Attachment G. Solar Glare Analysis Report

This page intentionally left blank

TETRA TECH

MEMO

To:	Lauren Altick, Julie Alpert, Tai Wallace, Cypress Creek Renewables, LLC
From:	Drew Timmis, Tetra Tech, Inc.
Cc:	Leslie McClain, Tetra Tech, Inc.
Date:	January 20, 2023
Subject:	Glint and Glare Analysis of the Proposed Carriger Solar Project in Klickitat County, Washington

At the request of Cypress Creek Renewables, LLC (Cypress Creek), Tetra Tech, Inc. (Tetra Tech) conducted a glint and glare analysis of the proposed Carriger Solar Project (Project) located in Klickitat County, Washington. The Project area covers approximately 2,011 acres of private lands and includes a generation interconnection with the Bonneville Power Administration's 500-kilovolt (kV) Knight substation, located adjacent to the northern portion of the Project area. The Project is divided into two geographic areas separated by approximately 1 mile, with the Project area mainly composed of agricultural and fallow fields.

This memorandum provides a description of the glint and glare anticipated from use of the Project as a solar energy generating facility. Included are a Project photovoltaic (PV) array area figure including identified observation points and roads subject to the analysis (Appendix A), the Sandia glare analysis reports (Appendix B), and the Federal Aviation Administration (FAA) Notice Criteria Tool Output (Appendix C).

GLARE ANALYSIS METHOD

As an industry standard, the term "glint and glare analysis" is typically used to describe an analysis of potential ocular impacts to defined receptors. ForgeSolar defines glint and glare in the following statement:

> *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 (Sandia Laboratories 2016).*

Based on ForgeSolar's definitions of glint and glare, and considering that the Project's solar modules are not likely to rotate faster than the relative daily motion of the sun, the potential reflectance from the Project modeled throughout this report will be referred to as glare.

The FAA issued an Interim Policy (78 FR 63276) on October 23, 2013, describing methods for obtaining FAA review and approval of proposed solar arrays on airport property (FAA 2013). These methods involved the use of the Sandia Laboratories Solar Glare Hazard Analysis Tool (SGHAT), a modeling/compliance analysis tool now licensed for public use within the ForgeSolar GlareGauge cloud software application. The SGHAT complies with FAA 78 FR 63276.

Sandia developed SGHAT v. 3.0, a web-based tool and methodology to evaluate potential glint/glare associated with solar energy installations. The validated tool provides a quantified assessment of when and where glare will

occur, as well as information about potential ocular impacts. The calculations and methods are based on analyses, test data, a database of different photovoltaic module surfaces (e.g., anti-reflective coating, texturing), and models developed over several years at Sandia. The results are presented in a simple easy-to-interpret plot that specifies when glare will occur throughout the year, with color indicating the potential ocular hazard (Sandia Laboratories 2016). There are three ocular hazards categories/colors in the model output:

- Red glare: glare predicted with a potential for permanent eye damage (retinal burn)
- Yellow glare: glare predicted with a potential for temporary after-image
- Green glare: glare predicted with a low potential for temporary after-image

These categories of glare are calculated using a typical observer's blink response time, ocular transmission coefficient (the amount of radiation absorbed in the eye prior to reaching the retina), pupil diameter, and eye focal length (the distance between where rays intersect in the eye and the retina). As a point of comparison, direct viewing of the sun without a filter is considered to be on the border between yellow glare and red glare, while typical camera flashes are considered to be lower tier yellow glare (approximately three orders of magnitude less than direct viewing of the sun). Upon exposure to yellow glare, the observer may experience a temporary spot in their vision after the exposure. Upon exposure to green glare, the observer may experience a bright reflection but typically no spot lasting after exposure.

On May 11, 2021, 14 CFR Part 77 was updated with final FAA policy (86 FR 25801), designed to ensure that solar projects on airport property do not produce hazardous glare. The updated policy includes narrative stating:

> *Initially, FAA believed that solar energy systems could introduce a novel glint and glare effect to pilots on final approach. FAA has subsequently concluded that in most cases, the glint and glare from solar energy systems to pilots on final approach is similar to glint and glare pilots routinely experience from water bodies, glass facade buildings, parking lots, and similar features. However, FAA has continued to receive reports of potential glint and glare from on-airport solar energy systems on personnel working in Air Traffic Control Tower (ATCT) cabs. Therefore, FAA has determined the scope of agency policy should be focused on the impact of on-airport solar energy systems to federally-obligated towered airports, specifically the airport's ATCT cab* (FAA 2021).

Additionally, the updated policy results in solar project sponsors on airport property attesting to the FAA that sponsors conducted an ocular analysis of potential impacts to ATCT cabs, instead of submitting analysis to FAA for review and approval. This change results in the FAA withdrawing the mandate that the SGHAT tool be used for analyzing ocular impact of solar projects on airport property.

Therefore, the FAA has developed the following criteria for analysis of solar energy projects located near jurisdictional airports:

- No potential for glint or glare in the existing or planned ATCT cab for federally obligated airports.

- Glare with a "low potential for after-image" along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan is allowed. The final approach path is defined as 2 miles from 50 feet above the landing threshold using a standard 3-degree glidepath.

The online FAA Notice Criteria Tool (NCT) reports whether a proposed structure is in proximity to a jurisdictional air navigation facility, and if formal submission to the FAA Obstruction Evaluation Group under CFR Title 14 Part 77.9 is recommended (FAA 2010a). The NCT was used to determine if the proposed Project is located within an FAA-identified impact area based on the Project boundaries and height above ground surface. The Project is located approximately 1 mile west of the Goldendale Municipal Airport (FAA 2022). The airport does not have an ATCT cab.

The SGHAT (GlareGauge, hosted by ForgeSolar) was used to evaluate the potential for glint and glare 1) when driving along segments of Butts Road, Mesecher Road, Knights Road, Pine Forest Road, and Route 142; 2) from eleven nearby locations selected to represent observer views at neighboring residential and commercial properties within the surrounding area; and 3) and from the 2-mile final approach paths for the nearby Goldendale Municipal Airport.

The panels to be used on the proposed Project are smooth glass surface material with an anti-reflection coating, which is noted in the glare analysis. The analysis was performed to simulate panels with single-axis tracking with a 60-degree maximum tracking range and backtracking with a resting angle of 5 degrees. Backtracking is the movement of the panels when the sun is outside the range of rotation, with the resting angle being the angle that the panels are set to when backtracking. The analysis was conducted for a panel height of 5 feet above ground surface (centroid height) with applicable panel specifications. The panel orientation, location, and specifications used in the analysis were provided by Cypress Creek in January 2023. The analysis includes calculations to predict potential glare minutes at the following specified receptors (see location of receptors/observation points in Appendix A, Figure 2):

- Viewing height of observer in standard first floor building at 6 feet above ground surface (Appendix B Analysis 1);
- Viewing height of observer in standard vehicle at 5 feet above ground surface (Appendix B Analysis 1);
- Viewing height of observer in standard second floor building at 16 feet above ground surface (Appendix B Analysis 2);
- Viewing height of observer in standard commercial truck at 9 feet above ground surface (Appendix B Analysis 2);
- Goldendale Municipal Airport 2-mile final approach path for Runway 07 (Appendix B Analysis 3)
- Goldendale Municipal Airport 2-mile final approach path for Runway 25 (Appendix B Analysis 3)

GLARE ANALYSIS RESULTS

FAA Notice Criteria Tool

The NCT output (Appendix C) noted that the Project does exceed notice criteria with the nearest airport being the Goldendale Municipal Airport and its two runways. Based on this information, formal filing with the FAA Obstruction Evaluation Group is necessary, and an analysis of the airport's 2-mile final approach paths was conducted.

Sandia Laboratories Solar Glare Hazard Analysis Tool

The SGHAT GlareGauge modeled the results for the Project. Analysis 1 and 2 predicted similar results with yellow glare predicted along a section of Route 142, with minimum yellow glare predicted at observation point (OP) 2 and along sections of Knights Road in Analysis 2. Glare is generally predicted between April through August from 4:00 to 5:30 a.m. and 7:00 to 8:00 p.m. for Route 142, with glare predicted between May through July for OP 2 and Knights Road. For Analysis 3, there is significant levels of green and yellow glare predicted for runway 07. For Runway 07 has green glare predicted between February through May and August through November from 2:00 to 5:00 p.m., and yellow glare predicted between September through March from 6:00 to 9:00 a.m. The glare summaries are outlined in the tables below.

Table 1. Analysis 1 Annual Minutes of Glare Summary

Receptor	Green Glare	Yellow Glare	Red Glare
OP 1	0	0	0
OP 2	0	0	0
OP 3	0	0	0
OP 4	0	0	0
OP 5	0	0	0
OP 6	0	0	0
OP 7	0	0	0
OP 8	0	0	0
OP 9	0	0	0
OP 10	0	0	0
OP 11	0	0	0
Butts/Mesecher Road	0	0	0
Knights Road	0	0	0
Pine Forest Road	0	0	0
Route 142	0	2,520	0

OP = Observation Point

Table 2. Analysis 2 Annual Minutes of Glare Summary

Receptor	Green Glare	Yellow Glare	Red Glare
OP 1	0	0	0
OP 2	0	203	0
OP 3	0	0	0
OP 4	0	0	0
OP 5	0	0	0
OP 6	0	0	0
OP 7	0	0	0
OP 8	0	0	0
OP 9	0	0	0
OP 10	0	0	0
OP 11	0	0	0
Butts/Mesecher Road	0	3,024	0
Knights Road	0	7	0
Pine Forest Road	0	0	0
Route 142	0	3,556	0

OP = Observation Point

Table 3. Analysis 3 Annual Minutes of Glare Summary

Receptor	Green Glare	Yellow Glare	Red Glare
S20 RWY 07	8,650	40,161	0
S20 RWY 25	0	0	0

S20 = FAA identifier for Goldendale Municipal Airport; RWY = Runway

Table 4. Analyses Detailed Glare Summary

Receptor	Type of Glare	Minutes per Day	Time of Day	Time of Year
OP 2	Green	Less than 5	4:00 – 5:00 a.m.	May through July
Knight Road	Yellow	Less than 2	4:00 – 5:00 a.m.	June
Route 142	Yellow	Less than 50	4:00 – 5:30 a.m 7:00 – 8:00 p.m.	May through August
S20 RWY 07	Green	Less than 100	2:00 – 5:00 p.m.	February through May; August through November
	Yellow	Less than 100	5:00 – 9:00 a.m	September through March

OP = Observation Point

S20 = FAA identifier for Goldendale Municipal Airport; RWY = Runway

SUMMARY

The Project layout was modeled on SGHAT GlareGauge in order to evaluate the potential extent of any glint and glare the proposed Project may have upon nearby points of observation and vehicle routes within the surrounding area of the Project, and the airport and associated flight paths referenced within the NCT report. Three analyses were performed:

- Analysis 1 represented the point of view from an average first floor residential/commercial structure and typical commuter car (6 feet and 5 feet, respectively);
- Analysis 2 represented the point of view from an average second-floor residential/commercial structure and typical semi-tractor-trailer truck (16 feet and 9 feet, respectively); and
- Analysis 3 represented the two 2-mile final approach flight paths for Goldendale Municipal Airport.

Analysis 1 and 2 predicted yellow glare at sections of Route 142, and additionally Analysis 2 predicted yellow glare at OP 2 and sections of Knight Road. Analysis 3 predicted green glare and yellow glare for runway 07. The predicted amounts of glare are considered conservative because the GlareGauge model does not account for varying ambient conditions (i.e., cloudy days, precipitation), atmospheric attenuation, screening due to existing topography not located within the defined array layouts, or existing vegetation or structures (including fences or walls), nor does the tool allow proposed landscaping to be included. In the case of this Project, existing topography and intervening structures and vegetation are expected to reduce the potential for glare at the OPs and roadway segments.

The times for predicted glare were generally around times of dawn (4:00 – 5:00 a.m.) and dusk (7:00 – 8:00 p.m.) during periods when the panels would be at resting angles. The module backtracking program that will be implemented on the Project detects the rising sun light and begins to tilt the modules out of the resting position

until they reach the maximum tracking angle (60 degrees). Five degrees was used for the resting angle, it is common for panels to have a slight tilt to prevent buildup of moisture and precipitation on the panels overnight. It is predicted that if there was an increase in the resting angle, or if the module backtracking program was removed, that there will be significant reductions in predicted glare.

Yellow glare was predicted for the 2-mile final approach path for runway 07. Based on the flight approach paths as described in the original 2013 FAA interim policy that the SGHAT tool is based on, the analysis would fail because there is yellow glare predicted (glare with a potential for temporary after-image). The 2-mile final approach path for runway 07 comes in close proximity and above four panel array areas, with predicted yellow glare only at those locations. The predicted duration of yellow glare is less than 100 minutes, but the actual duration of exposure of glare to a pilot is predicted to be much less during landing and takeoff. However, based on the final May 11, 2021 14 CFR Part 77 policy, this policy does not apply to proponents of solar energy systems located off airport property, and the FAA subsequently concluded that in most cases, the glint and glare from solar energy systems to pilots on final approach is similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features. The FAA has determined that the scope of agency policy should be focused on the impact of solar energy systems on airport property to federally obligated towered airports, specifically the airport's ATCT cab. Based on the FAA website on airport data, there is no ATCT located at the Goldendale Municipal Airport. Therefore, under the final policy, there would be no detrimental effects to the airport based on predicted glare.

The results of the FAA NCT showed that the Project does exceed Notice Criteria and would require filing with the FAA Obstruction Evaluation/Airport Airspace Analysis.

REFERENCES

FAA (Federal Aviation Administration) 2010 CFR Title 14 Part 77.9 Notice of Proposed Construction or Alteration Requiring Notice.

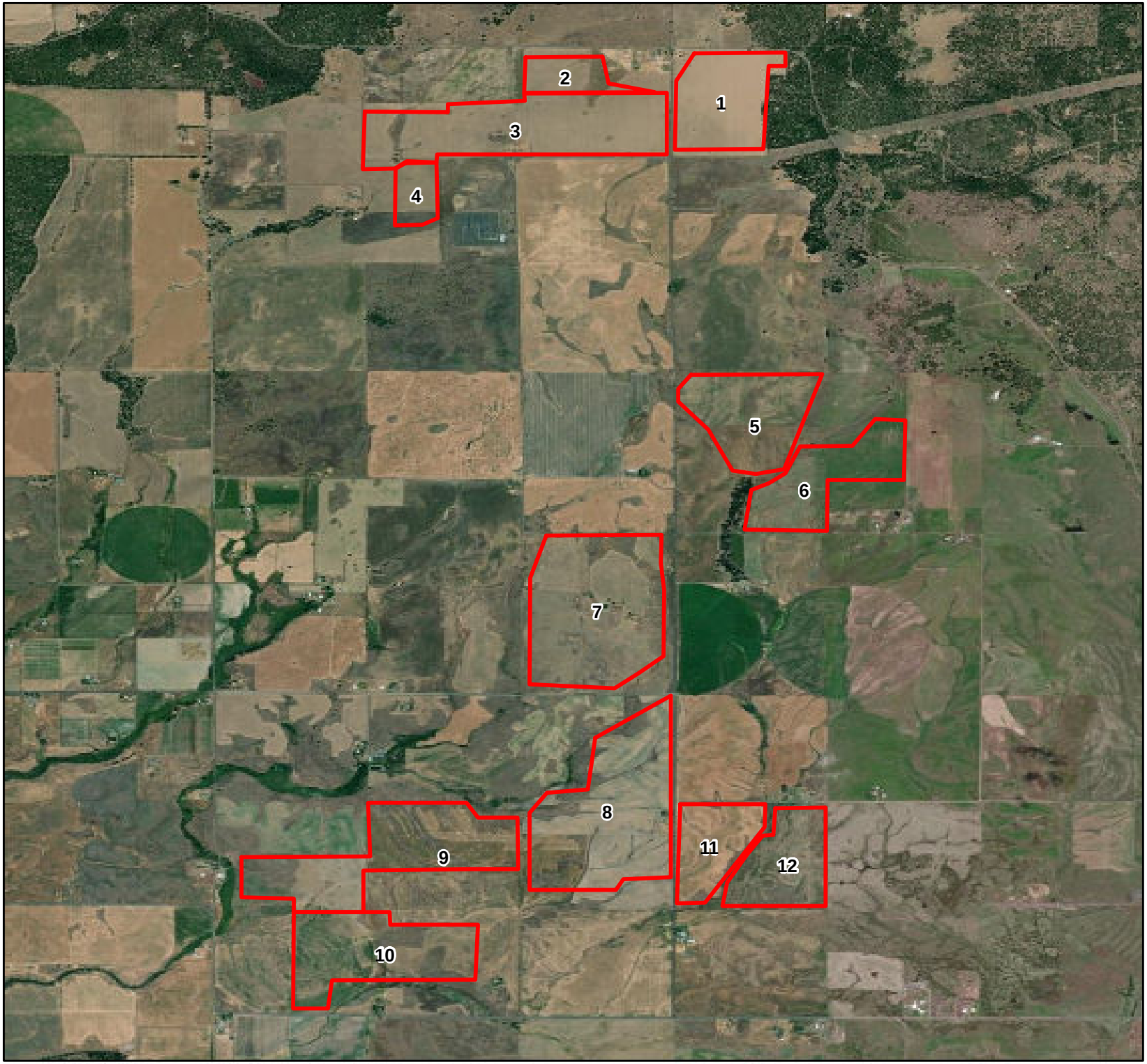
FAA. 2013. Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports. 78 FR 63276. October 23, 2013.

FAA. 2021. FAA Policy: Review of Solar Energy System Projects on Federally-Obligated Airports. 86 FR 25801. May 11, 2021.

FAA. 2022. Federal Aviation Administration Notice Criteria Tool. Obstruction Evaluation Version 2018.1.4. Accessed online at: https://oeaaa.faa.gov/oeaaa/external/gisTools/gisAction.jsp?action=showNoNoticeRequiredToolForm

Sandia Laboratories. 2016. Sandia Solar Glare Hazard Analysis Tool, GlareGauge hosted by ForgeSolar. Accessed online at: https://www.forgesolar.com/.

Appendix A: Figures



Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors

Legend

PV Array Area

Approximate Scale:

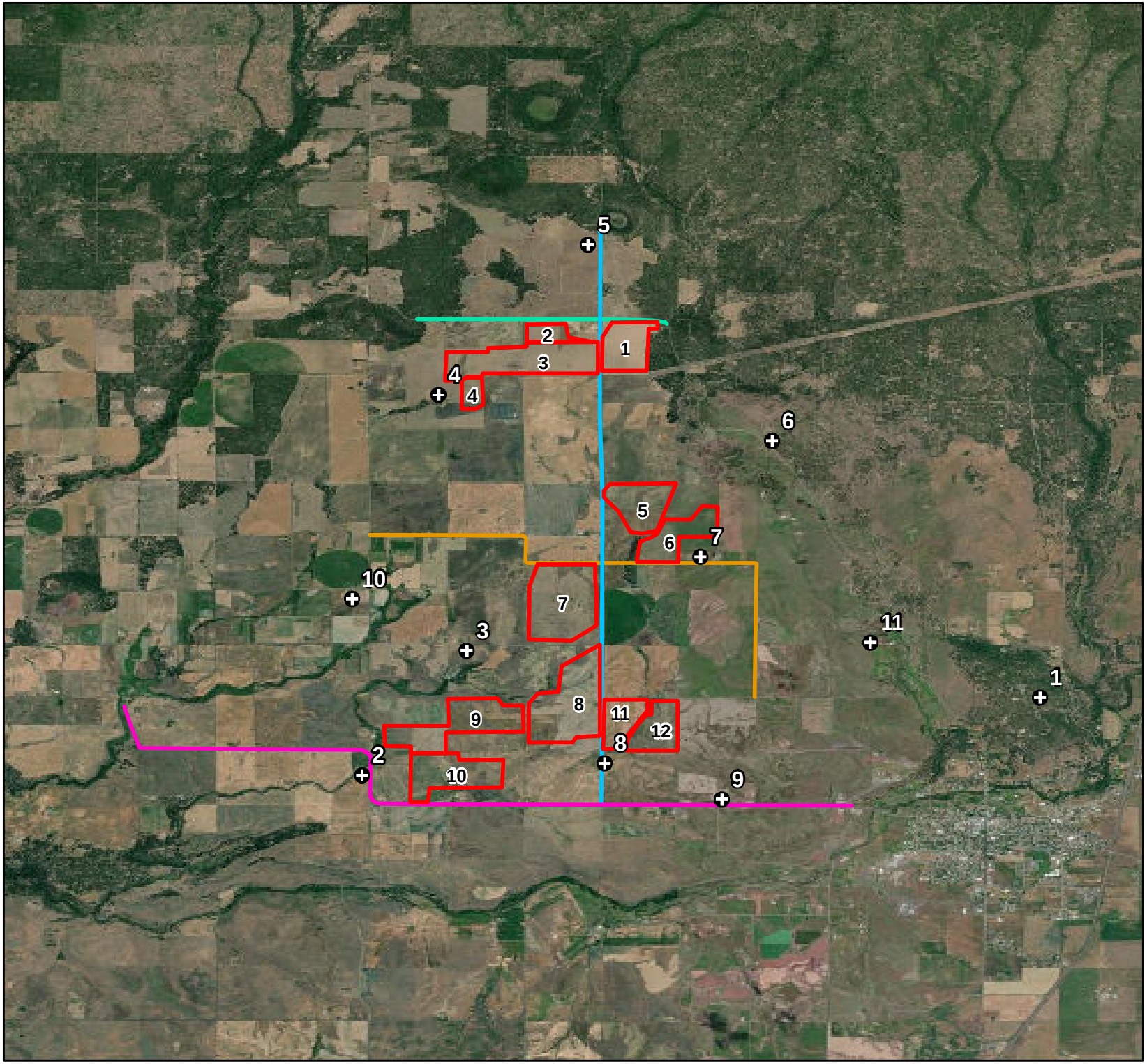
0 0.225 0.45 0.9 Miles

TETRA TECH

Date: 1/19/23

Figure 1
PV Array Areas

Carriger Solar Project
Klickitat County, Washington



Legend

- PV Array Area
- Observation Points (OPs)
- Route 142
- Knight Road
- Pine Forest Road
- Butt_Mesecher Road

Approximate Scale:

0 0.475 0.95 1.9 Miles

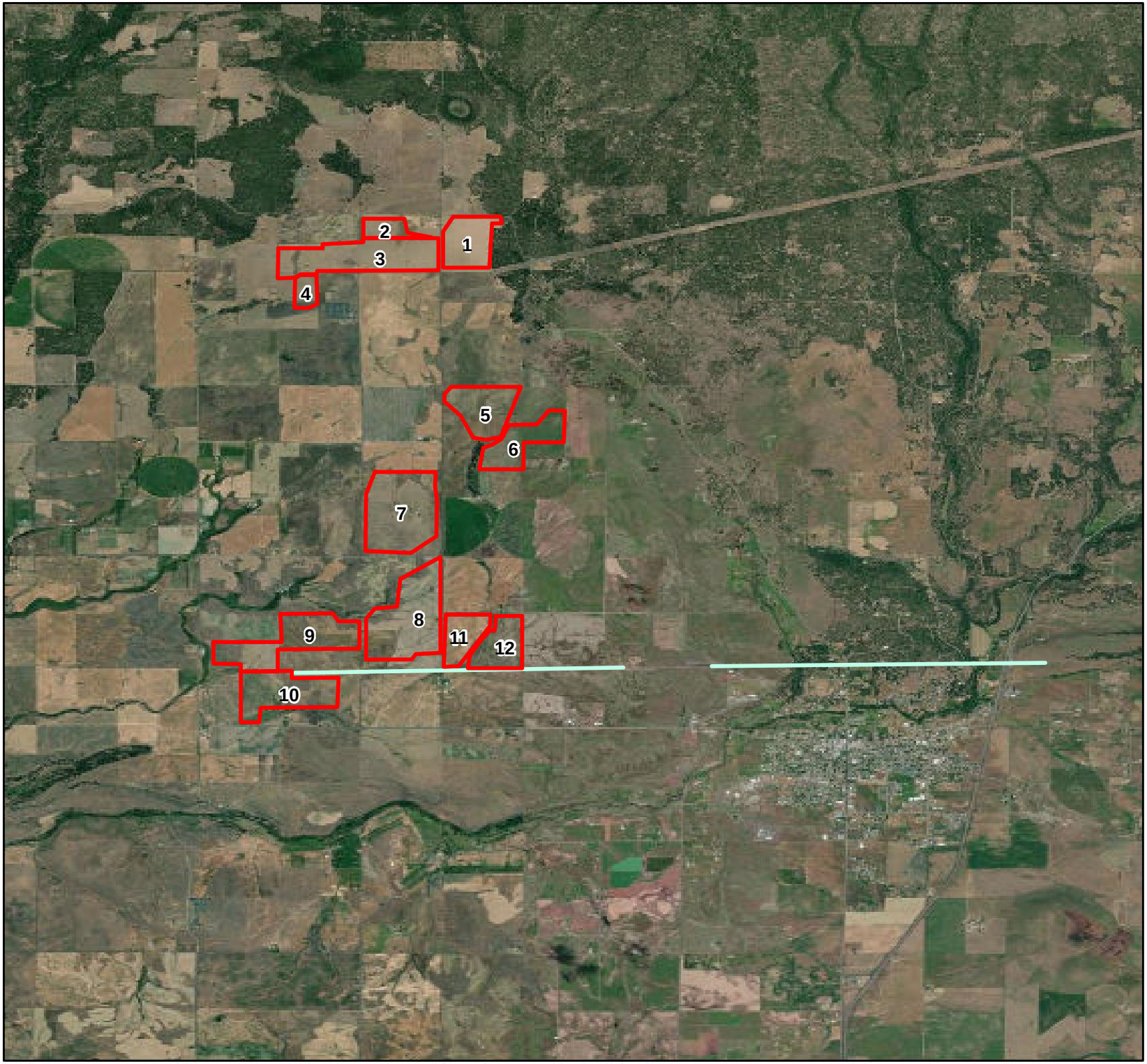
TETRA TECH

Date: 1/19/23

Figure 2
Receptors

Carriger Solar Project
Klickitat County, Washington

Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors



Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors

Legend

- PV Array Area
- S20 2-Mile Final Approach

Approximate Scale:

0 0.45 0.9 1.8 Miles

TETRA TECH

Date: 1/19/23

Figure 3
FAA Receptors

Carriger Solar Project
Klickitat County, Washington

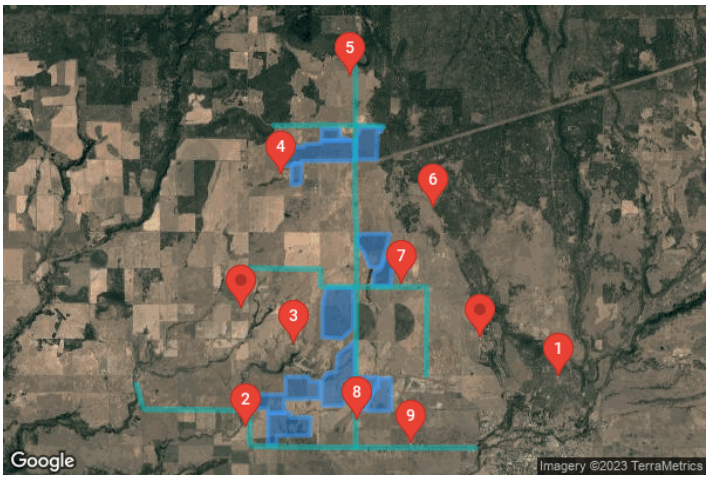
Appendix B: Sandia Glare Analysis Reports

Appendix B, Analysis 1

FORGESOLAR GLARE ANALYSIS

Project: **Cypress Creek**
Site configuration: **Carriger Analysis 1 01192023**

Created 07 Mar, 2022
Updated 20 Jan, 2023
Time-step 1 minute
Timezone offset UTC-8
Site ID 65746.11533
Category 100 MW to 1 GW
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 10	SA tracking	SA tracking	0	0.0	2,466	41.1	-
PV array 11	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 12	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 2	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 3	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 4	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 5	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 6	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 7	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 8	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 9	SA tracking	SA tracking	0	0.0	54	0.9	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	2,520	42.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

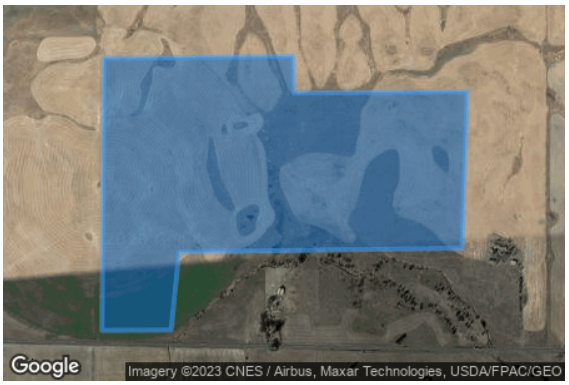
Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.889623	-120.873010	2171.73	5.00	2176.73
2	45.889629	-120.866864	2139.29	5.00	2144.29
3	45.888773	-120.866843	2139.44	5.00	2144.44
4	45.888770	-120.868029	2143.84	5.00	2148.84
5	45.883049	-120.868296	2097.33	5.00	2102.33
6	45.883044	-120.874307	2082.48	5.00	2087.48
7	45.887685	-120.874323	2139.04	5.00	2144.04

Name: PV array 10
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

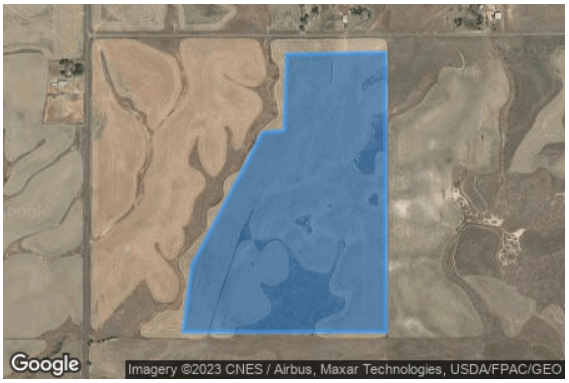


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.831456	-120.900147	1629.20	5.00	1634.20
2	45.831505	-120.893661	1642.69	5.00	1647.69
3	45.830632	-120.893625	1634.70	5.00	1639.70
4	45.830663	-120.887667	1642.64	5.00	1647.64
5	45.826929	-120.887845	1653.34	5.00	1658.34
6	45.826842	-120.897566	1623.34	5.00	1628.34
7	45.824977	-120.897840	1613.91	5.00	1618.91
8	45.824965	-120.900218	1617.98	5.00	1622.98

Name: PV array 11
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838795	-120.874116	1701.06	5.00	1706.06
2	45.838804	-120.868305	1679.06	5.00	1684.06
3	45.837249	-120.868278	1674.92	5.00	1679.92
4	45.832120	-120.872336	1660.18	5.00	1665.18
5	45.832105	-120.874246	1665.34	5.00	1670.34

Name: PV array 12
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

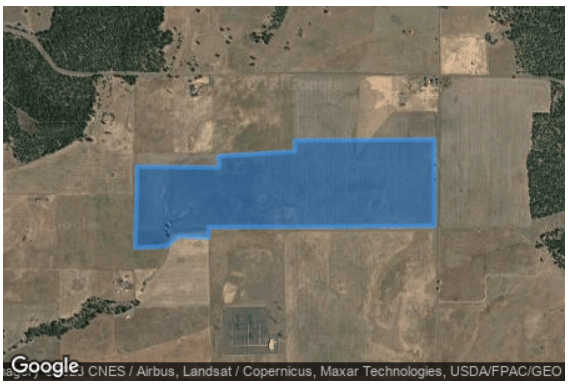


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.838554	-120.867608	1677.61	5.00	1682.61
2	45.838595	-120.864211	1687.35	5.00	1692.35
3	45.831919	-120.864193	1680.62	5.00	1685.62
4	45.831913	-120.871167	1660.05	5.00	1665.05
5	45.833507	-120.870865	1663.90	5.00	1668.90
6	45.836678	-120.868433	1671.90	5.00	1676.90
7	45.836734	-120.867695	1673.03	5.00	1678.03

Name: PV array 2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.889322	-120.884494	2064.61	5.00	2069.61
2	45.889383	-120.879272	2128.70	5.00	2133.70
3	45.887571	-120.878853	2134.78	5.00	2139.78
4	45.886956	-120.875695	2135.51	5.00	2140.51
5	45.886917	-120.884553	2058.16	5.00	2063.16

Name: PV array 3
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

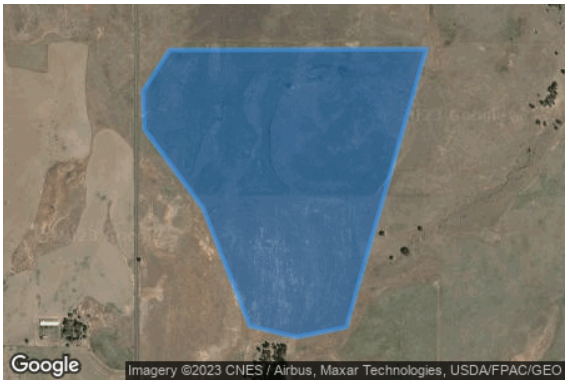


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.886902	-120.884529	2058.53	5.00	2063.53
2	45.886948	-120.874937	2134.84	5.00	2139.84
3	45.882806	-120.874919	2078.04	5.00	2083.04
4	45.882745	-120.890435	2004.11	5.00	2009.11
5	45.882249	-120.890434	2000.03	5.00	2005.03
6	45.882313	-120.892501	1986.65	5.00	1991.65
7	45.881832	-120.893339	1975.10	5.00	1980.10
8	45.881763	-120.895502	1973.40	5.00	1978.40
9	45.885651	-120.895370	2031.85	5.00	2036.85
10	45.885605	-120.889750	2021.20	5.00	2026.20
11	45.886153	-120.889735	2024.70	5.00	2029.70
12	45.886375	-120.884525	2057.15	5.00	2062.15

Name: PV array 4
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.882213	-120.892494	1985.11	5.00	1990.11
2	45.882221	-120.890412	1999.57	5.00	2004.57
3	45.878469	-120.890409	1993.00	5.00	1998.00
4	45.877990	-120.891493	1984.50	5.00	1989.50
5	45.877954	-120.893337	1967.70	5.00	1972.70
6	45.881793	-120.893295	1976.64	5.00	1981.64

Name: PV array 5
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

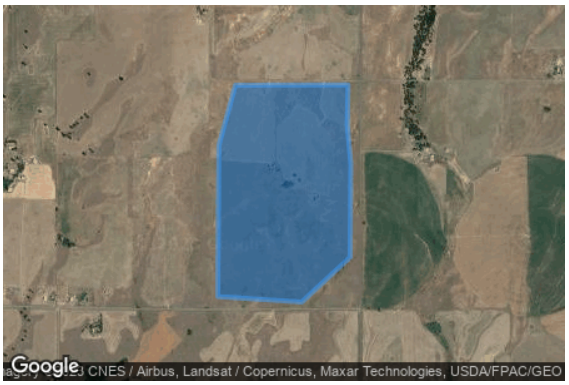


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.867926	-120.873257	1868.31	5.00	1873.31
2	45.867946	-120.864438	1880.44	5.00	1885.44
3	45.861312	-120.867184	1798.10	5.00	1803.10
4	45.861073	-120.868901	1802.84	5.00	1807.84
5	45.861342	-120.870510	1797.88	5.00	1802.88
6	45.864153	-120.872114	1813.70	5.00	1818.70
7	45.866035	-120.874131	1846.16	5.00	1851.16
8	45.866947	-120.874174	1862.99	5.00	1867.99

Name: PV array 6
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.857300	-120.869508	1788.47	5.00	1793.47
2	45.860065	-120.869229	1797.49	5.00	1802.49
3	45.860490	-120.867974	1800.45	5.00	1805.45
4	45.861200	-120.866869	1800.61	5.00	1805.61
5	45.863009	-120.865922	1807.31	5.00	1812.31
6	45.863066	-120.862371	1872.59	5.00	1877.59
7	45.864848	-120.860820	1864.37	5.00	1869.37
8	45.864779	-120.858778	1911.46	5.00	1916.46
9	45.860731	-120.858899	1872.79	5.00	1877.79
10	45.860721	-120.864029	1847.11	5.00	1852.11
11	45.857299	-120.864067	1789.73	5.00	1794.73

Name: PV array 7
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

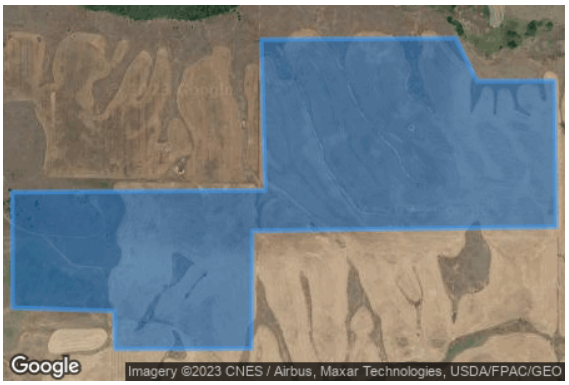


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.856994	-120.883031	1770.84	5.00	1775.84
2	45.857009	-120.875287	1766.25	5.00	1771.25
3	45.855097	-120.875345	1758.37	5.00	1763.37
4	45.853257	-120.875104	1745.93	5.00	1750.93
5	45.848789	-120.875144	1711.36	5.00	1716.36
6	45.846649	-120.878473	1709.27	5.00	1714.27
7	45.846911	-120.884237	1693.28	5.00	1698.28
8	45.854121	-120.884168	1758.96	5.00	1763.96

Name: PV array 8
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838221	-120.884240	1656.81	5.00	1661.81
2	45.839569	-120.883028	1655.29	5.00	1660.29
3	45.839806	-120.880284	1682.20	5.00	1687.20
4	45.843283	-120.879763	1675.87	5.00	1680.87
5	45.846139	-120.874647	1713.77	5.00	1718.77
6	45.833850	-120.874650	1670.18	5.00	1675.18
7	45.833732	-120.877861	1668.78	5.00	1673.78
8	45.833357	-120.878119	1665.70	5.00	1670.70
9	45.833020	-120.878337	1664.91	5.00	1669.91
10	45.832972	-120.884220	1647.27	5.00	1652.27

Name: PV array 9
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838876	-120.895132	1639.56	5.00	1644.56
2	45.838910	-120.888451	1645.28	5.00	1650.28
3	45.837885	-120.887707	1652.23	5.00	1657.23
4	45.837892	-120.885056	1656.36	5.00	1661.36
5	45.834404	-120.884998	1643.87	5.00	1648.87
6	45.834308	-120.895444	1653.88	5.00	1658.88
7	45.831503	-120.895461	1640.45	5.00	1645.45
8	45.831492	-120.900151	1629.20	5.00	1634.20
9	45.832395	-120.900182	1634.68	5.00	1639.68
10	45.832473	-120.903678	1616.52	5.00	1621.52
11	45.835234	-120.903692	1672.91	5.00	1677.91
12	45.835279	-120.894997	1649.84	5.00	1654.84

Route Receptors

Name: Butts_Mesecher Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.861005	-120.905669	1736.30	5.00	1741.30
2	45.860855	-120.894683	1804.86	5.00	1809.86
3	45.860766	-120.884705	1808.75	5.00	1813.75
4	45.857373	-120.884726	1776.04	5.00	1781.04
5	45.857209	-120.884533	1772.52	5.00	1777.52
6	45.857164	-120.874384	1757.85	5.00	1762.85
7	45.857137	-120.853660	1831.52	5.00	1836.52
8	45.839203	-120.853767	1689.14	5.00	1694.14

Name: Knight Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.902723	-120.875130	2381.66	5.00	2386.66
2	45.901857	-120.874679	2363.42	5.00	2368.42
3	45.900543	-120.874550	2313.14	5.00	2318.14
4	45.895988	-120.874497	2221.52	5.00	2226.52
5	45.889555	-120.874526	2168.10	5.00	2173.10
6	45.882600	-120.874633	2078.63	5.00	2083.63
7	45.874700	-120.874633	1955.83	5.00	1960.83
8	45.871296	-120.874522	1914.90	5.00	1919.90
9	45.868877	-120.874339	1883.67	5.00	1888.67
10	45.862870	-120.874350	1827.90	5.00	1832.90
11	45.857062	-120.874361	1757.17	5.00	1762.17
12	45.852612	-120.874382	1744.40	5.00	1749.40
13	45.846284	-120.874397	1714.30	5.00	1719.30
14	45.838968	-120.874425	1702.39	5.00	1707.39
15	45.824548	-120.874473	1644.50	5.00	1649.50

Name: Pine Forest Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.889742	-120.866524	2139.35	5.00	2144.35
2	45.889929	-120.868187	2145.61	5.00	2150.61
3	45.889944	-120.869088	2154.13	5.00	2159.13
4	45.890011	-120.877178	2158.21	5.00	2163.21
5	45.890093	-120.884141	2074.09	5.00	2079.09
6	45.890011	-120.891309	2078.50	5.00	2083.50
7	45.889981	-120.895182	2093.36	5.00	2098.36
8	45.890041	-120.898443	2120.61	5.00	2125.61

Name: Route 142
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.837267	-120.938698	1585.03	5.00	1590.03
2	45.832588	-120.936895	1599.51	5.00	1604.51
3	45.832244	-120.936166	1614.08	5.00	1619.08
4	45.832184	-120.923401	1636.73	5.00	1641.73
5	45.832005	-120.906989	1620.23	5.00	1625.23
6	45.831750	-120.906195	1618.37	5.00	1623.37
7	45.831227	-120.905637	1614.58	5.00	1619.58
8	45.825545	-120.905615	1627.71	5.00	1632.71
9	45.825097	-120.905336	1627.35	5.00	1632.35
10	45.824738	-120.904478	1628.41	5.00	1633.41
11	45.824559	-120.893277	1638.42	5.00	1643.42
12	45.824439	-120.867828	1651.71	5.00	1656.71
13	45.824394	-120.839500	1630.38	5.00	1635.38

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	45.838802	-120.815079	2106.15	6.00
OP 2	2	45.828563	-120.906512	1624.37	6.00
OP 3	3	45.845463	-120.892545	1691.72	6.00
OP 4	4	45.880002	-120.896361	1968.69	6.00
OP 5	5	45.900119	-120.876034	2299.69	6.00
OP 6	6	45.873293	-120.851528	1933.92	6.00
OP 7	7	45.857634	-120.860876	1820.36	6.00
OP 8	8	45.830061	-120.874003	1660.81	6.00
OP 9	9	45.825163	-120.858362	1665.20	6.00
OP 10	10	45.852627	-120.908057	1695.44	6.00
OP 11	11	45.846665	-120.837900	1707.30	6.00

Glare Analysis Results

Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 10	SA tracking	SA tracking	0	0.0	2,466	41.1	-
PV array 11	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 12	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 2	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 3	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 4	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 5	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 6	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 7	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 8	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 9	SA tracking	SA tracking	0	0.0	54	0.9	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	2,520	42.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 1 and Butts_Mesecher Road

Receptor type: Route

No glare found

PV array 1 and Knight Road

Receptor type: Route

No glare found

PV array 1 and Pine Forest Road

Receptor type: Route

No glare found

PV array 1 and Route 142

Receptor type: Route
No glare found

PV array 1 and OP 1

Receptor type: Observation Point
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
No glare found

PV array 1 and OP 3

Receptor type: Observation Point
No glare found

PV array 1 and OP 4

Receptor type: Observation Point
No glare found

PV array 1 and OP 5

Receptor type: Observation Point
No glare found

PV array 1 and OP 6

Receptor type: Observation Point
No glare found

PV array 1 and OP 7

Receptor type: Observation Point
No glare found

PV array 1 and OP 8

Receptor type: Observation Point
No glare found

PV array 1 and OP 9

Receptor type: Observation Point
No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 10 potential temporary after-image

Receptor results ordered by category of glare

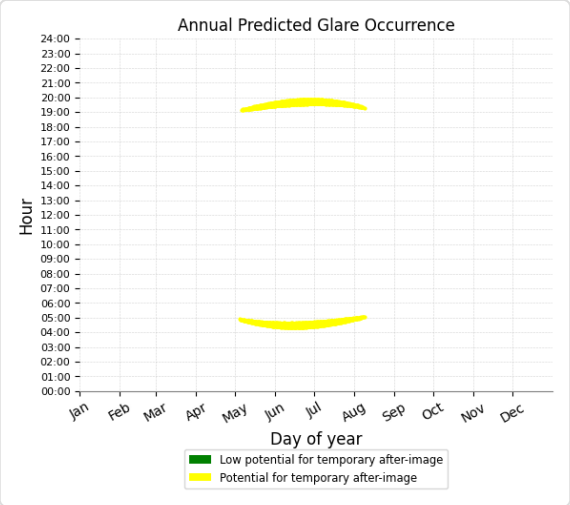
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 142	0	0.0	2,466	41.1
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

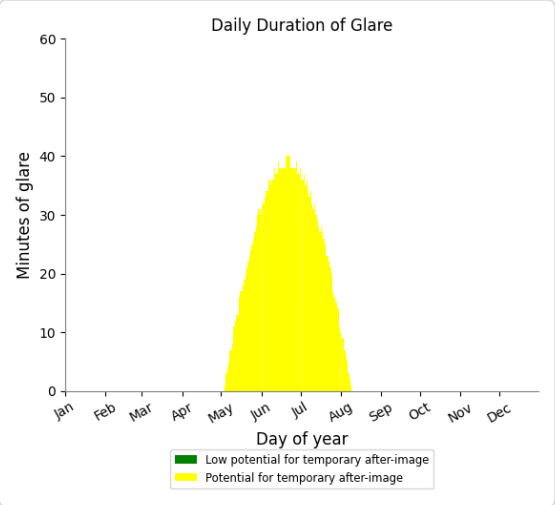
PV array 10 and Route 142

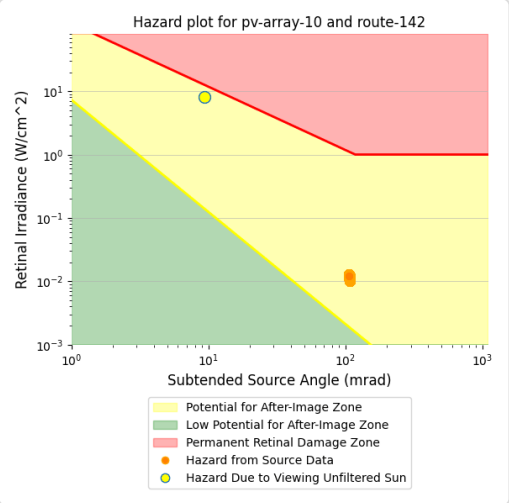
Receptor type: Route

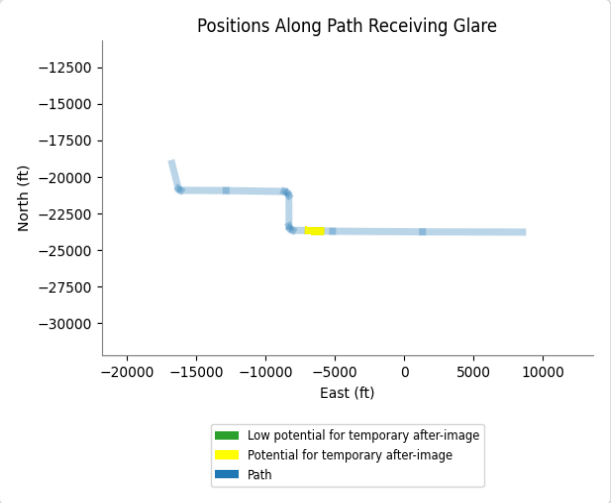
2,466 minutes of yellow glare

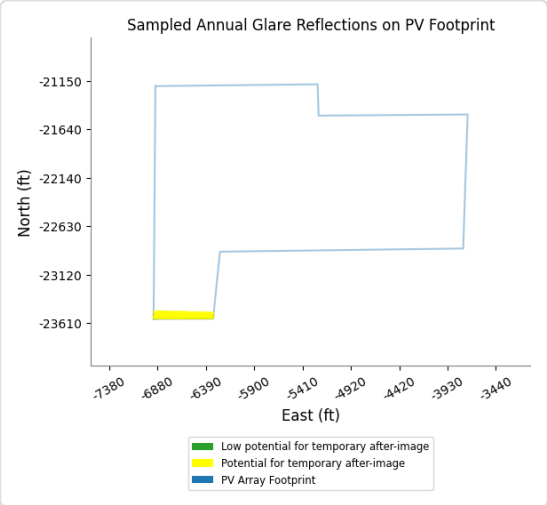
0 minutes of green glare











PV array 10 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 10 and Knight Road

Receptor type: Route
No glare found

PV array 10 and Pine Forest Road

Receptor type: Route
No glare found

PV array 10 and OP 1

Receptor type: Observation Point
No glare found

PV array 10 and OP 2

Receptor type: Observation Point
No glare found

PV array 10 and OP 3

Receptor type: Observation Point
No glare found

PV array 10 and OP 4

Receptor type: Observation Point
No glare found

PV array 10 and OP 5

Receptor type: Observation Point
No glare found

PV array 10 and OP 6

Receptor type: Observation Point
No glare found

PV array 10 and OP 7

Receptor type: Observation Point
No glare found

PV array 10 and OP 8

Receptor type: Observation Point
No glare found

PV array 10 and OP 9

Receptor type: Observation Point
No glare found

PV array 10 and OP 10

Receptor type: Observation Point
No glare found

PV array 10 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 11 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 11 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 11 and Knight Road

Receptor type: Route
No glare found

PV array 11 and Pine Forest Road

Receptor type: Route
No glare found

PV array 11 and Route 142

Receptor type: Route
No glare found

PV array 11 and OP 1

Receptor type: Observation Point
No glare found

PV array 11 and OP 2

Receptor type: Observation Point
No glare found

PV array 11 and OP 3

Receptor type: Observation Point
No glare found

PV array 11 and OP 4

Receptor type: Observation Point
No glare found

PV array 11 and OP 5

Receptor type: Observation Point
No glare found

PV array 11 and OP 6

Receptor type: Observation Point
No glare found

PV array 11 and OP 7

Receptor type: Observation Point
No glare found

PV array 11 and OP 8

Receptor type: Observation Point
No glare found

PV array 11 and OP 9

Receptor type: Observation Point
No glare found

PV array 11 and OP 10

Receptor type: Observation Point
No glare found

PV array 11 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 12 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 12 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 12 and Knight Road

Receptor type: Route
No glare found

PV array 12 and Pine Forest Road

Receptor type: Route
No glare found

PV array 12 and Route 142

Receptor type: Route
No glare found

PV array 12 and OP 1

Receptor type: Observation Point
No glare found

PV array 12 and OP 2

Receptor type: Observation Point
No glare found

PV array 12 and OP 3

Receptor type: Observation Point
No glare found

PV array 12 and OP 4

Receptor type: Observation Point
No glare found

PV array 12 and OP 5

Receptor type: Observation Point
No glare found

PV array 12 and OP 6

Receptor type: Observation Point
No glare found

PV array 12 and OP 7

Receptor type: Observation Point
No glare found

PV array 12 and OP 8

Receptor type: Observation Point
No glare found

PV array 12 and OP 9

Receptor type: Observation Point
No glare found

PV array 12 and OP 10

Receptor type: Observation Point
No glare found

PV array 12 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 2 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 2 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 2 and Knight Road

Receptor type: Route
No glare found

PV array 2 and Pine Forest Road

Receptor type: Route
No glare found

PV array 2 and Route 142

Receptor type: Route
No glare found

PV array 2 and OP 1

Receptor type: Observation Point
No glare found

PV array 2 and OP 2

Receptor type: Observation Point
No glare found

PV array 2 and OP 3

Receptor type: Observation Point
No glare found

PV array 2 and OP 4

Receptor type: Observation Point
No glare found

PV array 2 and OP 5

Receptor type: Observation Point
No glare found

PV array 2 and OP 6

Receptor type: Observation Point
No glare found

PV array 2 and OP 7

Receptor type: Observation Point
No glare found

PV array 2 and OP 8

Receptor type: Observation Point
No glare found

PV array 2 and OP 9

Receptor type: Observation Point
No glare found

PV array 2 and OP 10

Receptor type: Observation Point
No glare found

PV array 2 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 3 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 3 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 3 and Knight Road

Receptor type: Route
No glare found

PV array 3 and Pine Forest Road

Receptor type: Route
No glare found

PV array 3 and Route 142

Receptor type: Route
No glare found

PV array 3 and OP 1

Receptor type: Observation Point
No glare found

PV array 3 and OP 2

Receptor type: Observation Point
No glare found

PV array 3 and OP 3

Receptor type: Observation Point
No glare found

PV array 3 and OP 4

Receptor type: Observation Point
No glare found

PV array 3 and OP 5

Receptor type: Observation Point
No glare found

PV array 3 and OP 6

Receptor type: Observation Point
No glare found

PV array 3 and OP 7

Receptor type: Observation Point
No glare found

PV array 3 and OP 8

Receptor type: Observation Point
No glare found

PV array 3 and OP 9

Receptor type: Observation Point
No glare found

PV array 3 and OP 10

Receptor type: Observation Point
No glare found

PV array 3 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 4 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 4 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 4 and Knight Road

Receptor type: Route
No glare found

PV array 4 and Pine Forest Road

Receptor type: Route
No glare found

PV array 4 and Route 142

Receptor type: Route
No glare found

PV array 4 and OP 1

Receptor type: Observation Point
No glare found

PV array 4 and OP 2

Receptor type: Observation Point
No glare found

PV array 4 and OP 3

Receptor type: Observation Point
No glare found

PV array 4 and OP 4

Receptor type: Observation Point
No glare found

PV array 4 and OP 5

Receptor type: Observation Point
No glare found

PV array 4 and OP 6

Receptor type: Observation Point
No glare found

PV array 4 and OP 7

Receptor type: Observation Point
No glare found

PV array 4 and OP 8

Receptor type: Observation Point
No glare found

PV array 4 and OP 9

Receptor type: Observation Point
No glare found

PV array 4 and OP 10

Receptor type: Observation Point
No glare found

PV array 4 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 5 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 5 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 5 and Knight Road

Receptor type: Route
No glare found

PV array 5 and Pine Forest Road

Receptor type: Route
No glare found

PV array 5 and Route 142

Receptor type: Route
No glare found

PV array 5 and OP 1

Receptor type: Observation Point
No glare found

PV array 5 and OP 2

Receptor type: Observation Point
No glare found

PV array 5 and OP 3

Receptor type: Observation Point
No glare found

PV array 5 and OP 4

Receptor type: Observation Point
No glare found

PV array 5 and OP 5

Receptor type: Observation Point
No glare found

PV array 5 and OP 6

Receptor type: Observation Point
No glare found

PV array 5 and OP 7

Receptor type: Observation Point
No glare found

PV array 5 and OP 8

Receptor type: Observation Point
No glare found

PV array 5 and OP 9

Receptor type: Observation Point
No glare found

PV array 5 and OP 10

Receptor type: Observation Point
No glare found

PV array 5 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 6 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 6 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 6 and Knight Road

Receptor type: Route
No glare found

PV array 6 and Pine Forest Road

Receptor type: Route
No glare found

PV array 6 and Route 142

Receptor type: Route
No glare found

PV array 6 and OP 1

Receptor type: Observation Point
No glare found

PV array 6 and OP 2

Receptor type: Observation Point
No glare found

PV array 6 and OP 3

Receptor type: Observation Point
No glare found

PV array 6 and OP 4

Receptor type: Observation Point
No glare found

PV array 6 and OP 5

Receptor type: Observation Point
No glare found

PV array 6 and OP 6

Receptor type: Observation Point
No glare found

PV array 6 and OP 7

Receptor type: Observation Point
No glare found

PV array 6 and OP 8

Receptor type: Observation Point
No glare found

PV array 6 and OP 9

Receptor type: Observation Point
No glare found

PV array 6 and OP 10

Receptor type: Observation Point
No glare found

PV array 6 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 7 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 7 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 7 and Knight Road

Receptor type: Route
No glare found

PV array 7 and Pine Forest Road

Receptor type: Route
No glare found

PV array 7 and Route 142

Receptor type: Route
No glare found

PV array 7 and OP 1

Receptor type: Observation Point
No glare found

PV array 7 and OP 2

Receptor type: Observation Point
No glare found

PV array 7 and OP 3

Receptor type: Observation Point
No glare found

PV array 7 and OP 4

Receptor type: Observation Point
No glare found

PV array 7 and OP 5

Receptor type: Observation Point
No glare found

PV array 7 and OP 6

Receptor type: Observation Point
No glare found

PV array 7 and OP 7

Receptor type: Observation Point
No glare found

PV array 7 and OP 8

Receptor type: Observation Point
No glare found

PV array 7 and OP 9

Receptor type: Observation Point
No glare found

PV array 7 and OP 10

Receptor type: Observation Point
No glare found

PV array 7 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 8 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 8 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 8 and Knight Road

Receptor type: Route
No glare found

PV array 8 and Pine Forest Road

Receptor type: Route
No glare found

PV array 8 and Route 142

Receptor type: Route
No glare found

PV array 8 and OP 1

Receptor type: Observation Point
No glare found

PV array 8 and OP 2

Receptor type: Observation Point
No glare found

PV array 8 and OP 3

Receptor type: Observation Point
No glare found

PV array 8 and OP 4

Receptor type: Observation Point
No glare found

PV array 8 and OP 5

Receptor type: Observation Point
No glare found

PV array 8 and OP 6

Receptor type: Observation Point
No glare found

PV array 8 and OP 7

Receptor type: Observation Point
No glare found

PV array 8 and OP 8

Receptor type: Observation Point
No glare found

PV array 8 and OP 9

Receptor type: Observation Point
No glare found

PV array 8 and OP 10

Receptor type: Observation Point
No glare found

PV array 8 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 9 potential temporary after-image

Receptor results ordered by category of glare

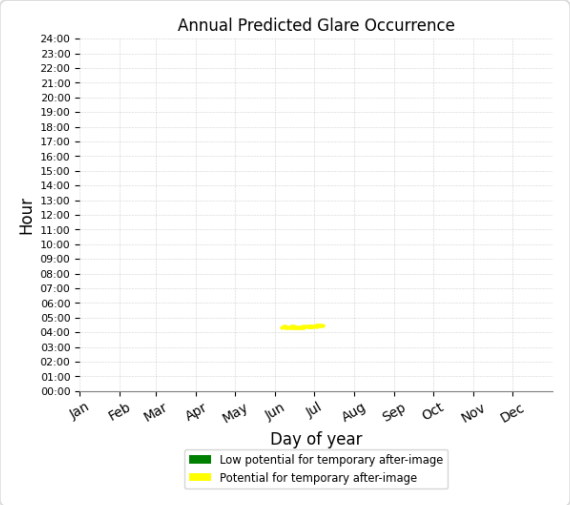
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 142	0	0.0	54	0.9
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

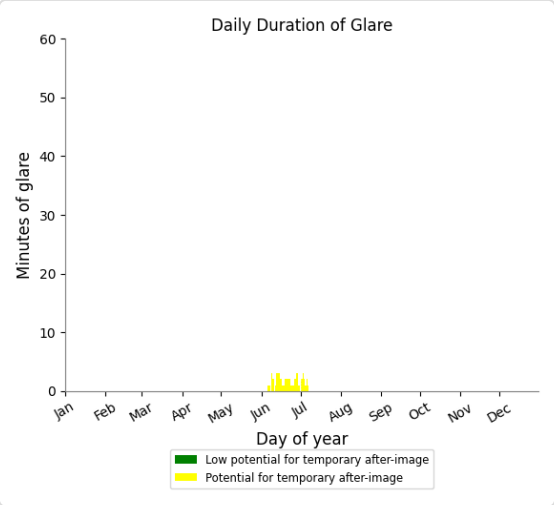
PV array 9 and Route 142

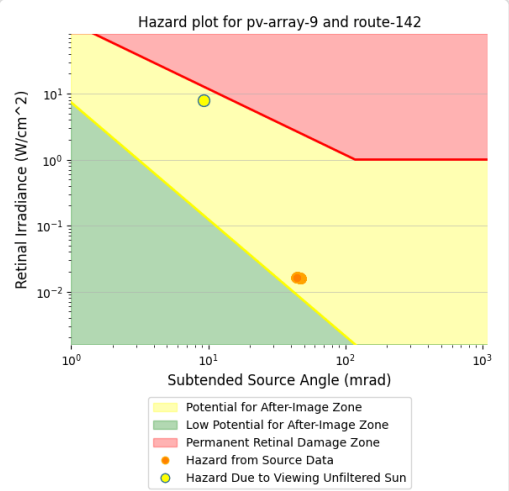
Receptor type: Route

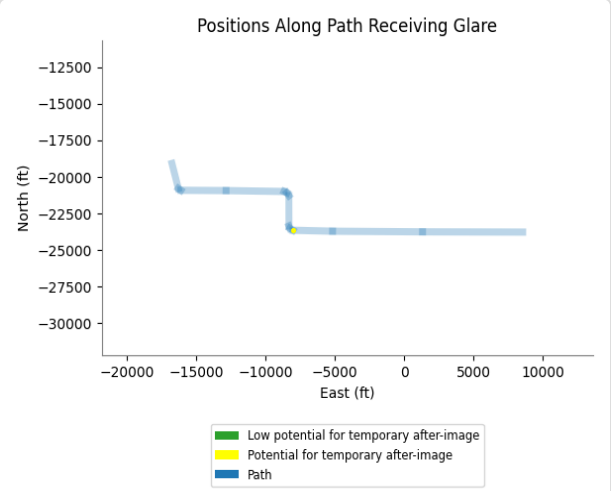
54 minutes of yellow glare

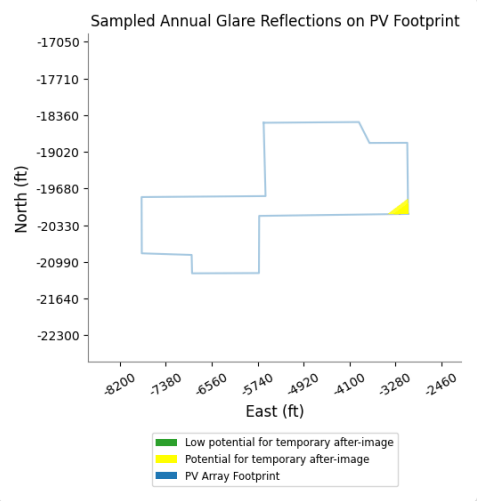
0 minutes of green glare











PV array 9 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 9 and Knight Road

Receptor type: Route
No glare found

PV array 9 and Pine Forest Road

Receptor type: Route
No glare found

PV array 9 and OP 1

Receptor type: Observation Point
No glare found

PV array 9 and OP 2

Receptor type: Observation Point
No glare found

PV array 9 and OP 3

Receptor type: Observation Point
No glare found

PV array 9 and OP 4

Receptor type: Observation Point
No glare found

PV array 9 and OP 5

Receptor type: Observation Point
No glare found

PV array 9 and OP 6

Receptor type: Observation Point
No glare found

PV array 9 and OP 7

Receptor type: Observation Point
No glare found

PV array 9 and OP 8

Receptor type: Observation Point
No glare found

PV array 9 and OP 9

Receptor type: Observation Point
No glare found

PV array 9 and OP 10

Receptor type: Observation Point
No glare found

PV array 9 and OP 11

Receptor type: Observation Point
No glare found

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.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
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. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
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.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
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.
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.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

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

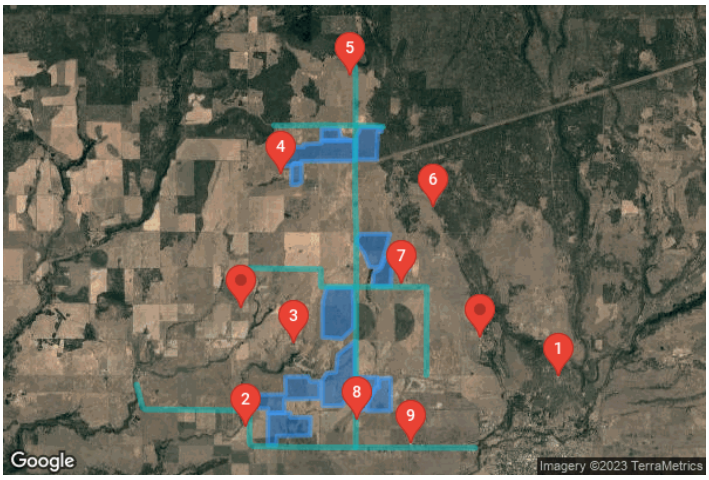
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

Appendix B, Analysis 2

FORGESOLAR GLARE ANALYSIS

Project: **Cypress Creek**
Site configuration: **Carriger Analysis 2 01192023**

Created 20 Jan, 2023
Updated 20 Jan, 2023
Time-step 1 minute
Timezone offset UTC-8
Site ID 82773.11533
Category 100 MW to 1 GW
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 10	SA tracking	SA tracking	0	0.0	3,508	58.5	-
PV array 11	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 12	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 2	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 3	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 4	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 5	SA tracking	SA tracking	0	0.0	7	0.1	-
PV array 6	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 7	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 8	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 9	SA tracking	SA tracking	0	0.0	251	4.2	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	7	0.1
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	3,556	59.3
OP 1	0	0.0	0	0.0
OP 2	0	0.0	203	3.4
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

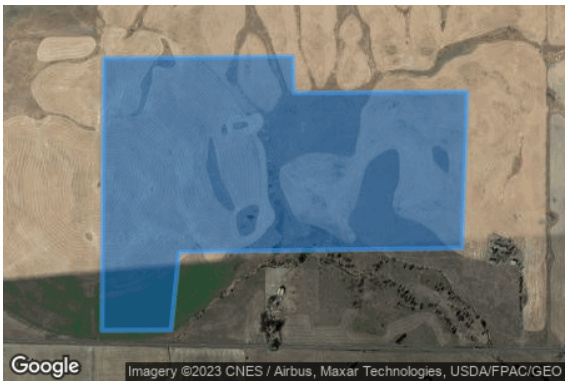
Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.889623	-120.873010	2171.73	5.00	2176.73
2	45.889629	-120.866864	2139.29	5.00	2144.29
3	45.888773	-120.866843	2139.44	5.00	2144.44
4	45.888770	-120.868029	2143.84	5.00	2148.84
5	45.883049	-120.868296	2097.33	5.00	2102.33
6	45.883044	-120.874307	2082.48	5.00	2087.48
7	45.887685	-120.874323	2139.04	5.00	2144.04

Name: PV array 10
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

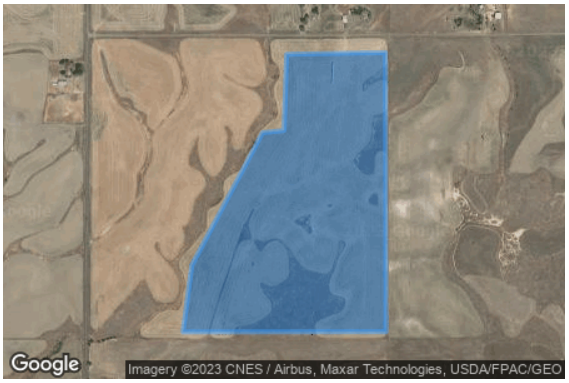


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.831456	-120.900147	1629.20	5.00	1634.20
2	45.831505	-120.893661	1642.69	5.00	1647.69
3	45.830632	-120.893625	1634.70	5.00	1639.70
4	45.830663	-120.887667	1642.64	5.00	1647.64
5	45.826929	-120.887845	1653.34	5.00	1658.34
6	45.826842	-120.897566	1623.34	5.00	1628.34
7	45.824977	-120.897840	1613.91	5.00	1618.91
8	45.824965	-120.900218	1617.98	5.00	1622.98

Name: PV array 11
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838795	-120.874116	1701.06	5.00	1706.06
2	45.838804	-120.868305	1679.06	5.00	1684.06
3	45.837249	-120.868278	1674.92	5.00	1679.92
4	45.832120	-120.872336	1660.18	5.00	1665.18
5	45.832105	-120.874246	1665.34	5.00	1670.34

Name: PV array 12
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

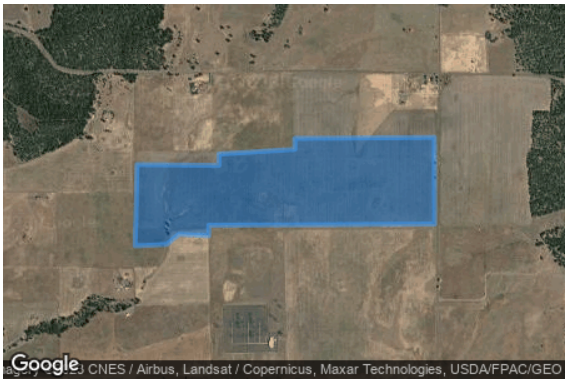


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.838554	-120.867608	1677.61	5.00	1682.61
2	45.838595	-120.864211	1687.35	5.00	1692.35
3	45.831919	-120.864193	1680.62	5.00	1685.62
4	45.831913	-120.871167	1660.05	5.00	1665.05
5	45.833507	-120.870865	1663.90	5.00	1668.90
6	45.836678	-120.868433	1671.90	5.00	1676.90
7	45.836734	-120.867695	1673.03	5.00	1678.03

Name: PV array 2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.889322	-120.884494	2064.61	5.00	2069.61
2	45.889383	-120.879272	2128.70	5.00	2133.70
3	45.887571	-120.878853	2134.78	5.00	2139.78
4	45.886956	-120.875695	2135.51	5.00	2140.51
5	45.886917	-120.884553	2058.16	5.00	2063.16

Name: PV array 3
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

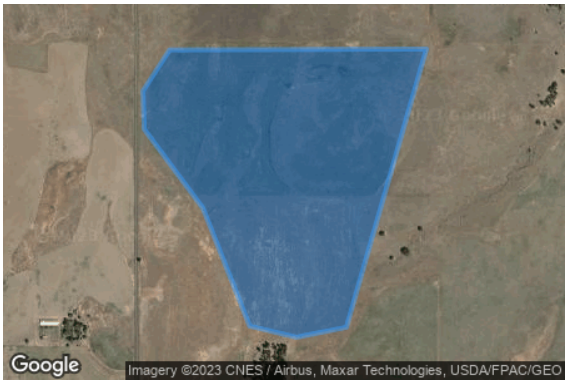


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.886902	-120.884529	2058.53	5.00	2063.53
2	45.886948	-120.874937	2134.84	5.00	2139.84
3	45.882806	-120.874919	2078.04	5.00	2083.04
4	45.882745	-120.890435	2004.11	5.00	2009.11
5	45.882249	-120.890434	2000.03	5.00	2005.03
6	45.882313	-120.892501	1986.65	5.00	1991.65
7	45.881832	-120.893339	1975.10	5.00	1980.10
8	45.881763	-120.895502	1973.40	5.00	1978.40
9	45.885651	-120.895370	2031.85	5.00	2036.85
10	45.885605	-120.889750	2021.20	5.00	2026.20
11	45.886153	-120.889735	2024.70	5.00	2029.70
12	45.886375	-120.884525	2057.15	5.00	2062.15

Name: PV array 4
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.882213	-120.892494	1985.11	5.00	1990.11
2	45.882221	-120.890412	1999.57	5.00	2004.57
3	45.878469	-120.890409	1993.00	5.00	1998.00
4	45.877990	-120.891493	1984.50	5.00	1989.50
5	45.877954	-120.893337	1967.70	5.00	1972.70
6	45.881793	-120.893295	1976.64	5.00	1981.64

Name: PV array 5
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

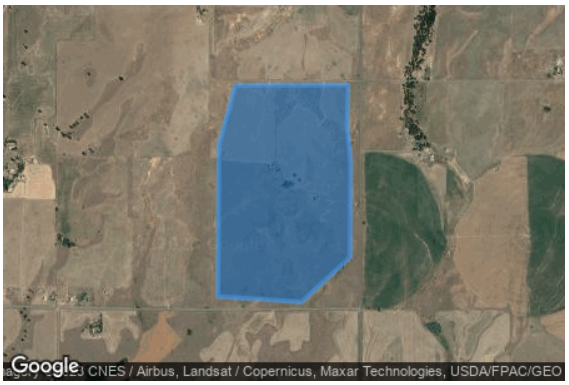


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.867926	-120.873257	1868.31	5.00	1873.31
2	45.867946	-120.864438	1880.44	5.00	1885.44
3	45.861312	-120.867184	1798.10	5.00	1803.10
4	45.861073	-120.868901	1802.84	5.00	1807.84
5	45.861342	-120.870510	1797.88	5.00	1802.88
6	45.864153	-120.872114	1813.70	5.00	1818.70
7	45.866035	-120.874131	1846.16	5.00	1851.16
8	45.866947	-120.874174	1862.99	5.00	1867.99

Name: PV array 6
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.857300	-120.869508	1788.47	5.00	1793.47
2	45.860065	-120.869229	1797.49	5.00	1802.49
3	45.860490	-120.867974	1800.45	5.00	1805.45
4	45.861200	-120.866869	1800.61	5.00	1805.61
5	45.863009	-120.865922	1807.31	5.00	1812.31
6	45.863066	-120.862371	1872.59	5.00	1877.59
7	45.864848	-120.860820	1864.37	5.00	1869.37
8	45.864779	-120.858778	1911.46	5.00	1916.46
9	45.860731	-120.858899	1872.79	5.00	1877.79
10	45.860721	-120.864029	1847.11	5.00	1852.11
11	45.857299	-120.864067	1789.73	5.00	1794.73

Name: PV array 7
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

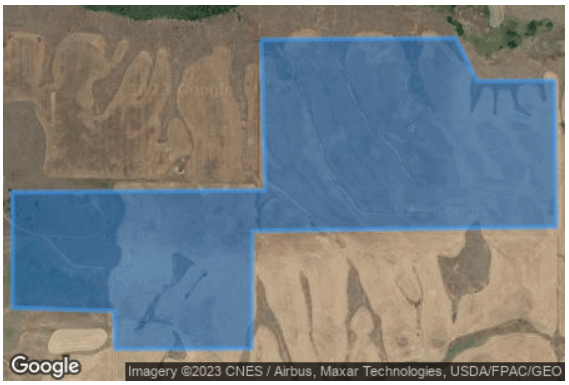


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.856994	-120.883031	1770.84	5.00	1775.84
2	45.857009	-120.875287	1766.25	5.00	1771.25
3	45.855097	-120.875345	1758.37	5.00	1763.37
4	45.853257	-120.875104	1745.93	5.00	1750.93
5	45.848789	-120.875144	1711.36	5.00	1716.36
6	45.846649	-120.878473	1709.27	5.00	1714.27
7	45.846911	-120.884237	1693.28	5.00	1698.28
8	45.854121	-120.884168	1758.96	5.00	1763.96

Name: PV array 8
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838221	-120.884240	1656.81	5.00	1661.81
2	45.839569	-120.883028	1655.29	5.00	1660.29
3	45.839806	-120.880284	1682.20	5.00	1687.20
4	45.843283	-120.879763	1675.87	5.00	1680.87
5	45.846139	-120.874647	1713.77	5.00	1718.77
6	45.833850	-120.874650	1670.18	5.00	1675.18
7	45.833732	-120.877861	1668.78	5.00	1673.78
8	45.833357	-120.878119	1665.70	5.00	1670.70
9	45.833020	-120.878337	1664.91	5.00	1669.91
10	45.832972	-120.884220	1647.27	5.00	1652.27

Name: PV array 9
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838876	-120.895132	1639.56	5.00	1644.56
2	45.838910	-120.888451	1645.28	5.00	1650.28
3	45.837885	-120.887707	1652.23	5.00	1657.23
4	45.837892	-120.885056	1656.36	5.00	1661.36
5	45.834404	-120.884998	1643.87	5.00	1648.87
6	45.834308	-120.895444	1653.88	5.00	1658.88
7	45.831503	-120.895461	1640.45	5.00	1645.45
8	45.831492	-120.900151	1629.20	5.00	1634.20
9	45.832395	-120.900182	1634.68	5.00	1639.68
10	45.832473	-120.903678	1616.52	5.00	1621.52
11	45.835234	-120.903692	1672.91	5.00	1677.91
12	45.835279	-120.894997	1649.84	5.00	1654.84

Route Receptors

Name: Butts_Mesecher Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.861005	-120.905669	1736.30	9.00	1745.30
2	45.860855	-120.894683	1804.86	9.00	1813.86
3	45.860766	-120.884705	1808.75	9.00	1817.75
4	45.857373	-120.884726	1776.04	9.00	1785.04
5	45.857209	-120.884533	1772.52	9.00	1781.52
6	45.857164	-120.874384	1757.85	9.00	1766.85
7	45.857137	-120.853660	1831.52	9.00	1840.52
8	45.839203	-120.853767	1689.14	9.00	1698.14

Name: Knight Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.902723	-120.875130	2381.66	9.00	2390.66
2	45.901857	-120.874679	2363.42	9.00	2372.42
3	45.900543	-120.874550	2313.14	9.00	2322.14
4	45.895988	-120.874497	2221.52	9.00	2230.52
5	45.889555	-120.874526	2168.10	9.00	2177.10
6	45.882600	-120.874633	2078.63	9.00	2087.63
7	45.874700	-120.874633	1955.83	9.00	1964.83
8	45.871296	-120.874522	1914.90	9.00	1923.90
9	45.868877	-120.874339	1883.67	9.00	1892.67
10	45.862870	-120.874350	1827.90	9.00	1836.90
11	45.857062	-120.874361	1757.17	9.00	1766.17
12	45.852612	-120.874382	1744.40	9.00	1753.40
13	45.846284	-120.874397	1714.30	9.00	1723.30
14	45.838968	-120.874425	1702.39	9.00	1711.39
15	45.824548	-120.874473	1644.50	9.00	1653.50

Name: Pine Forest Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.889742	-120.866524	2139.35	9.00	2148.35
2	45.889929	-120.868187	2145.61	9.00	2154.61
3	45.889944	-120.869088	2154.13	9.00	2163.13
4	45.890011	-120.877178	2158.21	9.00	2167.21
5	45.890093	-120.884141	2074.09	9.00	2083.09
6	45.890011	-120.891309	2078.50	9.00	2087.50
7	45.889981	-120.895182	2093.36	9.00	2102.36
8	45.890041	-120.898443	2120.61	9.00	2129.61

Name: Route 142
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.837267	-120.938698	1585.03	9.00	1594.03
2	45.832588	-120.936895	1599.51	9.00	1608.51
3	45.832244	-120.936166	1614.08	9.00	1623.08
4	45.832184	-120.923401	1636.73	9.00	1645.73
5	45.832005	-120.906989	1620.23	9.00	1629.23
6	45.831750	-120.906195	1618.37	9.00	1627.37
7	45.831227	-120.905637	1614.58	9.00	1623.58
8	45.825545	-120.905615	1627.71	9.00	1636.71
9	45.825097	-120.905336	1627.35	9.00	1636.35
10	45.824738	-120.904478	1628.41	9.00	1637.41
11	45.824559	-120.893277	1638.42	9.00	1647.42
12	45.824439	-120.867828	1651.71	9.00	1660.71
13	45.824394	-120.839500	1630.38	9.00	1639.38

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	45.838802	-120.815079	2106.15	16.00
OP 2	2	45.828563	-120.906512	1624.37	16.00
OP 3	3	45.845463	-120.892545	1691.72	16.00
OP 4	4	45.880002	-120.896361	1968.69	16.00
OP 5	5	45.900119	-120.876034	2299.69	16.00
OP 6	6	45.873293	-120.851528	1933.92	16.00
OP 7	7	45.857634	-120.860876	1820.36	16.00
OP 8	8	45.830061	-120.874003	1660.81	16.00
OP 9	9	45.825163	-120.858362	1665.20	16.00
OP 10	10	45.852627	-120.908057	1695.44	16.00
OP 11	11	45.846665	-120.837900	1707.30	16.00

Glare Analysis Results

Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 10	SA tracking	SA tracking	0	0.0	3,508	58.5	-
PV array 11	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 12	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 2	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 3	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 4	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 5	SA tracking	SA tracking	0	0.0	7	0.1	-
PV array 6	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 7	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 8	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 9	SA tracking	SA tracking	0	0.0	251	4.2	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	7	0.1
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	3,556	59.3
OP 1	0	0.0	0	0.0
OP 2	0	0.0	203	3.4
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 1 and Butts_Mesecher Road

Receptor type: Route

No glare found

PV array 1 and Knight Road

Receptor type: Route

No glare found

PV array 1 and Pine Forest Road

Receptor type: Route

No glare found

PV array 1 and Route 142

Receptor type: Route
No glare found

PV array 1 and OP 1

Receptor type: Observation Point
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
No glare found

PV array 1 and OP 3

Receptor type: Observation Point
No glare found

PV array 1 and OP 4

Receptor type: Observation Point
No glare found

PV array 1 and OP 5

Receptor type: Observation Point
No glare found

PV array 1 and OP 6

Receptor type: Observation Point
No glare found

PV array 1 and OP 7

Receptor type: Observation Point
No glare found

PV array 1 and OP 8

Receptor type: Observation Point
No glare found

PV array 1 and OP 9

Receptor type: Observation Point
No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 10 potential temporary after-image

Receptor results ordered by category of glare

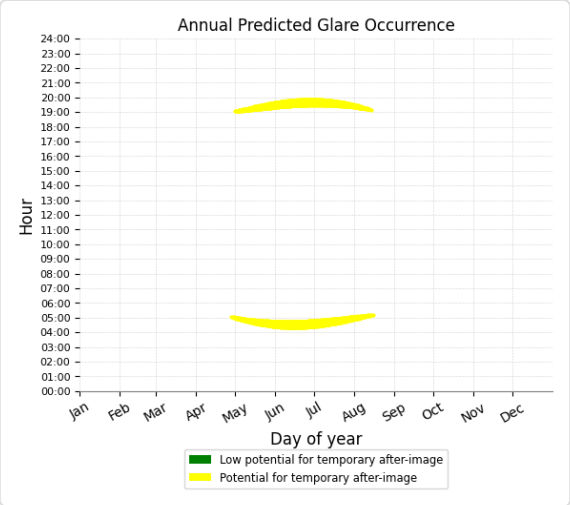
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 142	0	0.0	3,508	58.5
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

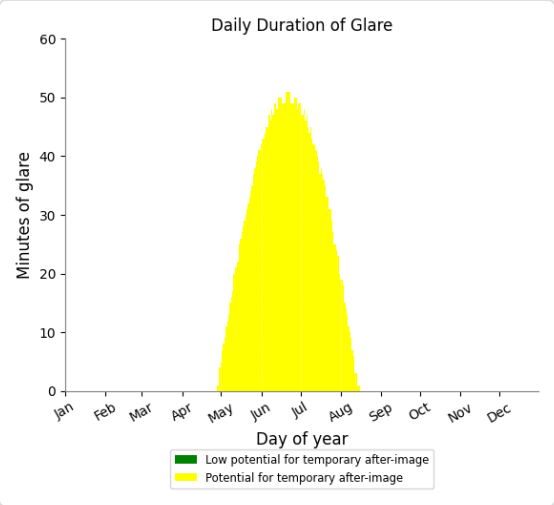
PV array 10 and Route 142

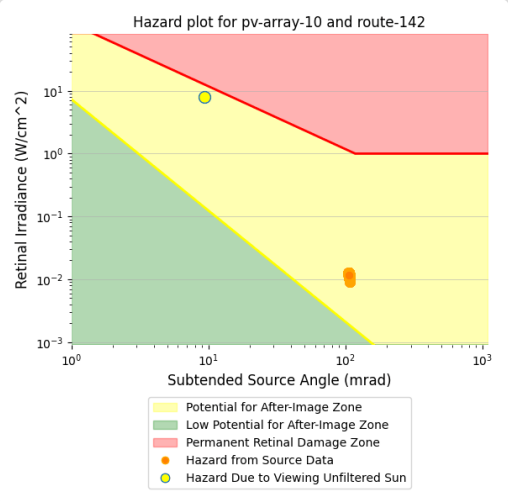
Receptor type: Route

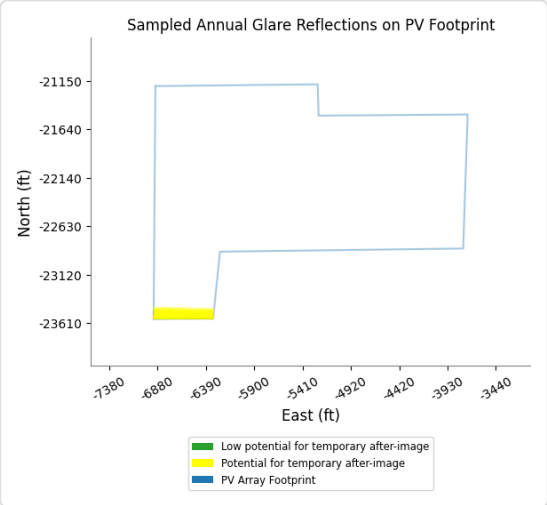
3,508 minutes of yellow glare

0 minutes of green glare









PV array 10 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 10 and Knight Road

Receptor type: Route
No glare found

PV array 10 and Pine Forest Road

Receptor type: Route
No glare found

PV array 10 and OP 1

Receptor type: Observation Point
No glare found

PV array 10 and OP 2

Receptor type: Observation Point
No glare found

PV array 10 and OP 3

Receptor type: Observation Point
No glare found

PV array 10 and OP 4

Receptor type: Observation Point
No glare found

PV array 10 and OP 5

Receptor type: Observation Point
No glare found

PV array 10 and OP 6

Receptor type: Observation Point
No glare found

PV array 10 and OP 7

Receptor type: Observation Point
No glare found

PV array 10 and OP 8

Receptor type: Observation Point
No glare found

PV array 10 and OP 9

Receptor type: Observation Point
No glare found

PV array 10 and OP 10

Receptor type: Observation Point
No glare found

PV array 10 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 11 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 11 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 11 and Knight Road

Receptor type: Route
No glare found

PV array 11 and Pine Forest Road

Receptor type: Route
No glare found

PV array 11 and Route 142

Receptor type: Route
No glare found

PV array 11 and OP 1

Receptor type: Observation Point
No glare found

PV array 11 and OP 2

Receptor type: Observation Point
No glare found

PV array 11 and OP 3

Receptor type: Observation Point
No glare found

PV array 11 and OP 4

Receptor type: Observation Point
No glare found

PV array 11 and OP 5

Receptor type: Observation Point
No glare found

PV array 11 and OP 6

Receptor type: Observation Point
No glare found

PV array 11 and OP 7

Receptor type: Observation Point
No glare found

PV array 11 and OP 8

Receptor type: Observation Point
No glare found

PV array 11 and OP 9

Receptor type: Observation Point
No glare found

PV array 11 and OP 10

Receptor type: Observation Point
No glare found

PV array 11 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 12 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 12 and Butts_Mesecher Road

Receptor type: Route

No glare found

PV array 12 and Knight Road

Receptor type: Route

No glare found

PV array 12 and Pine Forest Road

Receptor type: Route

No glare found

PV array 12 and Route 142

Receptor type: Route

No glare found

PV array 12 and OP 1

Receptor type: Observation Point

No glare found

PV array 12 and OP 2

Receptor type: Observation Point

No glare found

PV array 12 and OP 3

Receptor type: Observation Point
No glare found

PV array 12 and OP 4

Receptor type: Observation Point
No glare found

PV array 12 and OP 5

Receptor type: Observation Point
No glare found

PV array 12 and OP 6

Receptor type: Observation Point
No glare found

PV array 12 and OP 7

Receptor type: Observation Point
No glare found

PV array 12 and OP 8

Receptor type: Observation Point
No glare found

PV array 12 and OP 9

Receptor type: Observation Point
No glare found

PV array 12 and OP 10

Receptor type: Observation Point
No glare found

PV array 12 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 2 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 2 and Butts_Mesecher Road

Receptor type: Route

No glare found

PV array 2 and Knight Road

Receptor type: Route

No glare found

PV array 2 and Pine Forest Road

Receptor type: Route

No glare found

PV array 2 and Route 142

Receptor type: Route

No glare found

PV array 2 and OP 1

Receptor type: Observation Point

No glare found

PV array 2 and OP 2

Receptor type: Observation Point

No glare found

PV array 2 and OP 3

Receptor type: Observation Point
No glare found

PV array 2 and OP 4

Receptor type: Observation Point
No glare found

PV array 2 and OP 5

Receptor type: Observation Point
No glare found

PV array 2 and OP 6

Receptor type: Observation Point
No glare found

PV array 2 and OP 7

Receptor type: Observation Point
No glare found

PV array 2 and OP 8

Receptor type: Observation Point
No glare found

PV array 2 and OP 9

Receptor type: Observation Point
No glare found

PV array 2 and OP 10

Receptor type: Observation Point
No glare found

PV array 2 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 3 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 3 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 3 and Knight Road

Receptor type: Route
No glare found

PV array 3 and Pine Forest Road

Receptor type: Route
No glare found

PV array 3 and Route 142

Receptor type: Route
No glare found

PV array 3 and OP 1

Receptor type: Observation Point
No glare found

PV array 3 and OP 2

Receptor type: Observation Point
No glare found

PV array 3 and OP 3

Receptor type: Observation Point
No glare found

PV array 3 and OP 4

Receptor type: Observation Point
No glare found

PV array 3 and OP 5

Receptor type: Observation Point
No glare found

PV array 3 and OP 6

Receptor type: Observation Point
No glare found

PV array 3 and OP 7

Receptor type: Observation Point
No glare found

PV array 3 and OP 8

Receptor type: Observation Point
No glare found

PV array 3 and OP 9

Receptor type: Observation Point
No glare found

PV array 3 and OP 10

Receptor type: Observation Point
No glare found

PV array 3 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 4 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 4 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 4 and Knight Road

Receptor type: Route
No glare found

PV array 4 and Pine Forest Road

Receptor type: Route
No glare found

PV array 4 and Route 142

Receptor type: Route
No glare found

PV array 4 and OP 1

Receptor type: Observation Point
No glare found

PV array 4 and OP 2

Receptor type: Observation Point
No glare found

PV array 4 and OP 3

Receptor type: Observation Point
No glare found

PV array 4 and OP 4

Receptor type: Observation Point
No glare found

PV array 4 and OP 5

Receptor type: Observation Point
No glare found

PV array 4 and OP 6

Receptor type: Observation Point
No glare found

PV array 4 and OP 7

Receptor type: Observation Point
No glare found

PV array 4 and OP 8

Receptor type: Observation Point
No glare found

PV array 4 and OP 9

Receptor type: Observation Point
No glare found

PV array 4 and OP 10

Receptor type: Observation Point
No glare found

PV array 4 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 5 potential temporary after-image

Receptor results ordered by category of glare

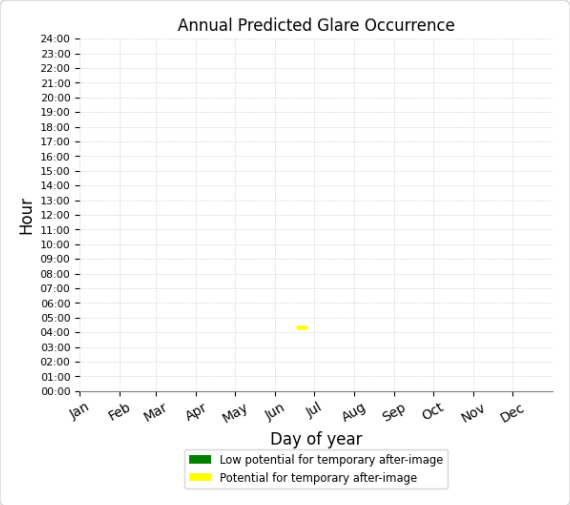
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Knight Road	0	0.0	7	0.1
Butts_Mesecher Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

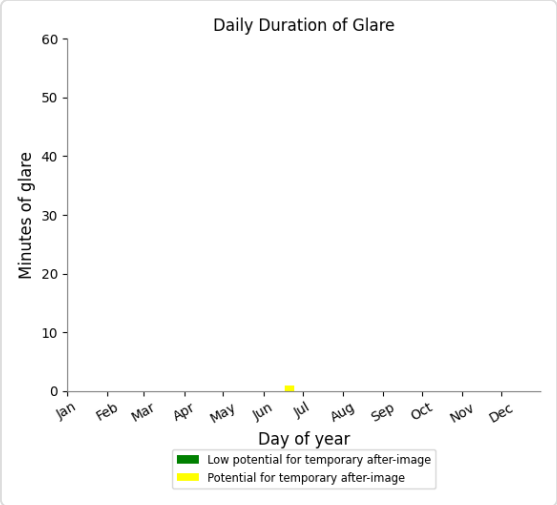
PV array 5 and Knight Road

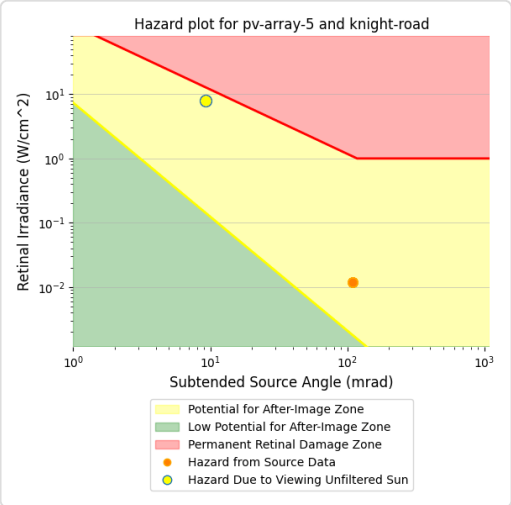
Receptor type: Route

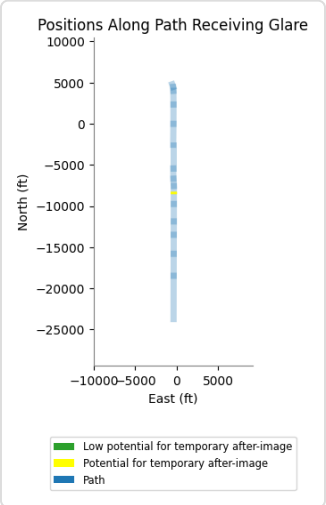
7 minutes of yellow glare

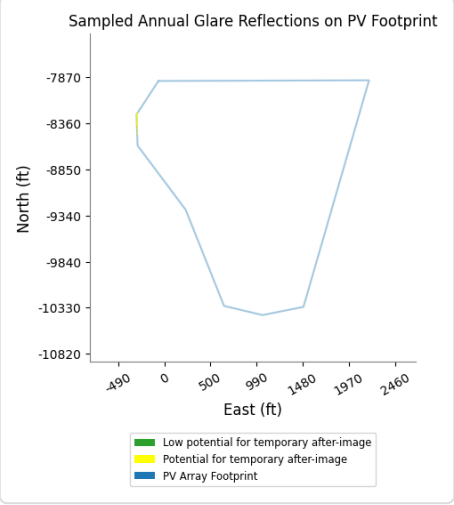
0 minutes of green glare











PV array 5 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 5 and Pine Forest Road

Receptor type: Route
No glare found

PV array 5 and Route 142

Receptor type: Route
No glare found

PV array 5 and OP 1

Receptor type: Observation Point
No glare found

PV array 5 and OP 2

Receptor type: Observation Point
No glare found

PV array 5 and OP 3

Receptor type: Observation Point
No glare found

PV array 5 and OP 4

Receptor type: Observation Point
No glare found

PV array 5 and OP 5

Receptor type: Observation Point
No glare found

PV array 5 and OP 6

Receptor type: Observation Point
No glare found

PV array 5 and OP 7

Receptor type: Observation Point
No glare found

PV array 5 and OP 8

Receptor type: Observation Point
No glare found

PV array 5 and OP 9

Receptor type: Observation Point
No glare found

PV array 5 and OP 10

Receptor type: Observation Point
No glare found

PV array 5 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 6 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 6 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 6 and Knight Road

Receptor type: Route
No glare found

PV array 6 and Pine Forest Road

Receptor type: Route
No glare found

PV array 6 and Route 142

Receptor type: Route
No glare found

PV array 6 and OP 1

Receptor type: Observation Point
No glare found

PV array 6 and OP 2

Receptor type: Observation Point
No glare found

PV array 6 and OP 3

Receptor type: Observation Point
No glare found

PV array 6 and OP 4

Receptor type: Observation Point
No glare found

PV array 6 and OP 5

Receptor type: Observation Point
No glare found

PV array 6 and OP 6

Receptor type: Observation Point
No glare found

PV array 6 and OP 7

Receptor type: Observation Point
No glare found

PV array 6 and OP 8

Receptor type: Observation Point
No glare found

PV array 6 and OP 9

Receptor type: Observation Point
No glare found

PV array 6 and OP 10

Receptor type: Observation Point
No glare found

PV array 6 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 7 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 7 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 7 and Knight Road

Receptor type: Route
No glare found

PV array 7 and Pine Forest Road

Receptor type: Route
No glare found

PV array 7 and Route 142

Receptor type: Route
No glare found

PV array 7 and OP 1

Receptor type: Observation Point
No glare found

PV array 7 and OP 2

Receptor type: Observation Point
No glare found

PV array 7 and OP 3

Receptor type: Observation Point
No glare found

PV array 7 and OP 4

Receptor type: Observation Point
No glare found

PV array 7 and OP 5

Receptor type: Observation Point
No glare found

PV array 7 and OP 6

Receptor type: Observation Point
No glare found

PV array 7 and OP 7

Receptor type: Observation Point
No glare found

PV array 7 and OP 8

Receptor type: Observation Point
No glare found

PV array 7 and OP 9

Receptor type: Observation Point
No glare found

PV array 7 and OP 10

Receptor type: Observation Point
No glare found

PV array 7 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 8 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
Route 142	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

PV array 8 and Butts_Mesecher Road

Receptor type: Route
No glare found

PV array 8 and Knight Road

Receptor type: Route
No glare found

PV array 8 and Pine Forest Road

Receptor type: Route
No glare found

PV array 8 and Route 142

Receptor type: Route
No glare found

PV array 8 and OP 1

Receptor type: Observation Point
No glare found

PV array 8 and OP 2

Receptor type: Observation Point
No glare found

PV array 8 and OP 3

Receptor type: Observation Point
No glare found

PV array 8 and OP 4

Receptor type: Observation Point
No glare found

PV array 8 and OP 5

Receptor type: Observation Point
No glare found

PV array 8 and OP 6

Receptor type: Observation Point
No glare found

PV array 8 and OP 7

Receptor type: Observation Point
No glare found

PV array 8 and OP 8

Receptor type: Observation Point
No glare found

PV array 8 and OP 9

Receptor type: Observation Point
No glare found

PV array 8 and OP 10

Receptor type: Observation Point
No glare found

PV array 8 and OP 11

Receptor type: Observation Point
No glare found

PV: PV array 9 potential temporary after-image

Receptor results ordered by category of glare

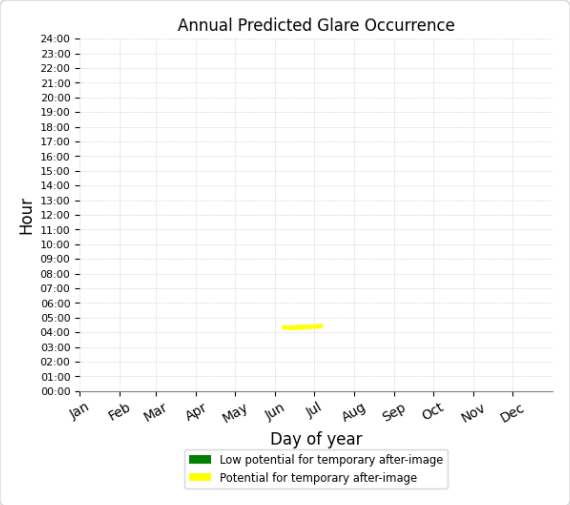
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 142	0	0.0	48	0.8
Butts_Mesecher Road	0	0.0	0	0.0
Knight Road	0	0.0	0	0.0
Pine Forest Road	0	0.0	0	0.0
OP 2	0	0.0	203	3.4
OP 1	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0

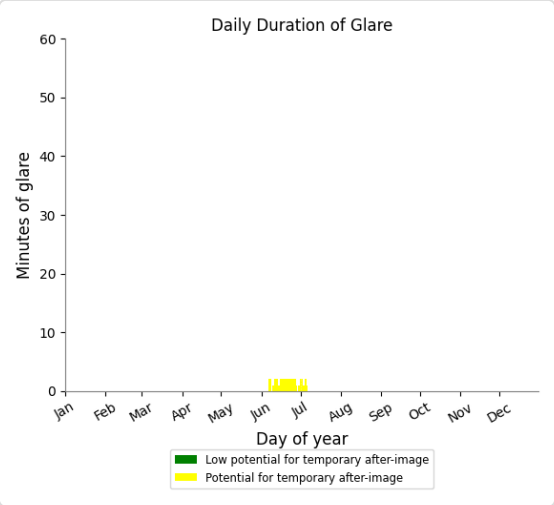
PV array 9 and Route 142

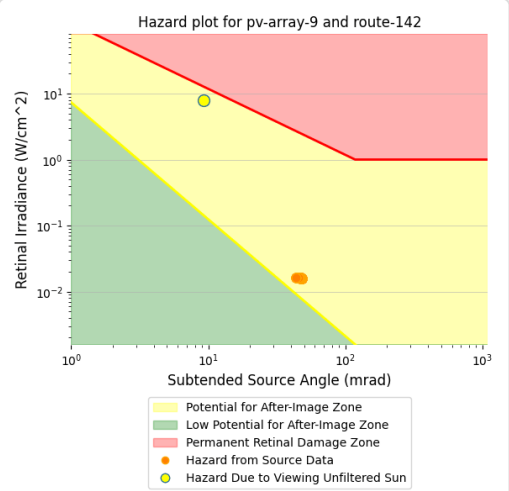
Receptor type: Route

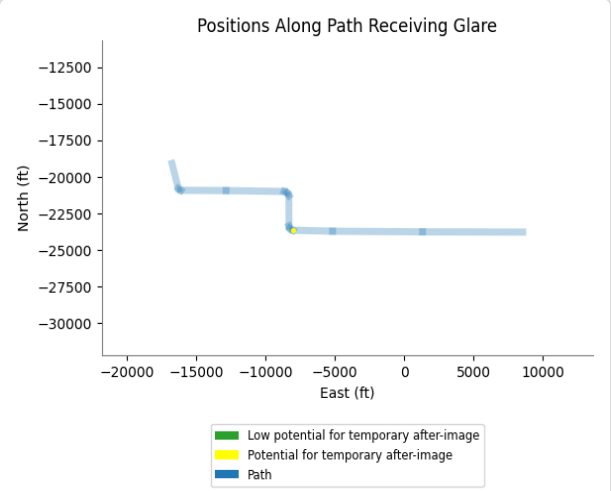
48 minutes of yellow glare

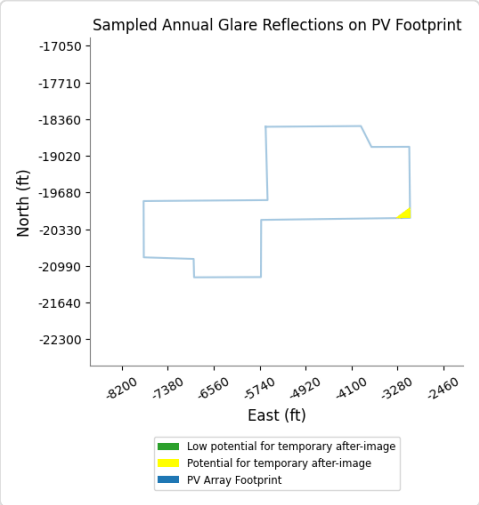
0 minutes of green glare











PV array 9 and Butts_Mesecher Road

Receptor type: Route

No glare found

PV array 9 and Knight Road

Receptor type: Route

No glare found

PV array 9 and Pine Forest Road

Receptor type: Route

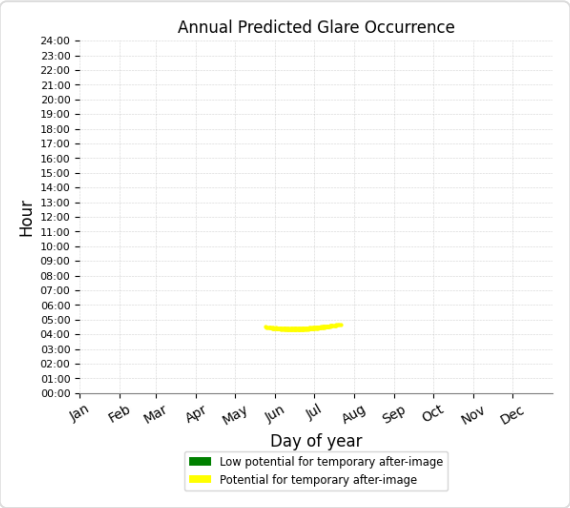
No glare found

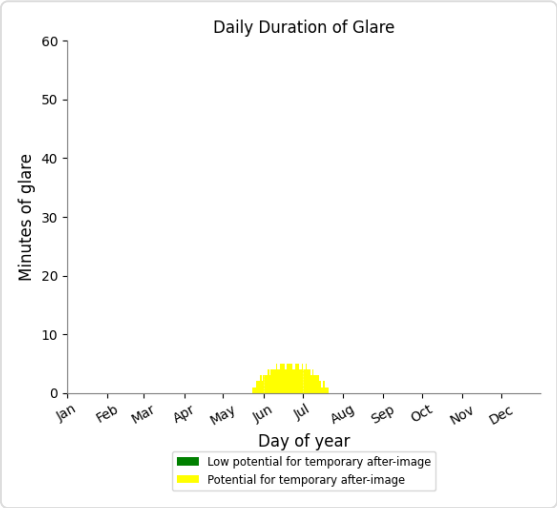
PV array 9 and OP 2

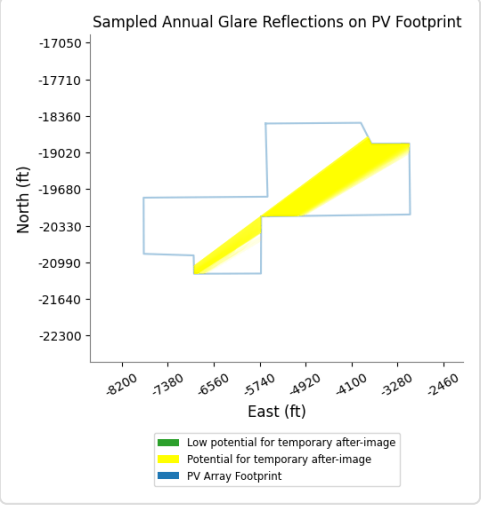
Receptor type: Observation Point

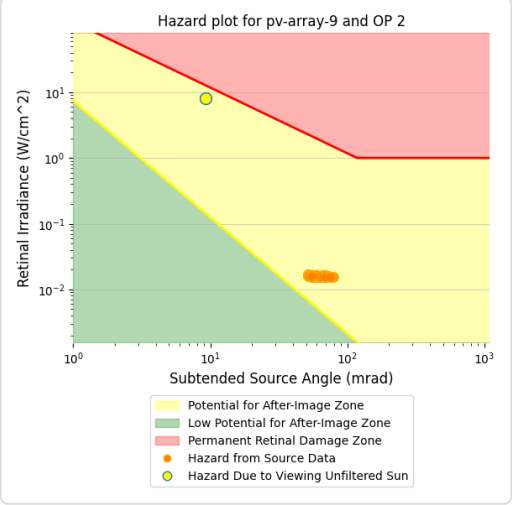
203 minutes of yellow glare

0 minutes of green glare









PV array 9 and OP 1

Receptor type: Observation Point

No glare found

PV array 9 and OP 3

Receptor type: Observation Point

No glare found

PV array 9 and OP 4

Receptor type: Observation Point
No glare found

PV array 9 and OP 5

Receptor type: Observation Point
No glare found

PV array 9 and OP 6

Receptor type: Observation Point
No glare found

PV array 9 and OP 7

Receptor type: Observation Point
No glare found

PV array 9 and OP 8

Receptor type: Observation Point
No glare found

PV array 9 and OP 9

Receptor type: Observation Point
No glare found

PV array 9 and OP 10

Receptor type: Observation Point
No glare found

PV array 9 and OP 11

Receptor type: Observation Point
No glare found

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.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
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. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
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.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
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.
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.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

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

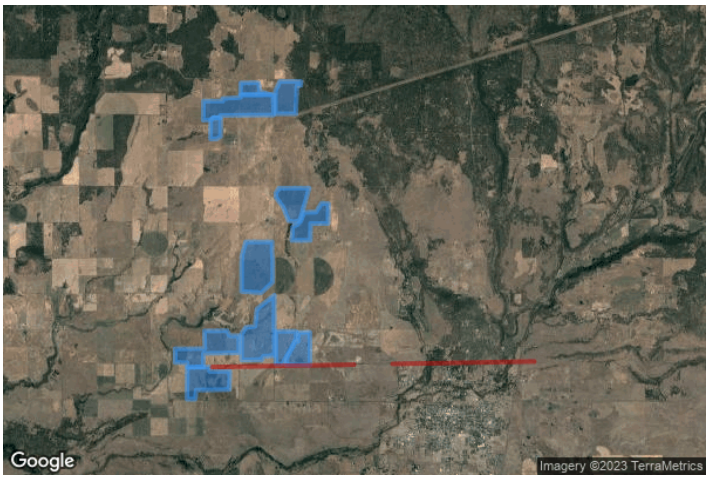
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

Appendix B, Analysis 3

FORGESOLAR GLARE ANALYSIS

Project: **Cypress Creek**
Site configuration: **Carriger Analysis 3 01192023**

Created 20 Jan, 2023
Updated 20 Jan, 2023
Time-step 1 minute
Timezone offset UTC-8
Site ID 82774.11533
Category 100 MW to 1 GW
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 10	SA tracking	SA tracking	7,606	126.8	5,609	93.5	-
PV array 11	SA tracking	SA tracking	116	1.9	10,097	168.3	-
PV array 12	SA tracking	SA tracking	928	15.5	12,264	204.4	-
PV array 2	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 3	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 4	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 5	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 6	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 7	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 8	SA tracking	SA tracking	0	0.0	10,886	181.4	-
PV array 9	SA tracking	SA tracking	0	0.0	1,305	21.8	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	8,650	144.2	40,161	669.4
S20 RWY 25	0	0.0	0	0.0

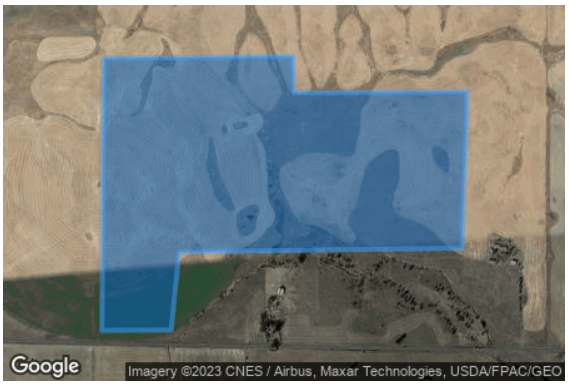
Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.889623	-120.873010	2171.73	5.00	2176.73
2	45.889629	-120.866864	2139.29	5.00	2144.29
3	45.888773	-120.866843	2139.44	5.00	2144.44
4	45.888770	-120.868029	2143.84	5.00	2148.84
5	45.883049	-120.868296	2097.33	5.00	2102.33
6	45.883044	-120.874307	2082.48	5.00	2087.48
7	45.887685	-120.874323	2139.04	5.00	2144.04

Name: PV array 10
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

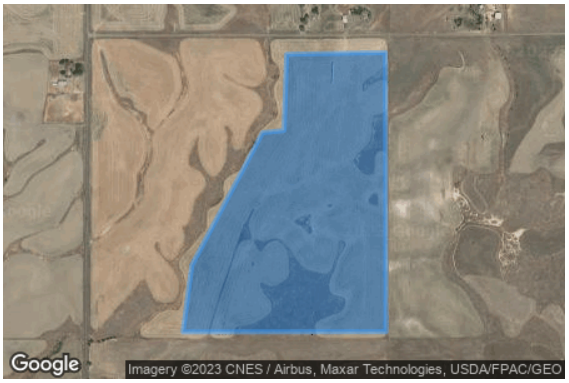


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.831456	-120.900147	1629.20	5.00	1634.20
2	45.831505	-120.893661	1642.69	5.00	1647.69
3	45.830632	-120.893625	1634.70	5.00	1639.70
4	45.830663	-120.887667	1642.64	5.00	1647.64
5	45.826929	-120.887845	1653.34	5.00	1658.34
6	45.826842	-120.897566	1623.34	5.00	1628.34
7	45.824977	-120.897840	1613.91	5.00	1618.91
8	45.824965	-120.900218	1617.98	5.00	1622.98

Name: PV array 11
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838795	-120.874116	1701.06	5.00	1706.06
2	45.838804	-120.868305	1679.06	5.00	1684.06
3	45.837249	-120.868278	1674.92	5.00	1679.92
4	45.832120	-120.872336	1660.18	5.00	1665.18
5	45.832105	-120.874246	1665.34	5.00	1670.34

Name: PV array 12
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

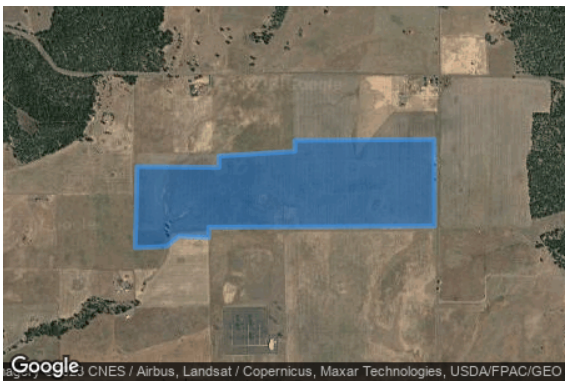


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.838554	-120.867608	1677.61	5.00	1682.61
2	45.838595	-120.864211	1687.35	5.00	1692.35
3	45.831919	-120.864193	1680.62	5.00	1685.62
4	45.831913	-120.871167	1660.05	5.00	1665.05
5	45.833507	-120.870865	1663.90	5.00	1668.90
6	45.836678	-120.868433	1671.90	5.00	1676.90
7	45.836734	-120.867695	1673.03	5.00	1678.03

Name: PV array 2
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.889322	-120.884494	2064.61	5.00	2069.61
2	45.889383	-120.879272	2128.70	5.00	2133.70
3	45.887571	-120.878853	2134.78	5.00	2139.78
4	45.886956	-120.875695	2135.51	5.00	2140.51
5	45.886917	-120.884553	2058.16	5.00	2063.16

Name: PV array 3
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

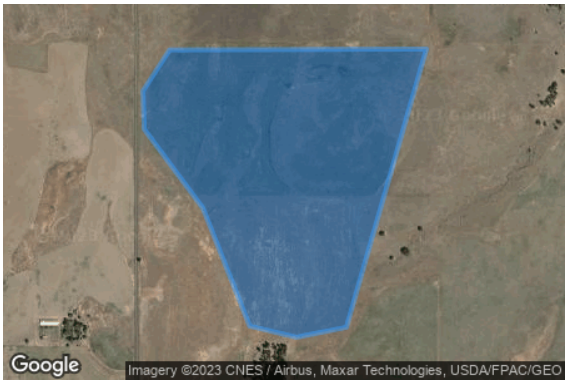


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.886902	-120.884529	2058.53	5.00	2063.53
2	45.886948	-120.874937	2134.84	5.00	2139.84
3	45.882806	-120.874919	2078.04	5.00	2083.04
4	45.882745	-120.890435	2004.11	5.00	2009.11
5	45.882249	-120.890434	2000.03	5.00	2005.03
6	45.882313	-120.892501	1986.65	5.00	1991.65
7	45.881832	-120.893339	1975.10	5.00	1980.10
8	45.881763	-120.895502	1973.40	5.00	1978.40
9	45.885651	-120.895370	2031.85	5.00	2036.85
10	45.885605	-120.889750	2021.20	5.00	2026.20
11	45.886153	-120.889735	2024.70	5.00	2029.70
12	45.886375	-120.884525	2057.15	5.00	2062.15

Name: PV array 4
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.882213	-120.892494	1985.11	5.00	1990.11
2	45.882221	-120.890412	1999.57	5.00	2004.57
3	45.878469	-120.890409	1993.00	5.00	1998.00
4	45.877990	-120.891493	1984.50	5.00	1989.50
5	45.877954	-120.893337	1967.70	5.00	1972.70
6	45.881793	-120.893295	1976.64	5.00	1981.64

Name: PV array 5
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

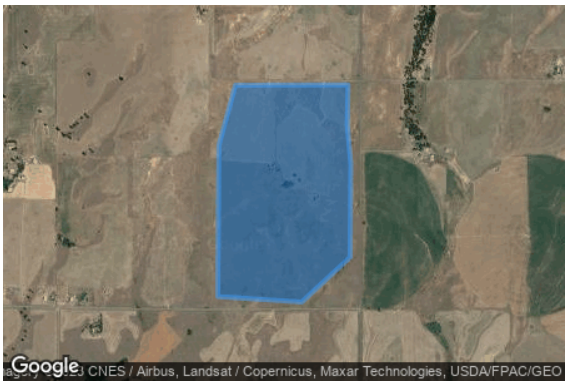


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.867926	-120.873257	1868.31	5.00	1873.31
2	45.867946	-120.864438	1880.44	5.00	1885.44
3	45.861312	-120.867184	1798.10	5.00	1803.10
4	45.861073	-120.868901	1802.84	5.00	1807.84
5	45.861342	-120.870510	1797.88	5.00	1802.88
6	45.864153	-120.872114	1813.70	5.00	1818.70
7	45.866035	-120.874131	1846.16	5.00	1851.16
8	45.866947	-120.874174	1862.99	5.00	1867.99

Name: PV array 6
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.857300	-120.869508	1788.47	5.00	1793.47
2	45.860065	-120.869229	1797.49	5.00	1802.49
3	45.860490	-120.867974	1800.45	5.00	1805.45
4	45.861200	-120.866869	1800.61	5.00	1805.61
5	45.863009	-120.865922	1807.31	5.00	1812.31
6	45.863066	-120.862371	1872.59	5.00	1877.59
7	45.864848	-120.860820	1864.37	5.00	1869.37
8	45.864779	-120.858778	1911.46	5.00	1916.46
9	45.860731	-120.858899	1872.79	5.00	1877.79
10	45.860721	-120.864029	1847.11	5.00	1852.11
11	45.857299	-120.864067	1789.73	5.00	1794.73

Name: PV array 7
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

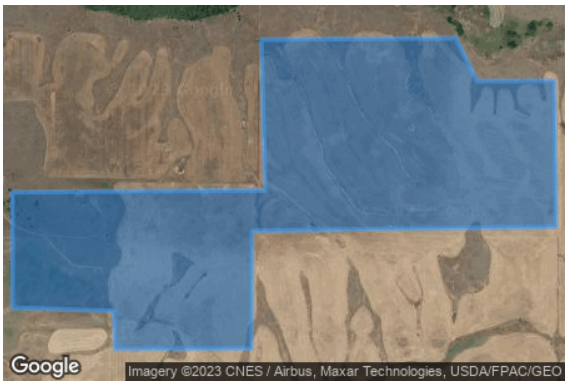


Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	45.856994	-120.883031	1770.84	5.00	1775.84
2	45.857009	-120.875287	1766.25	5.00	1771.25
3	45.855097	-120.875345	1758.37	5.00	1763.37
4	45.853257	-120.875104	1745.93	5.00	1750.93
5	45.848789	-120.875144	1711.36	5.00	1716.36
6	45.846649	-120.878473	1709.27	5.00	1714.27
7	45.846911	-120.884237	1693.28	5.00	1698.28
8	45.854121	-120.884168	1758.96	5.00	1763.96

Name: PV array 8
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838221	-120.884240	1656.81	5.00	1661.81
2	45.839569	-120.883028	1655.29	5.00	1660.29
3	45.839806	-120.880284	1682.20	5.00	1687.20
4	45.843283	-120.879763	1675.87	5.00	1680.87
5	45.846139	-120.874647	1713.77	5.00	1718.77
6	45.833850	-120.874650	1670.18	5.00	1675.18
7	45.833732	-120.877861	1668.78	5.00	1673.78
8	45.833357	-120.878119	1665.70	5.00	1670.70
9	45.833020	-120.878337	1664.91	5.00	1669.91
10	45.832972	-120.884220	1647.27	5.00	1652.27

Name: PV array 9
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with 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	45.838876	-120.895132	1639.56	5.00	1644.56
2	45.838910	-120.888451	1645.28	5.00	1650.28
3	45.837885	-120.887707	1652.23	5.00	1657.23
4	45.837892	-120.885056	1656.36	5.00	1661.36
5	45.834404	-120.884998	1643.87	5.00	1648.87
6	45.834308	-120.895444	1653.88	5.00	1658.88
7	45.831503	-120.895461	1640.45	5.00	1645.45
8	45.831492	-120.900151	1629.20	5.00	1634.20
9	45.832395	-120.900182	1634.68	5.00	1639.68
10	45.832473	-120.903678	1616.52	5.00	1621.52
11	45.835234	-120.903692	1672.91	5.00	1677.91
12	45.835279	-120.894997	1649.84	5.00	1654.84

Flight Path Receptors

Name: S20 RWY 07
Description:
Threshold height: 50 ft
Direction: 89.0°
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	45.832009	-120.851304	1663.83	50.00	1713.83
Two-mile	45.831505	-120.892842	1641.52	625.73	2267.25

Name: S20 RWY 25
Description:
Threshold height: 50 ft
Direction: 269.0°
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	45.832149	-120.840011	1676.24	50.00	1726.24
Two-mile	45.832654	-120.798473	1712.99	566.68	2279.67

Glare Analysis Results

Summary of Results

Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 10	SA tracking	SA tracking	7,606	126.8	5,609	93.5	-
PV array 11	SA tracking	SA tracking	116	1.9	10,097	168.3	-
PV array 12	SA tracking	SA tracking	928	15.5	12,264	204.4	-
PV array 2	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 3	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 4	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 5	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 6	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 7	SA tracking	SA tracking	0	0.0	0	0.0	-
PV array 8	SA tracking	SA tracking	0	0.0	10,886	181.4	-
PV array 9	SA tracking	SA tracking	0	0.0	1,305	21.8	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	8,650	144.2	40,161	669.4
S20 RWY 25	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	0	0.0
S20 RWY 25	0	0.0	0	0.0

PV array 1 and S20 RWY 07

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

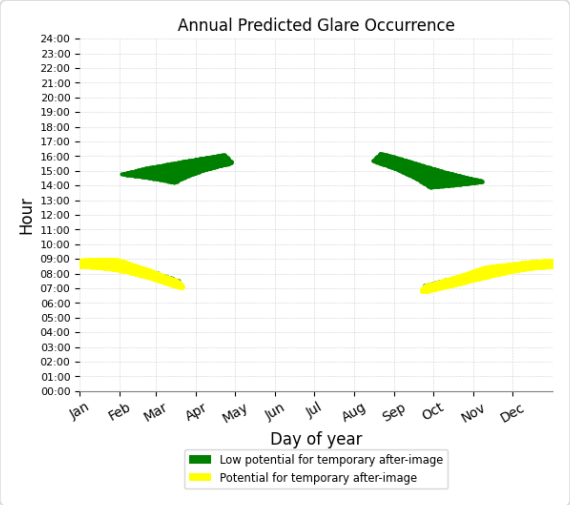
PV: PV array 10 potential temporary after-image

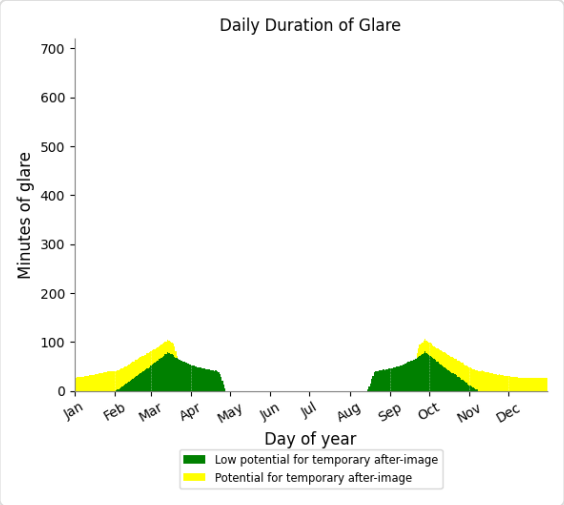
Receptor results ordered by category of glare

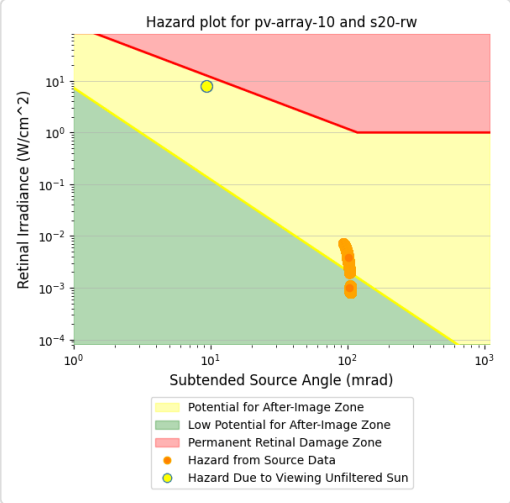
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	7,606	126.8	5,609	93.5
S20 RWY 25	0	0.0	0	0.0

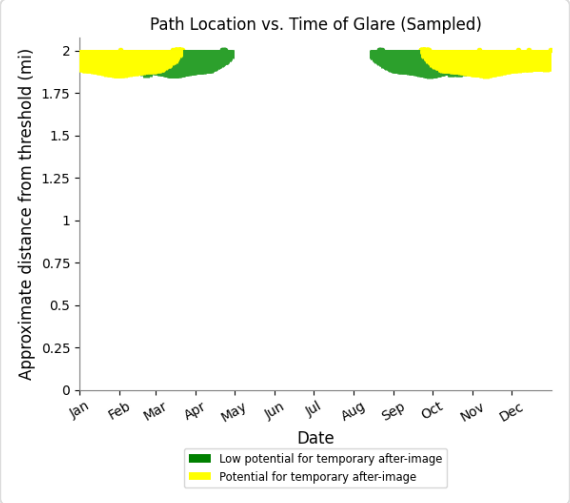
PV array 10 and S20 RWY 07

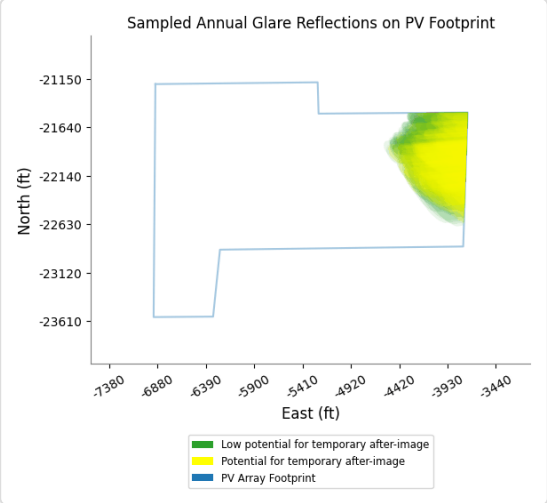
Receptor type: 2-mile Flight Path
5,609 minutes of yellow glare
7,606 minutes of green glare

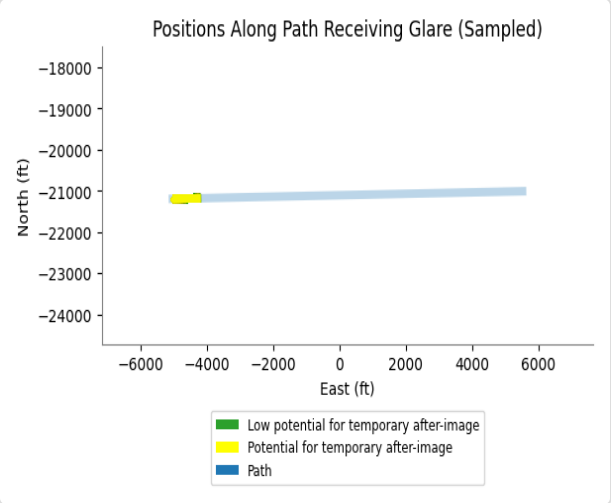












PV array 10 and S20 RWY 25

Receptor type: 2-mile Flight Path

No glare found

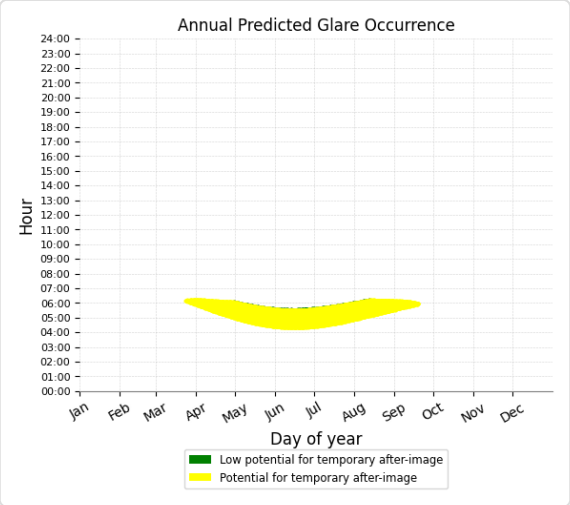
PV: PV array 11 potential temporary after-image

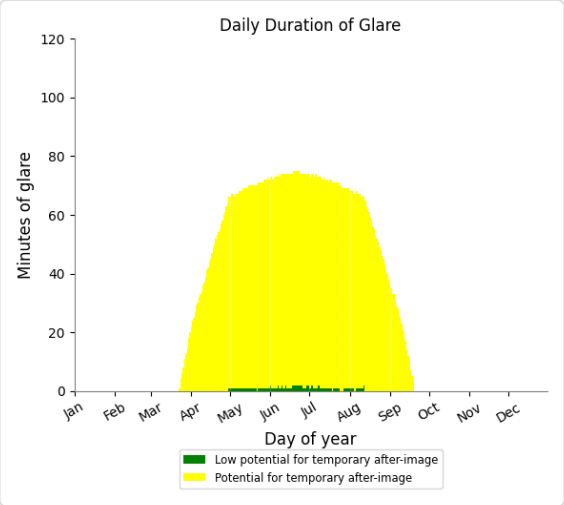
Receptor results ordered by category of glare

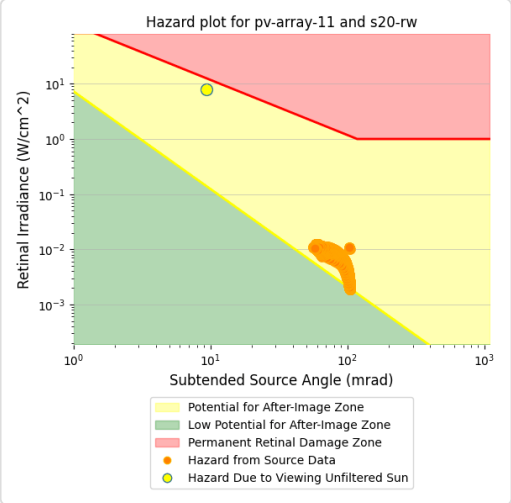
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	116	1.9	10,097	168.3
S20 RWY 25	0	0.0	0	0.0

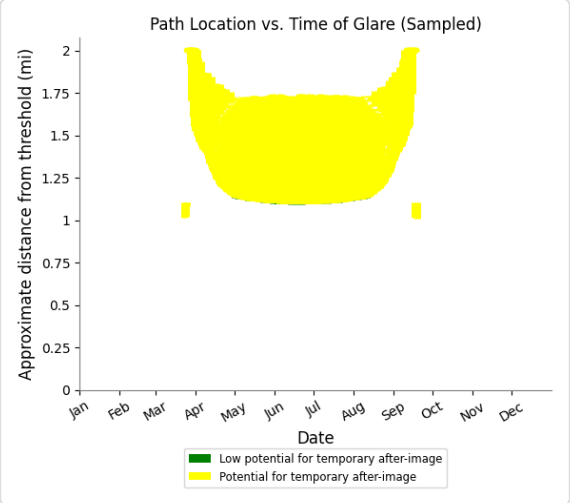
PV array 11 and S20 RWY 07

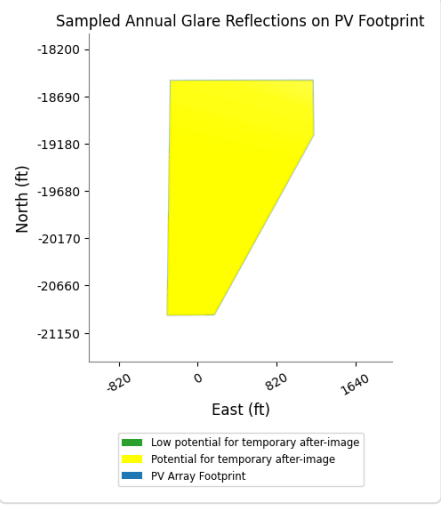
Receptor type: 2-mile Flight Path
10,097 minutes of yellow glare
116 minutes of green glare

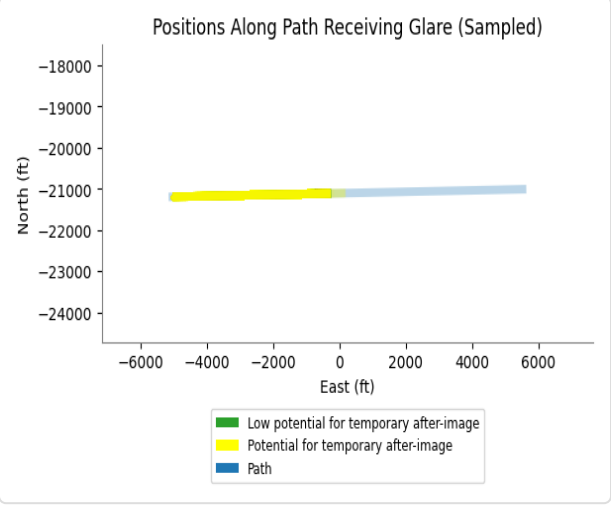












PV array 11 and S20 RWY 25

Receptor type: 2-mile Flight Path

No glare found

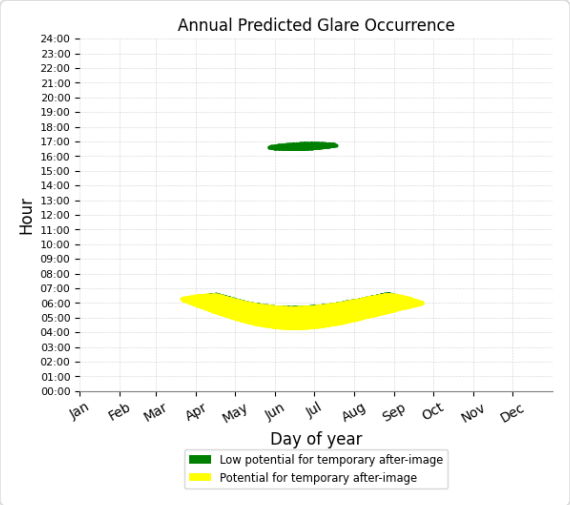
PV: PV array 12 potential temporary after-image

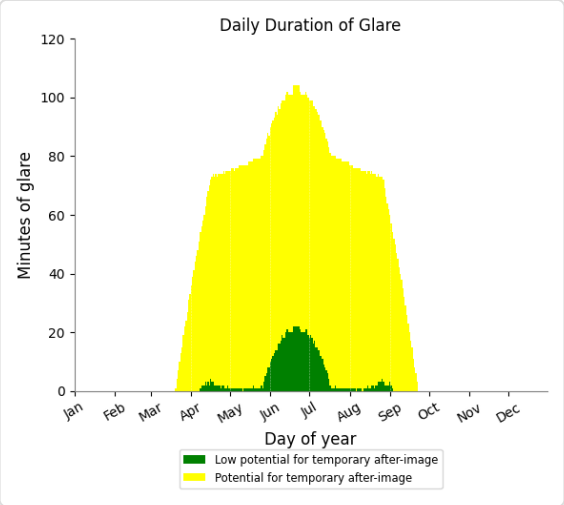
Receptor results ordered by category of glare

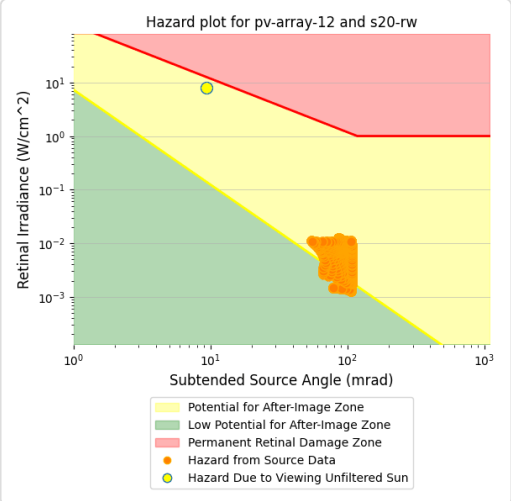
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	928	15.5	12,264	204.4
S20 RWY 25	0	0.0	0	0.0

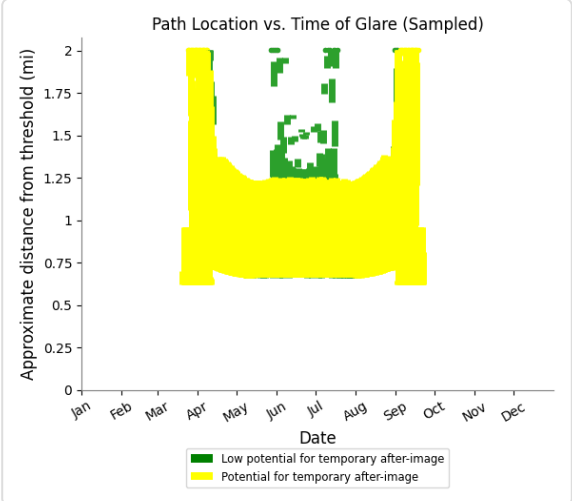
PV array 12 and S20 RWY 07

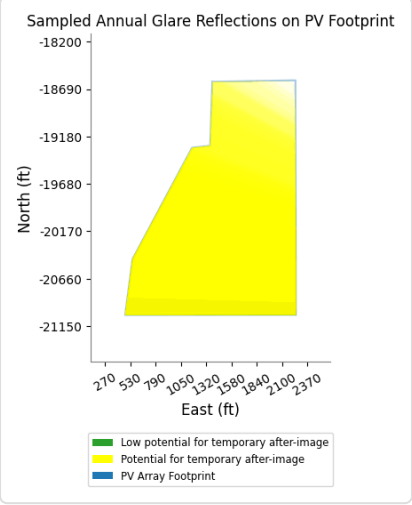
Receptor type: 2-mile Flight Path
12,264 minutes of yellow glare
928 minutes of green glare

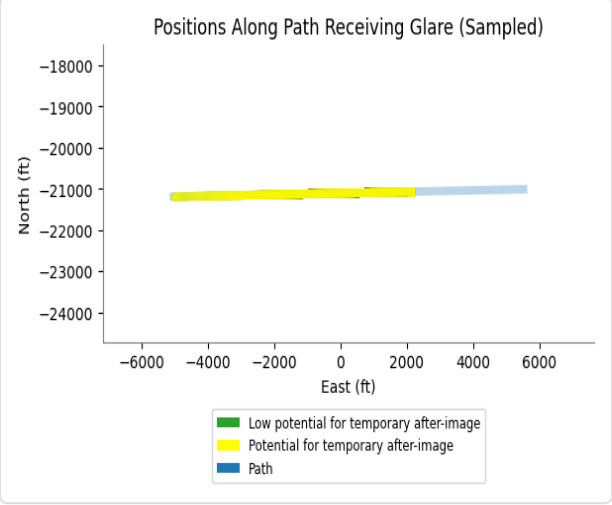












PV array 12 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

PV: PV array 2 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	0	0.0
S20 RWY 25	0	0.0	0	0.0

PV array 2 and S20 RWY 07

Receptor type: 2-mile Flight Path
No glare found

PV array 2 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

PV: PV array 3 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	0	0.0
S20 RWY 25	0	0.0	0	0.0

PV array 3 and S20 RWY 07

Receptor type: 2-mile Flight Path
No glare found

PV array 3 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

PV: PV array 4 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	0	0.0
S20 RWY 25	0	0.0	0	0.0

PV array 4 and S20 RWY 07

Receptor type: 2-mile Flight Path
No glare found

PV array 4 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

PV: PV array 5 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	0	0.0
S20 RWY 25	0	0.0	0	0.0

PV array 5 and S20 RWY 07

Receptor type: 2-mile Flight Path
No glare found

PV array 5 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

PV: PV array 6 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	0	0.0
S20 RWY 25	0	0.0	0	0.0

PV array 6 and S20 RWY 07

Receptor type: 2-mile Flight Path
No glare found

PV array 6 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

PV: PV array 7 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	0	0.0
S20 RWY 25	0	0.0	0	0.0

PV array 7 and S20 RWY 07

Receptor type: 2-mile Flight Path
No glare found

PV array 7 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

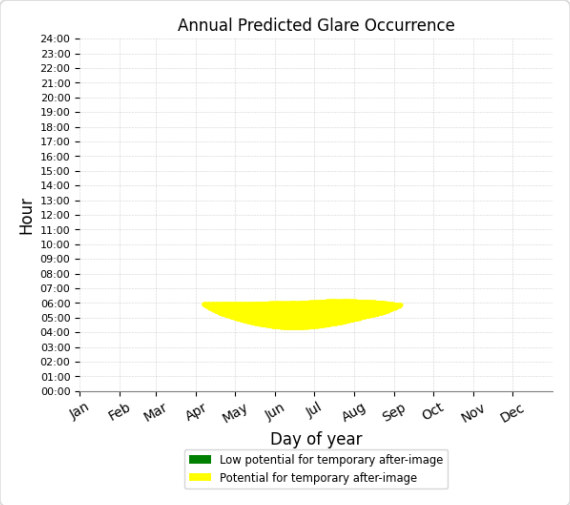
PV: PV array 8 potential temporary after-image

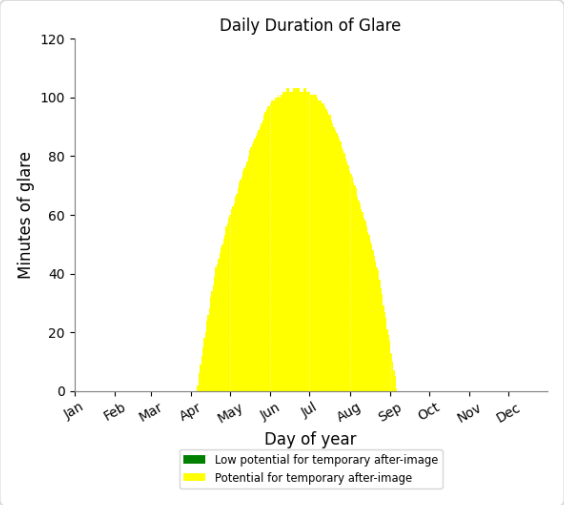
Receptor results ordered by category of glare

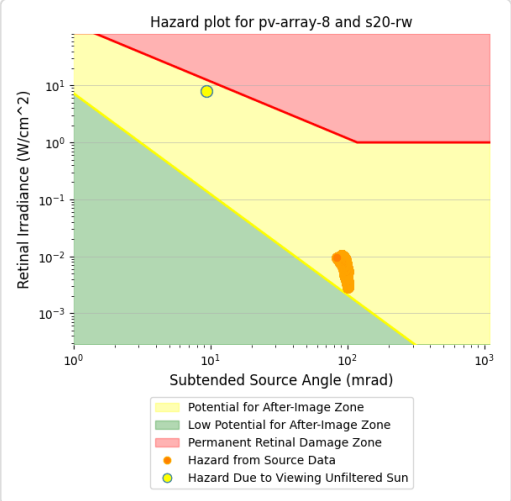
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	10,886	181.4
S20 RWY 25	0	0.0	0	0.0

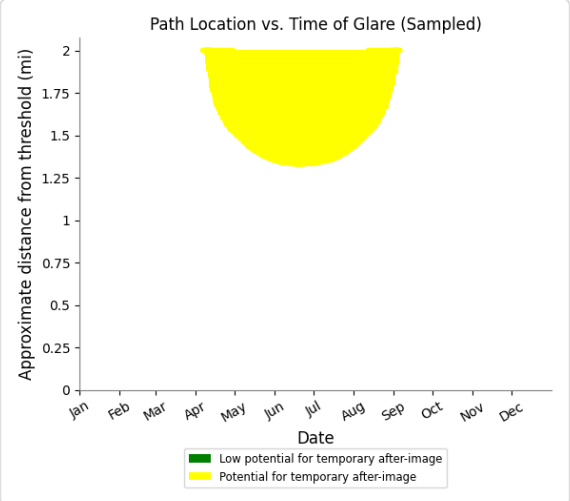
PV array 8 and S20 RWY 07

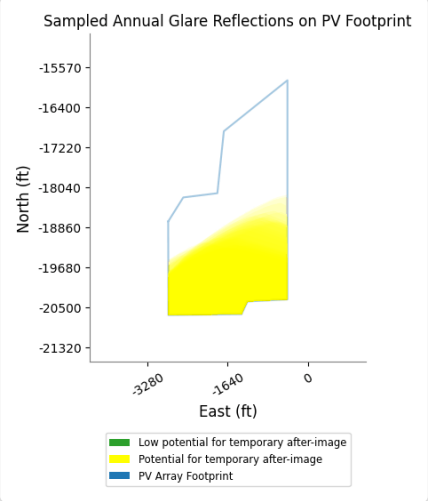
Receptor type: 2-mile Flight Path
10,886 minutes of yellow glare
0 minutes of green glare

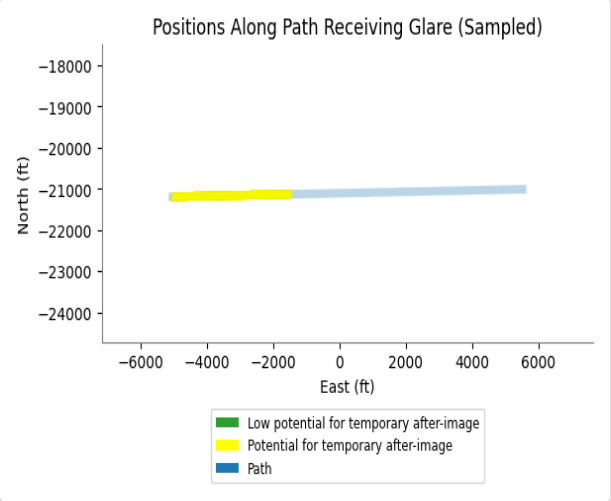












PV array 8 and S20 RWY 25

Receptor type: 2-mile Flight Path

No glare found

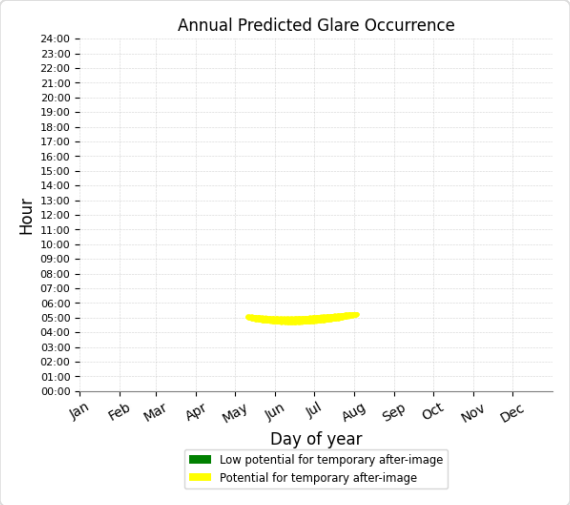
PV: PV array 9 potential temporary after-image

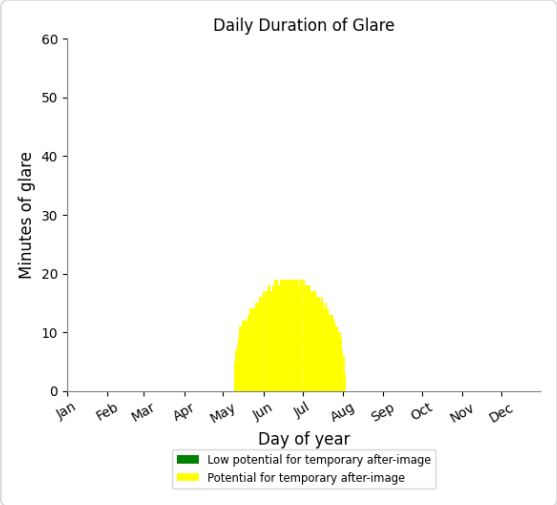
Receptor results ordered by category of glare

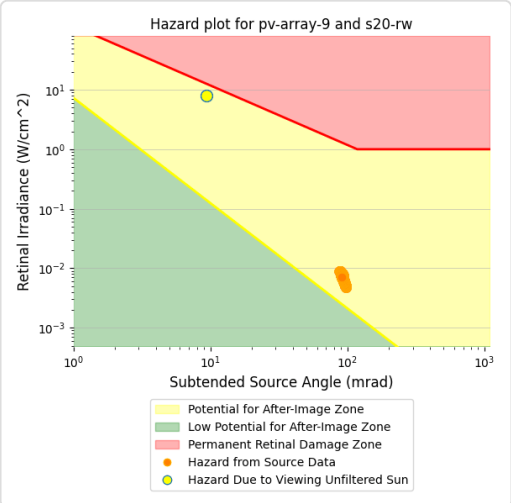
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
S20 RWY 07	0	0.0	1,305	21.8
S20 RWY 25	0	0.0	0	0.0

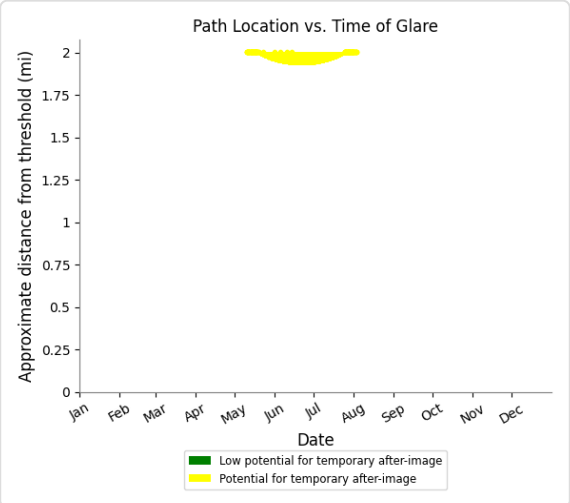
PV array 9 and S20 RWY 07

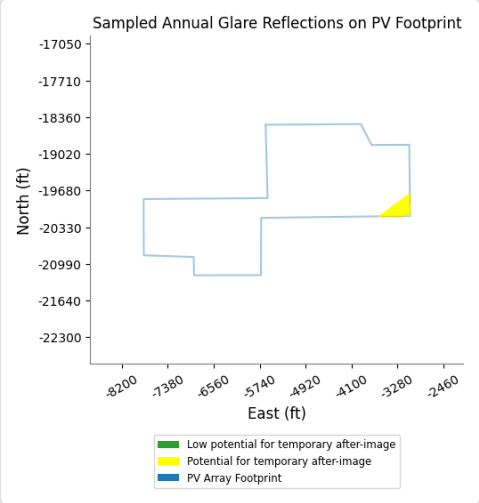
Receptor type: 2-mile Flight Path
1,305 minutes of yellow glare
0 minutes of green glare

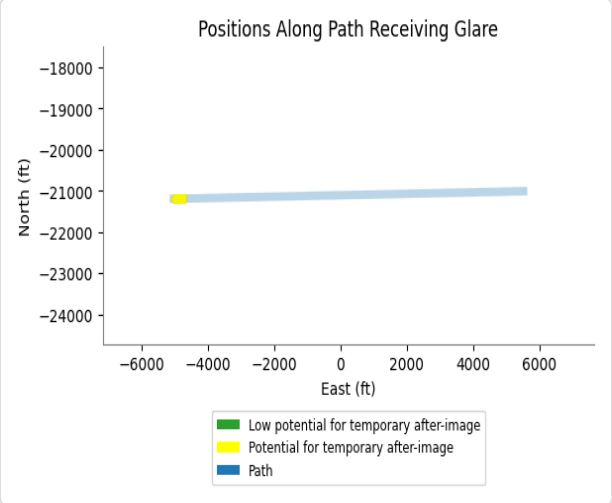












PV array 9 and S20 RWY 25

Receptor type: 2-mile Flight Path
No glare found

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.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
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. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
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.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
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.
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.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

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

Appendix C: FAA Notice Criteria Tool Output

Notice Criteria Tool

Notice Criteria Tool - Desk Reference Guide V_2018.2.0

The requirements for filing with the Federal Aviation Administration for proposed structures vary based on a number of factors: height, proximity to an airport, location, and frequencies emitted from the structure, etc. For more details, please reference CFR Title 14 Part 77.9.

You must file with the FAA at least 45 days prior to construction if:

- your structure will exceed 200ft above ground level
- your structure will be in proximity to an airport and will exceed the slope ratio
- your structure involves construction of a traverseway (i.e. highway, railroad, waterway etc...) and once adjusted upward with the appropriate vertical distance would exceed a standard of 77.9(a) or (b)
- your structure will emit frequencies, and does not meet the conditions of the FAA Co-location Policy
- your structure will be in an instrument approach area and might exceed part 77 Subpart C
- your proposed structure will be in proximity to a navigation facility and may impact the assurance of navigation signal reception
- your structure will be on an airport or heliport
- filing has been requested by the FAA

If you require additional information regarding the filing requirements for your structure, please identify and contact the appropriate FAA representative using the Air Traffic Areas of Responsibility map for Off Airport construction, or contact the FAA Airports Region / District Office for On Airport construction.

The tool below will assist in applying Part 77 Notice Criteria.

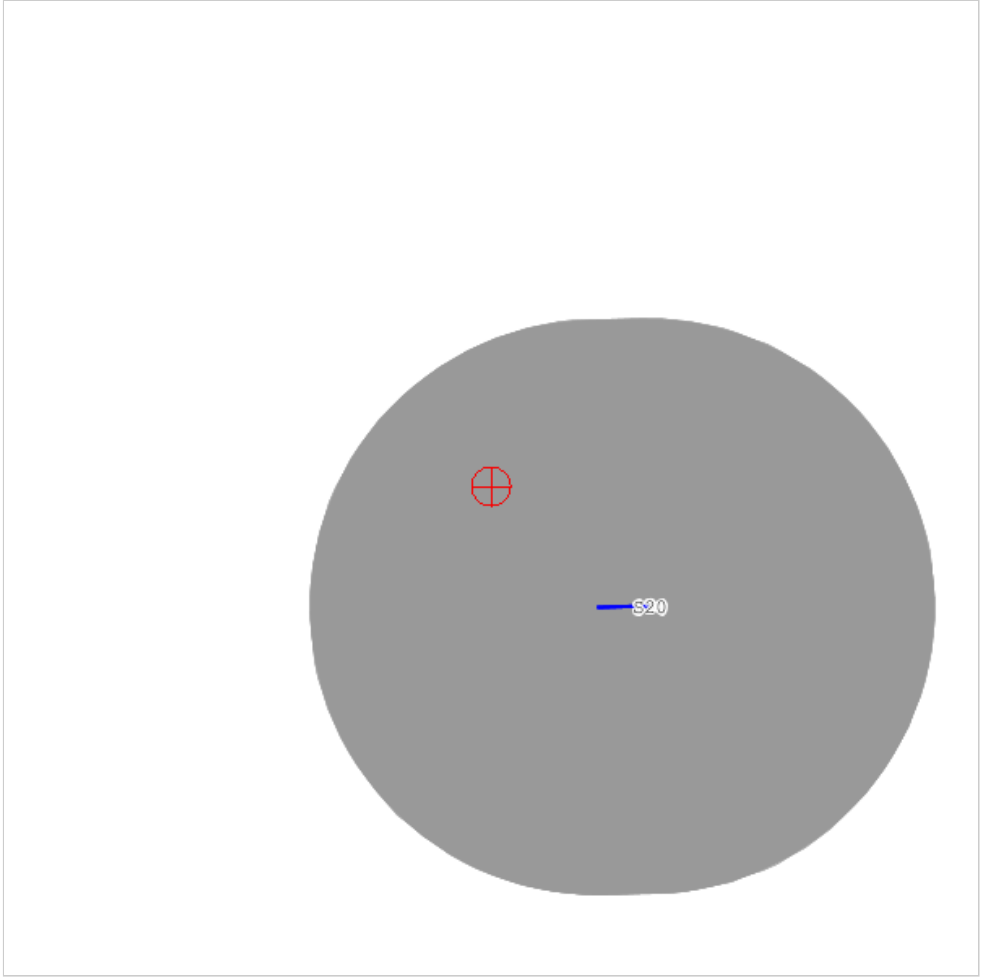
Latitude:	45 Deg 51 M 17.44 S N
Longitude:	120 Deg 52 M 52.34 S W
Horizontal Datum:	NAD83
Site Elevation (SE):	1777 (nearest foot)
Structure Height :	12 (nearest foot)
Traverseway:	No Traverseway (Additional height is added to certain structures under 77.9(c)) User can increase the default height adjustment for Traverseway, Private Roadway and Waterway
Is structure on airport:	(•) No ( ) Yes

Results

You exceed the following Notice Criteria:

77.9(b) by 5 ft. The nearest airport is S20, and the nearest runway is 07/25.

The FAA requests that you file


S20