Appendix H-Airport presentation and Glare Analysis

Dinosolar Solar Project

Capitol Airspace Group

Casper/Natrona County International Airport Board

January 15, 2020*

*Updated March 16, 2020 to include details from the revised Glare Study that was conducted to account for the changes made to the project layout.

Capitol Airspace Group

Who we are…

Provide analytical, strategic, and advocacy services to airports, communities, and commercial developers.

Goal: Strike a balance between the preservation of the National Airspace System and the need for economic development.

- Working airspace cases for 20 years
- Filed over 50,000 FAA cases
- Worked over 1,500 obstacle evaluation projects

Solar Systems and Establishing the FAA Interim Policy

- Installation of Solar photovoltaic (PV) systems on airports increasing
  - Absorb solar energy to maximize electrical energy production
  - In certain situations, may reflect sunlight and produce glint (a momentary flash of bright light) and glare (a continuous source of bright light)
  - The FAA has determined, that glint and glare could result in ocular (eye) impact to pilots and/or air traffic control (ATC) facilities and compromise the safety of the air transportation system.

  - FAA established working group in 2012 to establish:
    - Standards for measuring glint and glare
    - Thresholds for when glint and glare impact aviation safety

  - Interim policy: 78 FR 63726, 10/23/2013

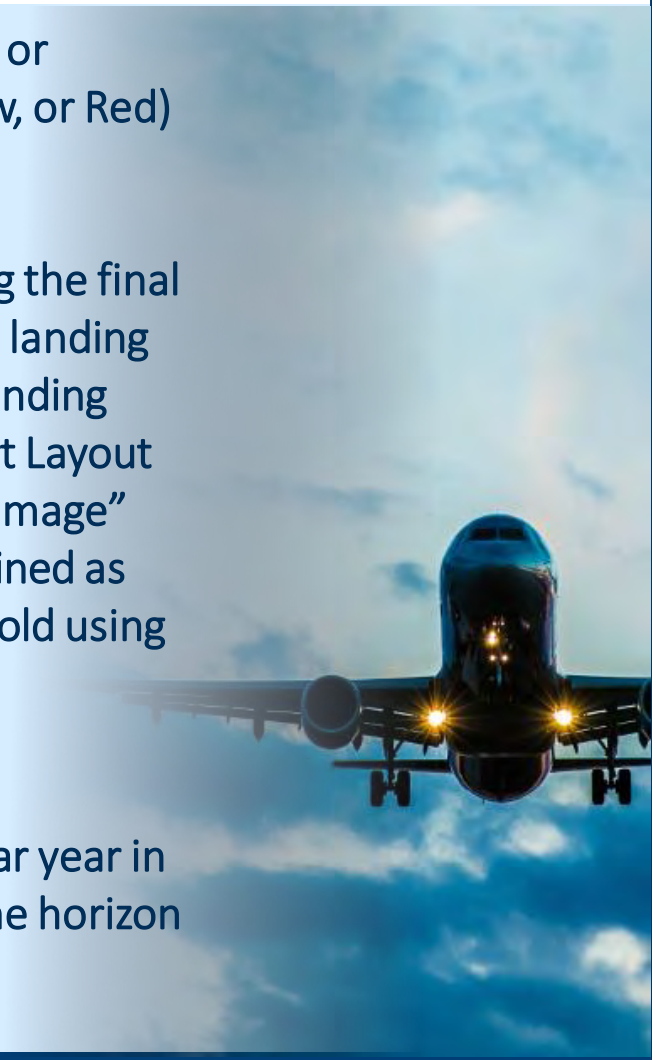
FAA Interim Policy for Solar Energy System Projects on Federally Obligated Airports

(78 FR 63726, 10/23/2013)

- 1) Must not have potential for glint or glare in the existing or planned air traffic control tower (ATCT) cab, (Green, Yellow, or Red)

- 2) Must not have a potential for glare (yellow or red) along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). An airport may have a "low potential for after image" (Green) within these areas. The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glideslope.

- 3) Ocular impact must be analyzed over the entire calendar year in one (1) minute intervals from when the sun rises above the horizon until the sun sets below the horizon.



FAA Interim Policy for Solar Energy System Projects on Federally Obligated Airports

(78 FR 63726, 10/23/2013)

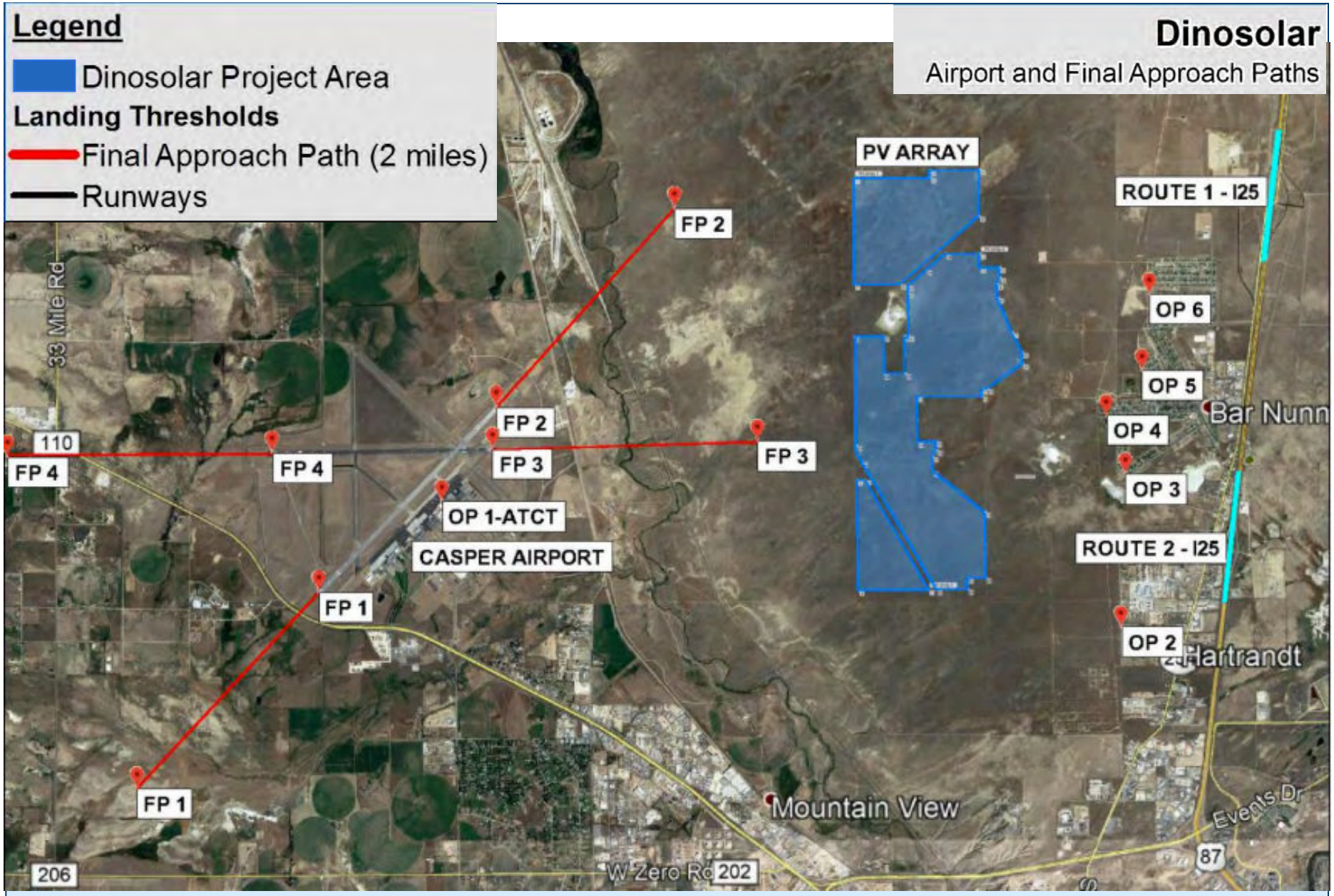
- Glare analyses do not account for physical obstructions between reflectors and receptors (buildings, tree cover, geographic obstructions, etc.)
- FAA will consider comments to the policy.
- Airports may request the FAA to analyze a project; however the FAA is under no obligation to do so if project does not meet requirements in interim policy.

FAA Interim Policy for Solar Energy System Projects on Federally Obligated Airports

(78 FR 63726, 10/23/2013)

- Solar energy systems located on an airport that is not federally-obligated, or located outside the property of a federally-obligated airport, are not subject to this policy.

- Proponents of solar energy systems located off-airport property or on non-federally obligated airports are strongly encouraged to consider the requirements of this policy when siting such systems.



This slide has been edited from the original to show information from the revised glare study.

Summary

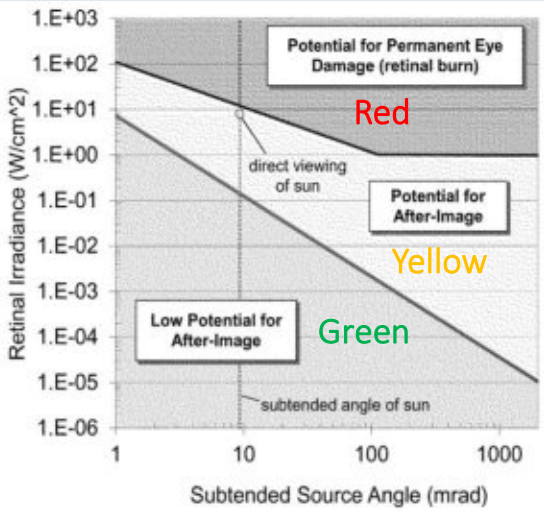
- FAA's interim policy applies to solar projects on airport property, and within 2 miles of the final approach path.
- Solar energy systems located outside the property of a federally-obligated airport, are not subject to this policy.
- Proponents located off-airport property or on non-federally obligated airports are strongly encouraged to consider the requirements of this policy when siting such systems.
- Airports may request the FAA to analyze a solar project, but the FAA is not required to do so if the project does not meet the guidelines set forth in the interim policy.

Background Slides

- Measuring Ocular Impact
- SGHAT Tool
- Example Solar Projects in Vicinity of Airports

Measuring Ocular Impact

- Glare Measurements indicating the potential ocular impact
  - Green – Low potential for temporary after image
  - Yellow – Potential for temporary after image
  - Red – Potential for permanent eye damage



Solar Glare Ocular Hazard Plot: The potential ocular hazard from solar glare is a function of retinal irradiance and the subtended angle (size/distance) of the glare source. It should be noted that the ratio of spectrally weighted solar illuminance to solar irradiance at the earth's surface yields a conversion factor of ~100 lumens/W. Plot adapted from Ho et al., 2011.

Chart References: Ho, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare Hazards from Concentrating Solar Power Plants: Analytical Models and Experimental Validation, J. Solar Energy Engineering, August 2011, Vol. 133, 031021-1 – 031021-9.

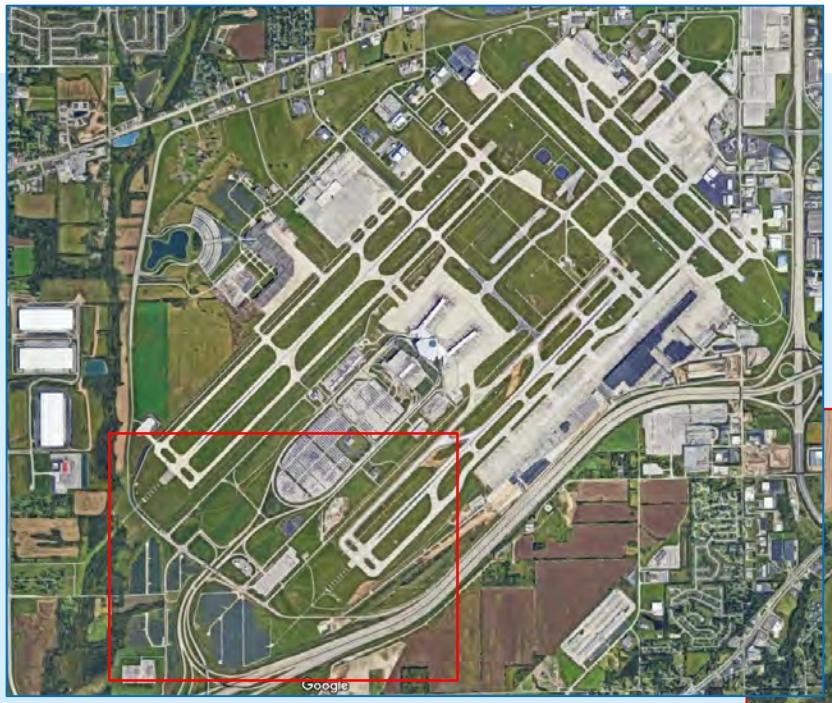
SGHAT – Solar Glare Hazard Analysis Tool

- Cooperating with the Department of Energy (DoE), the FAA developed and validated the Sandia National Laboratories, “Solar Glare Hazard Analysis Tool” (SGHAT).
- The FAA requires the use of SGHAT to demonstrate compliance with the standards for measuring ocular impact (where it applies, per the interim policy).
- User inputs for observer locations, orientation and tilt of the solar panels, reflectance, environment and ocular factors available through tool.
- Non-aviation related regulatory guidelines do not exist.
  - The FAA guidelines are generally applied to vehicular operations and buildings.

Example Solar Projects in Vicinity of Airports

- Indianapolis, IN
- Denver, CO
- Tucson, AZ
- Hawaii
- Minneapolis – St. Paul, MN
- Chattanooga, TN
- Tampa, FL
- Dover AFB, DE

Indianapolis International Airport (IND)



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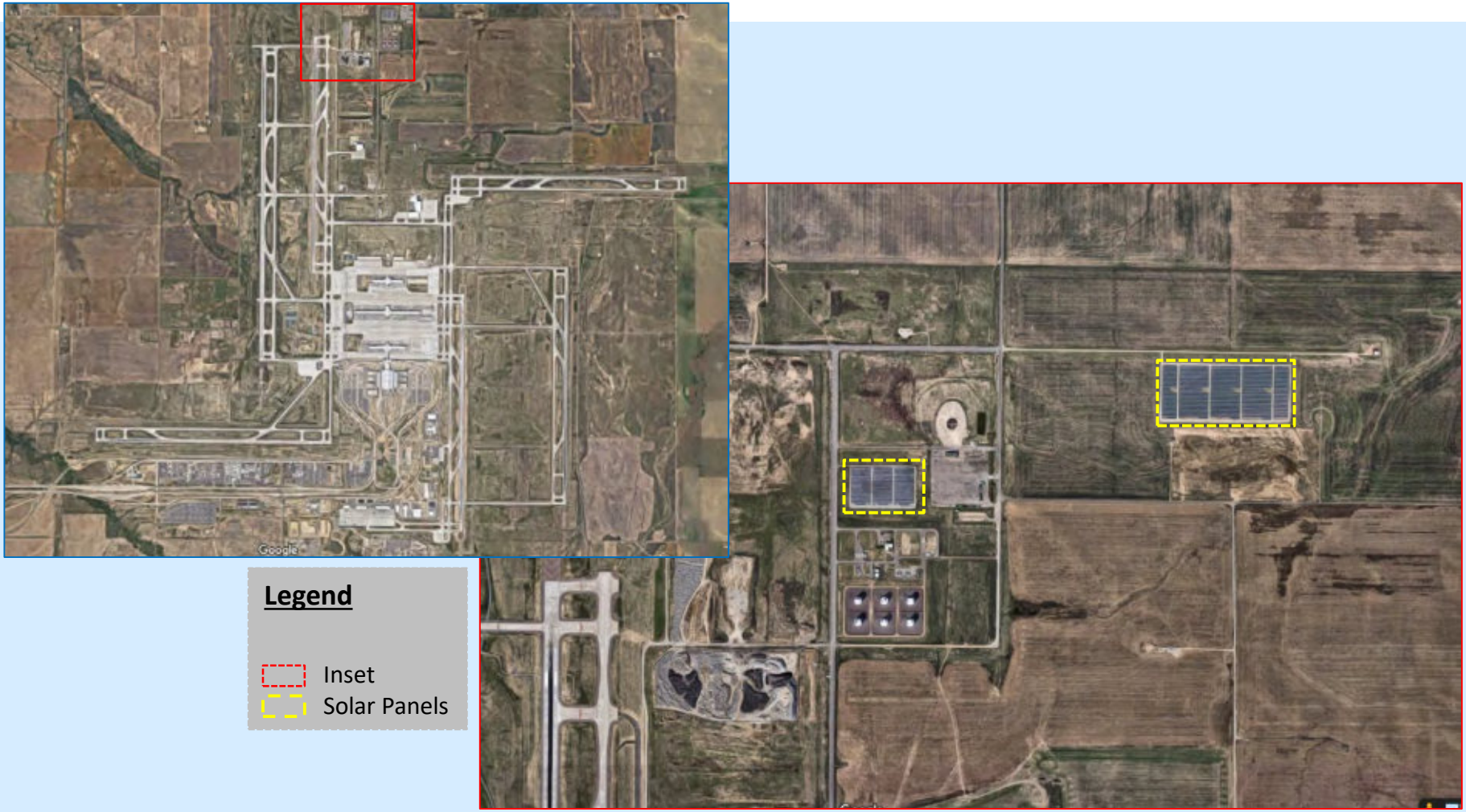
Solar Panels

Denver International Airport (DEN)



Tucson International Airport (TUS)

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Solar Panels

Kalaeloa Airport, Hawaii (JRF)

Daniel K. Inouye International Airport (HNL)

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Minneapolis-Saint Paul International Airport (MSP)

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Chattanooga Metropolitan Airport (CHA)

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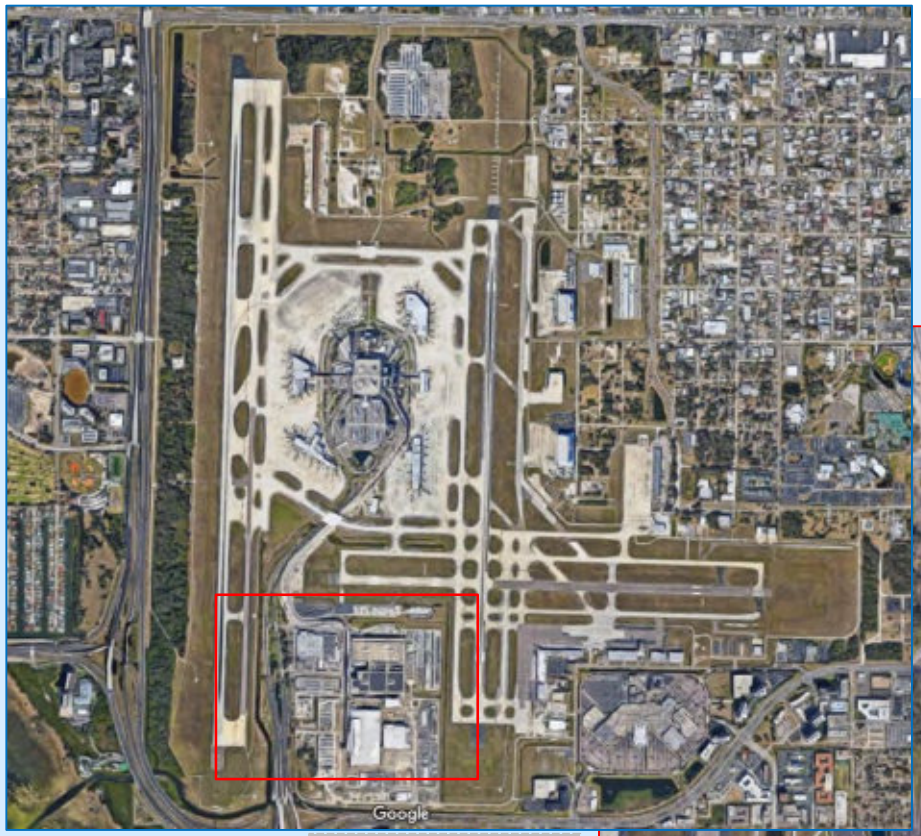
Solar Panels

Tampa International Airport (TPA)



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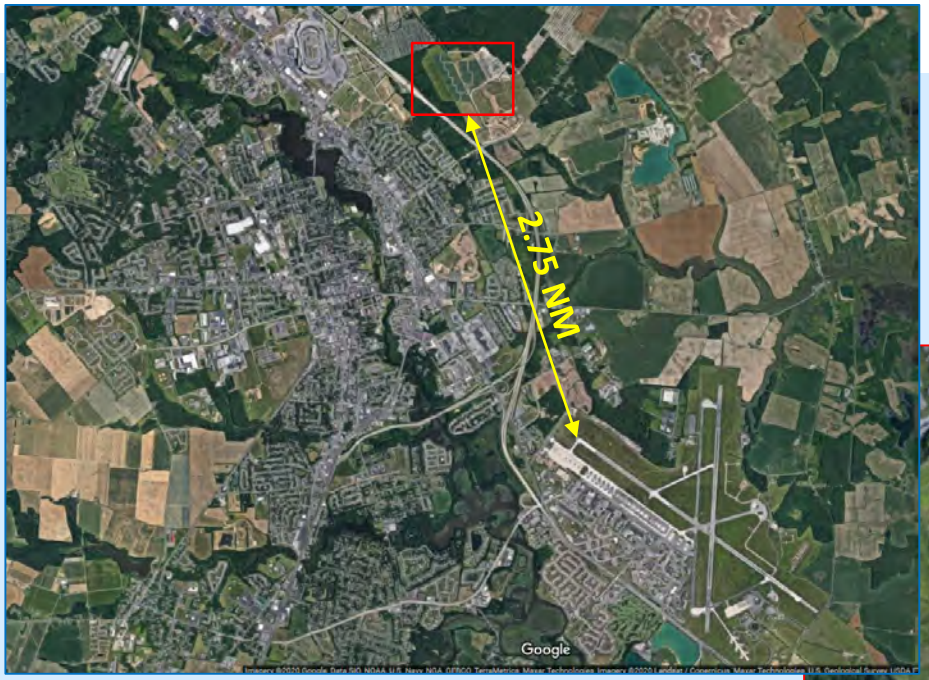
Solar Panels

Dover Air Force Base (DOV)



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- Solar Panels

AECOM

Dinosolar Solar Project
Glare Analysis – Revised Layout

Casper, WY

Dinosolar, LLC

Original - December 18, 2019
Revision - March 6, 2020

Section 1 EXECUTIVE SUMMARY 1
Section 2 SOLAR GLARE ANALYSIS 3
2.1 METHOD AND RESULTS 3
2.2 DETAILED GLARE ANALYSIS RESULTS 5
2.2.1 Resting Angle of Zero Degrees (Worst Case Scenario) 5
2.3 CONCLUSION 19
2.3.1 References 20

TABLES

Table 1: Observation Points, Flight Paths, and Routes Analyzed 4
Table 2: Glare Analysis Results (minutes per year) 5

FIGURES

Figure 1: Dinosolar Solar Project 1
Figure 2: Tracking and Resting Angles of a Typical Single Axis Tracker 2
Figure 3: Glare Location Map – OP 1 (Resting Angle 0) 6
Figure 4: Glare Occurrence Plot – OP 1 (Resting Angle 0) 7
Figure 5: Glare Location Map – OP 2 (Resting Angle 0) 8
Figure 6: Glare Occurrence Plot – OP 2 (Resting Angle 0) 9
Figure 7: Glare Location Map – OP 3 (Resting Angle 0) 10
Figure 8: Glare Occurrence Plot – OP 3 (Resting Angle 0) 11
Figure 9: Glare Location Map – OP 4 (Resting Angle 0) 12
Figure 10: Glare Occurrence Plot – OP 4 (Resting Angle 0) 13
Figure 11: Glare Location Map – OP 5 (Resting Angle 0) 14
Figure 12: Glare Occurrence Plot – OP 5 (Resting Angle 0) 15
Figure 13: Glare Location Map – OP 6 (Resting Angle 0) 16
Figure 14: Glare Occurrence Plot – OP 6 (Resting Angle 0) 17
Figure 15: Glare Occurrence Plot – FP 1 (Resting Angle 0) 18
Figure 16: Glare Occurrence Plot – FP 4 (Resting Angle 0) 19

SECTION 1 EXECUTIVE SUMMARY

Dinosolar, LLC (Dinosolar) is developing a single axis tracking solar photovoltaic (PV) project near Casper, Wyoming. Because the solar project is within 5 miles of Casper/Natrona County International Airport (Casper Airport), in close proximity to the communities of Bar Nunn and Hartrandt, and Interstate 25 (I-25), Dinosolar retained AECOM to perform a glint and glare analysis to determine the potential glare impacts to Casper Airport, the nearby communities, and vehicles traveling along I-25.

AECOM performed a revised glare analysis using ForgeSolar PV Planning and Glare Analysis software, the software originally developed at Sandia National Laboratories for Federal Aviation Administration (FAA) glare studies at airports around the country. The solar glare analysis was performed at six observation points (OPs), four flight paths (FPs), and two 1-mile routes of I-25 north of Bar Nunn and in between Bar Nunn and Hartrandt. The revised layout of the solar project, the OPs, FPs, and routes along I-25 analyzed are shown in **Figure 1**.

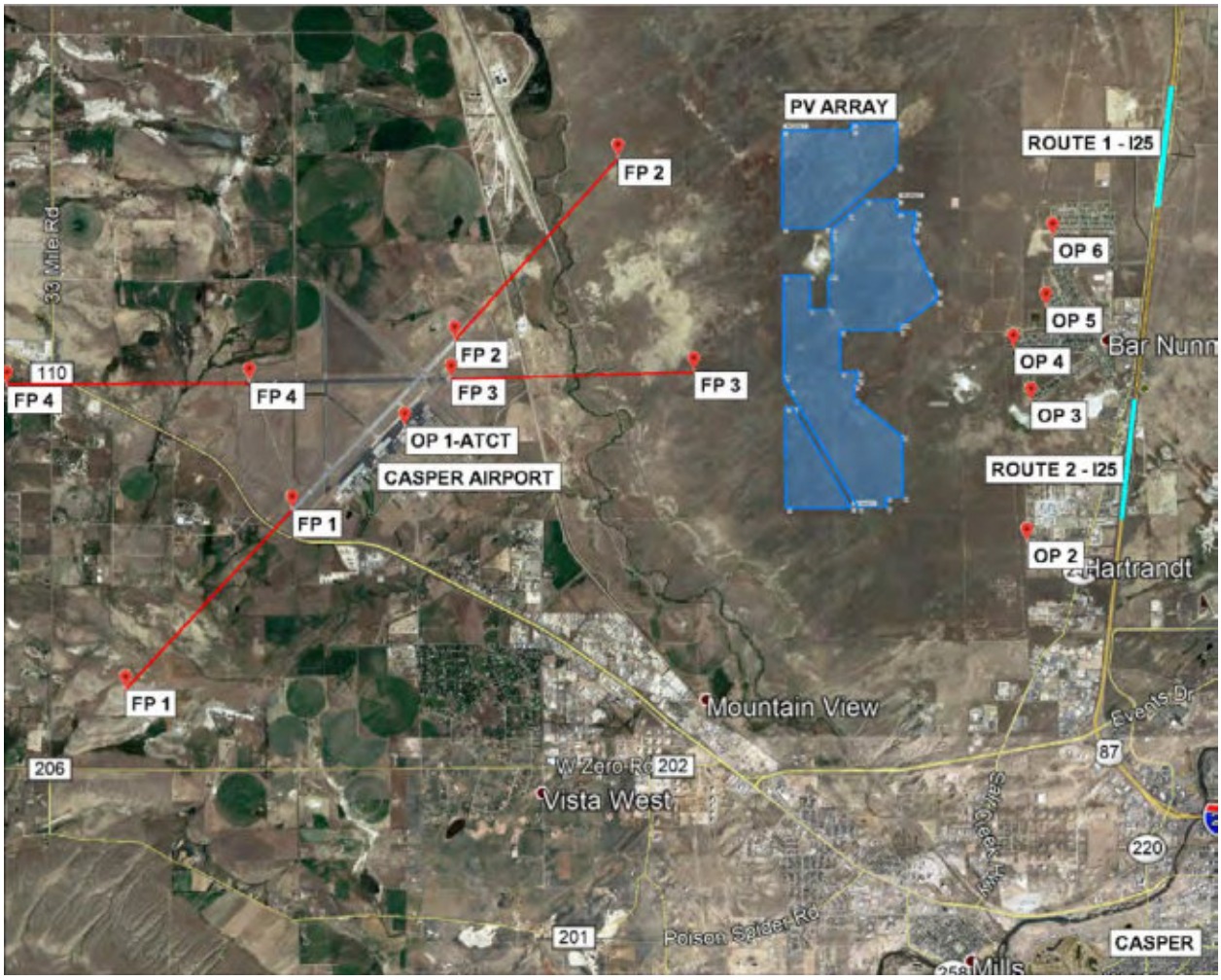


Figure 1: Dinosolar Solar Project

The glare analysis was modeled using a single axis tracking system with rows oriented in a north-south fashion with an east-to-west tracking range of motion of 300 degrees (maximum tracking angle of 60 degrees). Two glare analyses were modeled varying the resting angle of the single axis trackers to observe the change in glare impacts and recommend a mitigation strategy. The maximum amount of glare occurred when the tracking system is stowed at a resting angle of 0 degrees (typical of the evening and early morning). When the stowed resting angle was modified in the simulation to 5 degrees, the glare was eliminated. A typical example of the tracking, range of rotation, and resting angle is shown in **Figure 2**.

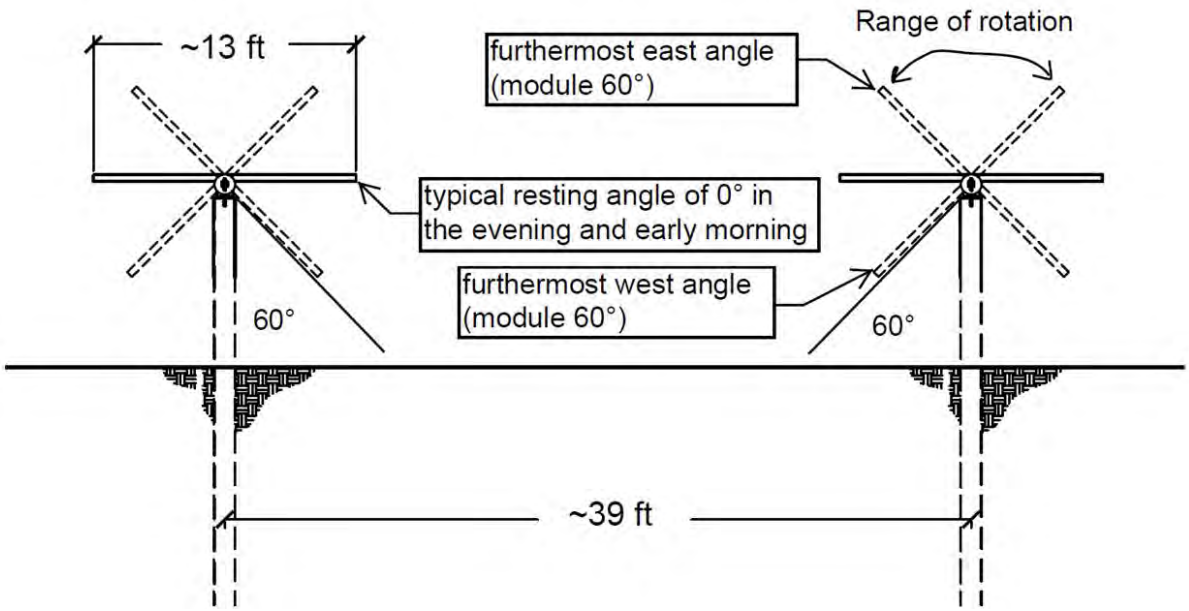


Figure 2: Tracking and Resting Angles of a Typical Single Axis Tracker

The resting angle, typically 0°, of single axis trackers is used in the glare analysis model when the sun is past the rotation limit (60 degrees), in the early morning and late afternoon. The module position is adjusted to the resting position when the sun's position would put it outside the module's range of rotation. With a resting angle of 0 degrees and rotation limit of 60 degrees, the modules lie flat in the morning until the sun reaches the position matching the 60-degree rotation. The modules are constantly rotating on the trackers throughout the day as it follows the sun from east to west. In the evening, once the sun moves past the corresponding 60-degree rotation position, the modules return to 0° again, or the resting angle. This analysis represents the worst-case scenario for glare occurrence due to the sunlight glancing off the modules when they are flat, and the sun is low in the sky. Modeling the system with a resting angle of 5 degrees however represents a more realistic situation where the modules do not lie flat but instead have a low resting angle. This is the approach when single axis trackers employ a backtracking strategy, which automatically adjusts the

angle of the modules early in the morning and late in the evening to lower tilt angles to avoid casting shadows on the surrounding rows.

Based on the iterations of the glare analysis, AECOM recommends that the backtracking strategy of the PV trackers limit the early morning and afternoon resting angle to 5 degrees. Doing so will eliminate the potential for glare at Casper Airport and all OPs defined near the project. Even at a resting angle of 0 degrees, no glare was observed for the routes along I-25.

SECTION 2 SOLAR GLARE ANALYSIS

Although primarily absorptive, the flat surface of modules in solar PV installations can reflect sunlight causing glare and potentially a brief loss of vision to observers. As PV installations are becoming increasingly common, the potential glare hazards to motorists, pilots, and air-traffic control personnel have been elevated. This need prompted Sandia National Laboratories to develop the online Solar Glare Hazard Analysis Tool (SGHAT), which provides a quantified assessment of when glare will occur throughout the year for a solar installation, as well as potential effects on the human eye for prescribed locations, including flight paths, routes along roads, and observation points.

If glare does occur for a particular analysis, SGHAT predicts the intensity and duration of the glare and potential ocular hazards. This tool has been validated against several operational solar PV systems and accurately predicted glare, including a roof-mounted PV array that was causing glare to the air traffic control tower at the Manchester-Boston Regional Airport.

SGHAT is now available for subscription through ForgeSolar, which offers additional glare analysis tools, including optimized PV module configurations to minimize glare while maximizing system output. SGHAT follows the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276, which has criteria for projects within airports, flight paths, and control towers.

2.1 METHOD AND RESULTS

The proposed PV system was modelled as three PV array footprints and defined at the project site north of Casper, Wyoming, using Google Maps on the SGHAT web-based user interface. Parameters including tracking, module surface material, panel tilt, and orientation are entered in to the program. Based on input from Dinosolar, the array was defined as single axis trackers oriented north-south with an orientation of 180 degrees with an east-west tracking range of motion of 60 degrees with an average height of 4.5 ft from the ground. The modules were assumed to be standard crystalline silicon (c-Si) type with smooth glass and anti-reflective coating (ARC).

Two analyses were performed to illustrate the worst-case scenario of glare occurrence for this project and to demonstrate a realistic scenario in which no or minimal glare will occur, including resting angles of zero and 5 degrees. The actual occurrence and duration of the resting angle of single axis trackers depends on the backtracking control strategy, the angle of the sun, and any horizon (global) shading that may occur at the project.

ForgeSolar does not include backtracking in their software model at this time; therefore, the resting angle was used as the variable to determine when glare will no longer occur. The resting angle input of the simulation determines how the tilt angle of the trackers is modeled when the sun is past the rotation limit (early morning and late evening).

Six observation points, four flight paths, and two routes along I-25 were identified by Dinosolar and AECOM for analysis. The Casper Airport Air Traffic Control Tower (ATCT) height was defined at 43 ft based on publicly available information and confirmed by the Air Traffic Manager of the airport. The height of the observation points and interstate routes was assumed to be 7.5 ft from the ground. **Table 1** summarizes the OPs, FPs, and routes defined in the vicinity of the project.

Table 1: Observation Points, Flight Paths, and Routes Analyzed

OP#	Description	GPS Coordinates
1	Casper Airport ATCT	42°54'11.99"N, 106°27'24.59"W
2	Intersection of Doane Lane and Andy Road in Hartrandt Community	42°53'22.56"N, 106°21'22.94"W
3	Intersection of Palomino Avenue and Trails End in Bar Nunn Community	42°54'22.48"N, 106°21'20.14"W
4	West End of Sunset Boulevard in Bar Nunn Community	42°54'44.92"N, 106°21'30.45"W
5	West End of Goosewing Street in Bar Nunn Community	42°55'2.84"N, 106°21'11.64"W
6	West End of Sioux Trail in Bar Nunn Community	42°55'32.48"N, 106°21'8.11"W
FP#	**Description**	**GPS Coordinates**
1	Casper Airport Runway 03	42°53'36.25"N, 106°28'30.11"W
2	Casper Airport Runway 21	42°54'48.58"N, 106°26'55.44"W
3	Casper Airport Runway 08	42°54'30.55"N, 106°28'54.86"W
4	Casper Airport Runway 26	42°54'32.20"N, 106°26'58.29"W
RT#	**Description**	**GPS Coordinates**
1	Interstate 25 - 1 Mile Section North of Bar Nunn	N/A
2	Interstate 25 - 1 Mile Section South of Bar Nunn	N/A

Table 2 summarizes the resulting glare from the analyses at resting angles of zero and 5 degrees. Observe how glare decreases as the resting angle increases, as this is due to greater reflectance at high incidence angles (angle between the panel normal and sun position). Any glare observed at the air traffic control tower (ATCT) is not allowed and is shown in the Table highlighted in yellow.

Table 2: Glare Analysis Results (minutes per year)

	Resting Angle 0		Resting Angle 5	
Component	**"Green" Glare**	**"Yellow" Glare**	**"Green" Glare**	**"Yellow" Glare**
OP 1 (ATCT)	1208	2412	0	0
OP 2	0	13	0	0
OP 3	2	63	0	0
OP 4	9	497	0	0
OP 5	56	1678	0	0
OP 6	64	2646	0	0
FP 1	926	0	0	0
FP 2	0	0	0	0
FP 3	0	0	0	0
FP 4	621	0	0	0
Route 1	0	0	0	0
Route 2	0	0	0	0
Total	**2886**	**7309**	**0**	**0**

2.2 DETAILED GLARE ANALYSIS RESULTS

Detailed results are presented for the analysis with a resting angle of zero to present the worst-case scenario glare impacts of this project.

2.2.1 Resting Angle of Zero Degrees (Worst Case Scenario)

OP 1: Casper Airport Air Traffic Control Tower

Figure 3 shows where the glare is predicted to occur from the reference of OP 1. Glare would be seen from the trackers in the morning hours as the light from the rising sun glances off the trackers while they are flat.

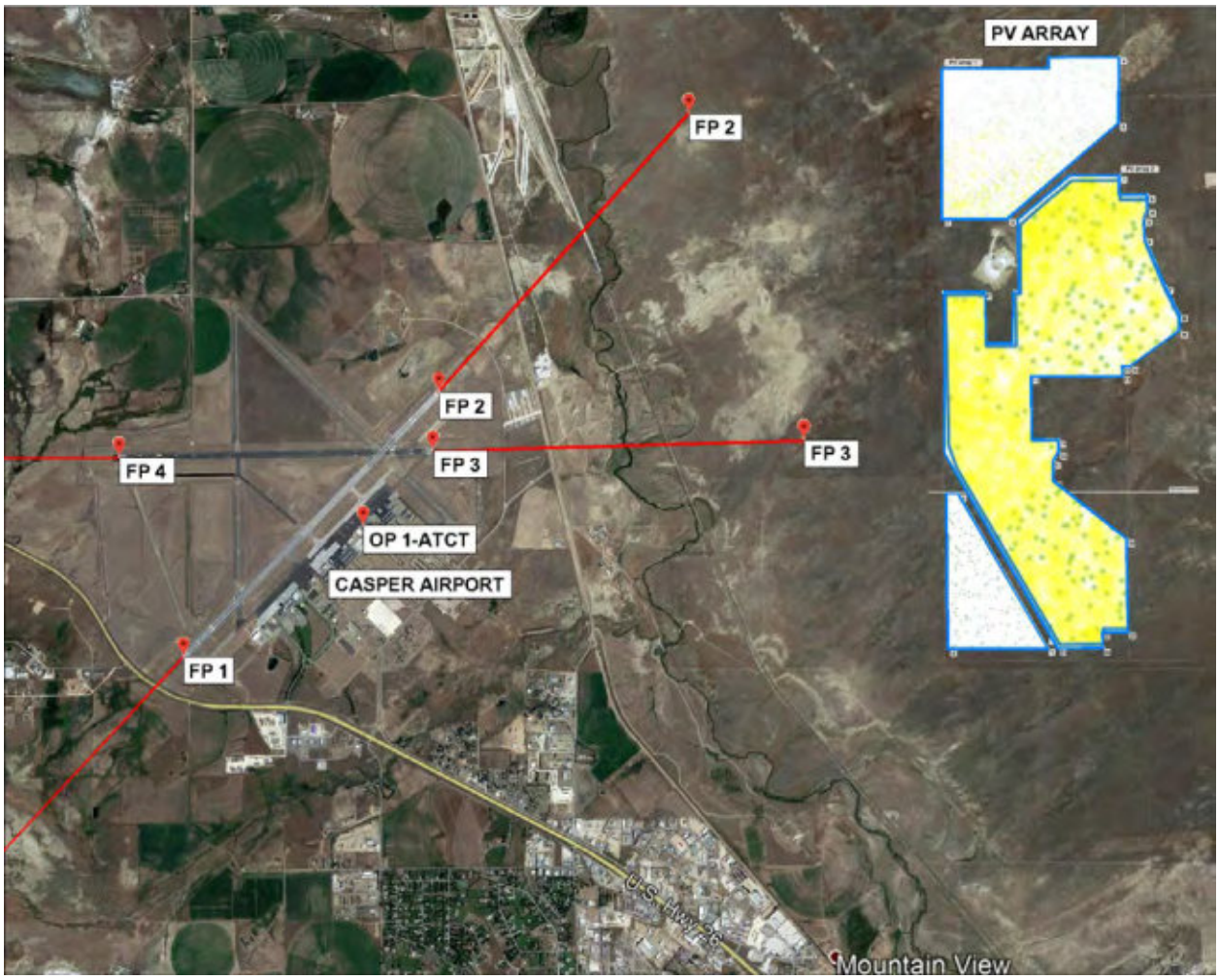


Figure 3: Glare Location Map – OP 1 (Resting Angle 0)

Glare is predicted to be visible at OP 1 during the early morning hours from late-February to mid-October for a total of 3,620 minutes, as seen in **Figure 4**.

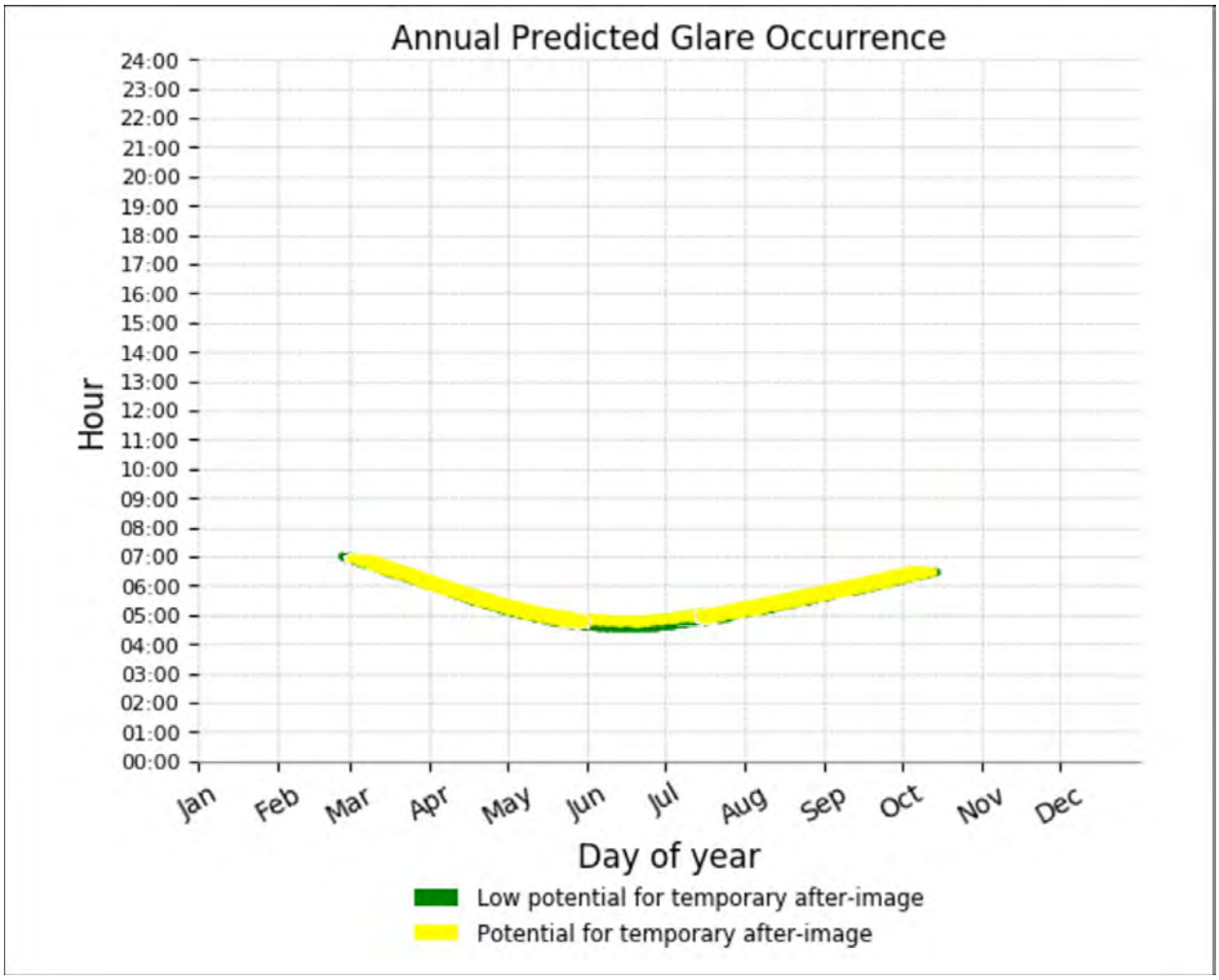


Figure 4: Glare Occurrence Plot – OP 1 (Resting Angle 0)

OP 2: Doane Lane and Andy Road (Hartrandt)

Figure 5 shows where the glare is predicted to occur from the reference of OP 2. Glare would be seen from the trackers in the afternoon hours as the light from the setting sun glances off the trackers while they are flat.

Figure 5: Glare Location Map – OP 2 (Resting Angle 0)

Glare is predicted to be visible at OP 2 during the afternoon around 7:00 PM in late-April and August for a total of 13 minutes, as seen in **Figure 6**.

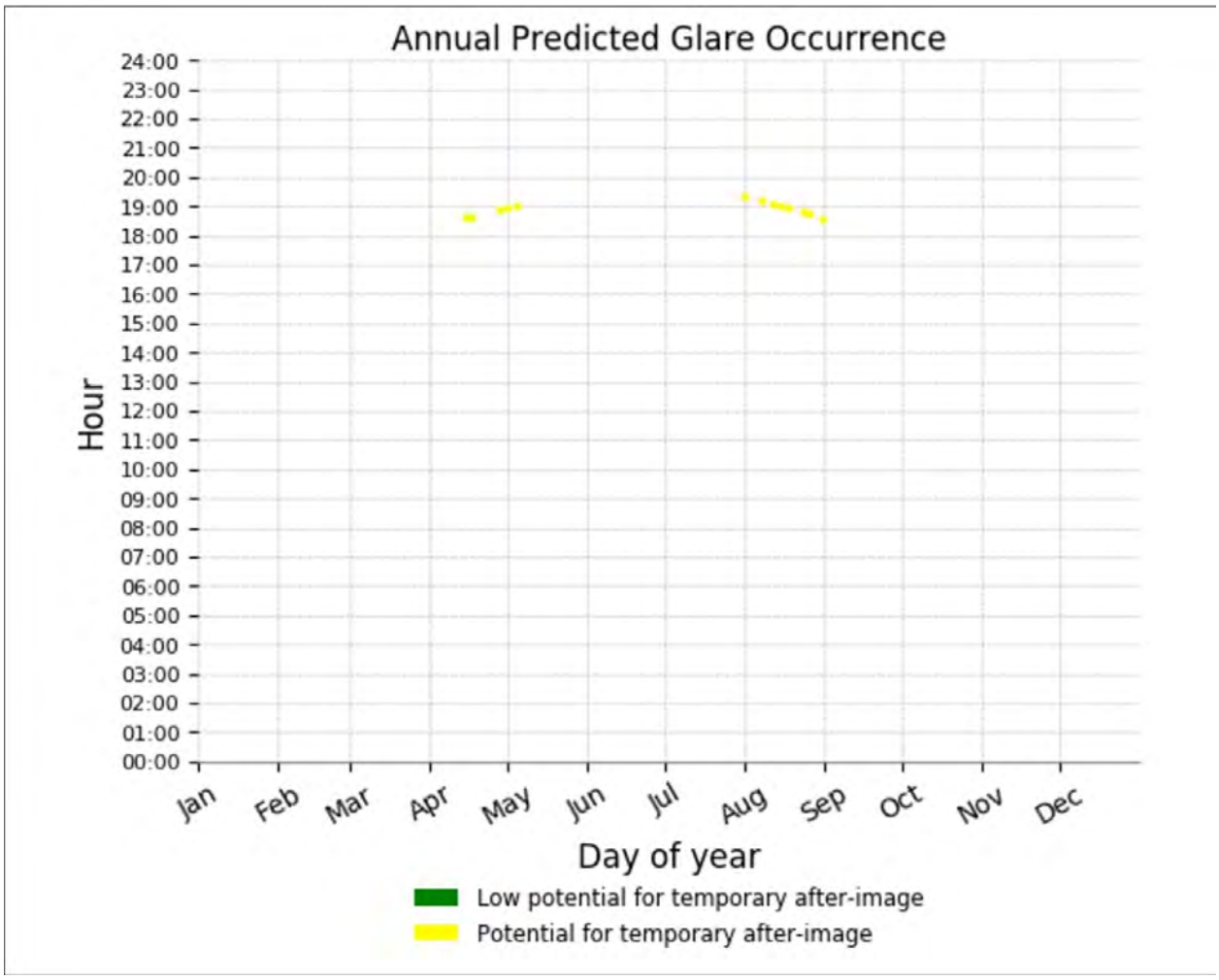


Figure 6: Glare Occurrence Plot – OP 2 (Resting Angle 0)

OP 3: Palomino Avenue and Trails End (Bar Nunn)

Figure 7 shows where the glare is predicted to occur from the reference of OP 3. Glare would be seen from the trackers in the afternoon hours as the light from the setting sun glances off the trackers while they are flat.

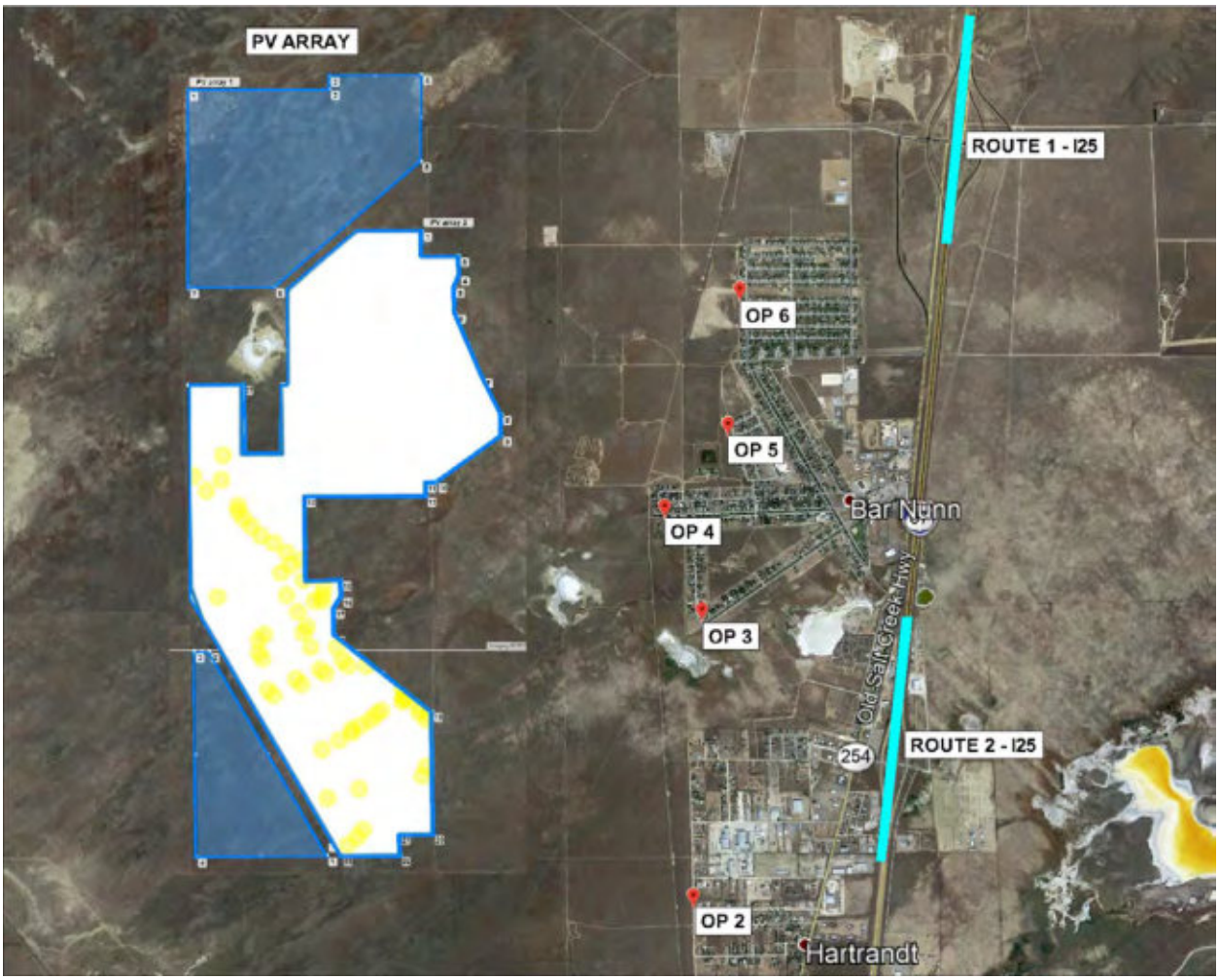


Figure 7: Glare Location Map – OP 3 (Resting Angle 0)

Glare is predicted to be visible at OP 3 during the late afternoon hours from February to May and August to November for a total of 65 minutes, as seen in **Figure 8**.

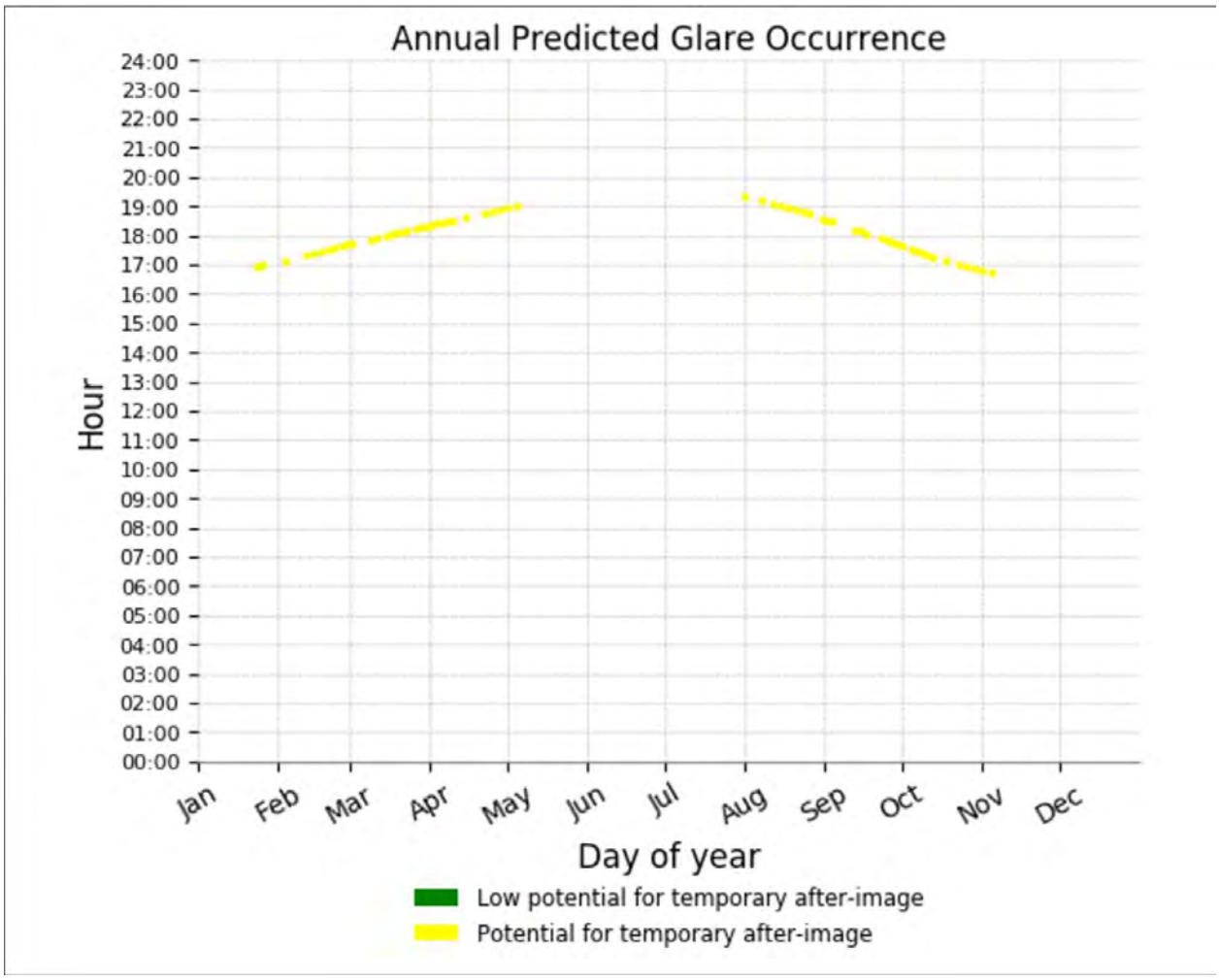


Figure 8: Glare Occurrence Plot – OP 3 (Resting Angle 0)

OP 4: Sunset Boulevard (Bar Nunn)

Figure 9 shows where the glare is predicted to occur from the reference of OP 4. Glare would be seen from the trackers in the afternoon hours as the light from the setting sun glances off the trackers while they are flat.

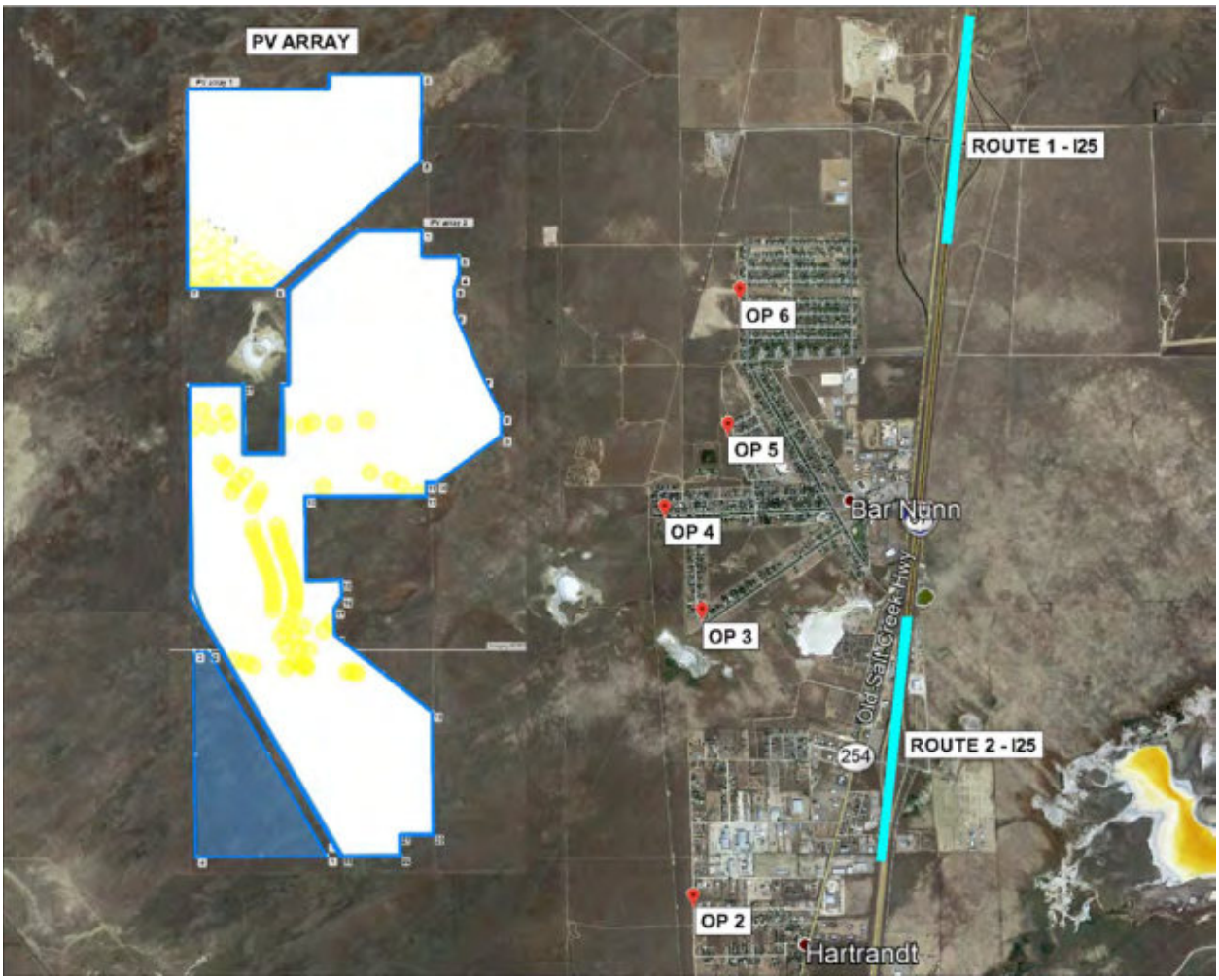


Figure 9: Glare Location Map – OP 4 (Resting Angle 0)

Glare is predicted to be visible at OP 4 during the late afternoon hours from February to November for a total of 506 minutes, as seen in **Figure 10**.

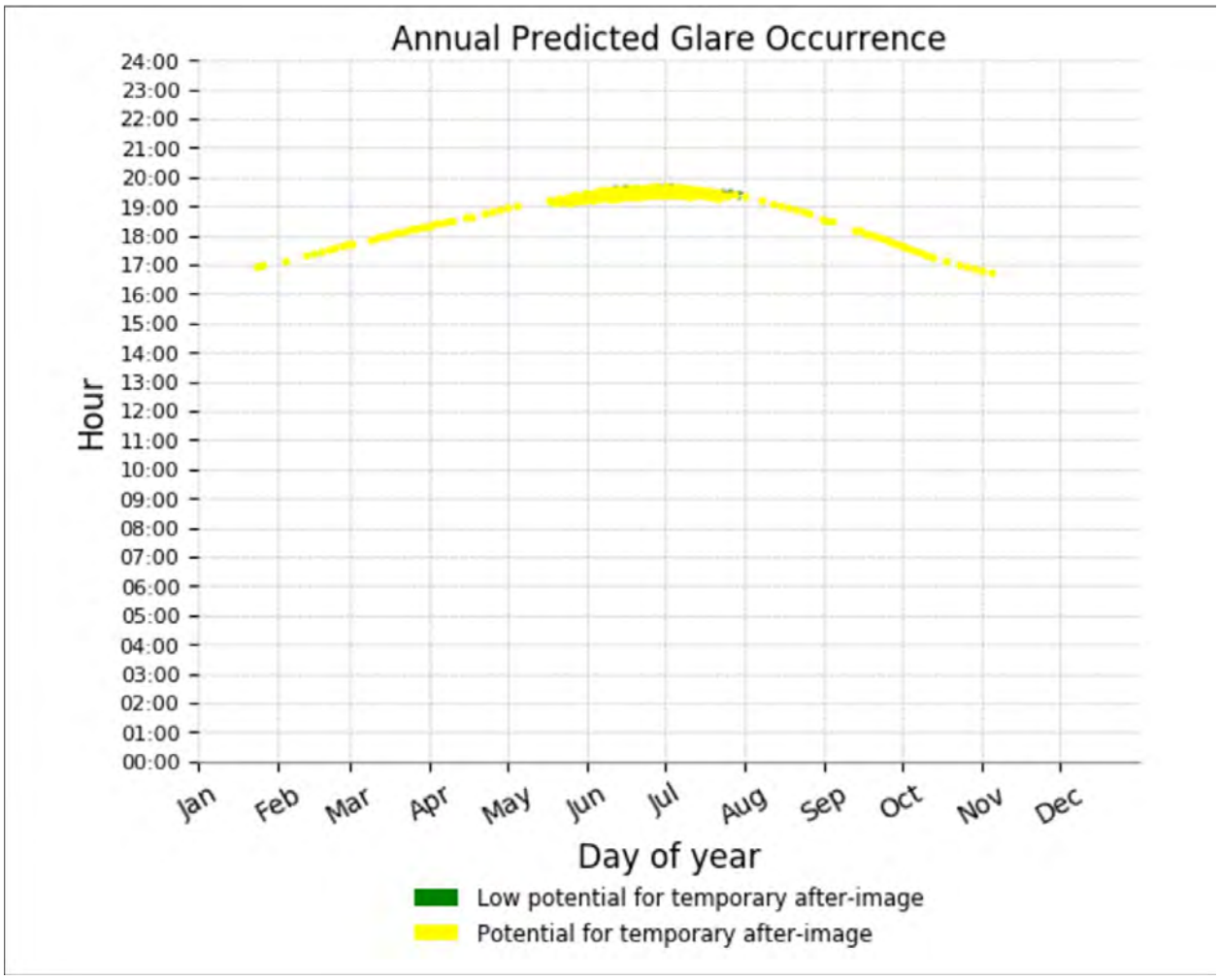


Figure 10: Glare Occurrence Plot – OP 4 (Resting Angle 0)

OP 5: Goosewing Street (Bar Nunn)

Figure 11 shows where the glare is predicted to occur from the reference of OP 5. Glare would be seen from the trackers in the afternoon hours as the light from the setting sun glances off the trackers while they are flat.

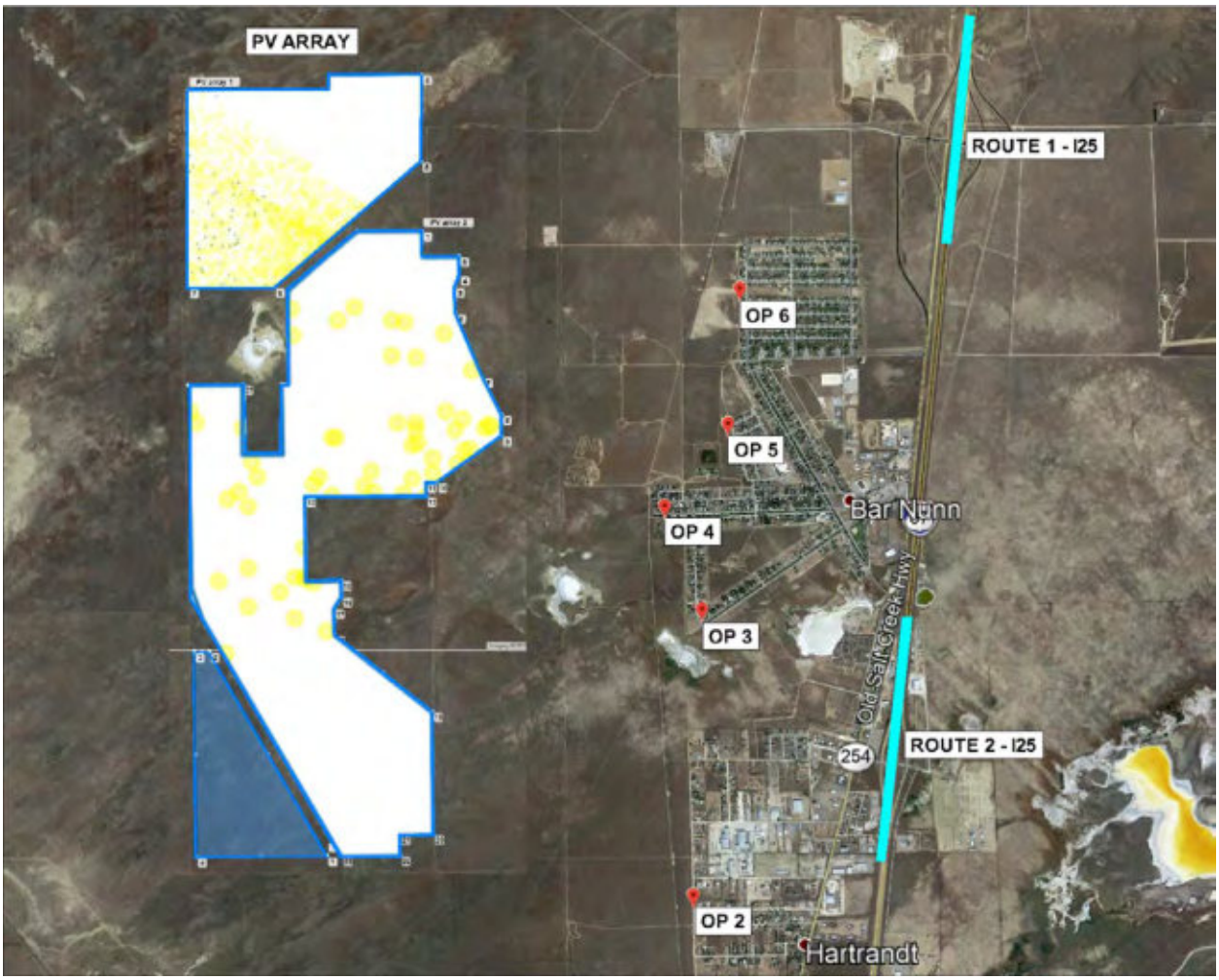


Figure 11: Glare Location Map – OP 5 (Resting Angle 0)

Glare is predicted to be visible at OP 5 during the afternoon hours from February to November for a total of 1,734 minutes, as seen in **Figure 12**.

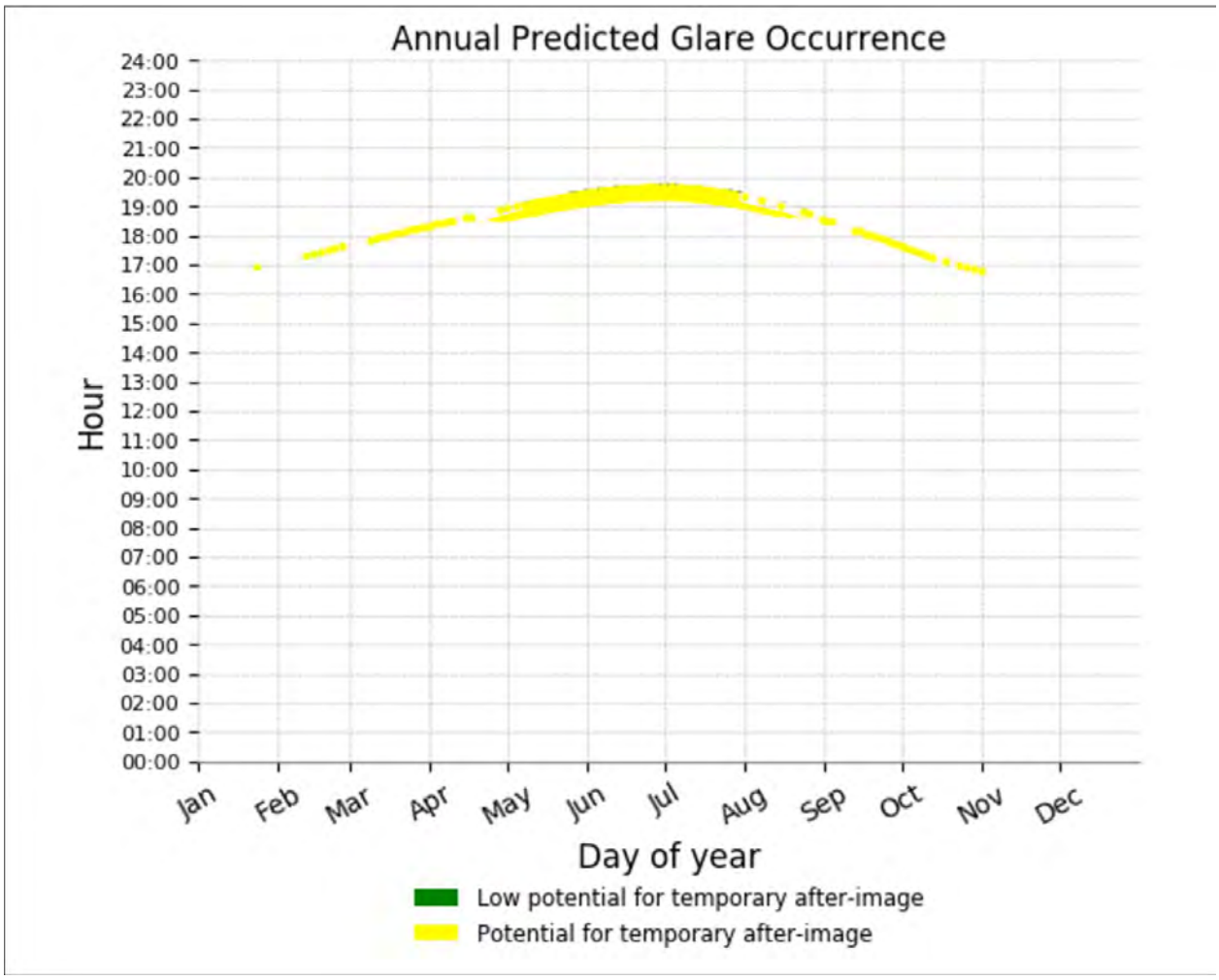


Figure 12: Glare Occurrence Plot – OP 5 (Resting Angle 0)

OP 6: Sioux Trail (Bar Nunn)

Figure 13 shows where the glare is predicted to occur from the reference of OP 6. Glare would be seen from the trackers in the afternoon hours as the light from the setting sun glances off the trackers while they are flat.

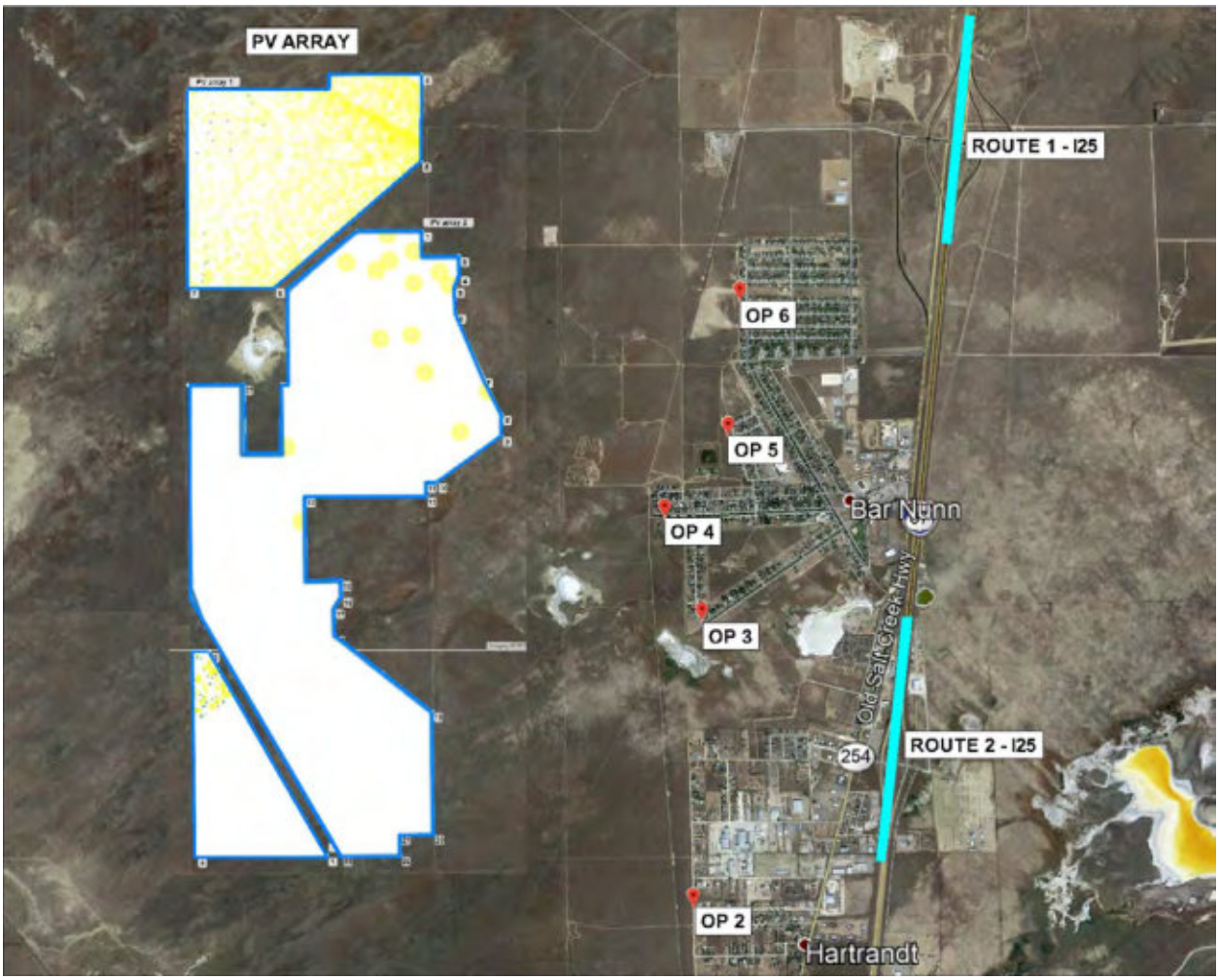


Figure 13: Glare Location Map – OP 6 (Resting Angle 0)

Glare is predicted to be visible at OP 6 during the afternoon hours from April through September and late November to mid-January for a total of 2,710 minutes, as seen in **Figure 14**.

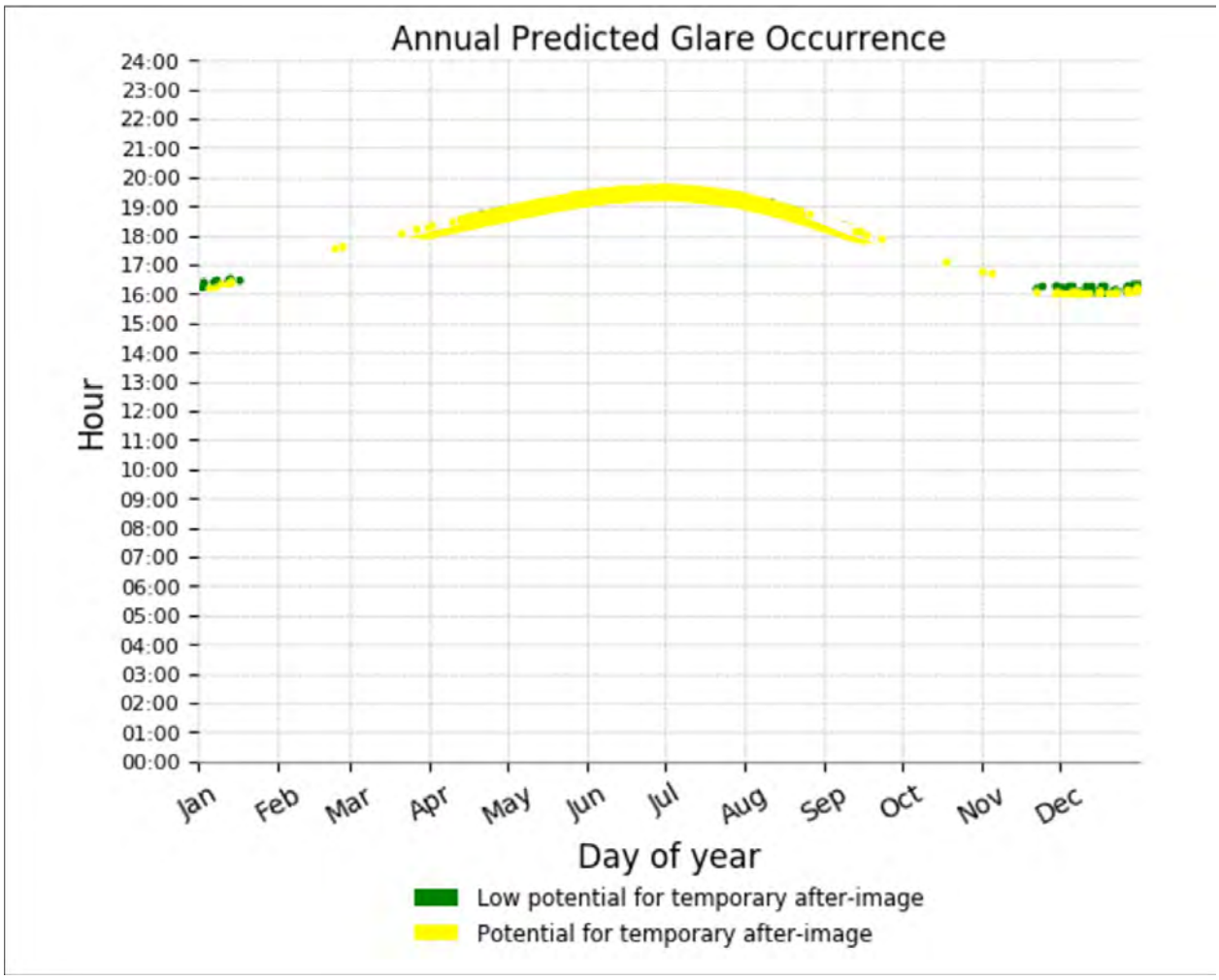


Figure 14: Glare Occurrence Plot – OP 6 (Resting Angle 0)

FP 1: Runway 03

As flights approach runway 03 from the southwest, glare would be seen from the trackers in the morning hours as the light from the rising sun glances off the trackers while they are flat. Glare is predicted to be visible at FP 1 during the early morning hours from April through mid-September for a total of 926 minutes, as seen in **Figure 15**.

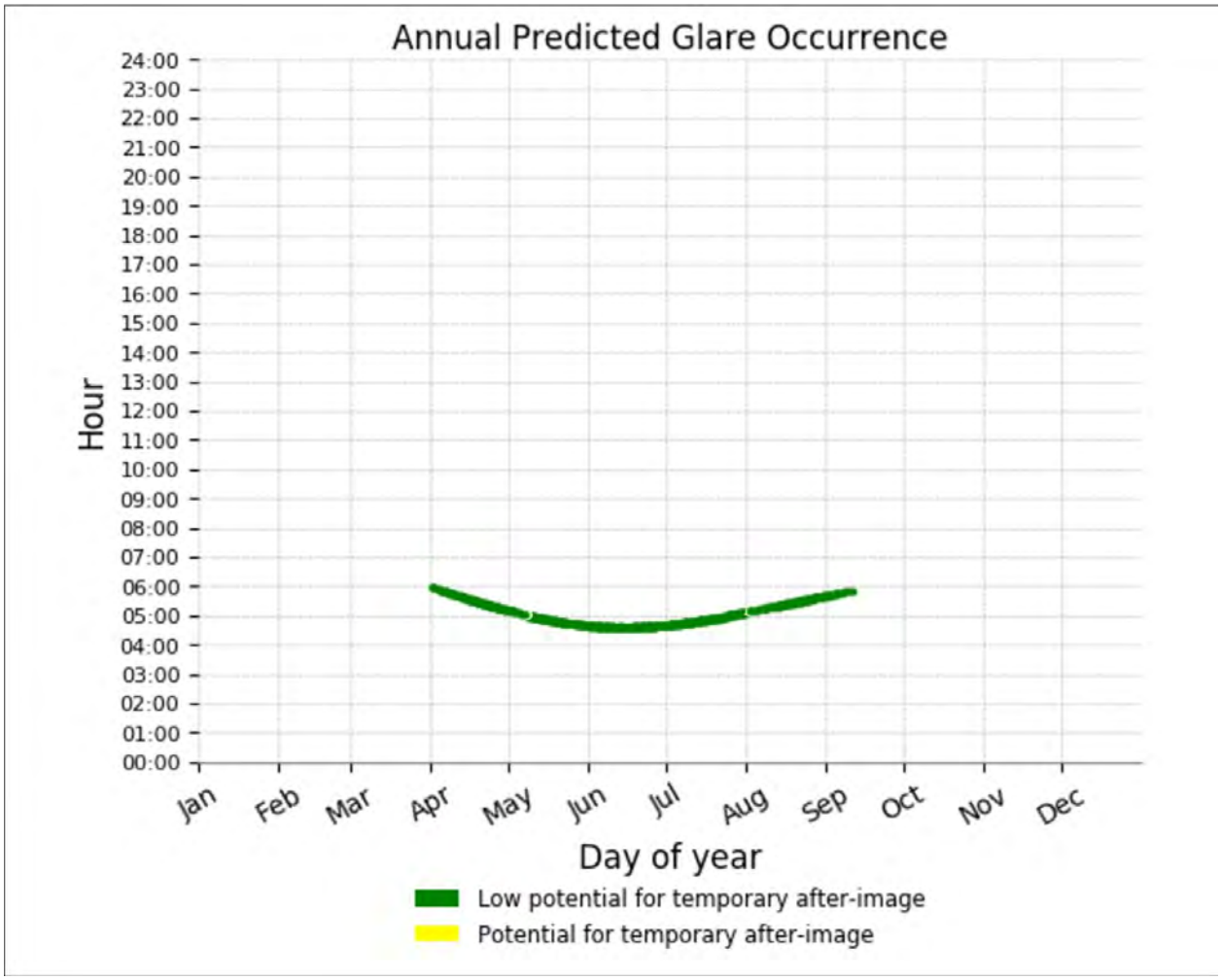


Figure 15: Glare Occurrence Plot – FP 1 (Resting Angle 0)

FP 4: Runway 08

As flights approach runway 08 from the west, glare would be seen from the trackers in the morning hours as the light from the rising sun glances off the trackers while they are flat. Glare is predicted to be visible at FP 4 during the morning hours from late-February to mid-May and August through mid-October for a total of 621 minutes, as seen in **Figure 16**.

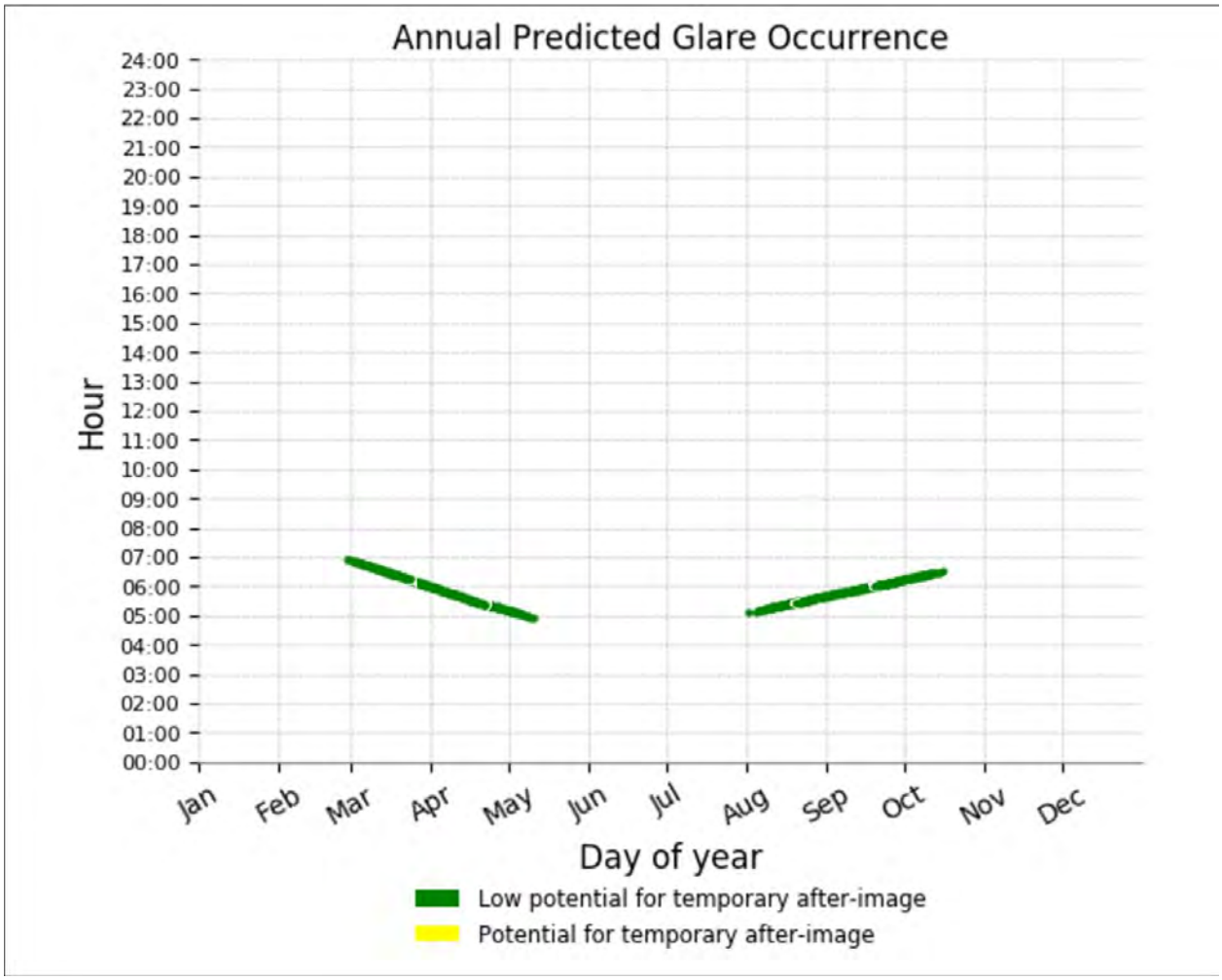


Figure 16: Glare Occurrence Plot – FP 4 (Resting Angle 0)

2.3 CONCLUSION

Based on the iterations of the glare analysis, AECOM recommends that the backtracking strategy of the PV trackers limit the early morning and afternoon resting angle to 5 degrees. Doing so will eliminate the potential for glare for all observation points, flight paths, and interstate routes defined near the Dinosolar project.

The current location of the Casper Airport ATCT may be relocated based on an Airport Traffic Control Tower Siting Study performed in April 2015 by RS&H, Inc at the direction of Natrona County. The study identified three alternate acceptable sites and corresponding heights for the ATCT. AECOM contacted the Air Traffic Manager for the airport to inquire if the ATCT will be relocated. He confirmed that there is only the one existing control tower on-site that was analyzed in this report.

2.3.1 References

Federal Aviation Administration. 2010. Technical Guidance for Evaluating Selected Solar Technology on Airports.

Sandia National Laboratories. 2015. Solar Glare Hazard Analysis Tool (SGHAT) Technical Reference Manual. SAND2014-18360 O.

Sandia National Laboratories. 2015. Solar Glare Hazard Analysis Tool (SGHAT) User's Manual. SAND2013-7063P. Updated July 2015.

Solar Energy Industries Association. 2016. Updates to the Solar Glare Hazard Analysis Tool and Its Application to Federal and Local Policies Regarding PV Installation [Webinar]. In SEIA Webinars.

National Renewable Energy Laboratories. 2014. Implementing Solar Technologies at Airports. NREL/TP-7A40-62349.

FORGESOLAR GLARE ANALYSIS

Project: **Dinosolar Glare Analysis**
Site configuration: **Revised Layout - RA 0 deg**
Analysis conducted by Samuel Monger (samuel.monger@aecom.com) at 00:30 on 29 Feb, 2020.

U.S. FAA 2013 Policy Adherence

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

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

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

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

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

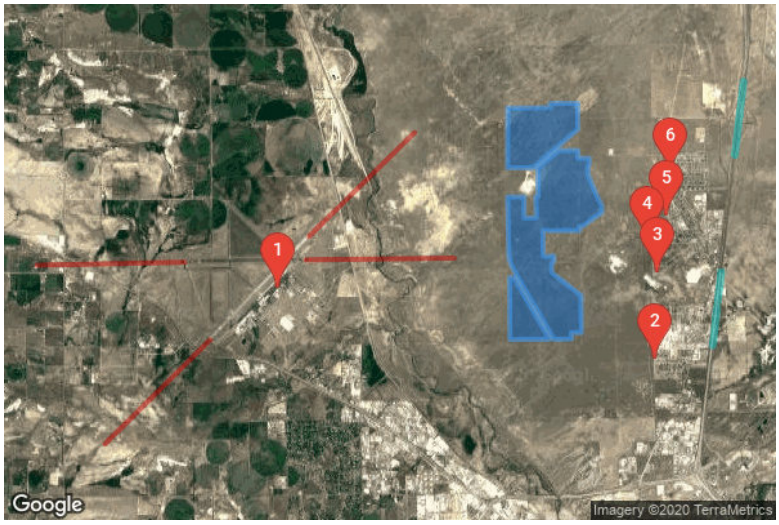
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 36219.6273



PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
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	42.938538	-106.395759	5342.86	4.50	5347.36
2	42.938610	-106.384379	5357.54	4.50	5362.04
3	42.939404	-106.384371	5364.80	4.50	5369.30
4	42.939477	-106.377007	5344.85	4.50	5349.35
5	42.934385	-106.377042	5322.13	4.50	5326.63
6	42.926940	-106.388820	5272.22	4.50	5276.72
7	42.926915	-106.395719	5284.35	4.50	5288.86

Name: PV array 2
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
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	42.930282	-106.376970	5319.07	4.50	5323.57
2	42.928753	-106.376951	5325.76	4.50	5330.26
3	42.928765	-106.374009	5348.57	4.50	5353.07
4	42.927690	-106.373958	5357.66	4.50	5362.16
5	42.926945	-106.374337	5357.02	4.50	5361.52
6	42.925455	-106.374250	5353.79	4.50	5358.29
7	42.921654	-106.372089	5349.54	4.50	5354.04
8	42.919481	-106.370592	5346.96	4.50	5351.46
9	42.918204	-106.370581	5351.00	4.50	5355.50
10	42.915492	-106.375773	5345.35	4.50	5349.85
11	42.915475	-106.376615	5346.24	4.50	5350.74
12	42.914665	-106.376620	5339.43	4.50	5343.93
13	42.914632	-106.386335	5303.82	4.50	5308.32
14	42.909635	-106.386240	5336.24	4.50	5340.74
15	42.909722	-106.383447	5335.35	4.50	5339.85
16	42.908767	-106.383408	5329.35	4.50	5333.85
17	42.908067	-106.384022	5331.29	4.50	5335.79
18	42.906508	-106.383969	5325.35	4.50	5329.85
19	42.901975	-106.376151	5319.78	4.50	5324.28
20	42.894771	-106.376062	5313.60	4.50	5318.10
21	42.894774	-106.378712	5315.90	4.50	5320.40
22	42.893520	-106.378726	5314.39	4.50	5318.89
23	42.893491	-106.383411	5312.07	4.50	5316.57
24	42.907462	-106.394511	5335.59	4.50	5340.09
25	42.909246	-106.395379	5328.29	4.50	5332.79
26	42.921209	-106.395748	5270.82	4.50	5275.32
27	42.921232	-106.391345	5267.46	4.50	5271.96
28	42.917125	-106.391331	5276.69	4.50	5281.19
29	42.917137	-106.388081	5284.30	4.50	5288.80
30	42.921269	-106.388211	5270.42	4.50	5274.92
31	42.921279	-106.387631	5271.39	4.50	5275.89
32	42.925995	-106.387669	5271.58	4.50	5276.08
33	42.926788	-106.387641	5273.56	4.50	5278.06
34	42.928518	-106.384981	5279.56	4.50	5284.06
35	42.930268	-106.382134	5291.07	4.50	5295.57

Name: PV array 3
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
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	42.893485	-106.384599	5318.41	4.50	5322.91
2	42.905460	-106.394046	5328.23	4.50	5332.73
3	42.905455	-106.395248	5329.65	4.50	5334.16
4	42.893411	-106.395095	5326.23	4.50	5330.73

Flight Path Receptor(s)

Name: FP 1 - Runway 03
Description:
Threshold height: 50 ft
Direction: 45.4°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	42.893401	-106.475044	5324.52	50.00	5374.52
Two-mile	42.873086	-106.503158	5278.51	649.46	5927.97

Name: FP 2 - Runway 21
Description:
Threshold height: 50 ft
Direction: 225.6°
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	42.913509	-106.448761	5326.10	50.00	5376.10
Two-mile	42.933756	-106.420546	5336.27	593.29	5929.55

Name: FP 3 - Runway 26
Description:
Threshold height: 50 ft
Direction: 269.3°
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	42.908950	-106.449543	5323.99	50.00	5373.99
Two-mile	42.909293	-106.410025	5279.65	647.80	5927.45

Name: FP 4 - Runway 08
Description:
Threshold height: 50 ft
Direction: 88.8°
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	42.908487	-106.481920	5343.75	50.00	5393.75
Two-mile	42.907902	-106.521433	5342.03	605.17	5947.21

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
1-ATCT	1	42.903361	-106.456847	5324.65	43.00
OP 2	2	42.889562	-106.356400	5295.55	7.50
OP 3	3	42.906303	-106.355635	5263.89	7.50
OP 4	4	42.912504	-106.358485	5252.45	7.50
OP 5	5	42.917495	-106.353188	5309.43	7.50
OP 6	6	42.925725	-106.352236	5351.25	7.50

Map image of 1-ATCT

Route Receptor(s)

Name: Route 1 - I25 North
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	42.929396	-106.335099	5351.65	7.50	5359.15
2	42.943723	-106.332793	5375.89	7.50	5383.39

Name: Route 2 - I25 South
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	42.906630	-106.338744	5250.12	7.50	5257.62
2	42.892292	-106.341026	5266.56	7.50	5274.06

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array 1	SA tracking	SA tracking	1,369	4,948	-
PV array 2	SA tracking	SA tracking	984	2,325	-
PV array 3	SA tracking	SA tracking	533	36	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 1 - Runway 03	926	0
FP 2 - Runway 21	0	0
FP 3 - Runway 26	0	0
FP 4 - Runway 08	621	0
1-ATCT	1208	2412
OP 2	0	13
OP 3	2	63
OP 4	9	497
OP 5	56	1678

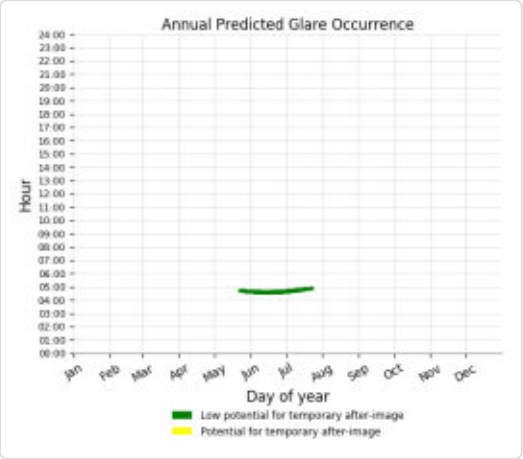
Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 6	64	2646
Route 1 - I25 North	0	0
Route 2 - I25 South	0	0

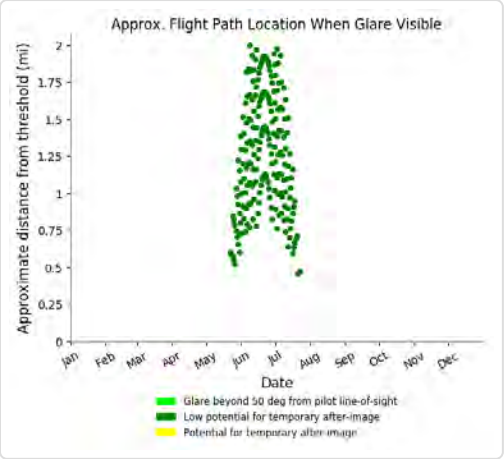
Results for: PV array 1

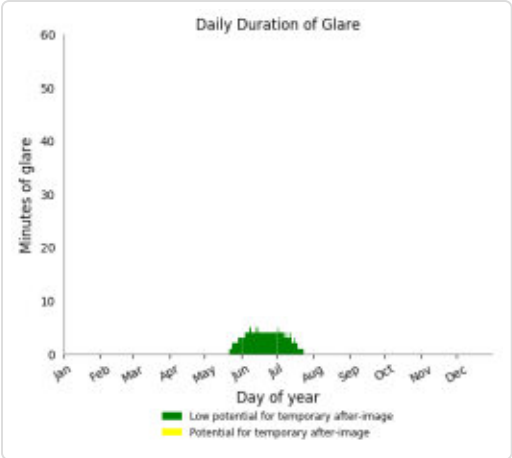
Receptor	Green Glare (min)	Yellow Glare (min)
FP 1 - Runway 03	205	0
FP 2 - Runway 21	0	0
FP 3 - Runway 26	0	0
FP 4 - Runway 08	186	0
1-ATCT	890	305
OP 2	0	0
OP 3	2	0
OP 4	9	428
OP 5	56	1620
OP 6	21	2595
Route 1 - I25 North	0	0
Route 2 - I25 South	0	0

Flight Path: FP 1 - Runway 03

0 minutes of yellow glare
205 minutes of green glare







Flight Path: FP 2 - Runway 21

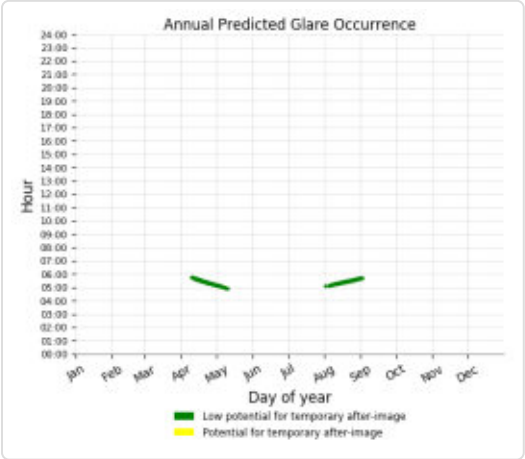
0 minutes of yellow glare
0 minutes of green glare

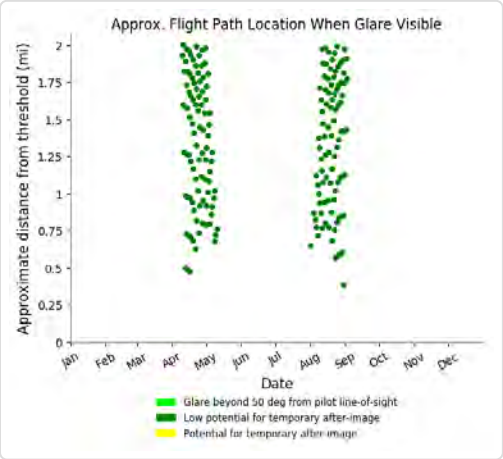
Flight Path: FP 3 - Runway 26

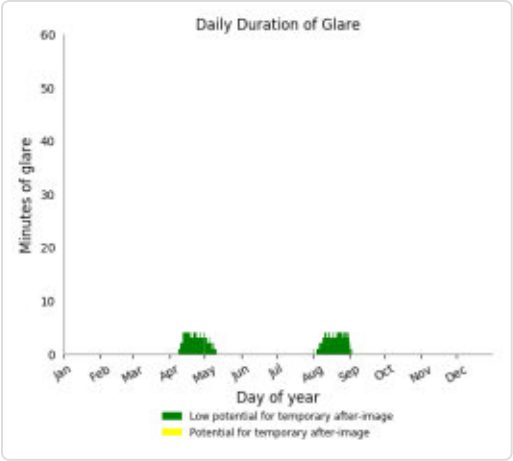
0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4 - Runway 08

0 minutes of yellow glare
186 minutes of green glare

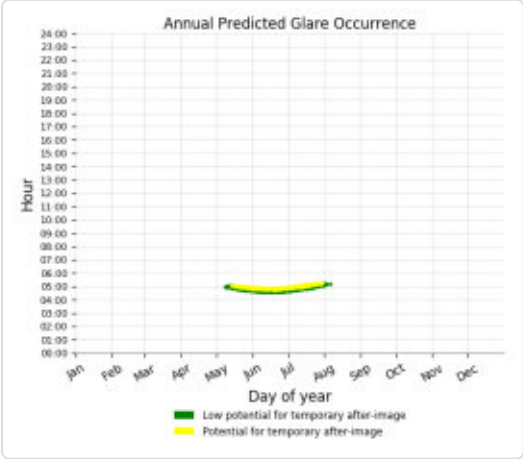


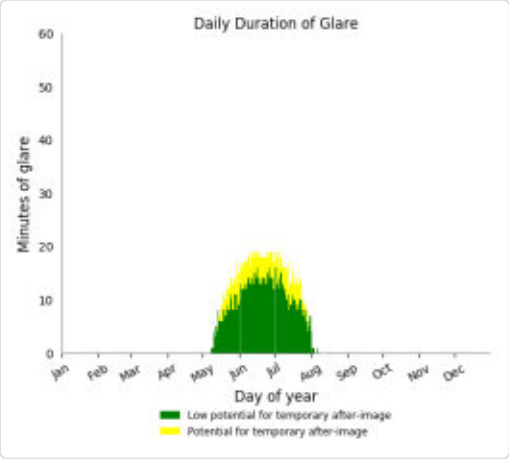




Point Receptor: 1-ATCT

305 minutes of yellow glare
890 minutes of green glare



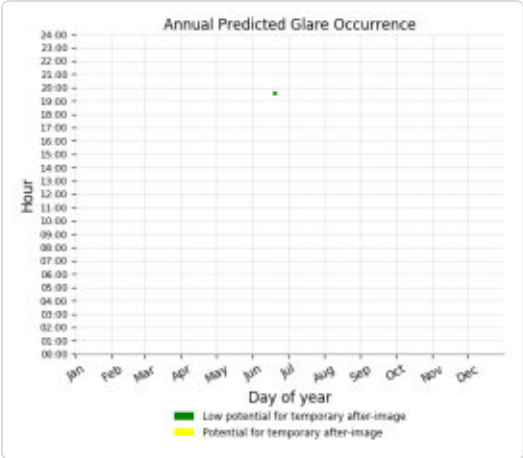


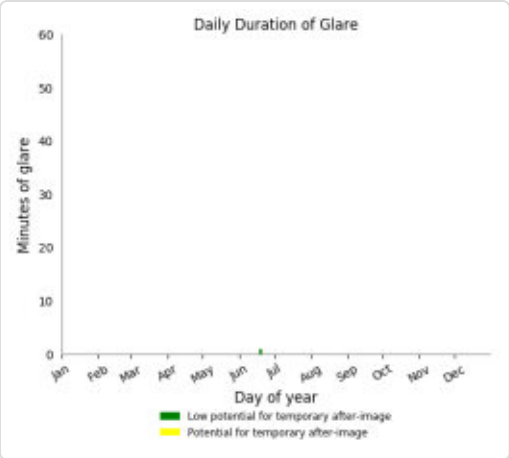
Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

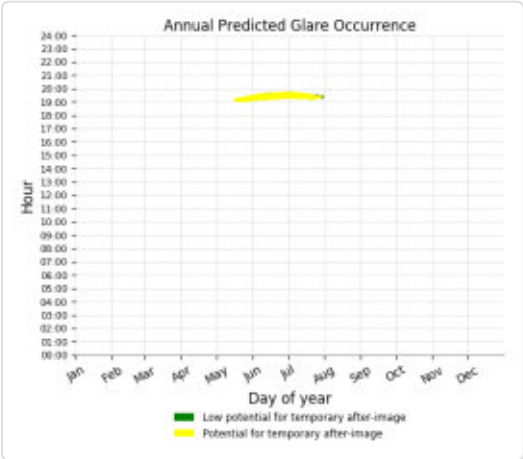
0 minutes of yellow glare
2 minutes of green glare

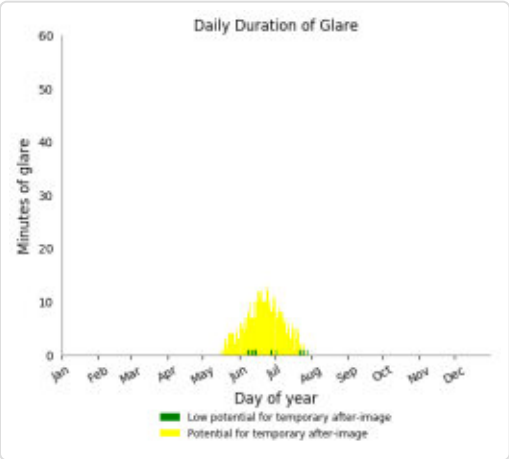




Point Receptor: OP 4

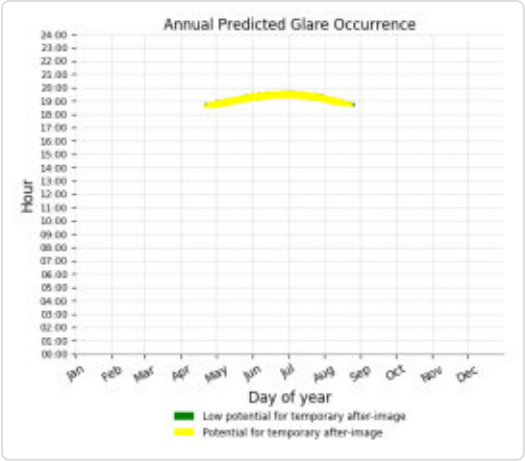
428 minutes of yellow glare
9 minutes of green glare

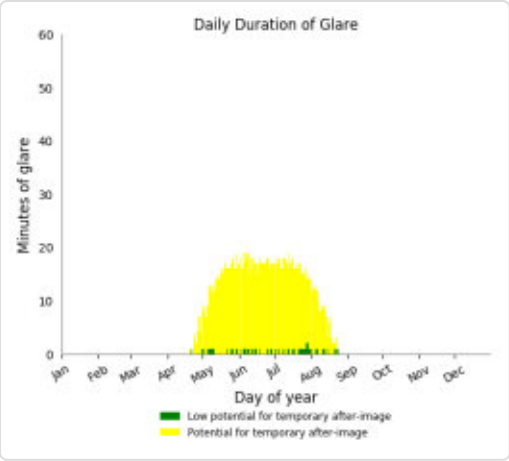




Point Receptor: OP 5

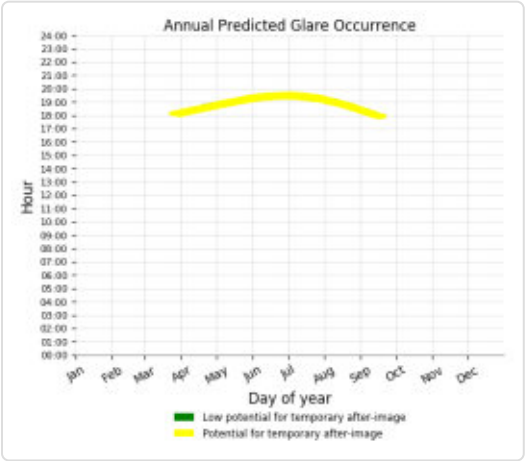
1620 minutes of yellow glare
56 minutes of green glare

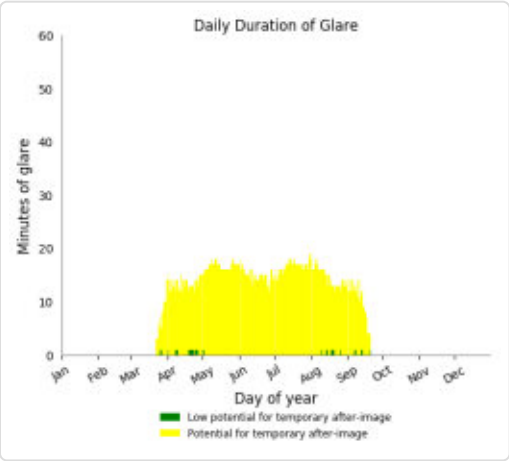




Point Receptor: OP 6

2595 minutes of yellow glare
21 minutes of green glare





Route: Route 1 - I25 North

0 minutes of yellow glare
0 minutes of green glare

Route: Route 2 - I25 South

0 minutes of yellow glare
0 minutes of green glare

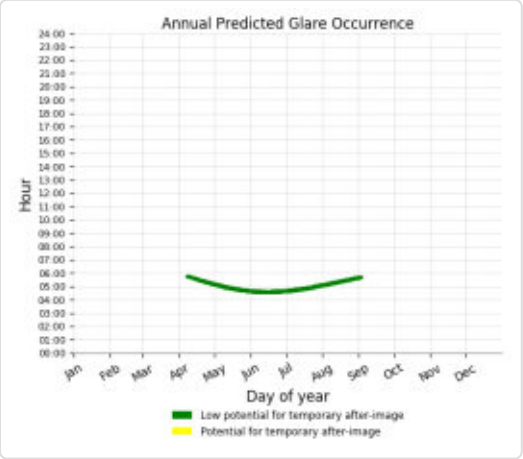
Results for: PV array 2

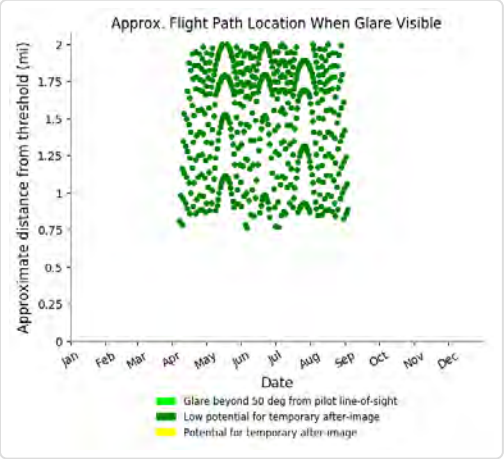
Receptor	Green Glare (min)	Yellow Glare (min)
FP 1 - Runway 03	524	0
FP 2 - Runway 21	0	0
FP 3 - Runway 26	0	0
FP 4 - Runway 08	291	0
1-ATCT	169	2107
OP 2	0	13
OP 3	0	63
OP 4	0	69
OP 5	0	58
OP 6	0	15
Route 1 - I25 North	0	0
Route 2 - I25 South	0	0

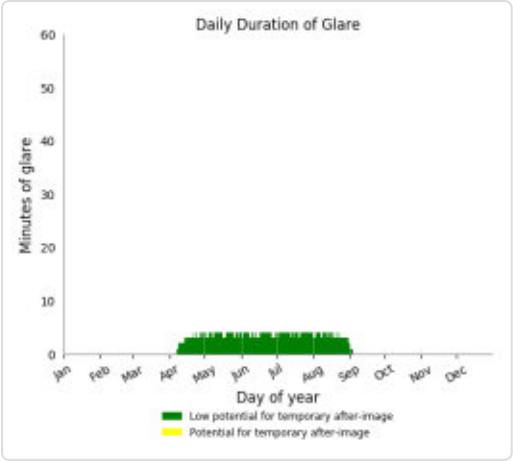
Flight Path: FP 1 - Runway 03

0 minutes of yellow glare

524 minutes of green glare







Flight Path: FP 2 - Runway 21

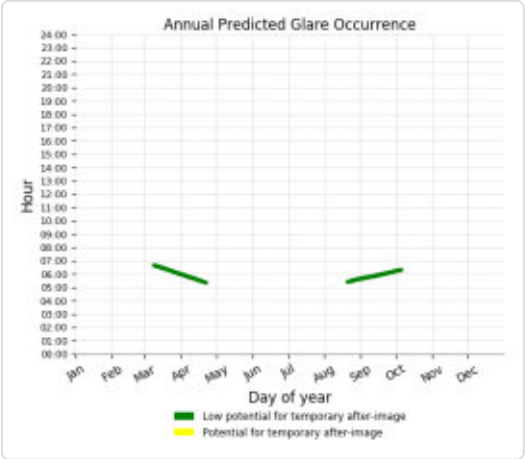
0 minutes of yellow glare
0 minutes of green glare

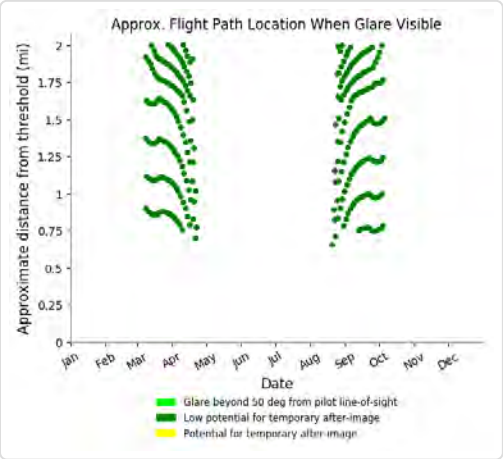
Flight Path: FP 3 - Runway 26

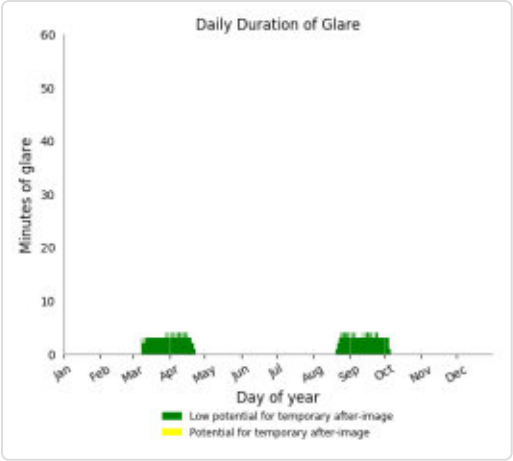
0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4 - Runway 08

0 minutes of yellow glare
291 minutes of green glare

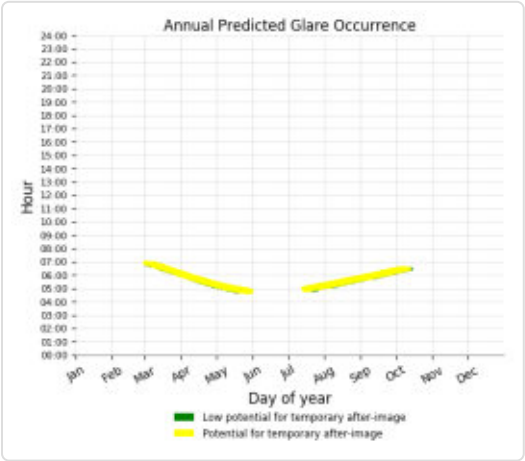


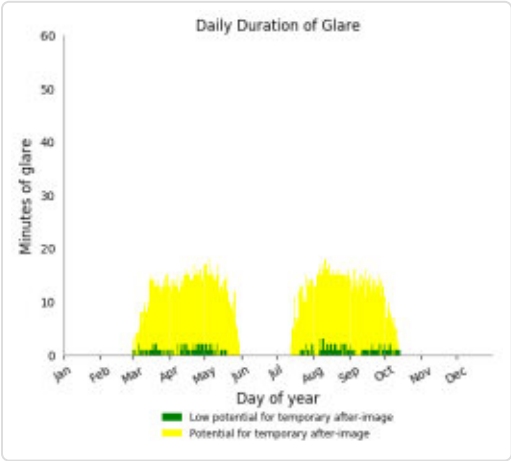




Point Receptor: 1-ATCT

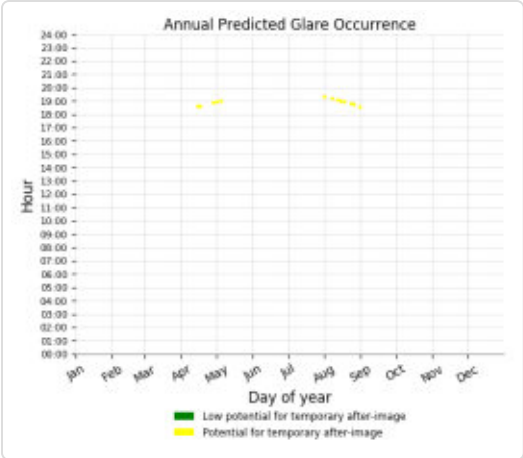
2107 minutes of yellow glare
169 minutes of green glare

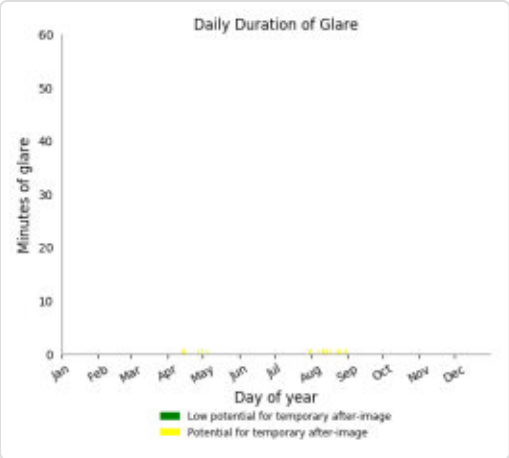




Point Receptor: OP 2

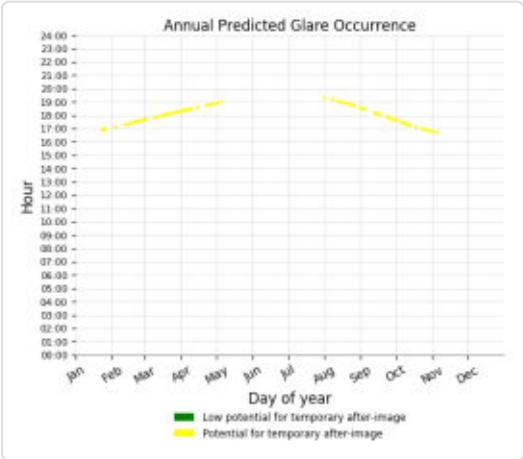
13 minutes of yellow glare
0 minutes of green glare

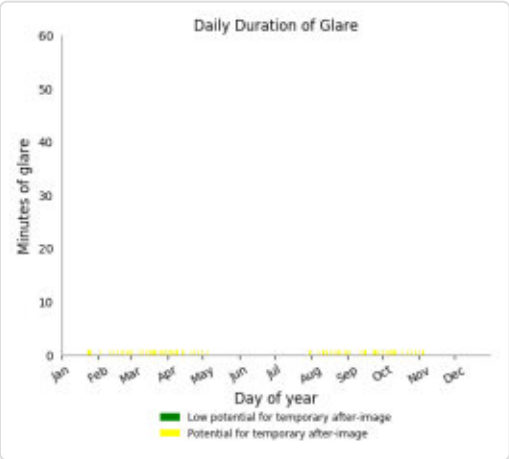




Point Receptor: OP 3

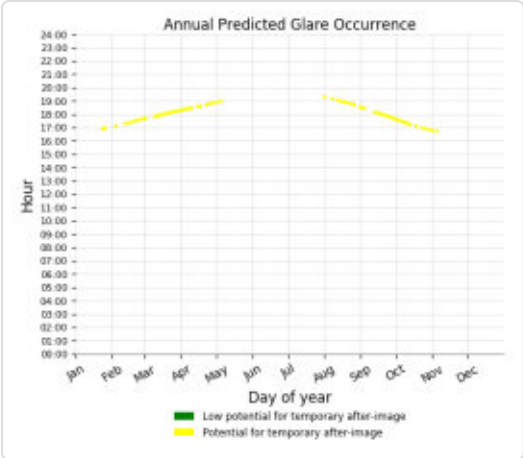
63 minutes of yellow glare
0 minutes of green glare

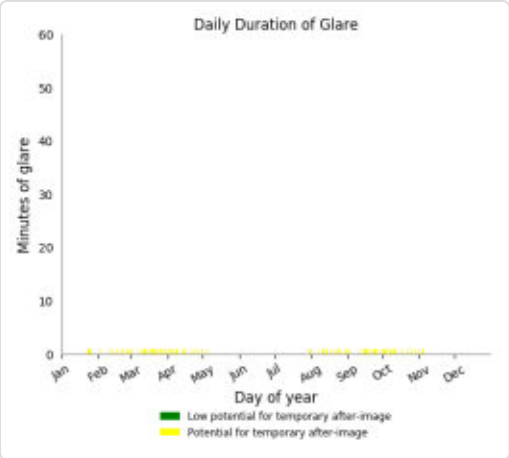




Point Receptor: OP 4

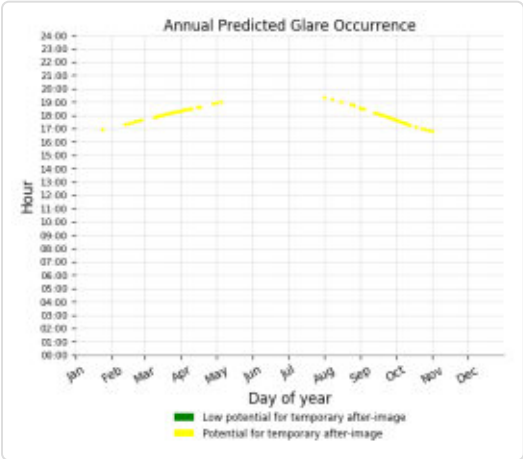
69 minutes of yellow glare
0 minutes of green glare

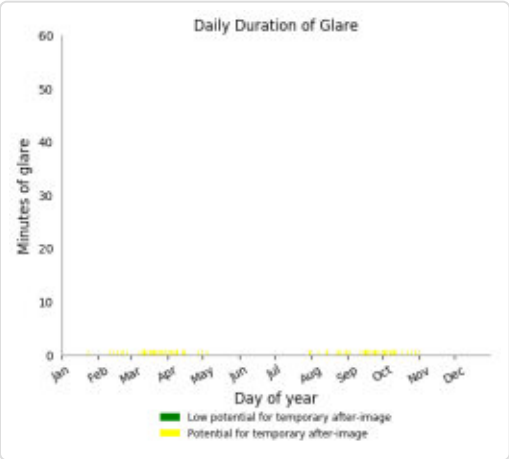




Point Receptor: OP 5

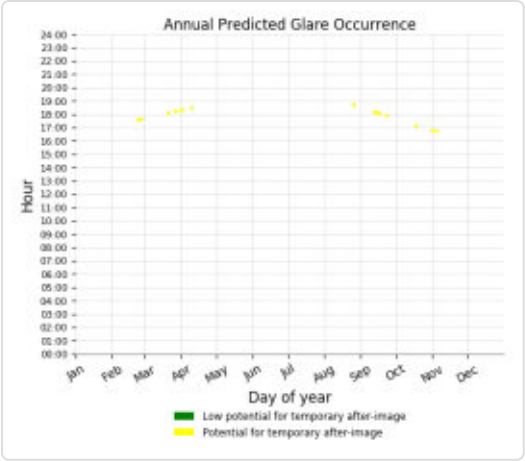
58 minutes of yellow glare
0 minutes of green glare

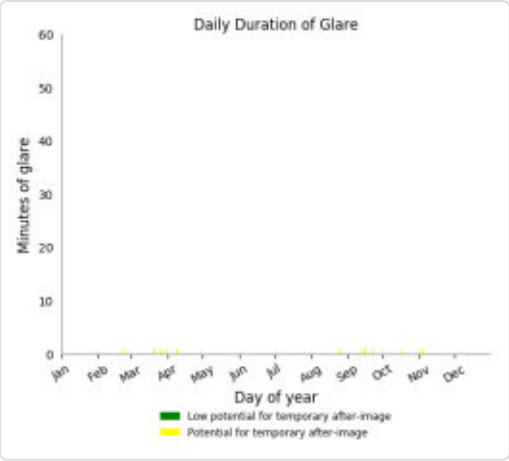




Point Receptor: OP 6

15 minutes of yellow glare
0 minutes of green glare





Route: Route 1 - I25 North

0 minutes of yellow glare
0 minutes of green glare

Route: Route 2 - I25 South

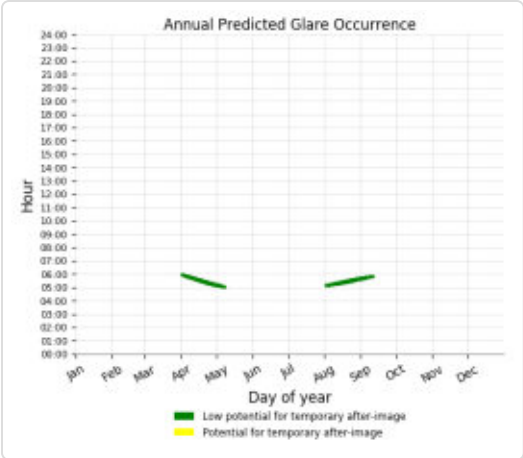
0 minutes of yellow glare
0 minutes of green glare

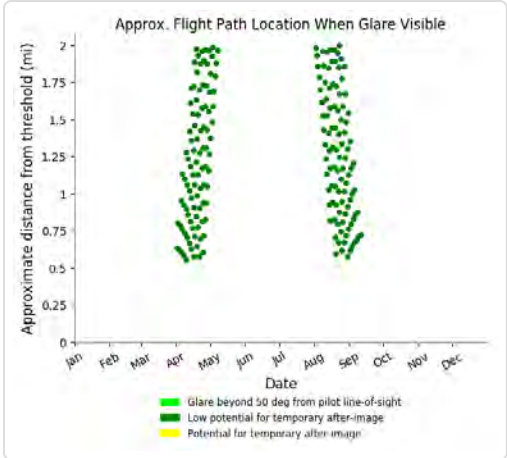
Results for: PV array 3

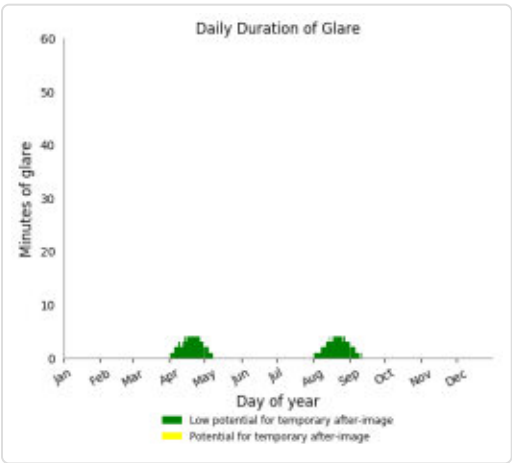
Receptor	Green Glare (min)	Yellow Glare (min)
FP 1 - Runway 03	197	0
FP 2 - Runway 21	0	0
FP 3 - Runway 26	0	0
FP 4 - Runway 08	144	0
1-ATCT	149	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	43	36
Route 1 - I25 North	0	0
Route 2 - I25 South	0	0

Flight Path: FP 1 - Runway 03

0 minutes of yellow glare
197 minutes of green glare







Flight Path: FP 2 - Runway 21

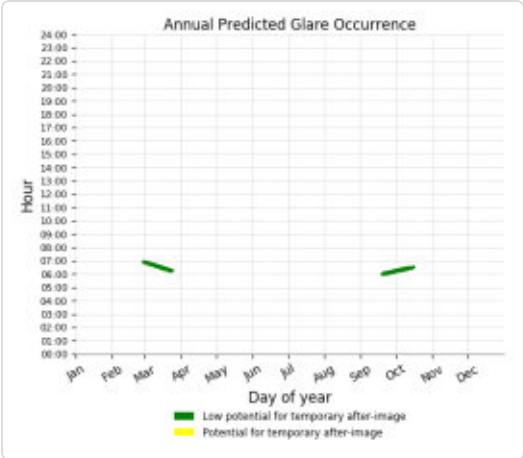
0 minutes of yellow glare
0 minutes of green glare

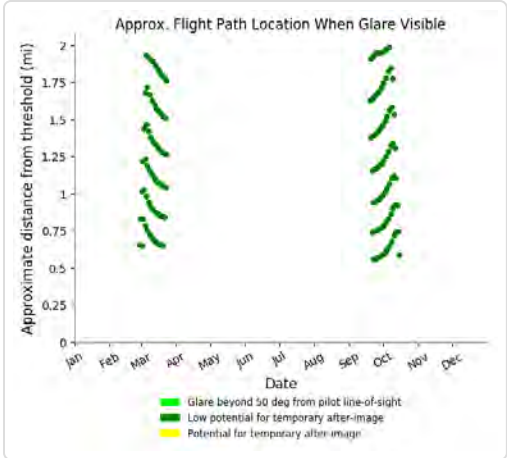
Flight Path: FP 3 - Runway 26

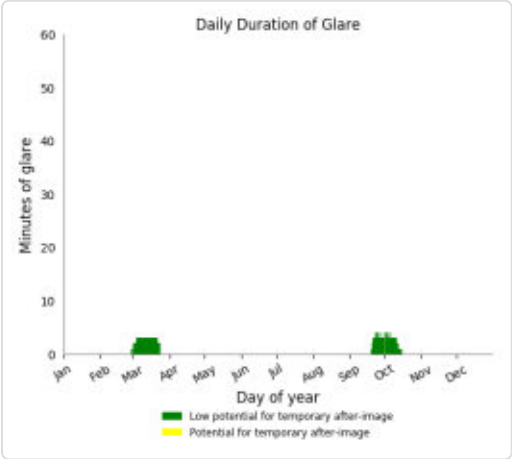
0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4 - Runway 08

0 minutes of yellow glare
144 minutes of green glare

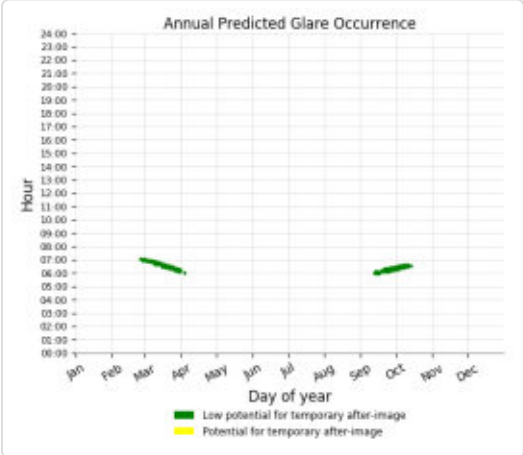


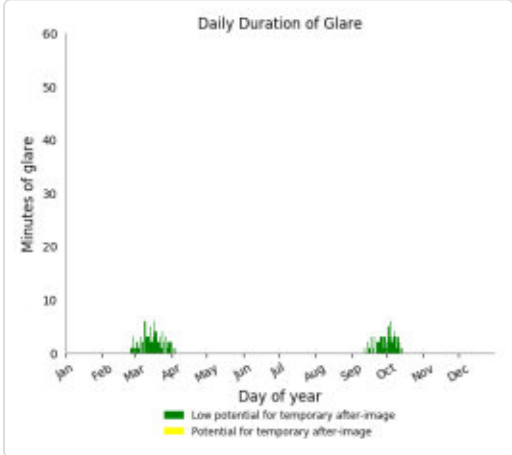




Point Receptor: 1-ATCT

0 minutes of yellow glare
149 minutes of green glare





Point Receptor: OP 2

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

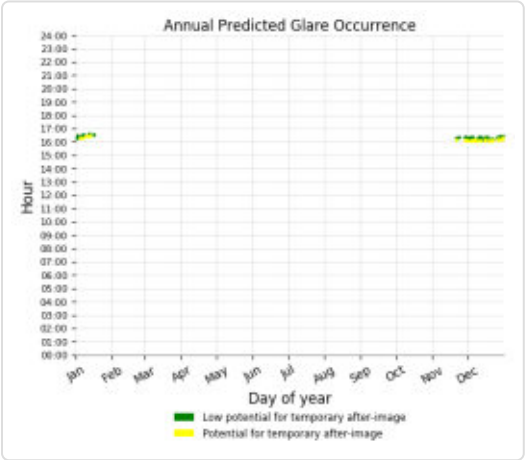
0 minutes of yellow glare
0 minutes of green glare

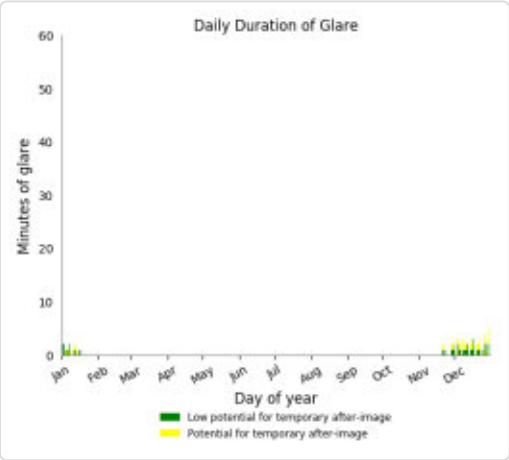
Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

36 minutes of yellow glare
43 minutes of green glare





Route: Route 1 - I25 North

0 minutes of yellow glare
0 minutes of green glare

Route: Route 2 - I25 South

0 minutes of yellow glare
0 minutes of green glare

Assumptions

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

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FORGESOLAR GLARE ANALYSIS

Project: **Dinosolar Glare Analysis**
Site configuration: **Revised Layout - RA 5 deg**
Analysis conducted by Samuel Monger (samuel.monger@aecom.com) at 16:40 on 02 Mar, 2020.

U.S. FAA 2013 Policy Adherence

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

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

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

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

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

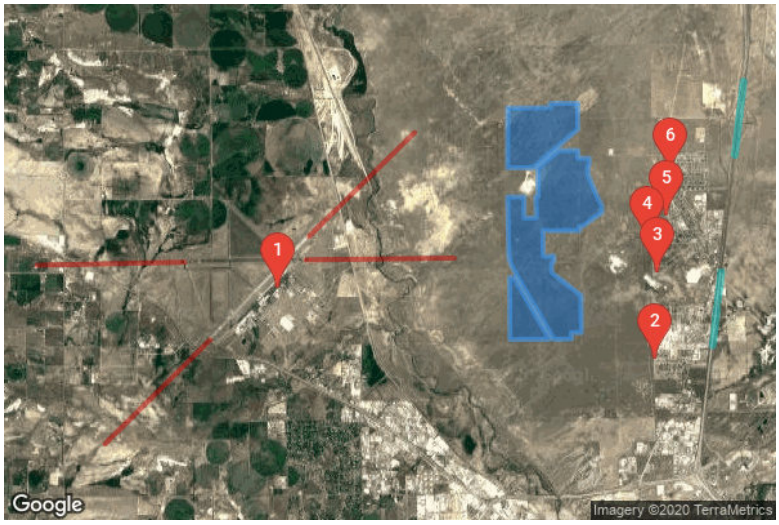
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 36274.6273



PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
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	42.938538	-106.395759	5342.86	4.50	5347.36
2	42.938610	-106.384379	5357.54	4.50	5362.04
3	42.939404	-106.384371	5364.80	4.50	5369.30
4	42.939477	-106.377007	5344.85	4.50	5349.35
5	42.934385	-106.377042	5322.13	4.50	5326.63
6	42.926940	-106.388820	5272.22	4.50	5276.72
7	42.926915	-106.395719	5284.35	4.50	5288.86

Name: PV array 2
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
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	42.930282	-106.376970	5319.07	4.50	5323.57
2	42.928753	-106.376951	5325.76	4.50	5330.26
3	42.928765	-106.374009	5348.57	4.50	5353.07
4	42.927690	-106.373958	5357.66	4.50	5362.16
5	42.926945	-106.374337	5357.02	4.50	5361.52
6	42.925455	-106.374250	5353.79	4.50	5358.29
7	42.921654	-106.372089	5349.54	4.50	5354.04
8	42.919481	-106.370592	5346.96	4.50	5351.46
9	42.918204	-106.370581	5351.00	4.50	5355.50
10	42.915492	-106.375773	5345.35	4.50	5349.85
11	42.915475	-106.376615	5346.24	4.50	5350.74
12	42.914665	-106.376620	5339.43	4.50	5343.93
13	42.914632	-106.386335	5303.82	4.50	5308.32
14	42.909635	-106.386240	5336.24	4.50	5340.74
15	42.909722	-106.383447	5335.35	4.50	5339.85
16	42.908767	-106.383408	5329.35	4.50	5333.85
17	42.908067	-106.384022	5331.29	4.50	5335.79
18	42.906508	-106.383969	5325.35	4.50	5329.85
19	42.901975	-106.376151	5319.78	4.50	5324.28
20	42.894771	-106.376062	5313.60	4.50	5318.10
21	42.894774	-106.378712	5315.90	4.50	5320.40
22	42.893520	-106.378726	5314.39	4.50	5318.89
23	42.893491	-106.383411	5312.07	4.50	5316.57
24	42.907462	-106.394511	5335.59	4.50	5340.09
25	42.909246	-106.395379	5328.29	4.50	5332.79
26	42.921209	-106.395748	5270.82	4.50	5275.32
27	42.921232	-106.391345	5267.46	4.50	5271.96
28	42.917125	-106.391331	5276.69	4.50	5281.19
29	42.917137	-106.388081	5284.30	4.50	5288.80
30	42.921269	-106.388211	5270.42	4.50	5274.92
31	42.921279	-106.387631	5271.39	4.50	5275.89
32	42.925995	-106.387669	5271.58	4.50	5276.08
33	42.926788	-106.387641	5273.56	4.50	5278.06
34	42.928518	-106.384981	5279.56	4.50	5284.06
35	42.930268	-106.382134	5291.07	4.50	5295.57

Name: PV array 3
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
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	42.893485	-106.384599	5318.41	4.50	5322.91
2	42.905460	-106.394046	5328.23	4.50	5332.73
3	42.905455	-106.395248	5329.65	4.50	5334.16
4	42.893411	-106.395095	5326.23	4.50	5330.73

Flight Path Receptor(s)

Name: FP 1 - Runway 03
Description:
Threshold height: 50 ft
Direction: 45.4°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	42.893401	-106.475044	5324.52	50.00	5374.52
Two-mile	42.873086	-106.503158	5278.51	649.46	5927.97

Name: FP 2 - Runway 21
Description:
Threshold height: 50 ft
Direction: 225.6°
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	42.913509	-106.448761	5326.10	50.00	5376.10
Two-mile	42.933756	-106.420546	5336.27	593.29	5929.55

Name: FP 3 - Runway 26
Description:
Threshold height: 50 ft
Direction: 269.3°
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	42.908950	-106.449543	5323.99	50.00	5373.99
Two-mile	42.909293	-106.410025	5279.65	647.80	5927.45

Name: FP 4 - Runway 08
Description:
Threshold height: 50 ft
Direction: 88.8°
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	42.908487	-106.481920	5343.75	50.00	5393.75
Two-mile	42.907902	-106.521433	5342.03	605.17	5947.21

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
1-ATCT	1	42.903361	-106.456847	5324.65	43.00
OP 2	2	42.889562	-106.356400	5295.55	7.50
OP 3	3	42.906303	-106.355635	5263.89	7.50
OP 4	4	42.912504	-106.358485	5252.45	7.50
OP 5	5	42.917495	-106.353188	5309.43	7.50
OP 6	6	42.925725	-106.352236	5351.25	7.50

Map image of 1-ATCT

Route Receptor(s)

Name: Route 1 - I25 North
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	42.929396	-106.335099	5351.65	7.50	5359.15
2	42.943723	-106.332793	5375.89	7.50	5383.39

Name: Route 2 - I25 South
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	42.906630	-106.338744	5250.12	7.50	5257.62
2	42.892292	-106.341026	5266.56	7.50	5274.06

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array 1	SA tracking	SA tracking	0	0	-
PV array 2	SA tracking	SA tracking	0	0	-
PV array 3	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 1 - Runway 03	0	0
FP 2 - Runway 21	0	0
FP 3 - Runway 26	0	0
FP 4 - Runway 08	0	0
1-ATCT	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 6	0	0
Route 1 - I25 North	0	0
Route 2 - I25 South	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
FP 1 - Runway 03	0	0
FP 2 - Runway 21	0	0
FP 3 - Runway 26	0	0
FP 4 - Runway 08	0	0
1-ATCT	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
Route 1 - I25 North	0	0
Route 2 - I25 South	0	0

Flight Path: FP 1 - Runway 03

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 2 - Runway 21

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 3 - Runway 26

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4 - Runway 08

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Route: Route 1 - I25 North

0 minutes of yellow glare
0 minutes of green glare

Route: Route 2 - I25 South

0 minutes of yellow glare
0 minutes of green glare

Results for: PV array 2

Receptor	Green Glare (min)	Yellow Glare (min)
FP 1 - Runway 03	0	0
FP 2 - Runway 21	0	0
FP 3 - Runway 26	0	0
FP 4 - Runway 08	0	0
1-ATCT	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
Route 1 - I25 North	0	0
Route 2 - I25 South	0	0

Flight Path: FP 1 - Runway 03

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 2 - Runway 21

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 3 - Runway 26

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4 - Runway 08

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Route: Route 1 - I25 North

0 minutes of yellow glare
0 minutes of green glare

Route: Route 2 - I25 South

0 minutes of yellow glare
0 minutes of green glare

Results for: PV array 3

Receptor	Green Glare (min)	Yellow Glare (min)
FP 1 - Runway 03	0	0
FP 2 - Runway 21	0	0
FP 3 - Runway 26	0	0
FP 4 - Runway 08	0	0
1-ATCT	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
Route 1 - I25 North	0	0
Route 2 - I25 South	0	0

Flight Path: FP 1 - Runway 03

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 2 - Runway 21

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 3 - Runway 26

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4 - Runway 08

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Route: Route 1 - I25 North

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2 - I25 South

0 minutes of yellow glare
0 minutes of green glare

Assumptions

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

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