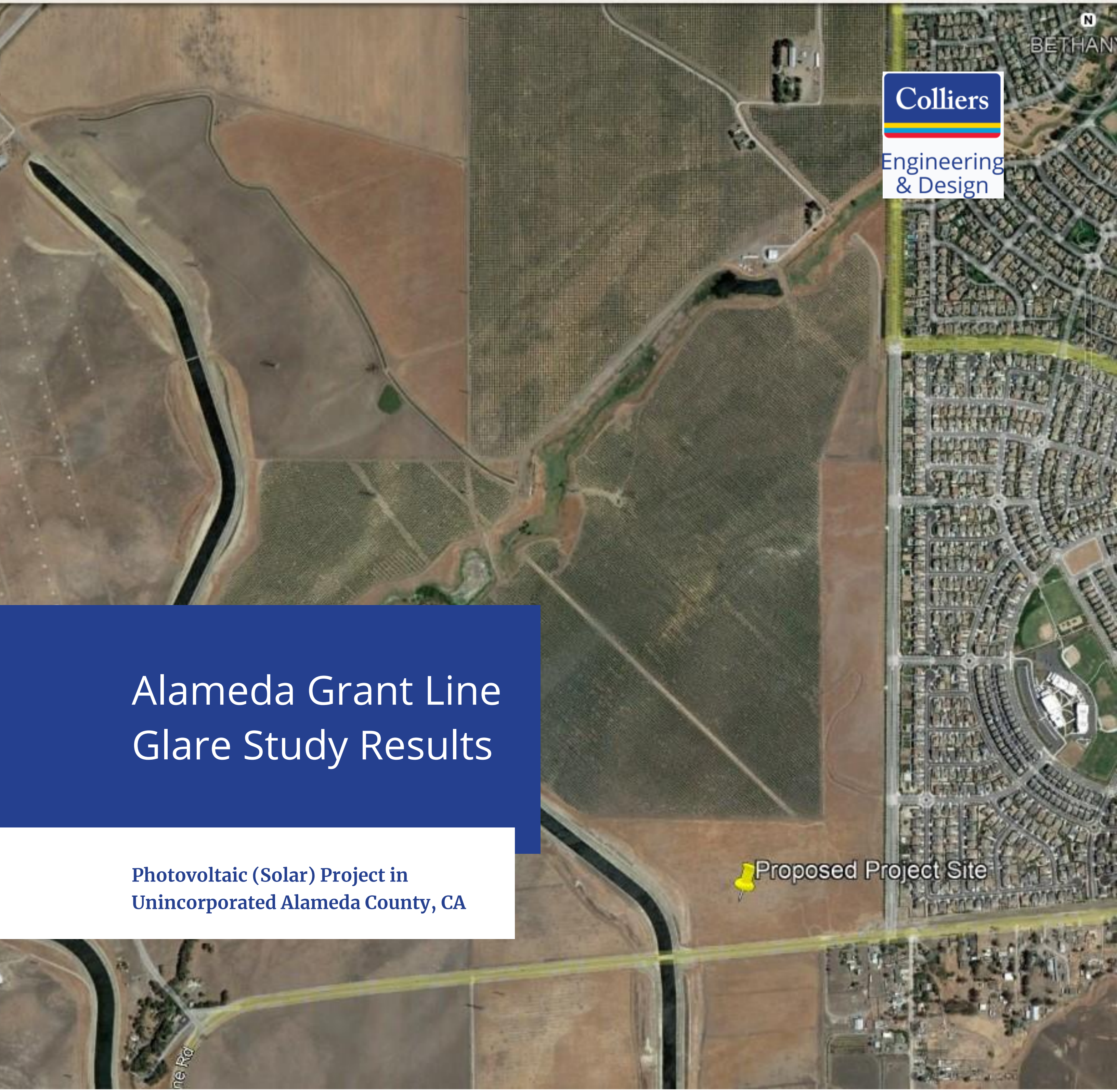
Appendix B

Glare Study



Colliers Engineering & Design

Alameda Grant Line Glare Study Results

Photovoltaic (Solar) Project in Unincorporated Alameda County, CA

October 7, 2021

Prepared for:

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Table of Contents

Results of Glare Study **1**
Methodology 1
Background Information 2
Executive Summary 3
Results & Recommendations 6
Summary of Areas of Predicted Glare 7
OPs 2/4/6/8 at 15 Feet *7*
OPs 11/12 at 5.5 Feet *9*
Route 1 at 4.5 Feet / Route 2 at 8.5 Feet *11*
Conclusion 13
Appendix

Results of Glare Study

Methodology

(Source Information: https://forgesolar.com/help/#intro)

Collier's Engineering & Design (CED) offers staff specifically trained on glare analyses utilizing *ForgeSolar*, a web-based interactive software that provides a quantified assessment of (1) when and where glare is predicted to occur throughout the year for a prescribed solar installation, (2) potential effects on the human eye at locations where glare is predicted to occur, and (3) an estimate of the maximum annual energy production. *ForgeSolar* includes *GlareGauge*, a standard solar glare hazard analysis software used in the industry. *ForgeSolar* is based on the Solar Glare Hazard Analysis Tool ("SGHAT") licensed from Sandia National Laboratories. These tools meet the FAA standards for glare analysis.

Determination of glare occurrence requires knowledge of the following: sun position, observer location, and the tilt, orientation, location, extent, and optical properties of the modules in the solar array. Vector algebra is then used to determine if glare is likely to be visible from the prescribed observation points.

If glare is predicted, the software calculates the retinal irradiance and subtended angle (size/distance) of the glare source to predict potential ocular hazards ranging from temporary after-image to more severe possible retinal damage. These results are presented in a simple, easy-to-interpret plot that specifies when glare is predicted to occur throughout the year, with color codes indicating the potential ocular hazard.

It is important to note that within this analysis, the PV array panels are approximated with simplified geometry and that blocking and shading (via buildings, elevation changes, and foliage, etc.) **are not** considered. Additionally, in the modelling scenarios, tracker panels move from their maximum rotation to their resting angle immediately, thus providing a worst case scenario for any predicted glare.

Background Information

Glint is typically defined as a momentary flash of bright light, often caused by a reflection off a moving source. A typical example of glint is a momentary solar reflection from a moving car. Glare is defined as a continuous source of bright light. Glare is generally associated with stationary objects, which, due to the slow relative movement of the sun, reflect sunlight for a longer duration.

The difference between glint and glare is duration. Industry-standard glare analysis tools evaluate the occurrence of glare on a minute-by-minute basis; accordingly, they generally refer to solar hazards as 'glare.'

The ocular impact of solar glare is quantified into three categories (Ho, 2011[1]):

- Green - Low potential to cause after-image (flash blindness).
- Yellow - Potential to cause temporary after-image.
- Red - Potential to cause retinal burn (permanent eye damage).

These categories assume a typical blink response in the observer.

Note that retinal burn is typically not possible for PV glare since PV modules do not focus reflected sunlight.

The ocular impact of glare is visualized with the Glare Hazard Plot. This chart displays the ocular impact as a function of glare subtended source angle and retinal irradiance. Each minute of glare is displayed on the chart as a small circle in its respective hazard zone.

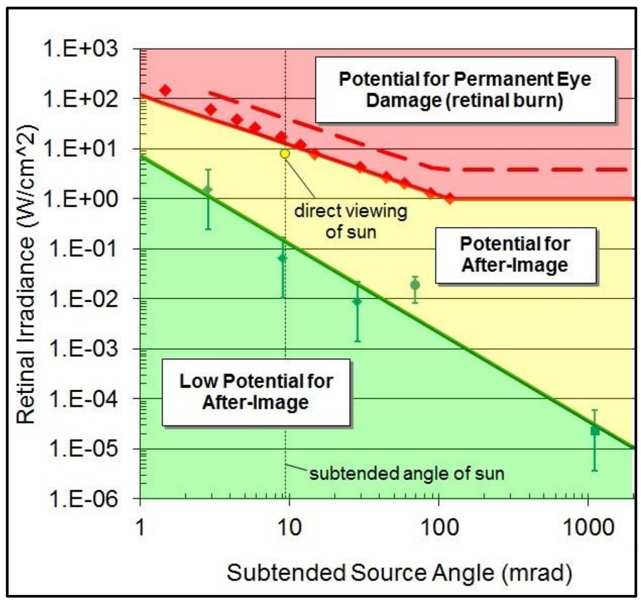

Figure 1 – From ForgeSolar website (Sample glare hazard plot defining ocular impact as function of retinal irradiance and subtended source angle (Ho, 2011)

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Executive Summary

The purpose of the requested glare study was to closely examine a proposed solar project in Unincorporated Alameda County, CA at the corner of Great Valley Parkway and Grant Line Road to provide detailed feedback regarding areas that may warrant closer boots-on-the-ground examination in order to mitigate possible problematic glare to the businesses, residences, and roads surrounding the project area.

Twelve (12) Observation Points were placed at different points around the site and programmed to an average height of 5 and a half (5.5) feet to model an average-sized person standing in these spots, and to a height of 15 feet to model a 5.5-foot person standing on the second floor of a home/business with 8-foot ceilings and a 1.5-foot plenum space.

Route Receptors (labeled Routes 1 through 4) were programmed for two-way traffic to heights of 4.25 feet and 8.5 feet, effectively representing the eyeline of an average person sitting on/in any vehicle from a bike to a motorcycle, a standard car or SUV, through to the approximated height of the cab of an 18-wheeler truck. In this study, Routes 1-2 run to the East and West, and Routes 4-5 run to the North and South.

PV modules do not focus reflected sunlight and therefore retinal burn is typically not possible. Rather, the glare we look to identify is much like sunrise and sunset glare for drivers who struggle to find the perfect angle for their car visors so they can continue to operate their vehicle safely while traveling through areas of such glare.

In general, photovoltaic panel systems of any size produce some glare predominately during early sunrise and sunset throughout the Spring through Fall months—although glare is possible throughout each day as well as throughout the entire year. While it is impossible to study every possible point and/or angle surrounding a photovoltaic (solar) project, Collier's Engineering & Design (CED) has modeled the project and surrounding areas as best as possible with the most likely points of concern.

Again, scenarios that were programmed for the area include:

- The eye-line of a 5 and a half-foot person.
- The eye-line of a 5 and a half-foot person standing in a second floor window of a buiding with 8-foot ceilings and a 1.5 foot plenum space between floors (15 feet).
- An average-height person sitting in a car (4.5 feet).
- An average-height person sitting in the cab of an 18-wheeler truck (8.5 feet).

It is noted again here that the *ForgeSolar* program does not factor any obstructions into the results and the tracking panels move from their maximum rotation to their resting angle immediately; thus providing a worst-case scenario.

Colliers Engineering & Design then cross-checked results for the tracker panels set at a 0-resting angle, a number of other resting angles, and the same panels resting at their maximum tracking angle (60 degrees) from sunset to sunrise. These reports are all included in the Appendix of this report.

After examining each point and then factoring in buildings, foliage and elevation changes, points where predicted glare is blocked by these natural obstructions were removed from the listing of points to be examined more closely. Finally, where glare was predicted, this analyst will address the areas that present the most possibility for likely glare.

Information was provided by the client and their representatives in order to complete this study. The project's single-axis tracker panels were programmed facing south at 180° with a maximum tracking angle of 60-degrees, a resting angle of 0-degrees, and an assumed midpoint height of 7 feet from the ground. It was further assumed that these panels are constructed of Smooth Glass with an Anti-Reflective coating. Additionally, the owner/developer is installing a 7-foot-high fence with tan slatting around the perimeter of the project. This additional obstruction was also considered when preparing the results of this study.

ASSUMPTIONS

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.*
- Tracker panel settings move from maximum tracking angle to resting angle immediately, thus providing a worst-case scenario for any predicted glare.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- 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.

Results & Recommendations

The analysis that Collier's Engineering & Design performed on the proposed solar project in Unincorporated Alameda County, CA at the corner of Great Valley Parkway and Grant Line Road, resulted in very little predicted glare even in the "worst case scenario" programmed for the study.

At a zero-degree system resting angle, a number of Observation Point (OP)/Route combinations in the attached reporting and in Appendix A show either low-grade GREEN or low-grade YELLOW glare. A crosscheck of the results with other resting angle scenarios shows that at an angle of 2 degrees or higher, no glare is predicted whatsoever.

The results returned by this study show that any low-grade glare resulting from a system with a resting angle of 0-degrees will still have little to no impact on the surrounding area because observation points/routes are either a) below the height of the panels because of elevation changes and therefore any predicted glare will be thrown over programmed observation points/routes, or b) the observation point/route has clearly observed obstructions (foliage, buildings and/or other) between the array and the study point.

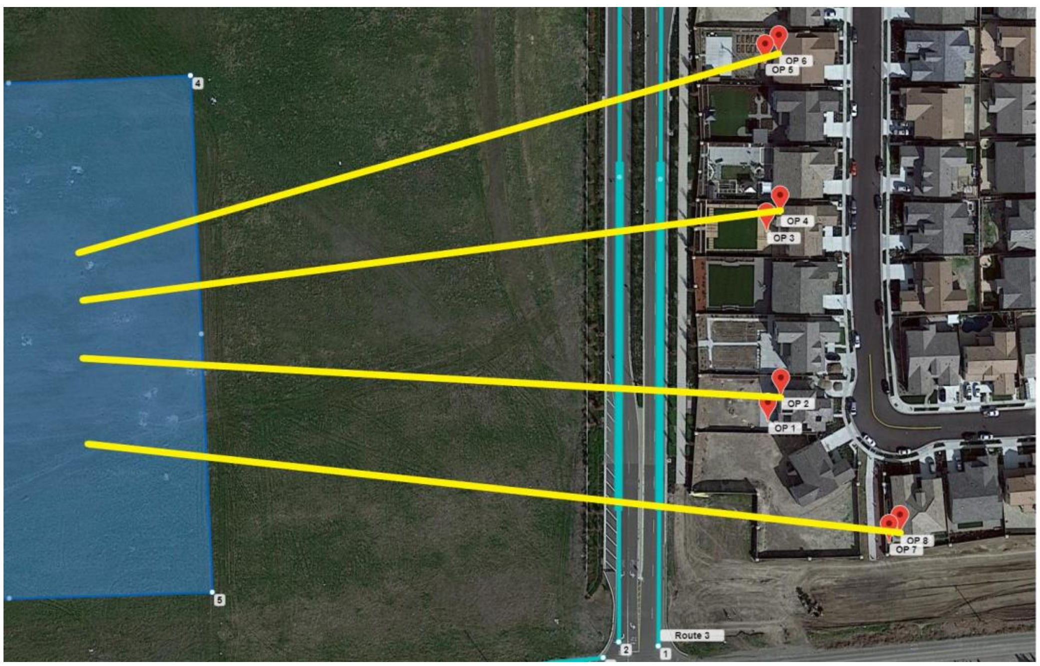
Summary of Areas of Predicted Glare

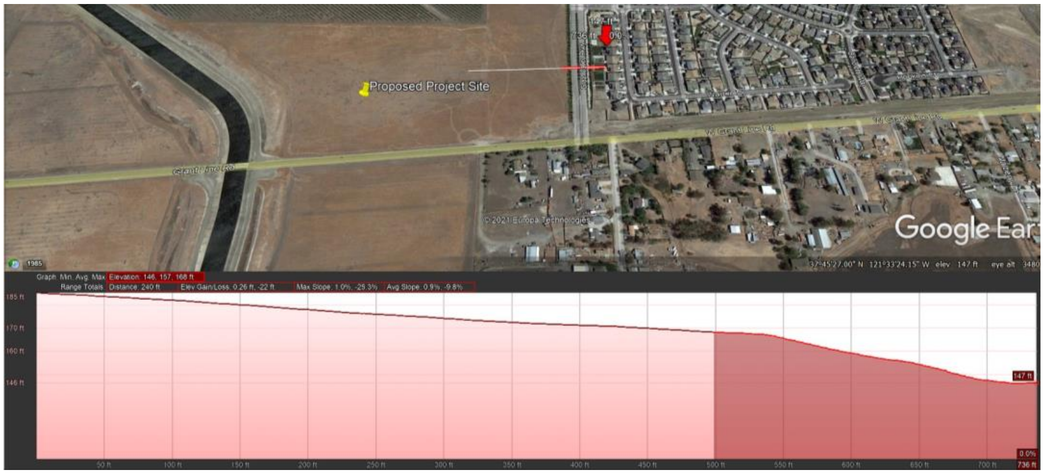
Below is a graphical summary of areas within the project where glare is a predicted possibility in the modelling, but likely not so in real world circumstances.

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

OPs 2/4/6/8 at 15 Feet

Though 10-12 minutes of low-grade YELLOW glare is predicted between approximately 5 PM and 7 PM* at differing times throughout the year, each 15-foot obseravation point is well below the base elevation of where panels will be installed. Any predicted glare will be thrown over these points once elevations are factored into the results.




Proposed Project Site

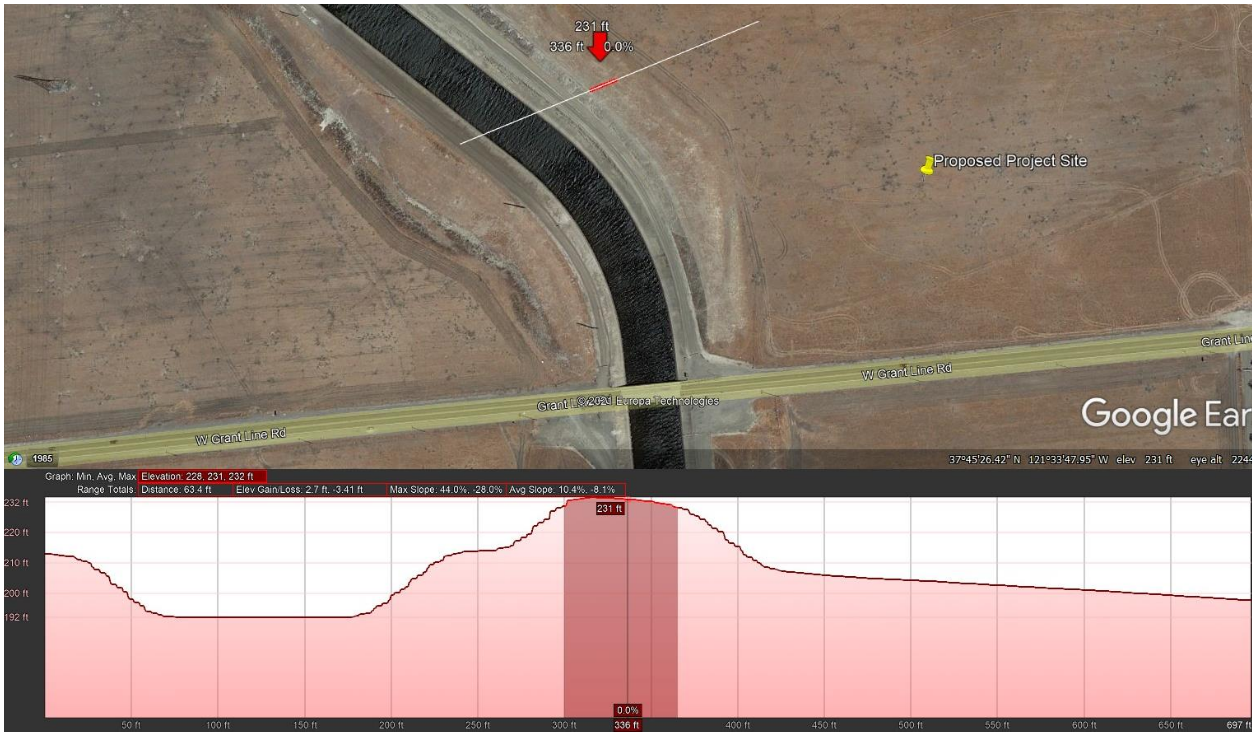

Proposed Project Site

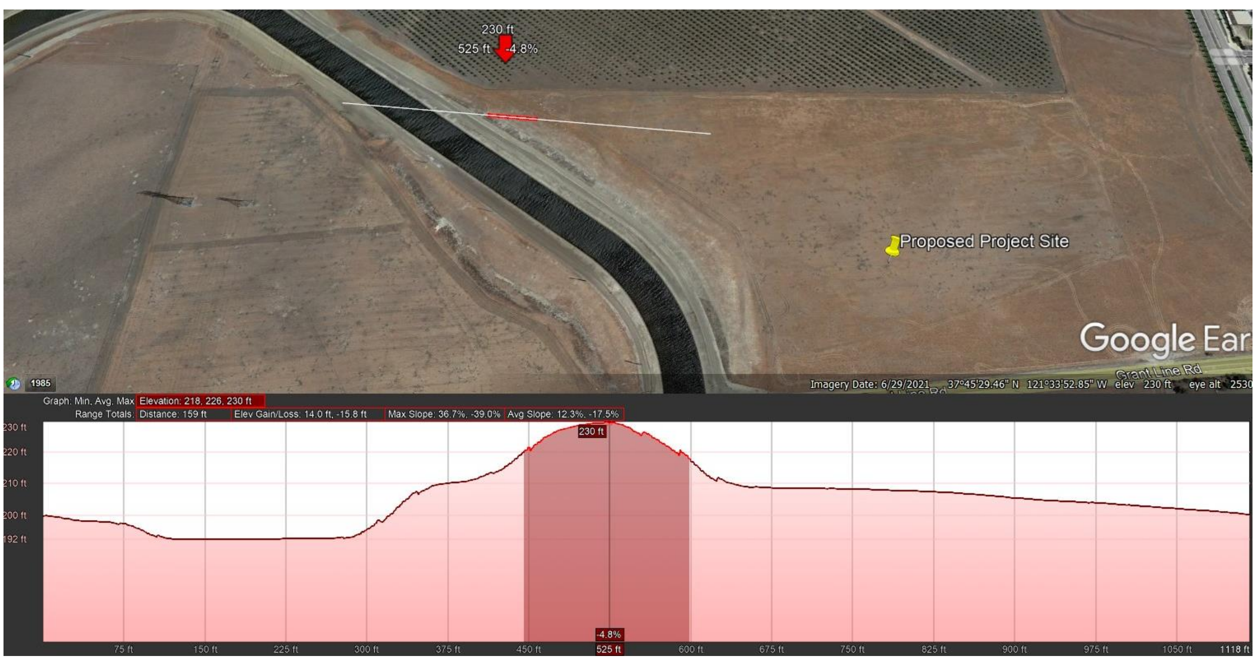

Proposed Project Site

OPs 11/12 at 5.5 Feet

Though 7-10 minutes of low-grade YELLOW glare is predicted between approximately 5 AM and 6 AM* from early-April through early-September each 5.5-foot obseravation point sits beyond a 20-foot rise in elevation at the far bank of what seems to be a local man-made waterway.

Predicted glare at these points will be effectively blocked by this elevation obstruction.


231 ft
336 ft
0.0%
Proposed Project Site
W Grant Line Rd
Google Ear
Graph: Min, Avg, Max Elevation: 228, 231, 232 ft
Range Totals: Distance: 63.4 ft Elev Gain/Loss: 2.7 ft, -3.41 ft Max Slope: 44.0%, -28.0% Avg Slope: 10.4%, -8.1%
231 ft


230 ft
525 ft
-4.8%
Proposed Project Site
Google Ear
Graph: Min, Avg, Max Elevation: 218, 226, 230 ft
Range Totals: Distance: 159 ft Elev Gain/Loss: 14.0 ft, -15.8 ft Max Slope: 36.7%, -39.0% Avg Slope: 12.3%, -17.5%
230 ft

Route 1 at 4.5 Feet / Route 2 at 8.5 Feet

The routes that run east and west to the south of the project.

Though 7-10 minutes of low-grade YELLOW glare is predicted daily between approximately 4:45 AM and 6 AM* from early-April through early-September, a closer look at elevation changes throughout the project facing these routes shows that the panel area sits beyond the rise of the far bank of the man-made waterway between points further from the project area and the route.

Panel areas of the project that are closer to the route sit at least 5-feet below installation grade. Between base elevation and the height of the racking the panels will be installed on, as well as the proposed fencing with tan slatting that has been proposed by the owner/developer, the predicted glare along this route should be effectively blocked by these real world circumstances.

Conclusion

The analysis that Collier's Engineering & Design performed on the proposed solar project in Unincorporated Alameda County, CA at the corner of Great Valley Parkway and Grant Line Road, resulted in very little predicted glare even in the "worst case scenario" programmed for the study.

The results returned by this study show that any low-grade glare resulting from a system with a resting angle of 0-degrees will still have little to no impact on the surrounding area because observation points/routes are either a) below the height of the panels because of elevation changes and therefore any predicted glare will be thrown over programmed observation points/routes, or b) the observation point/route has clearly observed obstructions (foliage, buildings and/or other) between the array and the study point.

Please feel free to contact me if you would like to go over these results or if you have any additional questions.

Sincerely,

Colliers Engineering & Design, Inc.
(DBA Maser Consulting)

Elizabeth Claire Myers, PMP
Project Manager, Electrical Engineering
Certified Glare Analyst through Sims Industries

cc: Craig Zeidman, Colliers Engineering & Design (via email)

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Additional Resources and Information

[1] Ho, C. K., Ghanbari, C. M., and Diver, R. B., 2011, Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation, *ASME J. Sol. Energy Eng., 133*.

Solar Glare Hazard Analysis Tool (SGHAT) Technical Reference Manual
https://forgesolar.com/static/docs/SGHAT_Technical_Reference-v6.pdf

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Appendix

Appendix A | Detailed Glare Study Result Reports

The following pages are the full reporting results delivered directly from *ForgeSolar*.

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Alameda Grant Line: SC-000099

Alameda_OPs and Routes 1_0Resting

Created Sept. 23, 2021
Updated Oct. 6, 2021
Time-step 1 minute
Timezone offset UTC-8
Site ID 59083.10515

Project type Advanced
Project status: active
Category 1 MW to 5 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:
- Observation point: **Version 2**
- 2-Mile Flight Path: **Version 2**
- Route: **Version 2**

Summary of Results

Glare with potential for temporary after-image predicted

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	4	12,052	-

Component Data

PV Array(s)

Total PV footprint area: 14.0 acres

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 0.0 deg
Footprint area: 14.0 acres
Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

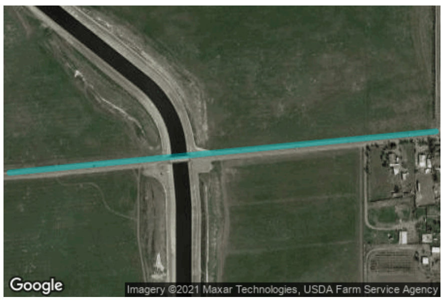
Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.758259	-121.562959	201.24	7.00	208.24
2	37.758289	-121.560417	181.36	7.00	188.36
3	37.757907	-121.560390	189.42	7.00	196.42
4	37.757954	-121.558957	181.16	7.00	188.16
5	37.756346	-121.558872	173.87	7.00	180.87
6	37.756308	-121.560470	191.62	7.00	198.62
7	37.756711	-121.560460	193.97	7.00	200.97
8	37.756660	-121.561795	205.68	7.00	212.68
9	37.757462	-121.562519	202.65	7.00	209.65
10	37.757712	-121.562959	204.41	7.00	211.41
11	37.757742	-121.563034	204.98	7.00	211.98
12	37.758268	-121.563034	201.88	7.00	208.88

Route Receptor(s)

Name: Route 1
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.756033	-121.557396	160.43	4.50	164.93
2	37.755286	-121.566688	230.10	4.50	234.60

Name: Route 2
Route type Two-way
View angle: 50.0 deg

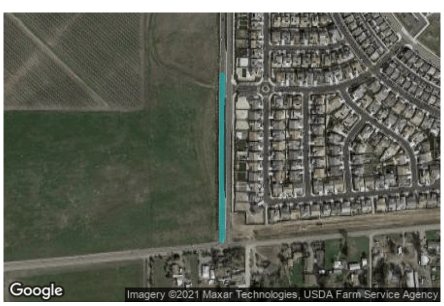


Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.755422	-121.566752	230.20	8.50	238.70
2	37.756143	-121.557332	159.48	8.50	167.98

Name: Route 3
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.756179	-121.557115	157.93	4.50	162.43
2	37.759084	-121.557099	139.29	4.50	143.79

Name: Route 4
Route type Two-way
View angle: 50.0 deg



Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.759084	-121.557265	142.39	8.50	150.89
2	37.756191	-121.557271	159.40	8.50	167.90

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total Elevation ft
OP 1	37.756877	-121.556682	150.70	5.50	156.20
OP 2	37.756953	-121.556631	150.35	15.00	165.35
OP 3	37.757469	-121.556687	146.82	5.50	152.32
OP 4	37.757522	-121.556634	146.42	15.00	161.42
OP 5	37.757993	-121.556694	142.62	5.50	148.12
OP 6	37.758021	-121.556641	142.24	15.00	157.24
OP 7	37.756500	-121.556206	150.33	5.50	155.83
OP 8	37.756528	-121.556163	149.93	15.00	164.93
OP 9	37.755782	-121.558319	163.58	5.50	169.08
OP 10	37.755744	-121.558319	163.62	15.00	178.62
OP 11	37.756987	-121.564131	204.78	5.50	210.28
OP 12	37.758578	-121.566630	197.81	5.50	203.31

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	4	12,052	-	-

Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pv-array-1 (green)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-1 (yellow)	223	258	382	479	603	650	641	543	411	325	253	170

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	2275
OP: OP 3	0	0
OP: OP 4	0	1626
OP: OP 5	0	0
OP: OP 6	0	1237
OP: OP 7	0	0
OP: OP 8	0	1854
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	1832
OP: OP 12	0	574
Route: Route 1	2	1314
Route: Route 2	2	1340
Route: Route 3	0	0
Route: Route 4	0	0

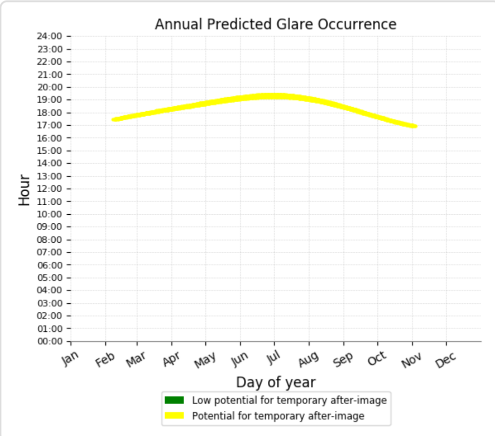
PV array 1 - OP Receptor (OP 1)

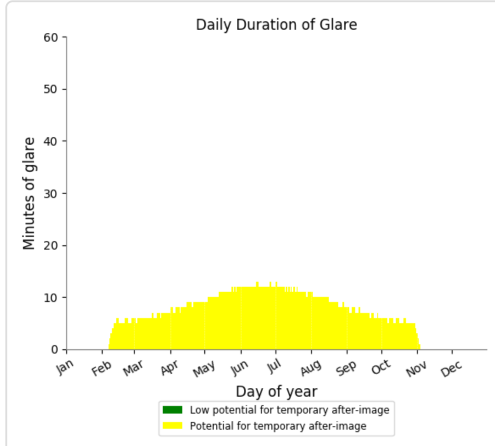
No glare found

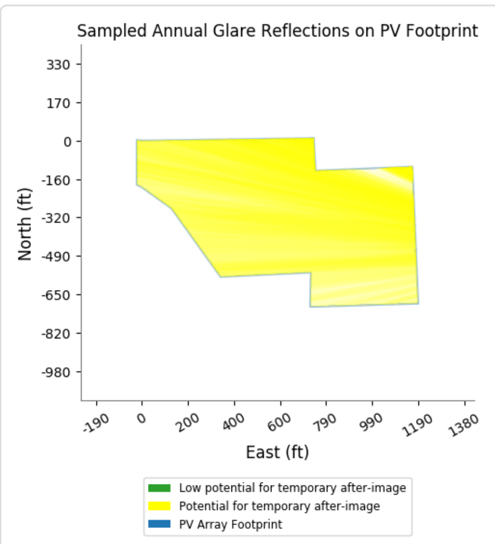
PV array 1 - OP Receptor (OP 2)

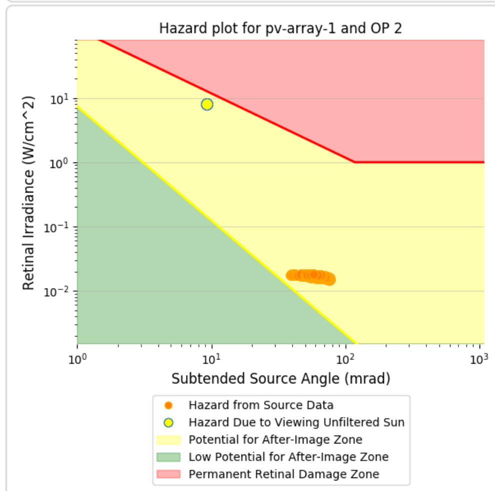
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,275 minutes of "yellow" glare with potential to cause temporary after-image.









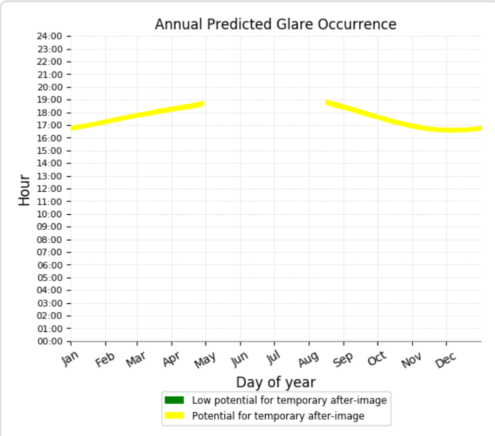
PV array 1 - OP Receptor (OP 3)

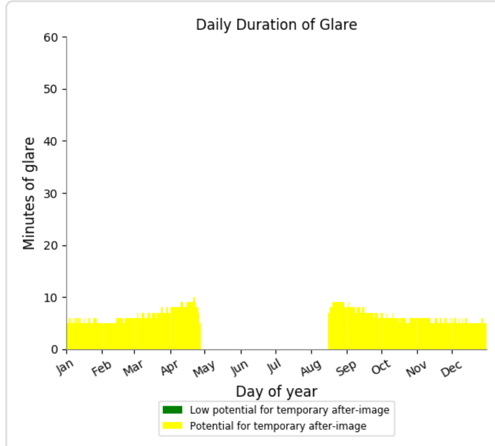
No glare found

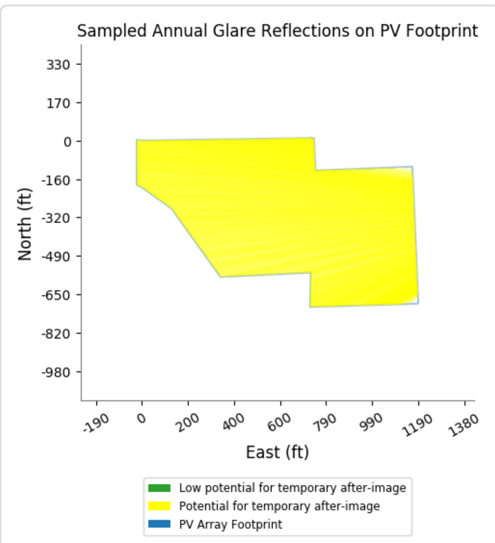
PV array 1 - OP Receptor (OP 4)

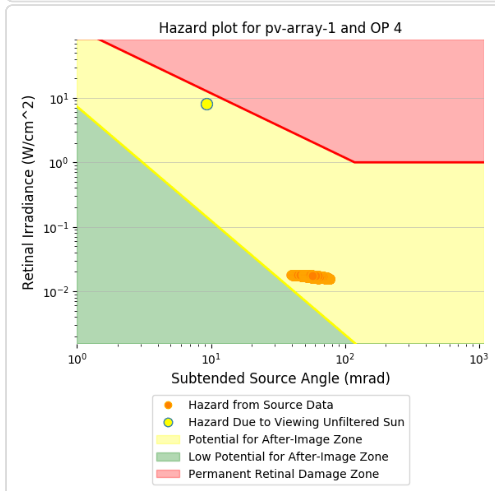
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,626 minutes of "yellow" glare with potential to cause temporary after-image.









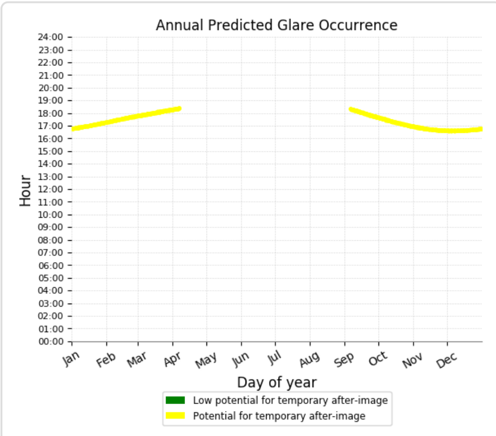
PV array 1 - OP Receptor (OP 5)

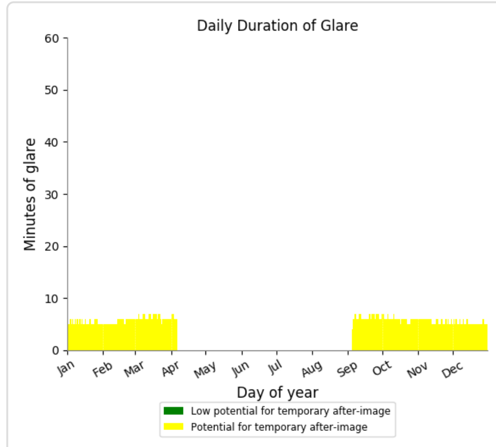
No glare found

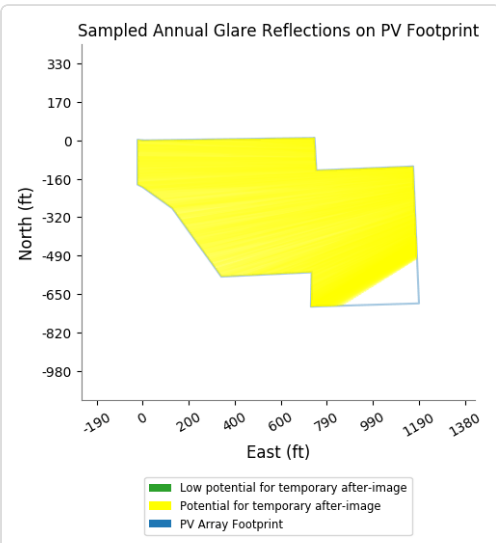
PV array 1 - OP Receptor (OP 6)

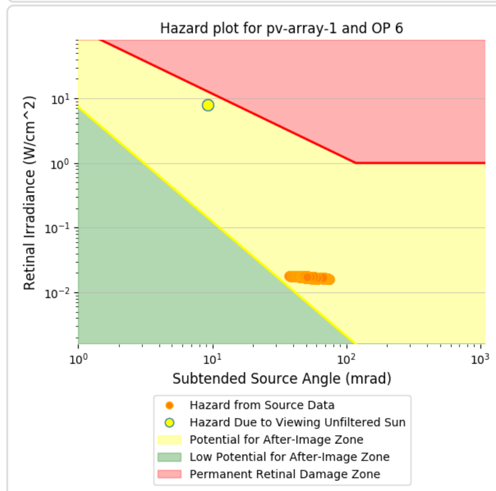
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,237 minutes of "yellow" glare with potential to cause temporary after-image.









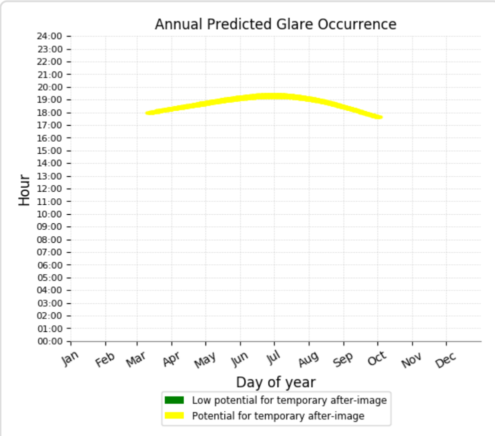
PV array 1 - OP Receptor (OP 7)

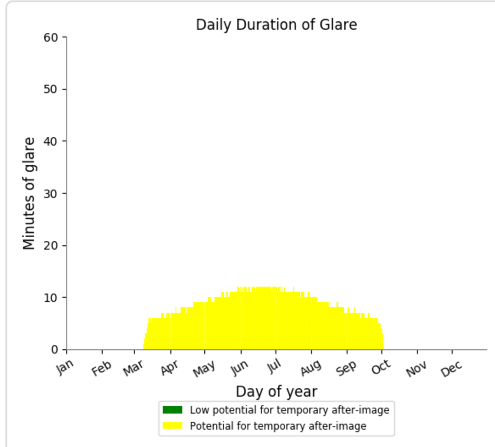
No glare found

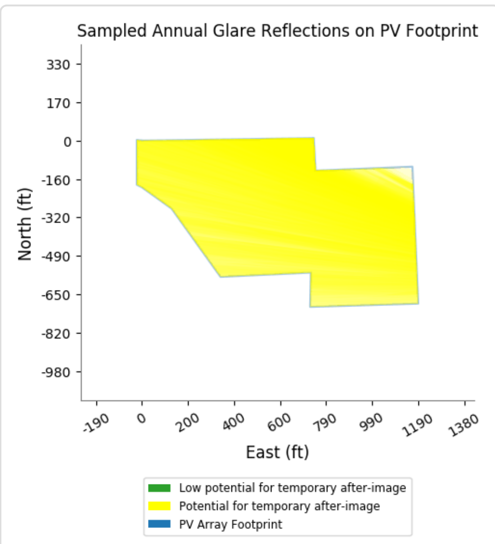
PV array 1 - OP Receptor (OP 8)

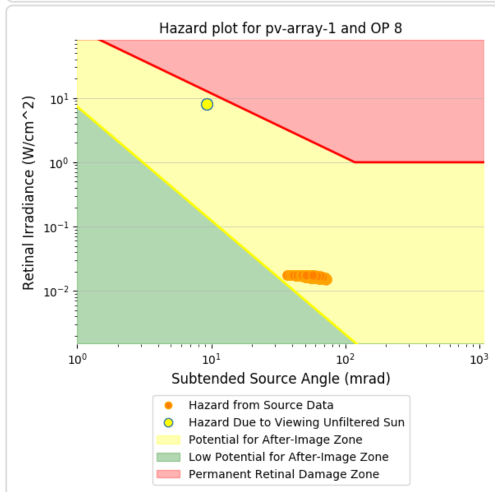
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,854 minutes of "yellow" glare with potential to cause temporary after-image.









PV array 1 - OP Receptor (OP 9)

No glare found

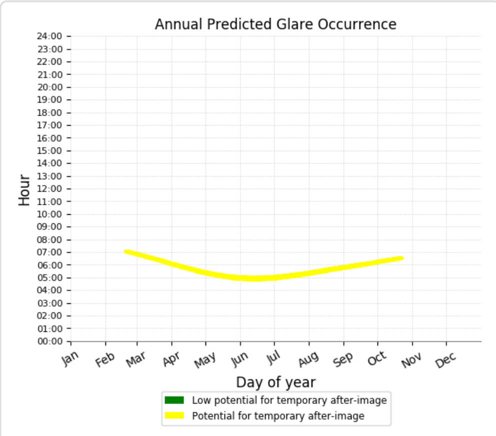
PV array 1 - OP Receptor (OP 10)

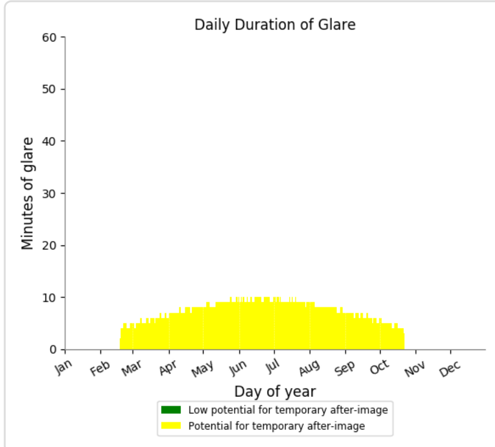
No glare found

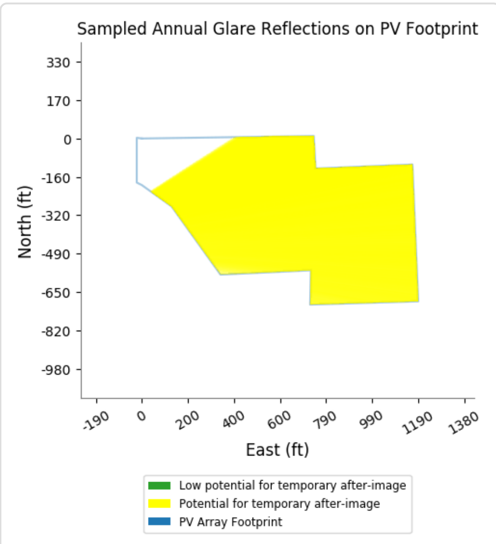
PV array 1 - OP Receptor (OP 11)

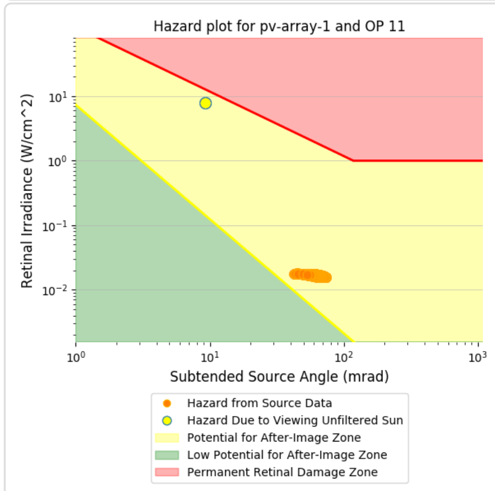
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,832 minutes of "yellow" glare with potential to cause temporary after-image.





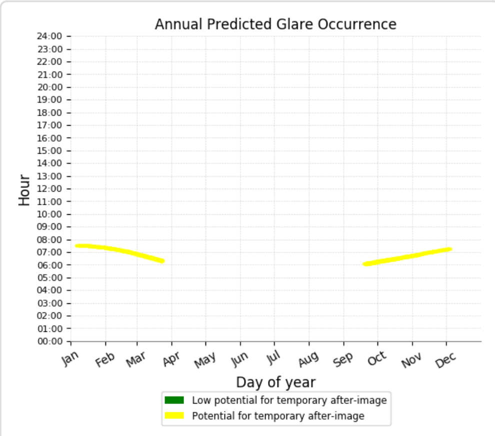


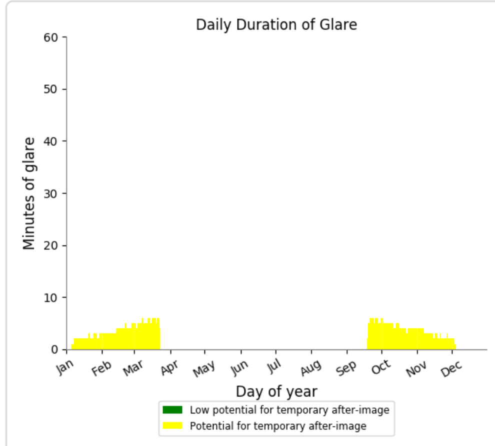


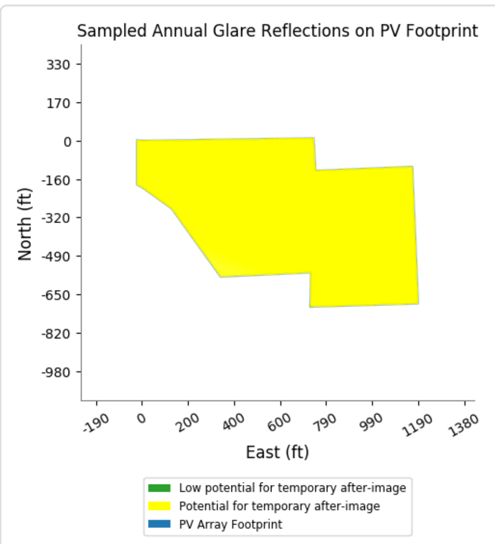
PV array 1 - OP Receptor (OP 12)

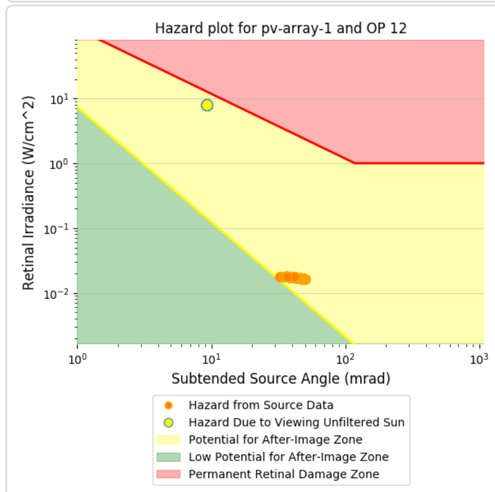
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 574 minutes of "yellow" glare with potential to cause temporary after-image.





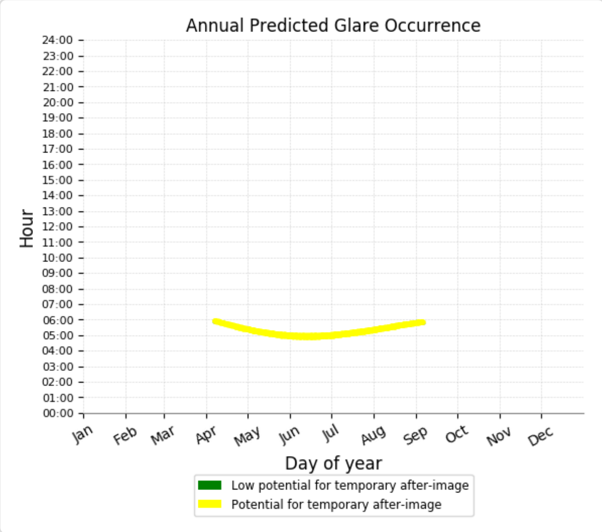


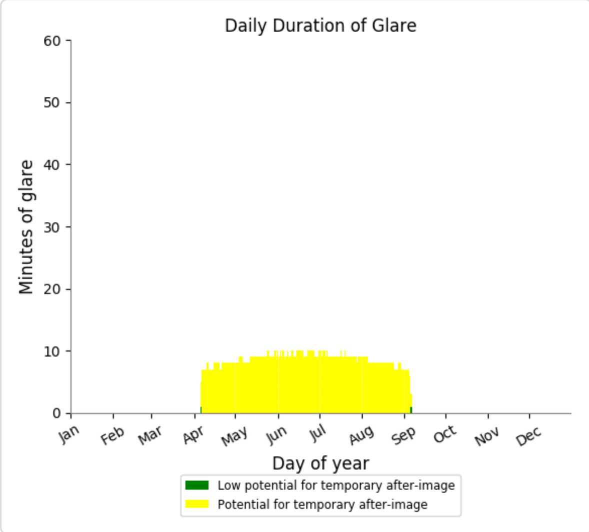


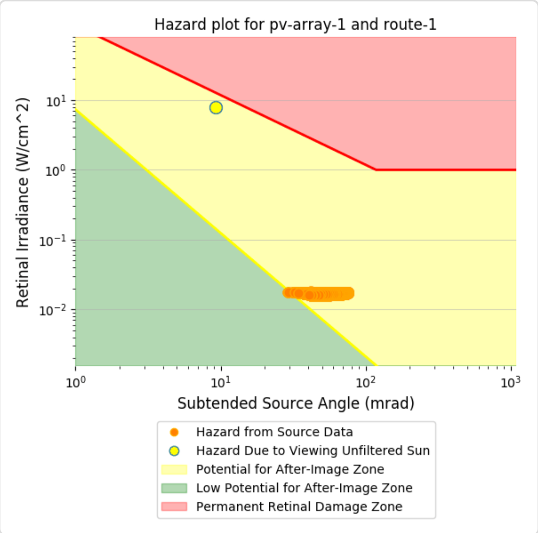
PV array 1 - Route Receptor (Route 1)

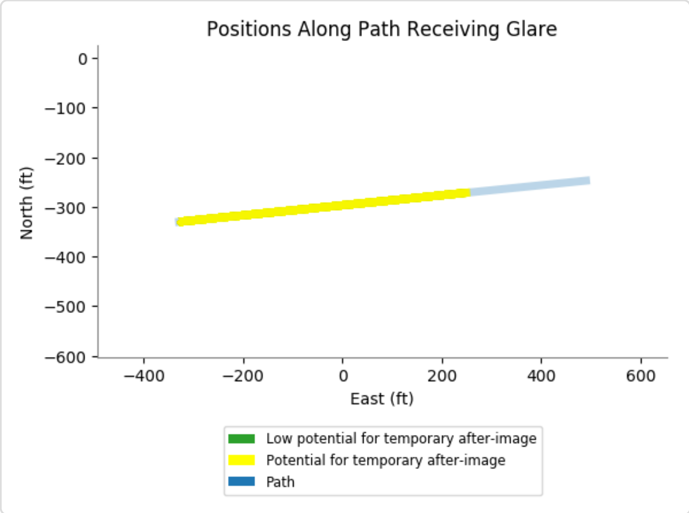
PV array is expected to produce the following glare for receptors at this location:

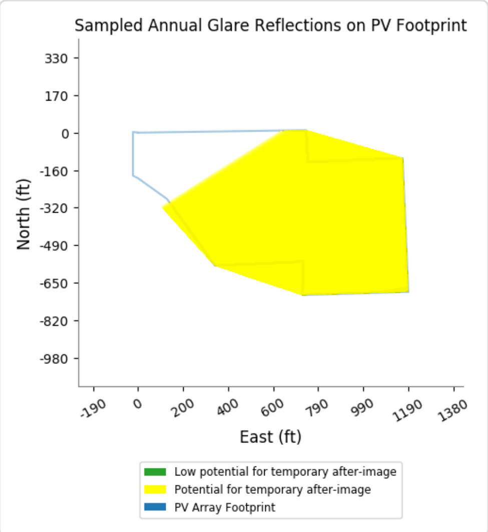
- 2 minutes of "green" glare with low potential to cause temporary after-image.
- 1,314 minutes of "yellow" glare with potential to cause temporary after-image.







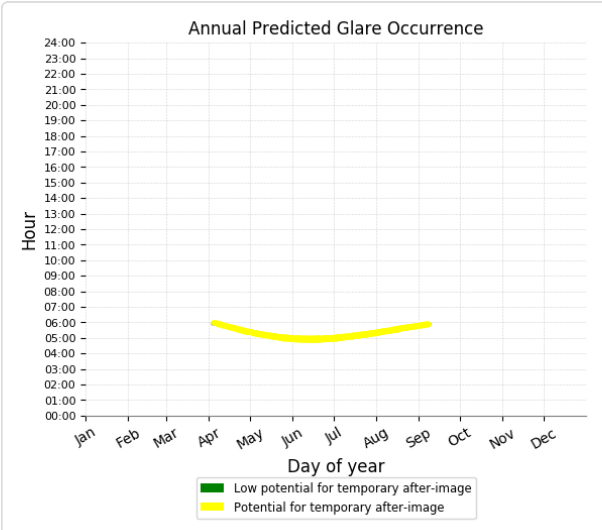


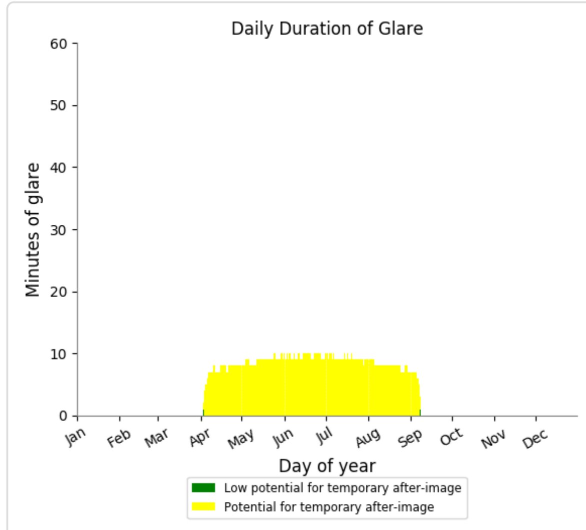


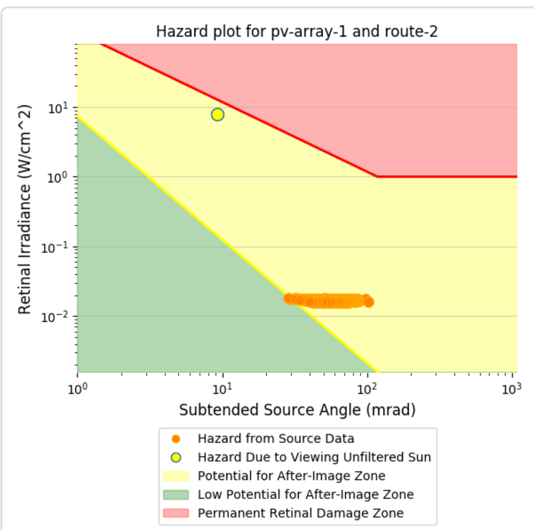
PV array 1 - Route Receptor (Route 2)

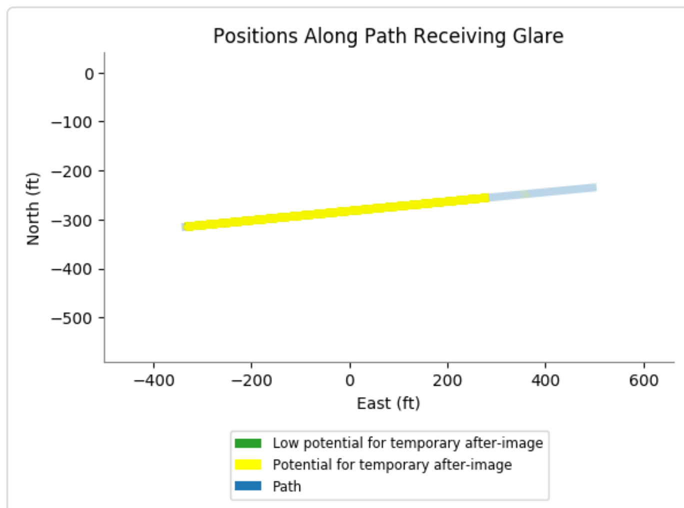
PV array is expected to produce the following glare for receptors at this location:

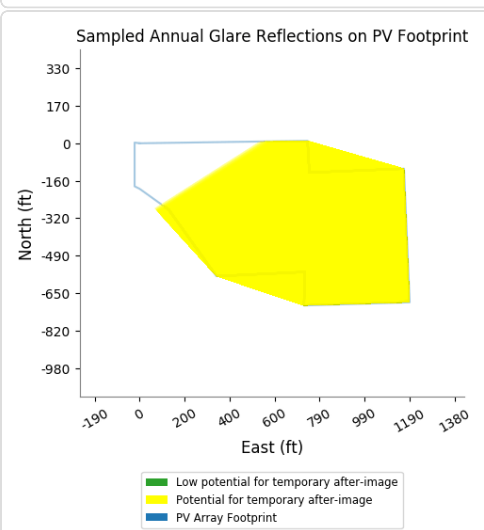
- 2 minutes of "green" glare with low potential to cause temporary after-image.
- 1,340 minutes of "yellow" glare with potential to cause temporary after-image.











PV array 1 - Route Receptor (Route 3)

No glare found

PV array 1 - Route Receptor (Route 4)

No glare found

Assumptions

- 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.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- 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.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

Alameda Grant Line: SC-000099

Alameda_OPs and Routes 1_2Resting

Created Oct. 5, 2021
Updated Oct. 6, 2021
Time-step 1 minute
Timezone offset UTC-8
Site ID 59534.10515

Project type Advanced
Project status: active
Category 1 MW to 5 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:
- Observation point: **Version 2**
- 2-Mile Flight Path: **Version 2**
- Route: **Version 2**

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 14.0 acres

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 2.0 deg
Footprint area: 14.0 acres
Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

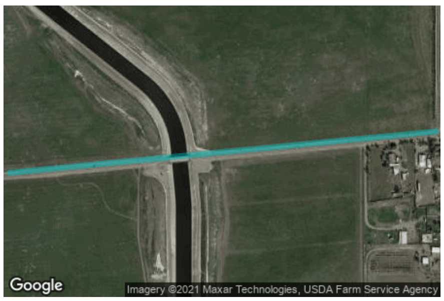
Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	ft	ft	ft
1	37.758259	-121.562959	201.24	7.00	208.24
2	37.758289	-121.560417	181.36	7.00	188.36
3	37.757907	-121.560390	189.42	7.00	196.42
4	37.757954	-121.558957	181.16	7.00	188.16
5	37.756346	-121.558872	173.87	7.00	180.87
6	37.756308	-121.560470	191.62	7.00	198.62
7	37.756711	-121.560460	193.97	7.00	200.97
8	37.756660	-121.561795	205.68	7.00	212.68
9	37.757462	-121.562519	202.65	7.00	209.65
10	37.757712	-121.562959	204.41	7.00	211.41
11	37.757742	-121.563034	204.98	7.00	211.98
12	37.758268	-121.563034	201.88	7.00	208.88

Route Receptor(s)

Name: Route 1
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.756033	-121.557396	160.43	4.50	164.93
2	37.755286	-121.566688	230.10	4.50	234.60

Name: Route 2
Route type Two-way
View angle: 50.0 deg

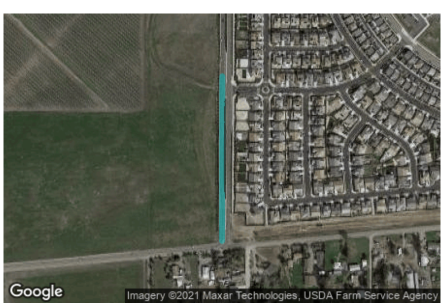


Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.755422	-121.566752	230.20	8.50	238.70
2	37.756143	-121.557332	159.48	8.50	167.98

Name: Route 3
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.756179	-121.557115	157.93	4.50	162.43
2	37.759084	-121.557099	139.29	4.50	143.79

Name: Route 4
Route type Two-way
View angle: 50.0 deg



Vertex	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total elevation ft
1	37.759084	-121.557265	142.39	8.50	150.89
2	37.756191	-121.557271	159.40	8.50	167.90

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	ft	ft	ft
OP 1	37.756877	-121.556682	150.70	5.50	156.20
OP 2	37.756953	-121.556631	150.35	15.00	165.35
OP 3	37.757469	-121.556687	146.82	5.50	152.32
OP 4	37.757522	-121.556634	146.42	15.00	161.42
OP 5	37.757993	-121.556694	142.62	5.50	148.12
OP 6	37.758021	-121.556641	142.24	15.00	157.24
OP 7	37.756500	-121.556206	150.33	5.50	155.83
OP 8	37.756528	-121.556163	149.93	15.00	164.93
OP 9	37.755782	-121.558319	163.58	5.50	169.08
OP 10	37.755744	-121.558319	163.62	15.00	178.62
OP 11	37.756987	-121.564131	204.78	5.50	210.28
OP 12	37.758578	-121.566630	197.81	5.50	203.31

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
Route: Route 1	0	0
Route: Route 2	0	0
Route: Route 3	0	0
Route: Route 4	0	0

No glare found

Assumptions

- 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.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- 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.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

Alameda Grant Line: SC-000099

Alameda_OPs and Routes 1_60Resting

Created Sept. 23, 2021
Updated Oct. 6, 2021
Time-step 1 minute
Timezone offset UTC-8
Site ID 59081.10515

Project type Advanced
Project status: active
Category 1 MW to 5 MW

Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:
- Observation point: **Version 2**
- 2-Mile Flight Path: **Version 2**
- Route: **Version 2**

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 14.0 acres

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 60.0 deg
Footprint area: 14.0 acres
Rated power: -
Panel material: Smooth glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 8.43 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	ft	ft	ft
1	37.758259	-121.562959	201.24	7.00	208.24
2	37.758289	-121.560417	181.36	7.00	188.36
3	37.757907	-121.560390	189.42	7.00	196.42
4	37.757954	-121.558957	181.16	7.00	188.16
5	37.756346	-121.558872	173.87	7.00	180.87
6	37.756308	-121.560470	191.62	7.00	198.62
7	37.756711	-121.560460	193.97	7.00	200.97
8	37.756660	-121.561795	205.68	7.00	212.68
9	37.757462	-121.562519	202.65	7.00	209.65
10	37.757712	-121.562959	204.41	7.00	211.41
11	37.757742	-121.563034	204.98	7.00	211.98
12	37.758268	-121.563034	201.88	7.00	208.88

Route Receptor(s)

Name: Route 1
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	ft	ft	ft
1	37.756033	-121.557396	160.43	4.50	164.93
2	37.755286	-121.566688	230.10	4.50	234.60

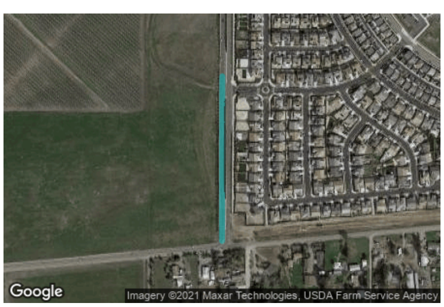
Name: Route 2
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	ft	ft	ft
1	37.755422	-121.566752	230.20	8.50	238.70
2	37.756143	-121.557332	159.48	8.50	167.98

Name: Route 3
Route type Two-way
View angle: 50.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	ft	ft	ft
1	37.756179	-121.557115	157.93	4.50	162.43
2	37.759084	-121.557099	139.29	4.50	143.79

Name: Route 4
Route type Two-way
View angle: 50.0 deg



Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	ft	ft	ft
1	37.759084	-121.557265	142.39	8.50	150.89
2	37.756191	-121.557271	159.40	8.50	167.90

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation ft	Height above ground ft	Total Elevation ft
OP 1	37.756877	-121.556682	150.70	5.50	156.20
OP 2	37.756953	-121.556631	150.35	15.00	165.35
OP 3	37.757469	-121.556687	146.82	5.50	152.32
OP 4	37.757522	-121.556634	146.42	15.00	161.42
OP 5	37.757993	-121.556694	142.62	5.50	148.12
OP 6	37.758021	-121.556641	142.24	15.00	157.24
OP 7	37.756500	-121.556206	150.33	5.50	155.83
OP 8	37.756528	-121.556163	149.93	15.00	164.93
OP 9	37.755782	-121.558319	163.58	5.50	169.08
OP 10	37.755744	-121.558319	163.62	15.00	178.62
OP 11	37.756987	-121.564131	204.78	5.50	210.28
OP 12	37.758578	-121.566630	197.81	5.50	203.31

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
Route: Route 1	0	0
Route: Route 2	0	0
Route: Route 3	0	0
Route: Route 4	0	0

No glare found

Assumptions

- 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.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- 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.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.