



## Agenda Submittal

**Agenda #:** 2      **Status:** ALUC-Regular-OD

**Type:** ALUC-Document      **Department:** Airport Land Use Commission

**File #:** AC 20-006      **Contact:** Jim Leland (707) 784-6765

**Agenda date:** 2/6/2020      **Final action:**

**Title:** ALUC-19-18 (Benicia Solar Project)  
 Conduct a Public Hearing to consider a Consistency Determination for the Benicia Solar Project with the Travis Air Force Base Land Use Compatibility Plan (County of Solano). (Project Planner: Jim Leland)

**Governing body:** Airport Land Use Commission

**District:**

**Attachments:** [A Application](#)  
[A1 Project Description](#)  
[A2 Vicinity Map](#)  
[A3 Aerial Map](#)  
[A4 Plans](#)  
[A5 SGHAT Analysis](#)  
[A6 Proposed Zoning Text Amendment](#)  
[Attachment B Travis Context Map Map.pdf](#)

Date	Ver.	Action By	Action	Result
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Published Notice Required?    Yes \_\_\_ No \_\_\_

Public Hearing Required?        Yes \_\_\_ No \_\_\_

Published Notice Required?    Yes \_\_\_ No X

Public Hearing Required?        Yes \_\_\_ No X

### INTRODUCTION

On January 9, 2020, the Solano County Airport Land Use Commission considered a request for a consistency determination from the City of Benicia for a solar project on Lake Herman Road. The project consisted of two major components, a zoning text amendment and a specific solar project on Lake Herman Road. Each component is described below.

### Zoning Text Amendment (See Attachment A6 Proposed Zoning Text Amendment)

The zoning text amendment would permit solar facilities on open space lands within the City of Benicia. The zoning amendment establishes standards for the development of solar utilities which include measures regulating:

1. Protection of agriculture,
2. No municipal services required,

3. Setbacks,
4. Height not exceeding 15 feet,
5. Noise levels,
6. Decommissioning procedures,
7. Stormwater management, and
8. Traffic minimization

### **Lake Herman Road Solar Project (Attachment A1 Project Description)**

The proposal is to establish a commercial scale solar electric generation project on the north side of Lake Herman Road opposite the intersection with Reservoir Road. The project site is approximately 90 acres in size and is located within Compatibility Zone D of the Travis Plan.

The project will be located on property in the City of Benicia with an open space zoning designation.

According to the project description, the project will:

“..... generate a total of 5.0 Megawatts (MW) AC (7 MW DC) of clean, reliable solar energy when complete. The Project will interconnect to PG&E’s pre-existing electrical distribution system located on site. The power generated from this facility will be sold to Marin Clean Energy (MCE) through a long-term Power Purchase Agreement (PPA). Additionally, the Project will be equipped with energy storage technology that will allow on site renewable energy generation to be stored and dispatched onto the grid when needed.

The Lake Herman Solar Project will utilize approximately 18,424 solar modules and 40 string inverters, which convert the sun’s energy into usable, AC power. Single axis tracking technology will be utilized to allow the modules to efficiently track the sun throughout the day and maximize the efficiency of solar collection. The modules will be mounted on a steel racking system, which will be anchored into the ground using driven steel piers. The overall height of the array will be no more than 8 feet tall.”

As a part of the specific project, a Solar Glare Hazard Analysis Tool (SGHAT) was utilized to assess the project impacts to flight operations at Travis Air Force Base, as required under the Travis Plan (See Attachment A5 Solar Glare Analysis). The report indicated no impact to Travis.

### **Commission Action of January 9, 2020**

The Commission conducted its hearing on the two project components and took the following actions:

1. Approved the Zoning Text Amendment with the condition that the solar standards proposed in the zoning text amendment be revised to include the following language:

*“ All solar utility projects shall prepare a solar glare analysis utilizing a SGHAT compliant analytical tool. Solar utility projects, including the results of the SGHAT analysis, shall be submitted to the Solano County Airport Land Use Commission for a consistency determination prior to approval by the City.”*

2. Continued consideration of the specific solar project until February 6, 2020 in order for Travis AFB to complete its review of the SGHAT analysis submitted by the City of Benicia and their applicant.

## Items Before the Commission

Both items are before the Commission again.

### Zoning Text Amendment

After the Commission's action on January 9<sup>th</sup>, staff has had several discussions with city representatives. The Benicia City Attorney has proposed alternative wording for the condition of approval cited above, as follows:

*“Solar facilities shall comply with the applicable provisions of the Travis Air Force Base Airport Land Use Compatibility Plan”.*

Staff has reviewed the language suggested by the City Attorney and is in agreement that it is preferable because it is more inclusive. Our language was specific to the requirement that a SGHAT study be prepared and submitted. The City's alternative is a general requirement that requires solar projects to comply with all applicable provisions of the Plan, including any additional requirements which the Commission may adopt in the future for solar utility projects.

### Specific Solar Project on Lake Herman Road

The specific project was continued from January 9<sup>th</sup> to permit Travis AFB to complete its review of the solar glare hazard analysis (SGHAT) study for the project. Travis has the expertise to review these studies for the Commission. Travis AFB has completed their review and has responded to staff that they have concluded that the Lake Herman Road solar installation creates no concerns for the Base.

Based on the discussion above, staff is making the following recommendation:

## **RECOMMENDATION**

Adopt the recommended findings and determine that the Benicia Solar Project, including the inclusion of the recommended additional language from the City of Benicia (above), is **consistent** with the Travis Air Force Base Land Use Compatibility Plan.

## **DISCUSSION**

### **REQUIRED TESTS FOR CONSISTENCY**

#### **ALUC Review Requirements**

State law, under Section 21661.5 of the Public Utilities Code, requires that any proposed zoning regulations or revisions to the local zoning ordinance be reviewed for consistency with adopted airport land use compatibility plans.

The ALUC is concerned with those aspects of the proposed zoning changes which have the potential to be incompatible with of the Travis Air Force Base Land Use Compatibility Plan.

#### **California Airport Land Use Planning Handbook**

The State Department of Aeronautics has published the California Airport Land Use Planning Handbook as a guide for Airport Land Use Commissions in the preparation and implementation of Land Use Compatibility Plans and Procedure Documents. Section 6.4.2 sets forth procedures for the review of local zoning ordinances

and directs agencies to consider the topics listed in Table 5A, as follows:

**Zoning or Other Policy Documents** (from Table 5A, CalTRANS Airport Land Use Planning Handbook)

The Handbook lists the following topics for consideration when reviewing zoning or other policy documents.

- *Intensity Limitations on Nonresidential Uses*
- *Identification of Prohibited Uses*
- *Open Land Requirements*
- *Infill Development*
- *Height Limitations and Other Hazards to Flight*
- *Buyer Awareness Measures*
- *Non-conforming Uses and Reconstruction*

Staff has reviewed the Benicia Solar Project in light of the tests outlined above as well as the specific compatibility factors applicable to lands within the City of Benicia. Our analysis is presented below.

**ALUC Context**

The Benicia Solar Project applies to properties which lie within the area of influence of the Travis AFB Land Use Compatibility Plan (Travis Plan), more particularly within Compatibility Zone D (See Attachments B, C and D).

**Travis Air Force Base Land Use Compatibility Plan**

The requirements for Compatibility Zone D are listed below under the appropriate topical areas from topics suggested for consideration as identified in the State Handbook. They are as follows:

- **Intensity Limitations** *None*
- **Identification of Prohibited Uses** *Hazards to Flight (See below)*
- **Open Land Requirements** *None*
- **Infill Development** *Not Applicable*
- **Height Limitations and Other Hazards to Flight**
  - ALUC review required for objects > 200 feet AGL
  - All proposed wind turbines must meet line-of-sight criteria in Policy 3.3.4
  - All new or expanded commercial-scale solar facilities must conduct an SGHAT glint and glare study for ALUC review
  - All new or expanded meteorological towers > 200 feet AGL, whether temporary or permanent, require ALUC review
  - Areas within the Bird Strike Hazard Zone must prepare a WHA and incorporate all feasible mitigation measures.
  - Outside of the Bird Strike Hazard Zone but within the Outer Perimeter, any new or expanded land use that has the potential to attract the movement of wildlife that could cause bird strikes are required to prepare a WHA.
- **Buyer Awareness Measures** *None*
- **Non-conforming Uses and Reconstruction** *Not Applicable*

Staff has reviewed the proposed Benicia Solar Project Ordinance for consistency with the compatibility criteria for Compatibility Zone D of the Travis Plan. Our analysis is presented below.

## **ANALYSIS**

### **Intensity Limitations on Nonresidential Uses**

Within Compatibility Zone D, there are no limitations on intensity for non-residential land uses and as a result the Benicia Solar Project is consistent with this provision.

### **Identification of Prohibited Uses**

There are no prohibited uses within Compatibility Zone D. Therefore, the Benicia Solar Project is consistent with this provision.

### **Open Land Requirements**

Compatibility Zone D has no open land requirements for development. As a result, the Benicia Solar Project is consistent with this requirement.

### **Infill Development**

This project is not a part of an infill development. No further consideration is required for this criterion.

### **Height Limitations and Other Hazards to Flight**

The “Height Limitations” and “Other Development Conditions” listed in Compatibility Zone D are as follows:

1. ALUC review required for objects > 200 feet AGL
2. All proposed wind turbines in excess of 100 feet in height must meet line-of-sight criteria in Policy 3.4.4
3. All new or expanded commercial-scale solar facilities must conduct an SGHAT glint and glare study for ALUC review
4. All new or expanded meteorological towers > 200 feet AGL, whether temporary or permanent, require ALUC review
5. For areas within the Bird Strike Hazard Zone, reviewing agencies shall prepare a WHA for discretionary projects that have the potential to attract wildlife that could cause bird strikes. Based on the findings of the WHA, all reasonably feasible mitigation measures must be incorporated into the planned land use.
6. For areas outside of the Bird Strike Hazard Zone but within the Outer Perimeter, any new or expanded land use involving discretionary review that has the potential to attract the movement of wildlife that could cause bird strikes are required to prepare a WHA.

None of the hazards listed above are associated with the lawful use of the property for cannabis business purposes for reasons discussed in the following sections.

#### **1 & 4. Height Review for Objects Greater than 200 Feet in Height**

The Benicia Solar Project do not permit any structures taller than 50 feet, so ALUC review of this item is not required.

## 2. Wind Turbines in Excess of 100 Feet in Height

The Benicia Solar Project do not permit any wind turbines, so ALUC review of this item is not required.

## 3. Commercial Scale Solar Projects

Commercial Solar projects require review by the Airport Land Use Commission. The Travis Plan requires that commercial solar projects submit a SGHAT analysis for review by the ALUC (See Attachment A5). The Solar Glare Hazard Analysis indicates that there will be no adverse impact to Travis AFB by the installation and operation of the proposed solar project. Travis AFB has confirmed that there are no issues for the Base created by this project. As such, the Benicia Solar Project is consistent with this provision.

## 5 & 6 Projects within the Bird Strike Hazard Zone or the Outer Perimeter Area

The solar project lies outside of the Bird Strike Hazard Zone and the Outer Perimeter Area. As a result, the Benicia Solar Project is not subject to the bird strike requirements within the Travis Plan.

## **Buyer Awareness Measures**

The proposed project lies within Compatibility Zone D and outside of any noise contours of concern. As a result, Buyer Awareness Measures are not required by the Travis Plan.

## **Non-conforming Uses and Reconstruction**

The project is proposed on vacant land and does not require review under the non-conforming provisions.

## **CONCLUSION**

The analysis above, including the SGHAT, demonstrates that the specific solar project being proposed is consistent with the Travis Plan. The zoning text amendment could permit other solar facilities on other open space lands. Staff is recommending that the solar standards proposed in the zoning text amendment be revised to include the following language:

“All solar utility projects shall prepare a solar glare analysis utilizing a SGHAT compliant analytical tool. Solar utility projects, including the results of the SGHAT analysis, shall be submitted to the Solano County Airport Land Use Commission for a consistency determination prior to approval by the City.”

This provision would reflect the requirements of the Travis Plan which apply to new solar projects being considered by local jurisdictions.

## **RECOMMENDATION**

Adopt the recommended findings and determine that the Benicia Solar Project, including the recommended additional language from above, is **consistent** with the Travis Air Force Base Land Use Compatibility Plan.

Attachments

- Attachment A: Application
- Attachment A1 Application Project Description
- Attachment A2 Vicinity Map
- Attachment A3 Aerial Map
- Attachment A4 Plans
- Attachment A5 SGHAT Analysis
- Attachment A6 Proposed Zoning Text Amendment
- Attachment B: Travis Plan Context Map
- Attachment C: Resolution (To be Distributed at Hearing)

## Solano County Airport Land Use Commission

675 Texas Street Suite 5500  
Fairfield, CA 94533  
Tel 707.784.6765  
Fax 707.784.4805

### LAND USE COMPATIBILITY DETERMINATION: APPLICATION FORM

TO BE COMPLETED BY STAFF		
APPLICATION NUMBER:	FILING FEE:	
DATE FILED:	RECEIPT NUMBER:	
JURISDICTION:	RECEIVED BY:	
PROJECT APN(S):		
TO BE COMPLETED BY THE APPLICANT		
I. GENERAL INFORMATION		
NAME OF AGENCY: City of Benicia	DATE: December 5, 2019	
ADDRESS: 250 East L Street, Benicia, CA 94510		
E-MAIL ADDRESS: sthorsen@ci.benicia.ca.us	DAYTIME PHONE: (707) 746-4382	FAX: (707) 747-1637
NAME OF PROPERTY OWNER: Benicia North Gateway, LLC	DATE:	
ADDRESS: Attn: Bradley Lowe 4171 Essen Lane, Baton Rouge, LA 70809		DAYTIME PHONE: (225) 932-5884
NAME OF DOCUMENT PREPARER: Suzanne Thorsen, City of Benicia	DATE: December 5, 2019	
ADDRESS: 250 East L Street, Benicia CA 94510	DAYTIME PHONE: (707) 746-4382	FAX: (707) 747-1637
NAME OF PROJECT: Lake Herman Solar Facility		
PROJECT LOCATION: 88.54 acre parcel located on north side of Lake Herman Road, zoned Open Space (OS) within City of Benicia APN 0080-030-050		
STREET ADDRESS: No address		

**PLEASE CALL THE APPOINTMENT DESK AT (707) 784-6765 FOR AN APPLICATION APPOINTMENT.**



TO BE COMPLETED BY THE APPLICANT

II. DESCRIPTION OF PROJECT

Development of five Megawatt (MW) AC solar farm - please see attached documentation and written description. Project requires City of Benicia approval of zoning text amendment to establish new use classification in OS District (solar utility); adoption of IS/MND and Mitigation Monitoring and Reporting Program; use permit and design review. No grading permit nor extension of urban utilities is required.

PLEASE CALL THE APPOINTMENT DESK AT (707) 784-6765 FOR AN APPLICATION APPOINTMENT.

TO BE COMPLETED BY THE APPLICANT	
<b>II. DESCRIPTION OF PROJECT (CONT'D)</b>	
POTENTIAL PROJECT EMISSIONS: (i.e. smoke, steam, glare, radio, signals): None	
PROJECT AIRPORT LAND USE COMPATIBILITY PLAN: Travis Airport Land Use Compatibility Plan	COMPATIBILITY ZONE: D
PERCENTAGE OF LAND COVERAGE: 40% lot coverage	MAXIMUM PERSONS PER ACRE: 0
THE FOLLOWING INFORMATION MUST BE SUBMITTED AS A MINIMUM REQUIREMENT:	
<input checked="" type="checkbox"/> JURISDICTION REFERRAL LETTER: <input checked="" type="checkbox"/> ENVIRONMENTAL DOCUMENTATION: <input checked="" type="checkbox"/> LOCATION MAP: <input checked="" type="checkbox"/> ASSESSOR'S PARCEL MAP, with subject property marked in red: <input checked="" type="checkbox"/> SITE PLAN, drawn to scale and fully dimensioned including topographical information, and 8 1/2 x 11 inch reduction(s): <input type="checkbox"/> ELEVATIONS, if located in APZ, clear zones and A,B,C compatibility zones or over 200' in height, plus 8 1/2 x 11 inch reduction(s) : <input type="checkbox"/> WIND TURBINE STUDY, including cumulative impact studies. Such studies shall include an analysis of (1) the individual effects of the proposed project, and (2) as required by law, an analysis of the cumulative effects of the proposed project considered in connection with the effects of past projects, the effects of other current projects and proposed projects, and the effects of probable future projects, including (i) the probable build out for wind energy development of the remaining vacant parcels within the wind resource areas described in the Solano County General Plan and (ii) any probable replacement of existing turbines or meteorological towers with structures having different dimensions.	
<input checked="" type="checkbox"/> SUPPLEMENTAL INFORMATION: <input type="checkbox"/> FEES: <input checked="" type="checkbox"/> ELECTRONIC COPIES OF ALL APPLICATION MATERIALS ON A CD: <span style="color: red;">Provided on flash drive</span>	
APPLICANT SIGNATURE:	DATE:
X.....	
DOES THE PROJECT PROPOSE THE DEMOLITION OR ALTERATION OF ANY EXISTING STRUCTURES ON THE PROJECT SITE? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO    If yes, describe below:	

**PLEASE CALL THE APPOINTMENT DESK AT (707) 784-6765 FOR AN APPLICATION APPOINTMENT.**

**Renewable Properties, LLC**

655 Montgomery Street, Suite 1430  
San Francisco, CA 94111  
[www.renewprop.com](http://www.renewprop.com)



July 12, 2019

Suzanne Thorsen  
Principal Planner  
Community Development Department  
250 East L Street  
Benicia, CA 94510

Dear Suzanne,

**RE: Lake Herman Solar Project – Written Statement**

In accordance with Use Permit and Design Review Submission, please find an updated description of the proposed project below:

The Lake Herman Solar project (“Project”) is a small-scale utility solar and energy storage project located on approximately 35 acres of an 89-acre parcel of land in the City of Benicia, CA. The Project is located off Lake Herman Road (APN # 0080-030-050). Renewable Properties, LLC has entered into a purchase agreement with the property owner (Benicia North Gateway II, LLC) to facilitate the development of a small scale, utility solar power generation facility.

The Project will generate a total of 5.0 Megawatts (MW) AC (7 MW DC) of clean, reliable solar energy when complete. The Project will interconnect to PG&E’s pre-existing electrical distribution system located on site. The power generated from this facility will be sold to Marin Clean Energy (MCE) through a long-term Power Purchase Agreement (PPA). Additionally, the Project will be equipped with energy storage technology that will allow on site renewable energy generation to be stored and dispatched onto the grid when needed.

The Lake Herman Solar Project will utilize approximately 18,424 solar modules and 40 string inverters, which convert the sun’s energy into usable, AC power. Single axis tracking technology will be utilized to allow the modules to efficiently track the sun throughout the day and maximize the efficiency of solar collection. The modules will be mounted on a steel racking system, which will be anchored into the ground using driven steel piers. The overall height of the array will be no more than 8 feet tall.

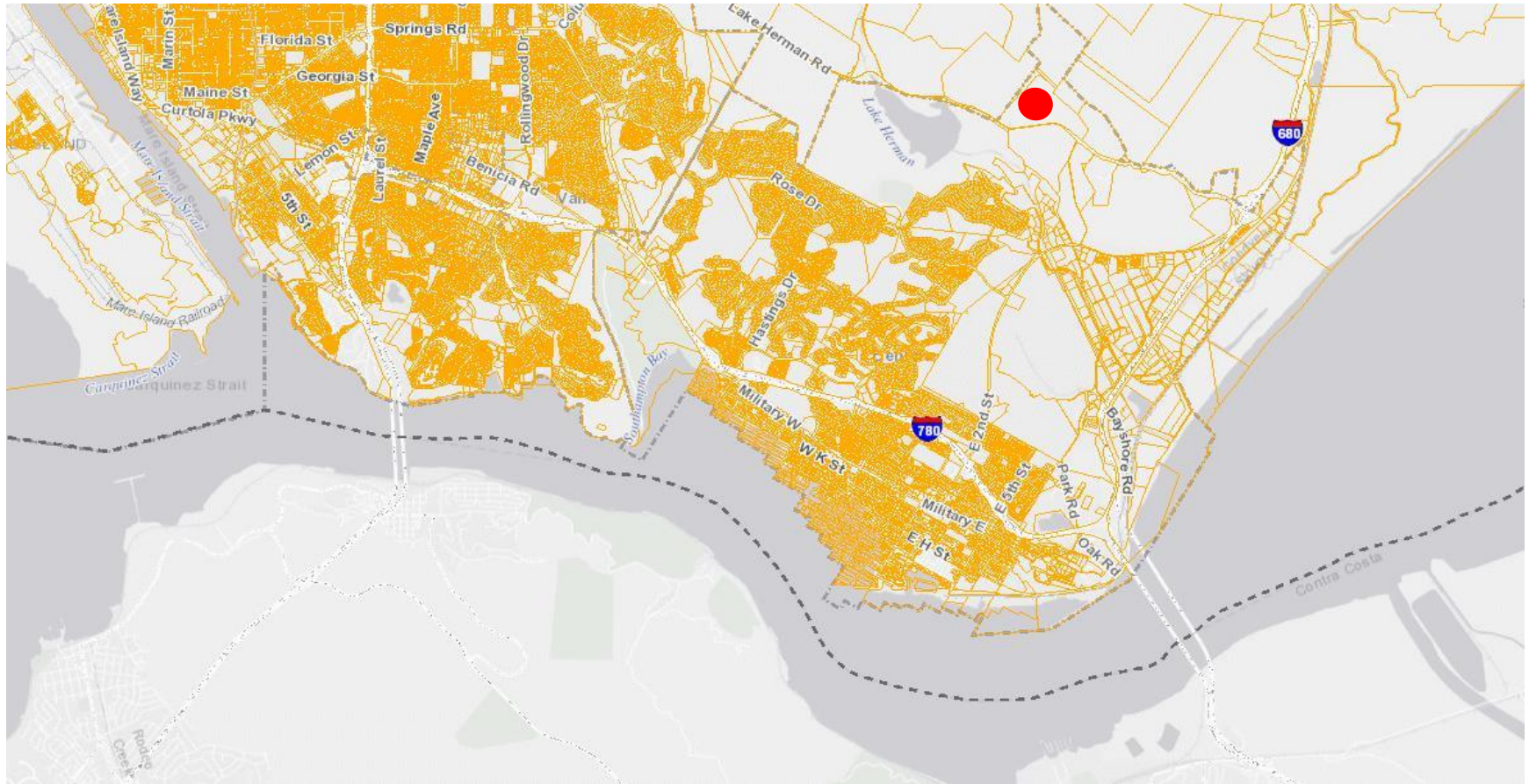
Please don’t hesitate to reach out with any questions or comments. We look forward to working with you to bring this project to fruition.

Sincerely,

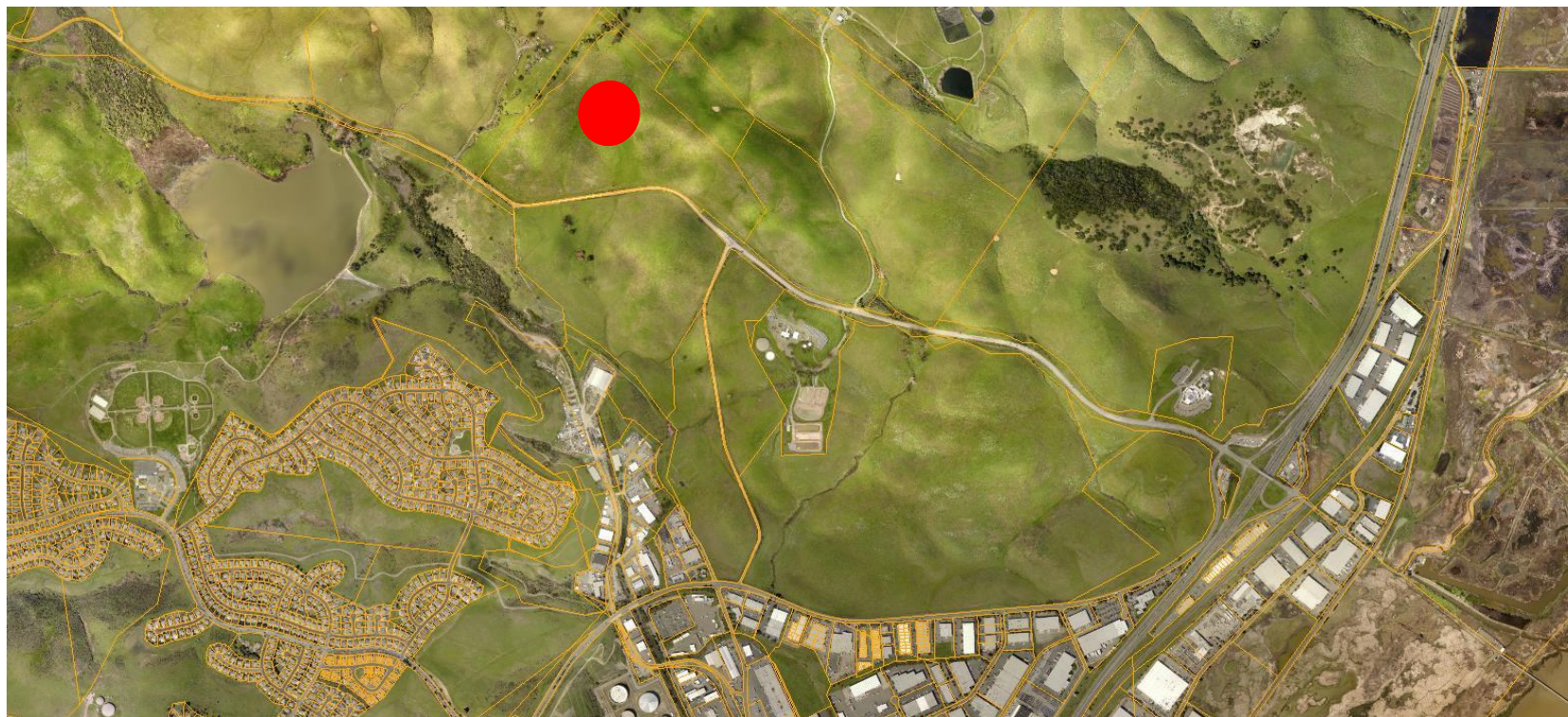


Aaron Halimi  
President

# Attachment B: Vicinity Map



Attachment C: Aerial Map



**LAKE HERMAN SOLAR**

LAKE HERMAN RD,  
BENICIA, CA 94510, USA

LAT: 38.097075°  
LON: -122.141678°

REV. NO	DESCRIPTION	DATE
0	FOR UTILITY APPLICATION	09/18/19

SHEET TITLE:

**PRELIMINARY LAYOUT**

DRAWING NO.:

**PV-100**

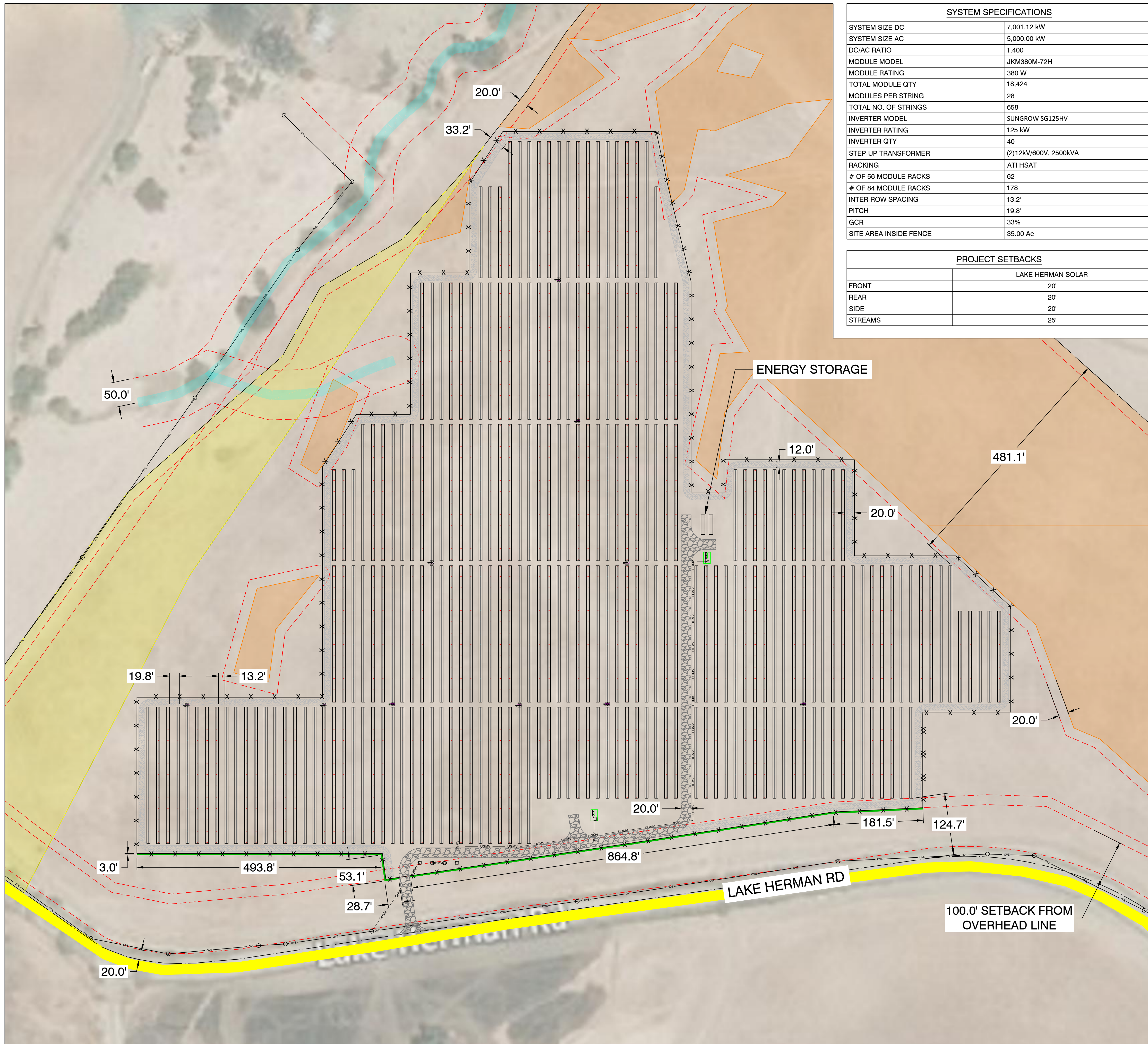
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REVIEWED BY:

DATE: 09/17/19

SCALE: AS SHOWN

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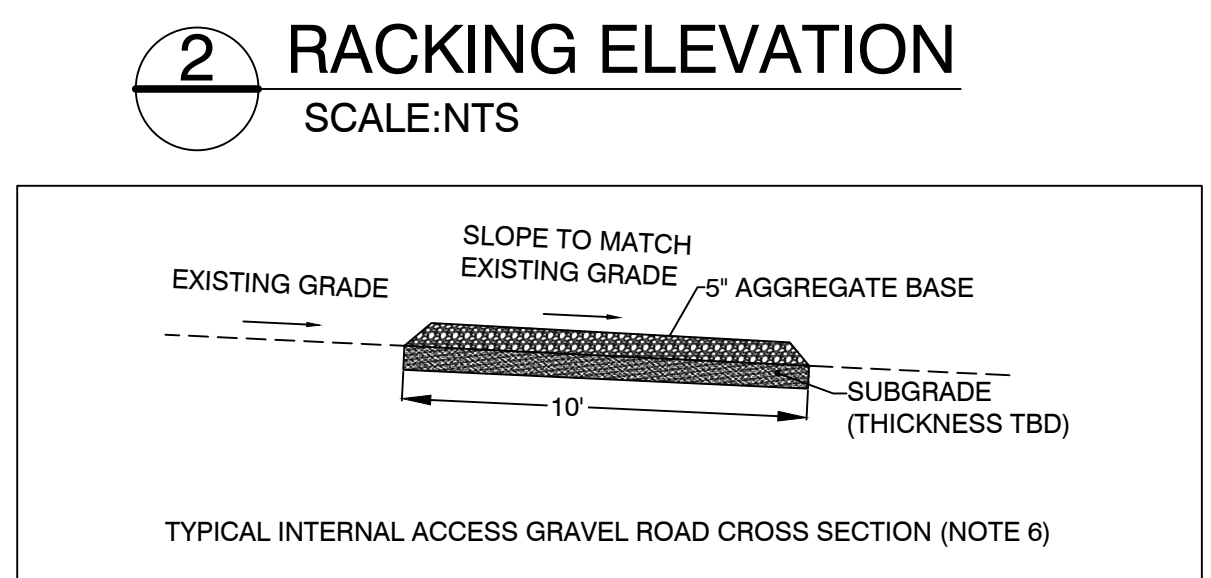
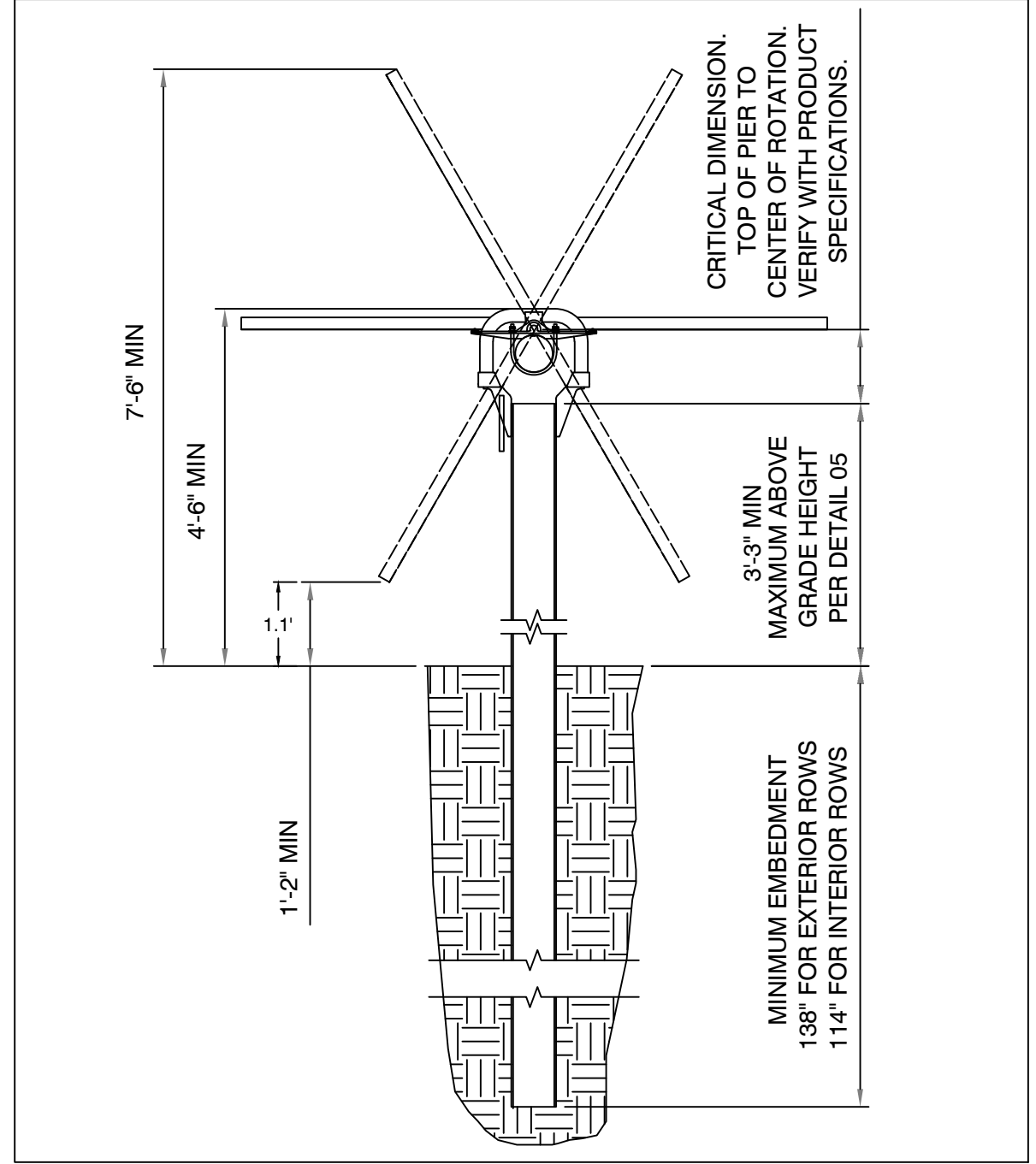


SYSTEM SPECIFICATIONS	
SYSTEM SIZE DC	7,001.12 kW
SYSTEM SIZE AC	5,000.00 kW
DC/AC RATIO	1.400
MODULE MODEL	JKM380M-72H
MODULE RATING	380 W
TOTAL MODULE QTY	18,424
MODULES PER STRING	28
TOTAL NO. OF STRINGS	658
INVERTER MODEL	SUNGROW SG125HV
INVERTER RATING	125 kW
INVERTER QTY	40
STEP-UP TRANSFORMER	(2)12kV/600V, 2500kVA
RACKING	ATI HSAT
# OF 56 MODULE RACKS	62
# OF 84 MODULE RACKS	178
INTER-ROW SPACING	13.2'
PITCH	19.8°
GCR	33%
SITE AREA INSIDE FENCE	35.00 Ac

PROJECT SETBACKS	
	LAKE HERMAN SOLAR
FRONT	20'
REAR	20'
SIDE	20'
STREAMS	25'

LEGEND	
	ATI 84 MODULE TRACKER ROW
	ATI 56 MODULE TRACKER ROW
	POWER STATION (TYP. OF 2) - (1) MV TRANSFORMER, (1) DAS, (1) WEATHER STATION
	EQUIPMENT RACK (TYP. OF 10) - (4) SUNGROW 125kW STRING INVERTER, (1) 600A MLO PANEL
	20' WIDE SITE ACCESS GRAVEL ROAD
	12' WIDE PERIMETER DIRT ROAD
	(E) WETLAND
	PUBLIC ROAD
	HIGH SLOPE AREAS
	UNEVEN SLOPE AREAS
	VEGETATIVE SCREEN
	PROPERTY LINE
	PROPERTY LINE
	SETBACK
	(E) OH LINES
	OVERHEAD MV CABLE
	UNDERGROUND MV CABLE

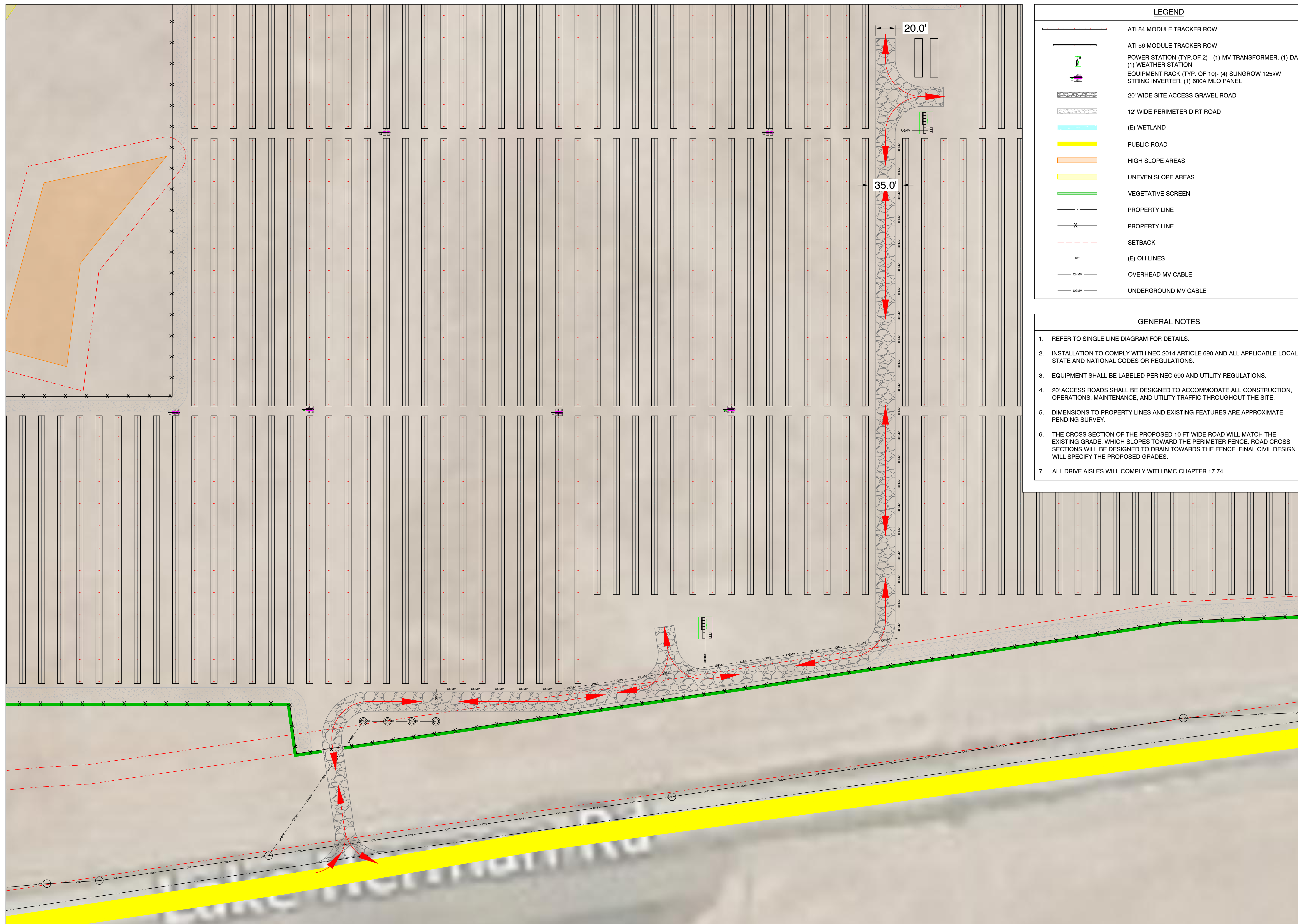
- GENERAL NOTES**
- REFER TO SINGLE LINE DIAGRAM FOR DETAILS.
  - INSTALLATION TO COMPLY WITH NEC 2014 ARTICLE 690 AND ALL APPLICABLE LOCAL, STATE AND NATIONAL CODES OR REGULATIONS.
  - EQUIPMENT SHALL BE LABELED PER NEC 690 AND UTILITY REGULATIONS.
  - 20' ACCESS ROADS SHALL BE DESIGNED TO ACCOMMODATE ALL CONSTRUCTION, OPERATIONS, MAINTENANCE, AND UTILITY TRAFFIC THROUGHOUT THE SITE.
  - DIMENSIONS TO PROPERTY LINES AND EXISTING FEATURES ARE APPROXIMATE PENDING SURVEY.
  - THE CROSS SECTION OF THE PROPOSED 10 FT WIDE ROAD WILL MATCH THE EXISTING GRADE, WHICH SLOPES TOWARDS THE PERIMETER FENCE. ROAD CROSS SECTIONS WILL BE DESIGNED TO DRAIN TOWARDS THE FENCE. FINAL CIVIL DESIGN WILL SPECIFY THE PROPOSED GRADES.
  - ALL DRIVE AISLES WILL COMPLY WITH BMC CHAPTER 17.74.



**1 ARRAY PLAN**  
SCALE: 1"=100'



**3 GRAVEL ROAD CROSS SECTION**  
SCALE: NTS



LEGEND	
	20' WIDE SITE ACCESS GRAVEL ROAD
	12' WIDE PERIMETER DIRT ROAD
	(E) WETLAND
	PUBLIC ROAD
	HIGH SLOPE AREAS
	UNEVEN SLOPE AREAS
	VEGETATIVE SCREEN
	PROPERTY LINE
	SETBACK
	(E) OH LINES
	OVERHEAD MV CABLE
	UNDERGROUND MV CABLE

- GENERAL NOTES**
- REFER TO SINGLE LINE DIAGRAM FOR DETAILS.
  - INSTALLATION TO COMPLY WITH NEC 2014 ARTICLE 690 AND ALL APPLICABLE LOCAL, STATE AND NATIONAL CODES OR REGULATIONS.
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  - ALL DRIVE AISLES WILL COMPLY WITH BMC CHAPTER 17.74.



**LAKE HERMAN SOLAR**

LAKE HERMAN RD,  
BENICIA, CA 94510, USA  
  
LAT: 38.097075°  
LON: -122.141678°

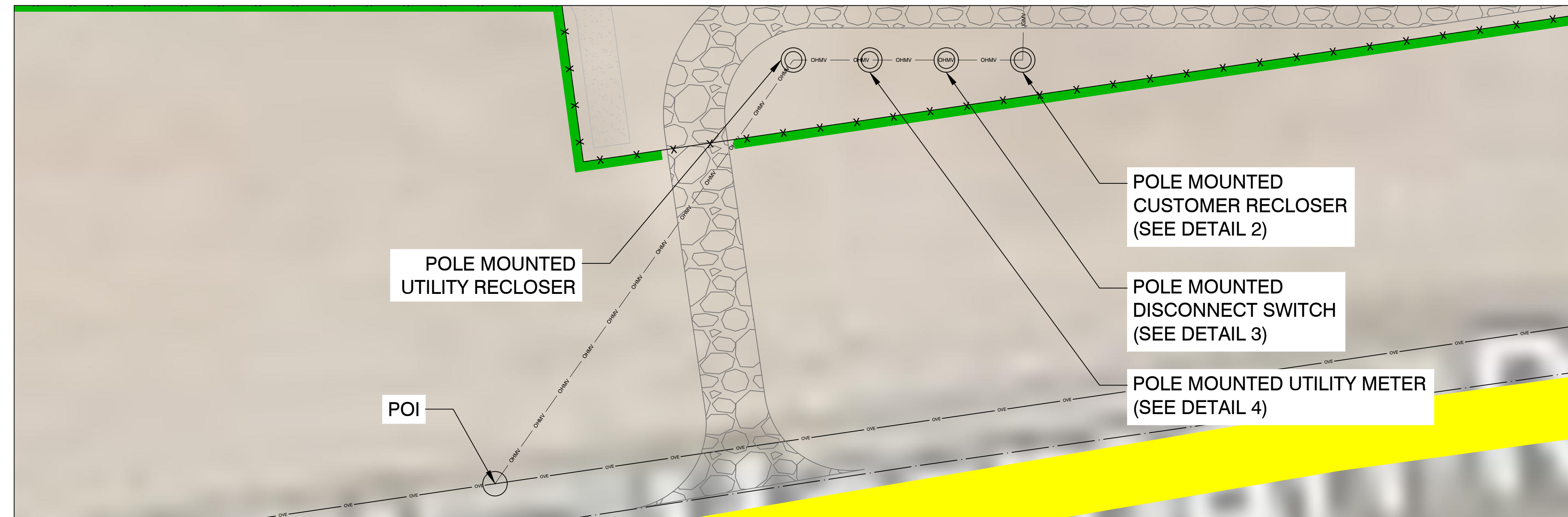
REV. NO	DESCRIPTION	DATE
0	FOR UTILITY APPLICATION	09/18/19

SHEET TITLE:

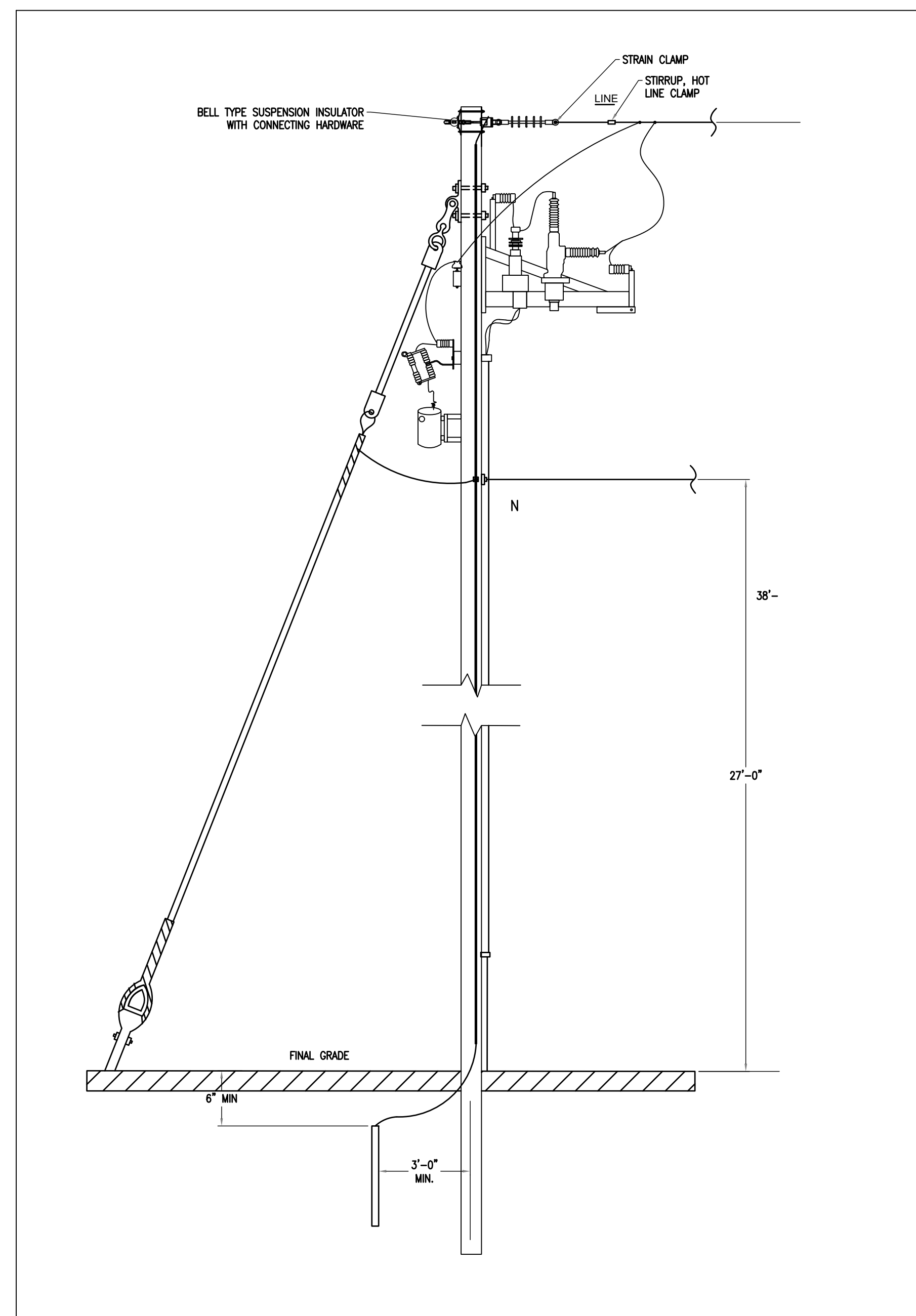
**CIRCULATION PLAN FOR VEHICLES**

DRAWING NO.:  
**PV-101**

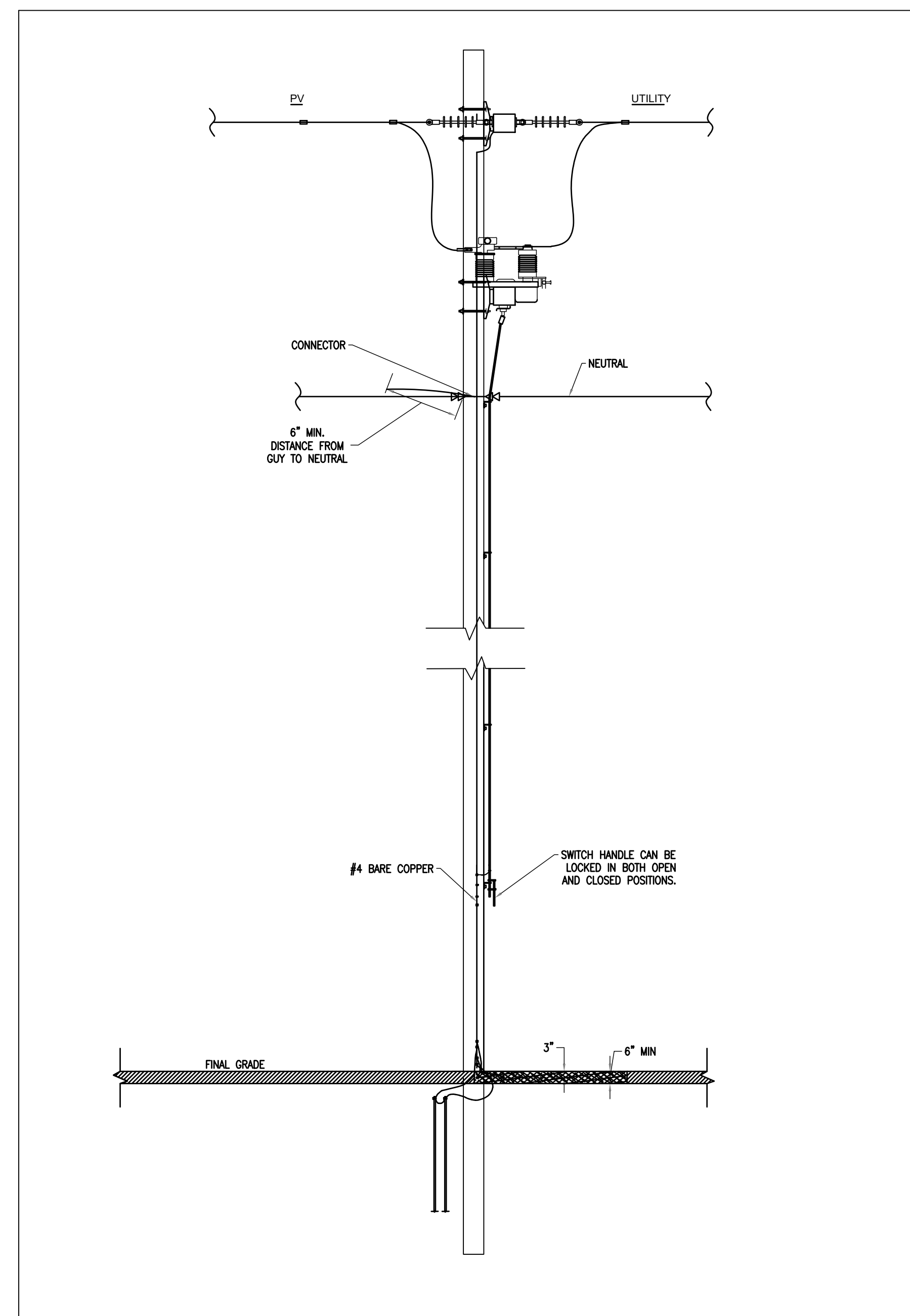
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REVIEWED BY:  
DATE: 09/17/19  
SCALE: AS SHOWN  
PROJECT NO.:



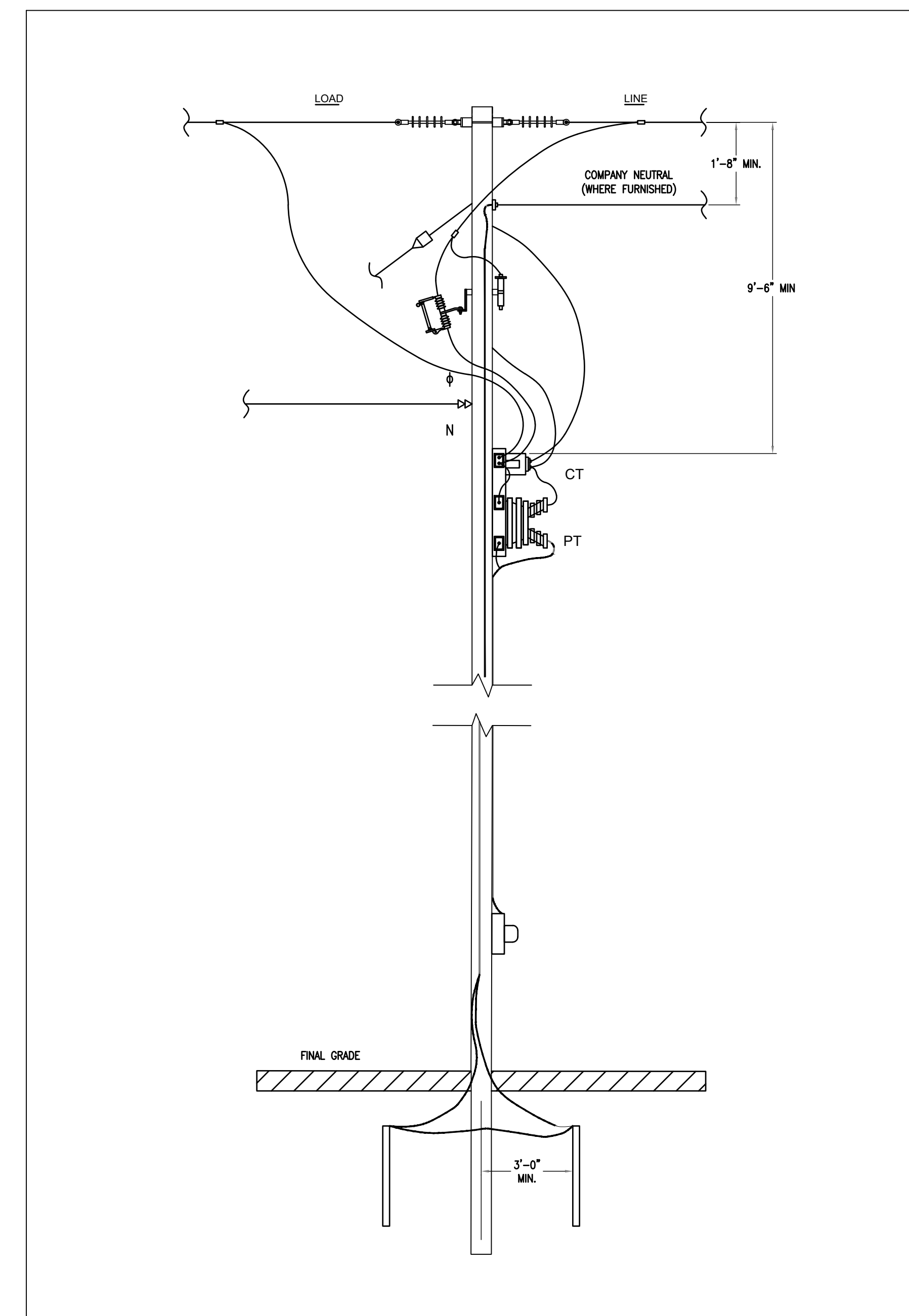
**1** INTERCONNECTION DETAILS  
SCALE: NTS



**2** RISER POLE WITH CUSTOMER RECLOSER  
SCALE: NTS



**3** DISCONNECT SWITCH  
SCALE: NTS



**4** REVENUE METER  
SCALE: NTS



**LAKE HERMAN SOLAR**

LAKE HERMAN RD,  
BENICIA, CA 94510, USA

LAT: 38.097075°  
LON: -122.141678°

REV. NO.	DESCRIPTION	DATE
0	FOR UTILITY APPLICATION	09/18/19

SHEET TITLE:

**INTERCONNECTION DETAILS**

DRAWING NO.:

**PV-102**

DRAWN BY:

LR

REVIEWED BY:

DATE:

09/17/19

SCALE:

AS SHOWN

PROJECT NO.:



# Glare Impact Study of Lake Herman Solar Facility



Thomas Cleveland, PE  
Raleigh, NC  
July 29, 2019

## Table of Contents

Executive Summary.....	2
Background .....	3
Glare Impact Analysis.....	3
Modeling the Lake Herman Solar Facility .....	3
Analysis of the Travis Air Force Base Airport (KSUU).....	6
Analysis of Potential Glare Impacts to Nearby Motorists.....	8
Analysis of Residential and Commercial Neighbors.....	10
SGHAT Results.....	11
Conclusion.....	12
Appendix A: SGHAT/ForgeSolar Results Report.....	13
Appendix B: SGHAT/ForgeSolar Results Report for Sunrise Backtrack Simulation.....	26
Appendix C: SGHAT/ForgeSolar Results Report for Sunset Backtrack Simulation.....	39
Appendix D: Thomas Cleveland’s CV .....	52



## Executive Summary

Photovoltaic (PV) modules (aka solar panels) are designed to absorb, and thus not reflect, close to 100% of the solar energy that strikes them. However, when sunlight strikes the glass front of a solar panel at a glancing angle a significant portion of the solar radiation is reflected, which can potentially lead to solar glint or glare impacting a person's vision, including pilots landing aircraft. Thankfully, the conditions required for a PV project to create hazardous glare rarely occur. Also, it is possible to use specialized 3-D modeling software to predict when and where glare may be produced, which allows adjustment of solar project designs before they are constructed in order to avoid the potential for glare hazards.

To avoid construction of solar PV projects that could create a solar glare hazard for aircraft, the Federal Aviation Administration (FAA) and the US Department of Energy's Sandia National Laboratories partnered to develop a software to calculate the potential for a PV project to create glare intense enough to be a hazard to nearby aviation. The software, called Solar Glare Hazard Analysis Tool (SGHAT), may also be used to assess the potential for a PV project to cause solar glare for other viewers, such as vehicle drivers on nearby roads and neighbors looking out of their windows.

The analysis presented in this report used a privately licensed version of the SGHAT software, called ForgeSolar, to conduct a detailed site-specific PV solar glare analysis of the proposed Lake Herman Solar project (Project). The software from ForgeSolar has been validated as effective for this type of solar glare analysis. The software analysis checks for the potential for low or high intensity solar glare for every minute of the year at many user-defined observation points and/or routes. Specifically, the analysis of the Lake Herman Solar project included the final approach flight paths for the six runways at Travis Air Force Base, the air traffic control tower at Travis Air Force Base, the 2-mile section of Lake Herman Road immediately south of the PV project, and buildings within about 1 mile of the site (see figure to the right for locations as modeled in ForgeSolar).

The analysis predicts **no glare** of any intensity at any time during the year at any of the analyzed observation locations.



**Observation Locations Analyzed in ForgeSolar: Flight Paths at Travis Air Force Base in upper right (red lines); Lake Herman Road 2-way route (aqua lines), and buildings (red OP# markers) [Cover image shows Lake Herman Road and building locations in detail]**

## Background

At the request of RPCA Solar 4, LLC, I conducted an analysis of the potential for solar glare impacts by the proposed 5 MW<sub>AC</sub> Lake Herman solar facility located on the northern city limits of Benicia, California. The study analyzed the potential for glare impacts to drivers on Lake Herman Road, pilots approaching the runways at Travis Air Force Base, the air traffic control tower at Travis Air Force Base, and residential and commercial neighbors within one mile.

## Glare Impact Analysis

Intense glare can create a visual hazard. Every experienced driver is familiar with the type of glare shown in the photo to the right that occurs when an auto driver is heading directly into the rising or setting sun. Similarly, airplane and helicopter pilots often fly in the direction of the sun and thus experience very intense glare directly from the sun itself. Pilots also experience glare from reflections off a variety of objects on the ground, such as metal roofs, bodies of water, and car windshields. Consequently, pilots fly with sunglasses and tinted visors to minimize this hazard. The reflected glare produced by these objects is not nearly as intense as direct sunlight. Like many



**Figure 1: Glare coming directly from the Sun**

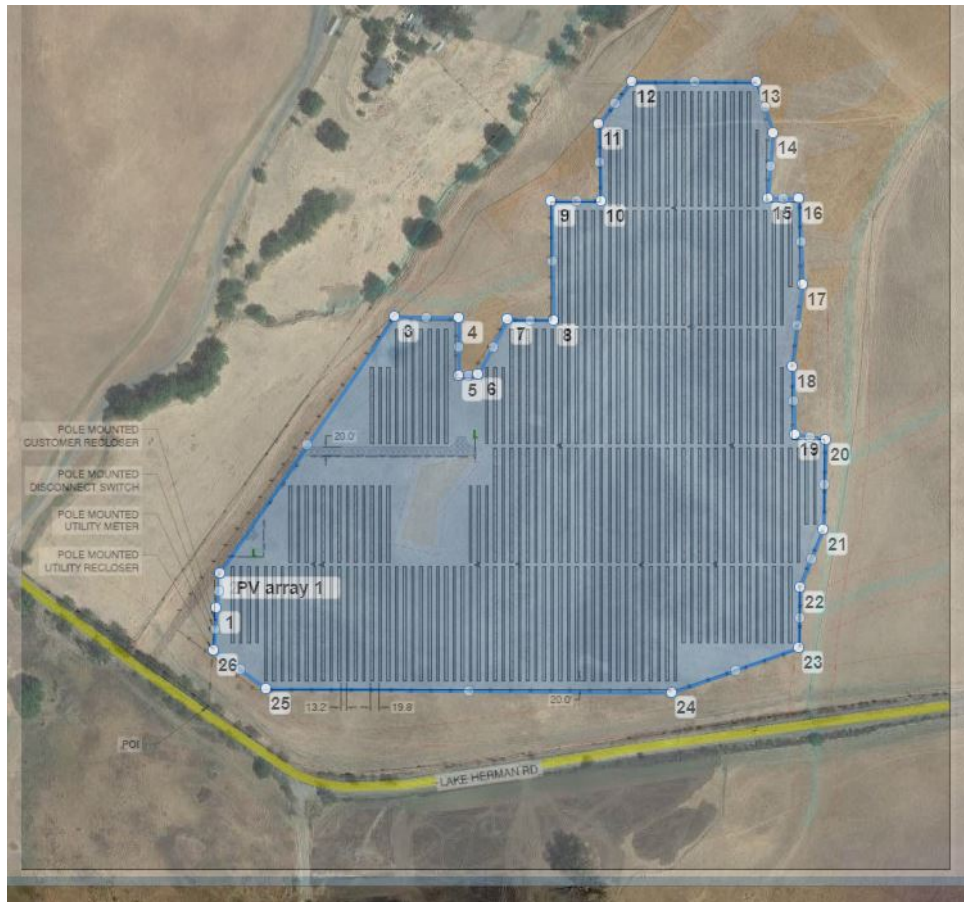
other objects on or near the ground, reflections off solar panels (aka PV modules) can also cause glare visible to pilots. There is also the potential for solar panels on or very near the airport to cause distracting glare for air traffic controllers. Due to these potential hazards, the Federal Aviation Administration (FAA) and the US Department of Energy's Sandia National Laboratories collaborated to create an online software tool, known as the Solar Glare Hazard Analysis Tool, or SGHAT, to analyze solar photovoltaic projects for their potential to create hazardous solar glare. After multiple years of free public availability, access to the SGHAT tool was ended in 2017 and the SGHAT technology was licensed to a private company, ForgeSolar. ForgeSolar improved upon the original SGHAT technology and offers a private solar glare hazard analysis tool, which is the only such tool available today. The analysis presented in this report used the current professional ForgeSolar software.

The software calculates the potential for glare at each modeled observer (e.g. approaching pilot, passing motorist, neighbor) for every minute of the year. The model knows the position of the sun each minute, assumes a cloud-free sky, and calculates the potential for glare from each section of the proposed solar facility. The software can calculate not only whether there is a possibility for glare each minute, but also the intensity of the glare. Thus, it can assess the degree of hazard any glare may present to pilots and motorists.

## Modeling the Lake Herman Solar Facility

The models presented in this report use the default SGHAT values for model variables that are not site specific, such as the sun subtended angle of 9.3 milliradians and 0.017 meter eye focal length. All the model variables are visible in the ForgeSolar results reports included in the appendix of this report.

Figure 2 shows the location of the PV array in the ForgeSolar model. The array layout from a Lake Herman site plan containing satellite imagery was overlaid over the ForgeSolar software so that the PV array location in the model accurately represents the location of the array in the actual project. To be conservative the array in ForgeSolar extends all the way to the site's perimeter fence.

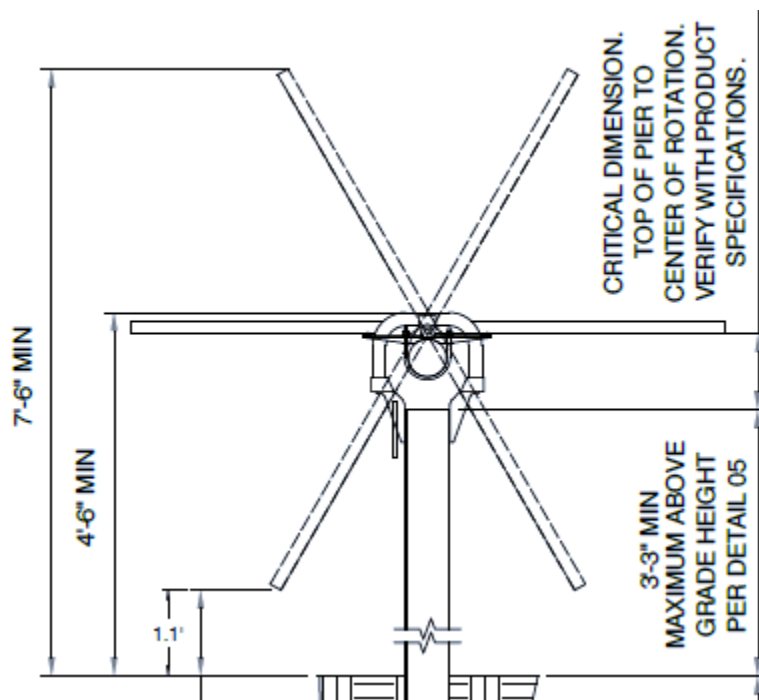


**Figure 2. Lake Herman PV Array in ForgeSolar (blue area with numbered vertices) with Overlay of Lake Herman Site Plan Showing the Array Layout, Site Fence, and Satellite Imagery**

The entire project uses single-axis tracking racking to mount the PV modules. As is typical for this type of PV module racking, the array at the Lake Herman site consists of 1-module-wide rows that are each oriented along a North-South line. This North-South line is also the axis of rotation of each row. The basic motion is that each row slowly rotates over the course of every day from a 60-degree tilt toward the east at sunrise to a 60-degree tilt toward the west by sunset. Around midday when the sun is at its highest position in the sky the rows of modules are horizontal, with each module facing straight up. The ForgeSolar analysis assumes that the rows remain tilted 60 degrees (from horizontal) to the west from the time of sunset each day until the time of sunrise the next day. In actuality the tracking system is likely to be more sophisticated and implement automatic backtracking, which means that near sunrise and sunset the rows will tilt less than the full 60 degrees in order to avoid each row partially shading the row behind it. Solar module electricity production is very sensitive to partial shading, so the system can produce more power by facing the modules a little more horizontal than otherwise optimal if it means avoiding one row shading another. This backtracking will increase the incidence angle of the sunlight on the modules which increases the reflectivity of the modules and thus the potential for glare impacts.

Unfortunately, the ForgeSolar software is not currently able to model automatic backtracking; however, additional ForgeSolar simulations were conducted to assess the glare impact of backtracking. Four additional systems were analyzed, two with the PV array facing west and with a fixed-tilt 45 degrees and 30 degrees from horizontal and another two facing east also with tilts of 45 and 30 degrees. The west-facing models represent a backtracked array near sunset and the east-facing models represent a backtracked array near sunrise.

For all SGHAT models in this report, the solar array is modeled at a height of 5 feet, representing a typical height for the center of each PV module. Models were also run with array heights of 2 feet and 8 feet, representing the bottom and top of the array, as recommended in the SGHAT user manual. The results of the 2-ft and 8-ft height models were the same as the model with a 5-foot array height, so for simplicity only the 5-foot array data is presented in this report.



**Figure 3. Diagram of PV Module Racking from the Lake Herman Solar Site Plan, Including Minimum Height Above Grade for Horizontal and Extreme Angles of Rotation**

It is vital to realize that the software does *not* take into account visual obstructions between the solar array and the observer. This includes both topographical barriers, such as a hill, and living or man-made barriers such as a forest or building. A comprehensive analysis of the visibility of the solar array from each observation route or point is not included in this report, although aerial 3D surface models clearly show that several of the nearby buildings and the air traffic control tower at Travis Air Force Bases have their view of the solar array, and thus any glare it may produce, blocked by elevated topography between the observation point and every part of the array. For simplicity no potential relevant observation points were omitted from the ForgeSolar analysis due to having no line of sight to the array; however, some potential residential observation points were omitted from the ForgeSolar analysis due to other building blocking their sight of the array and because other modeled observation points represent a closer observation point along the same line of sight.

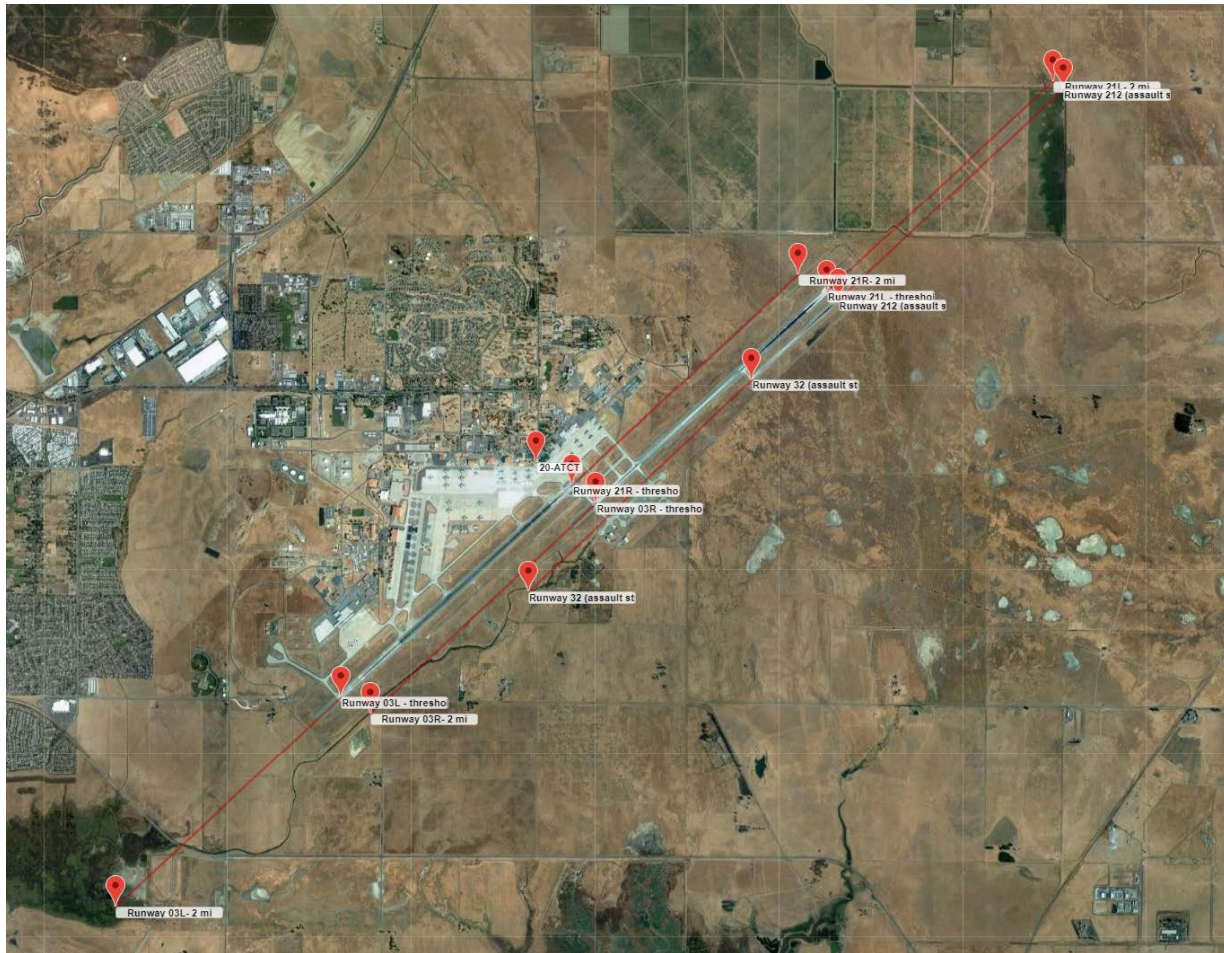
### Analysis of the Travis Air Force Base Airport (KSUU)

This analysis modeled the potential for glare hazards for Travis Air Force Base (KSUU), which is located about 14.1 miles northeast from the Lake Herman Solar project (measured from the threshold of the closest runway to the closest solar module). The Travis Air Force Base Land Use Compatibility Plan classifies all the land around the base as one of several impact zones (Zones A to E) depending on its potential to impact operations at the base with Zone A having the most potential for impact. The proposed site for the Lake Herman Solar project is in Zone D, which requires that any commercial-scale solar facility not create a glare hazard at the base. To comply the solar project must not create glare along any final approach path that is more intense than glare that has a “low potential for after-image”. Travis Air Force Base has six runways, Runway 3L/21R, Runway 03R/21L, and a shorter assault strip Runway 32/212. Each set of runways share the same physical runway but represent approaches from opposite ends. The specifics of the typical approach for each runway were set based on FAA data for Travis Air Force Base<sup>1</sup>. The airport also has an air traffic control tower located just to the northwest of the runways that was included in the solar glare analysis as Observation Point 20.



**Figure 4. Location of Travis Air Force Base Airport in Relation to the Lake Herman Solar Project Site; 14.1 Miles Between Them Along the Red Line (Image is Oriented with North Toward the Top)**

<sup>1</sup> Sourced from <https://maps.avnwx.com/airport/KSUU> which presents the current airport data provided by FAA ([https://aeronav.faa.gov/afd/20jun2019/sw\\_233\\_20JUN2019.pdf](https://aeronav.faa.gov/afd/20jun2019/sw_233_20JUN2019.pdf)) in a user-friendly format



**Figure 5. Approach Flight Paths (Red Lines) to Travis Air Force Base’s Six Runways and the Airports Air Traffic Control Tower (“20 – ATCT” slightly to the left of the center of the image), as Modeled in ForgeSolar**

As specified in the Interim Policy for the FAA Review of Solar Energy System Projects on Federally Obligated Airports<sup>2</sup>, the ForgeSolar software examines the last two miles of the landing approach to each runway. The analysis is limited to this portion of the flight path because severe glare during the final approach has the potential to create a hazard for the pilot, whereas severe glare earlier in the flight is generally a not hazard.

The SGHAT results for the Project were **no glare** of any intensity during any minute of the year for any of the flight paths and for the air traffic control tower. The four additional ForgeSolar models representing intelligent backtracking of the array near sunrise and sunset predicted **no glare** from a backtracking array.

<sup>2</sup> “Interim Policy for the FAA Review of Solar Energy System Projects on Federally Obligated Airports.”, <http://www.gpo.gov/fdsys/pkg/FR-2013-10-23/pdf/2013-24729.pdf>

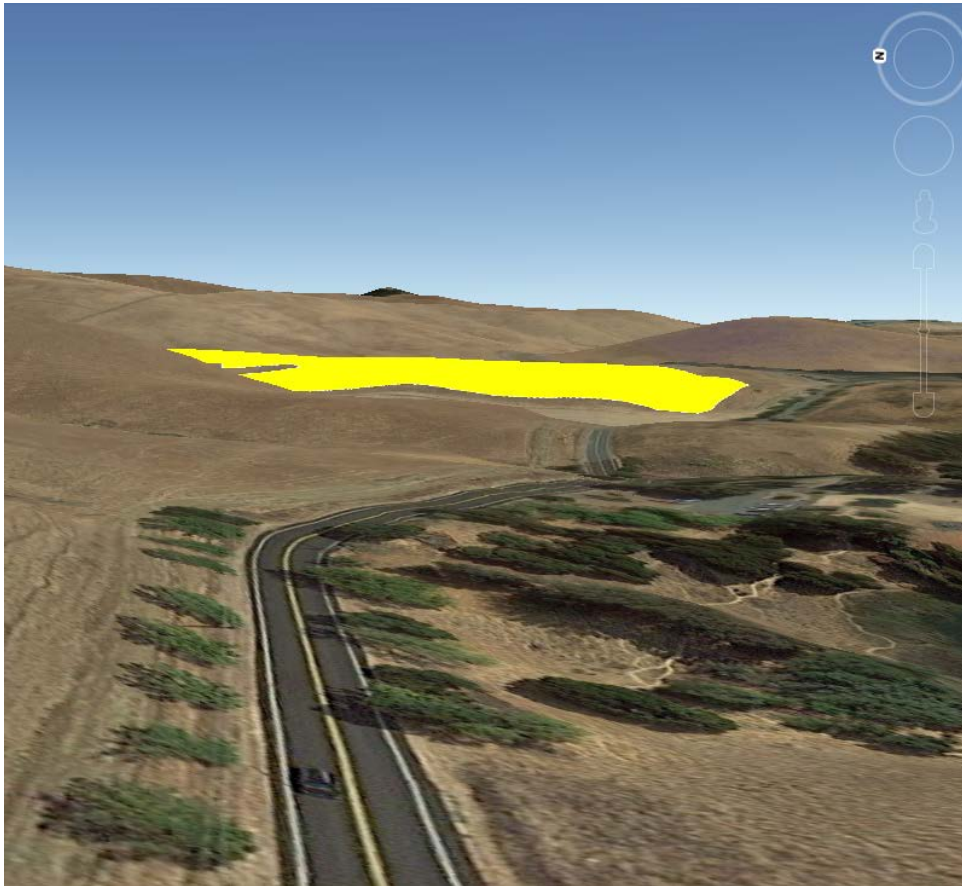


### Analysis of Potential Glare Impacts to Nearby Motorists

The proposed project is just to the north of Lake Herman Road, which is a small rural roadway, and was analyzed in ForgeSolar for any potential glare impacts from the proposed solar facility. The other nearby roads are small private roads with very limited traffic volume and slow traffic speeds, so these roads were not included in the ForgeSolar glare analysis. There are some rolling hills in the area, but the proposed solar facility is generally at the same elevation as Lake Herman Road. The rolling hills block view of the solar project along several portions of the road but there is limited vegetation to block motorists' views of the solar modules where there is no hill to impede view. Therefore, there are sections of Lake Herman road where the proposed solar project will be visible within 45 degrees of the automobile's direction of travel. The following two images from a 3D model of the site in Google Earth use elevated views from above the area to provide a sense of the views of the site for both the eastbound and westbound motorists on Lake Herman Road. The yellow area seen in these images show the location of the site footprint within the project's perimeter fence.



**Figure 6. View from Southeast of the Solar Site from an Elevated Viewpoint across Lake Herman Road. Lake Herman is Visible in the Upper Left Corner of the Image. The Yellow Area is the site footprint within the perimeter fence.**



**Figure 7. View Facing East from above Lake Herman Road to the West of the Solar Site from an Elevated Viewpoint**

ForgeSolar provides a “route” type of observation location that is designed to model the potential for glare hazards along roads and other routes. One route was modeled in ForgeSolar as shown in Figure 8, which is analyzed by ForgeSolar as both an eastbound route and a westbound route. The route was modeled at 3.5 feet above the ground, to represent the height of a driver, per the American Association of State Highway and Transportation Officials (AASHTO) eye height of a driver of a passenger vehicle<sup>3</sup>. The software checks for glare from up to 50 degrees from the direction of travel. Studies of pilots have shown that glare from beyond 45 degrees from their direction of travel does not present any glare hazard, and it is reasonable to assume that the same holds true for motor vehicle drivers as well.

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<sup>3</sup> A Policy on Geometric Design of Highways and Streets. American Association of State Highway and Transportation Officials, Washington, D. C., 2004 edition



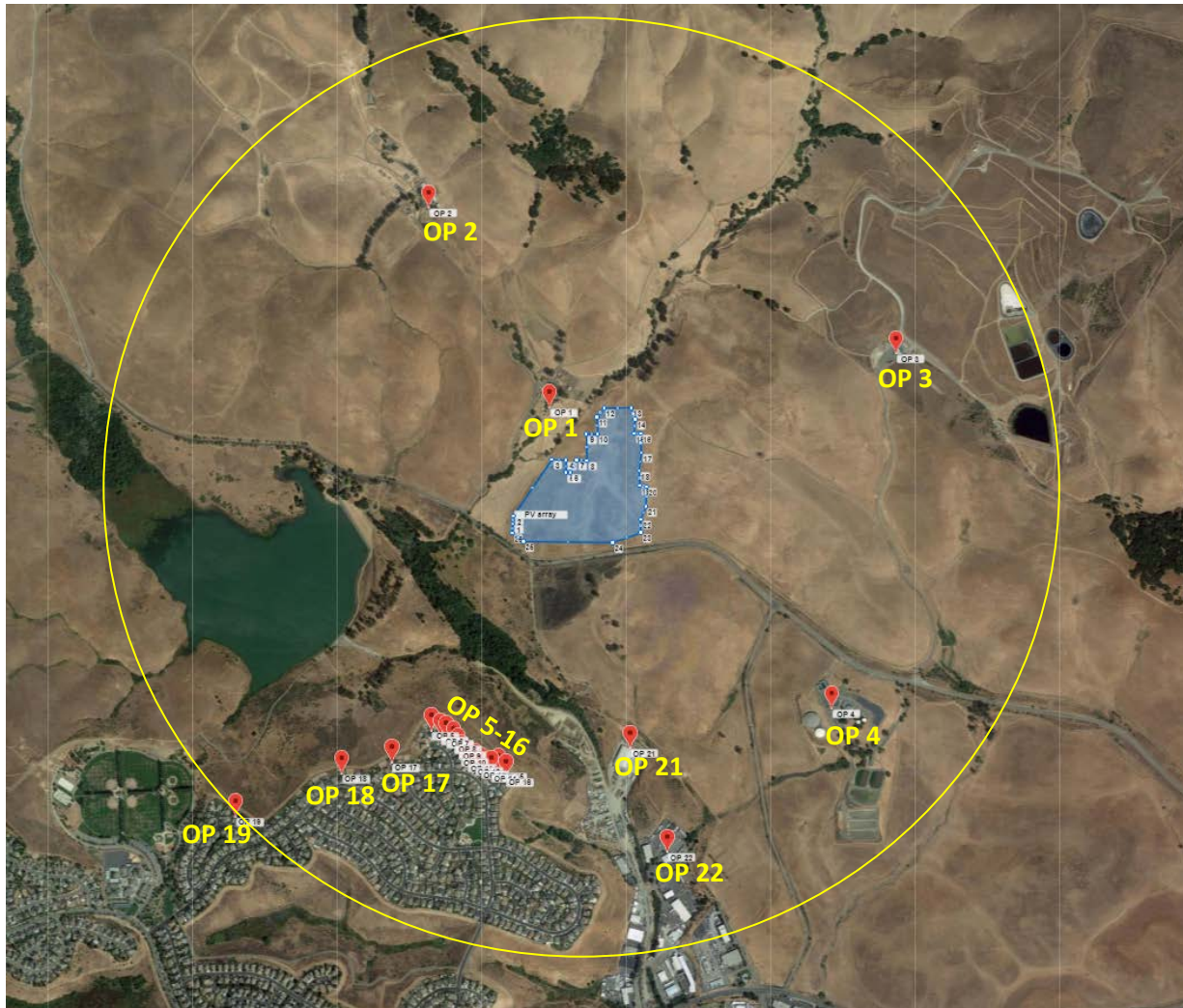


**Figure 8. Observation Route on Lake Herman Road (Aqua Line) as Modeled in ForgeSolar, Approximately 2 Miles End-to-End**

The SGHAT results for the Project were **no glare** of any intensity during any minute of the year for motorists on Lake Herman Road. The four additional ForgeSolar models representing intelligent backtracking of the array near sunrise and sunset predicted **no glare** from a backtracking array for motorists on Lake Herman Road.

### **Analysis of Residential and Commercial Neighbors**

There is only one occupied building closer than  $\frac{1}{2}$  mile from the proposed solar facility, which is a home about  $\frac{1}{10}$  of a mile to the northwest of the project. There are numerous residential, industrial, and commercial buildings between about  $\frac{1}{2}$  and 1 mile from the PV site. Twenty of these buildings were included in the ForgeSolar model (Observation Points 2 through 19, 21, and 22. Observation Point 20 is the air traffic control tower at Travis Air Force Base). There are additional buildings within a 1-mile radius of the solar facility, but these buildings are either unoccupied, have their view blocked by a building included in the analysis, or are represented by the analysis results of a nearby building included in the analysis. All but four of the buildings within 1 mile of the proposed site are in an area of development to the south of the project. Most of the buildings have their view of the Project at least partially blocked by higher ground between the building and the site, and some of the buildings have their view fully blocked by a hill. Rather than include a line-of-sight to justify not modeling some buildings all appropriate buildings were simply included in the ForgeSolar analysis.



**Figure 9. Residential and Non-Residential Buildings within 1 Mile Radius (Yellow Circle) of the Center of the Proposed Solar Facility Modeled in ForgeSolar (Observation Points, OP)**

The SGHAT results for the Project were **no glare** of any intensity during any minute of the year for any of the observation points located at buildings. The four additional ForgeSolar models representing intelligent backtracking of the array near sunrise and sunset predicted **no glare** from a backtracking array for any of the observation points located at buildings.

### **SGHAT Results**

As described above, the ForgeSolar SGHAT software was used to conduct a glare hazard analysis of pilots landing at Travis Air Force Base, air traffic controllers at Travis Air Force Base, motorists on Lake Herman Road, and people at nearby buildings. A summary of results is presented in this section of the report and the full ForgeSolar-generated report is provided in Appendix A.

The ForgeSolar SGHAT defines two intensities of glare, “green” and “yellow”. Green glare represents a “Low Potential for Temporary After-Image” and is about 1/1000<sup>th</sup> the intensity of looking directly into

the sun (based on Hazards Plot in the SGHAT User's Manual)<sup>4</sup>. According to the FAA Interim solar policy<sup>5</sup>, which defines the requirements for solar projects constructed on airport property, glare visible to pilots on their final landing approach that is classified in this green range is acceptable. In other words, any amount of green glare is considered non-hazardous. Yellow glare has a "Potential for Temporary After-Image"; such glare could affect the pilot's ability to see clearly even after looking away from the glare. The FAA Interim solar policy (which only has authority for solar built on airports) does not allow solar arrays that produce yellow glare visible to pilots on final approach to be built on airport property. The ForgeSolar results use the same green and yellow glare classifications for glare visible at other types of observation points as well, such as to motorists and pedestrians.

The ForgeSolar SGHAT results for the Project were **no glare** of any intensity during any minute of the year for every flight path, air traffic control tower, roadway route, and the land-based observation point. As described in the *Modeling the Lake Herman Solar Facility* section, additional ForgeSolar models were constructed to simulate intelligent backtracking by the tracking system early and late in the day to avoid inter-row shading. When backtracking the modules are turned away from the sun and thus have more potential to create a glare hazard. The results of these simulations showed that backtracked rows (45 and 30 degrees from horizontal) did not produce any glare during the hours near sunrise and sunset in which backtracking may be used. The models did predict some glare near noon, but this glare result is meaningless because the array will be tracking the sun at this time of day and not in a backtracked position at that time. The ForgeSolar-generated reports for the 30-tilt east-facing and west-facing are provided in Appendix B and Appendix C respectively.

## Conclusion

The solar glare hazard analysis of the proposed Lake Herman solar facility finds that the PV system will not produce any glare hazards. ForgeSolar, a detailed, proven solar glare hazard analysis software, was used to model the potential for the proposed solar array to cause glare for approaching motorists, people at nearby buildings, and pilots and air traffic controllers at Travis Air Force Base. In fact, the software analysis found **no glare of any intensity at any time during the year at any of the analyzed locations**. The proposed PV project uses a single-axis tracking racking system to support the solar modules/panels which keeps the solar modules generally facing toward the sun. This design avoids situations where the sunlight hits the solar panels with a glancing angle, which is when the glass of a solar panel is reflective and thus has a potential to cause visible glare to an observer.

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<sup>4</sup> *Solar Glare Hazard Analysis Tool Users Manual version 2.0*,  
[https://share.sandia.gov/phlux/static/references/glint-glare/SGHAT\\_Users\\_Manual\\_v2-0\\_final.pdf](https://share.sandia.gov/phlux/static/references/glint-glare/SGHAT_Users_Manual_v2-0_final.pdf)

<sup>5</sup> *Interim Policy for the FAA Review of Solar Energy System Projects on Federally Obligated Airports*,  
<http://www.gpo.gov/fdsys/pkg/FR-2013-10-23/pdf/2013-24729.pdf>

## Appendix A: SGHAT/ForgeSolar Results Report

ForgeSolar Glare Analysis Report – Page 1 of 13



### FORGESOLAR GLARE ANALYSIS

Project: **Lake Herman**

Proposed 5 MW solar facility on Lake Herman Rd. in Benicia California near Travis Air Force Base. Will use single axis tracking array

Site configuration: **Baseline**

Analysis conducted by Tommy Cleveland (thcleveland@gmail.com) at 05:10 on 21 Jul, 2019.

### U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>

## SITE CONFIGURATION

### Analysis Parameters

DNI: peaks at 1,000.0 W/m<sup>2</sup>  
Time interval: 1 min  
Ocular transmission coefficient: 0.5  
Pupil diameter: 0.002 m  
Eye focal length: 0.017 m  
Sun subtended angle: 9.3 mrad  
Site Config ID: 29667.5349



**PV Array(s)**

**Name:** PV array  
**Axis tracking:** Single-axis rotation  
**Tracking axis orientation:** 180.0°  
**Tracking axis tilt:** 0.0°  
**Tracking axis panel offset:** 0.0°  
**Max tracking angle:** 60.0°  
**Resting angle:** 60.0°  
**Rated power:** 5000.0 kW  
**Panel material:** Smooth glass without AR coating  
**Reflectivity:** Vary with sun  
**Slope error:** correlate with material

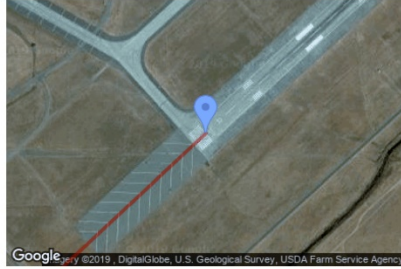


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	38.096105	-122.144826	106.95	5.00	111.95
2	38.096333	-122.144794	108.88	5.00	113.88
3	38.098021	-122.143334	116.12	5.00	121.12
4	38.098013	-122.142798	130.51	5.00	135.51
5	38.097633	-122.142798	145.05	5.00	150.05
6	38.097641	-122.142637	150.85	5.00	155.85
7	38.098004	-122.142390	142.65	5.00	147.65
8	38.097996	-122.142004	150.95	5.00	155.95
9	38.098781	-122.142026	154.44	5.00	159.44
10	38.098781	-122.141607	158.77	5.00	163.77
11	38.099288	-122.141629	142.58	5.00	147.58
12	38.099566	-122.141350	161.93	5.00	166.93
13	38.099566	-122.140309	188.83	5.00	193.83
14	38.099229	-122.140169	193.00	5.00	198.00
15	38.098798	-122.140212	183.89	5.00	188.89
16	38.098798	-122.139955	182.04	5.00	187.04
17	38.098232	-122.139923	168.46	5.00	173.46
18	38.097692	-122.140008	160.23	5.00	165.23
19	38.097244	-122.139987	146.89	5.00	151.89
20	38.097211	-122.139730	139.04	5.00	144.04
21	38.096620	-122.139751	131.05	5.00	136.05
22	38.096240	-122.139944	121.39	5.00	126.39
23	38.095843	-122.139955	115.49	5.00	120.50
24	38.095547	-122.141017	145.56	5.00	150.56
25	38.095573	-122.144407	128.45	5.00	133.45
26	38.095826	-122.144847	104.06	5.00	109.06



**Flight Path Receptor(s)**

**Name:** Runway 03L  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 47.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



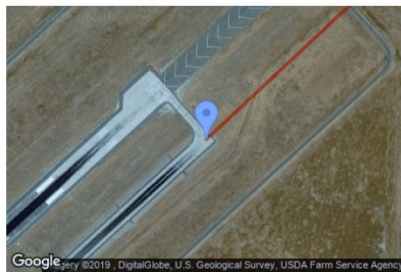
Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.243510	-121.956684	32.62	75.00	107.63
Two-mile	38.223792	-121.983639	3.64	657.44	661.08

**Name:** Runway 03R  
**Description:**  
**Threshold height:** 69 ft  
**Direction:** 47.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.261684	-121.926204	52.29	69.00	121.29
Two-mile	38.241965	-121.953166	19.57	655.17	674.75

**Name:** Runway 212 (assault strip)  
**Description:**  
**Threshold height:** 50 ft  
**Direction:** 226.9°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.280787	-121.897193	52.14	50.00	102.14
Two-mile	38.300545	-121.870272	37.97	617.63	655.60

ForgeSolar Glare Analysis Report – Page 5 of 13

**Name:** Runway 21L  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 227.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



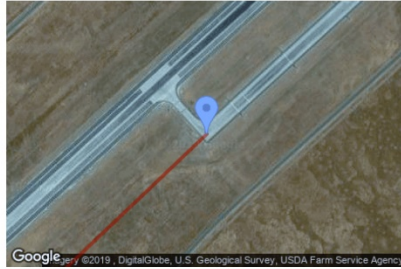
Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.281560	-121.898514	53.07	75.00	128.08
Two-mile	38.301279	-121.871545	37.42	644.11	681.53

**Name:** Runway 21R  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 227.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.263417	-121.928980	48.70	75.00	123.70
Two-mile	38.283136	-121.902017	46.98	630.18	677.15

**Name:** Runway 32 (assault strip)  
**Description:**  
**Threshold height:** 50 ft  
**Direction:** 46.4°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.273315	-121.907571	58.49	50.00	108.49
Two-mile	38.253380	-121.934277	39.73	622.21	661.94

**Discrete Observation Receptors**

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	38.099556	-122.143422	116.45	6.00
OP 2	2	38.105524	-122.148023	186.99	6.00
OP 3	3	38.101159	-122.130236	392.05	6.00
OP 4	4	38.090553	-122.132693	254.76	6.00
OP 5	5	38.089899	-122.147898	204.10	6.00
OP 6	6	38.089743	-122.147560	202.99	6.00
OP 7	7	38.089662	-122.147346	201.52	6.00
OP 8	8	38.089502	-122.147077	198.72	6.00
OP 9	9	38.089316	-122.146900	198.50	6.00
OP 10	10	38.089109	-122.146788	196.28	6.00
OP 11	11	38.088932	-122.146535	191.32	6.00
OP 12	12	38.088835	-122.146262	189.79	6.00
OP 13	13	38.088733	-122.146037	187.96	6.00
OP 14	14	38.088641	-122.145629	188.97	6.00
OP 15	15	38.088691	-122.145345	190.06	6.00
OP 16	16	38.088522	-122.145076	189.01	6.00
OP 17	17	38.088964	-122.149402	220.54	6.00
OP 18	18	38.088617	-122.151312	249.51	6.00
OP 19	19	38.087342	-122.155356	248.27	6.00
20-ATCT	20	38.265538	-121.933272	51.83	100.00
OP 21	21	38.088387	-122.140280	42.90	6.00
OP 22	22	38.086251	-122.139004	41.33	6.00

Map image of 20-ATCT



**Route Receptor(s)**

**Name:** Route 1  
**Path type:** Two-way  
**Observer view angle:** 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	38.098603	-122.156958	147.66	3.50	151.36
2	38.098464	-122.154163	151.17	3.50	154.67
3	38.098411	-122.152891	146.38	3.50	149.88
4	38.098283	-122.152460	145.63	3.50	149.13
5	38.097681	-122.151210	127.57	3.50	131.07
6	38.097535	-122.150708	114.88	3.50	118.38
7	38.097267	-122.148975	103.07	3.50	106.57
8	38.097105	-122.148418	117.17	3.50	120.67
9	38.096507	-122.146875	85.81	3.50	89.31
10	38.095543	-122.145159	100.36	3.50	103.86
11	38.095207	-122.144547	120.38	3.50	123.88
12	38.095026	-122.144196	127.21	3.50	130.71
13	38.094924	-122.143858	131.01	3.50	134.51
14	38.094922	-122.143316	134.99	3.50	138.49
15	38.095232	-122.140725	137.78	3.50	141.28
16	38.095517	-122.138239	136.33	3.50	139.83
17	38.095431	-122.137447	148.37	3.50	151.87
18	38.095277	-122.137005	148.82	3.50	152.32
19	38.095045	-122.136624	145.33	3.50	148.83
20	38.094711	-122.136243	139.69	3.50	143.19
21	38.093616	-122.134698	130.76	3.50	134.26
22	38.092566	-122.132939	153.79	3.50	157.29
23	38.091918	-122.131833	176.45	3.50	179.95
24	38.091621	-122.130903	182.10	3.50	185.60
25	38.091015	-122.128041	180.03	3.50	183.53
26	38.090618	-122.125619	197.60	3.50	201.10

## GLARE ANALYSIS RESULTS

### Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array	SA tracking	SA tracking	0	0	15,490,000.0

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
Runway 03L	0	0
Runway 03R	0	0
Runway 212 (assault strip)	0	0
Runway 21L	0	0
Runway 21R	0	0
Runway 32 (assault strip)	0	0
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
20-ATCT	0	0
OP 21	0	0



Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 22	0	0
Route 1	0	0

**Results for: PV array**

Receptor	Green Glare (min)	Yellow Glare (min)
Runway 03L	0	0
Runway 03R	0	0
Runway 212 (assault strip)	0	0
Runway 21L	0	0
Runway 21R	0	0
Runway 32 (assault strip)	0	0
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
20-ATCT	0	0
OP 21	0	0
OP 22	0	0
Route 1	0	0

**Flight Path: Runway 03L**

0 minutes of yellow glare  
 0 minutes of green glare



**Flight Path: Runway 03R**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 212 (assault strip)**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 21L**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 21R**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 32 (assault strip)**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 1**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 2**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 3**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 4**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 5**

0 minutes of yellow glare

## ForgeSolar Glare Analysis Report – Page 11 of 13

0 minutes of green glare

**Point Receptor: OP 6**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 7**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 8**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 9**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 10**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 11**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 12**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 13**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 14**

0 minutes of yellow glare  
0 minutes of green glare



## ForgeSolar Glare Analysis Report – Page 12 of 13

**Point Receptor: OP 15**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 16**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 17**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 18**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 19**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: 20-ATCT**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 21**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 22**

0 minutes of yellow glare  
0 minutes of green glare

**Route: Route 1**

0 minutes of yellow glare  
0 minutes of green glare

## Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size.

Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

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## Appendix B: SGHAT/ForgeSolar Results Report for Sunrise Backtrack Simulation

ForgeSolar Glare Analysis Report (Sunrise Backtrack Simulation) – Page 1 of 13



### FORGESOLAR GLARE ANALYSIS

Project: **Lake Herman**

Proposed 5 MW solar facility on Lake Herman Rd. in Benicia California near Travis Air Force Base. Will use single axis tracking array

Site configuration: **East facing fixed 30-tilt to simulate backtracking**

Analysis conducted by Tommy Cleveland (thcleveland@gmail.com) at 03:12 on 21 Jul, 2019.

### U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	FAIL	Receptor(s) marked as ATCT receive green and/or yellow glare

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>

## SITE CONFIGURATION

### Analysis Parameters

DNI: peaks at 1,000.0 W/m<sup>2</sup>  
Time interval: 1 min  
Ocular transmission coefficient: 0.5  
Pupil diameter: 0.002 m  
Eye focal length: 0.017 m  
Sun subtended angle: 9.3 mrad  
Site Config ID: 29690.5349



ForgeSolar Glare Analysis Report (Sunrise Backtrack Simulation) – Page 3 of 13

**PV Array(s)**

**Name:** PV array  
**Axis tracking:** Fixed (no rotation)  
**Tilt:** 30.0°  
**Orientation:** 90.0°  
**Rated power:** 5000.0 kW  
**Panel material:** Smooth glass without AR coating  
**Reflectivity:** Vary with sun  
**Slope error:** correlate with material

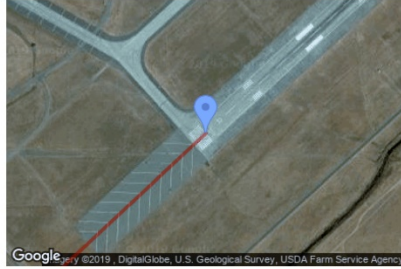


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	38.096105	-122.144826	106.95	5.00	111.95
2	38.096333	-122.144794	108.88	5.00	113.88
3	38.098021	-122.143334	116.12	5.00	121.12
4	38.098013	-122.142798	130.51	5.00	135.51
5	38.097633	-122.142798	145.05	5.00	150.05
6	38.097641	-122.142637	150.85	5.00	155.85
7	38.098004	-122.142390	142.65	5.00	147.65
8	38.097996	-122.142004	150.95	5.00	155.95
9	38.098781	-122.142026	154.44	5.00	159.44
10	38.098781	-122.141607	158.77	5.00	163.77
11	38.099288	-122.141629	142.58	5.00	147.58
12	38.099566	-122.141350	161.93	5.00	166.93
13	38.099566	-122.140309	188.83	5.00	193.83
14	38.099229	-122.140169	193.00	5.00	198.00
15	38.098798	-122.140212	183.89	5.00	188.89
16	38.098798	-122.139955	182.04	5.00	187.04
17	38.098232	-122.139923	168.46	5.00	173.46
18	38.097692	-122.140008	160.23	5.00	165.23
19	38.097244	-122.139987	146.89	5.00	151.89
20	38.097211	-122.139730	139.04	5.00	144.04
21	38.096620	-122.139751	131.05	5.00	136.05
22	38.096240	-122.139944	121.39	5.00	126.39
23	38.095843	-122.139955	115.49	5.00	120.50
24	38.095547	-122.141017	145.56	5.00	150.56
25	38.095573	-122.144407	128.45	5.00	133.45
26	38.095826	-122.144847	104.06	5.00	109.06

ForgeSolar Glare Analysis Report (Sunrise Backtrack Simulation) – Page 4 of 13

**Flight Path Receptor(s)**

**Name:** Runway 03L  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 47.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



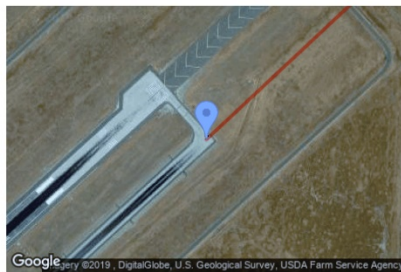
Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.243510	-121.956684	32.62	75.00	107.63
Two-mile	38.223792	-121.983639	3.64	657.44	661.08

**Name:** Runway 03R  
**Description:**  
**Threshold height:** 69 ft  
**Direction:** 47.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.261684	-121.926204	52.29	69.00	121.29
Two-mile	38.241965	-121.953166	19.57	655.17	674.75

**Name:** Runway 212 (assault strip)  
**Description:**  
**Threshold height:** 50 ft  
**Direction:** 226.9°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.280787	-121.897193	52.14	50.00	102.14
Two-mile	38.300545	-121.870272	37.97	617.63	655.60

ForgeSolar Glare Analysis Report (Sunrise Backtrack Simulation) – Page 5 of 13

**Name:** Runway 21L  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 227.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



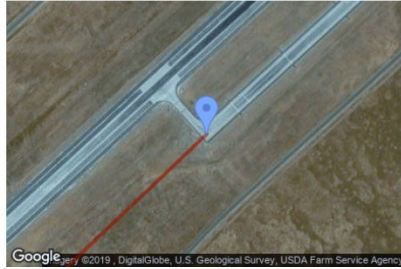
Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.281560	-121.898514	53.07	75.00	128.08
Two-mile	38.301279	-121.871545	37.42	644.11	681.53

**Name:** Runway 21R  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 227.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.263417	-121.928980	48.70	75.00	123.70
Two-mile	38.283136	-121.902017	46.98	630.18	677.15

**Name:** Runway 32 (assault strip)  
**Description:**  
**Threshold height:** 50 ft  
**Direction:** 46.4°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.273315	-121.907571	58.49	50.00	108.49
Two-mile	38.253380	-121.934277	39.73	622.21	661.94

**Discrete Observation Receptors**

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	38.099556	-122.143422	116.45	6.00
OP 2	2	38.105524	-122.148023	186.99	6.00
OP 3	3	38.101159	-122.130236	392.05	6.00
OP 4	4	38.090553	-122.132693	254.76	6.00
OP 5	5	38.089899	-122.147898	204.10	6.00
OP 6	6	38.089743	-122.147560	202.99	6.00
OP 7	7	38.089662	-122.147346	201.52	6.00
OP 8	8	38.089502	-122.147077	198.72	6.00
OP 9	9	38.089316	-122.146900	198.50	6.00
OP 10	10	38.089109	-122.146788	196.28	6.00
OP 11	11	38.088932	-122.146535	191.32	6.00
OP 12	12	38.088835	-122.146262	189.79	6.00
OP 13	13	38.088733	-122.146037	187.96	6.00
OP 14	14	38.088641	-122.145629	188.97	6.00
OP 15	15	38.088691	-122.145345	190.06	6.00
OP 16	16	38.088522	-122.145076	189.01	6.00
OP 17	17	38.088964	-122.149402	220.54	6.00
OP 18	18	38.088617	-122.151312	249.51	6.00
OP 19	19	38.087342	-122.155356	248.27	6.00
20-ATCT	20	38.265538	-121.933272	51.83	100.00

Map image of 20-ATCT





ForgeSolar Glare Analysis Report (Sunrise Backtrack Simulation) – Page7 of 13

**Route Receptor(s)**

**Name:** Route 1  
**Path type:** Two-way  
**Observer view angle:** 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	38.098603	-122.156958	147.66	3.50	151.36
2	38.098464	-122.154163	151.17	3.50	154.67
3	38.098411	-122.152891	146.38	3.50	149.88
4	38.098283	-122.152460	145.63	3.50	149.13
5	38.097681	-122.151210	127.57	3.50	131.07
6	38.097535	-122.150708	114.88	3.50	118.38
7	38.097267	-122.148975	103.07	3.50	106.57
8	38.097105	-122.148418	117.17	3.50	120.67
9	38.096507	-122.146875	85.81	3.50	89.31
10	38.095543	-122.145159	100.36	3.50	103.86
11	38.095207	-122.144547	120.38	3.50	123.88
12	38.095026	-122.144196	127.21	3.50	130.71
13	38.094924	-122.143858	131.01	3.50	134.51
14	38.094922	-122.143316	134.99	3.50	138.49
15	38.095232	-122.140725	137.78	3.50	141.28
16	38.095517	-122.138239	136.33	3.50	139.83
17	38.095431	-122.137447	148.37	3.50	151.87
18	38.095277	-122.137005	148.82	3.50	152.32
19	38.095045	-122.136624	145.33	3.50	148.83
20	38.094711	-122.136243	139.69	3.50	143.19
21	38.093616	-122.134698	130.76	3.50	134.26
22	38.092566	-122.132939	153.79	3.50	157.29
23	38.091918	-122.131833	176.45	3.50	179.95
24	38.091621	-122.130903	182.10	3.50	185.60
25	38.091015	-122.128041	180.03	3.50	183.53
26	38.090618	-122.125619	197.60	3.50	201.10

## GLARE ANALYSIS RESULTS

### Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array	30.0	90.0	3,743	0	9,191,000.0

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
Runway 03L	0	0
Runway 03R	0	0
Runway 212 (assault strip)	0	0
Runway 21L	0	0
Runway 21R	0	0
Runway 32 (assault strip)	0	0
OP 1	0	0
OP 2	0	0
OP 3	3697	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
20-ATCT	46	0
Route 1	0	0



**Results for: PV array**

Receptor	Green Glare (min)	Yellow Glare (min)
Runway 03L	0	0
Runway 03R	0	0
Runway 212 (assault strip)	0	0
Runway 21L	0	0
Runway 21R	0	0
Runway 32 (assault strip)	0	0
OP 1	0	0
OP 2	0	0
OP 3	3697	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
20-ATCT	46	0
Route 1	0	0

**Flight Path: Runway 03L**

0 minutes of yellow glare  
 0 minutes of green glare

**Flight Path: Runway 03R**

0 minutes of yellow glare  
 0 minutes of green glare



**Flight Path: Runway 212 (assault strip)**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 21L**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 21R**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 32 (assault strip)**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 1**

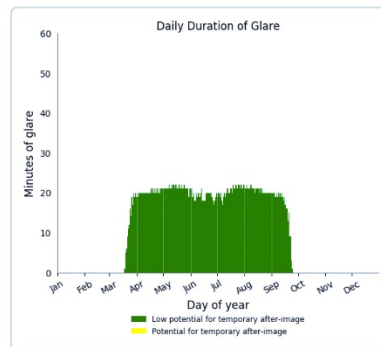
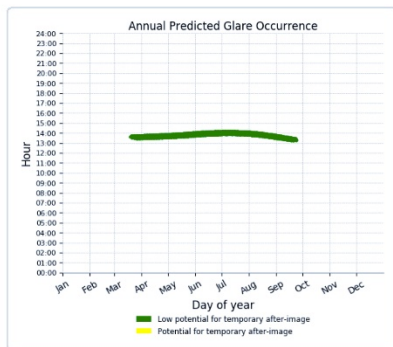
0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 2**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 3**

0 minutes of yellow glare  
3697 minutes of green glare



## ForgeSolar Glare Analysis Report (Sunrise Backtrack Simulation) – Page 11 of 13

**Point Receptor: OP 4**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 5**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 6**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 7**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 8**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 9**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 10**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 11**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 12**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 13**

0 minutes of yellow glare

## ForgeSolar Glare Analysis Report (Sunrise Backtrack Simulation) – Page 12 of 13

0 minutes of green glare

**Point Receptor: OP 14**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 15**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 16**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 17**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 18**

0 minutes of yellow glare  
0 minutes of green glare

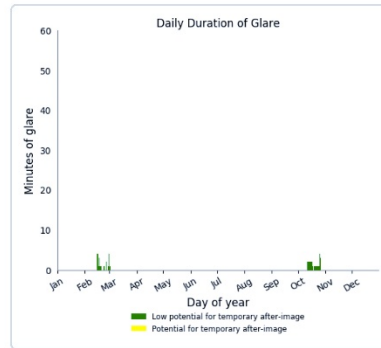
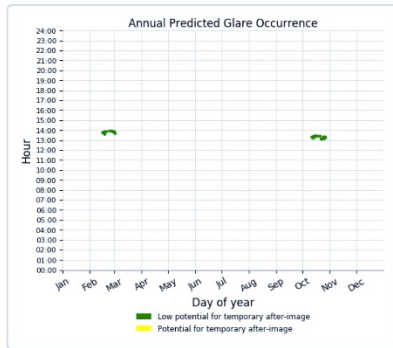
**Point Receptor: OP 19**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: 20-ATCT**

0 minutes of yellow glare  
46 minutes of green glare

ForgeSolar Glare Analysis Report (Sunrise Backtrack Simulation) – Page 13 of 13



**Route: Route 1**

0 minutes of yellow glare  
 0 minutes of green glare

**Assumptions**

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.  
 "Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.  
 Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.  
 Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.  
 Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.  
 The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)  
 Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.  
 Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.  
 The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.  
 Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

## Appendix C: SGHAT/ForgeSolar Results Report for Sunset Backtrack Simulation

ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 1 of 13



### FORGESOLAR GLARE ANALYSIS

Project: **Lake Herman**

Proposed 5 MW solar facility on Lake Herman Rd. in Benicia California near Travis Air Force Base. Will use single axis tracking array

Site configuration: **west facing 30 fixed tilt to simulate backtracking**

Analysis conducted by Tommy Cleveland (thcleveland@gmail.com) at 02:28 on 21 Jul, 2019.

### U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>



## SITE CONFIGURATION

### Analysis Parameters

DNI: peaks at 1,000.0 W/m<sup>2</sup>  
Time interval: 1 min  
Ocular transmission coefficient: 0.5  
Pupil diameter: 0.002 m  
Eye focal length: 0.017 m  
Sun subtended angle: 9.3 mrad  
Site Config ID: 29688.5349



ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 3 of 13

**PV Array(s)**

**Name:** PV array  
**Axis tracking:** Fixed (no rotation)  
**Tilt:** 30.0°  
**Orientation:** 270.0°  
**Rated power:** 5000.0 kW  
**Panel material:** Smooth glass without AR coating  
**Reflectivity:** Vary with sun  
**Slope error:** correlate with material

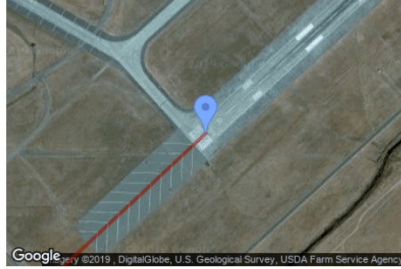


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	38.096105	-122.144826	106.95	5.00	111.95
2	38.096333	-122.144794	108.88	5.00	113.88
3	38.098021	-122.143334	116.12	5.00	121.12
4	38.098013	-122.142798	130.51	5.00	135.51
5	38.097633	-122.142798	145.05	5.00	150.05
6	38.097641	-122.142637	150.85	5.00	155.85
7	38.098004	-122.142390	142.65	5.00	147.65
8	38.097996	-122.142004	150.95	5.00	155.95
9	38.098781	-122.142026	154.44	5.00	159.44
10	38.098781	-122.141607	158.77	5.00	163.77
11	38.099288	-122.141629	142.58	5.00	147.58
12	38.099566	-122.141350	161.93	5.00	166.93
13	38.099566	-122.140309	188.83	5.00	193.83
14	38.099229	-122.140169	193.00	5.00	198.00
15	38.098798	-122.140212	183.89	5.00	188.89
16	38.098798	-122.139955	182.04	5.00	187.04
17	38.098232	-122.139923	168.46	5.00	173.46
18	38.097692	-122.140008	160.23	5.00	165.23
19	38.097244	-122.139987	146.89	5.00	151.89
20	38.097211	-122.139730	139.04	5.00	144.04
21	38.096620	-122.139751	131.05	5.00	136.05
22	38.096240	-122.139944	121.39	5.00	126.39
23	38.095843	-122.139955	115.49	5.00	120.50
24	38.095547	-122.141017	145.56	5.00	150.56
25	38.095573	-122.144407	128.45	5.00	133.45
26	38.095826	-122.144847	104.06	5.00	109.06

ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 4 of 13

**Flight Path Receptor(s)**

**Name:** Runway 03L  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 47.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



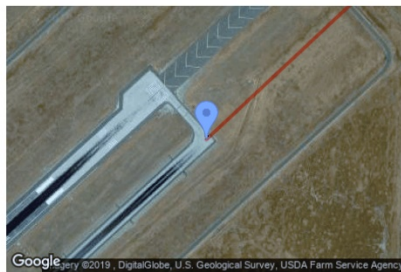
Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.243510	-121.956684	32.62	75.00	107.63
Two-mile	38.223792	-121.983639	3.64	657.44	661.08

**Name:** Runway 03R  
**Description:**  
**Threshold height:** 69 ft  
**Direction:** 47.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.261684	-121.926204	52.29	69.00	121.29
Two-mile	38.241965	-121.953166	19.57	655.17	674.75

**Name:** Runway 212 (assault strip)  
**Description:**  
**Threshold height:** 50 ft  
**Direction:** 226.9°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.280787	-121.897193	52.14	50.00	102.14
Two-mile	38.300545	-121.870272	37.97	617.63	655.60

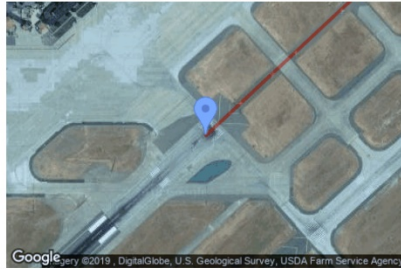
ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 5 of 13

**Name:** Runway 21L  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 227.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



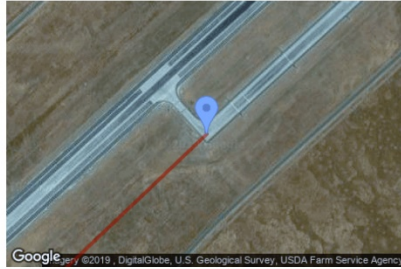
Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.281560	-121.898514	53.07	75.00	128.08
Two-mile	38.301279	-121.871545	37.42	644.11	681.53

**Name:** Runway 21R  
**Description:**  
**Threshold height:** 75 ft  
**Direction:** 227.0°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.263417	-121.928980	48.70	75.00	123.70
Two-mile	38.283136	-121.902017	46.98	630.18	677.15

**Name:** Runway 32 (assault strip)  
**Description:**  
**Threshold height:** 50 ft  
**Direction:** 46.4°  
**Glide slope:** 3.0°  
**Pilot view restricted?** Yes  
**Vertical view:** 30.0°  
**Azimuthal view:** 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	38.273315	-121.907571	58.49	50.00	108.49
Two-mile	38.253380	-121.934277	39.73	622.21	661.94

ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 6 of 13

**Discrete Observation Receptors**

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	38.099556	-122.143422	116.45	6.00
OP 2	2	38.105524	-122.148023	186.99	6.00
OP 3	3	38.101159	-122.130236	392.05	6.00
OP 4	4	38.090553	-122.132693	254.76	6.00
OP 5	5	38.089899	-122.147898	204.10	6.00
OP 6	6	38.089743	-122.147560	202.99	6.00
OP 7	7	38.089662	-122.147346	201.52	6.00
OP 8	8	38.089502	-122.147077	198.72	6.00
OP 9	9	38.089316	-122.146900	198.50	6.00
OP 10	10	38.089109	-122.146788	196.28	6.00
OP 11	11	38.088932	-122.146535	191.32	6.00
OP 12	12	38.088835	-122.146262	189.79	6.00
OP 13	13	38.088733	-122.146037	187.96	6.00
OP 14	14	38.088641	-122.145629	188.97	6.00
OP 15	15	38.088691	-122.145345	190.06	6.00
OP 16	16	38.088522	-122.145076	189.01	6.00
OP 17	17	38.088964	-122.149402	220.54	6.00
OP 18	18	38.088617	-122.151312	249.51	6.00
OP 19	19	38.087342	-122.155356	248.27	6.00
20-ATCT	20	38.265538	-121.933272	51.83	100.00

Map image of 20-ATCT



ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 7 of 13

**Route Receptor(s)**

**Name:** Route 1  
**Path type:** Two-way  
**Observer view angle:** 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	38.098603	-122.156958	147.66	3.50	151.36
2	38.098464	-122.154163	151.17	3.50	154.67
3	38.098411	-122.152891	146.38	3.50	149.88
4	38.098283	-122.152460	145.63	3.50	149.13
5	38.097681	-122.151210	127.57	3.50	131.07
6	38.097535	-122.150708	114.88	3.50	118.38
7	38.097267	-122.148975	103.07	3.50	106.57
8	38.097105	-122.148418	117.17	3.50	120.67
9	38.096507	-122.146875	85.81	3.50	89.31
10	38.095543	-122.145159	100.36	3.50	103.86
11	38.095207	-122.144547	120.38	3.50	123.88
12	38.095026	-122.144196	127.21	3.50	130.71
13	38.094924	-122.143858	131.01	3.50	134.51
14	38.094922	-122.143316	134.99	3.50	138.49
15	38.095232	-122.140725	137.78	3.50	141.28
16	38.095517	-122.138239	136.33	3.50	139.83
17	38.095431	-122.137447	148.37	3.50	151.87
18	38.095277	-122.137005	148.82	3.50	152.32
19	38.095045	-122.136624	145.33	3.50	148.83
20	38.094711	-122.136243	139.69	3.50	143.19
21	38.093616	-122.134698	130.76	3.50	134.26
22	38.092566	-122.132939	153.79	3.50	157.29
23	38.091918	-122.131833	176.45	3.50	179.95
24	38.091621	-122.130903	182.10	3.50	185.60
25	38.091015	-122.128041	180.03	3.50	183.53
26	38.090618	-122.125619	197.60	3.50	201.10

## GLARE ANALYSIS RESULTS

### Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array	30.0	270.0	122	10,281	9,190,000.0

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
Runway 03L	0	0
Runway 03R	0	0
Runway 212 (assault strip)	0	0
Runway 21L	0	0
Runway 21R	0	0
Runway 32 (assault strip)	0	0
OP 1	98	8474
OP 2	0	1807
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
20-ATCT	0	0
Route 1	24	0



**Results for: PV array**

Receptor	Green Glare (min)	Yellow Glare (min)
Runway 03L	0	0
Runway 03R	0	0
Runway 212 (assault strip)	0	0
Runway 21L	0	0
Runway 21R	0	0
Runway 32 (assault strip)	0	0
OP 1	98	8474
OP 2	0	1807
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
20-ATCT	0	0
Route 1	24	0

**Flight Path: Runway 03L**

0 minutes of yellow glare  
 0 minutes of green glare

**Flight Path: Runway 03R**

0 minutes of yellow glare  
 0 minutes of green glare





ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 10 of 13

**Flight Path: Runway 212 (assault strip)**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 21L**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 21R**

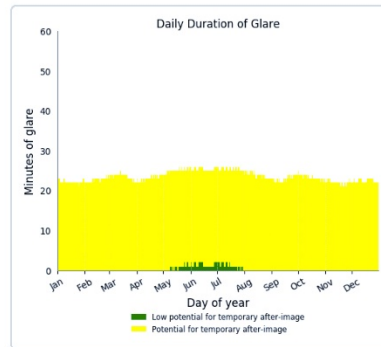
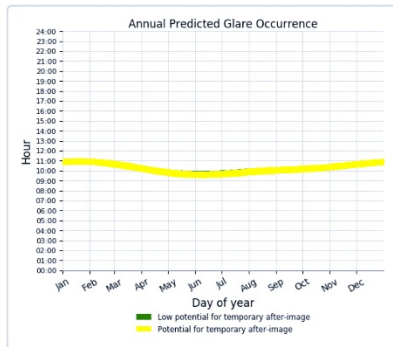
0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: Runway 32 (assault strip)**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 1**

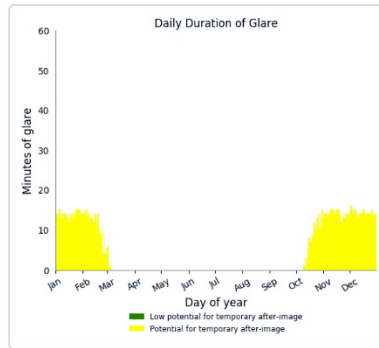
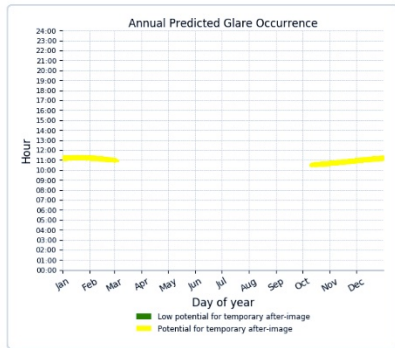
8474 minutes of yellow glare  
98 minutes of green glare



**Point Receptor: OP 2**

1807 minutes of yellow glare  
0 minutes of green glare

ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 11 of 13



**Point Receptor: OP 3**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 4**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 5**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 6**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 7**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 8**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 9**

0 minutes of yellow glare  
0 minutes of green glare

## ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 12 of 13

**Point Receptor: OP 10**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 11**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 12**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 13**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 14**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 15**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 16**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 17**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 18**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 19**

0 minutes of yellow glare

## ForgeSolar Glare Analysis Report (Sunset Backtrack Simulation) – Page 13 of 13

0 minutes of green glare

### Point Receptor: 20-ATCT

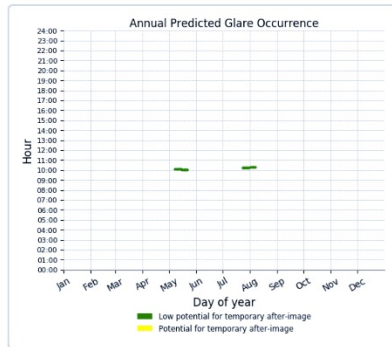
0 minutes of yellow glare

0 minutes of green glare

### Route: Route 1

0 minutes of yellow glare

24 minutes of green glare



## Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size.

Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

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## Appendix D: Thomas Cleveland's CV

### Thomas (Tommy) H. Cleveland, P.E.

---

4141 Laurel Hills Rd. Raleigh, NC

thcleveland@gmail.com

919-923-5490

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#### Education & Training

North Carolina State University, Mechanical Engineering M.S. 2004

North Carolina State University, Mechanical Engineering B.S., Business Mgmt. minor 2001 - Summa Cum Laude

Lumberton Sr. High School, Lumberton, NC, 1997 – Valedictorian

Professional Engineer, licensed in North Carolina (#033711), 2008 - Present

#### Professional Experience

*Solar PV Engineer, Advanced Energy, Raleigh, NC, April 2017–Present*

- Evaluation of commercial and utility scale solar PV facilities to assess the quality of design, construction, and operation
- Engineering analysis and concise presentation of results to customers

*Solar Energy Engineer (various progressive titles), North Carolina Solar Center/NC Clean Energy Technology Center, North Carolina State University, 2005–April, 2017*

- Lead solar engineer at the Center (2008-2017)
- Conducted detailed PV + storage feasibility study for community solar project for a NC municipal utility
- Provided quality assurance and technical support to development of in-house training program of every stage of solar farm construction for a leading regional utility-scale photovoltaic EPC firm
- Guided design of prototype residential Plug and Play PV system and collected AHJ feedback (Department of Energy SunShot project)
- Co-led stakeholder process to develop Template Solar Development Ordinance for North Carolina
- Led design and development of ISO-17025 accredited solar thermal collector testing lab
- Designed and installed PV field performance monitoring system, conducted performance analysis
- Conducted renewable energy site assessments for commercial, industrial, and institutional clients
- Presented to local government officials, community leaders, and general public on solar energy
- Provided technical support to a wide variety of energy consumers and stakeholders across North Carolina

*Consultant/Expert Witness, Private consultant for over 15 solar developer clients, 2012–Present*

- Provides expert witness testimony at special/conditional use and re-zoning public hearings regarding the health, safety, and environmental impact of utility-scale solar photovoltaic systems. Experience in NC, SC, VA, and FL (over 60 projects to date)
- Provides respectful clear answers to sometimes ill-informed and/or hostile questions
- Conduct site-specific studies of EMF, sound, and solar glare hazard for several projects

*Instructor of ET 220 Solar Photovoltaic Assessment, Department of Forestry and Environmental Resources, North Carolina State University, 2014–Present*

- Developed all course content for this new three credit hour online course
- Course covers all aspects of photovoltaic site assessment including energy use, solar resource, system design, utility tariffs, estimating, economics, and more
- Course is optional course for an Environmental Technology and Management degree
- Course is required for a Renewable Energy Assessment minor

*Instructor of MAE 421 Design of Solar Energy Systems, Mechanical and Aerospace Engineering Department of North Carolina State University, 2009-2014*

- Instructor of the solar energy engineering course, MAE 421, in the NC State University Mechanical and Aerospace Engineering department
- The course was offered during the spring semester and typically had 30 to 50 undergraduate and up to twelve graduate engineering students
- Previously co-instructor of the course for two years (2007, 2009)

*Research Assistant, North Carolina Solar Center, North Carolina State University, 2003–2005*

- Developed and validated a TRNSYS simulation model of a unique solar thermal concentrating collector
- Assisted with the installation of photovoltaic systems ranging in capacity from 1 kW to 5 kW

### Selected Publications

“Balancing Agricultural Productivity with Ground-Based Photovoltaic Development”, NCCETC/NCSU white paper, August 2017, <https://nccleantech.ncsu.edu/wp-content/uploads/Balancing-Ag-and-Solar-final-version-update.pdf>

“Health and Safety Impacts of Photovoltaics”, NCCETC/NCSU white paper, May 2017, [https://nccleantech.ncsu.edu/wp-content/uploads/Health-and-Safety-Impacts-of-Solar-Photovoltaics-2017\\_white-paper-1.pdf](https://nccleantech.ncsu.edu/wp-content/uploads/Health-and-Safety-Impacts-of-Solar-Photovoltaics-2017_white-paper-1.pdf)

“Community Solar (+ Storage) Program Design for Fayetteville Public Works Commission”, NCSU/NCCETC report, March 2017, (Public version) [https://nccleantech.ncsu.edu/wp-content/uploads/FPWC\\_CommunitySolar\\_Public\\_Version.pdf](https://nccleantech.ncsu.edu/wp-content/uploads/FPWC_CommunitySolar_Public_Version.pdf)

T. Cleveland, H. Tsai, “Charlotte-Mecklenburg Schools Roadmap to 100% Renewable Electricity” & “Durham Public Schools Roadmap to 100% Renewable Electricity”, NCCETC, February 2016

T. Cleveland, et al, “Template Solar Energy Development Ordinance for North Carolina”, NCCETC & NCSEA, December 2013, [www.go.ncsu.edu/template-solar-ordinance](http://www.go.ncsu.edu/template-solar-ordinance)

M. Sheehan, T. Cleveland, “Updated Recommendations for Federal Energy Regulatory Commission Small Generator Interconnection Procedures Screens”, Solar America Board for Codes and Standards Study Report, 64 p., July 2010, [www.solarabcs.org/about/publications/reports/ferc-screens/pdfs/ABCS-FERC\\_studyreport.pdf](http://www.solarabcs.org/about/publications/reports/ferc-screens/pdfs/ABCS-FERC_studyreport.pdf)

T. Cleveland, et al, “Optimizing Solar Thermal Resource Use at Commercial Buildings”, Solar 2010 – ASES National Solar Energy Conference 2010, 6 p., May 2010, [www.ases.org/papers/101.pdf](http://www.ases.org/papers/101.pdf)

T. Cleveland, “Description and Performance of a TRNSYS Model of the Solargenix Tracking Power Roof™”, Solar 2005 – ASES National Solar Energy Conference, 6 p.

T. Cleveland, K. Creamer, & Dr. R. Johnson, “Energy Metering of Solar Domestic Hot Water Systems for Inclusion in Green Power and Renewable Portfolio Standards Programs”, Solar 2004 – ASES National Solar Energy Conference 2004, 6 p.

T. Cleveland, “Effective Energy Metering of Solar Domestic Hot Water Systems for Inclusion in Green Power and Renewable Portfolio Standards”, Master’s Thesis, North Carolina State University, Raleigh, 191 p., April 2004, <http://repository.lib.ncsu.edu/ir/handle/1840.16/1152>

### Selected Recent Presentations

T. Cleveland, A. Huang, “Plug and Play Residential PV System Innovation and Demonstration”, Solar Power International Conference 2015

T. Cleveland, “Make Solar Energy Economical”, recorded video lecture for E102: Grand Challenges of Engineering course at NC State University, January 2015

T. Cleveland, M. Clark, “Template Solar Ordinance for North Carolina”, Solar Power International Conference 2014

Jeff Dodd  
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July 30, 2019

**VIA ELECTRONIC MAIL (email: aaron@renewprop.com)**

Aaron Halimi  
RPCA Solar 4, LLC  
655 Montgomery Ave., Suite 1430  
San Francisco, CA 94111

Re: Benicia zoning text amendment

Dear Aaron:

This letter provides additional guidance on a zoning text amendment to facilitate a solar utility project ("Project") in the City of Benicia, North of Lake Herman Road (APN: 080-030-050; the "Property"). As you know, the Property is within the "OS – Open Space" zoning district. The uses within the "OS – Open Space" district are set forth in Chapter 17.36 of the Benicia Municipal Code (BMC).

As noted in our May 30, 2019 letter to you, the Project can amend the BMC to create and define a new land use classification of "Utilities, Solar" and permit that use in the "OS" zoning district, subject to a conditional use permit. Based on input from the Community Development Department, the Project should also amend Chapter 17.70 to address the conditions for developing a solar utility project in the City. The Project's compliance with these conditions would measure how the City would issue a conditional use permit for a solar utility use.

We have provided the proposed zoning text amendments to both BMC Chapters 17.36 and 17.70 to facilitate the Project below. All amendments are identified in **red font**.

**I. Amendments to Chapter 17.36 (OS OPEN SPACE DISTRICT)**

**BMC § 17.16.040 Public and semipublic use classifications.**

**"Utilities, solar" means photovoltaic electric panels and appurtenant structures and facilities, designed to provide energy for off-site use such as a power purchase agreement, or direct sale of energy to a local utility company.**

**BMC § 17.36.030 Land use regulations.**

Aaron Halimi  
July 30, 2019  
Page 2

**OS District: Land Use Regulations**

	<b>OS</b>	<b>Additional Regulations</b>
<b>Public and Semipublic</b>		
Utilities, Major	U	(F)
Waste Facility	U	(F)
Utilities, Solar	U	(I)
Utilities, Minor	P	

OS District: Additional Use Regulations  
[footnotes for L1 – H omitted]  
(I) See BMC 17.70.420, Solar utilities.

**II. Amendments to Chapter 17.70 (GENERAL REGULATIONS)**

**BMC § 17.70.420 Solar utilities.**

The following standards shall apply to all solar utilities:

- A. Agricultural Protections. Solar utilities shall not be sited on any land subject to a Williamson Act Contract, unless the landowner has rescinded that contract pursuant to its terms.
- B. No Municipal Services. Solar utilities shall not require or benefit from municipal services, such as water or sewer services.
- C. Development Standards. Solar arrays shall comply with all applicable setback restrictions, including creek setbacks, for the applicable zoning district.
- D. Height. For ground-mounted installations, the maximum height shall not exceed 15 feet from finished grade.
- E. Noise. Noise levels shall be in compliance with the noise regulations identified in Chapter 8.20 BMC.
- F. Decommissioning. Upon ceasing operations, or if the facility is non-operational for a period of 12 months, the facility should be decommissioned (or deactivated and removed) in an efficient and thorough manner.



Aaron Halimi  
July 30, 2019  
Page 3

- G. **Stormwater Management.** All projects greater than one acre shall submit a Stormwater Pollution Prevention Plan and include erosion and sediment control best management practices into the plan.
- H. **Minimal Traffic.** Solar utilities shall not generate new daily traffic trips during normal operation outside of occasional trips for maintenance.

We believe the proposed amendments to BMC Chapters 17.36 and 17.70 address the City's request for providing the appropriate conditions under which the City could issue a conditional use permit for the development of a solar utility, including the Project. We would be happy to discuss this further with the City Attorney or the Community Development Department upon your request.

Sincerely yours,

COBLENTZ PATCH DUFFY & BASS LLP



Jeff Dodd

jtd:JTD

# Travis AFB Context Map

