, Connie M CIV NAVFAC PAC" <connie.chang@navy.mil>
To: "Nakagawa, John (DBEDT)" <jnakagaw@dbedt.hawaii.gov>
Date: 03/20/2015 02:25 PM
Subject: Use of De Minimis List for Photovoltaic Systems EA, JBPHH, West Loch Annex

_____

Aloha John,

In accordance with DBEDT's letter dated July 9, 2009, this e-mail notification is provided to the State CZM office in compliance with "Project Mitigation / General Conditions" when the Department of the Navy/Marine Corps de minimis list under CZMA is used for projects that require an Environmental Assessment (EA).

NAVFAC Pacific, on behalf of Joint Base Pearl Harbor Hickam, is preparing a Photovoltaic Systems EA and has determined that the proposed project falls under the de minimis list.

Project information and relevant "Project Mitigation / General Conditions" are provided below. Please let me know if you have any questions.

Regards,
Connie

Connie Chang
NAVFAC Pacific
Environmental Planning
472-1395

Background:
Recent Congressional and service mandates require an increased focus on production of renewable energy to reduce the Federal government's reliance on non-renewable energy sources. In support of these mandates, SECNAV created the 1 Gigawatt (GW) Initiative-named for the amount of renewable energy generation capacity to be deployed by the Navy in 2015 (DoN 2012), either on or near DoN installations. This goal was initially stated in the President's 2012 State of the Union Address and is consistent with SECNAVs 2009 alternative energy goal and the 2013 presidential memorandum.

Proposed Action:
The DoN proposes to lease up to 380 acres of land to Hawaiian Electric (HE), the local electric utility company, who would engage a renewable energy contractor to build and operate a ground-mounted solar PV system at Joint Base Pearl Harbor Hickam (JBPHH), West Loch Annex. The PV system would utilize solar panels and electrical equipment to convert sunlight into electrical energy and feed into HE's electrical grid for Oahu. The land underlying the PV site would be leased to HE for 37 years after which time the lease would either be renewed or the facility would be decommissioned.

The Draft EA will be issued for a 30-day public comment period in Apr 2015. Section 106 consultation with SHPO has been initiated and will be completed prior to issuance of the Final EA and FONSI.

Applicability of De Minimis Activities under CZMA:
The Proposed Action to install a PV system at JBPHH falls within Items 1 (New Construction) & 2 (Utility Line Activities) on the de minimis list.

The relevant mitigation/conditions are as follow:

(1) All activities will occur on DoD property.
(6) No project-related materials will be stockpiled in the water.
(9) Fueling of project-related vehicles and equipment will take place away from the water. A contingency plan will be established to control accidental petroleum releases during project construction.
(10) All fill material will be protected from erosion as soon as practicable.
(11) All exposed soil will be protected from erosion and stabilized as soon as practicable.
(12) Consultation pursuant to Section 106 of the NHPA will be completed.
(13) No species or habitats protected under ESA will be affected by the Proposed Action.
(14) NEPA EA process will be completed.
(16) State CZM office notified on use of de minimis list for an EA.

Appendix C

SGHAT Glint and Glare Analysis

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Solar Glare Hazard Analysis Flight Path Report

Generated Dec. 22, 2014, 6:50 p.m.

Flight path: HIA 8R

Glare found

Print

Analysis & PV array parameters

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	180.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	90.0
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	21.3391300271	-158.016228676	29.53	4.0	33.53
2	21.3411086869	-158.014383316	29.53	4.0	33.53
3	21.3413485226	-158.012731075	28.24	4.0	32.24
4	21.3422878755	-158.0114007	26.71	4.0	30.71
5	21.3403897769	-158.009319305	26.25	4.0	30.25
6	21.3385909876	-158.005714417	16.84	4.0	20.84
7	21.3383511474	-158.002281189	19.69	4.0	23.69
8	21.3367122285	-158.000822067	16.34	4.0	20.34
9	21.3357128788	-157.997817993	9.84	4.0	13.84
10	21.3364324113	-157.995715141	13.3	4.0	17.3
11	21.3359127493	-157.99489975	19.69	4.0	23.69
12	21.3331944873	-157.99738884	19.69	4.0	23.69
13	21.3314555727	-157.992453575	16.4	4.0	20.4
14	21.3275579306	-157.996273041	13.12	4.0	17.12
15	21.3304361994	-158.003096581	19.31	4.0	23.31
16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

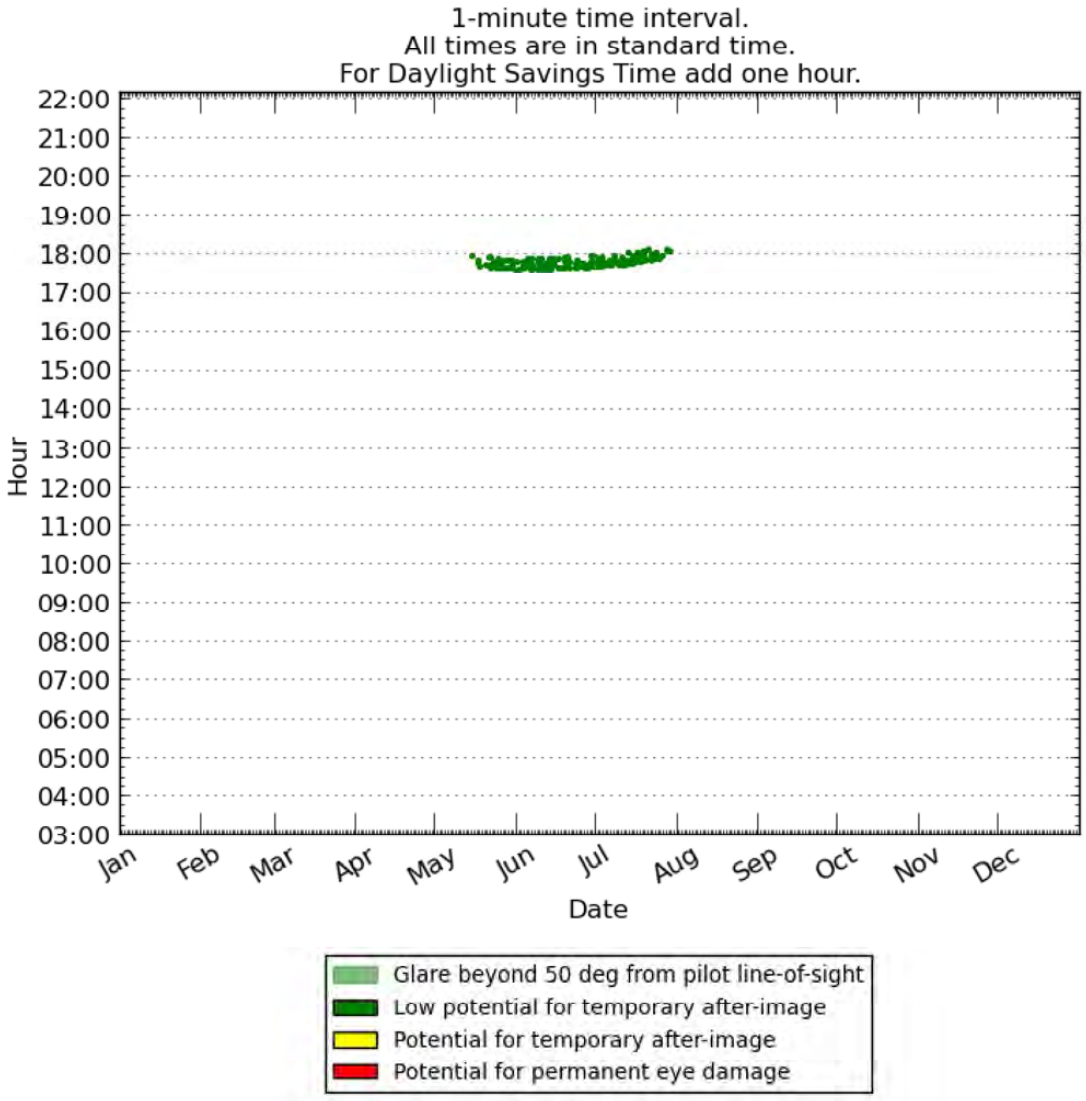
Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	21.3067881494	-157.945804596	3.26	50.0	Yes
1/4 mi	21.3067881494	-157.949688005	0.0	122.43	Yes
1/2 mi	21.3067881494	-157.953571414	0.0	191.62	Yes
3/4 mi	21.3067881494	-157.957454823	0.0	260.79	Yes
1 mi	21.3067881494	-157.961338231	0.0	329.96	No
1 1/4 mi	21.3067881494	-157.96522164	0.0	399.15	No
1 1/2 mi	21.3067881494	-157.969105049	0.0	468.32	No
1 3/4 mi	21.3067881494	-157.972988458	0.0	537.51	No
2 mi	21.3067881494	-157.976871867	0.0	606.68	No

Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

Threshold


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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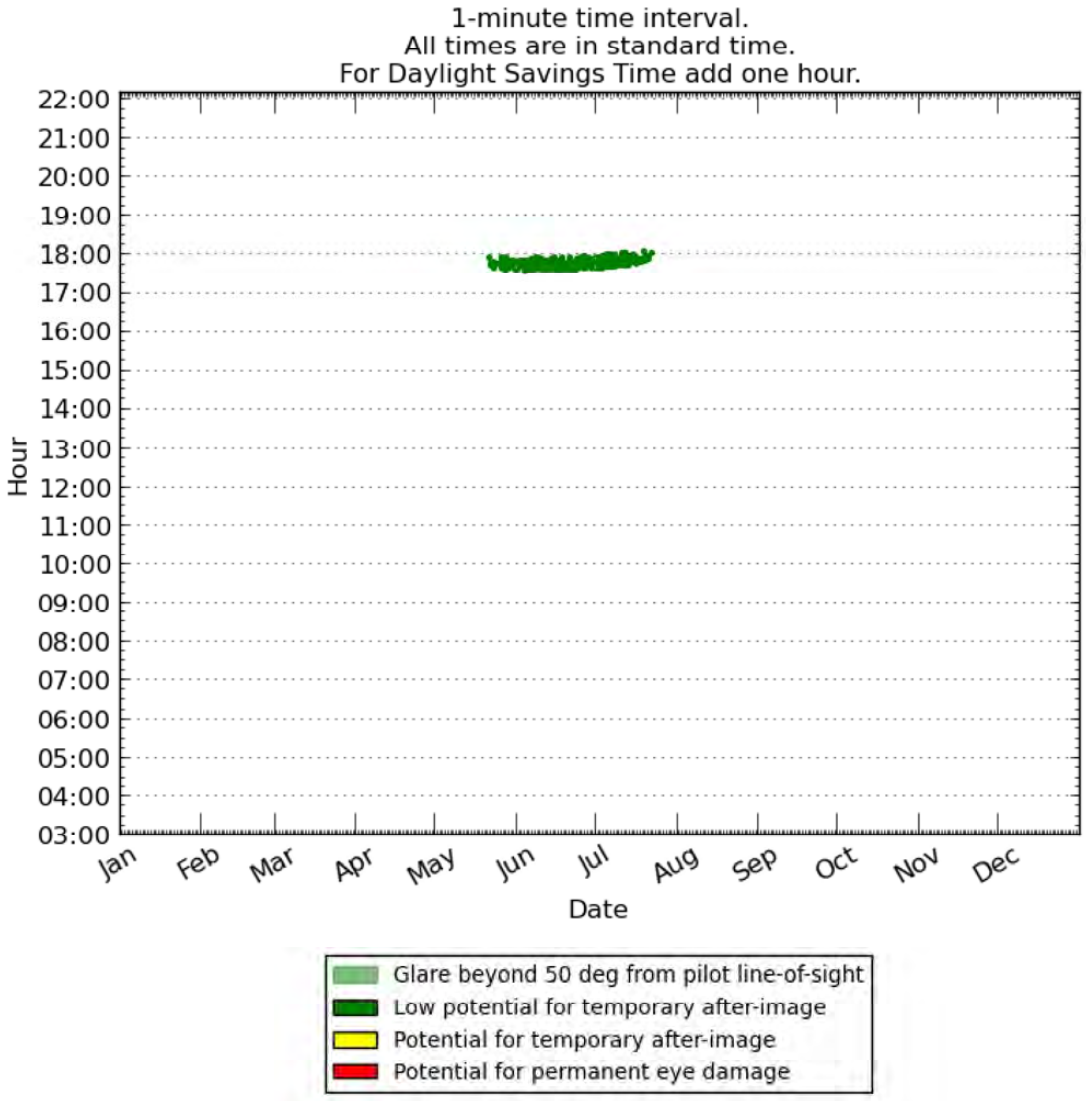
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/4 mi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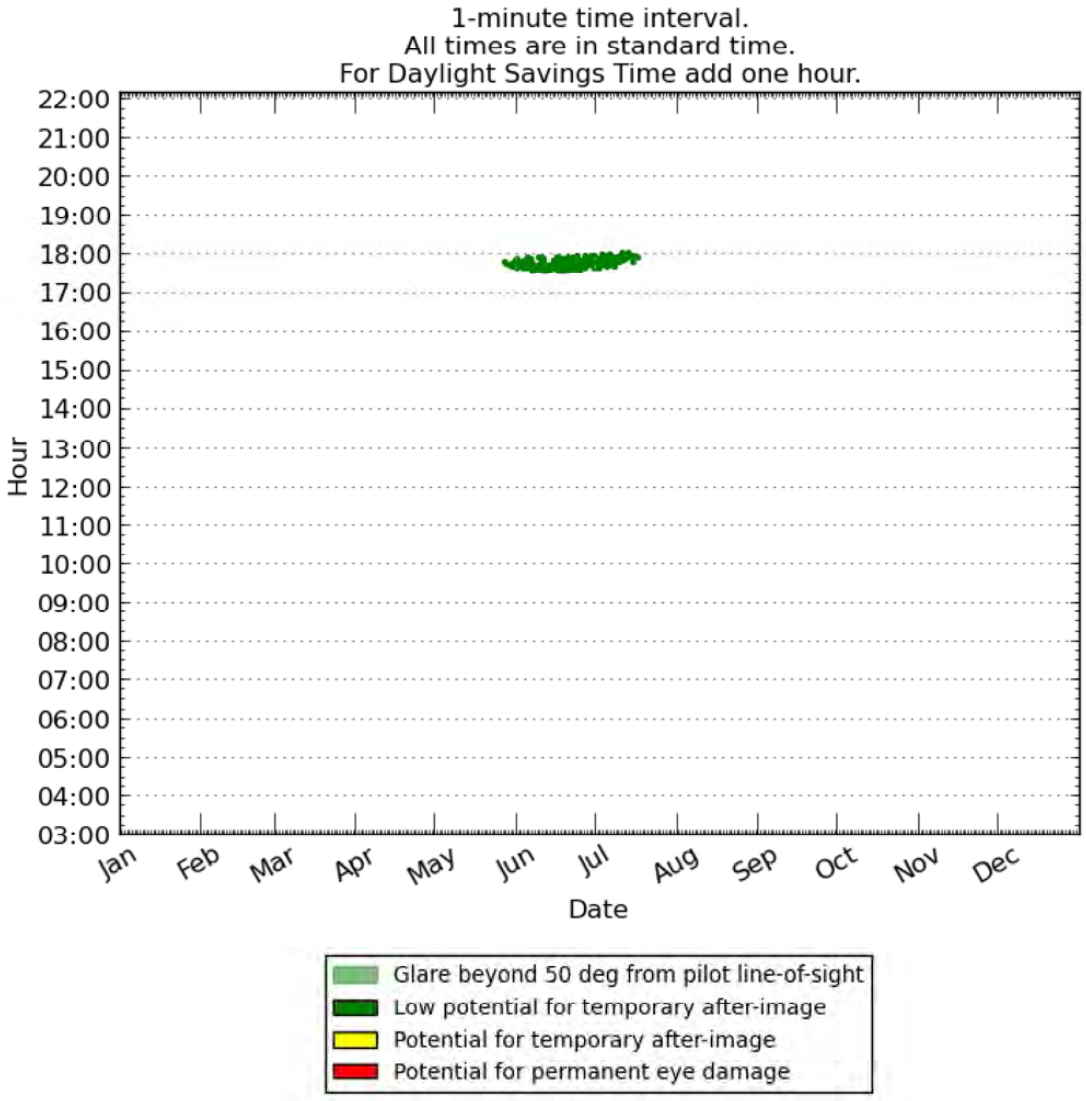
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/2 mi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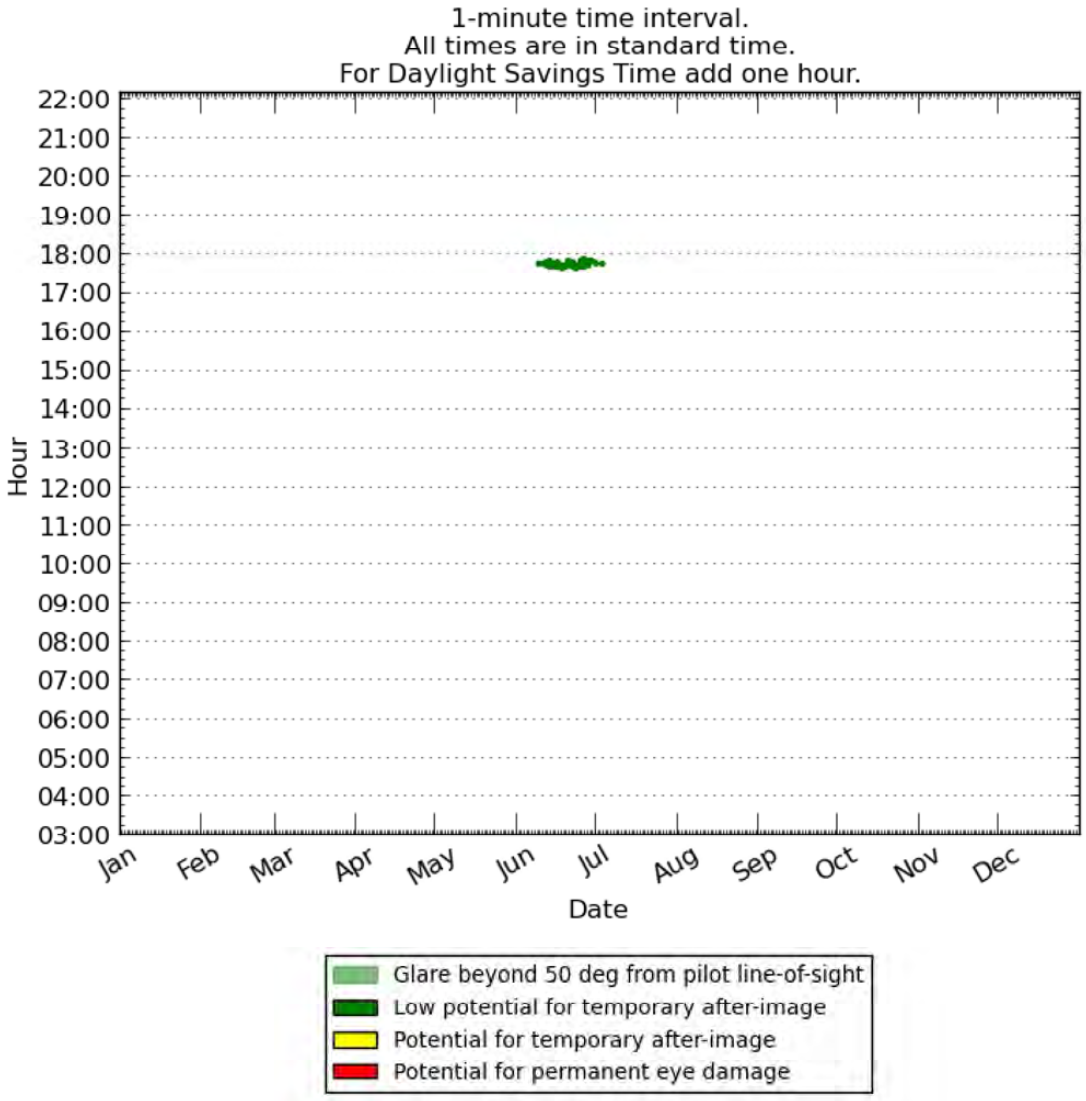
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

3/4 mi


1-minute time interval.
All times are in standard time.
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Nov
Dec
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 mi

No glare

1 1/4 mi

No glare

1 1/2 mi

No glare

1 3/4 mi

No glare

2 mi

No glare

Solar Glare Hazard Analysis Flight Path Report

Generated Dec. 22, 2014, 8:33 p.m.

Flight path: HIA 8R

No glare found

Print

Analysis & PV array parameters

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	220.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	90.0
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
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8	21.3367122285	-158.000822067	16.34	4.0	20.34
9	21.3357128788	-157.997817993	9.84	4.0	13.84
10	21.3364324113	-157.995715141	13.3	4.0	17.3
11	21.3359127493	-157.99489975	19.69	4.0	23.69
12	21.3331944873	-157.99738884	19.69	4.0	23.69
13	21.3314555727	-157.992453575	16.4	4.0	20.4
14	21.3275579306	-157.996273041	13.12	4.0	17.12
15	21.3304361994	-158.003096581	19.31	4.0	23.31
16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	21.3068189356	-157.945852876	3.26	50.0	No
1/4 mi	21.3068189356	-157.949736285	0.0	122.43	No
1/2 mi	21.3068189356	-157.953619695	0.0	191.62	No
3/4 mi	21.3068189356	-157.957503105	0.0	260.79	No
1 mi	21.3068189356	-157.961386514	0.0	329.96	No
1 1/4 mi	21.3068189356	-157.965269924	0.0	399.15	No
1 1/2 mi	21.3068189356	-157.969153334	0.0	468.32	No
1 3/4 mi	21.3068189356	-157.973036743	0.0	537.51	No
2 mi	21.3068189356	-157.976920153	0.0	606.68	No

No glare found.

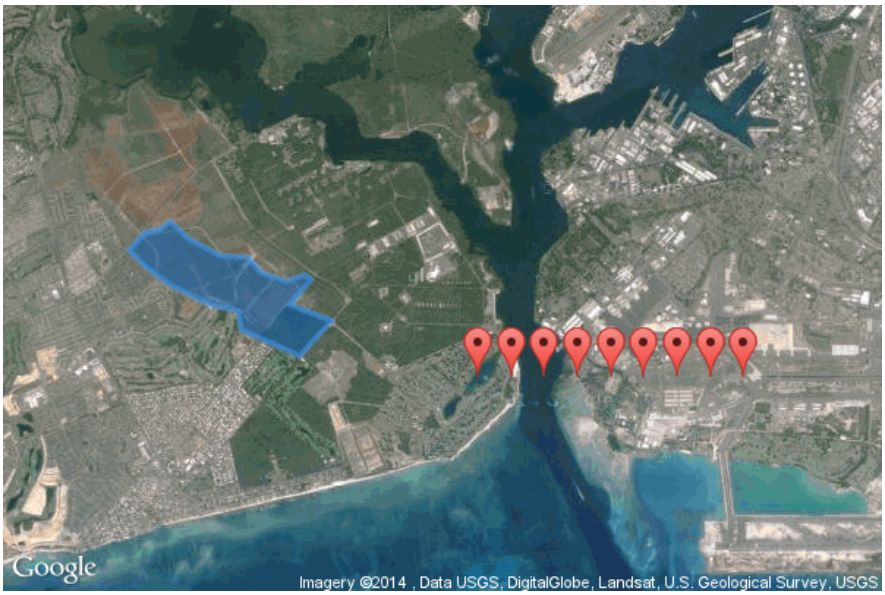
Solar Glare Hazard Analysis Flight Path Report

Generated Dec. 22, 2014, 6:52 p.m.

Flight path: HIA 8L

Glare found

Print



Analysis & PV array parameters

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	180.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	90.0
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	21.3391300271	-158.016228676	29.53	4.0	33.53
2	21.3411086869	-158.014383316	29.53	4.0	33.53
3	21.3413485226	-158.012731075	28.24	4.0	32.24
4	21.3422878755	-158.0114007	26.71	4.0	30.71
5	21.3403897769	-158.009319305	26.25	4.0	30.25
6	21.3385909876	-158.005714417	16.84	4.0	20.84
7	21.3383511474	-158.002281189	19.69	4.0	23.69
8	21.3367122285	-158.000822067	16.34	4.0	20.34
9	21.3357128788	-157.997817993	9.84	4.0	13.84
10	21.3364324113	-157.995715141	13.3	4.0	17.3
11	21.3359127493	-157.99489975	19.69	4.0	23.69
12	21.3331944873	-157.99738884	19.69	4.0	23.69
13	21.3314555727	-157.992453575	16.4	4.0	20.4
14	21.3275579306	-157.996273041	13.12	4.0	17.12
15	21.3304361994	-158.003096581	19.31	4.0	23.31
16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

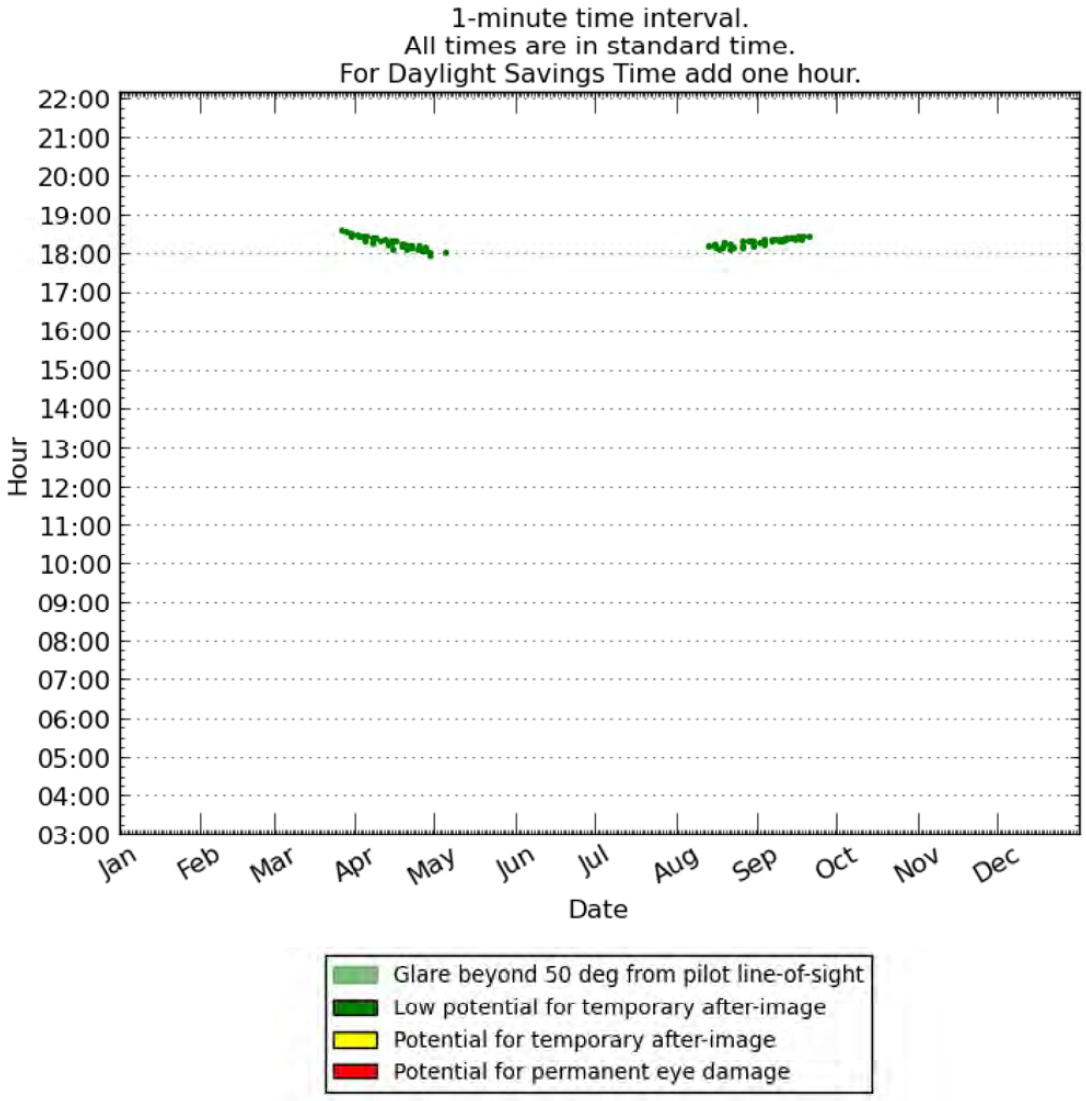
Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	21.3252658689	-157.944227457	9.84	50.0	Yes
1/4 mi	21.3252658689	-157.948111355	2.15	126.86	Yes
1/2 mi	21.3252658689	-157.951995252	3.28	194.92	Yes
3/4 mi	21.3252658689	-157.95587915	3.28	264.1	Yes
1 mi	21.3252658689	-157.959763047	3.28	333.27	Yes
1 1/4 mi	21.3252658689	-157.963646945	0.06	405.68	Yes
1 1/2 mi	21.3252658689	-157.967530843	0.0	474.91	Yes
1 3/4 mi	21.3252658689	-157.97141474	3.28	540.82	Yes
2 mi	21.3252658689	-157.975298638	0.0	613.27	Yes

Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

Threshold


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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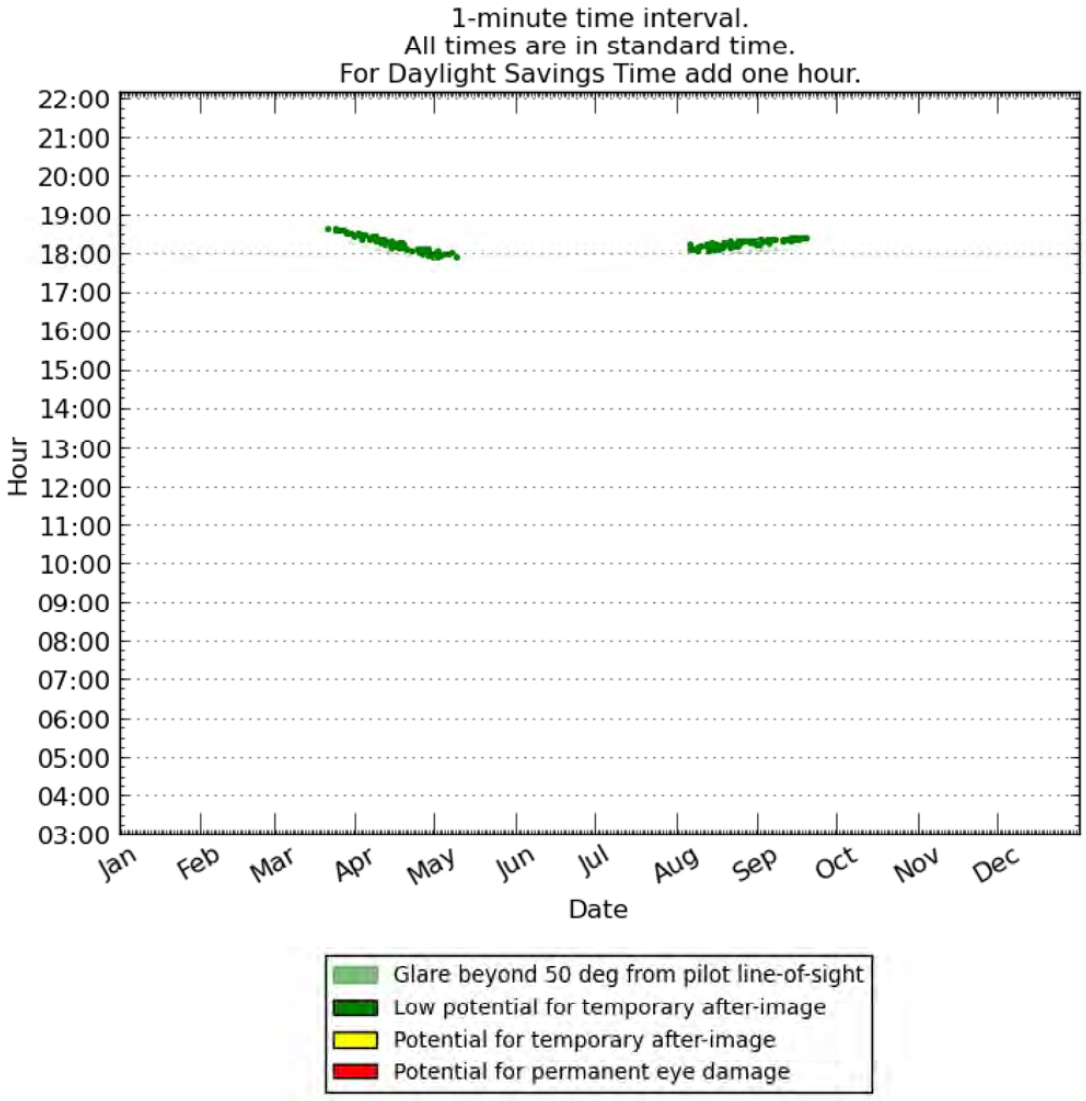
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/4 mi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All times are in standard time.
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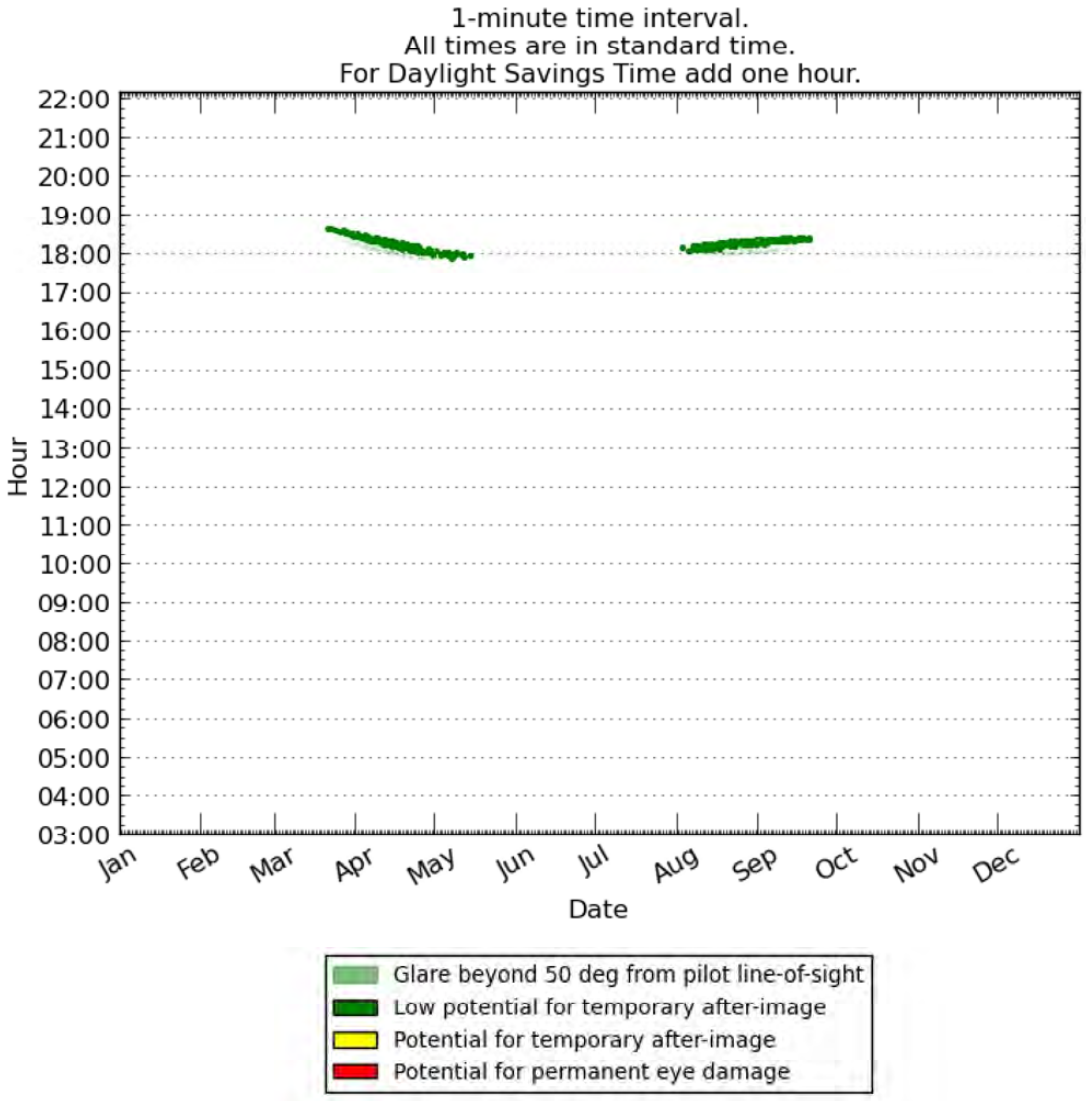
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/2 mi


1-minute time interval.
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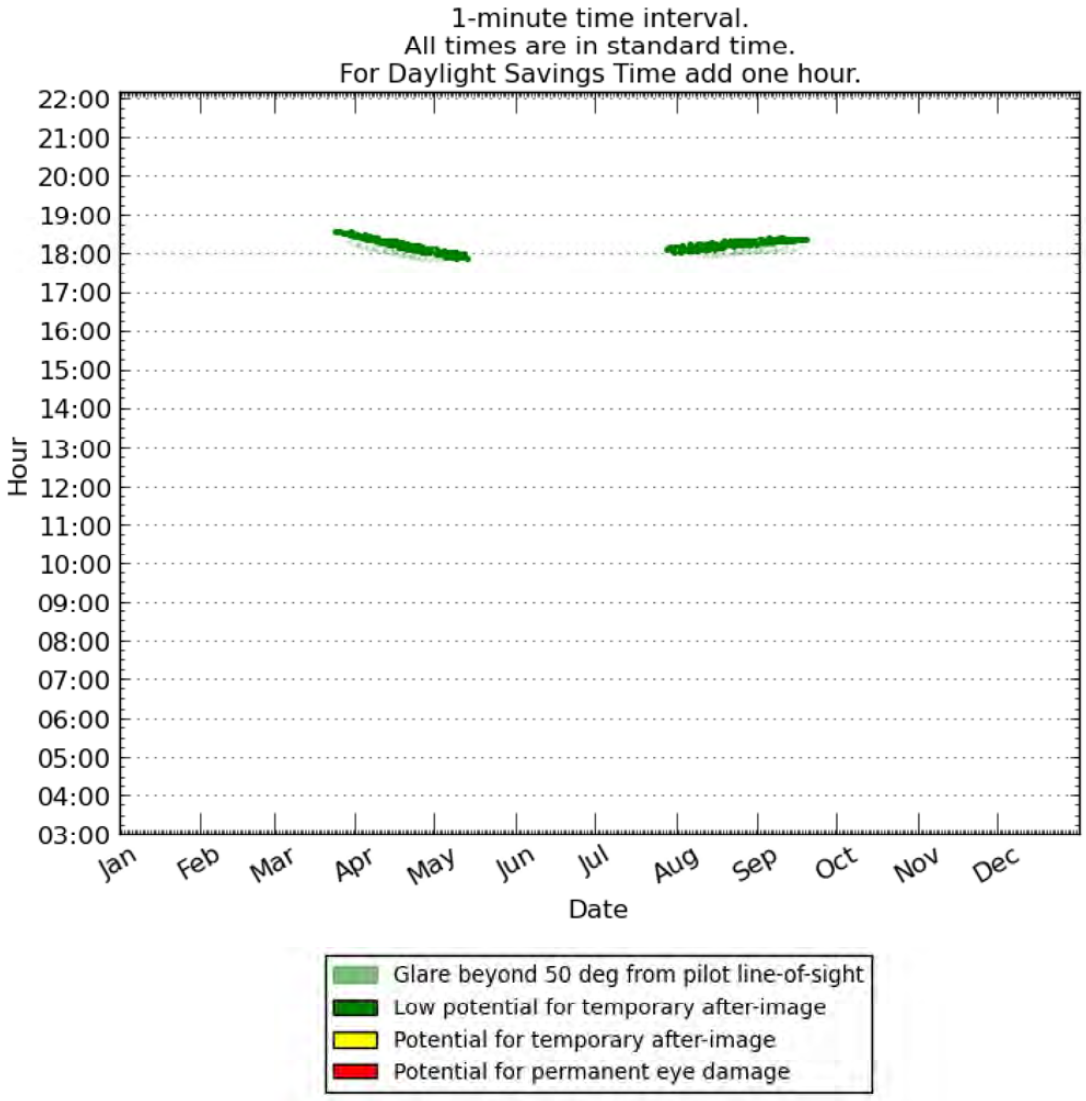
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

3/4 mi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All times are in standard time.
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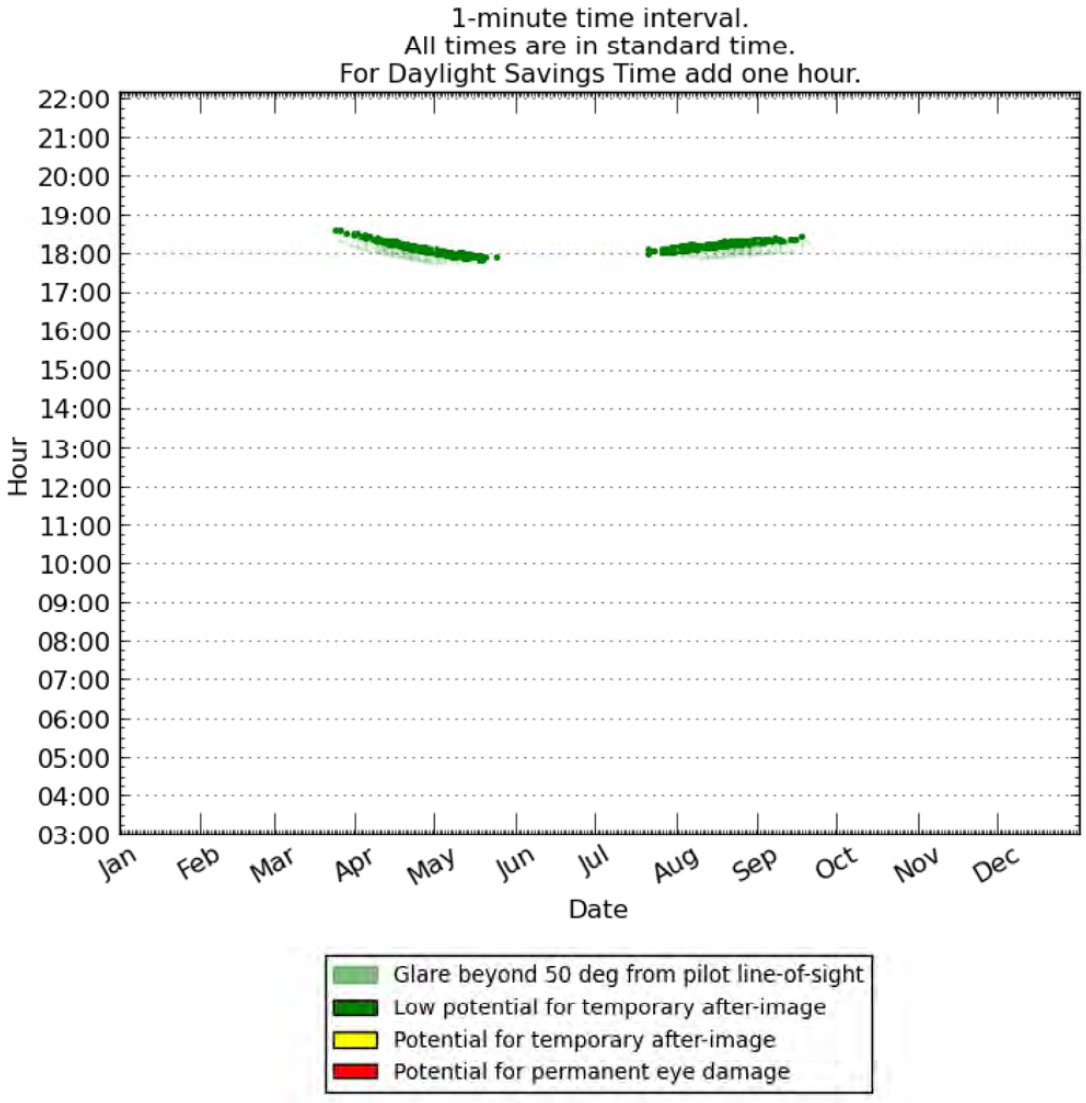
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 mi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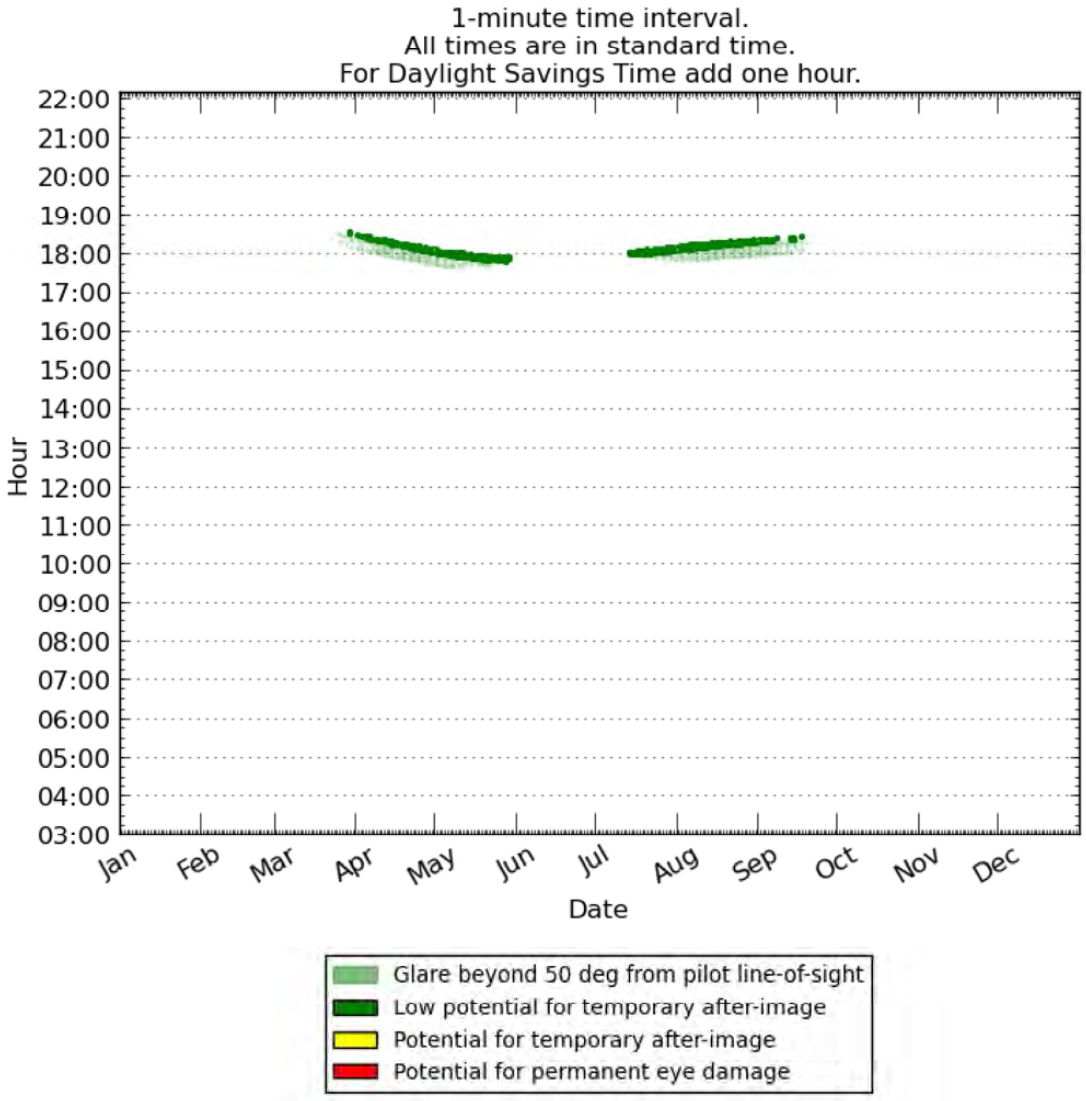
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 1/4 mi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All times are in standard time.
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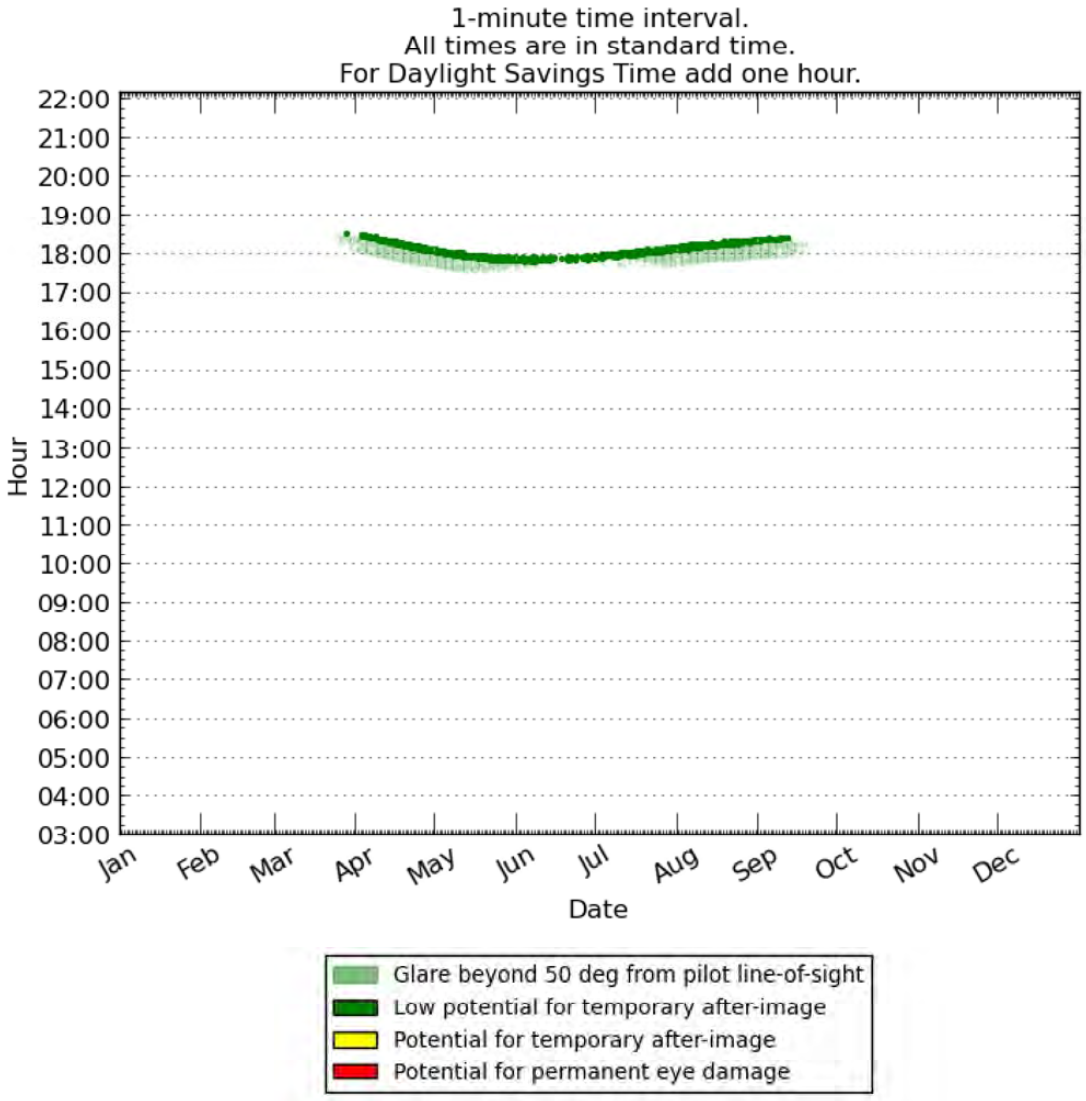
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 1/2 mi


1-minute time interval.
All times are in standard time.
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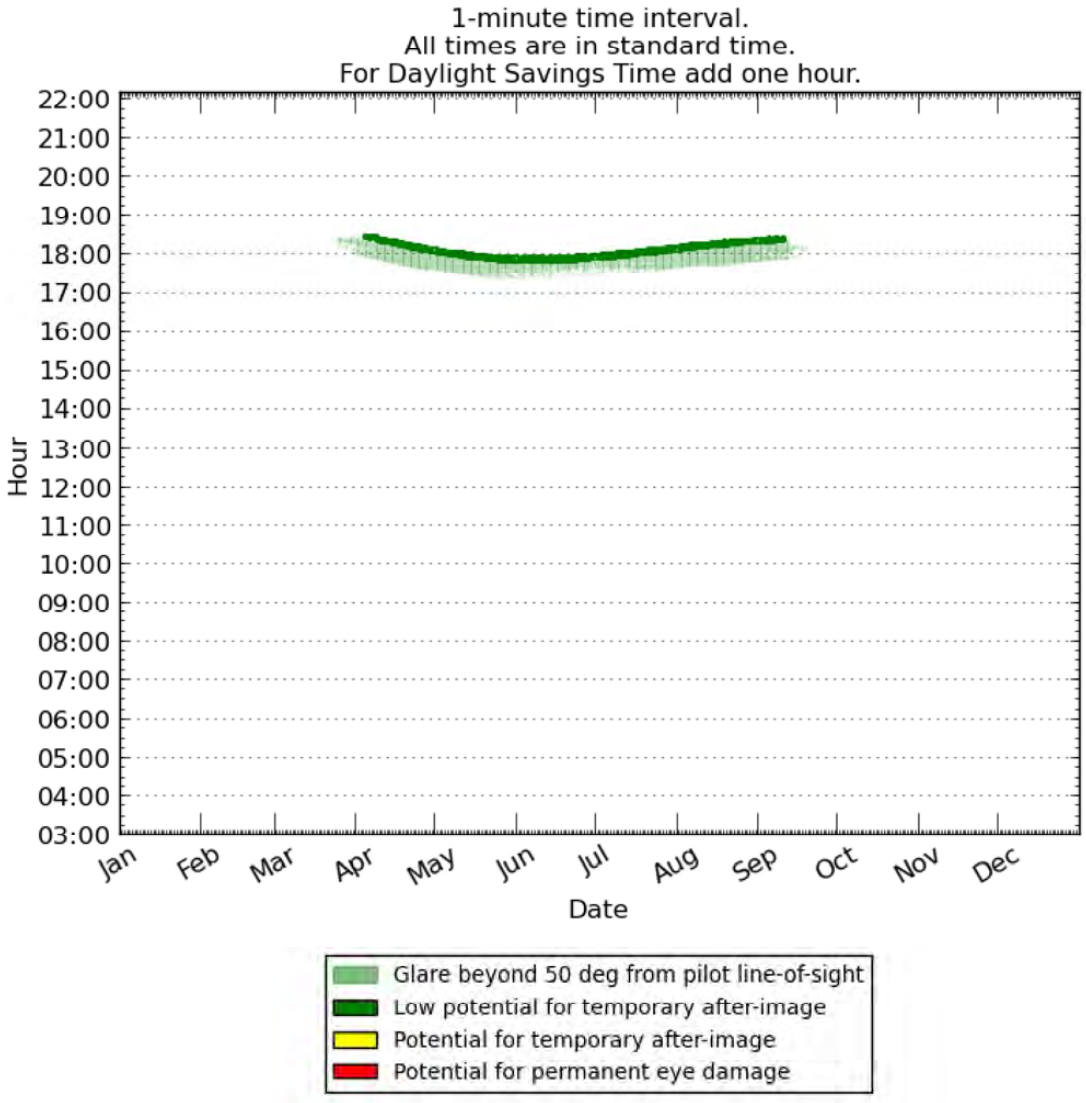
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 3/4 mi


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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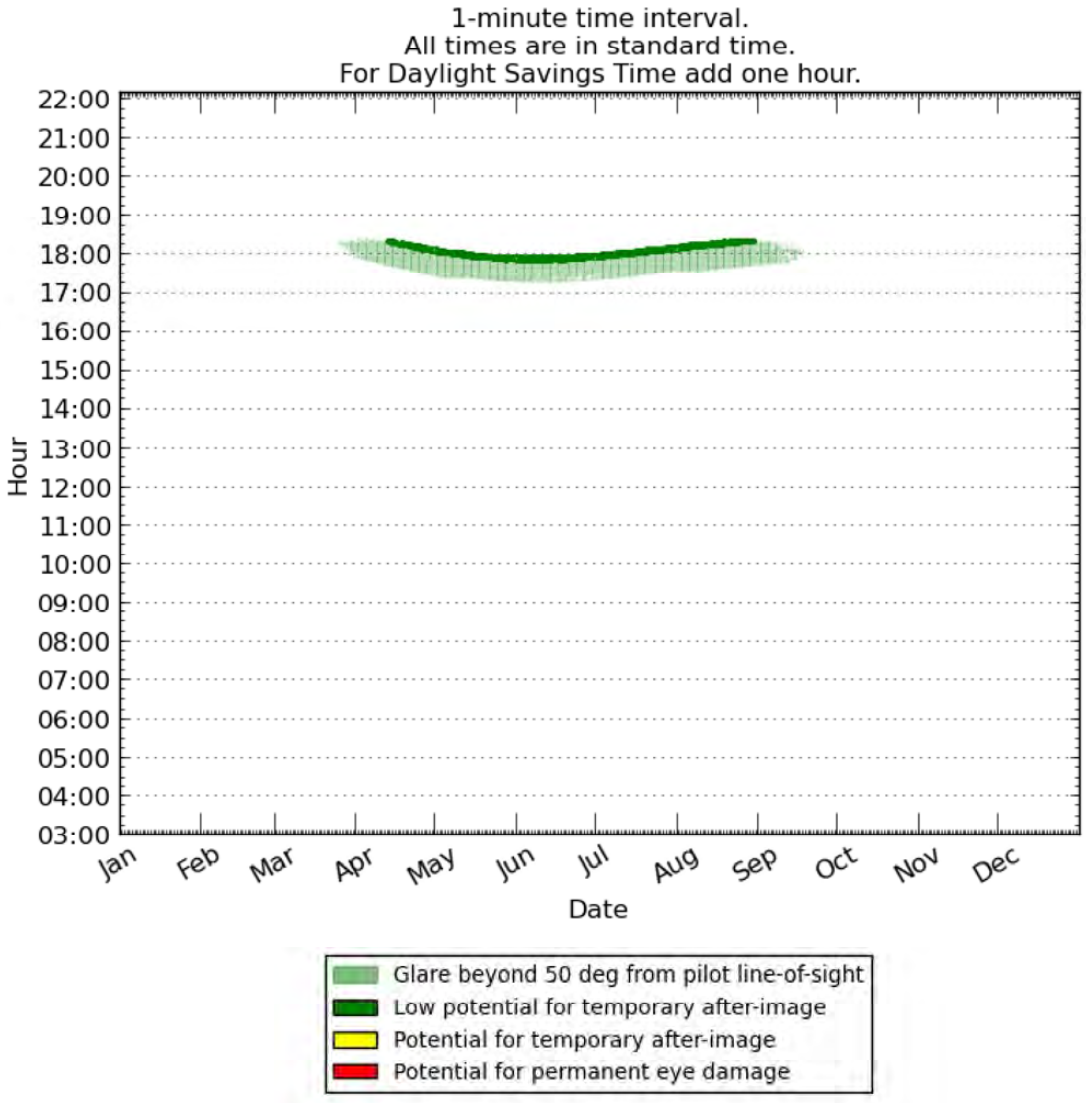
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

2 mi



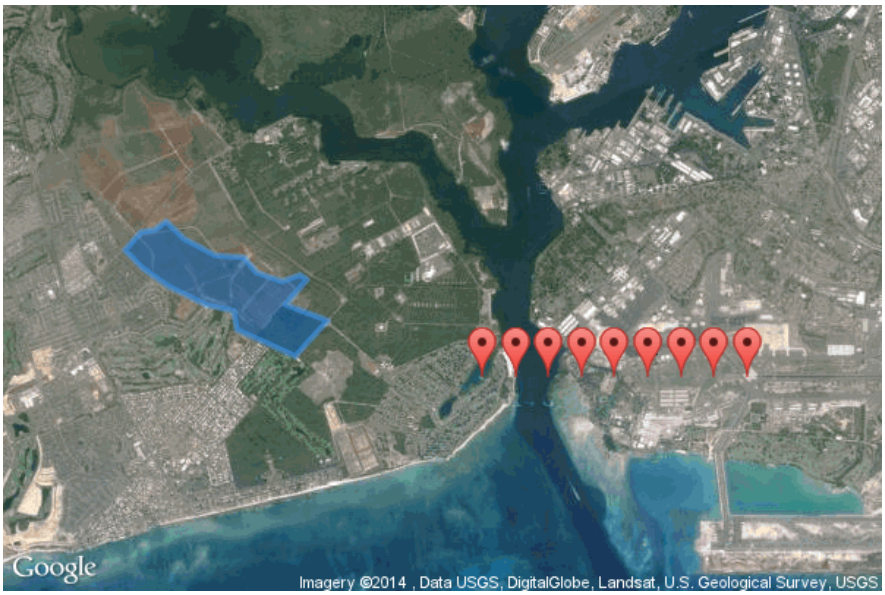
Solar Glare Hazard Analysis Flight Path Report

Generated Dec. 22, 2014, 8:33 p.m.

Flight path: HIA 8L

No glare found

Print



Analysis & PV array parameters

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	220.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	90.0
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	21.3391300271	-158.016228676	29.53	4.0	33.53
2	21.3411086869	-158.014383316	29.53	4.0	33.53
3	21.3413485226	-158.012731075	28.24	4.0	32.24
4	21.3422878755	-158.0114007	26.71	4.0	30.71
5	21.3403897769	-158.009319305	26.25	4.0	30.25
6	21.3385909876	-158.005714417	16.84	4.0	20.84
7	21.3383511474	-158.002281189	19.69	4.0	23.69
8	21.3367122285	-158.000822067	16.34	4.0	20.34
9	21.3357128788	-157.997817993	9.84	4.0	13.84
10	21.3364324113	-157.995715141	13.3	4.0	17.3
11	21.3359127493	-157.99489975	19.69	4.0	23.69
12	21.3331944873	-157.99738884	19.69	4.0	23.69
13	21.3314555727	-157.992453575	16.4	4.0	20.4
14	21.3275579306	-157.996273041	13.12	4.0	17.12
15	21.3304361994	-158.003096581	19.31	4.0	23.31
16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	21.325265644	-157.943229675	9.84	50.0	No
1/4 mi	21.325265644	-157.947113573	3.28	125.73	No
1/2 mi	21.325265644	-157.95099747	3.28	194.92	No
3/4 mi	21.325265644	-157.954881368	3.28	264.1	No
1 mi	21.325265644	-157.958765266	3.28	333.27	No
1 1/4 mi	21.325265644	-157.962649163	3.28	402.46	No
1 1/2 mi	21.325265644	-157.966533061	0.0	474.91	No
1 3/4 mi	21.325265644	-157.970416958	0.99	543.11	No
2 mi	21.325265644	-157.974300856	0.0	613.27	No

No glare found.

Solar Glare Hazard Analysis Flight Path Report

Generated Dec. 22, 2014, 7:21 p.m.

Flight path: HIA 4R

Glare found

Print

Analysis & PV array parameters

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	180.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	53.9
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	21.3391300271	-158.016228676	29.53	4.0	33.53
2	21.3411086869	-158.014383316	29.53	4.0	33.53
3	21.3413485226	-158.012731075	28.24	4.0	32.24
4	21.3422878755	-158.0114007	26.71	4.0	30.71
5	21.3403897769	-158.009319305	26.25	4.0	30.25
6	21.3385909876	-158.005714417	16.84	4.0	20.84
7	21.3383511474	-158.002281189	19.69	4.0	23.69
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16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

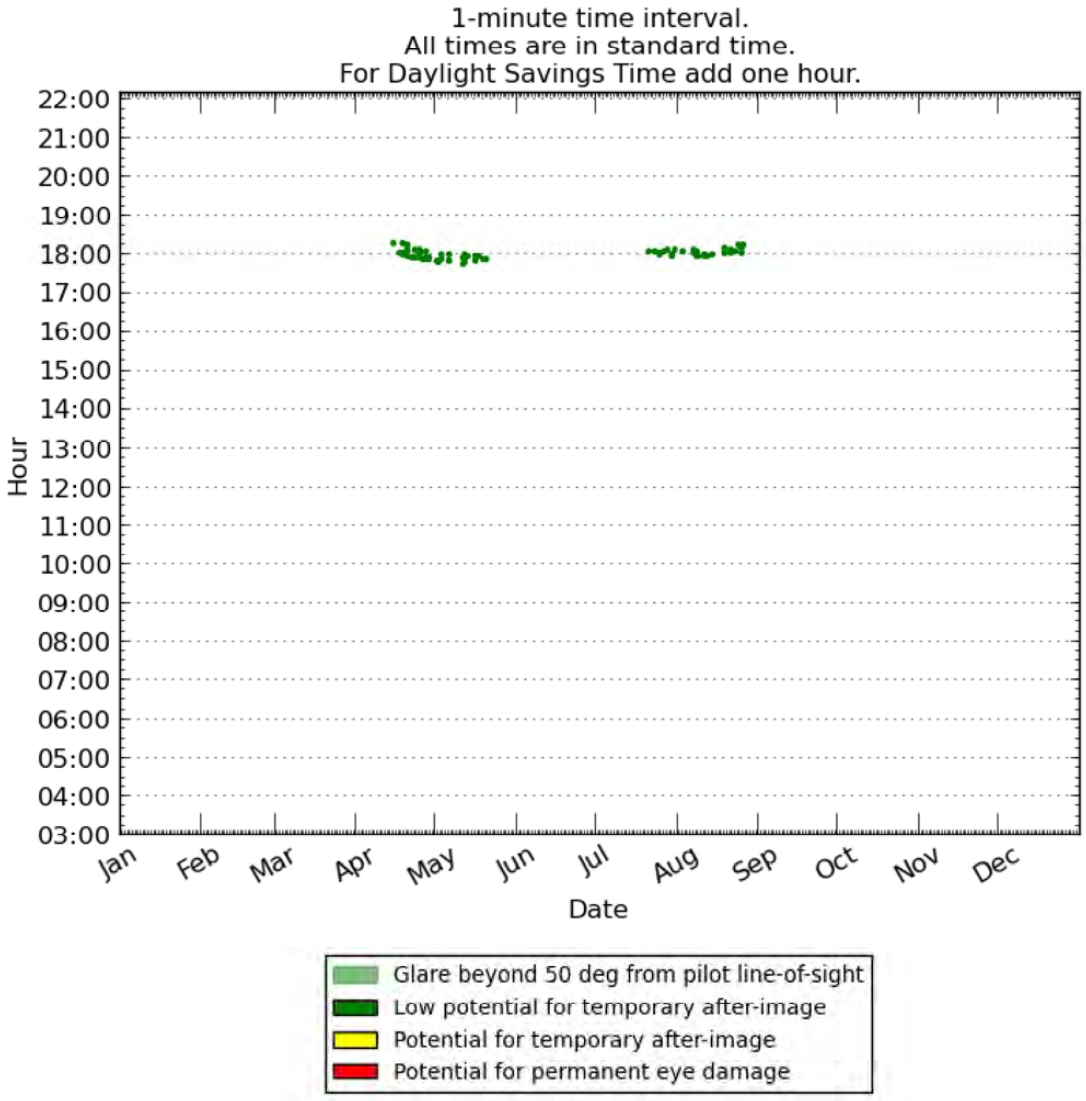
Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	21.3139443038	-157.927136421	3.28	50.0	Yes
1/4 mi	21.3118150992	-157.930274329	0.0	122.45	Yes
1/2 mi	21.3096858947	-157.933412237	3.28	188.36	Yes
3/4 mi	21.3075566902	-157.936550145	3.28	257.53	Yes
1 mi	21.3054274857	-157.939688053	3.21	326.77	Yes
1 1/4 mi	21.3032982811	-157.942825961	0.0	399.18	Yes
1 1/2 mi	21.3011690766	-157.945963869	0.0	468.35	Yes
1 3/4 mi	21.2990398721	-157.949101777	0.0	537.54	No
2 mi	21.2969106675	-157.952239685	0.0	606.71	No

Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

Threshold


1-minute time interval.
All times are in standard time.
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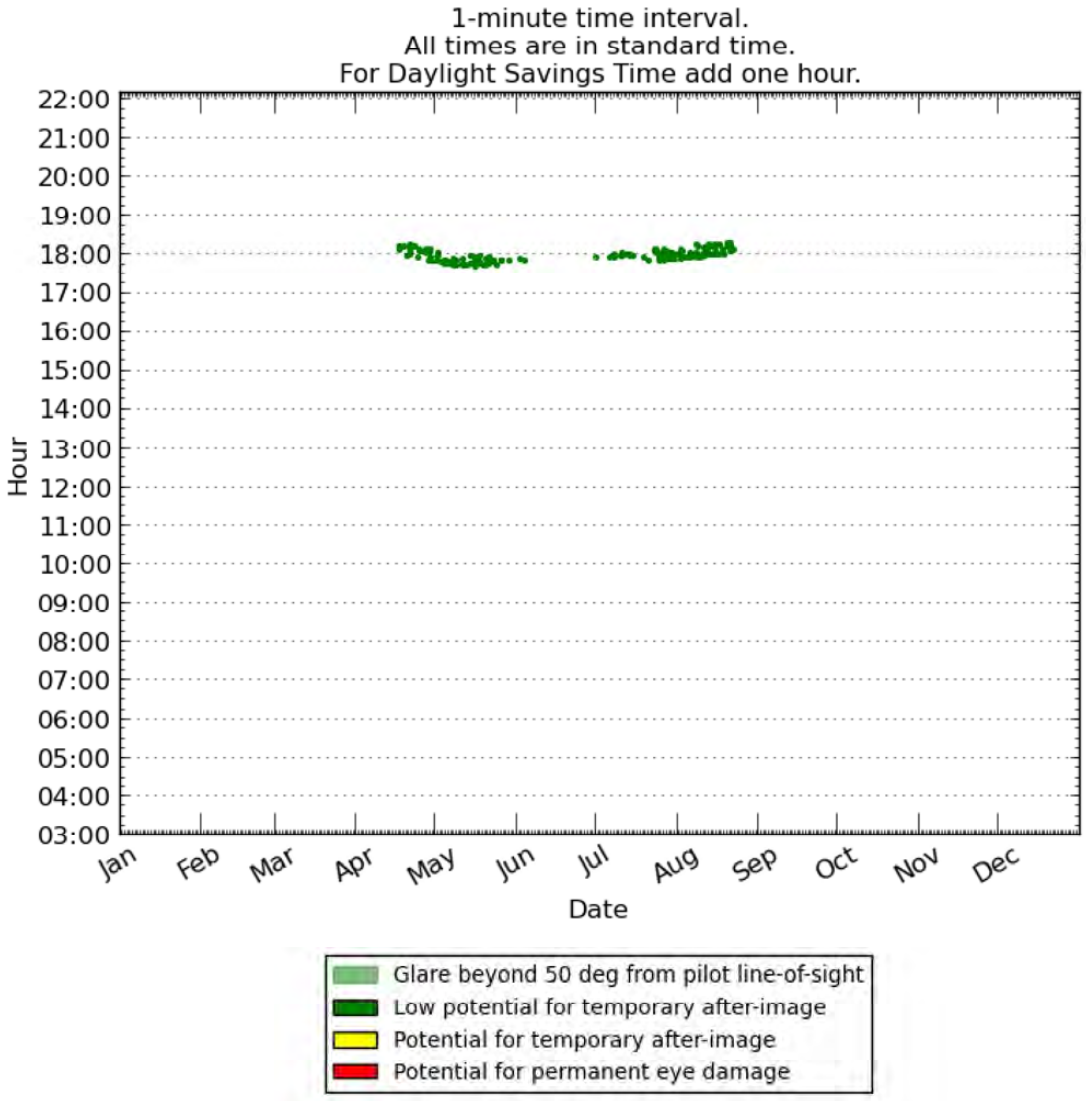
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/4 mi


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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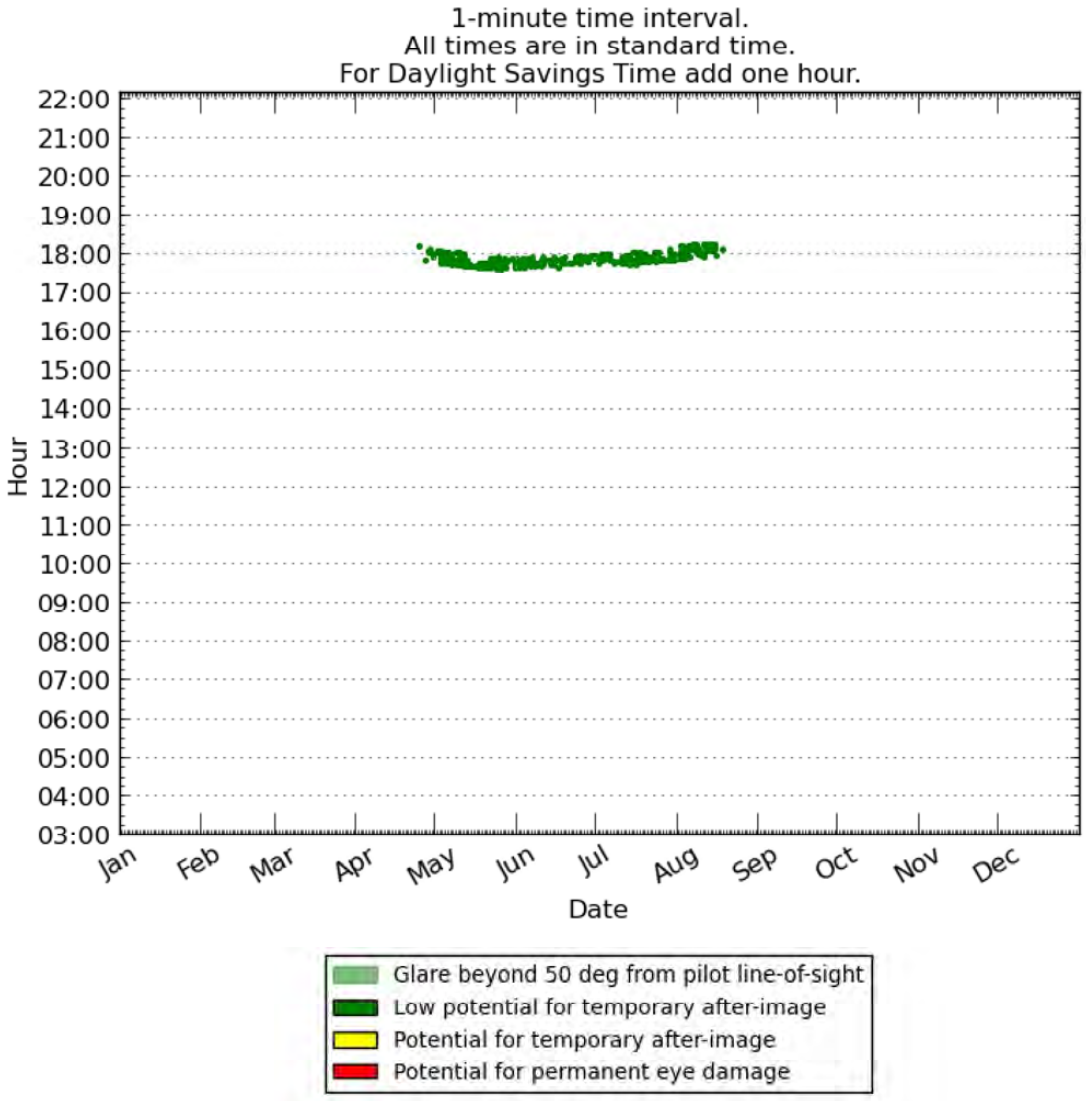
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/2 mi


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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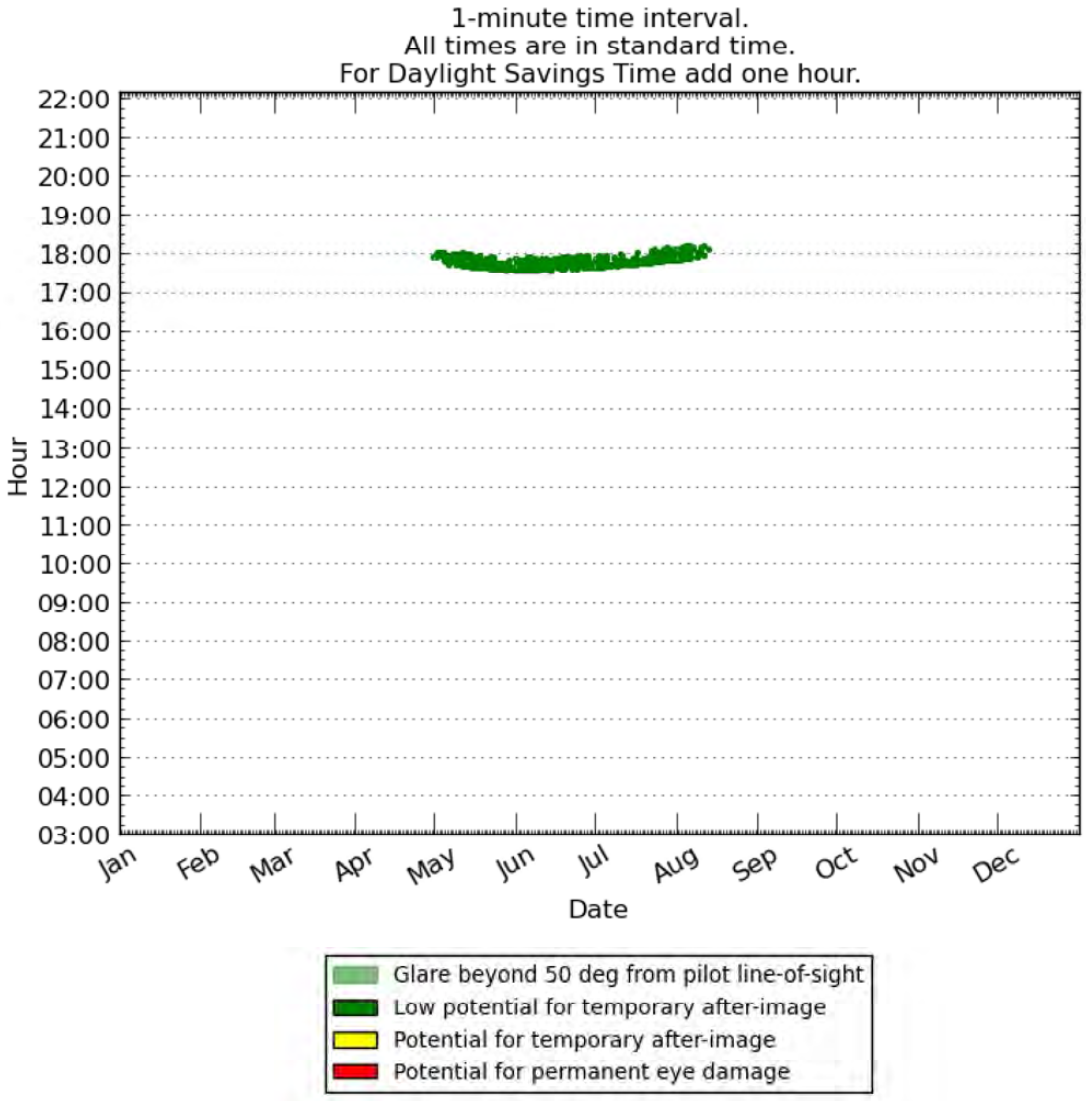
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

3/4 mi


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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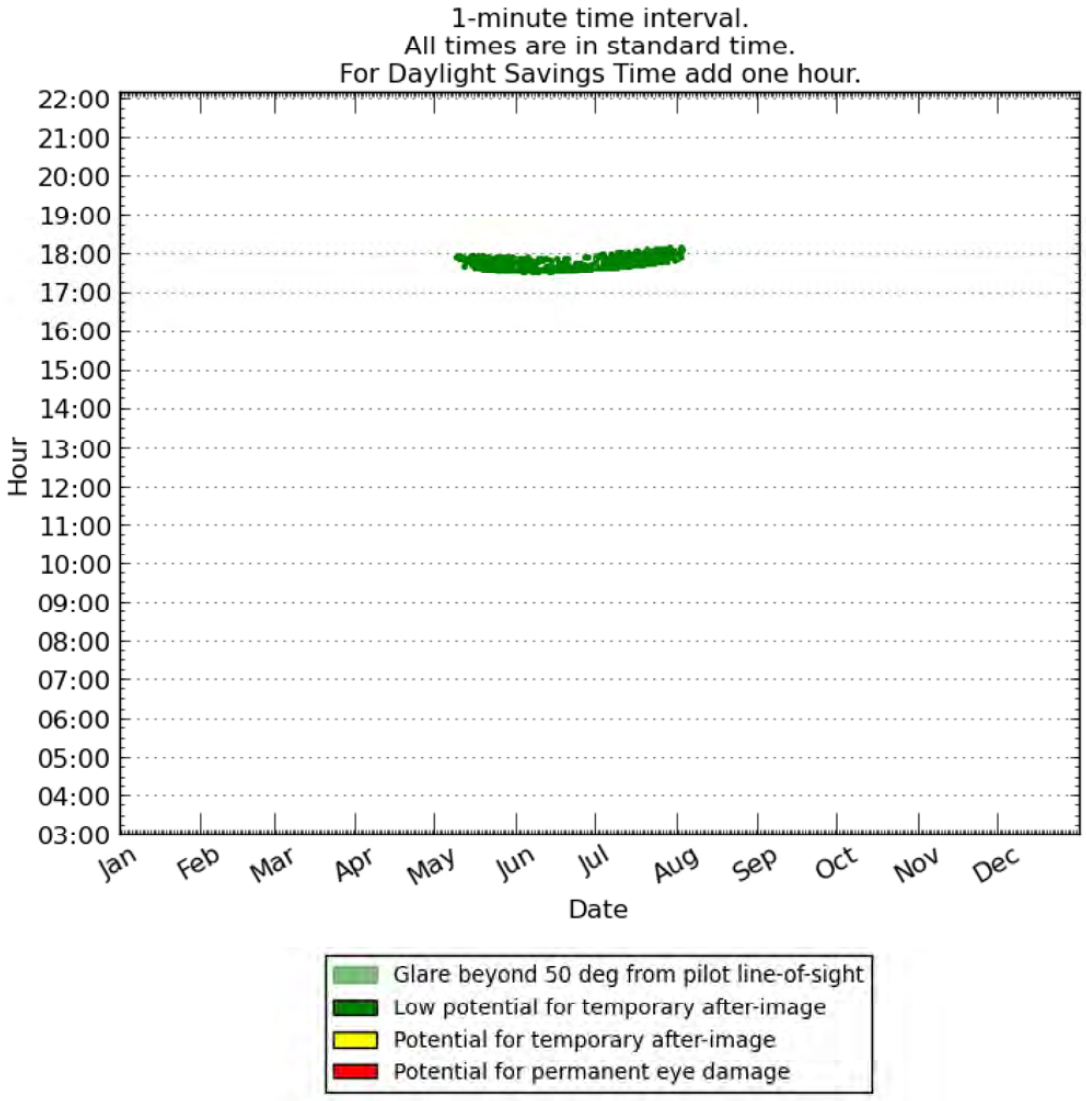
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 mi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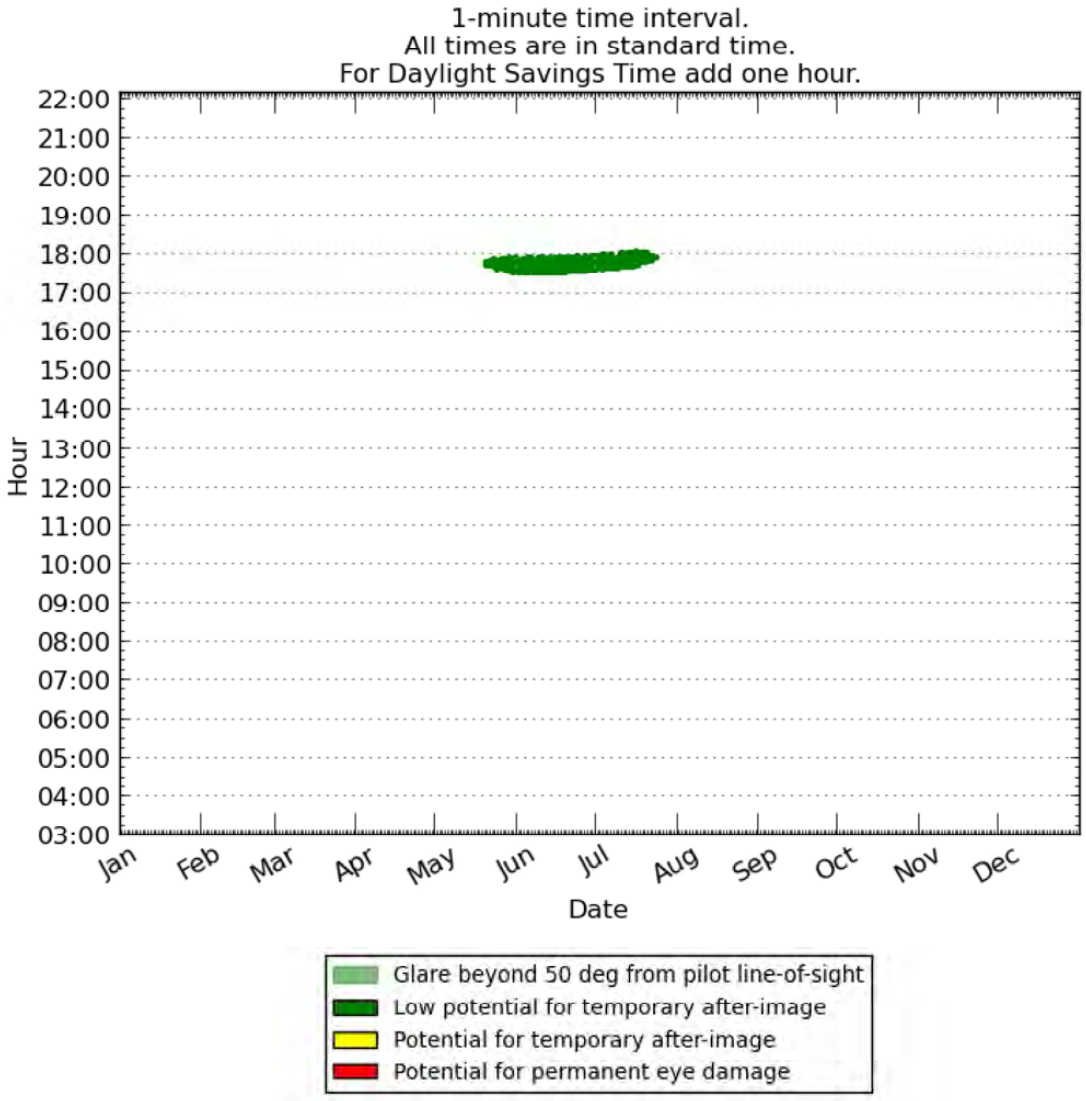
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 1/4 mi


1-minute time interval.
All times are in standard time.
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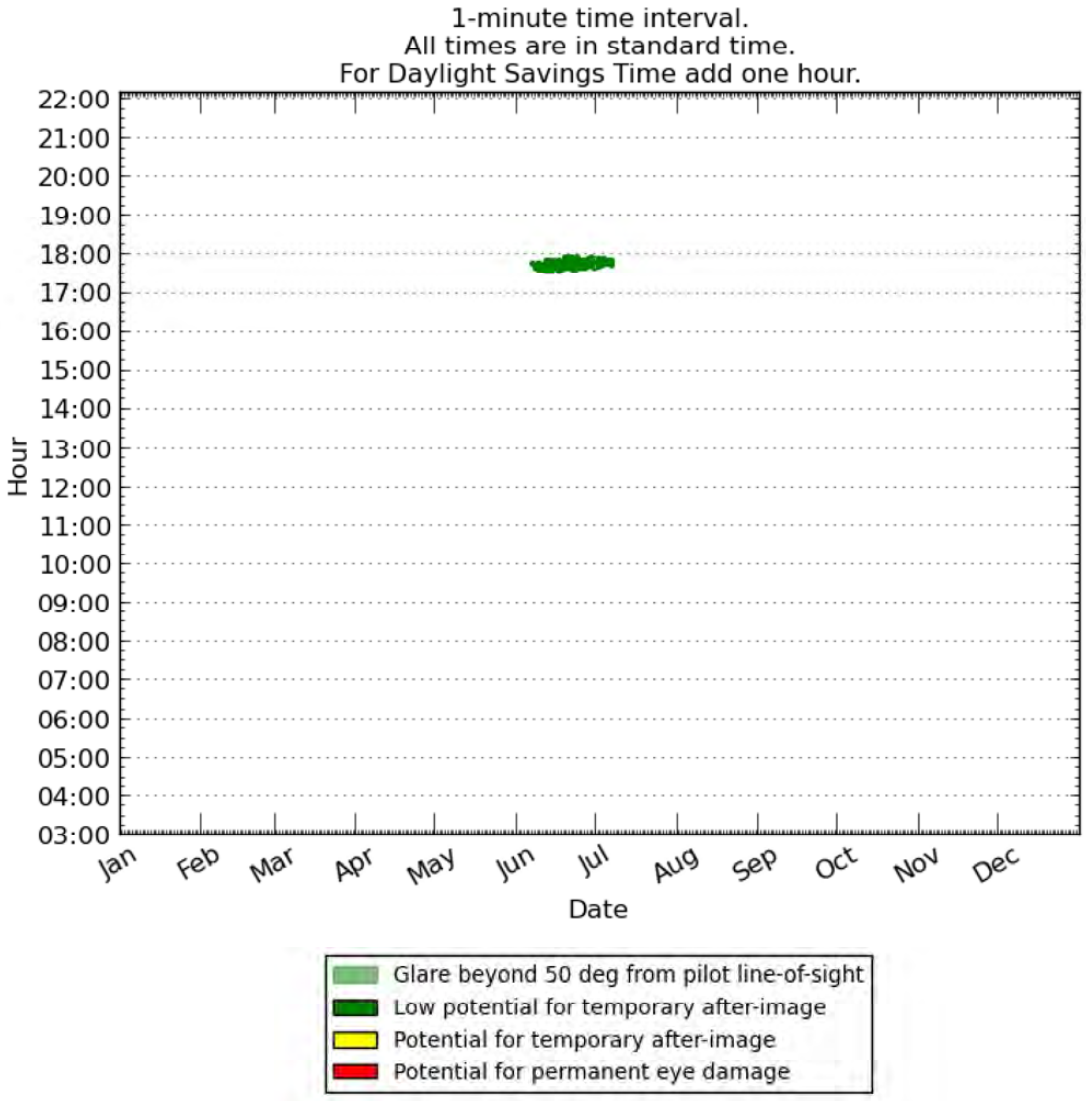
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 1/2 mi


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 3/4 mi

No glare

2 mi

No glare

Solar Glare Hazard Analysis Flight Path Report

Generated Dec. 22, 2014, 7:32 p.m.

Flight path: HIA 4R

No glare found

Print

Analysis & PV array parameters

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	220.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	53.9
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	21.3391300271	-158.016228676	29.53	4.0	33.53
2	21.3411086869	-158.014383316	29.53	4.0	33.53
3	21.3413485226	-158.012731075	28.24	4.0	32.24
4	21.3422878755	-158.0114007	26.71	4.0	30.71
5	21.3403897769	-158.009319305	26.25	4.0	30.25
6	21.3385909876	-158.005714417	16.84	4.0	20.84
7	21.3383511474	-158.002281189	19.69	4.0	23.69
8	21.3367122285	-158.000822067	16.34	4.0	20.34
9	21.3357128788	-157.997817993	9.84	4.0	13.84
10	21.3364324113	-157.995715141	13.3	4.0	17.3
11	21.3359127493	-157.99489975	19.69	4.0	23.69
12	21.3331944873	-157.99738884	19.69	4.0	23.69
13	21.3314555727	-157.992453575	16.4	4.0	20.4
14	21.3275579306	-157.996273041	13.12	4.0	17.12
15	21.3304361994	-158.003096581	19.31	4.0	23.31
16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	21.3139443038	-157.927136421	3.28	50.0	No
1/4 mi	21.3118150992	-157.930274329	0.0	122.45	No
1/2 mi	21.3096858947	-157.933412237	3.28	188.36	No
3/4 mi	21.3075566902	-157.936550145	3.28	257.53	No
1 mi	21.3054274857	-157.939688053	3.21	326.77	No
1 1/4 mi	21.3032982811	-157.942825961	0.0	399.18	No
1 1/2 mi	21.3011690766	-157.945963869	0.0	468.35	No
1 3/4 mi	21.2990398721	-157.949101777	0.0	537.54	No
2 mi	21.2969106675	-157.952239685	0.0	606.71	No

No glare found.

Solar Glare Hazard Analysis Flight Path Report

Generated Dec. 22, 2014, 7:22 p.m.

Flight path: HIA 4L

Glare found

Print

Analysis & PV array parameters

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	180.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	53.87
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	21.3391300271	-158.016228676	29.53	4.0	33.53
2	21.3411086869	-158.014383316	29.53	4.0	33.53
3	21.3413485226	-158.012731075	28.24	4.0	32.24
4	21.3422878755	-158.0114007	26.71	4.0	30.71
5	21.3403897769	-158.009319305	26.25	4.0	30.25
6	21.3385909876	-158.005714417	16.84	4.0	20.84
7	21.3383511474	-158.002281189	19.69	4.0	23.69
8	21.3367122285	-158.000822067	16.34	4.0	20.34
9	21.3357128788	-157.997817993	9.84	4.0	13.84
10	21.3364324113	-157.995715141	13.3	4.0	17.3
11	21.3359127493	-157.99489975	19.69	4.0	23.69
12	21.3331944873	-157.99738884	19.69	4.0	23.69
13	21.3314555727	-157.992453575	16.4	4.0	20.4
14	21.3275579306	-157.996273041	13.12	4.0	17.12
15	21.3304361994	-158.003096581	19.31	4.0	23.31
16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

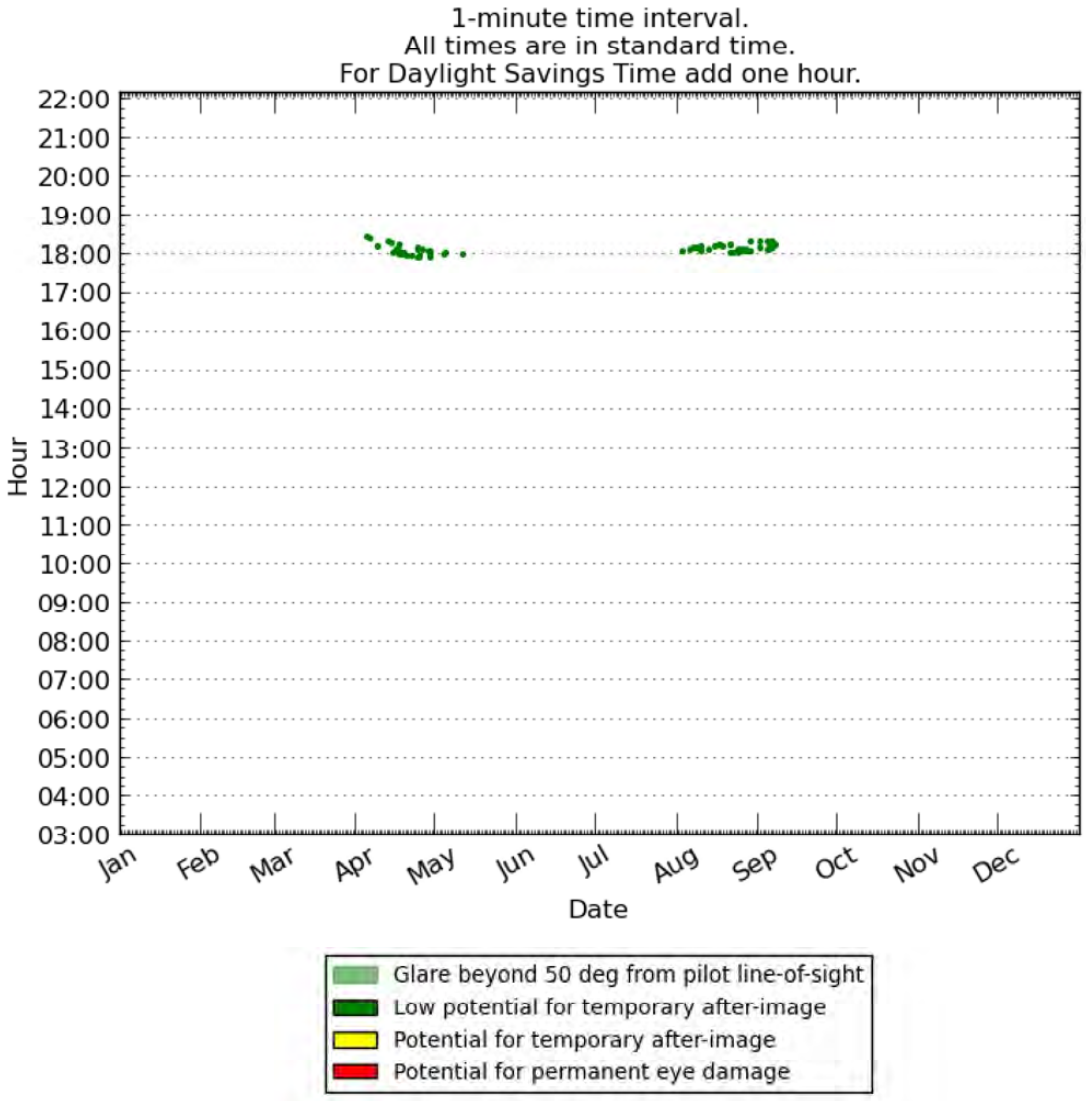
Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	21.318357036	-157.923327684	6.56	50.0	Yes
1/4 mi	21.3162263029	-157.926464488	3.28	122.45	Yes
1/2 mi	21.3140955698	-157.929601292	3.28	191.64	Yes
3/4 mi	21.3119648368	-157.932738095	0.0	264.1	Yes
1 mi	21.3098341037	-157.935874899	3.28	329.99	Yes
1 1/4 mi	21.3077033706	-157.939011703	3.28	399.18	Yes
1 1/2 mi	21.3055726375	-157.942148507	3.21	468.42	Yes
1 3/4 mi	21.3034419044	-157.94528531	0.0	540.82	Yes
2 mi	21.3013111714	-157.948422114	0.0	609.99	Yes

Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

Threshold


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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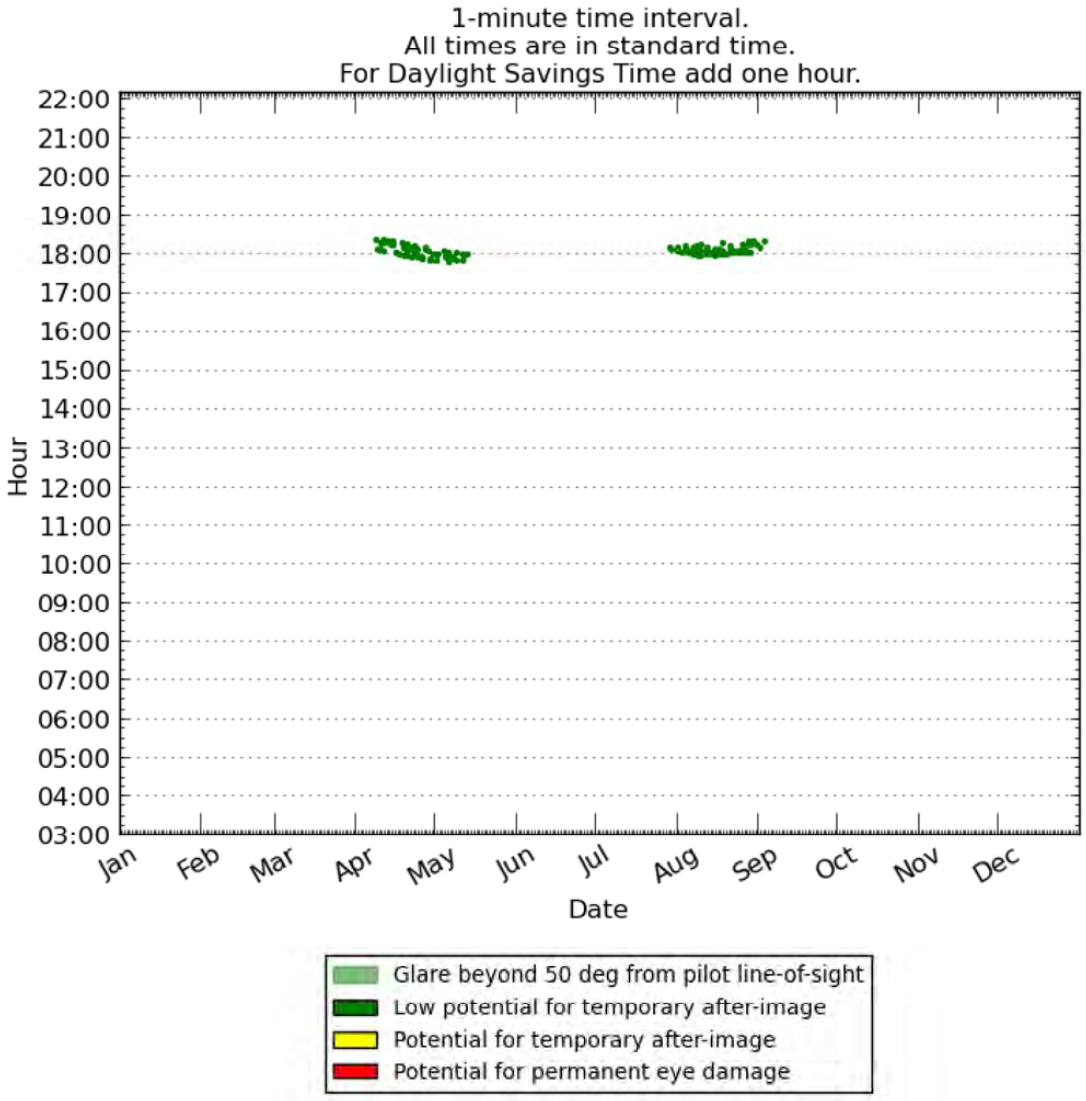
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/4 mi


1-minute time interval.
All times are in standard time.
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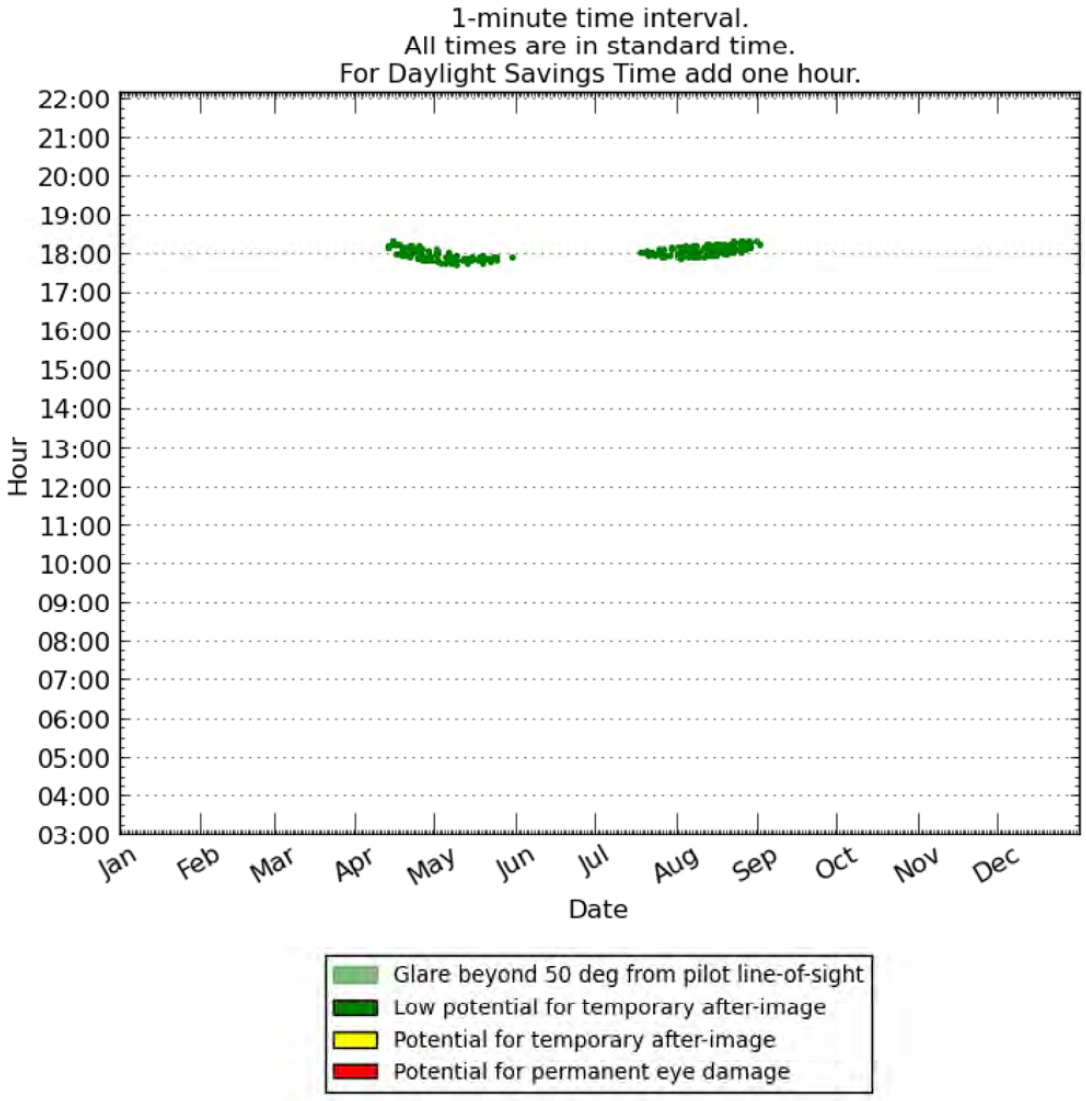
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/2 mi


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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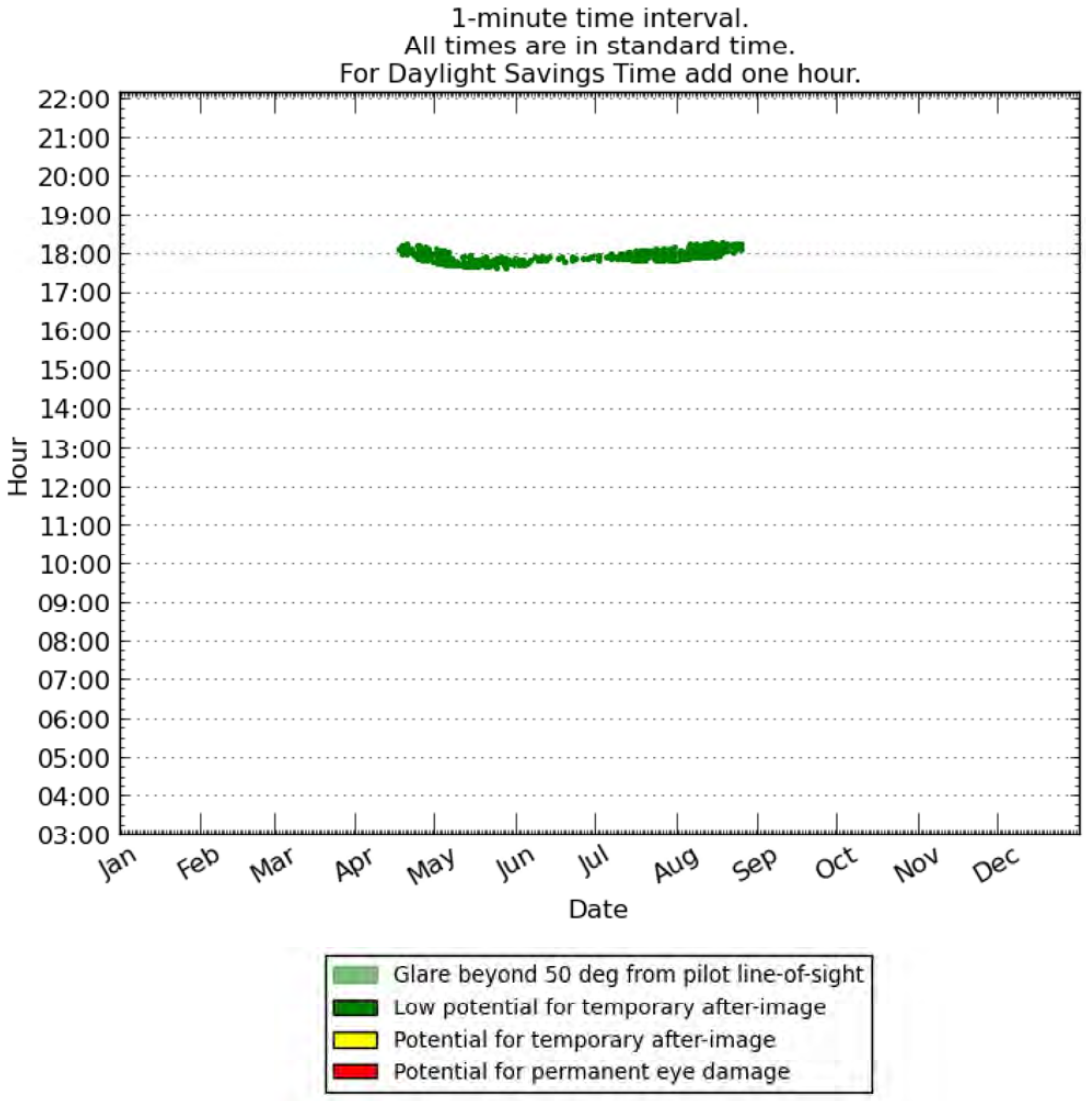
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

3/4 mi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All times are in standard time.
For Daylight Savings Time add one hour.
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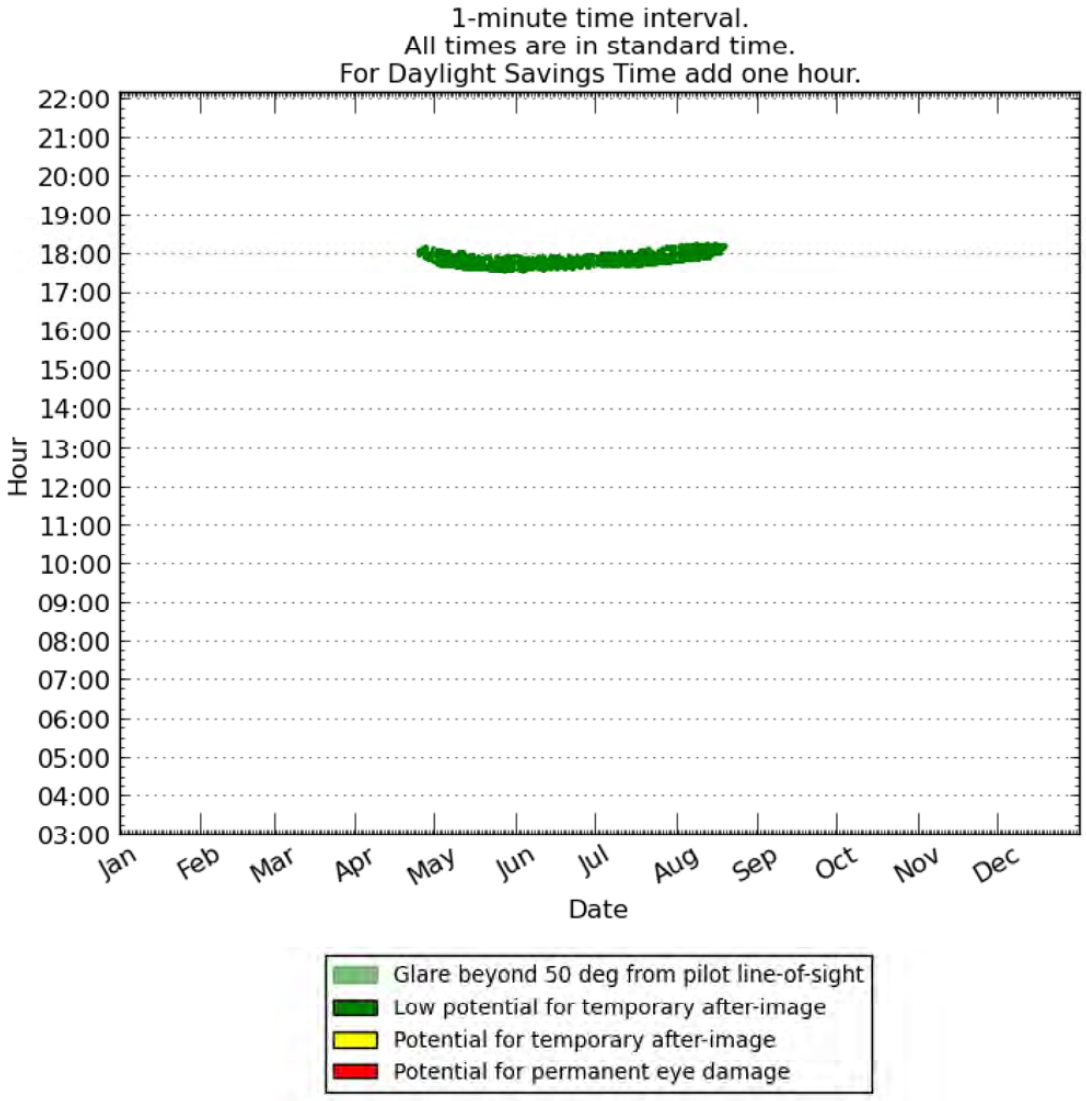
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 mi


1-minute time interval.
All times are in standard time.
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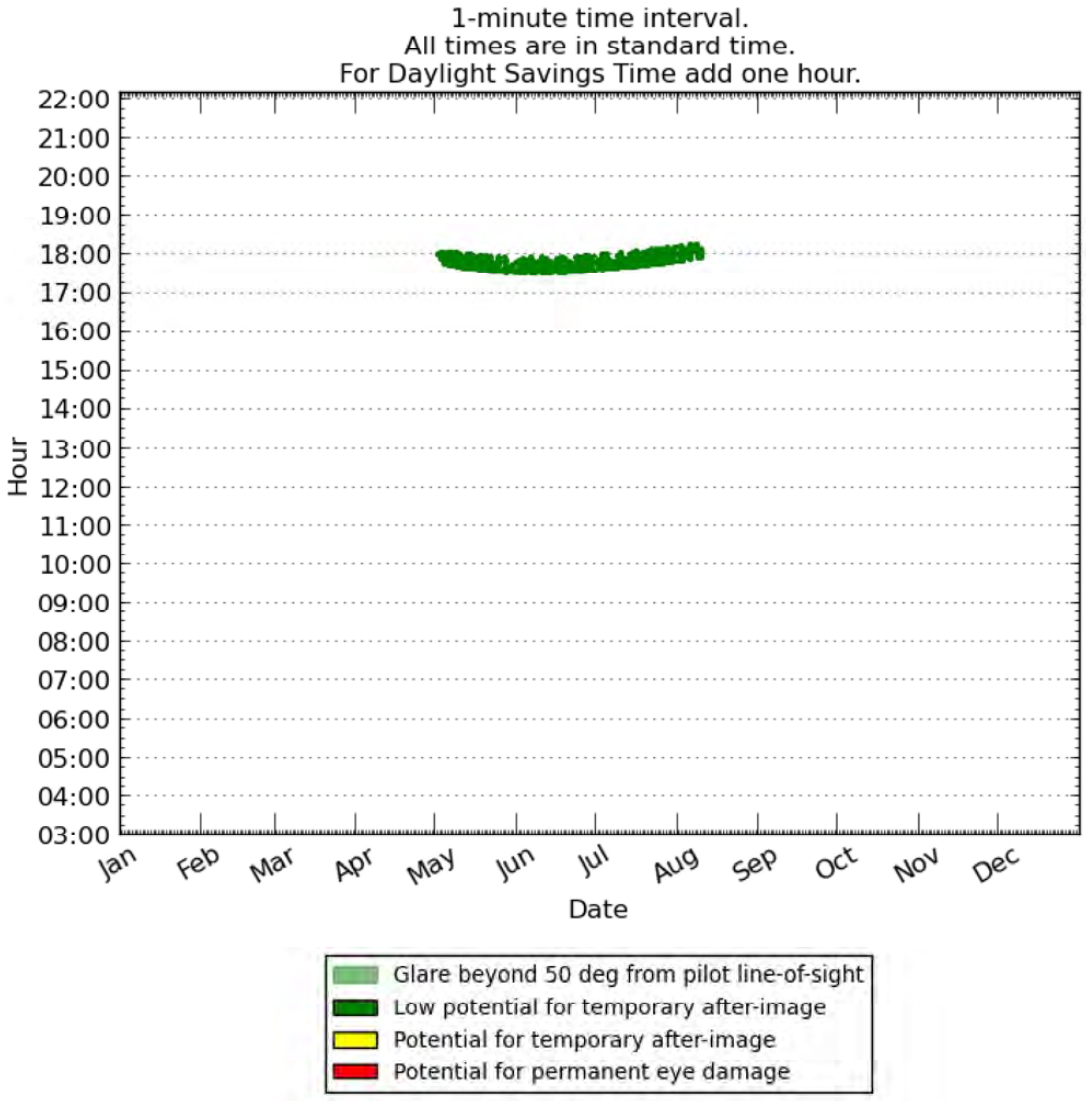
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 1/4 mi


1-minute time interval.
All times are in standard time.
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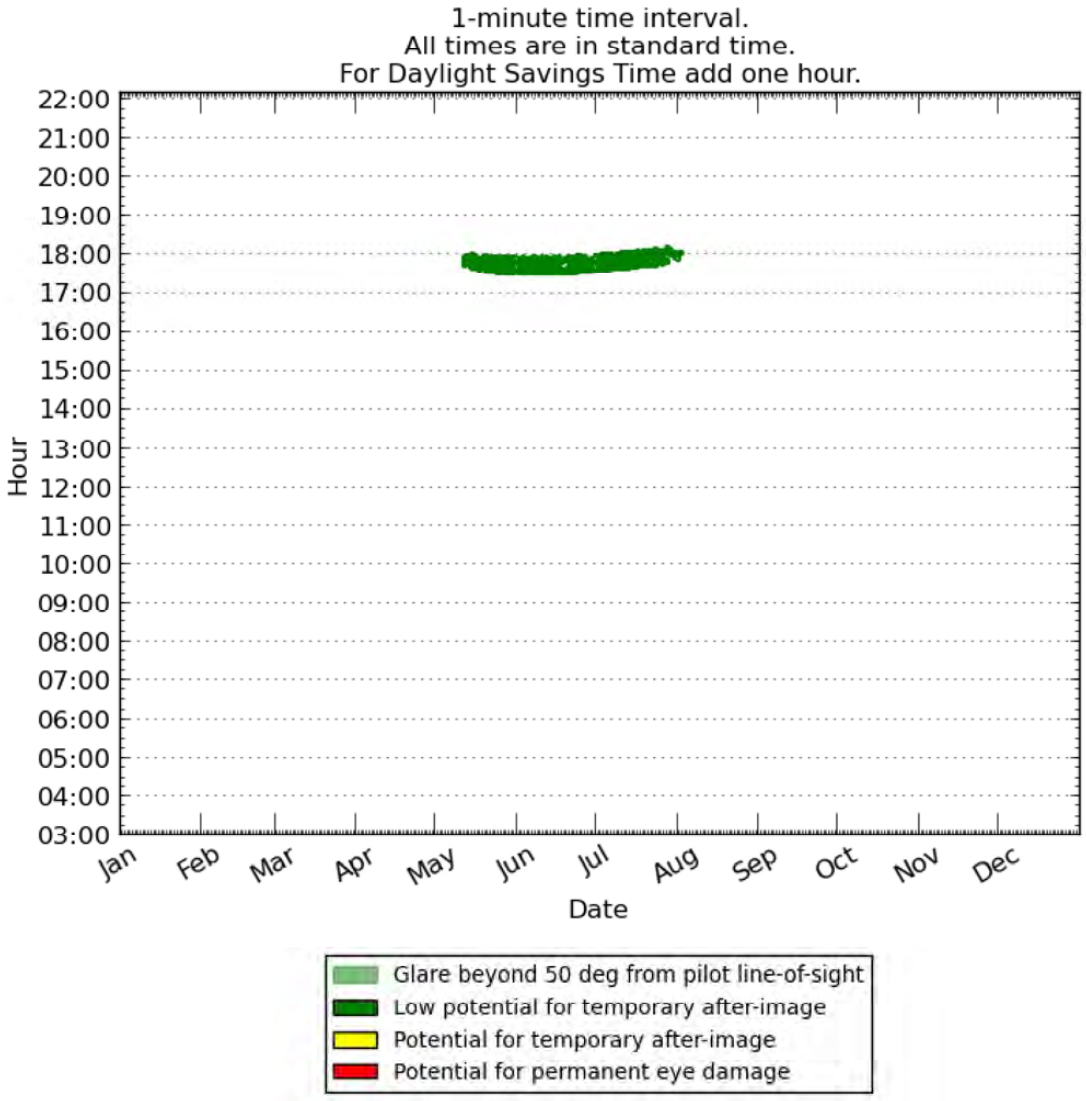
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 1/2 mi


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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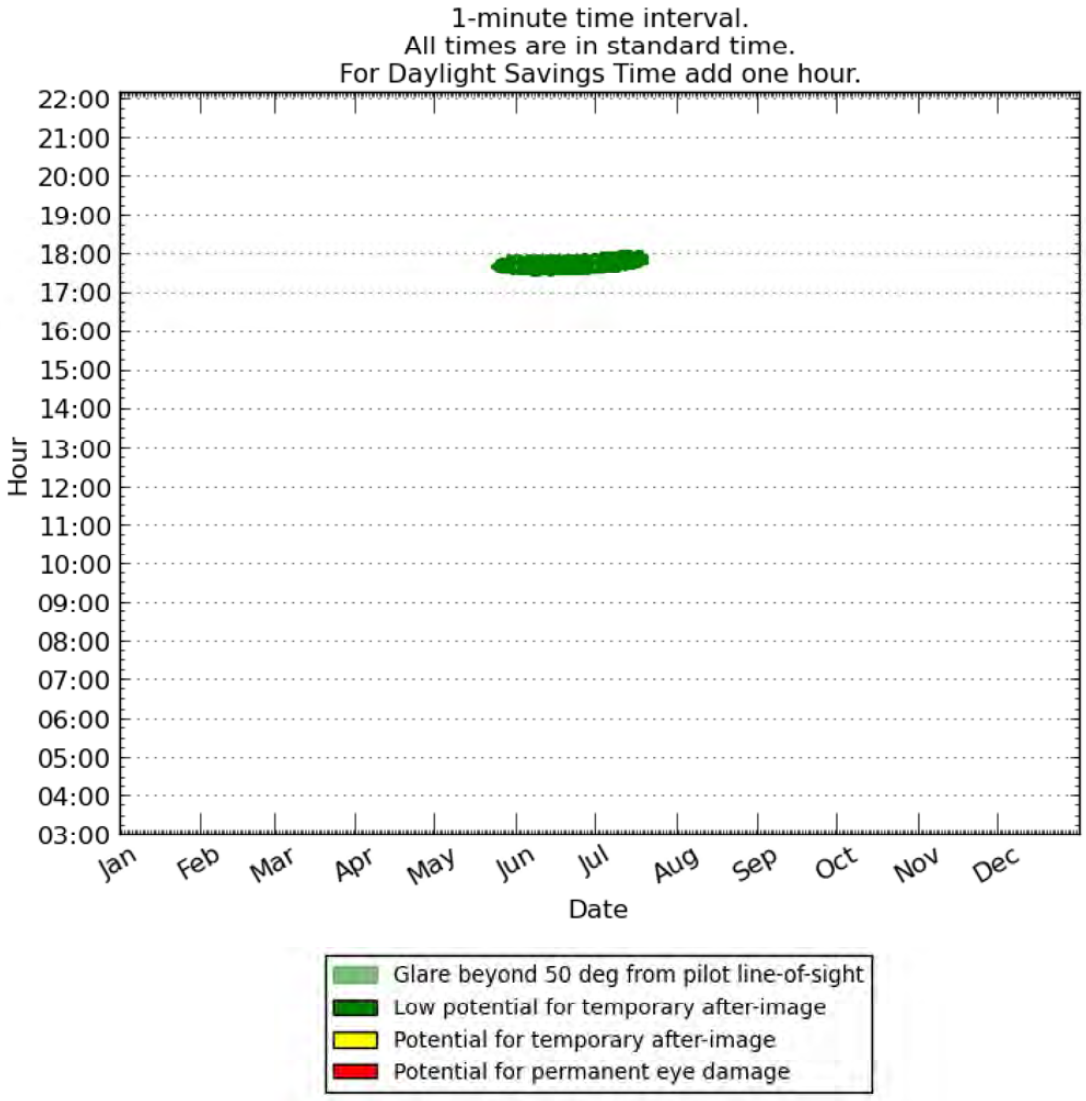
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1 3/4 mi


1-minute time interval.
All times are in standard time.
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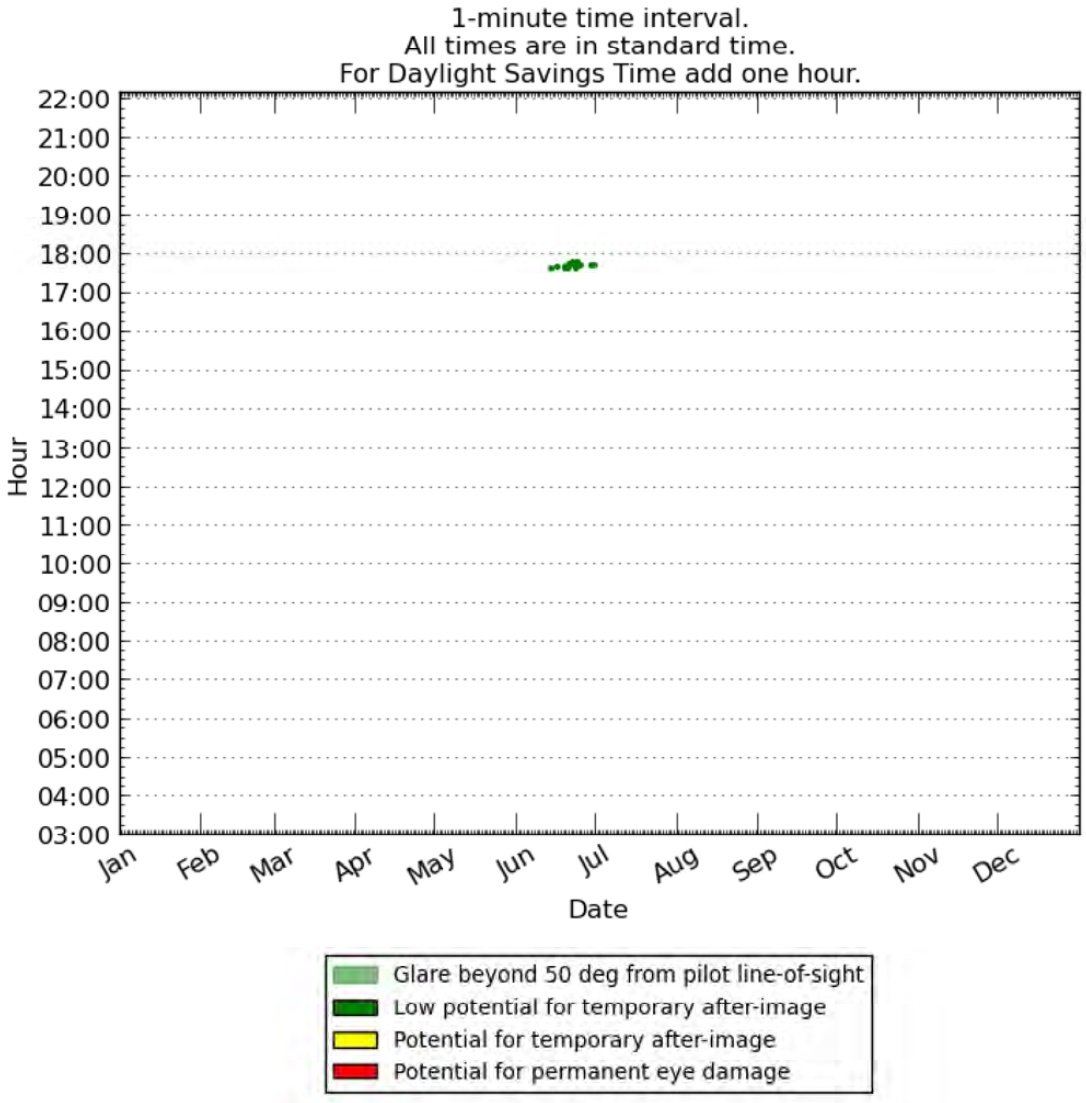
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

2 mi



Solar Glare Hazard Analysis Flight Path Report

Generated Dec. 22, 2014, 7:33 p.m.

Flight path: HIA 4L

No glare found

Print

Analysis & PV array parameters

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	220.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	53.87
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	21.3391300271	-158.016228676	29.53	4.0	33.53
2	21.3411086869	-158.014383316	29.53	4.0	33.53
3	21.3413485226	-158.012731075	28.24	4.0	32.24
4	21.3422878755	-158.0114007	26.71	4.0	30.71
5	21.3403897769	-158.009319305	26.25	4.0	30.25
6	21.3385909876	-158.005714417	16.84	4.0	20.84
7	21.3383511474	-158.002281189	19.69	4.0	23.69
8	21.3367122285	-158.000822067	16.34	4.0	20.34
9	21.3357128788	-157.997817993	9.84	4.0	13.84
10	21.3364324113	-157.995715141	13.3	4.0	17.3
11	21.3359127493	-157.99489975	19.69	4.0	23.69
12	21.3331944873	-157.99738884	19.69	4.0	23.69
13	21.3314555727	-157.992453575	16.4	4.0	20.4
14	21.3275579306	-157.996273041	13.12	4.0	17.12
15	21.3304361994	-158.003096581	19.31	4.0	23.31
16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	21.318357036	-157.923327684	6.56	50.0	No
1/4 mi	21.3162263029	-157.926464488	3.28	122.45	No
1/2 mi	21.3140955698	-157.929601292	3.28	191.64	No
3/4 mi	21.3119648368	-157.932738095	0.0	264.1	No
1 mi	21.3098341037	-157.935874899	3.28	329.99	No
1 1/4 mi	21.3077033706	-157.939011703	3.28	399.18	No
1 1/2 mi	21.3055726375	-157.942148507	3.21	468.42	No
1 3/4 mi	21.3034419044	-157.94528531	0.0	540.82	No
2 mi	21.3013111714	-157.948422114	0.0	609.99	No

No glare found.

Solar Glare Hazard Analysis Report

Generated March 27, 2015, 12:37 p.m.

Air Traffic Control Tower: No glare found

Print

Inputs

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	220.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	False

Reflectivity of PV module	0.1

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	21.3391300271	-158.016228676	29.53	4.0	33.53
2	21.3411086869	-158.014383316	29.53	4.0	33.53
3	21.3413485226	-158.012731075	28.24	4.0	32.24
4	21.3422878755	-158.0114007	26.71	4.0	30.71
5	21.3403897769	-158.009319305	26.25	4.0	30.25
6	21.3385909876	-158.005714417	16.84	4.0	20.84
7	21.3383511474	-158.002281189	19.69	4.0	23.69
8	21.3367122285	-158.000822067	16.34	4.0	20.34

9	21.3357128788	-157.997817993	9.84	4.0	13.84
10	21.3364324113	-157.995715141	13.3	4.0	17.3
11	21.3359127493	-157.99489975	19.69	4.0	23.69
12	21.3331944873	-157.99738884	19.69	4.0	23.69
13	21.3314555727	-157.992453575	16.4	4.0	20.4
14	21.3275579306	-157.996273041	13.12	4.0	17.12
15	21.3304361994	-158.003096581	19.31	4.0	23.31
16	21.3325149139	-158.003525734	19.69	4.0	23.69
17	21.3331545125	-158.006701469	22.54	4.0	26.54
18	21.33515324	-158.011078835	16.4	4.0	20.4
19	21.3371519403	-158.014125824	28.92	4.0	32.92

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
ATCT	21.3208605404	-157.927206159	6.56	180.0

No glare found.

Solar Glare Hazard Analysis Report

Generated March 27, 2015, 12:39 p.m.

Air Traffic Control Tower: No glare found

Print

Inputs

Analysis name	West Loch
PV array axis tracking	none
Orientation of array (deg)	180.0
Tilt of solar panels (deg)	21.3
Rated power (kW)	0.0
Vary reflectivity	False

Reflectivity of PV module	0.1

Timezone offset	-10.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
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19	21.3371519403	-158.014125824	28.92	4.0	32.92

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
ATCT	21.3208605404	-157.927206159	6.56	180.0

No glare found.