

Solar Array



Underground Collection Line  
Easement



Key Observation Point

Viewshed Model



Not Visible



Visible



CIVIL ENGINEERING  
DEVELOPMENT CONSULTING  
NATURAL RESOURCES CONSULTING  
LAND SURVEYING  
**303.703.4444**  
1950 W. Littleton Blvd., Ste. 109  
Littleton, CO 80120

# Grazing Yak Solar Project

## Key Observation Point Location Map

El Paso County, Colorado

Date: 9/28/2018



# Grazing Yak Solar Project - Key Observation Point 1

Modeled View  
August 2018

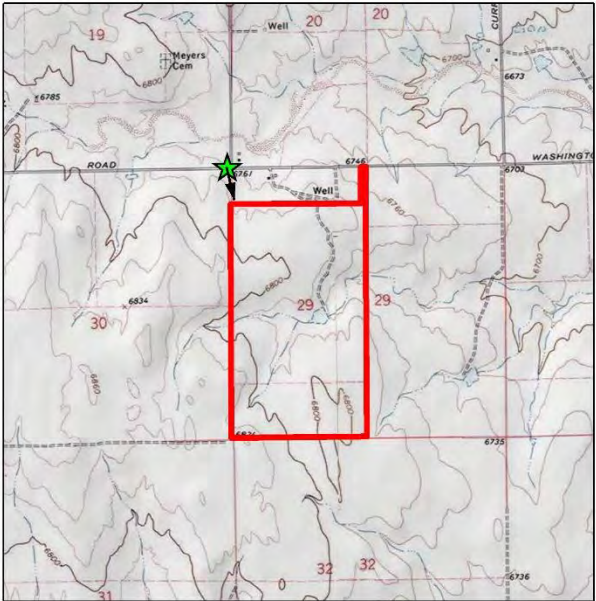


**KOP 1**

**Name**  
Washington Road & McQueen Road

**Latitude/Longitude**  
38.983635/-104.4257688

**Direction/Distance**  
North/±725 ft



Vicinity Map

Proposed View



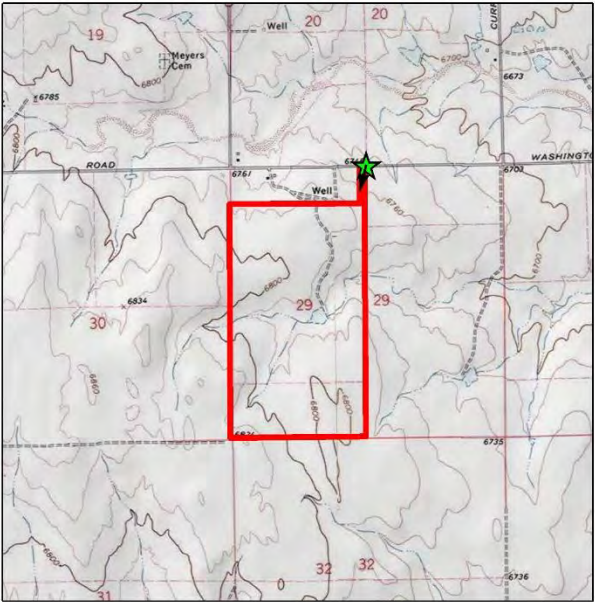


# Grazing Yak Solar Project - Key Observation Point 2

Modeled View  
August 2018



**KOP 2**  
**Name**  
Washington Road at Project Access  
**Latitude/Longitude**  
38.983593/-104.248206  
**Direction/Distance**  
North/±725 ft



Vicinity Map

Proposed View





# Grazing Yak Solar Project - Key Observation Point 3

Modeled View  
August 2018

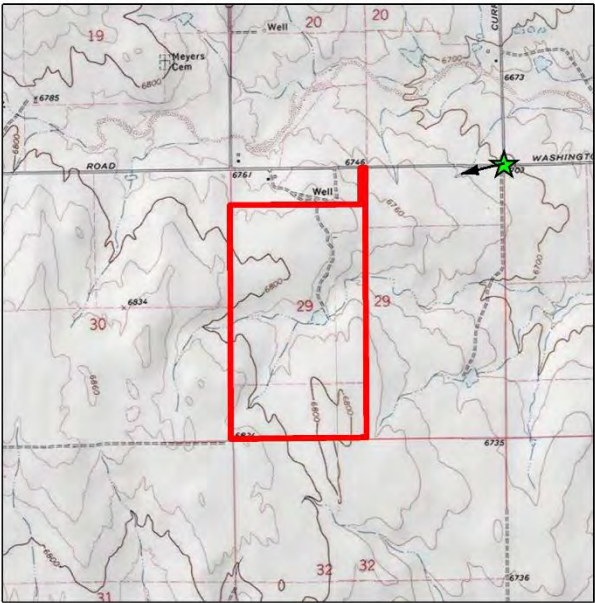


**KOP 3**

**Name**  
Washington Road & Currier Road

**Latitude/Longitude**  
38.983651/-104.238897

**Direction/Distance**  
Northeast/±2,880 ft



Vicinity Map

Proposed View



Project #18-082  
Date 9/21/2018





# Grazing Yak Solar Project - Key Observation Point 4

Modeled View  
August 2018

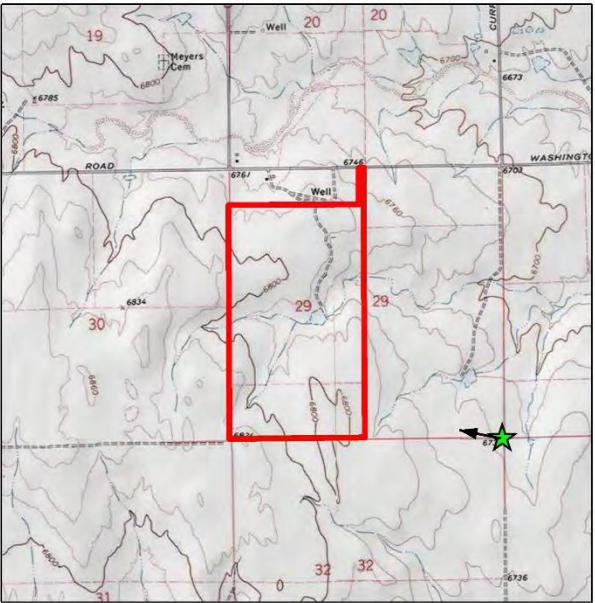


**KOP 4**

**Name**  
Currier Road Southern Project Extent

**Latitude/Longitude**  
38.969207/-104.239164

**Direction/Distance**  
East/±2,650 ft



Vicinity Map

Proposed View





# Grazing Yak Solar Project - Key Observation Point 5

Modeled View  
August 2018

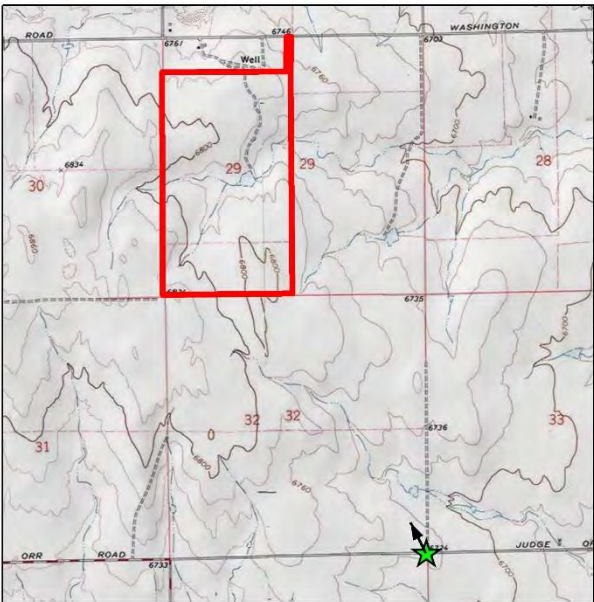


**KOP 5**

**Name**  
Judge Orr & Currier Road

**Latitude/Longitude**  
38.954836/-104.239183

**Direction/Distance**  
Southeast/±5,880 ft



Vicinity Map

Proposed View





Grazing Yak Solar Project - Key Observation Point 6

Modeled View  
August 2018

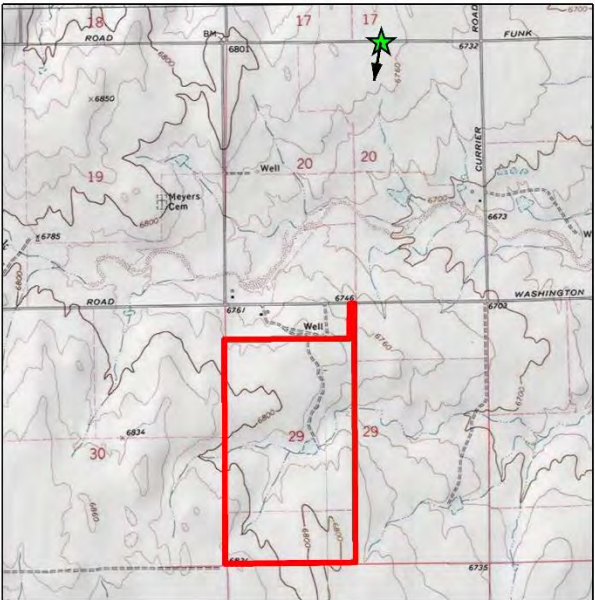


**KOP 6**

**Name**  
Funk Road

**Latitude/Longitude**  
38.997932/-104.239183

**Direction/Distance**  
North/±10,450 ft



Vicinity Map

Proposed View







## GlareGauge Glare Analysis Results

### Site Configuration: Grazing Yak

Project site configuration details and results.



Created **Sept. 28, 2018 3:21 p.m.**  
 Updated **Sept. 28, 2018 4:02 p.m.**  
 DNI **varies** and peaks at **1,000.0 W/m<sup>2</sup>**  
 Analyze every **1 minute(s)**  
**0.5** ocular transmission coefficient  
**0.002 m** pupil diameter  
**0.017 m** eye focal length  
**9.3 mrad** sun subtended angle  
 Timezone **UTC-7**  
 Site Configuration ID: 21497.3679

### Summary of Results

Glare with low potential for temporary after-image predicted

| PV name    | Tilt        | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced |
|------------|-------------|-------------|---------------|----------------|-----------------|
|            | deg         | deg         | min           | min            | kWh             |
| PV array 1 | SA tracking | SA tracking | 13,860        | 0              | -               |

### Component Data

#### PV Array(s)

Name: PV array 1

Axis tracking: Single-axis rotation

Tracking axis orientation: 180.0 deg

Tracking axis tilt: 60.0 deg

Tracking axis panel offset: 0.0 deg

Maximum tracking angle: 60.0 deg

Resting angle: 60.0 deg

Rated power: -

Panel material: Smooth glass without AR coating

Vary reflectivity with sun position? Yes

Correlate slope error with surface type? Yes

Slope error: 6.55 mrad

| Vertex | Latitude  | Longitude   | Ground elevation | Height above ground | Total elevation |
|--------|-----------|-------------|------------------|---------------------|-----------------|
|        | deg       | deg         | ft               | ft                  | ft              |
| 1      | 38.969174 | -104.257648 | 6824.39          | 4.80                | 6829.19         |
| 2      | 38.969174 | -104.248421 | 6782.32          | 4.80                | 6787.12         |
| 3      | 38.981985 | -104.248378 | 6759.29          | 4.80                | 6764.09         |
| 4      | 38.982019 | -104.257648 | 6773.74          | 4.80                | 6778.54         |



#### Flight Path Receptor(s)



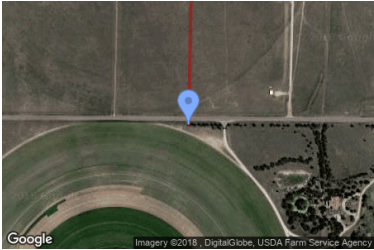
**Name:** FP 1  
**Description:**  
**Threshold height :** 50 ft  
**Direction:** 99.7 deg  
**Glide slope:** 3.0 deg  
**Pilot view restricted?** Yes  
**Vertical view restriction:** 30.0 deg  
**Azimuthal view restriction:** 50.0 deg

| Point        | Latitude  | Longitude   | Ground elevation | Height above ground | Total elevation |
|--------------|-----------|-------------|------------------|---------------------|-----------------|
|              | deg       | deg         | ft               | ft                  | ft              |
| Threshold    | 38.892089 | -104.185572 | 6414.13          | 50.00               | 6464.13         |
| 2-mile point | 38.896980 | -104.222226 | 6484.23          | 533.35              | 7017.58         |



**Name:** FP 2  
**Description:**  
**Threshold height :** 50 ft  
**Direction:** 181.0 deg  
**Glide slope:** 3.0 deg  
**Pilot view restricted?** Yes  
**Vertical view restriction:** 30.0 deg  
**Azimuthal view restriction:** 50.0 deg

| Point        | Latitude  | Longitude   | Ground elevation | Height above ground | Total elevation |
|--------------|-----------|-------------|------------------|---------------------|-----------------|
|              | deg       | deg         | ft               | ft                  | ft              |
| Threshold    | 38.953790 | -104.398088 | 6377.65          | 50.00               | 6427.66         |
| 2-mile point | 38.982698 | -104.397432 | 6458.23          | 522.88              | 6981.11         |





Discrete Observation Receptors

| Number | Latitude  | Longitude   | Ground elevation | Height above ground | Total Elevation |
|--------|-----------|-------------|------------------|---------------------|-----------------|
|        | deg       | deg         | ft               | ft                  | ft              |
| OP 1   | 38.983541 | -104.270394 | 6812.16          | 0.00                | 6812.16         |
| OP 2   | 38.983574 | -104.257648 | 6758.47          | 0.00                | 6758.47         |
| OP 3   | 38.983507 | -104.238980 | 6705.33          | 0.00                | 6705.33         |
| OP 4   | 38.955008 | -104.220617 | 6640.88          | 0.00                | 6640.88         |
| OP 5   | 38.954892 | -104.239231 | 6727.03          | 0.00                | 6727.03         |
| OP 6   | 38.954524 | -104.294291 | 6845.11          | 0.00                | 6845.11         |
| OP 7   | 38.969006 | -104.258053 | 6825.73          | 0.00                | 6825.73         |
| 8-ATCT | 38.816483 | -104.699069 | 6179.76          | 50.00               | 6229.77         |

8-ATCT map image





## PV Array Results

### PV array 1 low potential for temporary after-image

| Component  | Green glare (min) | Yellow glare (min) |
|------------|-------------------|--------------------|
| FP: FP 1   | 0                 | 0                  |
| FP: FP 2   | 0                 | 0                  |
| OP: OP 1   | 0                 | 0                  |
| OP: OP 2   | 0                 | 0                  |
| OP: OP 3   | 0                 | 0                  |
| OP: OP 4   | 1728              | 0                  |
| OP: OP 5   | 3448              | 0                  |
| OP: OP 6   | 644               | 0                  |
| OP: OP 7   | 8040              | 0                  |
| OP: 8-ATCT | 0                 | 0                  |

#### PV array 1 - Flight Path Receptor (FP 1)

*No glare found*

#### PV array 1 - Flight Path Receptor (FP 2)

*No glare found*

#### PV array 1 - OP Receptor (OP 1)

*No glare found*

#### PV array 1 - OP Receptor (OP 2)

*No glare found*

#### PV array 1 - OP Receptor (OP 3)

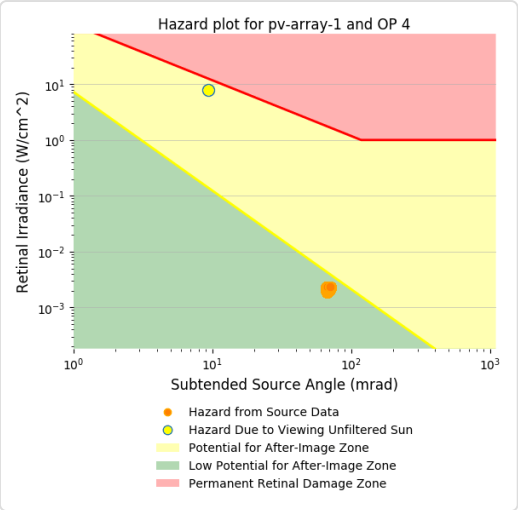
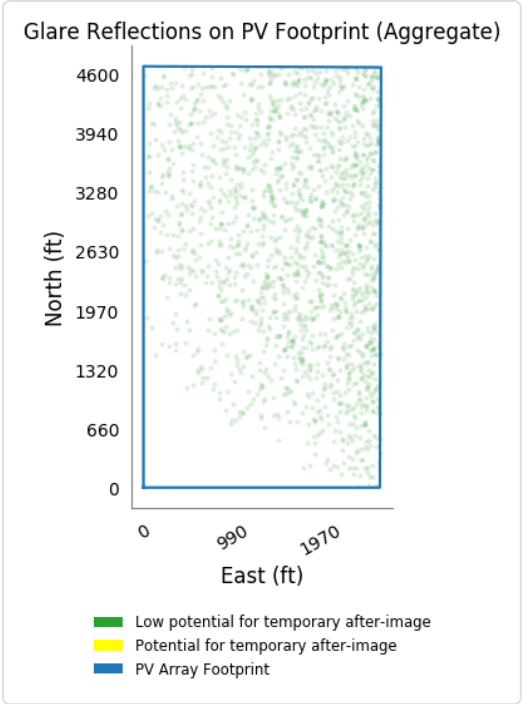
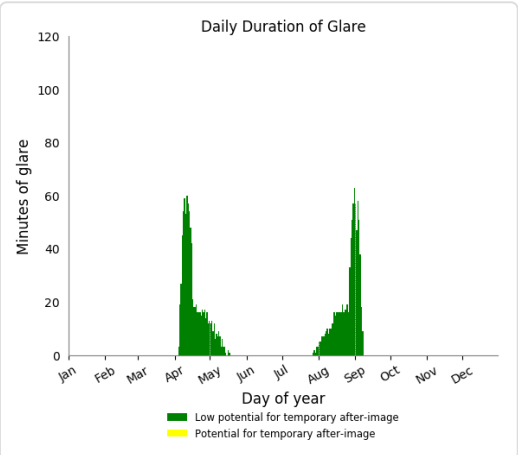
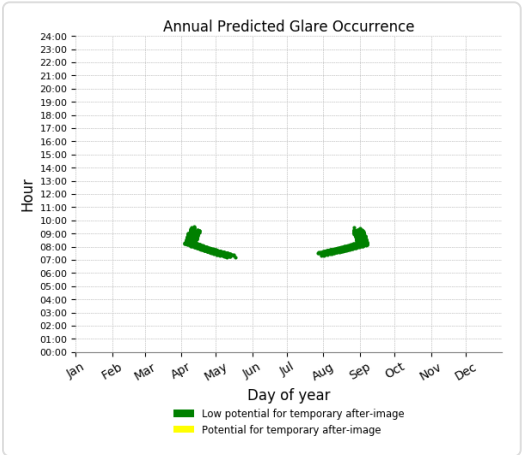
*No glare found*



PV array 1 - OP Receptor (OP 4)

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

- 1,728 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

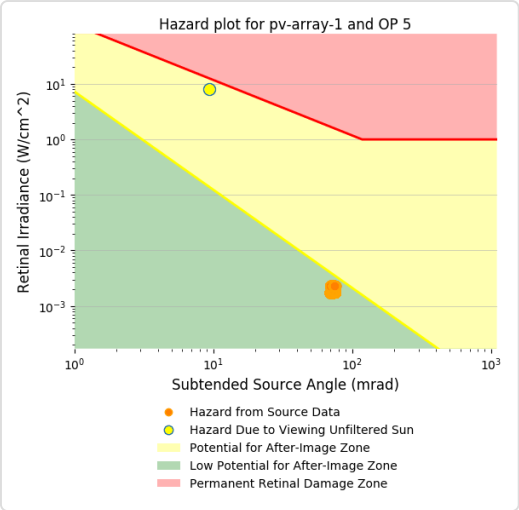
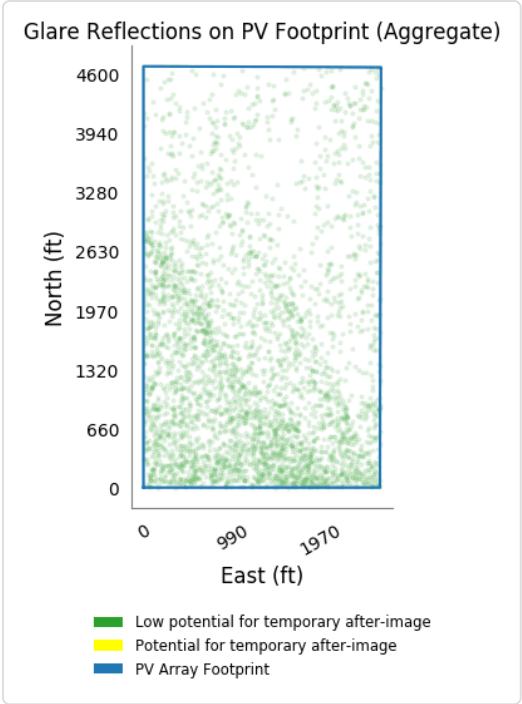
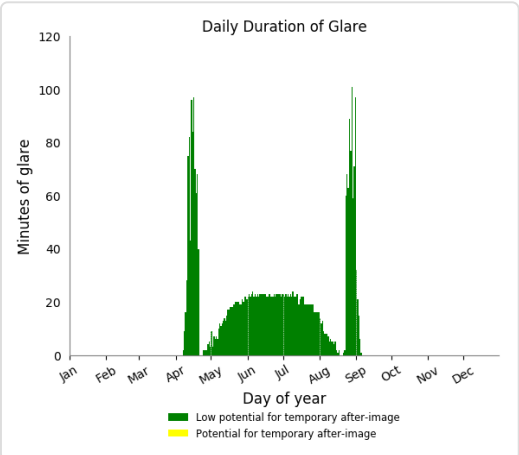
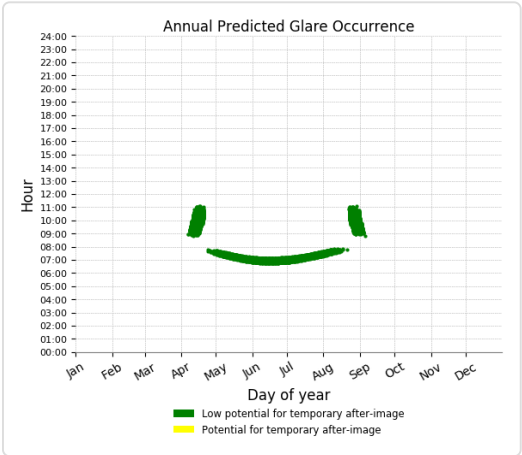




PV array 1 - OP Receptor (OP 5)

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

- 3,448 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

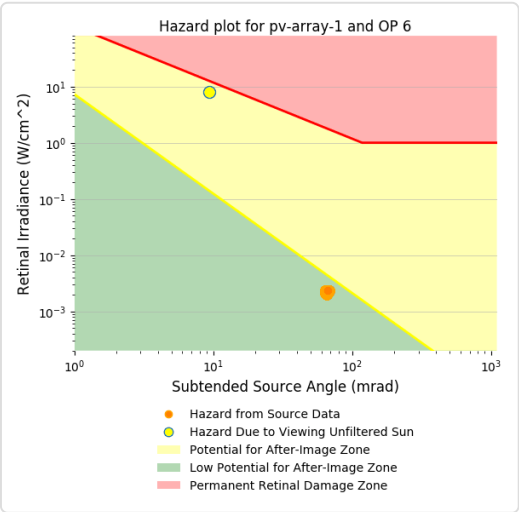
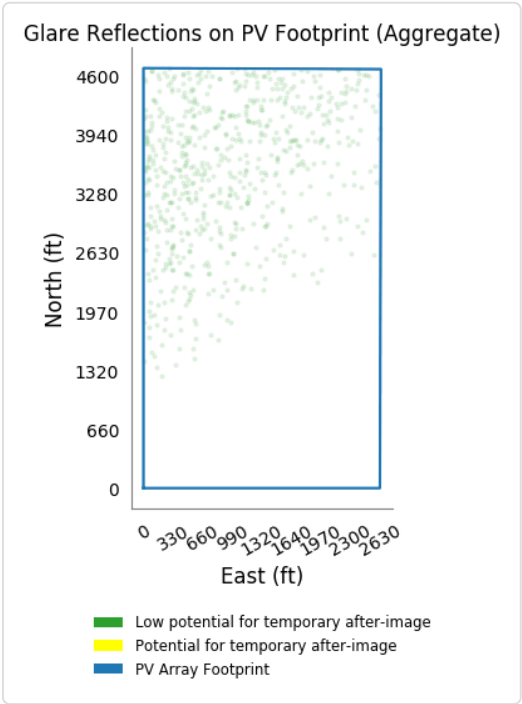
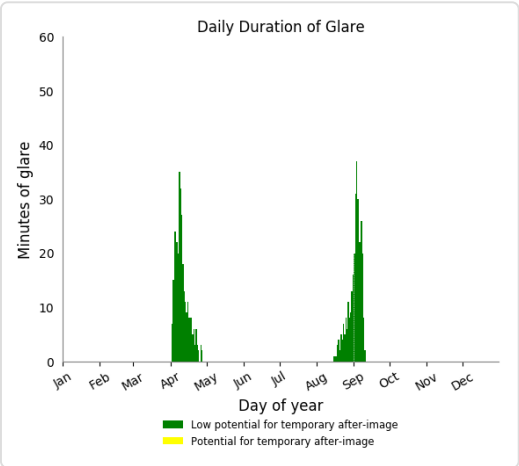
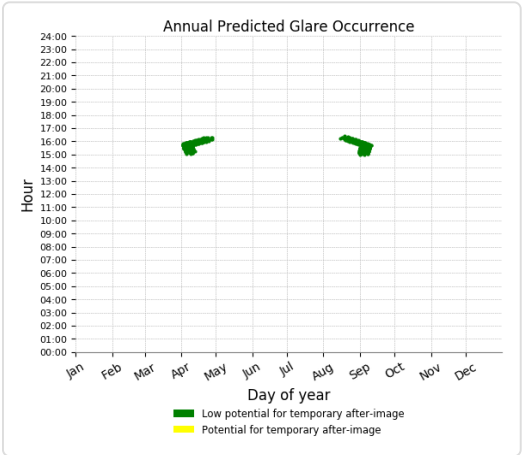




PV array 1 - OP Receptor (OP 6)

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

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

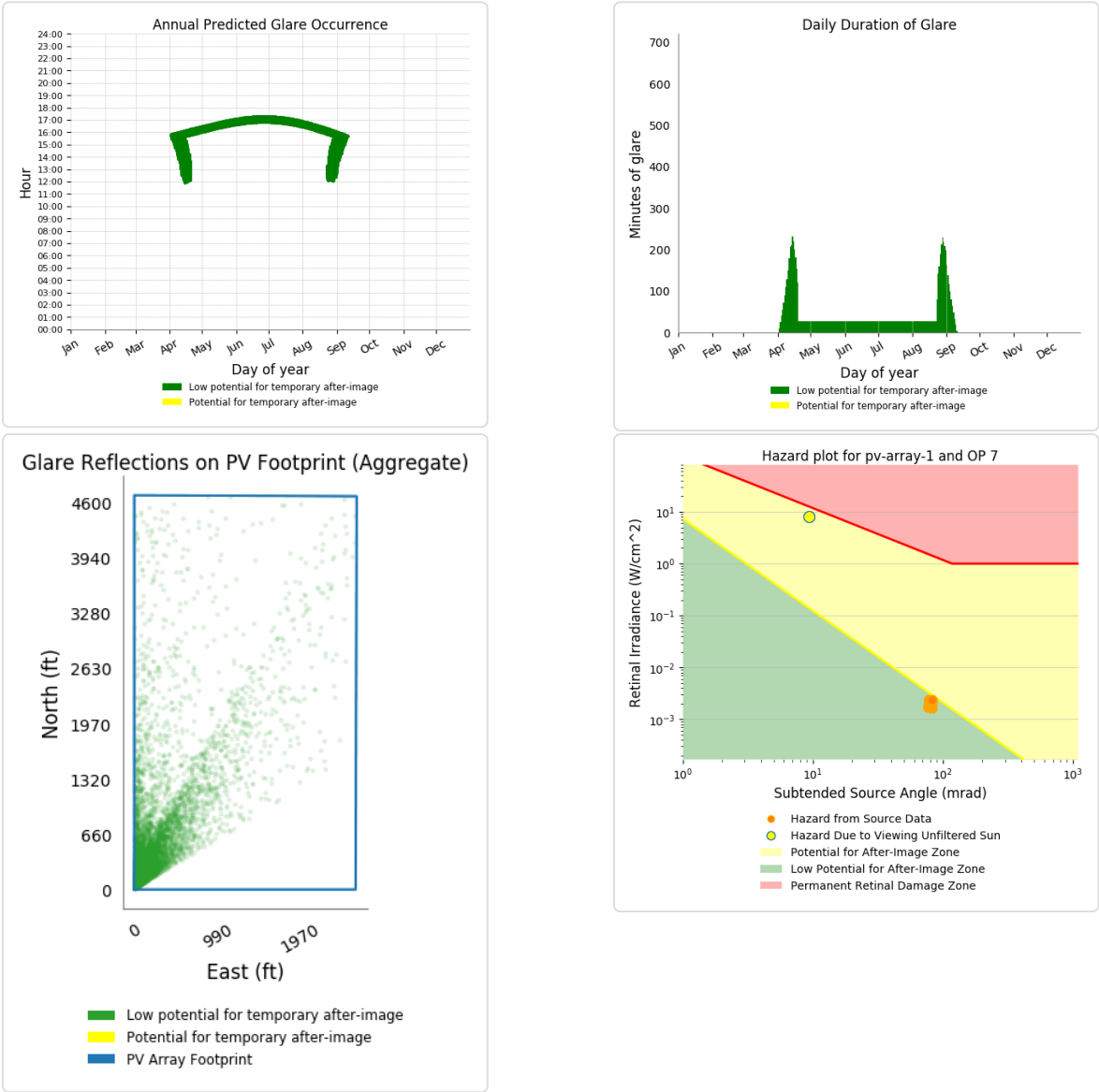




PV array 1 - OP Receptor (OP 7)

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

- 8,040 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



PV array 1 - OP Receptor (8-ATCT)

No glare found



## Assumptions

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- 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.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass : continuous, not discrete, spectrum.



# FORGESOLAR GLARE ANALYSIS

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Project: **Grazing Yak**

PV Array El Paso County

Site configuration: **Grazing Yak**

Analysis conducted by Leonard Powell (powell@corecivil.com) at 20:01 on 28 Sep, 2018.

## 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 and observer eye characteristics are as follows:

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

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



# SITE CONFIGURATION

## Analysis Parameters

DNI: peaks at 1,000.0 W/m<sup>2</sup>  
Time interval: 1 min  
Ocular transmission  
coefficient: 0.5  
Pupil diameter: 0.002 m  
Eye focal length: 0.017 m  
Sun subtended angle: 9.3  
mrad  
Site Config ID: 21497.3679



## PV Array(s)

**Name:** PV array 1

*PV google static map*

**Axis tracking:** Single-axis rotation

**Tracking axis orientation:** 180.0°

**Tracking axis tilt:** 60.0°

**Tracking axis panel offset:** 0.0°

**Max tracking angle:** 60.0°

**Resting angle:** 60.0°

**Rated power:** -

**Panel material:** Smooth glass without AR coating

**Reflectivity:** Vary with sun

**Slope error:** correlate with material

| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|--------|--------------|---------------|-----------------------|--------------------------|----------------------|
| 1      | 38.969174    | -104.257648   | 6824.39               | 4.80                     | 6829.19              |
| 2      | 38.969174    | -104.248421   | 6782.32               | 4.80                     | 6787.12              |
| 3      | 38.981985    | -104.248378   | 6759.29               | 4.80                     | 6764.09              |
| 4      | 38.982019    | -104.257648   | 6773.74               | 4.80                     | 6778.54              |



## Flight Path Receptor(s)

**Name:** FP 1

*Flight path map*

**Description:**

**Threshold height:** 50 ft

**Direction:** 99.7°

**Glide slope:** 3.0°

**Pilot view restricted?** Yes

**Vertical view:** 30.0°

**Azimuthal view:** 50.0°

| Point     | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|-----------|--------------|---------------|-----------------------|--------------------------|----------------------|
| Threshold | 38.892089    | -104.185572   | 6414.13               | 50.00                    | 6464.13              |
| Two-mile  | 38.896980    | -104.222226   | 6484.23               | 533.35                   | 7017.58              |

**Name:** FP 2

*Flight path map*

**Description:**

**Threshold height:** 50 ft

**Direction:** 181.0°

**Glide slope:** 3.0°

**Pilot view restricted?** Yes

**Vertical view:** 30.0°

**Azimuthal view:** 50.0°

| Point     | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|-----------|--------------|---------------|-----------------------|--------------------------|----------------------|
| Threshold | 38.953790    | -104.398088   | 6377.65               | 50.00                    | 6427.66              |
| Two-mile  | 38.982698    | -104.397432   | 6458.23               | 522.88                   | 6981.11              |

## Discrete Observation Receptors

| Name   | ID | Latitude (°) | Longitude (°) | Elevation (ft) | Height (ft) |
|--------|----|--------------|---------------|----------------|-------------|
| OP 1   | 1  | 38.983541    | -104.270394   | 6812.16        | 0.00        |
| OP 2   | 2  | 38.983574    | -104.257648   | 6758.47        | 0.00        |
| OP 3   | 3  | 38.983507    | -104.238980   | 6705.33        | 0.00        |
| OP 4   | 4  | 38.955008    | -104.220617   | 6640.88        | 0.00        |
| OP 5   | 5  | 38.954892    | -104.239231   | 6727.03        | 0.00        |
| OP 6   | 6  | 38.954524    | -104.294291   | 6845.11        | 0.00        |
| OP 7   | 7  | 38.969006    | -104.258053   | 6825.73        | 0.00        |
| 8-ATCT | 8  | 38.816483    | -104.699069   | 6179.76        | 50.00       |

*Map image of 8-ATCT*

*OP map*



# GLARE ANALYSIS RESULTS

## Summary of Glare

| PV Array Name | Tilt           | Orient         | "Green" Glare | "Yellow" Glare | Energy |
|---------------|----------------|----------------|---------------|----------------|--------|
|               | (°)            | (°)            | min           | min            | kWh    |
| PV array 1    | SA<br>tracking | SA<br>tracking | 13,860        | 0              | -      |

*Total annual glare received by each receptor*

| Receptor | Annual Green Glare (min) | Annual Yellow Glare (min) |
|----------|--------------------------|---------------------------|
| FP 1     | 0                        | 0                         |
| FP 2     | 0                        | 0                         |
| OP 1     | 0                        | 0                         |
| OP 2     | 0                        | 0                         |
| OP 3     | 0                        | 0                         |
| OP 4     | 1728                     | 0                         |
| OP 5     | 3448                     | 0                         |
| OP 6     | 644                      | 0                         |
| OP 7     | 8040                     | 0                         |
| 8-ATCT   | 0                        | 0                         |

## Results for: PV array 1

| Receptor | Green Glare (min) | Yellow Glare (min) |
|----------|-------------------|--------------------|
| FP 1     | 0                 | 0                  |
| FP 2     | 0                 | 0                  |
| OP 1     | 0                 | 0                  |
| OP 2     | 0                 | 0                  |
| OP 3     | 0                 | 0                  |
| OP 4     | 1728              | 0                  |
| OP 5     | 3448              | 0                  |
| OP 6     | 644               | 0                  |
| OP 7     | 8040              | 0                  |
| 8-ATCT   | 0                 | 0                  |



**Flight Path: FP 1**

0 minutes of yellow glare  
0 minutes of green glare

**Flight Path: FP 2**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 1**

0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 2**

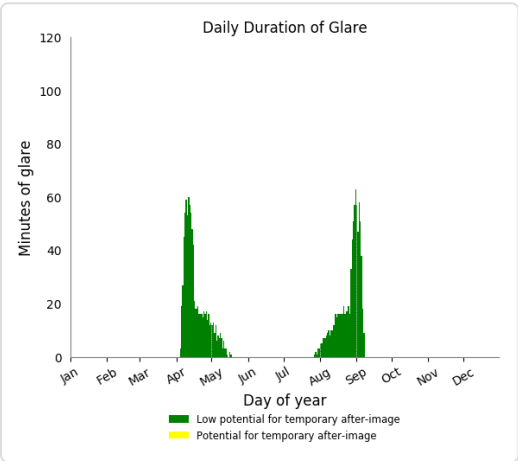
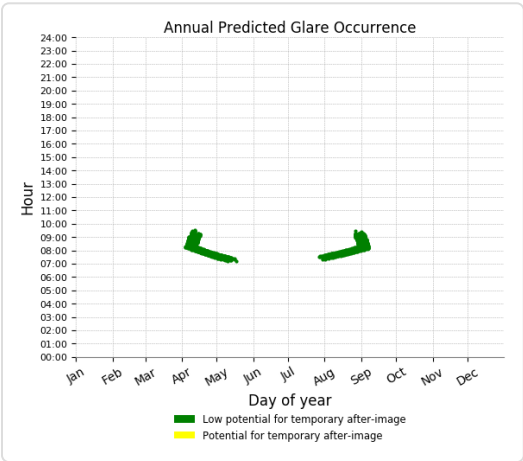
0 minutes of yellow glare  
0 minutes of green glare

**Point Receptor: OP 3**

0 minutes of yellow glare  
0 minutes of green glare

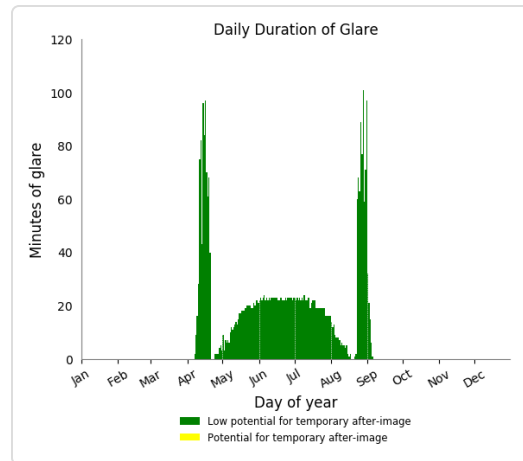
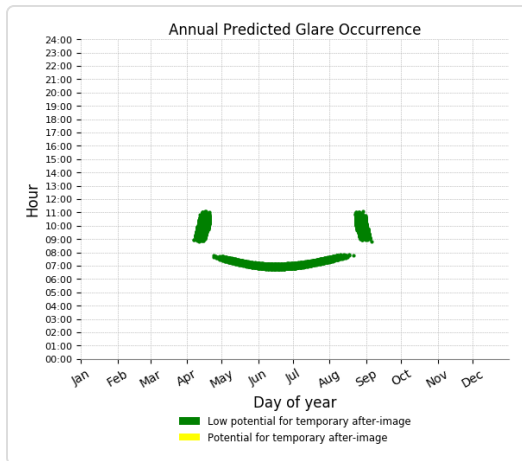
**Point Receptor: OP 4**

0 minutes of yellow glare  
1728 minutes of green glare



**Point Receptor: OP 5**

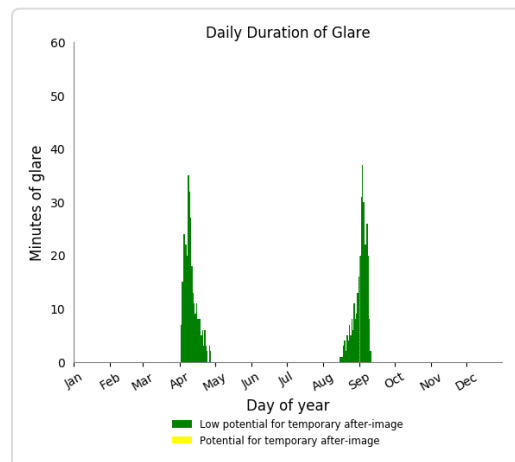
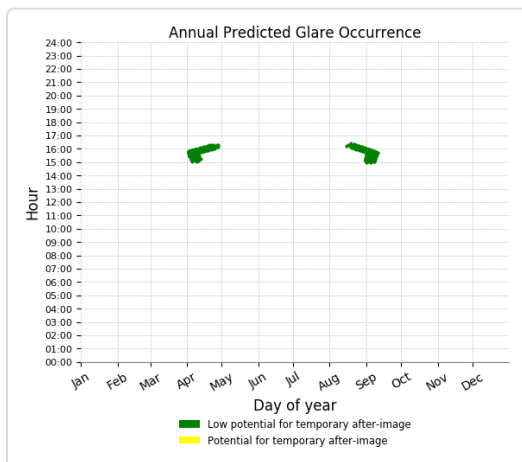
0 minutes of yellow glare  
3448 minutes of green glare



## Point Receptor: OP 6

0 minutes of yellow glare

644 minutes of green glare

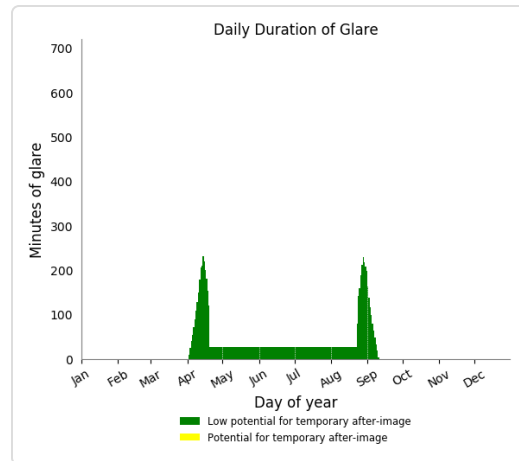
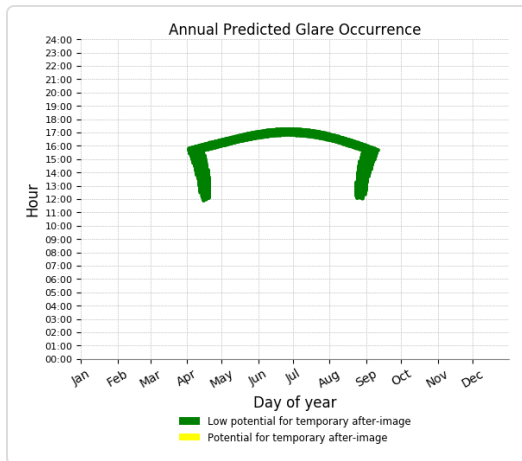


## Point Receptor: OP 7

0 minutes of yellow glare

8040 minutes of green glare





## Point Receptor: 8-ATCT

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.

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