Technical Appendix 7: Glint and Glare Assessment

Penpergwm Solar Farm

23/06/2021

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STATEMENT OF PURPOSE

This draft Glint and Glare Assessment is being published to accompany pre-application consultation carried out under Articles 8 and 9 of the Development of National Significance (Procedure) (Wales) Order 2016. The formal pre-application consultation runs until 25th August 2021. This report is to be read in conjunction with the accompanying reports and plans:

- *Volume 3, Technical Appendix 1A: Landscape and Visual Appraisal*
- *Volume 3, Technical Appendix 1B: Green Infrastructure Strategy*

EXECUTIVE SUMMARY

7.1. This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km survey area around the Application Site is considered adequate for the assessment of ground-based receptors, whilst a 30km study area is chosen for aviation receptors. Within 1km of the Application Site, there are 73 residential receptors and 54 road receptors which were considered. As per the methodology section, where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for full assessment as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group have been assessed in detail. 25 residential and 26 road-based receptors were dismissed as they are located within the no reflection zones and therefore, will not be impacted upon by the Proposed Development. There were four aviation assets within 30km of the Proposed Development. However, only Abergavenny Airfield required a detailed assessment as the Proposed Development is located within its respective safeguarding buffer zones, which are outlined in paragraph 7.67.

7.2. The solar panels will face south and will be inclined at an angle of 25 degrees and at a height of 2.8 m above ground level (AGL). As the panels will be fixed in this position, points at the tops of the panels have been used to determine the worst-case impacts on receptors.

7.3. Geometric analysis was conducted for 48 residential receptors (40 individual receptors, plus eight where a proxy receptor was chosen) and 28 road receptors.

7.4. Following an initial assessment, rail receptors were scoped out as assets that will be impacted upon from the Proposed Development as the closest rail receptor falls outside of the 1km study area.

7.5. The assessment concludes that:

- Solar reflections are possible at 48 of 73 residential receptors within the 1km study area. The initial impacts as **High** at 19 receptors, **Medium** at six receptors, **Low** at 16, including one residential area, and **None** at seven receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **None** at all receptors, including one residential area. Therefore, overall impacts on residential receptors are **None**.

- Solar reflections are possible at 28 of 54 road receptors within the 1km study area. Upon reviewing the actual visibility of the road receptors, glint and glare impacts reduce to **Low** at two receptors and **None** at 26 receptors. Once mitigation was taken into consideration impacts remained **Low** at two receptors and **None** at the remaining 26 receptors. Therefore, overall impacts on road receptors are **Low** and **acceptable impacts**.

- **No impact** on train drivers or railway infrastructure is predicted.

- Both runways at Abergavenny Airfield will have **No impacts**. Therefore, overall aviation impacts are **None**.

7.6. Although **no mitigation** is required to be put in place as the highest impacts are **Low** at Road Receptors 9 and 10, a number have been included as part of the GI Plan (See **Figure 1.23a: Technical Appendix 1: Landscape and Visual Impact Assessment**). These measures include hedgerow planting along the northeast boundary of Field 11. By combining this hedgerow with the location of the sun at the time of impact upon Road Receptors 9 and 10, the impacts will remain **Low**.

7.7. The effects of glint and glare and their impact on local receptors has been analysed in detail and there is predicted to be no impacts, and therefore **No Effects** at residential and aviation receptors. However, road receptors are expected to have **Low** and therefore **acceptable impacts**.

INTRODUCTION

Background

7.8. Neo Environmental Ltd has been appointed by Great House Energy Centre Limited (the "Applicant") to complete a Glint and Glare Assessment for a proposed solar farm and associated infrastructure (the "Proposed Development") on land 0.5km north of Penpergwm and c. 3.9km southeast of Abergavenny, Monmouthshire (the "Application Site").

7.9. Please see **Figure 4 of Volume 2: Planning Application Drawings** for the layout of the Proposed Development.

Development Description

7.10. The Proposed Development consists of the construction of a 40MW solar farm and will comprise PV panels mounted on metal frames, inverter and transformer units, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, a temporary construction compound and all ancillary grid infrastructure and associated works.

Site Description

7.11. The Application Site is located on land 0.5km north of Penpergwm and c. 3.9km southeast of Abergavenny, Monmouthshire; the approximate centre point of which is Grid Reference E332954, N211435. Comprising 14 agricultural fields, the Application Site measures 70.03 hectares (ha) in total with only c. 17.61 hectares of the landscape under the solar arrays themselves. See **Figure 4 of Volume 2: Planning Application Drawings** for details.

7.12. Land within the Application Site itself is undulating, ranging between 61 – 140m Above Ordnance Datum (AOD) and consists of fields typically of medium scale, bound by a mixture of grassy field margins, semi-mature hedgerows, and intermittent trees (see **Figure 3 of Volume 2: Planning Application Drawings** for field numbers).

7.13. The Application Site is in an area with existing electricity infrastructure with a pylon line crossing Field 3 to the north and running in a north – south direction between Fields 6 and 7 and to the west of Field 8.

7.14. The local area is largely agricultural in nature, punctuated by individual properties and farmsteads; the nearest residential areas are the villages of Penpergwm and The Bryn; located 0.5km and 0.9km north respectively. Recreational Routes include two Public Rights of Way (PRoW) which pass through Fields 8, 9, 10 and 11 in the southern section of the site and an Other Route with Public Access (ORPA) which passes from Great House along the eastern boundary of Field 14 and through the treeline on the southern border of Fields 5, 6 and 7. Another PRoW passes along the northern boundary of Fields 1, 3 and 4.

7.15. While there are a number of drains and watercourses throughout the Application Site, including a small tributary of the Ffrwd Brook bordering Field 11, the site is entirely contained within Flood Zone A, an area described as having a "*Low probability*" of flooding.

7.16. The Application Site will be accessed via an improved farm access situated on the southern boundary. Traffic will approach the site entrance from the south using a local road from Penpergwm for approximately 800m. Traffic will be routed to Penpergwm from the north via the B4598. This road connects to the strategic road network south of Abergavenny at the A40 / A465 interchange.

Scope of Report

7.17. Although there may be small amounts of glint and glare from the metal structures associated with the solar farm, the main source of glint and glare will be from the panels themselves and this will be the focus of this assessment.

7.18. Solar panels are designed to absorb as much light as possible and not to reflect it. However, glint can be produced as a reflection of the sun from the surface of the solar PV panel. This can also be described as a momentary flash and may be an issue due to visual impact and viewer distraction on ground-based receptors and on aviation.

7.19. Glare is significantly less intense in comparison to glint and can be described as a continuous source of bright light, relative to diffused lighting. This is not a direct reflection of the sun, but a reflection of the sky around the sun.

7.20. This report will concentrate on the impacts of glint and its effect on local receptors and will be supported with the following Figures and Appendices.

- Appendix 7A: Figures
  - Figure 7.1: Residential Receptors
  - Figure 7.2: Road Based Receptors
- Appendix 7B: Residential Receptor Results
- Appendix 7C: Road Receptor Results
- Appendix 7D: Aviation Receptor Glare Results
- Appendix 7E: Photo Register
- Appendix 7F: Solar Module Glare and Reflectance Technical Memo[1]

[1] Sunpower Corporation (September 2009), T09014 Solar Module Glare and Reflectance Technical Memo

Statement of Authority

7.21. This Glint and Glare Assessment has been produced by Tom Saddington and Michael McGhee of Neo Environmental Ltd. Having completed a civil engineering degree in 2012, Michael has produced Glint and Glare assessments for over 1GW of solar farm developments across the UK and Ireland. Tom has an undergraduate degree in Bioengineering and graduated with an MSc in Environmental and Energy Engineering in January 2020. He has been working on various technical assessments including glint and glare reports for numerous solar farms in Ireland and the UK.

Definitions

7.22. This study examined the potential hazard and nuisance effects of glint and glare in relation to ground-based receptors, including the occupants of surrounding dwellings as well as road users. The Federal Aviation Guidance (FAA) in their "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[2] have defined the terms 'Glint' and 'Glare' as meaning;

- Glint – *"A momentary flash of bright light"*
- Glare – *"A continuous source of bright light"*

7.23. Glint and glare are essentially the unwanted reflection of sunlight from reflective surfaces. This study used a multi-step process of elimination to determine which receptors had the potential to experience the effects of glint and glare. It then examined, using a computer-generated geometric model, the times of the year and the times of the day such effects could occur. This is based on the relative angles between the sun, the panels and the receptor throughout the year.

General Nature of Reflectance from Photovoltaic Panels

7.24. In terms of reflectance, photovoltaic solar panels are not highly reflective surfaces. They are designed to absorb sunlight and not to reflect it. Nonetheless, photovoltaic panels have a flat polished surface, which omits 'specular' reflectance rather than a 'diffuse' reflectance, which would occur from a rough surface. Several studies have shown that photovoltaic panels (as opposed to Concentrated Solar Power) have similar reflectance characteristics to water, which is much lower than glass, steel, snow and white concrete by comparison (see **Appendix 7F** for details). Similar levels of reflectance can be found in rural environments from shed roofs and the lines of plastic mulch used in cropping. In terms of the potential for reflectance from photovoltaic panels to cause hazard and / or nuisance effects, there have been several studies

[2] Harris, Miller, Miller & Hanson Inc. (November 2010). Technical Guidance for Evaluating Selected Solar Technologies on Airports; 3.1.2 Reflectivity. Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at:

https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide.pdf

undertaken in respect of schemes in close proximity to airports. The most recent of these was compiled by the Solar Trade Association (STA) in April 2016 which used a number of case studies and expert opinions, including from Neo Environmental. The summary of this report states that "*the STA does not believe that there is cause for concern in relation to the impact of glint and glare from solar PV on aviation and airports…*"[3].

Time Zones / Datum's

7.25. Locations in this report are given in Eastings and Northings using the 'British National Grid' grid reference system unless otherwise stated.

7.26. Wales uses British Summer Time (BST, UTC + 01:00) in the summer months and Greenwich Mean Time (UTC+0) in the winter period. For the purposes of this report all time references are in GMT.

[3] Solar Trade Association. (April 2016). *Summary of evidence compiled by the Solar Trade Association to help inform the debate around permitted development for non - domestic solar PV in Scotland. Impact of solar PV on aviation and airports.* Available at: http://www.solar-trade.org.uk/wp-content/uploads/2016/04/STA-glint-and-glare-briefing-April-2016-v3.pdf

LEGISLATION AND GUIDANCE

Future Wales – The National Plan 2040[4]

7.27. *"Policy 17 – Renewable and Low Carbon Energy and Associated Infrastructure"* sets out the planning considerations that relate to large scale renewable energy infrastructure. With the policy specifically mentioning the following about visual impacts:

- *"New strategic grid infrastructure for the transmission and distribution of energy should be designed to minimise visual impact on nearby communities."*

7.28. Although there is no specific mention of Glint and Glare impacts, there will be a consideration towards the visual impact from a Glint and Glare perspective throughout this report.

Planning Policy Wales (PPW): Edition 11

7.29. Planning Policy Wales (PPW) Edition 11 was adopted by the Welsh Government in February 2021. This replaced the previously adopted PPW and sets out the land use planning policy for Wales. Chapter 5 of the PPW outlines the planning policy in relation to 'Renewable and Low Carbon Energy'. With regards to Glint and Glare, it states:

"Planning authorities should also identify and require suitable ways to avoid, mitigate or compensate adverse impacts of renewable and low carbon energy development. The construction, operation, decommissioning, remediation and aftercare of proposals should take into account:

- *the need to minimise impacts on local communities, such as from noise and air pollution, to safeguard quality of life for existing and future generations"*

7.30. Although there is no specific mention of Glint and Glare impacts, there will be a consideration towards the impact on local communities from a Glint and Glare perspective throughout this report.

Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems

7.31. As outlined within the BRE document 'Planning Guidance for the Development of Large Scale Ground Mounted Solar PV Systems'[5]

[4] Future Wales: The National Plan 2040. Available at: https://gov.wales/sites/default/files/publications/2021-02/future-wales-the-national-plan-2040.pdf

[5] BRE (2013) *Planning Guidance for the Development of Large Scale Ground Mounted Solar PV Systems*. Available at: https://www.bre.co.uk/filelibrary/pdf/other_pdfs/KN5524_Planning_Guidance_reduced.pdf

"Glint may be produced as a direct reflection of the sun in the surface of the solar PV panel. It may be the source of the visual issues regarding viewer distraction. Glare is a continuous source of brightness, relative to diffused lighting. This is not a direct reflection of the sun, but rather a reflection of the bright sky around the sun. Glare is significantly less intense than glint.

Solar PV panels are designed to absorb, not reflect, irradiation. However, the sensitivities associated with glint and glare, and the landscape/ visual impact and the potential impact on aircraft safety, should be a consideration. In some instances, it may be necessary to seek a glint and glare assessment as part of a planning application. This may be particularly important if 'tracking' panels are proposed as these may cause differential diurnal and/or seasonal impacts.

The potential for solar PV panels, frames and supports to have a combined reflective quality should be assessed. This assessment needs to consider the likely reflective capacity of all of the materials used in the construction of the solar PV farm."

Interim CAA Guidance – Solar Photovoltaic Systems (2010)

7.32. There is little guidance on the assessment of glint and glare from solar farms with regards to aviation safety. The Civil Aviation Authority (CAA) has published interim guidance on 'Solar Photovoltaic Systems[6]', they also intend to undertake a review of the potential impacts of solar PV developments upon aviation, however this is yet to be published.

7.33. The interim guidance identifies the key safety issues with regards to aviation, including *"glare, dazzling pilots leading them to confuse reflections with aeronautical lights."* It is outlined that solar farm developers should be aware of the requirements to comply with the Air Navigation Order (ANO), published in 2009. In particular, developers should take cognisant of the following articles of the ANO[7], including:

- ***"Article 137** – Endangering safety of an aircraft – A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft."*
- ***Article 221** - Lights liable to endanger – "A person must not exhibit in the United Kingdom any light which:*
  - *a) by reason of its glare is liable to endanger aircraft taking off or from landing at an aerodrome; or*

[6] CAA (2010) Interim CAA Guidance – Solar Photovoltaic Systems. Available at: http://www.enstoneflyingclub.co.uk/files/caa_view_on_solar_panel_instalations.pdf?PHPSESSID=8900a41db8a205da84fca7bbc14eae69

[7] CAA (2015) Air Navigation: The Order and Regulations. Available at: http://publicapps.caa.co.uk/docs/33/CAP%20393%20Fourth%20edition%20Amendment%201%20April%202015.pdf

- *b) by reason of its liability to be mistaken for an aeronautical ground light liable to endanger aircraft"*

- *Article 222 – Lights which dazzle or distract – "A person must not in the United Kingdom direct or shine any light at any aircraft in flight so as to dazzle or distract the pilot of the aircraft."*

7.34. Relevant studies generally agree that there is potential for glint and glare from photovoltaic panels to cause a hazard or nuisance for surrounding receptors, but that the intensity of such reflections is similar to that emanating from still water. This is considerably lower than for other manmade materials such as glass, steel or white concrete (SunPower – 2009).

7.35. These Articles are considered within the assessment of glint and glare of the Proposed Development.

US Federal Aviation Administration Policy

7.36. The US Federal Aviation Administration (FAA) in their Solar Guide (Federal Aviation Authority, 2010)[8] incorporates a chapter on the impact and assessment of glint from solar panels. It concludes that (although subject to revision):

"…evidence suggests that either significant glare is not occurring during times of operation or if glare is occurring, it is not a negative effect and is a minor part of the landscape to which pilots and tower personnel are exposed."

7.37. The current policy (Federal Register, 2013)[9] requires an ocular impact assessment be assessed at 1-minute intervals from when the sun rises above the horizon until the sun sets below the horizon. Specifically, the developer must use the 'Solar Glare Hazard Analysis Tool' (SGHAT) tool specifically and reference its results as this was developed by the FAA and Sandia National Laboratories as a standard and approved methodology for assessing potential impacts on aviation interests, although it notes other assessment methods may be considered. The SGHAT tool has since been licensed to a private organisation who were also involved in its development and it is the software model used in this assessment.

7.38. Crucially, the policy provides a quantitative threshold which is lacking in the UK guidance. This outlines that a solar development will not automatically receive an objection on glint grounds if low intensity glint is visible to pilots on final approach. In other words, low intensity glint with a low potential to form a temporary after-image would be considered acceptable under

[8] FAA (2010), Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide-print.pdf

[9] FAA (2013), Interim Policy, *FAA Review of Solar Energy System Projects on Federally Obligated Airports*. Available at https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

US guidance. Due to the lack of legislation and guidance within Ireland, this US document has been utilised as guidance for this report.

7.39. The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection, the following two criteria must be met:

- No potential for glint or glare in the existing or planned Air Traffic Control Tower (ATCT)
- No potential for glare (glint) or "low potential for after-image" along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the approved layout plan (ALP). The final approach path is defined as 2 miles from 50 feet above the landing threshold using a standard 3-degree glide path.

7.40. The geometric analysis included later in this report, which defines the extent and time at which glint may occur, is required by the FAA as the methodology to be used when assessing glint and glare impacts on aviation receptors. This report will follow the methodology required by the FAA as it offers the most robust assessment method currently available.

Review of Local Plan

Monmouthshire County Council Adopted Local Plan 2011 - 2021

7.41. The Monmouthshire County Council Adopted Local Plan (2011 – 2021)[10] was adopted by the county council in February 2014.

The plan states in **The Spatial Strategy** section of **Strategic Policies**:

"The Strategy will aim to disperse development around the County while focusing on those locations that provide the best opportunities for achieving sustainable development.

The Strategy proposes:

• An emphasis on the three main towns of Abergavenny, Chepstow and Monmouth, where environmental and infrastructure constraints allow.

• Some development at settlements in the Severnside area which provide opportunities for regeneration and infrastructure improvements.

• An appropriate amount of development in rural areas with a focus on those settlements that have best access to services and public transport.

• Residential growth to take place in association with opportunities for mixed use development schemes particularly in Chepstow and Monmouth."

[10] Strategy Document - Adopted April 2016 lo (2).pdf

7.42. Policy SD1: Renewable Energy is the only policy of relevance in relation to Glint and Glare. This policy states:

"Renewable energy schemes will be permitted where:

(1) There are no unacceptable adverse impacts upon the landscape, townscape and historic features and there is compliance with Policy LC5, with regard to protection and enhancement of landscape character;

(2) There are no unacceptable adverse impacts on biodiversity;

(3) There are no unacceptable adverse impacts on the amenities of nearby residents by way of noise, dust, odour or increases in traffic;

(4) The wider environmental, economic, social and community benefits directly related to the scheme outweigh any potentially adverse impacts; and

(5) The distinct identity of Monmouthshire will not be compromised.

For all types of renewable energy, cumulative impacts will be an important consideration where there are other renewable energy schemes currently operating in the area.

When the technology is no longer operational there is a requirement to decommission, remove the facility and complete a restoration of the site to its original condition."

7.43. The visual impact on nearby receptors will be assessed in detail within this report.

METHODOLOGY

7.44. A desk-based assessment was undertaken to identify when and where glint and glare may be visible at receptors within the vicinity of the Proposed Development, throughout the day and the year.

Sun Position and Reflection Model

Sun Data Model

7.45. The calculations in the solar position calculator are based on equations from Astronomical Algorithms[11]. The sunrise and sunset results are theoretically accurate to within a minute for locations between +/- 72° latitude, and within 10 minutes outside of those latitudes. However, due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary from calculations.

Solar Reflection Model

7.46. The position of the sun is calculated at one-minute intervals of a typical year, in this instance the year assessed is 2021.

7.47. In order to determine if a solar reflection will reach a receptor, the following variables are required:

- Sun position;
- Observer location; and
- Tilt, orientation, and extent of the modules in the solar array.

7.48. The model assumes that the azimuth and horizontal angle of the sun is the same across the whole solar farm. This is considered acceptable due to the distance of the sun from the Proposed Development and the miniscule differences in location of the sun over the Proposed Development.

7.49. Once the position of the sun is known for each time interval, a vector reflection equation determines the reflected sun vector, based on the normal vector of the solar array panels. This assumes that the angle of reflection is equal to the angle of incidence reflected across a normal plane. In this instance the plane being the vector which the solar panels are facing.

7.50. On knowing the vector of the solar reflection, the azimuth is calculated and the horizontal reflection from multiple points within the solar farm. These are then compared with the

[11] Jean Meeus, *Astronomical Algorithms* (Second Edition), 1999

azimuth and horizontal angle of the receptor from the solar farm to determine if it is within range to receive solar reflections.

7.51. The solar reflection in the model is considered to be specular as a worst-case scenario. In practice the light from the sun will not be fully reflected as solar panels are designed to absorb light rather than reflect it. The previous text and Appendix 7F outline the reflective properties of solar glass and compares it to other reflective surfaces. Although the exact figures in this report are not conclusive, it is included as a visual guide and it agrees with most other reports, in that solar glass has less reflective properties than other types of glass and that the amount of reflective energy drops as the angle of incidence decreases.

7.52. Most modern panels have a slight surface texture which should have a small effect on diffusing the solar radiation further; although, this has not been modelled to conform with the worst-case scenario assessment.

Determination of Ocular Impact

7.53. The software used for this assessment is based on the Sandia Laboratories Solar Glare Hazard Analysis Tool (SGHAT). This tool is specifically mentioned in the FAA guidance as the software which should be used in this type of assessment.

7.54. Determination of the ocular impact requires knowledge of the direct normal irradiance, PV module reflectance, size and orientation of the array, optical properties of the PV module, and ocular parameters. These values are used to determine the retinal irradiance and subtended source angle used in the ocular hazard plot.

7.55. The ocular impact[12] of viewed glare can be classified into three levels based on the retinal irradiance and subtended source angle: low potential for after-image (green), potential for after-image (yellow), and potential for permanent eye damage (red).

7.56. Green glare can be ignored when looking at ground based and some aviation receptors. Green glare does not cause temporary flash blindness and happens at an instant with very slight disturbance. As per FAA guidelines mitigation is only required for green glare when affecting an Air Traffic Control Tower, but not for when affecting pilots. Therefore, it can be assumed that green glare is acceptable for ground-based receptors.

7.57. The subtended source angle represents the size of the glare viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles can result in glare of high intensity, even if the retinal irradiance is low.

[12] 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, Journal of Solar Energy Engineering-Transactions of the Asme, 133(3).

Relevant Parameters of the Proposed Development

7.58. The photovoltaic panels are oriented in a southwards direction and will be inclined at an angle of 25 degrees to maximise solar gain and will remain in a fixed position throughout the day and during the year (i.e. they will not rotate to track the movement of the sun).

7.59. The height of the panels above ground level is a maximum of 2.8m and points at the top of the panels are used to determine the potential for glint and glare generation.

Identification of Receptors

Ground Based Receptors

7.60. Glint is most likely to impact upon a ground-based receptor close to dusk and dawn when the sun is at its lowest in the sky. Therefore, any effect would likely occur early in the day or late in the day, reflected to the west at dawn and east at dusk.

7.61. A 1km study area from the panels was deemed appropriate for the assessment of ground-based receptors as this seemed to contain a good spread of residential and road receptors in most directions from the Proposed Development. The further distance a receptor is from a solar farm, the less chance it has of being affected by glint and glare due to scattering of the reflected beam and atmospheric attenuation, in addition to obstructions from ground sources, such as any intervening vegetation or buildings.

7.62. An observer height of 2m was utilised for residential receptors, as this is a typical height for a ground-floor window. Upper floor windows are not analysed geometrically; however, are considered as part of the visual analysis. With regards to road users, a receptor height of 1.5m was employed as this is typical of eye level. Rail driver's eye level was assumed to be 2.75m above the rail for signal signing purposes and therefore this is the height used for assessment purposes.

7.63. An assessment was undertaken to determine zones where solar reflections will never be directed near ground level.

7.64. Where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for full assessment as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group has been analysed in detail with the worst-case impacts attributed to that receptor.

Aviation

7.65. Glint is only considered to be an issue with regards to aviation safety when the solar farm lies within close proximity to a runway, particularly when the aircraft is descending to land. En-route activities are not considered an issue as the flight will most likely be at a higher altitude than the solar reflection.

7.66. Should a solar farm be proposed within the safeguarded zone of an aerodrome, a full geometric study may be required (depending on the orientation from the Proposed Development) which would determine if there is potential for glint and glare at key locations, most likely on the descent to land.

7.67. Buffer zones to identify aviation assets vary depending on the safeguarding criteria of that asset. All aerodromes within 20km will be identified, however generally the detailed assessments are only required within: 20km for large international aerodromes, 10km for military aerodromes and 5km for small aerodromes.

Magnitude of Impact

Static Receptors

7.68. Although there is no specific guidance set out to identify the magnitude of impact from solar reflections, the following criteria has been set out for the purposes of this report:

- High - Solar reflections impacts of over 30 hours per year or over 30 minutes per day
- Medium - Solar reflections impacts between 20 and 30 hours per year or between 20 minutes and 30 minutes per day
- Low - Solar reflections impacts between 0 and 20 hours per year or between 0 minutes and 20 minutes per day
- None - Effects not geometrically possible or no visibility of reflective surfaces likely due to high levels of intervening screening

Moving Receptors (Road and Rail)

7.69. Again, no specific guidance is available to identify the magnitude of impact from solar reflections on moving receptors except in aviation, however it is thought that a similar approach should be applied to moving receptors as aviation, based on the ocular impact and the potential for after-image.

7.70. The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection the following criteria must be met:

- No potential for glare (glint) or “low potential for after-image” along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the approved layout plan (ALP).

Moving Receptors (Aviation)

Approach Paths

7.71. Each final approach path which has the potential to receive glint is assessed using the Solar Glare Hazard Analysis Tool (SGHAT) model. The model assumes an approach bearing on the runway centreline, a 3-degree glide path with the origin 50 ft (15.24 m) above the runway threshold.

7.72. The computer model considers the pilots field of view. The azimuthal field of view (AFOV) or horizontal field of view (HFOV) as it is sometimes referred, refers to the extents of the pilot's horizontal field of view measured in degrees left and right from directly in front of the cockpit. The vertical field of view (VFOV) refers to the extents of the pilot's vertical field of view measured in degrees from directly in front of the cockpit. The HFOV is modelled at 90 degrees left and right from the front of the cockpit whilst the VFOV is modelled at 30 degrees.

7.73. The FAA guidance states that there should be no potential for glare or '*low potential for after-image'* at any existing or future planned runway landing thresholds in order for the proposed Development to be acceptable.

Air Traffic Control Tower (ATCT)

7.74. An air traffic controller uses the visual control room to monitor and direct aircraft on the ground, approaching and departing the aerodrome. It is essential that air traffic controllers have a clear unobstructed view of aviation activity. The key areas on an aerodrome are the views towards the runway thresholds, taxiways and aircraft bays.

7.75. The FAA guidance states that no solar reflection towards the ATCT should be produced by a proposed solar development (see Legislation and Guidance section above), however this should be assessed on a site by site basis and will depend on the operations at a particular aerodrome.

7.76. In order to determine the impact on the ATCT, the location and height of the tower will need to be fed into the SGHAT model and where there is a potential for 'low potential for After-Image' or more, then mitigation measures will be required.

Assessment Limitations

7.77. Below is a list of assumptions and limitations of the model and methods used within this report:

- The model does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.

- The model does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results.
- Due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary slightly from calculated positions.
- The model does not account for the effects of diffraction; however, buffers are applied as a factor of safety.

BASELINE CONDITIONS

Ground Based Receptors Reflection Zones

7.78. In the northern hemisphere, there will never be solar reflections due south of a solar PV development as the position of the sun is always south. Furthermore, due to the slant of a solar panel (where the sun is due south, with an azimuth angle of 180 degrees), reflections will be directed skyward and not impact on ground-based receptors. The ground-based receptor reflection zone is a procedure which eliminates certain areas in order to reduce the assessment procedure, much in the same way a zone of theoretical visibility (ZTV) map allows a Landscape Architect to focus their assessment on areas where the solar PV development will be visible.

7.79. Based on the relatively flat topography in the study area, solar reflections between five degrees below the horizontal plane to five degrees above it are described as near horizontal. Reflections from the proposed solar farm within this arc have the potential to be seen by receptors at or near ground level.

7.80. Further analysis showed that this will only occur between the azimuth of 248.2 degrees and 292.3 degrees in the western direction (late day reflections) and 67.6 degrees and 114.7 degrees in the eastern direction (morning reflections) and therefore any ground-based receptor outside these arcs will not have any impact from solar reflections.

7.81. Figure 7.1 and 7.2 of Appendix 7A show the respective study areas whilst also subtracting from this the areas where solar reflections will not impact on ground-based receptors due to the reasons set out in paragraphs 7.78 to 7.80.

Residential Receptors

7.82. Residential receptors located within 1km of the Application Site have been identified in Table 7-1 below. Glint was assumed to be possible if the receptor is located within the ground-based receptor zones outlined previously.

7.83. There are 25 residential receptors (Receptors 41 to 65) which are within the no-reflection zones and are clearly identifiable in Figure 7.1: Appendix 7A. The process of how these are calculated is explained in paragraphs 7.78 to 7.80 of this report.

7.84. As per the methodology section, where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for detailed analysis as the impacts will not vary to any significant degree. Where small groups of receptors are evident, the receptors on either end of the group have been assessed in detail. A total of 48 receptors are considered in the assessment section, with detailed assessment undertaken for receptors 1 to 40. Receptors 66 - 73 have not been included in the detailed analysis as

Receptors 4, 10, 13, 15, 30 and 38, respectively, have been used as proxies to predict their impacts.

Table 7 - 1: Residential Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	332206	211499	Yes
2	332043	211354	Yes
3	331954	211404	Yes
4	331861	211284	Yes
5	332524	210964	Yes
6	332511	210927	Yes
7	332605	210925	Yes
8	333086	210807	Yes
9	333108	210804	Yes
10	332542	210400	Yes
11	332473	210290	Yes
12	332919	210269	Yes
13	333260	210263	Yes
14	333528	210440	Yes
15	334231	210392	Yes
16	334260	210334	Yes
17	334409	210444	Yes
18	334770	210162	Yes
19	334734	210172	Yes
20	334775	210265	Yes
21	334803	210305	Yes
22	334798	210367	Yes

23	334838	210596	Yes
24	334867	210609	Yes
25	334913	210724	Yes
26	334937	210792	Yes
27	334465	210954	Yes
28	334764	211229	Yes
29	334577	211220	Yes
30	334343	211254	Yes
31	334501	211632	Yes
32	334673	211760	Yes
33	334206	211274	Yes
34	334198	211293	Yes
35	333565	211336	Yes
36	333671	211387	Yes
37	333707	211418	Yes
38	333734	211655	Yes
39	333831	211921	Yes
40	333811	211957	Yes
41	333350	211952	No
42	333766	212165	No
43	333578	212375	No
44	333460	212394	No
45	333451	212409	No
46	333432	212414	No
47	332599	212403	No

48	332589	212105	No
49	332635	212093	No
50	332796	211822	No
51	333033	210056	No
52	333024	209886	No
53	333035	209917	No
54	333079	209938	No
55	333165	209915	No
56	333273	209932	No
57	333269	209821	No
58	333586	210416	No
59	333482	210202	No
60	333496	210136	No
61	333563	210121	No
62	333654	210140	No
63	333837	210153	No
64	333909	210139	No
65	334094	210115	No
66	331800	211349	Yes
67	331856	211289	Yes
68	332525	210372	Yes
69	333017	210068	Yes
70	333285	210257	Yes
71	334263	210366	Yes
72	334349	211267	Yes

73	333734	211655	Yes

Road / Rail Receptors

7.85. The closest railway line to the Application Site is outside the 1km study area and due to its distance, glint and glare effects from the Proposed Development will not be possible. Effects on rail have therefore been scoped out of the rest of this assessment.

7.86. There are five roads within the 1km study area that require a detailed glint and glare analysis: the A40, B4598, and three unnamed roads east of the Proposed Development. There are some minor roads which serve dwellings; however, these have been dismissed as vehicle users of these roads will likely be travelling at low speeds and therefore there is a negligible risk of safety impacts from glint and glare.

7.87. The ground receptor no-reflection zones are clearly identifiable on **Figure 7.2: Appendix 7A** and the process of how these are calculated is explained in **paragraphs 7.78 to 7.80** of this report. Assessment points 200m apart are used.

Table 7 - 2: Road Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	332067	210578	Yes
2	332191	210426	Yes
3	332307	210265	Yes
4	332476	210160	Yes
5	332666	210101	Yes
6	332865	210122	Yes
7	333062	210152	Yes
8	333795	210593	Yes
9	333949	210721	Yes
10	334119	210823	Yes
11	334271	210952	Yes
12	334297	211117	Yes

13	334379	211297	Yes
14	334436	211481	Yes
15	334552	211643	Yes
16	334421	210916	Yes
17	334522	211083	Yes
18	334664	211185	Yes
19	334852	211161	Yes
20	334997	211021	Yes
21	334954	210829	Yes
22	334860	210659	Yes
23	334794	210477	Yes
24	334795	210280	Yes
25	334682	210151	Yes
26	334493	210095	Yes
27	332917	210002	Yes
28	332719	210031	Yes
29	332605	212581	No
30	332795	212632	No
31	332992	212625	No
32	333186	212576	No
33	333357	212481	No
34	333522	212368	No
35	333717	212327	No
36	333915	212345	No

37	333675	210437	No
38	333527	210315	No
39	333251	210215	No
40	333446	210199	No
41	333628	210118	No
42	333823	210076	No
43	334020	210046	No
44	334218	210028	No
45	334364	209895	No
46	334516	209921	No
47	334316	209935	No
48	334117	209950	No
49	333917	209962	No
50	333717	209970	No
51	333517	209978	No
52	333317	209986	No
53	333117	209993	No
54	334302	210061	No

Aviation Receptors

7.88. Aerodromes within 30km of the proposed solar development can be found in **Table 7-3.**

Table 7 - 3: Airfields in close proximity

Airfield	Distance	Use
Abergavenny Airfield	1.20 km	Small Grass Strip
The Blorenge	5.8km	Gliding Club

Kemeys Commander Airfield	6.32 km	Small Grass Strip
Tallgarth Airfield	25.59 km	Gliding Club

7.89. Only Abergavenny Airfield is located within its safeguarding buffer zone and will require a detailed assessment. The remaining two aviation receptors **Table 7- 3** are located within their respective safeguarding buffer zones, outlined in **paragraph 7.67**, they have not been assessed further due to their size.

Abergavenny Airfield

7.90. Abergavenny Airfield is a small grass strip which is located approximately 3.5km southeast of Abergavenny.

7.91. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 206ft (63m). It has two grass runways, details of which are given in **Table 7-4**.

Table 7 - 4: Abergavenny Airfield Runways

Runway Designation	Bearing (°)	Length (m)	Width (m)
15	145.20	660	12
33	324.90	660	12

7.92. The threshold locations and heights of the runways at Abergavenny Airfield are given in **Table 7-5.**

Table 7 - 5: Abergavenny Airfield Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
15	51° 47′ 49″ N	002° 59′ 48″ W	62.24
33	51° 47′ 32″ N	002° 59′ 30″ W	57.99

7.93. No ATCT is present at Abergavenny Airfield.

IMPACT ASSESSMENT

7.94. Following the methodology outlined earlier in this report, geometrical analysis comparing the azimuth and horizontal angle of the receptors from the Proposed Development and the solar reflection was conducted. Although this assessment did not take into account obstructions such as vegetation and buildings, discussion on the potentially impacted receptors is provided where necessary.

Ground Based Receptors

Residential Receptors

7.95. Table 7-6 identifies the receptors that will experience solar reflections based on solar reflection modelling and whether the reflections will be experienced in the morning (AM), evening (PM), or both.

7.96. The 25 receptors which were within the no reflection zones outlined previously have been excluded from the detailed modelling as they will never receive any glint and glare impacts from the Proposed Development.

7.97. Appendix 7B contains the detailed analysis of the glint and glare impacts. Table 7-6 below shows the impact at each receptor.

Table 7 - 6: Potential for Glint and Glare impact on Residential Receptors

	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact
Receptor	AM	PM	Minutes	Hours	
1	Yes	No	3627	60.5	High
2	Yes	No	5292	88.2	High
3	Yes	No	3249	54.2	High
4 (66, 67) *	Yes	No	4681	78.0	High
5	Yes	No	3345	55.8	High
6	Yes	No	2502	41.7	High
7	Yes	No	2722	45.4	High
8	Yes	No	2140	35.7	High
9	Yes	No	2689	44.8	High
10 (68) *	Yes	No	1843	30.7	High

11	Yes	No	1319	22.0	Medium
12	Yes	No	184	3.1	Low
13 (69, 70) *	No	No	0	0.0	None
14	No	No	0	0.0	None
15 (71) *	No	Yes	131	2.2	Low
16	No	Yes	10	0.2	Low
17	No	Yes	527	8.8	Low
18	No	Yes	285	4.8	Low
19	No	Yes	287	4.8	Low
20	No	Yes	528	8.8	Low
21	No	Yes	598	10.0	Low
22	No	Yes	922	15.4	Low
23	No	Yes	1024	17.1	Low
24	No	Yes	1050	17.5	Low
25	No	Yes	1600	26.7	Medium
26	No	Yes	1509	25.2	Medium
27	No	Yes	1535	25.6	Medium
28	No	Yes	1155	19.3	Low
29	No	Yes	1589	26.5	Medium
30 (72) *	No	Yes	2153	35.9	High
31	No	Yes	50	0.8	Low
32	No	No	0	0.0	None
33	No	Yes	2318	38.6	High
34	No	Yes	2162	36.0	High
35	No	Yes	2287	38.1	High
36	No	Yes	2707	45.1	High
37	No	Yes	1767	29.5	Medium
38 (73) *	No	Yes	51	0.9	Low

39	No	No	0	0.0	None
40	No	No	0	0.0	None

7.98. The asterisk (*) in Table 7-6 denotes the receptors that were not included in the analysis, but still had possible glare effects. For these receptors the worst-case receptor next to them has been chosen to indicate their glint and glare impacts in the bald-earth scenario. These were not individually assessed due to being part of a cluster and the adjacent receptor experiencing a more significant effect.

7.99. As it can be seen in Table 7-6 there is a High impact at 19 receptors, Medium at six receptors, Low at 16 receptors and None impact for the remaining seven receptors. Appendix 7B shows detailed analysis of when the glare impacts are possible, whilst also showing which parts of the solar farm the solar glint is reflected from.

7.100. In general, the glare impacts occur between mid- March and the end of September, so there will be no impacts during the winter months. Additionally, to view the specific times at which glare will impact upon a receptor, then this can be viewed within Appendix 7B.

7.101. Appendix 7E shows Google Earth images that give an insight into how each receptor will be impacted by the glint and glare from the Proposed Development. There is a mixture of images used, which include aerial, ground level and street level. The aerial images show the location of the receptor with the solar farm drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The area of the solar farm from where reflections may be possible has been drawn as a yellow polygon. The ground level terrain is based on the height data of the surrounding land showing no intervening vegetation or buildings. The white and yellow polygons can be seen in this view also. The street view gives a good indication as to whether the area of the solar farm where reflections are theoretically possible will be visible from the receptor point. Also, where appropriate images that have been taken from within the Application Site have been used to show up to date imaging. Also, where appropriate images that have been taken from within the Application Site have been used to show up to date imaging.

Receptor 1

7.102. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptor.

7.103. The first image in Appendix 7E is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 2 (See Figure 3 of Volume 2: Planning Application Drawings), which has a view of the vegetation on the western boundary of field 2. The Second image confirms that there is

sufficient vegetation to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptor 2

7.104. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptor.

7.105. The first image in Appendix 7E is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located within the vicinity of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation within the vicinity of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptor 3

7.106. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptor.

7.107. The first image in Appendix 7E is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation to the east of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptor 4 (Including Receptors 66 and 67)

7.108. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptors.

7.109. The first image in Appendix 7E is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the northeast of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation to the northeast of the receptors. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptors 5 - 7

7.110. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from the southern half of the Proposed Development can only potentially impact on the receptors.

7.111. The first image in **Appendix 7E** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 5 (See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view towards the receptors. The third image has been taken within the Application Site in Field 8 (See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view towards the receptors. The Second and third images confirm that there is sufficient vegetation to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 8 - 9

7.112. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of the Proposed Development can only potentially impact on the receptors.

7.113. The first image in **Appendix 7E** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 8 (See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view towards the receptors from the northern section of field 8 and shows that only the roof of each receptor is visible from the highest point in the field. The third image has been taken within the Application Site in Field 8 (See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view towards the receptors from the southern section of field 8. The Second and third images confirm that there is sufficient vegetation to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 10 – 11 (Including Receptor 68)

7.114. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of the Proposed Development can only potentially impact on the receptors.

7.115. The first image in **Appendix 7E** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 9 (See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view towards the receptors. The Second image confirms that there is sufficient vegetation to screen all views

of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptor 12

7.116. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from a southern section of the Proposed Development can only potentially impact on the receptor.

7.117. The first image in Appendix 7E is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the northeast of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptor and of the vegetation to the northeast of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptors 15 - 22

7.118. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from a southern section of the Proposed Development can only potentially impact on the receptors.

7.119. The first image in Appendix 7E is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located between the receptors and Proposed Development to screen all views where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptors. This second image confirms that the topography of the land and vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptors 23 and 24

7.120. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from northern, central, and southern sections of the Proposed Development can only potentially impact on the receptors.

7.121. The first image in Appendix 7E is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the northwest of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the Proposed Development and of the vegetation that is located to the northwest of the receptors. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptors 25 and 26

7.122. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from northern and southern sections of the Proposed Development can only potentially impact on the receptors.

7.123. The first image in Appendix 7E is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the northwest of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the Proposed Development and of the vegetation that is located to the northwest of the receptors. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptor 27

7.124. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from northern, central, and southern sections of the Proposed Development can only potentially impact on the receptor.

7.125. The first image in Appendix 7E is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the Proposed Development and of the vegetation that is located to the west of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptors 28 and 29

7.126. The 'Glare Reflections on PV Footprint' chart in Appendix 7B shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptors.

7.127. The first image in Appendix 7E is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the Proposed Development and of the vegetation that is located to the west of the receptors. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to None.

Receptor 30 (Including Receptor 72)

7.128. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptors.

7.129. The first image in **Appendix 7E** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient buildings and vegetation located to the west of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the buildings and vegetation that are located to the west of the receptors. This second image confirms that the buildings and vegetation are sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 31

7.130. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptor.

7.131. The first image in **Appendix 7E** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation that is located to the west of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 33 and 34

7.132. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptors.

7.133. The first image in **Appendix 7E** is an aerial view which shows the location of the receptors in relation to the Proposed Development. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptors. This second image shows that the topography of the land and vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 35

7.134. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptor.

7.135. The first image in **Appendix 7E** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 3 (See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view towards the receptor. The Second image shows that the topography of the land will screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 36

7.136. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptor.

7.137. The first image in **Appendix 7E** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation that is located to the west of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 37

7.138. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptor.

7.139. The first image in **Appendix 7E** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation that is located to the west of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 38 (Including Receptor 73)

7.140. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a northern section of the Proposed Development can only potentially impact on the receptors.

7.141. The first image in **Appendix 7E** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located along the northern boundary of the Proposed Development to screen all

views where glint and glare is possible. The second image has been taken within the Application Site in Field 1 (See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view of the vegetation located along the northern boundary of field 1. The Second image shows that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Road Receptors

7.142. **Table 7-7** shows a summary of the modelling results for each of the Road Receptor Points whilst the detailed results and ocular impact charts can be viewed in **Appendix 7C.**

7.143. The 26 receptors within the no reflection zones outlined previously have been excluded from the detailed modelling as they will never receive glint and glare impacts from the Proposed Development.

Table 7 - 7: Potential for Glint and Glare impact on Road Based Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact
1	291	1859	0	High
2	117	2483	0	High
3	0	1371	0	High
4	0	646	0	High
5	0	141	0	High
6	0	0	0	None
7	0	0	0	None
8	0	96	0	High
9	7	7206	0	High
10	192	5344	0	High
11	393	3686	0	High
12	167	1351	0	High
13	140	1744	0	High
14	277	625	0	High
15	265	26	0	High
16	472	2464	0	High

17	266	1839	0	High
18	278	1541	0	High
19	573	1157	0	High
20	1093	1151	0	High
21	1262	1389	0	High
22	995	859	0	High
23	445	865	0	High
24	48	619	0	High
25	10	26	0	High
26	0	0	0	None
27	0	0	0	None
28	0	0	0	None

7.144. As can be seen in **Table 7-7**, there are 23 receptor points analysed in detail that have potential glare impacts and also have the "potential for after-image" (yellow glare) which is a **High** impact. **Appendix 7C** shows detailed analysis of when the glint and glare impacts are possible, whilst also showing from which parts of the solar farm the solar glint is reflected from.

7.145. In general, the glare impacts occur between mid- March and the end of September, so there will be no impacts during the winter months. Additionally, to view the specific times at which glare will impact upon a receptor, then this can be viewed within **Appendix 7C**.

7.146. **Appendix 7E** shows Google Earth images that give an insight into how each receptor will be impacted by the glint and glare from the Proposed Development. There is a mixture of images used, which include ground level and street level. The ground level views show the location of the receptor with the solar farm drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The area of the solar farm from where reflections may be possible has been drawn as a yellow polygon. The ground level terrain is also based on the height data of the surrounding land showing no intervening vegetation or buildings. The white and yellow polygons can be seen in this view also. The street view gives a good indication as to whether the area of the solar farm where reflections are theoretically possible will be visible from the receptor point.

7.147. As can be seen in **Appendix 7E**, views into the Proposed Development where glint and glare is possible are blocked through a mixture of vegetation and topography for 23 of the 25 "**High** impact" receptors. Therefore, their impacts are reduced to **None.**

7.148. The impacts on Road receptors 9 and 10 all occur when the sun is directly behind the Proposed Development and low in the sky. The images in **Appendix 7E** show examples of where the sun

will be in relation to the Proposed Development. In these images it shows the sun, areas where glare occurs from the Proposed Development and the view of the driver at the time of which glare impacts will occur. The reflections from the Proposed Development will be much less intense than the suns direct glare and therefore it will be this which will be the main impact on the drivers' vision, not the reflections from the Proposed Development. Therefore, as the suns glare will be the main impact on road users at these receptor points, during the times when glare occurs from the Proposed Development, the impacts can be reduced to **Low**.

Aviation Receptors

7.149. **Table 7-8** shows a summary of the modelling results for each of the runway approach paths, whilst the detailed results and ocular impact charts can be viewed in **Appendix 7D.**

Table 7 - 8: Potential for Glint and Glare impact on Road Based Receptors

Component	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)
Abergavenny Airfield			
Runway 15	0	0	0
Runway 33	0	0	0

7.150. As can be seen in **Table 7-8**, there is no glare anticipated at both the runways at Abergavenny Airfield.

7.151. Therefore, the impact on aviation assets is **None**.

GROUND BASED RECEPTOR MITIGATION

7.152. **No Mitigation** is required to be put in place as the highest impacts are **Low** at Road Receptors 9 and 10. However, a number have been included as part of the GI Plan (See **Figure 1.23a: Technical Appendix 1: Landscape and Visual Appraisal**). These measures include hedgerow planting along the northeast boundary of Field 11. By combining this hedgerow with the location of the sun at the time of impact upon Road Receptors 9 and 10, the impacts will remain **Low**.

7.153. **Tables 7-9 and 7-10** show the impacts at each stage of the glint and glare analysis, with the final residual impacts considered once the mitigation is in place.

Table 7 - 9: Potential Residual Glint and Glare Impacts on Residential Receptors

	Magnitude of Impact		
Receptor	After Geometric Analysis	After Visibility Analysis	Residual Impacts
1	High	None	None
2	High	None	None
3	High	None	None
4 (66, 67) *	High	None	None
5	High	None	None
6	High	None	None
7	High	None	None
8	High	None	None
9	High	None	None
10 (68) *	High	None	None
11	Medium	None	None
12	Low	None	None
13	None	None	None
14	None	None	None
15 (71) *	Low	None	None
16	Low	None	None

17	Low	None	None
18	Low	None	None
19	Low	None	None
20	Low	None	None
21	Low	None	None
22	Low	None	None
23	Low	None	None
24	Low	None	None
25	Medium	None	None
26	Medium	None	None
27	Medium	None	None
28	Low	None	None
29	Medium	None	None
30 (72) *	High	None	None
31	Low	None	None
32	None	None	None
33	High	None	None
34	High	None	None
35	High	None	None
36	High	None	None
37	Medium	None	None
38	Low	None	None
39	None	None	None
40	None	None	None

Table 7 - 10: Potential Residual Glint and Glare Impacts on Road Receptors

	Magnitude of Impact		
Receptor	After Geometric Analysis	After Visibility Analysis	Residual Impacts
1	High	None	None
2	High	None	None
3	High	None	None
4	High	None	None
5	High	None	None
6	None	None	None
7	None	None	None
8	High	None	None
9	High	Low	Low
10	High	Low	Low
11	High	None	None
12	High	None	None
13	High	None	None
14	High	None	None
15	High	None	None
16	High	None	None
17	High	None	None
18	High	None	None
19	High	None	None
20	High	None	None
21	High	None	None
22	High	None	None
23	High	None	None
24	High	None	None

25	High	None	None
26	None	None	None
27	None	None	None
28	None	None	None

SUMMARY

7.154. As identified by UK policy, glint and glare is recognised as a potential impact which needs to be considered for a proposed solar development.

7.155. This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km survey area around the Application Site is considered adequate for the assessment of ground-based receptors, whilst a 30km study area is chosen for aviation receptors. Within 1km of the Application Site, there are 73 residential receptors and 54 road receptors which were considered. As per the methodology section, where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for full assessment as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group have been assessed in detail. 25 residential and 26 road-based receptors were dismissed as they are located within the no reflection zones and therefore, will not be impacted upon by the Proposed Development. There were four aviation assets within 30km of the Proposed Development. However, only Abergavenny Airfield required a detailed assessment as the Proposed Development is located within its respective safeguarding buffer zones, which are outlined in paragraph 7.67.

7.156. The solar panels will face south and will be inclined at an angle of 25 degrees and at a height of 2.8 m above ground level (AGL). As the panels will be fixed in this position, points at the tops of the panels have been used to determine the worst-case impacts on receptors.

7.157. Geometric analysis was conducted for 48 residential receptors (40 individual receptors, plus eight where a proxy receptor was chosen) and 28 road receptors.

7.158. Following an initial assessment, rail receptors were scoped out as assets that will be impacted upon from the Proposed Development as the closest rail receptor falls outside of the 1km study area.

7.159. The assessment concludes that:

- Solar reflections are possible at 48 of 73 residential receptors within the 1km study area. The initial impacts as High at 19 receptors, Medium at six receptors, Low at 16, including one residential area, and None at seven receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to None at all receptors, including one residential area. Therefore, overall impacts on residential receptors are None.
- Solar reflections are possible at 28 of 54 road receptors within the 1km study area. Upon reviewing the actual visibility of the road receptors, glint and glare impacts reduce to Low at two receptors and None at 26 receptors. Once mitigation was taken into

consideration impacts remained **Low** at two receptors and **None** at the remaining 26 receptors. Therefore, overall impacts on road receptors are **Low** and **acceptable impacts**.

- **No impact** on train drivers or railway infrastructure is predicted.
- Both runways at Abergavenny Airfield will have **No impacts**. Therefore, overall aviation impacts are **None**.

7.160. **Although no mitigation** is required to be put in place as the highest impacts are **Low** at Road Receptors 9 and 10, a number have been included as part of the GI Plan (See **Figure 1.23a: Technical Appendix 1: Landscape and Visual Impact Assessment**). These measures include hedgerow planting along the northeast boundary of field 11. Therefore, by combining this hedgerow with the location of the sun at the time of impact upon Road Receptors 9 and 10, the impacts will remain **Low**.

7.161. The effects of glint and glare and their impact on local receptors has been analysed in detail and there is predicted to be no impacts, and therefore **No Effects** at residential and aviation receptors. However, road receptors are expected to have **Low** and therefore **acceptable impacts**.

APPENDICES

Appendix 7A: Figures

- Figure 7.1: Residential Based Receptors
- Figure 7.2: Road Based Receptors

Appendix 7B: Residential Receptor Results

Appendix 7C: Road Receptor Results

Appendix 7D: Aviation Receptor Glare Results

Appendix 7E: Photo Register

Appendix 7F: Solar Module Glare and Reflectance Technical Memo

Appendix 7A: Figures

Penpergwm Solar Farm
Residential Based Receptors
Figure 7.1

Key

- Development Boundary
- Panel Boundary
- 1km Study Area
- Glare Not Possible at Receptor
- Glare Possible at Receptor
- Glare Possible at Receptor
- Residential Area
- Non Reflection Zones

Neo Office Address:
Wright Business Centre, 1 Lonmay Road, Glasgow, G33 4EL

0 0.25 0.5 1 Kilometers

Date: 23/06/2021
Drawn By: Scott Griffin
Scale (A3): 1:12,000
Drawing No: NEO00668/020I/B

neo ENVIRONMENTAL

Penpergwm Solar Farm
Road Based Receptors
Figure 7.2

Key

- Development Boundary
- Panel Boundary
- 1km Study Area
- Glare Not Possible at Receptor
- Glare Possible at Receptor
- Non Reflection Zones

0 0.25 0.5 1 Kilometers

Neo Office Address:
Wright Business Centre, 1 Lonmay Road, Glasgow, G33 4EL

Date: 23/06/2021
Drawn By: Scott Griffin
Scale (A3): 1:12,000
Drawing No: NEO00668/021I/B

neo ENVIRONMENTAL

Appendix 7B: Residential Receptor Glare Results

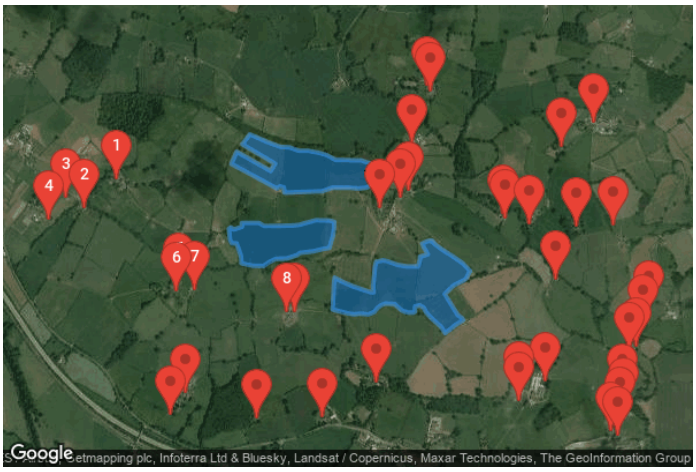
ForgeSolar

Penpergwm

Penpergwm Residential

Created April 14, 2021
Updated April 14, 2021
Time-step 1 minute
Timezone offset UTC0
Site ID 52409.9145

Project type V1
Project status: active



Misc. Analysis Settings

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

Analysis Methodologies:

- Observation point: **Version 1**
- 2-Mile Flight Path: **Version 1**
- Route: **Version 1**

Summary of Results Glare with potential for temporary after-image predicted

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	25.0	180.0	3,524	34,754	-
PV array 2	25.0	180.0	3,869	7,818	-
PV array 3	25.0	180.0	145	17,266	-

Component Data

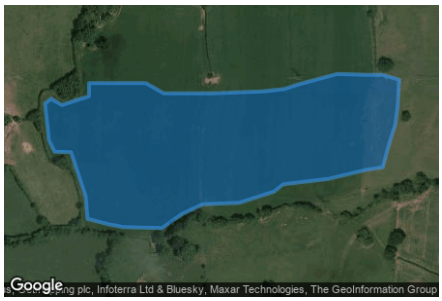
PV Array(s)

Total PV footprint area: 353,260 m^2

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 115,625 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.800092	-2.974531	116.92	2.80	119.72
2	51.799641	-2.975089	125.04	2.80	127.84
3	51.798752	-2.972643	111.83	2.80	114.63
4	51.798407	-2.972986	116.43	2.80	119.23
5	51.799296	-2.975518	129.09	2.80	131.89
6	51.798739	-2.975904	133.96	2.80	136.76
7	51.797611	-2.972514	116.57	2.80	119.37
8	51.797703	-2.972278	114.81	2.80	117.61
9	51.797664	-2.971999	113.64	2.80	116.44
10	51.797412	-2.971935	115.68	2.80	118.48
11	51.797451	-2.970647	110.29	2.80	113.09
12	51.797478	-2.969166	105.87	2.80	108.67
13	51.797637	-2.968415	103.57	2.80	106.37
14	51.797637	-2.967021	96.08	2.80	98.88
15	51.797611	-2.966441	92.02	2.80	94.82
16	51.797650	-2.965798	86.45	2.80	89.25
17	51.797743	-2.965562	84.26	2.80	87.06
18	51.797969	-2.965411	82.86	2.80	85.66
19	51.798301	-2.965347	81.62	2.80	84.42
20	51.798702	-2.965454	80.78	2.80	83.58
21	51.798760	-2.965548	81.02	2.80	83.82
22	51.798818	-2.965862	81.94	2.80	84.74
23	51.798898	-2.966205	83.36	2.80	86.16
24	51.798898	-2.966785	85.57	2.80	88.37
25	51.798911	-2.967171	86.22	2.80	89.02
26	51.798924	-2.968158	89.05	2.80	91.85
27	51.799150	-2.968823	91.61	2.80	94.41
28	51.799256	-2.969467	92.98	2.80	95.78
29	51.799336	-2.970154	95.84	2.80	98.64
30	51.799336	-2.970862	97.93	2.80	100.73
31	51.799495	-2.971570	100.24	2.80	103.04
32	51.799521	-2.972256	102.77	2.80	105.57
33	51.799734	-2.973201	107.62	2.80	110.42

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 86,272 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad



Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.796026	-2.973854	130.26	2.80	133.06
2	51.796026	-2.975120	131.96	2.80	134.76
3	51.795847	-2.975120	129.27	2.80	132.07
4	51.795727	-2.975721	127.97	2.80	130.77
5	51.795813	-2.975957	129.62	2.80	132.42
6	51.795747	-2.976096	129.09	2.80	131.89
7	51.795249	-2.976011	121.67	2.80	124.47
8	51.795090	-2.975882	119.77	2.80	122.57
9	51.795083	-2.975517	119.27	2.80	122.07
10	51.794486	-2.975195	114.08	2.80	116.88
11	51.794174	-2.975152	111.31	2.80	114.11
12	51.794101	-2.974691	110.52	2.80	113.32
13	51.794062	-2.974348	109.93	2.80	112.73
14	51.794048	-2.973500	110.45	2.80	113.25
15	51.794234	-2.973071	112.11	2.80	114.91
16	51.794373	-2.972599	113.92	2.80	116.72
17	51.794393	-2.971783	115.80	2.80	118.60
18	51.794546	-2.971011	117.25	2.80	120.05
19	51.794645	-2.970807	117.74	2.80	120.54
20	51.794718	-2.969809	116.53	2.80	119.33
21	51.794845	-2.968951	115.50	2.80	118.30
22	51.794878	-2.968597	113.92	2.80	116.72
23	51.795170	-2.968468	117.81	2.80	120.61
24	51.795462	-2.968318	120.46	2.80	123.26
25	51.795714	-2.968264	121.97	2.80	124.77
26	51.796072	-2.968232	123.02	2.80	125.82
27	51.796138	-2.968597	124.11	2.80	126.91
28	51.796138	-2.968930	123.64	2.80	126.44
29	51.796152	-2.969605	123.47	2.80	126.27
30	51.796006	-2.970485	125.00	2.80	127.80
31	51.795946	-2.970775	125.17	2.80	127.97
32	51.795913	-2.971258	125.60	2.80	128.40
33	51.795886	-2.972384	126.12	2.80	128.92
34	51.795886	-2.973457	128.50	2.80	131.30

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 151,362 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.793511	-2.968200	83.07	2.80	85.87
2	51.793332	-2.967664	78.70	2.80	81.50
3	51.793126	-2.966902	73.34	2.80	76.14
4	51.792933	-2.965990	69.15	2.80	71.95
5	51.792841	-2.965518	67.66	2.80	70.46
6	51.792834	-2.965292	66.38	2.80	69.18
7	51.793139	-2.965335	68.32	2.80	71.12
8	51.794015	-2.965196	76.58	2.80	79.38
9	51.794241	-2.965089	78.56	2.80	81.36
10	51.794307	-2.964606	76.84	2.80	79.64
11	51.794274	-2.964327	75.07	2.80	77.87
12	51.794101	-2.963522	71.25	2.80	74.05
13	51.794028	-2.962889	69.41	2.80	72.21
14	51.794022	-2.962342	68.42	2.80	71.22
15	51.794022	-2.961988	69.13	2.80	71.93
16	51.794307	-2.961849	69.43	2.80	72.23
17	51.794480	-2.961816	70.15	2.80	72.95
18	51.794526	-2.961505	69.34	2.80	72.14
19	51.794586	-2.961248	69.38	2.80	72.18
20	51.794924	-2.961570	69.81	2.80	72.61
21	51.795070	-2.961666	70.06	2.80	72.86
22	51.795183	-2.961280	69.22	2.80	72.02
23	51.795209	-2.960947	69.06	2.80	71.86
24	51.795024	-2.960690	68.80	2.80	71.60
25	51.794791	-2.960164	66.76	2.80	69.56
26	51.794499	-2.959424	65.26	2.80	68.06
27	51.794188	-2.958684	63.12	2.80	65.92
28	51.793823	-2.958104	61.50	2.80	64.30
29	51.793478	-2.958383	61.09	2.80	63.89
30	51.793365	-2.958641	61.23	2.80	64.03
31	51.793239	-2.959059	61.45	2.80	64.25
32	51.793146	-2.959338	61.68	2.80	64.48
33	51.792761	-2.959992	61.74	2.80	64.54
34	51.791799	-2.959027	65.96	2.80	68.76
35	51.791653	-2.958716	67.66	2.80	70.46
36	51.791566	-2.958619	68.29	2.80	71.09
37	51.791328	-2.959220	67.32	2.80	70.12
38	51.791102	-2.959649	66.46	2.80	69.26
39	51.790963	-2.959960	65.68	2.80	68.48
40	51.791274	-2.960293	64.72	2.80	67.52
41	51.791633	-2.960958	63.32	2.80	66.12
42	51.791905	-2.961355	62.51	2.80	65.31
43	51.792137	-2.961570	61.86	2.80	64.66
44	51.792237	-2.961827	61.80	2.80	64.60
45	51.792197	-2.962192	62.04	2.80	64.84
46	51.792080	-2.962213	61.68	2.80	64.48
47	51.791954	-2.962213	61.82	2.80	64.62
48	51.791907	-2.962310	61.91	2.80	64.71
49	51.791901	-2.962675	62.06	2.80	64.86
50	51.791954	-2.963007	62.19	2.80	64.99
51	51.792000	-2.963179	62.17	2.80	64.97
52	51.792305	-2.963742	62.00	2.80	64.80
53	51.792319	-2.964434	62.90	2.80	65.70
54	51.792259	-2.964692	62.97	2.80	65.77
55	51.792139	-2.964981	63.56	2.80	66.36
56	51.791927	-2.965260	64.13	2.80	66.93
57	51.791821	-2.965689	65.22	2.80	68.02
58	51.791854	-2.966365	65.69	2.80	68.49
59	51.791821	-2.966752	66.96	2.80	69.76
60	51.791861	-2.967149	68.44	2.80	71.24
61	51.792046	-2.968372	72.73	2.80	75.53

62	51.792358	-2.968329	74.26	2.80	77.06
63	51.793308	-2.968254	81.43	2.80	84.23

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	51.797996	-2.984479	103.80	2.00	105.80
OP 2	51.796656	-2.986861	91.21	2.00	93.21
OP 3	51.797147	-2.988234	89.77	2.00	91.77
OP 4	51.796138	-2.989564	80.17	2.00	82.17
OP 5	51.793259	-2.979844	102.27	2.00	104.27
OP 6	51.792860	-2.980016	99.92	2.00	101.92
OP 7	51.792900	-2.978664	102.24	2.00	104.24
OP 8	51.791895	-2.971790	84.09	2.00	86.09
OP 9	51.791895	-2.971189	82.56	2.00	84.56
OP 10	51.788178	-2.979343	68.46	2.00	70.46
OP 11	51.787176	-2.980427	58.34	2.00	60.34
OP 12	51.787010	-2.973979	63.86	2.00	65.86
OP 13	51.787042	-2.969079	51.20	2.00	53.20
OP 14	51.788681	-2.965056	56.39	2.00	58.39
OP 15	51.788268	-2.954444	56.66	2.00	58.66
OP 16	51.787797	-2.954455	54.74	2.00	56.74
OP 17	51.788732	-2.952417	54.38	2.00	56.38
OP 18	51.786408	-2.947517	50.15	2.00	52.15
OP 19	51.786209	-2.947012	50.63	2.00	52.63
OP 20	51.787099	-2.946905	48.43	2.00	50.43
OP 21	51.787557	-2.946605	46.42	2.00	48.42
OP 22	51.788167	-2.946723	46.81	2.00	48.81
OP 23	51.790112	-2.946186	47.58	2.00	49.58
OP 24	51.790317	-2.945703	47.73	2.00	49.73
OP 25	51.791365	-2.945134	51.65	2.00	53.65
OP 26	51.791976	-2.944715	52.17	2.00	54.17
OP 27	51.793363	-2.951650	54.08	2.00	56.08
OP 28	51.795878	-2.947380	65.08	2.00	67.08
OP 29	51.795798	-2.950116	63.00	2.00	65.00
OP 30	51.795954	-2.953619	62.51	2.00	64.51
OP 31	51.799484	-2.951211	89.16	2.00	91.16
OP 32	51.800625	-2.948819	113.57	2.00	115.57
OP 33	51.796176	-2.955455	64.55	2.00	66.55
OP 34	51.796412	-2.955648	63.98	2.00	65.98
OP 35	51.796654	-2.964767	86.23	2.00	88.23
OP 36	51.797138	-2.963265	74.21	2.00	76.21
OP 37	51.797483	-2.962697	76.14	2.00	78.14
OP 38	51.799670	-2.962424	75.36	2.00	77.36
OP 39	51.802012	-2.960997	80.41	2.00	82.41
OP 40	51.802324	-2.961330	81.01	2.00	83.01

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	25.0	180.0	3,524	34,754	-	-
PV array 2	25.0	180.0	3,869	7,818	-	-
PV array 3	25.0	180.0	145	17,266	-	-

Distinct glare per month

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

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pv-array-1 (green)	0	0	133	135	0	3	0	45	232	0	0	0
pv-array-1 (yellow)	0	0	184	1438	2412	2193	2376	2009	484	0	0	0
pv-array-2 (green)	0	0	16	234	333	347	409	252	65	0	0	0
pv-array-2 (yellow)	0	0	0	394	781	831	754	737	0	0	0	0
pv-array-3 (green)	0	0	34	8	0	0	0	0	44	0	0	0
pv-array-3 (yellow)	0	0	325	1274	1039	965	974	1281	733	0	0	0

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 potential temporary after-image

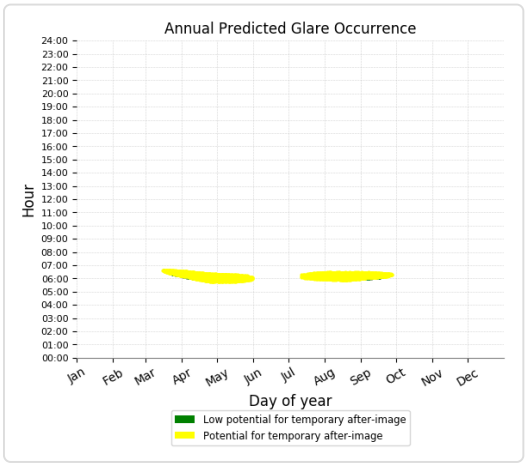
Component	Green glare (min)	Yellow glare (min)
OP: OP 1	61	3627
OP: OP 2	209	5292
OP: OP 3	367	3249
OP: OP 4	409	4681
OP: OP 5	0	10
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0

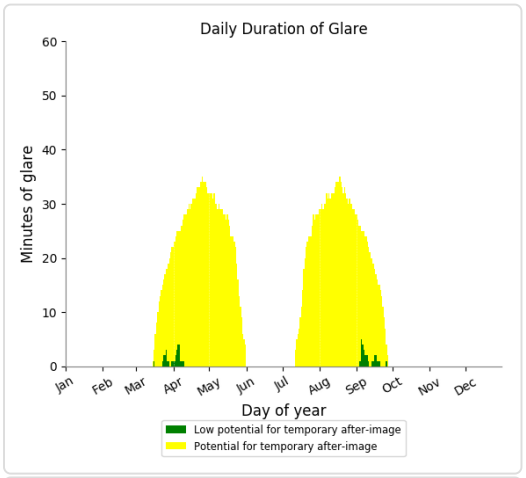
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	0	0
OP: OP 23	35	2
OP: OP 24	118	59
OP: OP 25	549	388
OP: OP 26	556	774
OP: OP 27	0	433
OP: OP 28	450	1155
OP: OP 29	217	1589
OP: OP 30	87	2153
OP: OP 31	260	50
OP: OP 32	78	0
OP: OP 33	55	2318
OP: OP 34	61	2162
OP: OP 35	0	2287
OP: OP 36	0	2707
OP: OP 37	0	1767
OP: OP 38	12	51
OP: OP 39	0	0
OP: OP 40	0	0

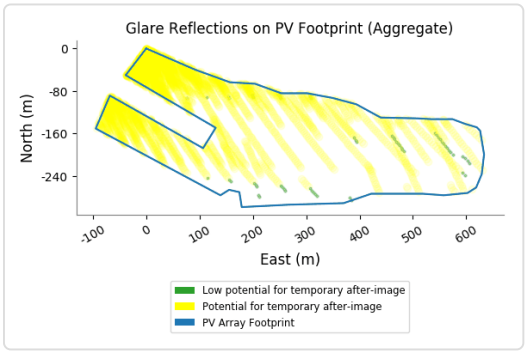
PV array 1 - OP Receptor (OP 1)

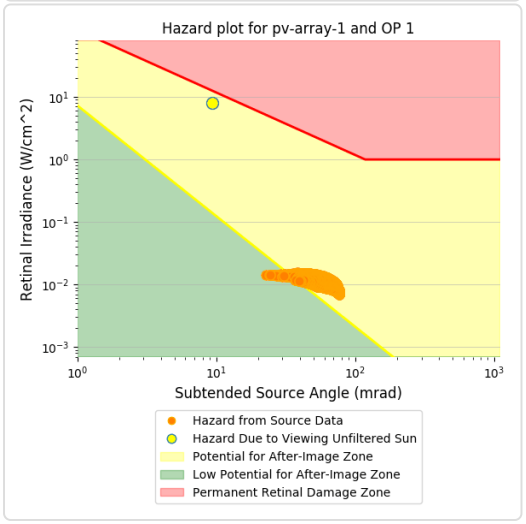
PV array is expected to produce the following glare for receptors at this location:

- 61 minutes of "green" glare with low potential to cause temporary after-image.
- 3,627 minutes of "yellow" glare with potential to cause temporary after-image.





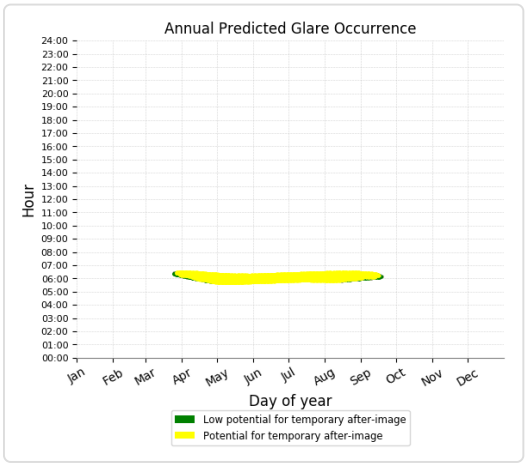


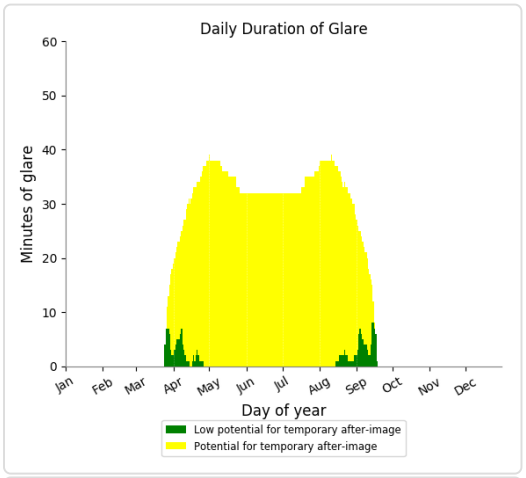


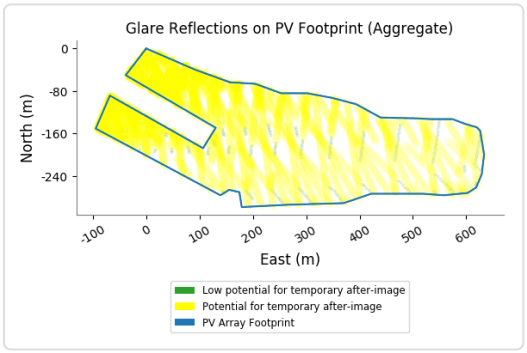
PV array 1 - OP Receptor (OP 2)

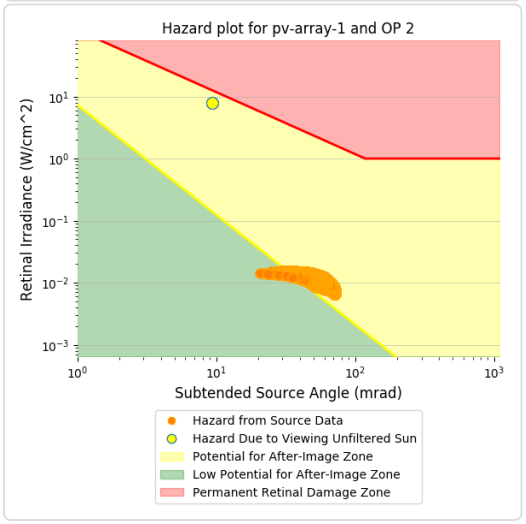
PV array is expected to produce the following glare for receptors at this location:

- 209 minutes of "green" glare with low potential to cause temporary after-image.
- 5,292 minutes of "yellow" glare with potential to cause temporary after-image.





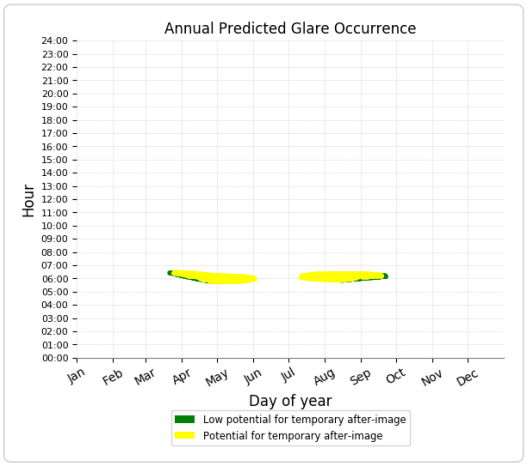


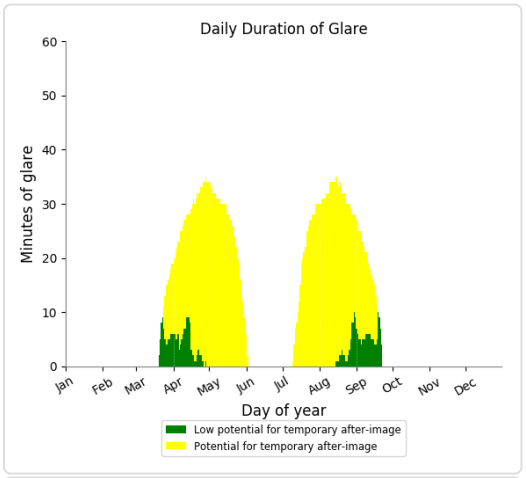


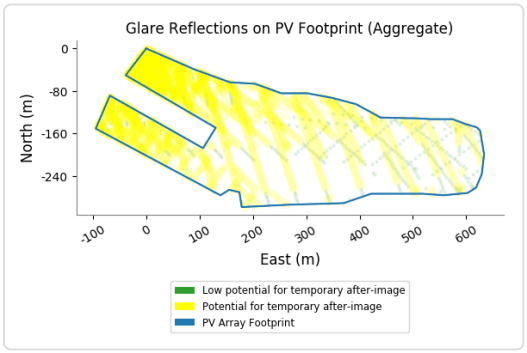
PV array 1 - OP Receptor (OP 3)

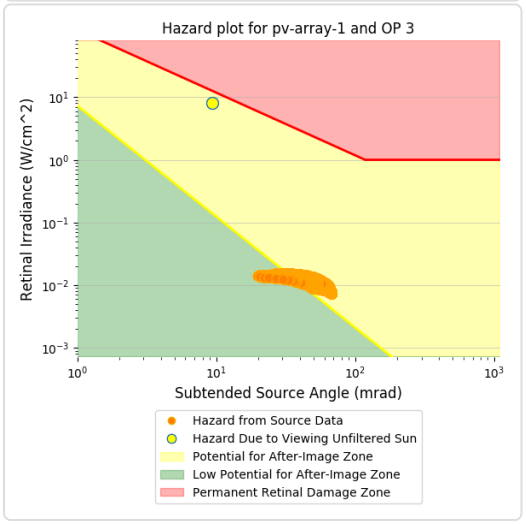
PV array is expected to produce the following glare for receptors at this location:

- 367 minutes of "green" glare with low potential to cause temporary after-image.
- 3,249 minutes of "yellow" glare with potential to cause temporary after-image.





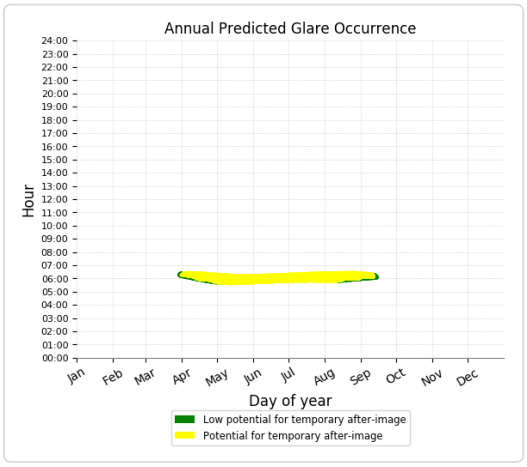


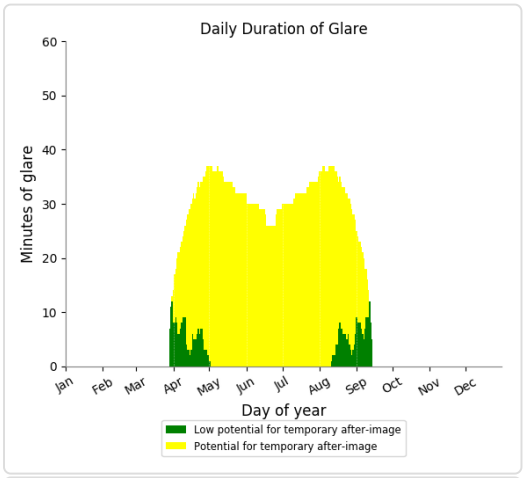


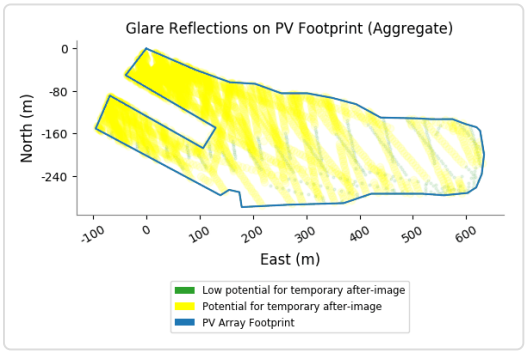
PV array 1 - OP Receptor (OP 4)

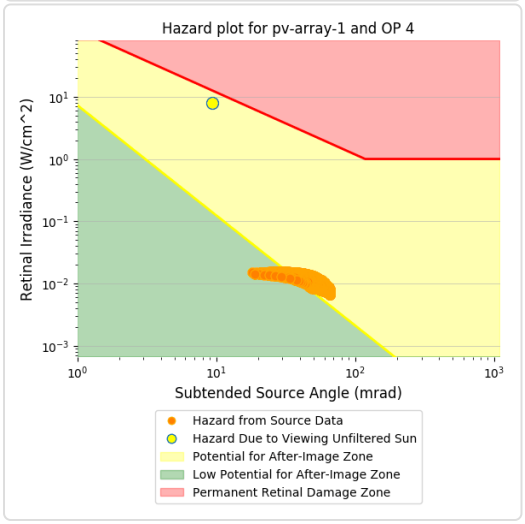
PV array is expected to produce the following glare for receptors at this location:

- 409 minutes of "green" glare with low potential to cause temporary after-image.
- 4,681 minutes of "yellow" glare with potential to cause temporary after-image.





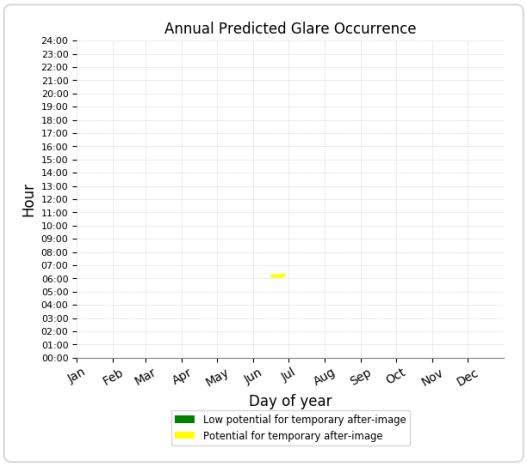


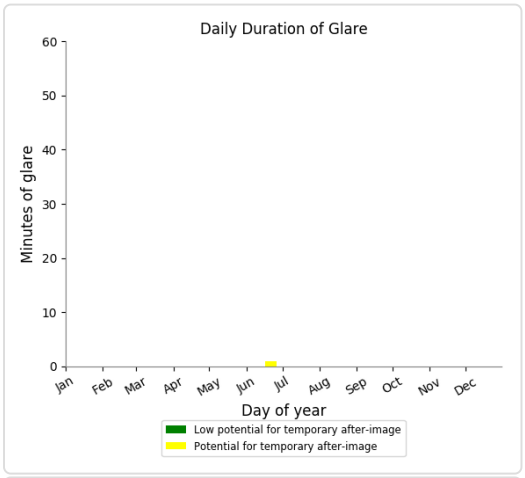


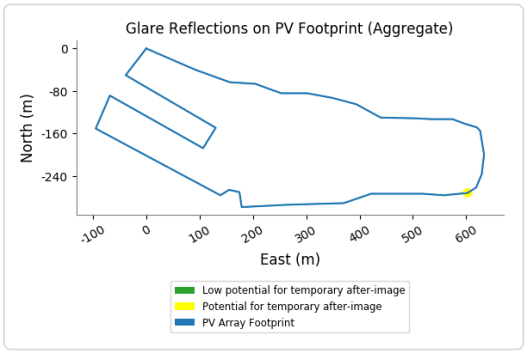
PV array 1 - OP Receptor (OP 5)

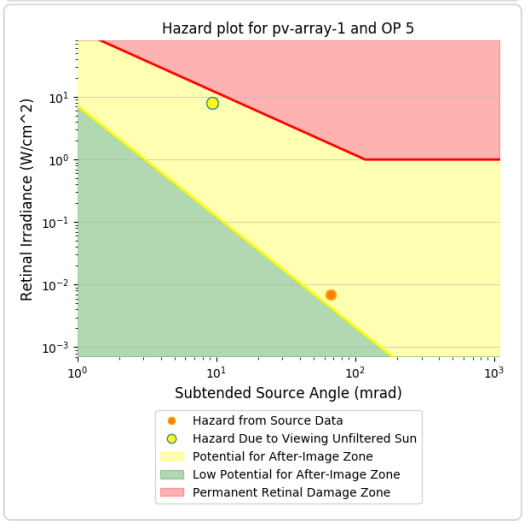
PV array is expected to produce the following glare for receptors at this location:

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









PV array 1 - OP Receptor (OP 6)

No glare found

PV array 1 - OP Receptor (OP 7)

No glare found

PV array 1 - OP Receptor (OP 8)

No glare found

PV array 1 - OP Receptor (OP 9)

No glare found

PV array 1 - OP Receptor (OP 10)

No glare found

PV array 1 - OP Receptor (OP 11)

No glare found

PV array 1 - OP Receptor (OP 12)

No glare found

PV array 1 - OP Receptor (OP 13)

No glare found

PV array 1 - OP Receptor (OP 14)

No glare found

PV array 1 - OP Receptor (OP 15)

No glare found

PV array 1 - OP Receptor (OP 16)

No glare found

PV array 1 - OP Receptor (OP 17)

No glare found

PV array 1 - OP Receptor (OP 18)

No glare found

PV array 1 - OP Receptor (OP 19)

No glare found

PV array 1 - OP Receptor (OP 20)

No glare found

PV array 1 - OP Receptor (OP 21)

No glare found

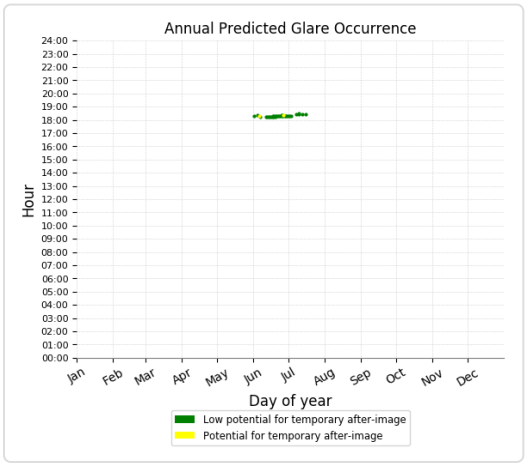
PV array 1 - OP Receptor (OP 22)

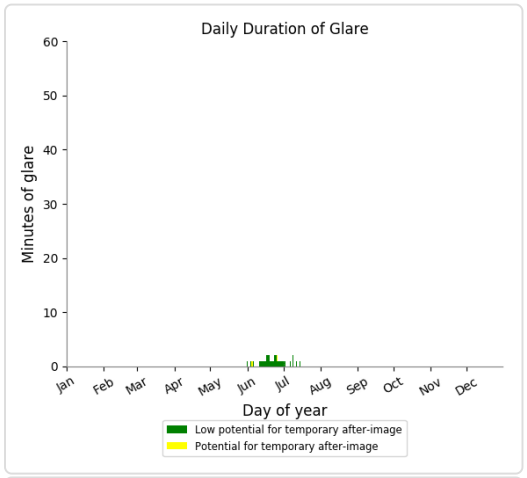
No glare found

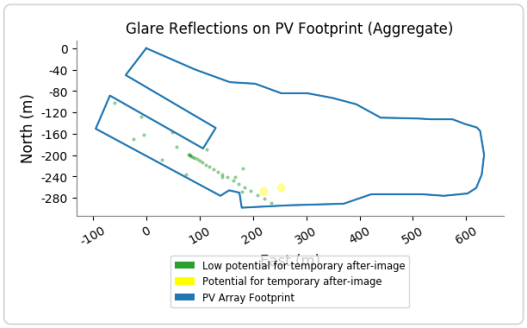
PV array 1 - OP Receptor (OP 23)

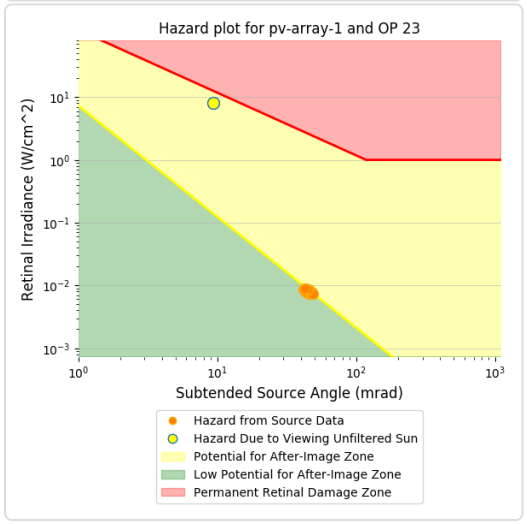
PV array is expected to produce the following glare for receptors at this location:

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





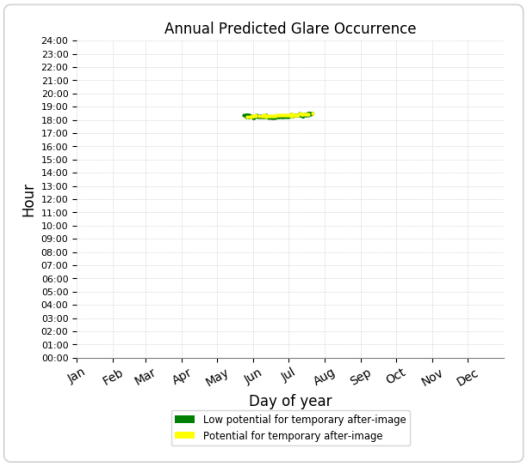


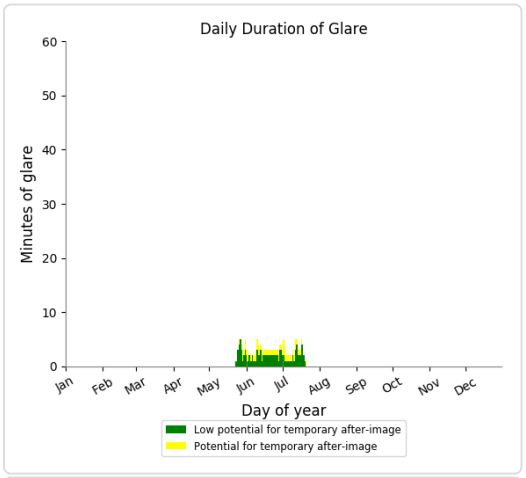


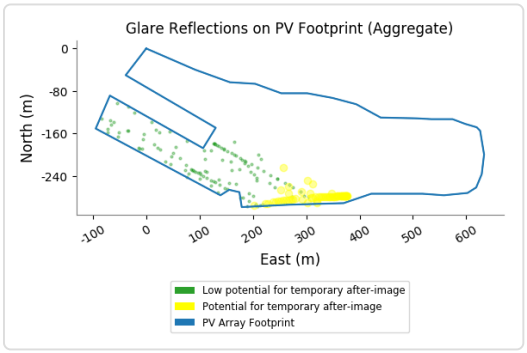
PV array 1 - OP Receptor (OP 24)

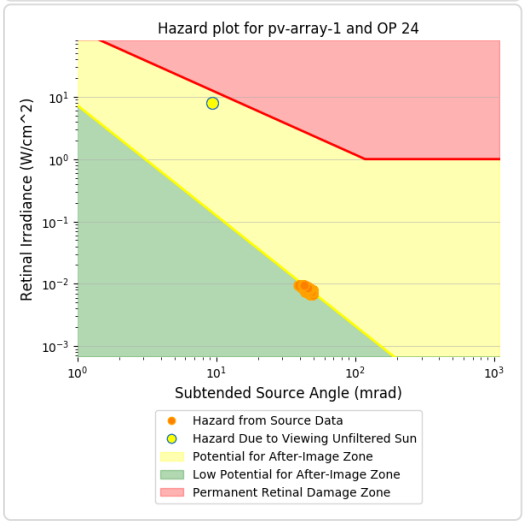
PV array is expected to produce the following glare for receptors at this location:

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





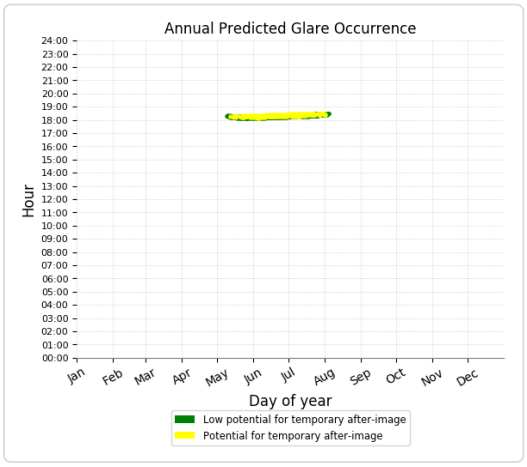


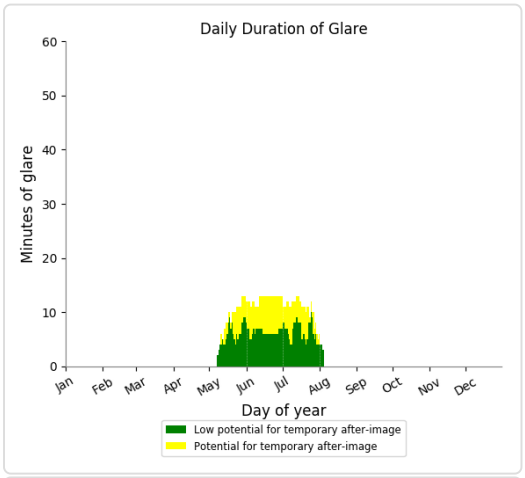


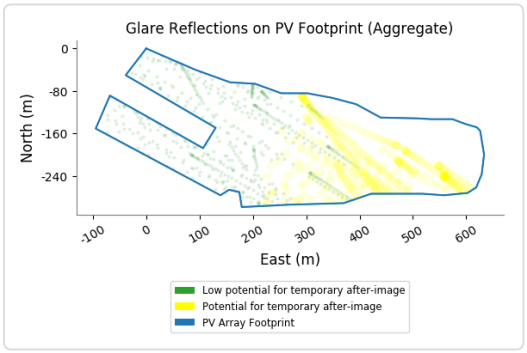
PV array 1 - OP Receptor (OP 25)

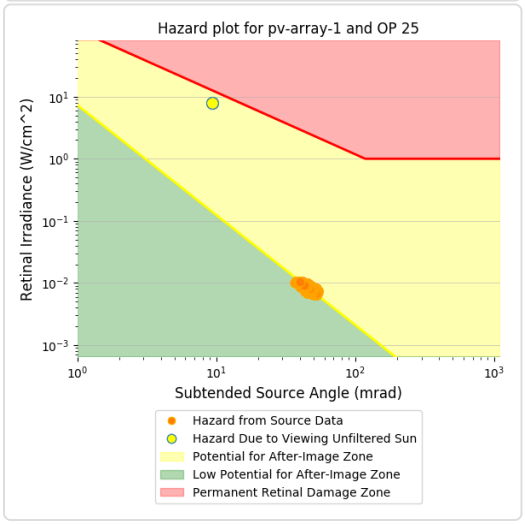
PV array is expected to produce the following glare for receptors at this location:

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





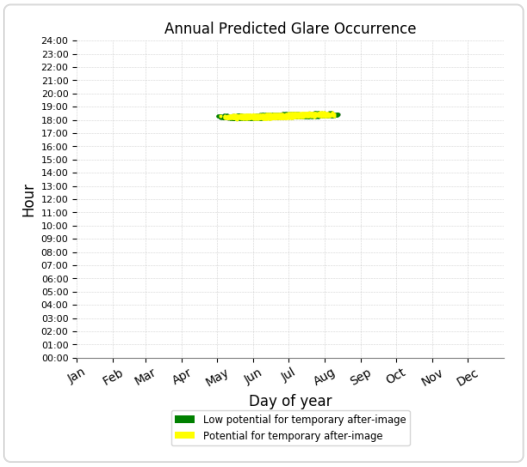


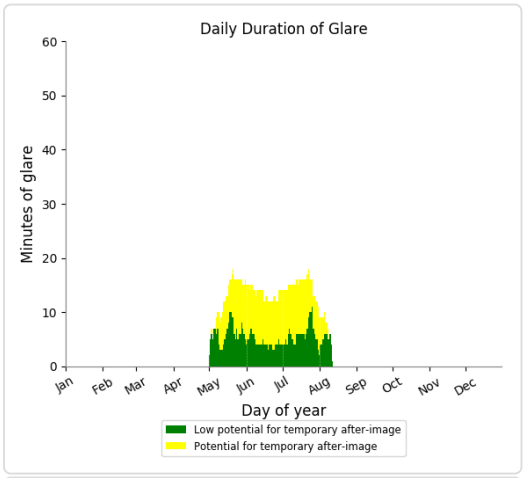


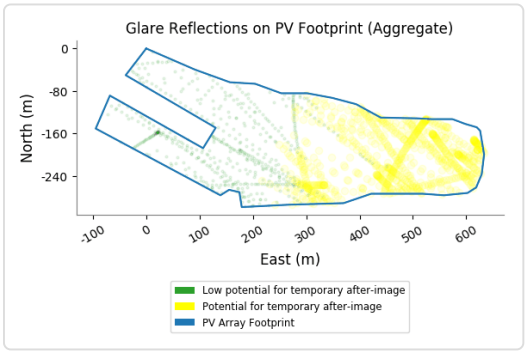
PV array 1 - OP Receptor (OP 26)

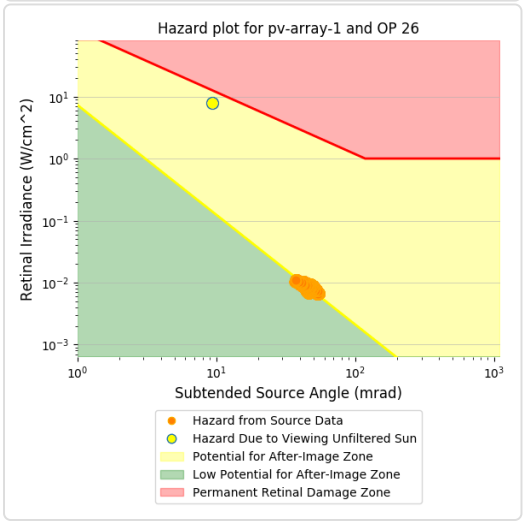
PV array is expected to produce the following glare for receptors at this location:

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





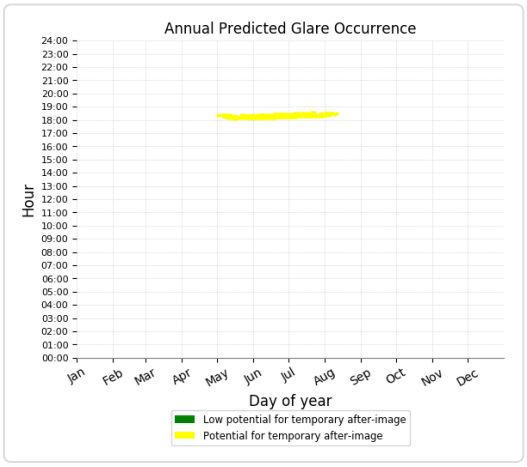


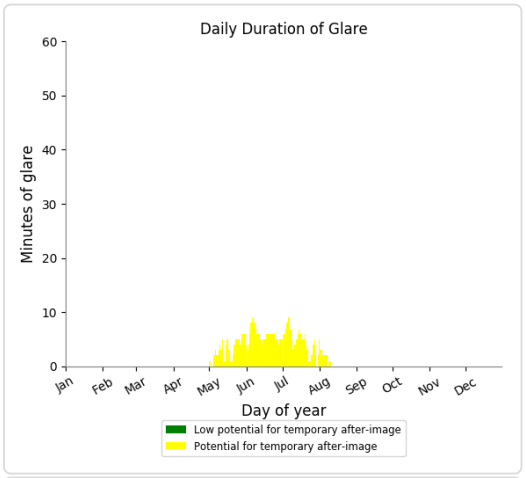


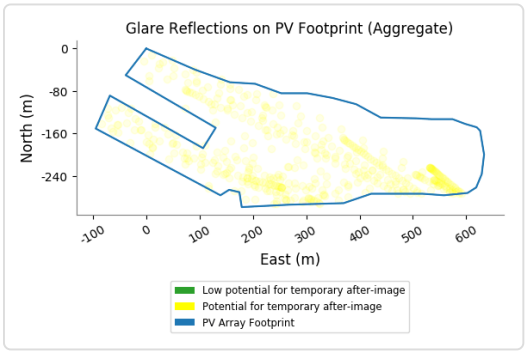
PV array 1 - OP Receptor (OP 27)

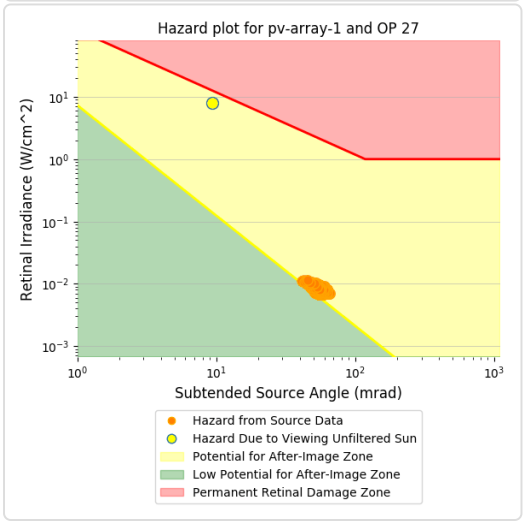
PV array is expected to produce the following glare for receptors at this location:

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





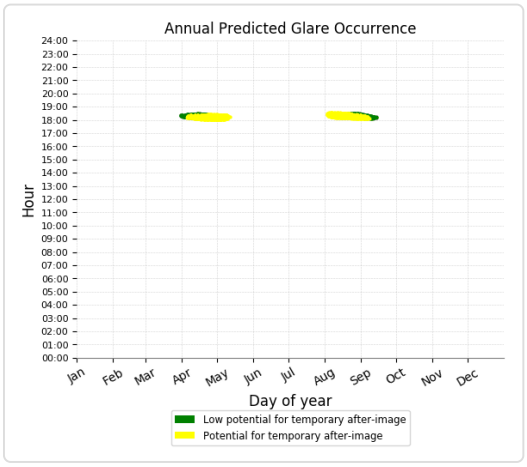


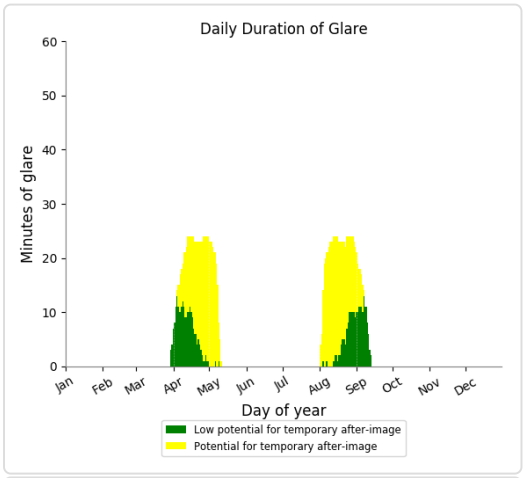


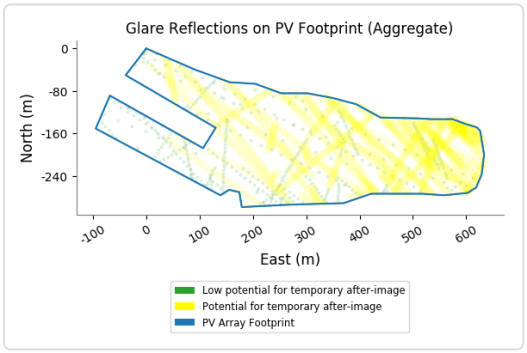
PV array 1 - OP Receptor (OP 28)

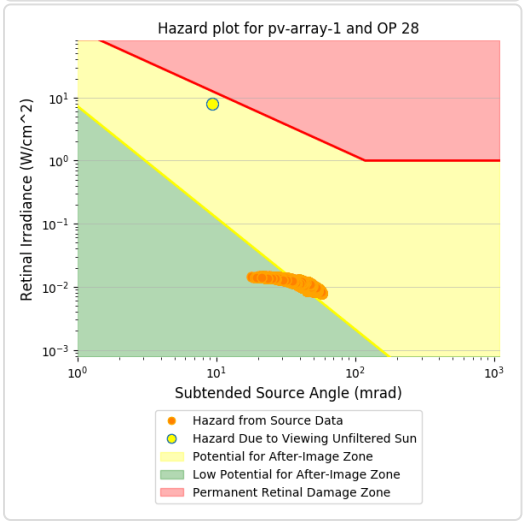
PV array is expected to produce the following glare for receptors at this location:

- 450 minutes of "green" glare with low potential to cause temporary after-image.
- 1,155 minutes of "yellow" glare with potential to cause temporary after-image.





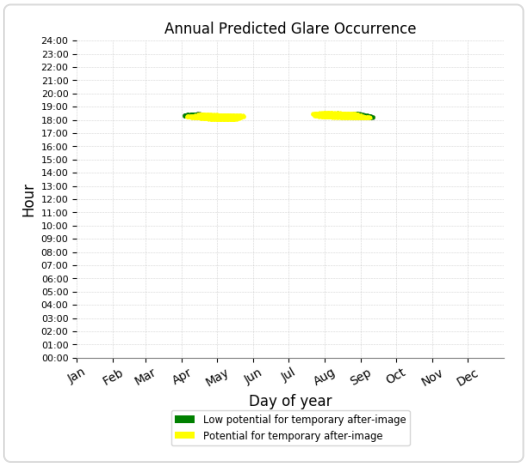


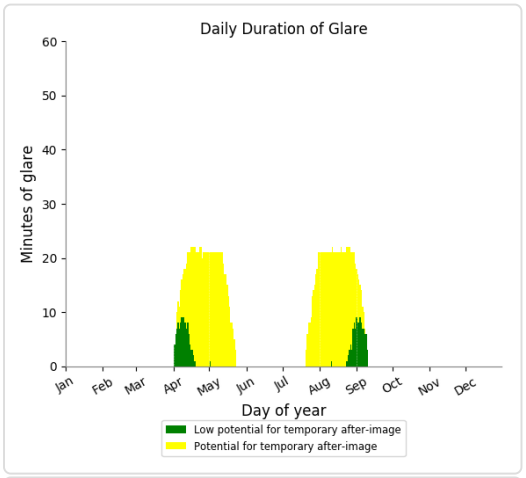


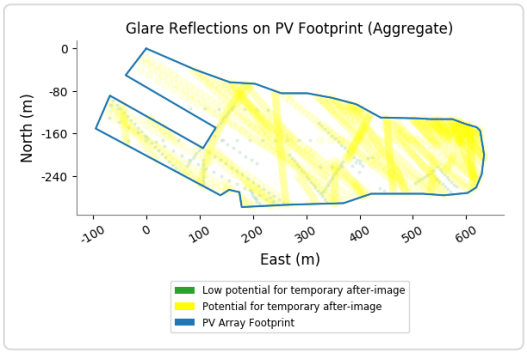
PV array 1 - OP Receptor (OP 29)

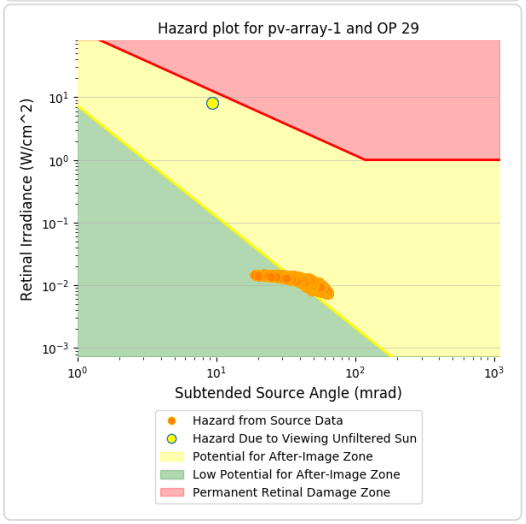
PV array is expected to produce the following glare for receptors at this location:

- 217 minutes of "green" glare with low potential to cause temporary after-image.
- 1,589 minutes of "yellow" glare with potential to cause temporary after-image.





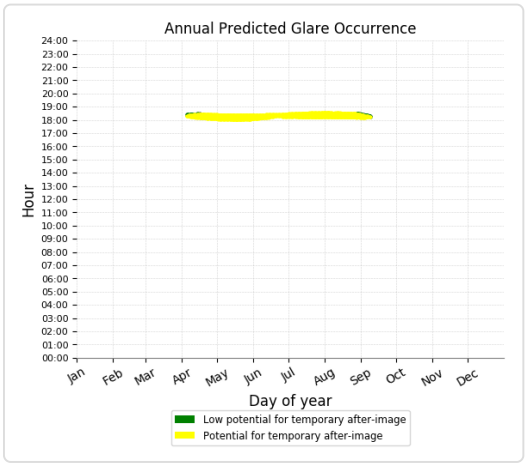


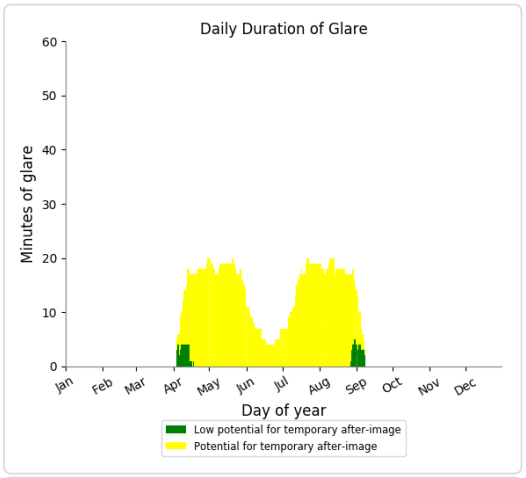


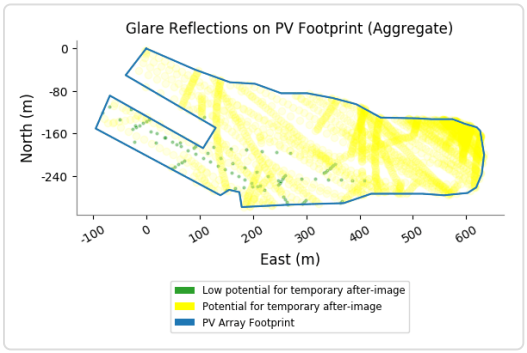
PV array 1 - OP Receptor (OP 30)

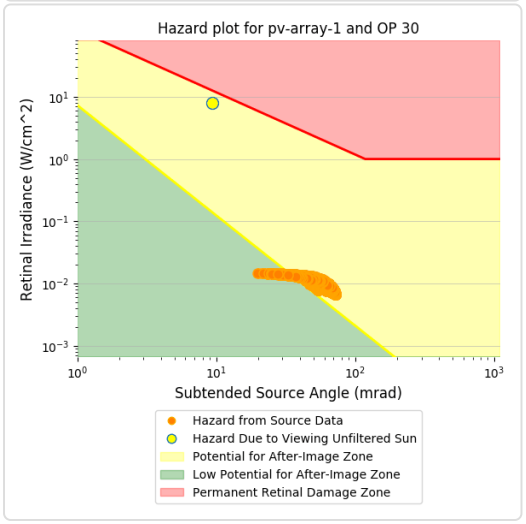
PV array is expected to produce the following glare for receptors at this location:

- 87 minutes of "green" glare with low potential to cause temporary after-image.
- 2,153 minutes of "yellow" glare with potential to cause temporary after-image.





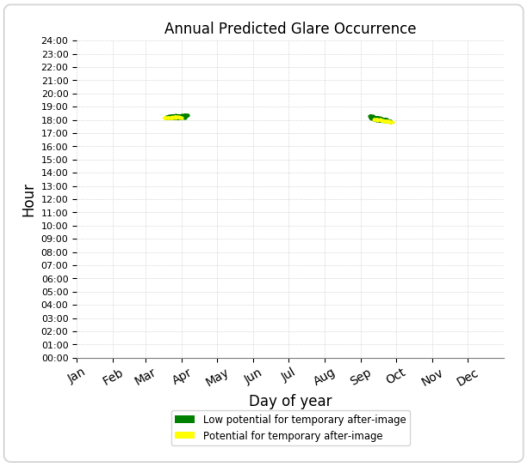


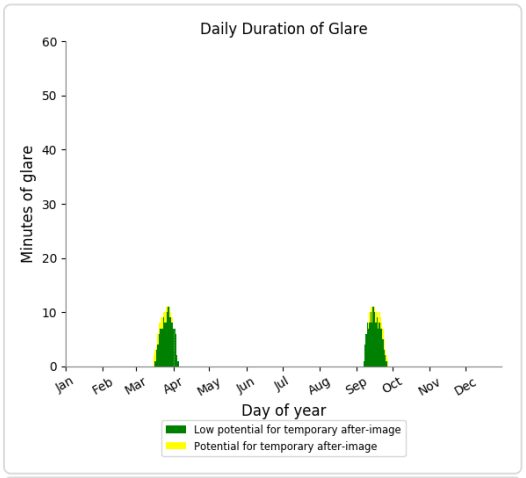


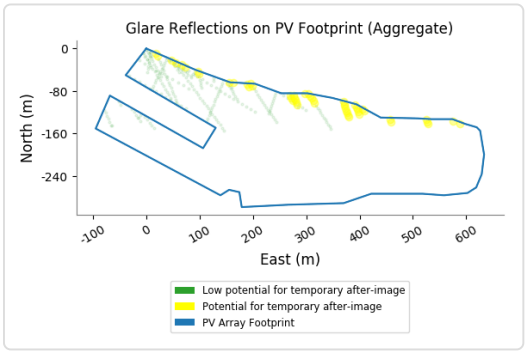
PV array 1 - OP Receptor (OP 31)

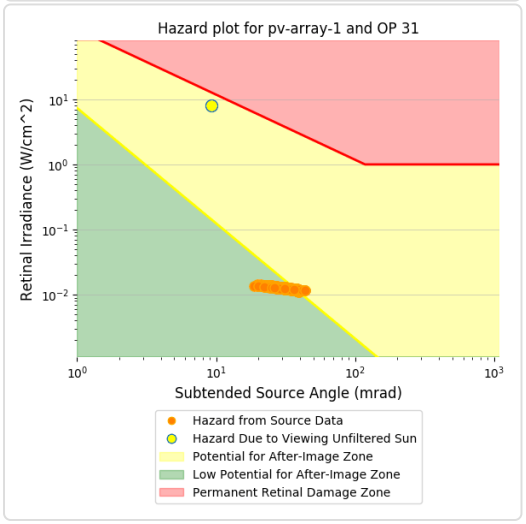
PV array is expected to produce the following glare for receptors at this location:

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





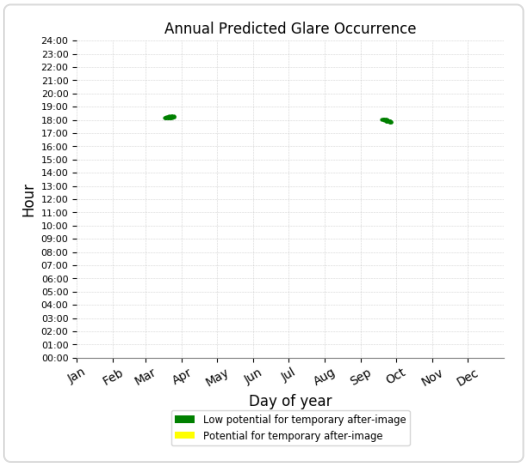


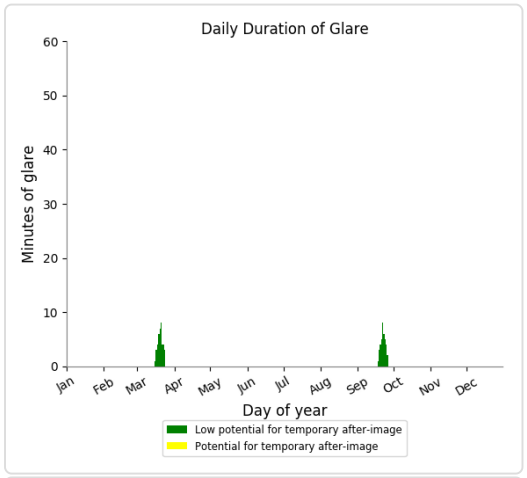


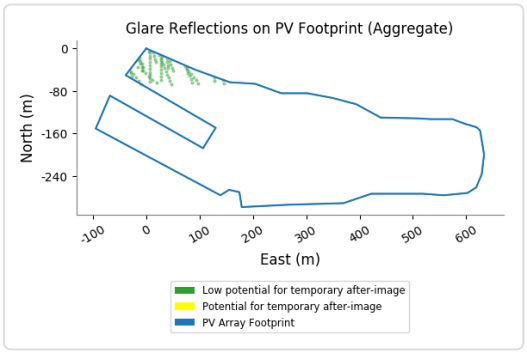
PV array 1 - OP Receptor (OP 32)

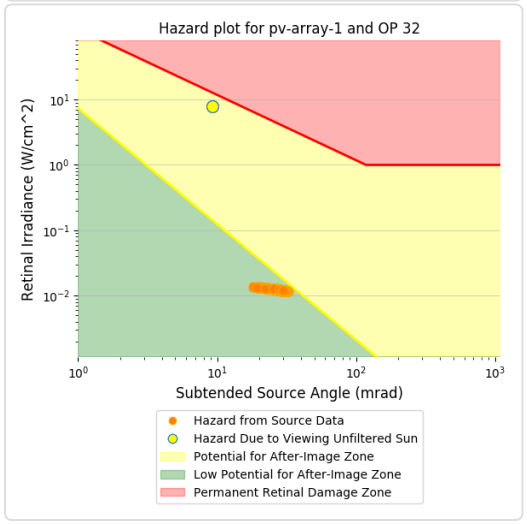
PV array is expected to produce the following glare for receptors at this location:

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





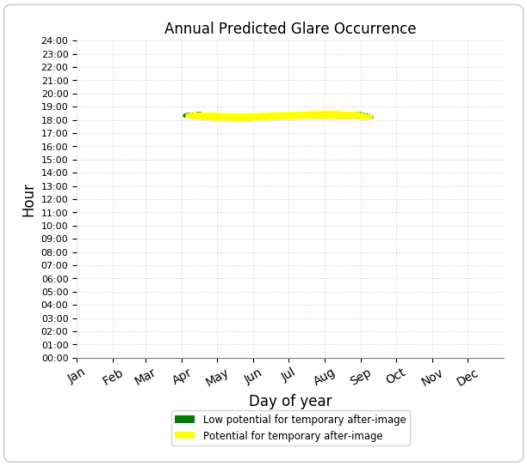


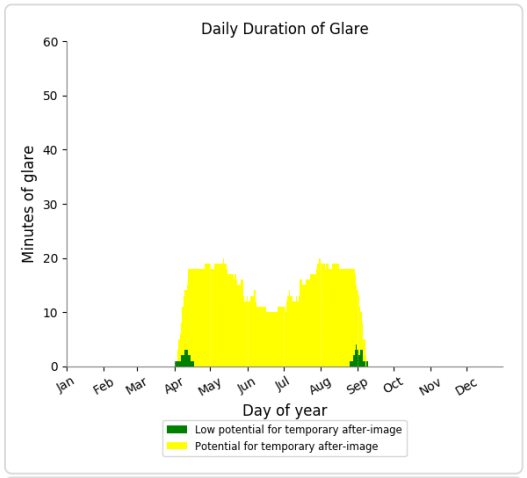


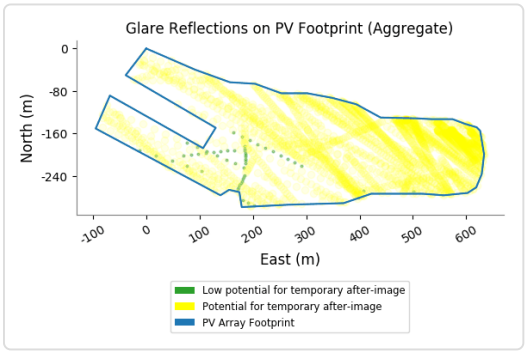
PV array 1 - OP Receptor (OP 33)

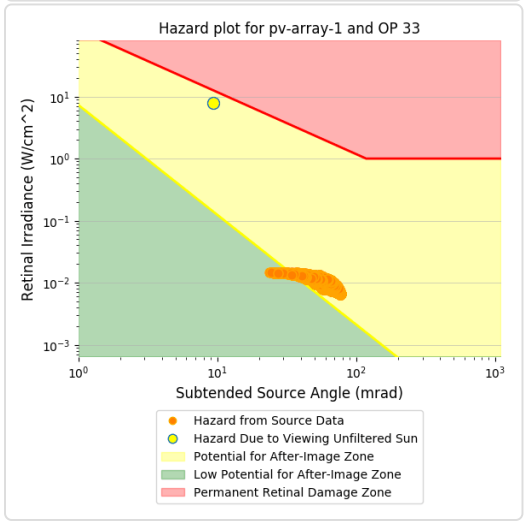
PV array is expected to produce the following glare for receptors at this location:

- 55 minutes of "green" glare with low potential to cause temporary after-image.
- 2,318 minutes of "yellow" glare with potential to cause temporary after-image.





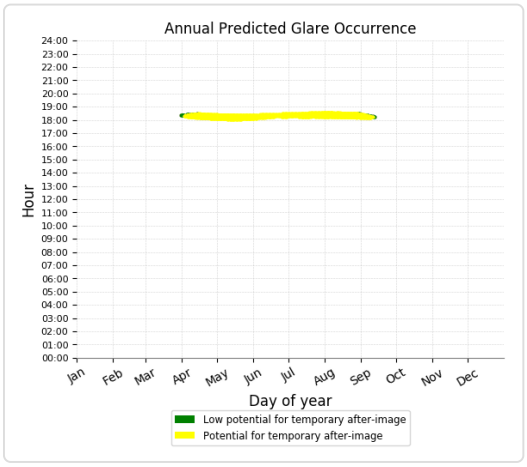


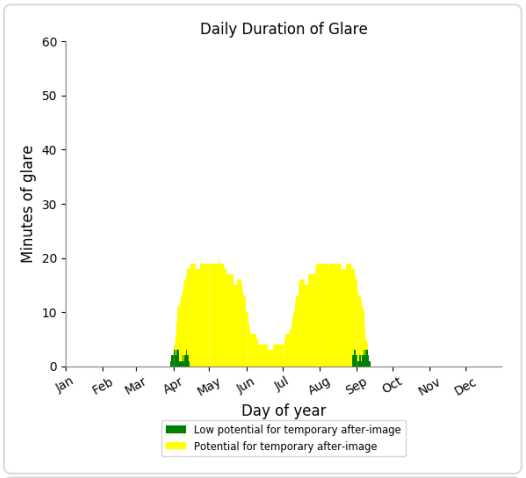


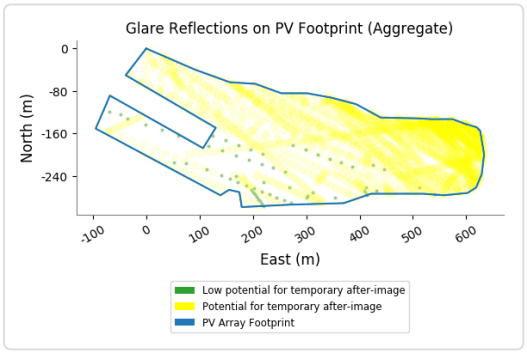
PV array 1 - OP Receptor (OP 34)

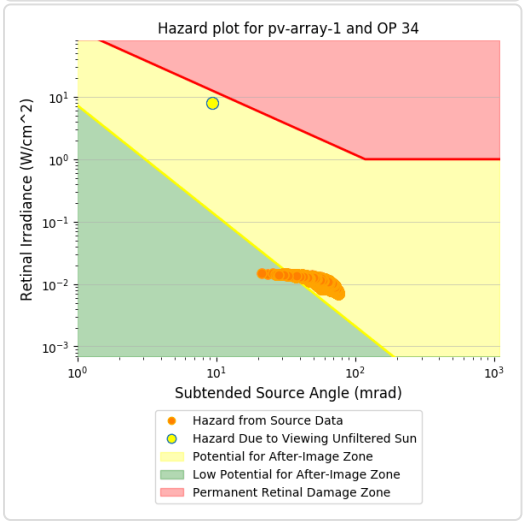
PV array is expected to produce the following glare for receptors at this location:

- 61 minutes of "green" glare with low potential to cause temporary after-image.
- 2,162 minutes of "yellow" glare with potential to cause temporary after-image.





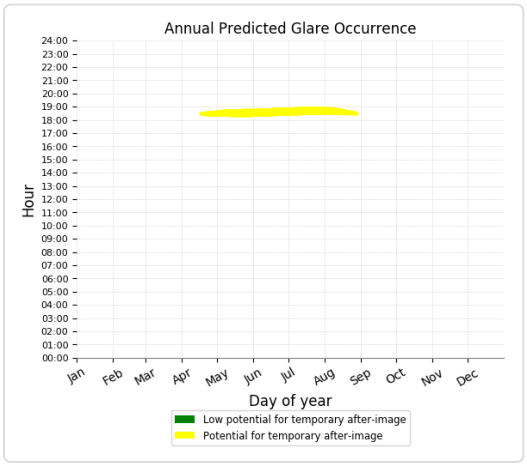


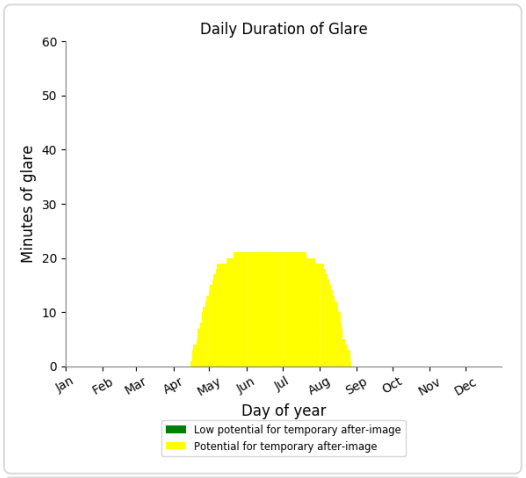


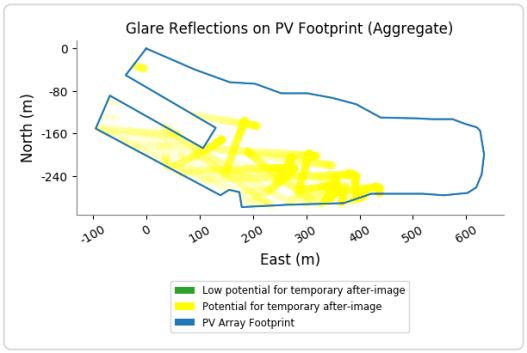
PV array 1 - OP Receptor (OP 35)

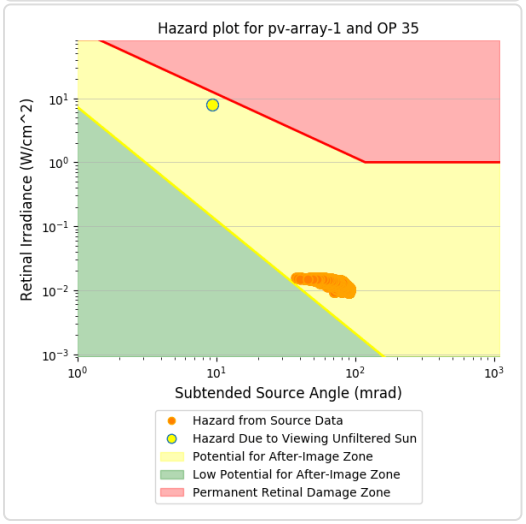
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,287 minutes of "yellow" glare with potential to cause temporary after-image.





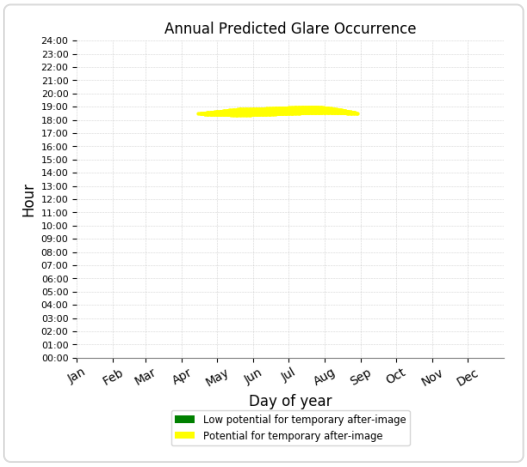


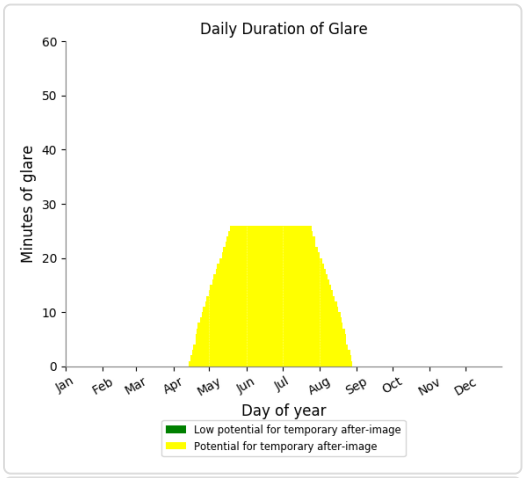


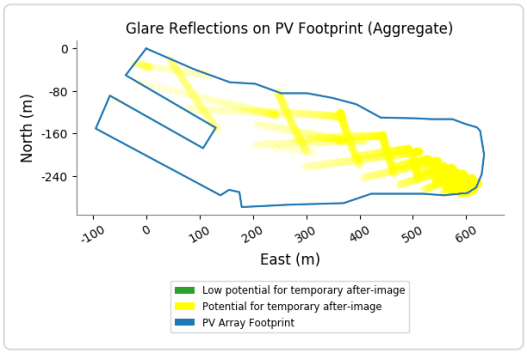
PV array 1 - OP Receptor (OP 36)

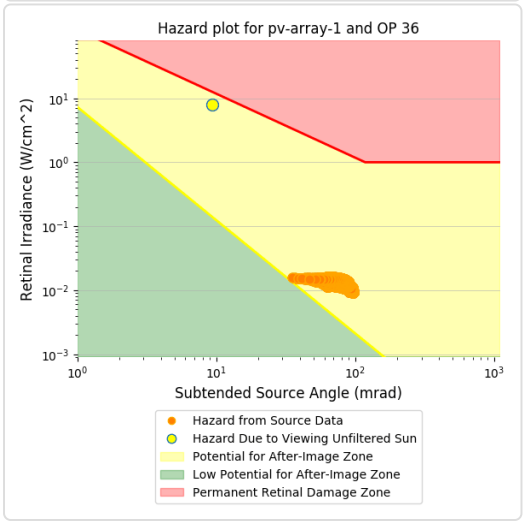
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,707 minutes of "yellow" glare with potential to cause temporary after-image.





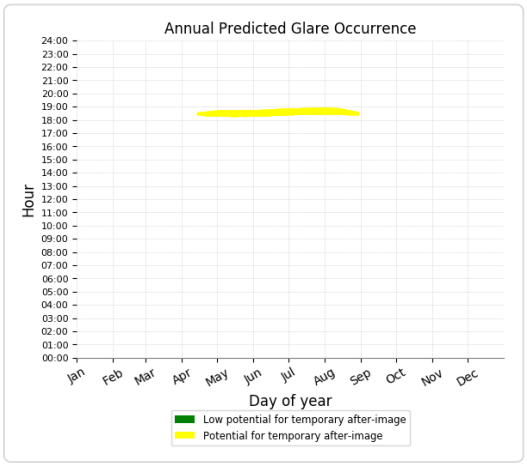


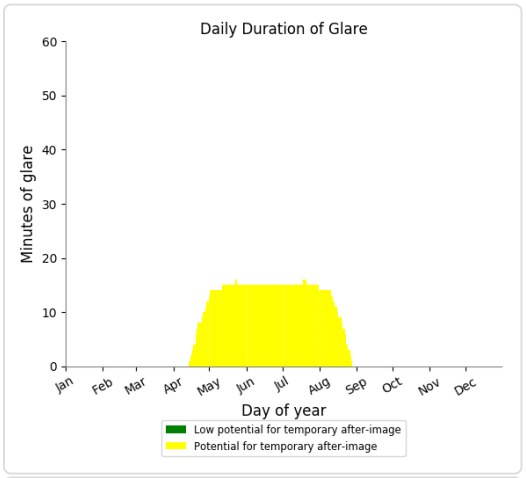


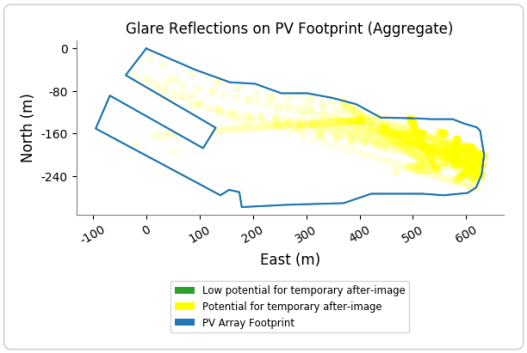
PV array 1 - OP Receptor (OP 37)

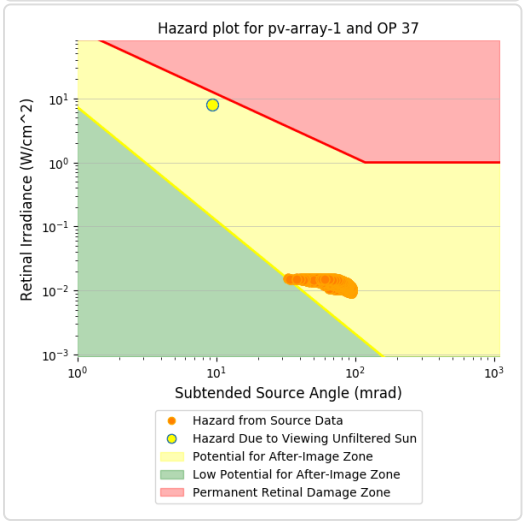
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,767 minutes of "yellow" glare with potential to cause temporary after-image.





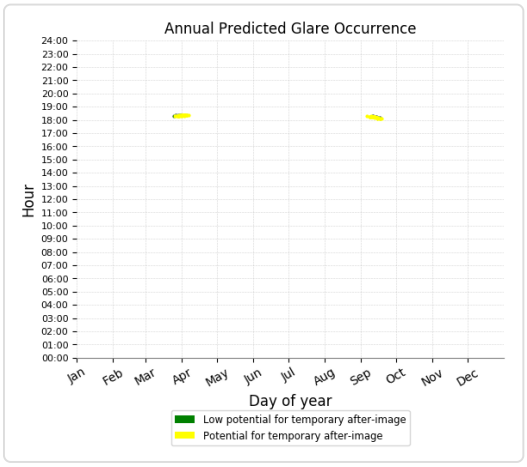


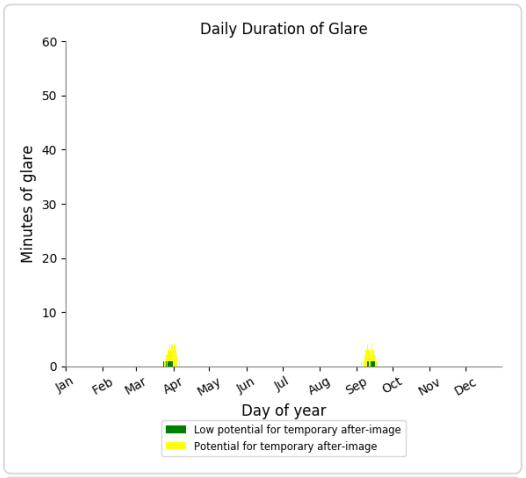


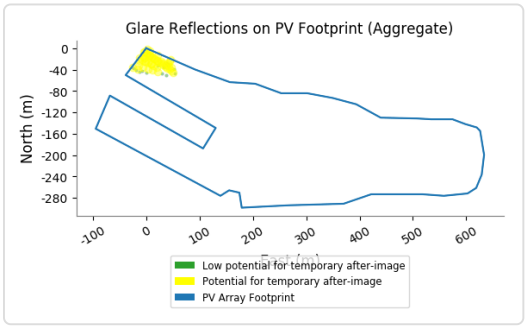
PV array 1 - OP Receptor (OP 38)

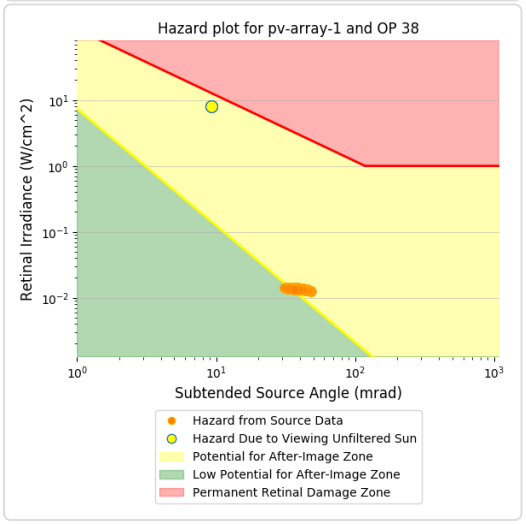
PV array is expected to produce the following glare for receptors at this location:

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









PV array 1 - OP Receptor (OP 39)

No glare found

PV array 1 - OP Receptor (OP 40)

No glare found

PV array 2 potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	26	0
OP: OP 5	0	2978
OP: OP 6	0	2321
OP: OP 7	0	1863
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0

OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	2
OP: OP 16	0	7
OP: OP 17	41	116
OP: OP 18	126	0
OP: OP 19	46	0
OP: OP 20	103	0
OP: OP 21	47	0
OP: OP 22	154	0
OP: OP 23	797	94
OP: OP 24	792	68
OP: OP 25	721	8
OP: OP 26	486	0
OP: OP 27	506	361
OP: OP 28	9	0
OP: OP 29	13	0
OP: OP 30	2	0
OP: OP 31	0	0
OP: OP 32	0	0
OP: OP 33	0	0
OP: OP 34	0	0
OP: OP 35	0	0
OP: OP 36	0	0
OP: OP 37	0	0
OP: OP 38	0	0
OP: OP 39	0	0
OP: OP 40	0	0

PV array 2 - OP Receptor (OP 1)

No glare found

PV array 2 - OP Receptor (OP 2)

No glare found

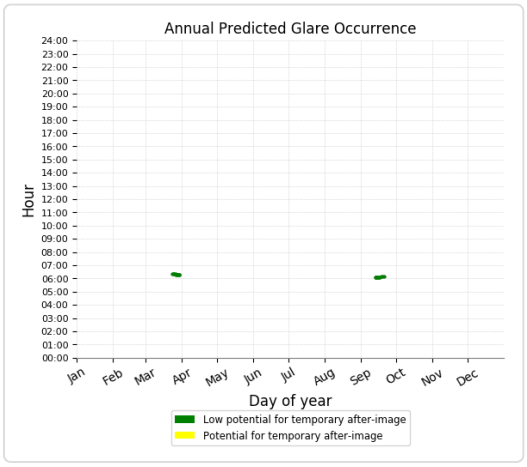
PV array 2 - OP Receptor (OP 3)

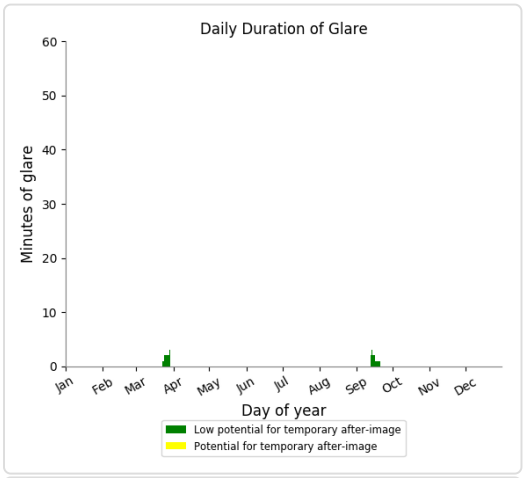
No glare found

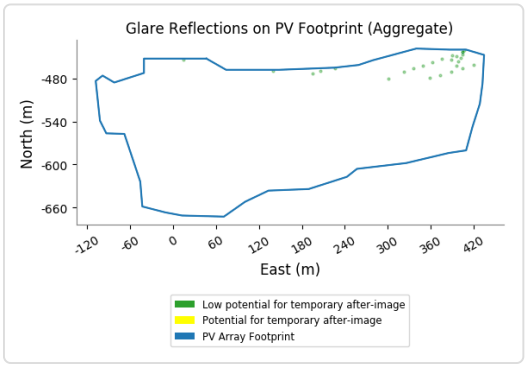
PV array 2 - OP Receptor (OP 4)

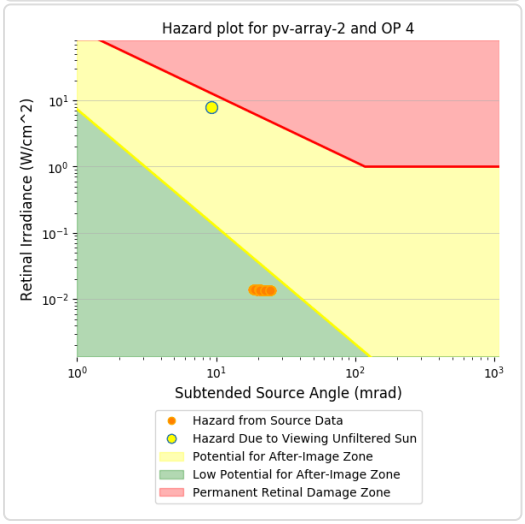
PV array is expected to produce the following glare for receptors at this location:

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





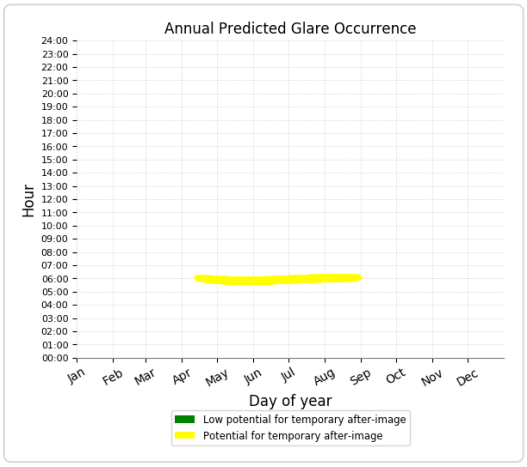


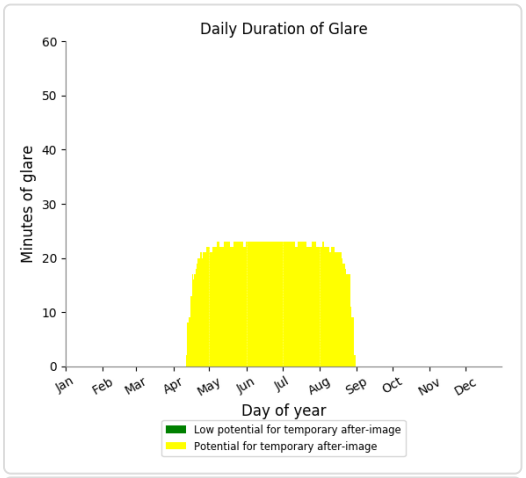


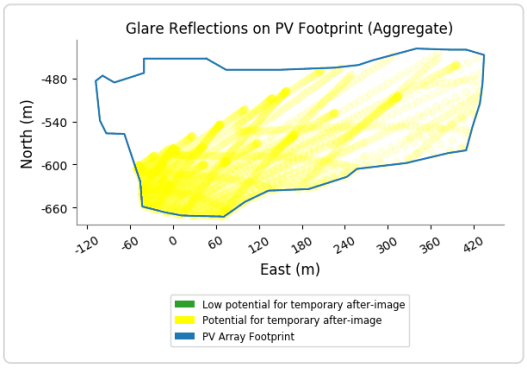
PV array 2 - OP Receptor (OP 5)

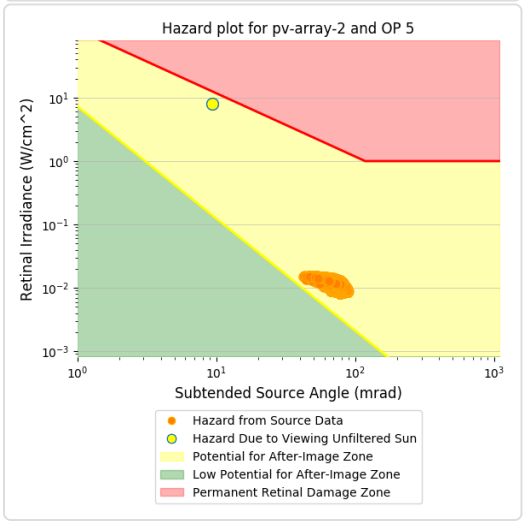
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,978 minutes of "yellow" glare with potential to cause temporary after-image.





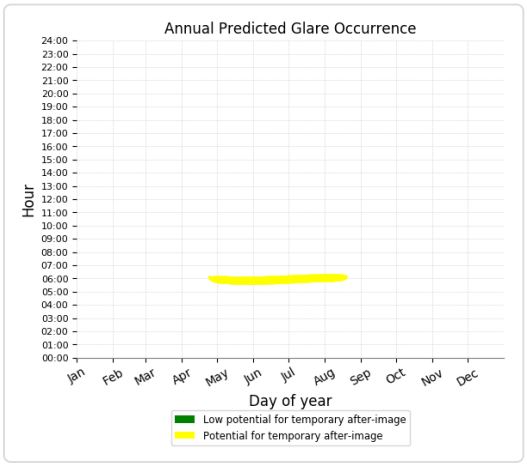


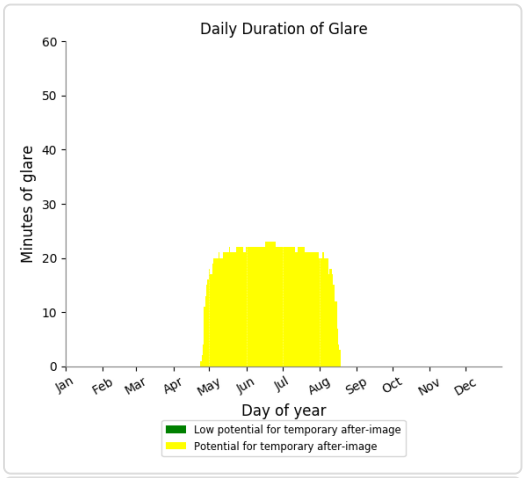


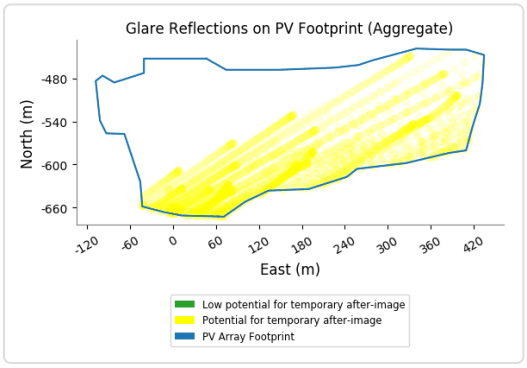
PV array 2 - OP Receptor (OP 6)

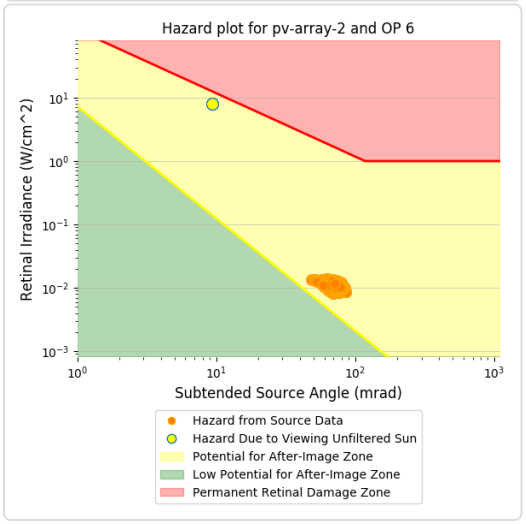
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,321 minutes of "yellow" glare with potential to cause temporary after-image.





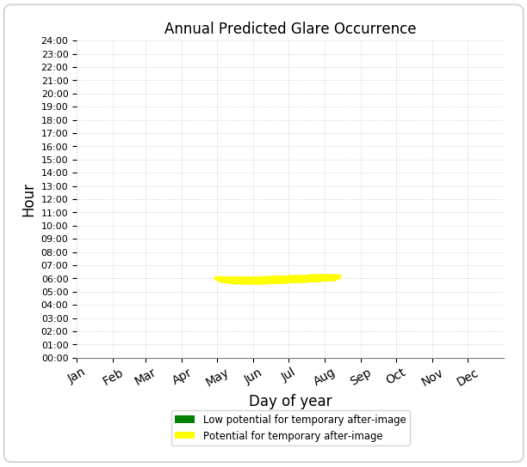


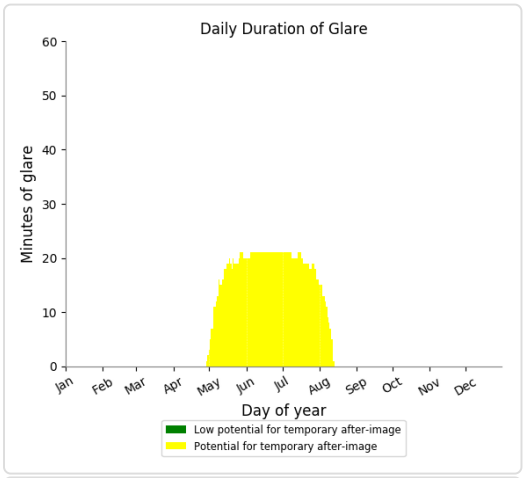


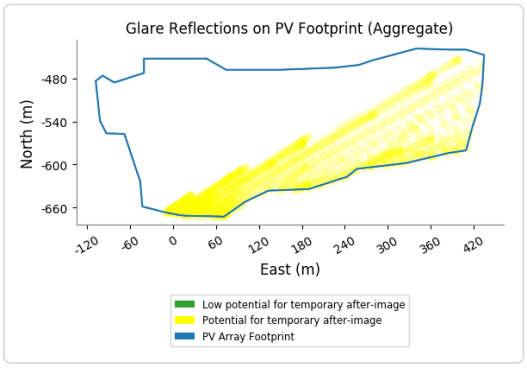
PV array 2 - OP Receptor (OP 7)

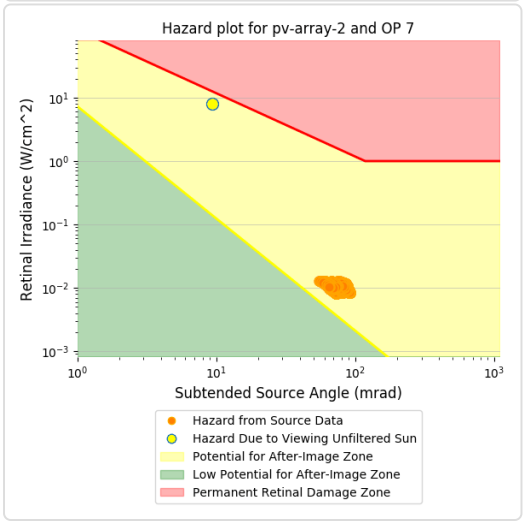
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,863 minutes of "yellow" glare with potential to cause temporary after-image.









PV array 2 - OP Receptor (OP 8)

No glare found

PV array 2 - OP Receptor (OP 9)

No glare found

PV array 2 - OP Receptor (OP 10)

No glare found

PV array 2 - OP Receptor (OP 11)

No glare found

PV array 2 - OP Receptor (OP 12)

No glare found

PV array 2 - OP Receptor (OP 13)

No glare found

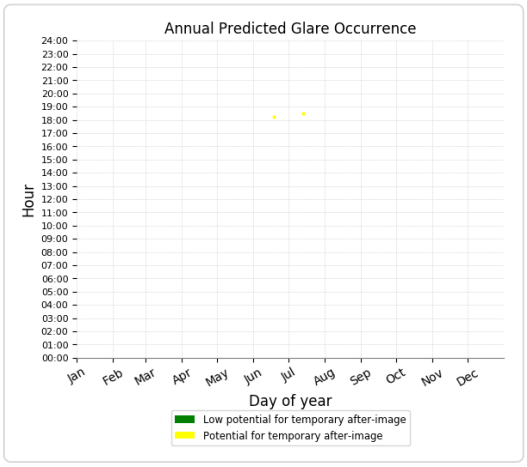
PV array 2 - OP Receptor (OP 14)

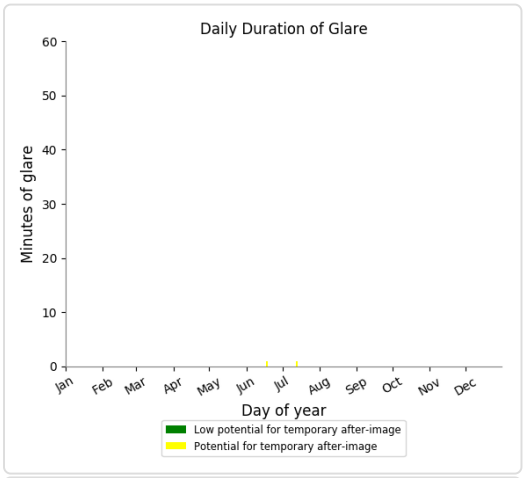
No glare found

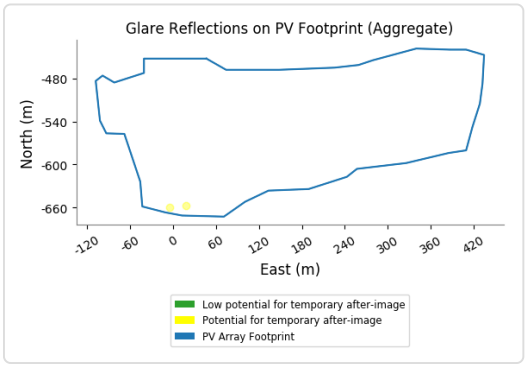
PV array 2 - OP Receptor (OP 15)

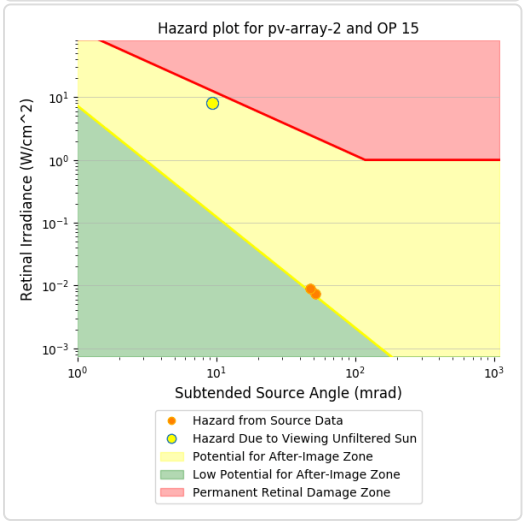
PV array is expected to produce the following glare for receptors at this location:

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





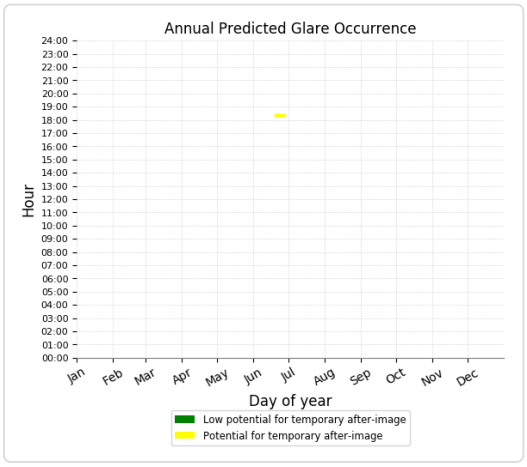


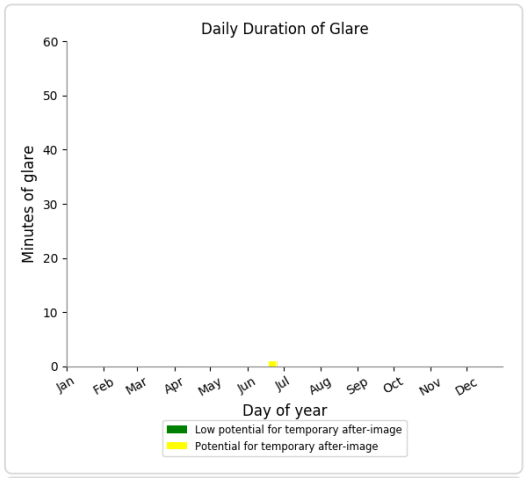


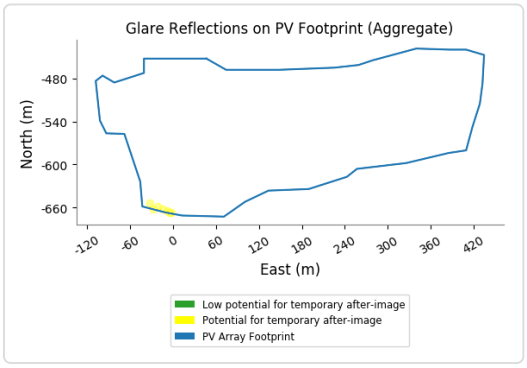
PV array 2 - OP Receptor (OP 16)

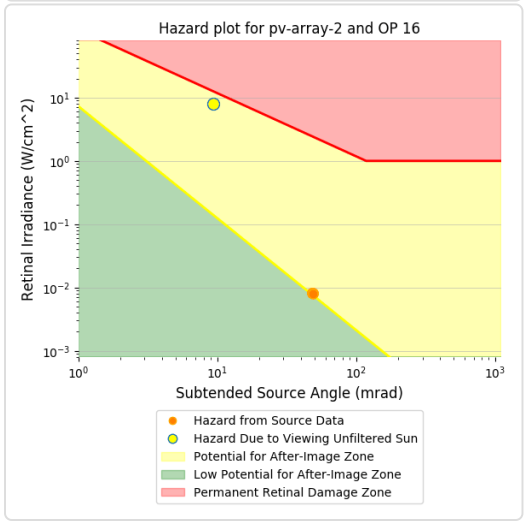
PV array is expected to produce the following glare for receptors at this location:

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





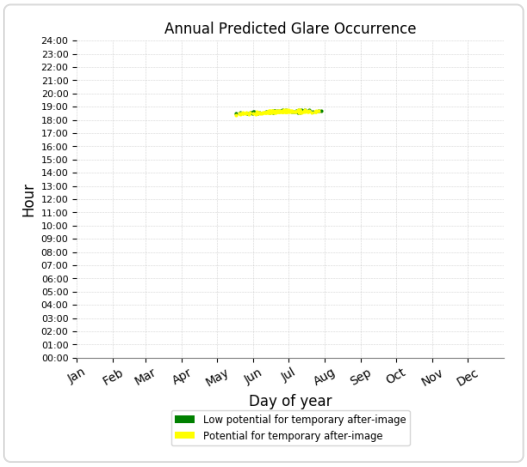


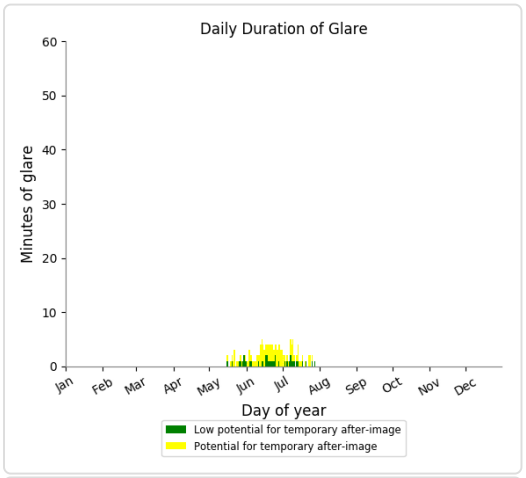


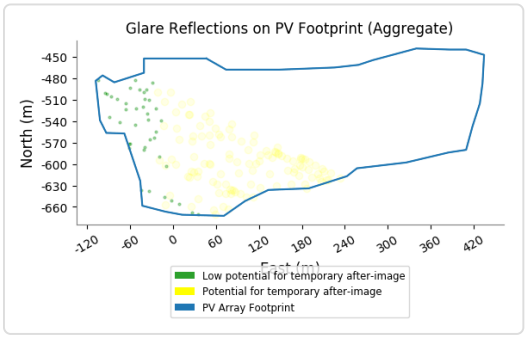
PV array 2 - OP Receptor (OP 17)

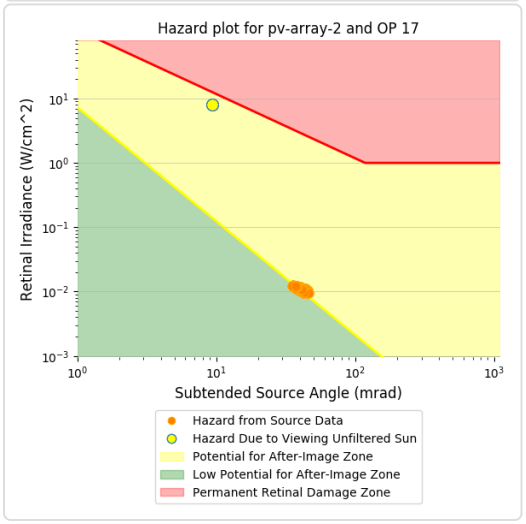
PV array is expected to produce the following glare for receptors at this location:

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





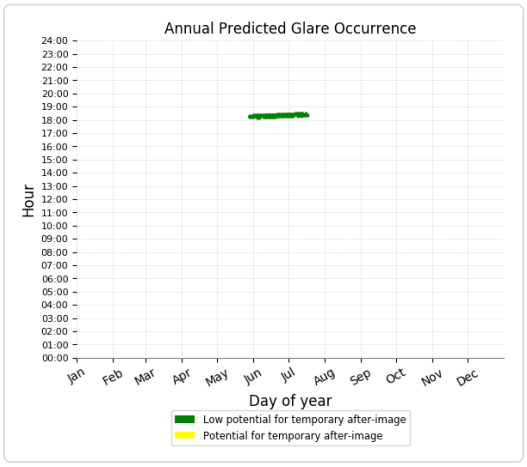


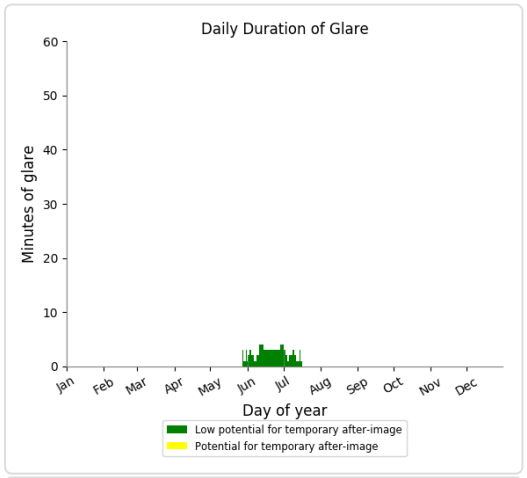


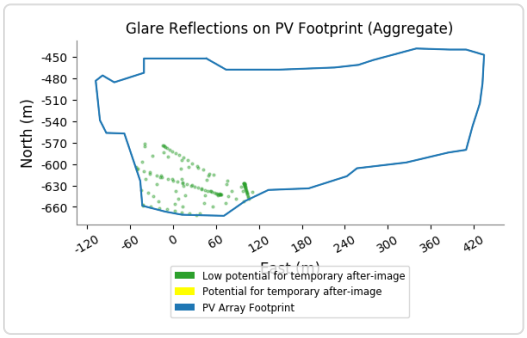
PV array 2 - OP Receptor (OP 18)

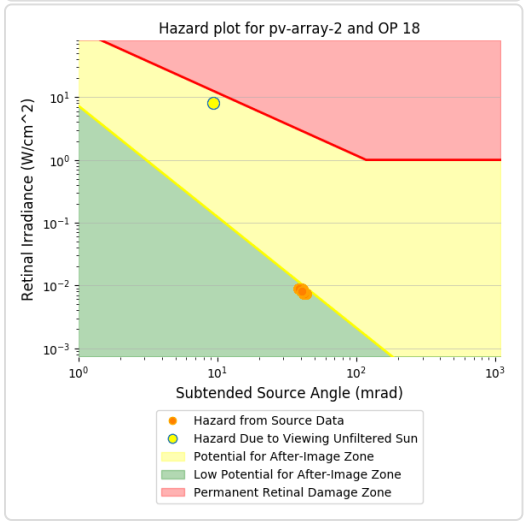
PV array is expected to produce the following glare for receptors at this location:

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





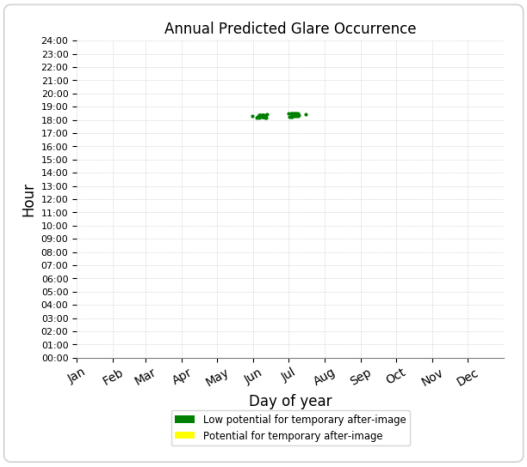


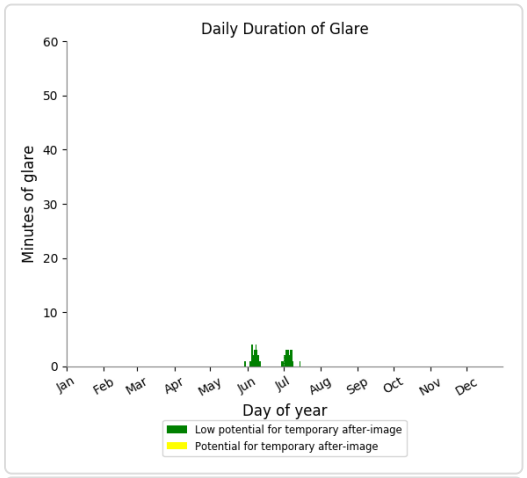


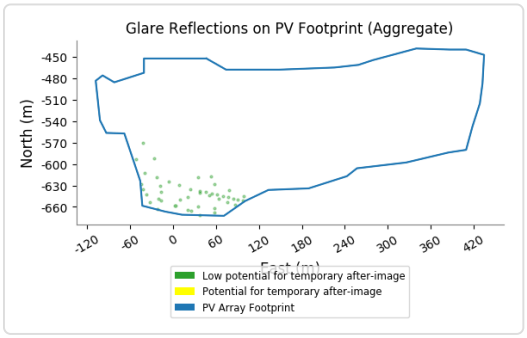
PV array 2 - OP Receptor (OP 19)

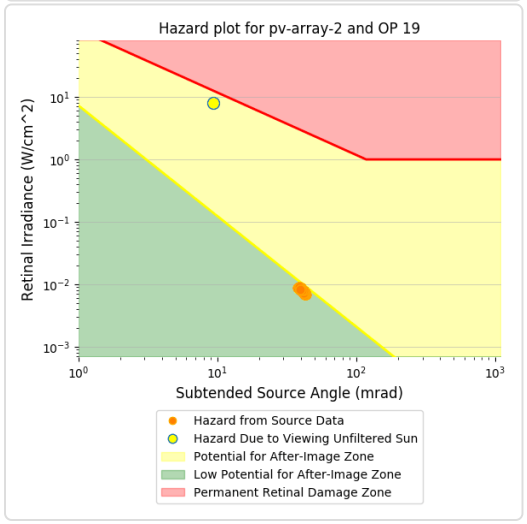
PV array is expected to produce the following glare for receptors at this location:

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





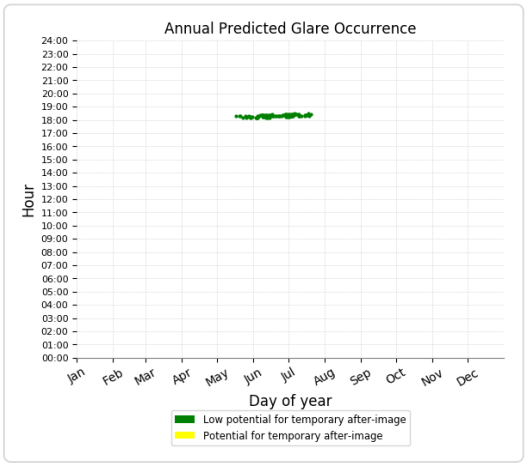


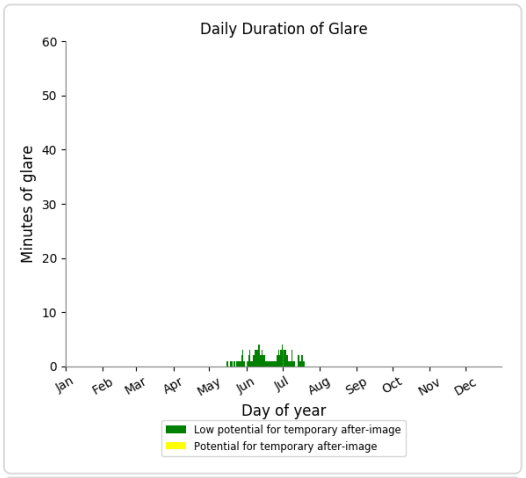


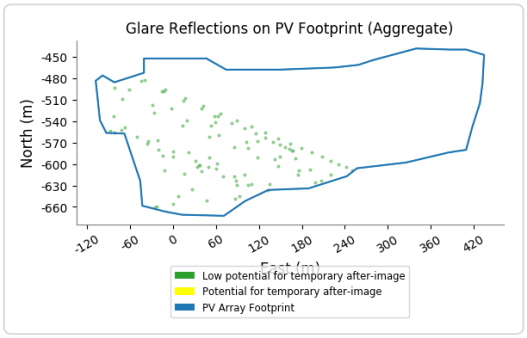
PV array 2 - OP Receptor (OP 20)

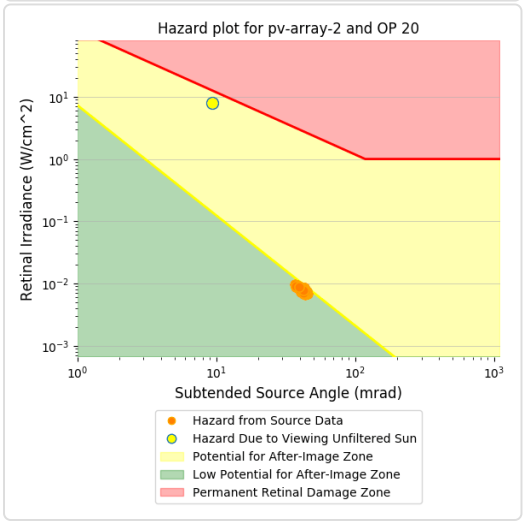
PV array is expected to produce the following glare for receptors at this location:

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





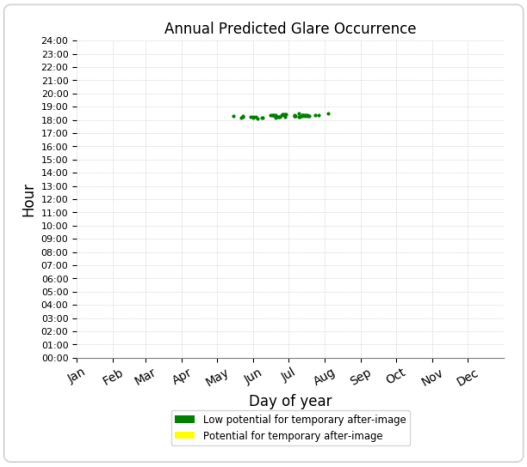


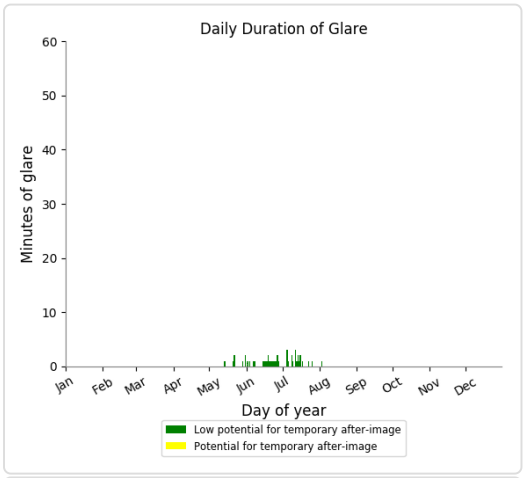


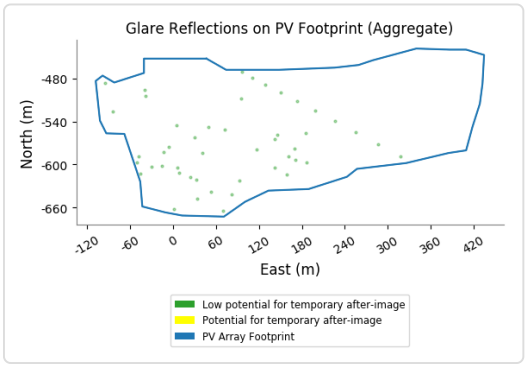
PV array 2 - OP Receptor (OP 21)

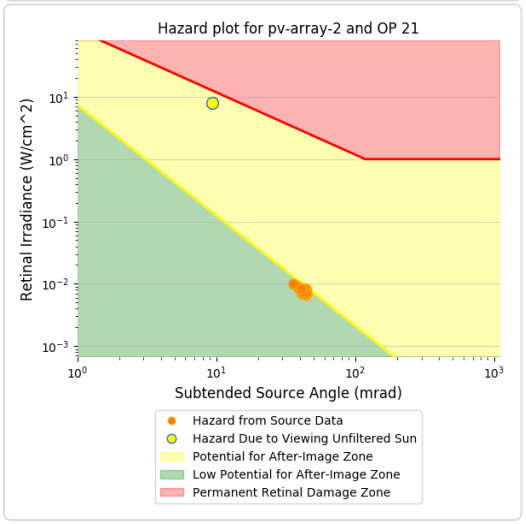
PV array is expected to produce the following glare for receptors at this location:

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





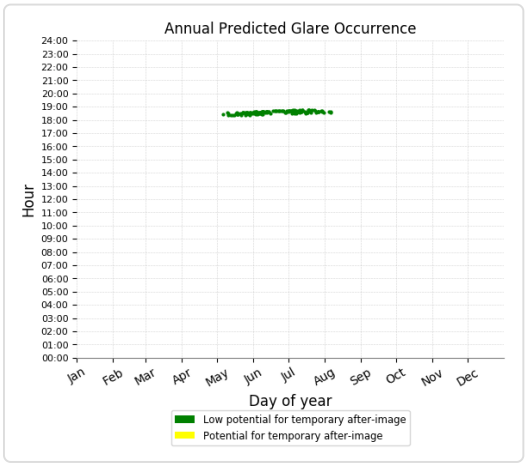


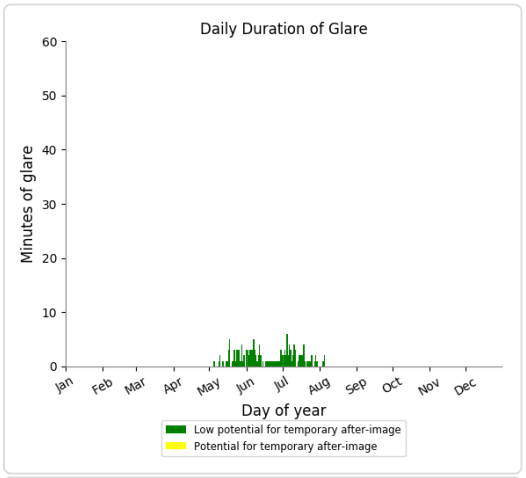


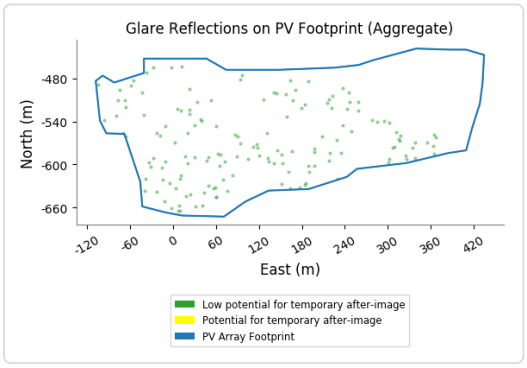
PV array 2 - OP Receptor (OP 22)

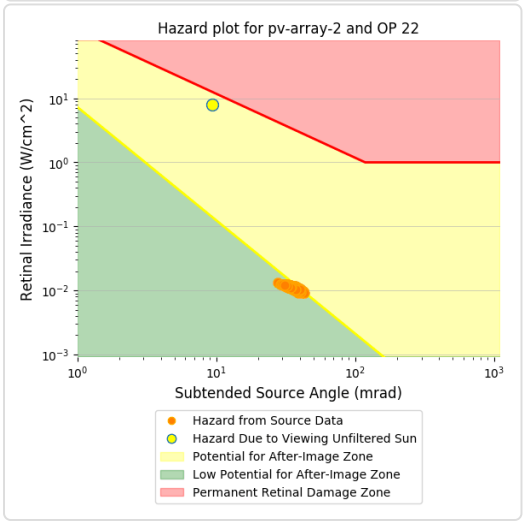
PV array is expected to produce the following glare for receptors at this location:

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





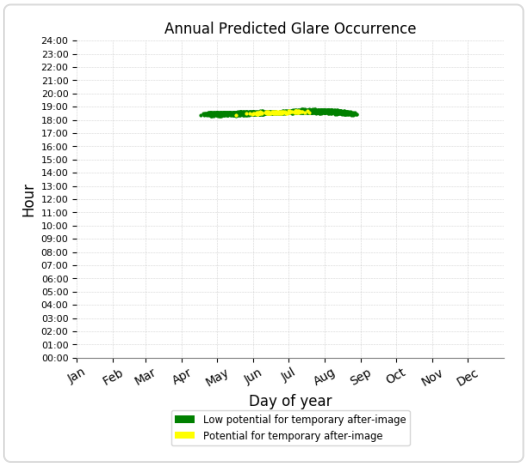


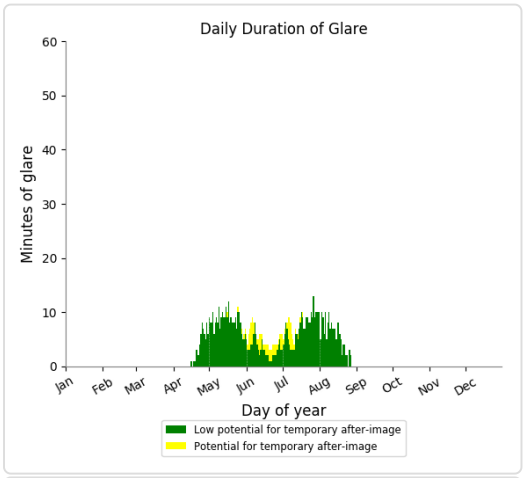


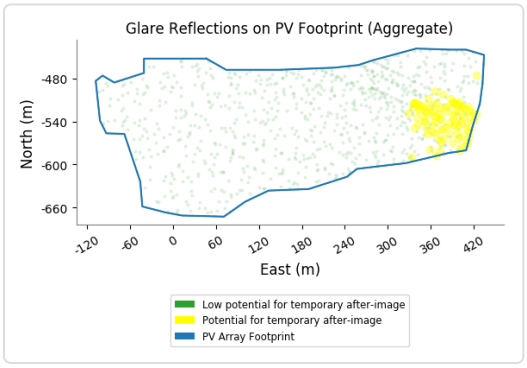
PV array 2 - OP Receptor (OP 23)

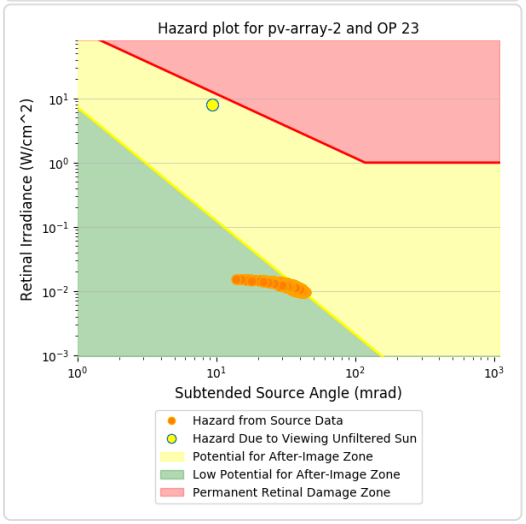
PV array is expected to produce the following glare for receptors at this location:

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





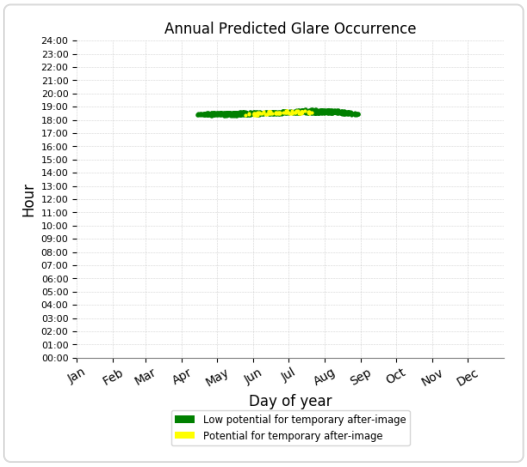


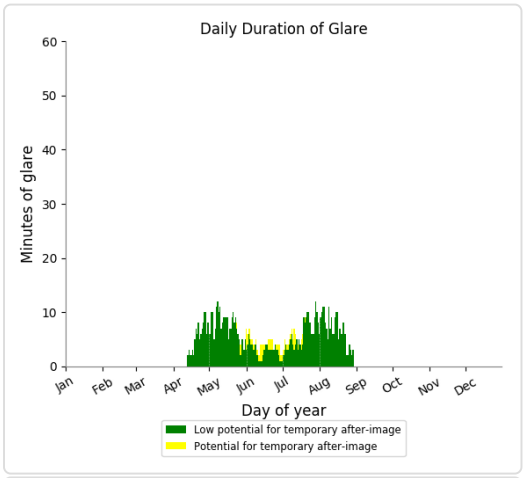


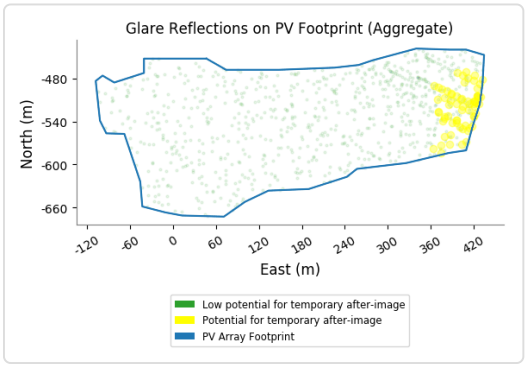
PV array 2 - OP Receptor (OP 24)

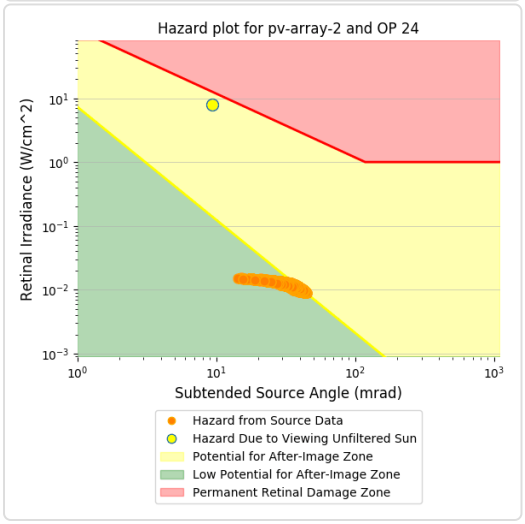
PV array is expected to produce the following glare for receptors at this location:

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





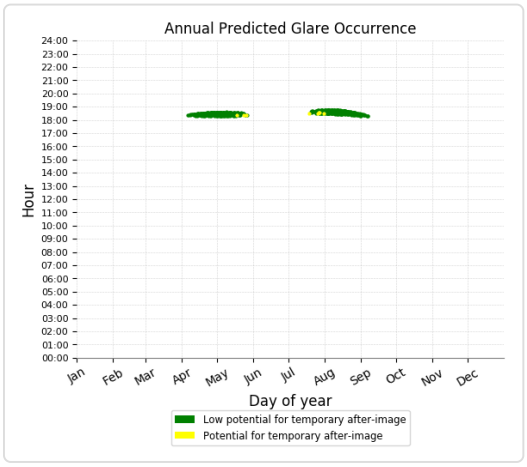


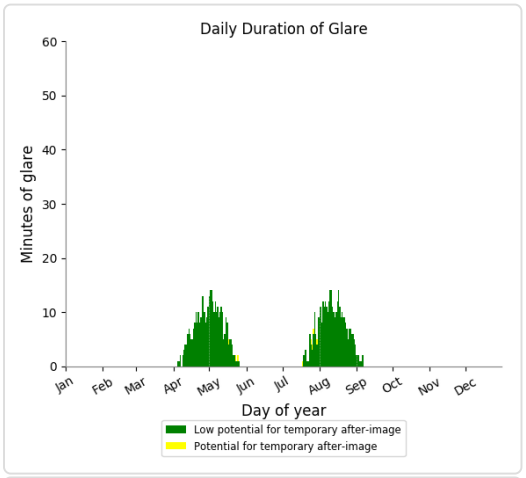


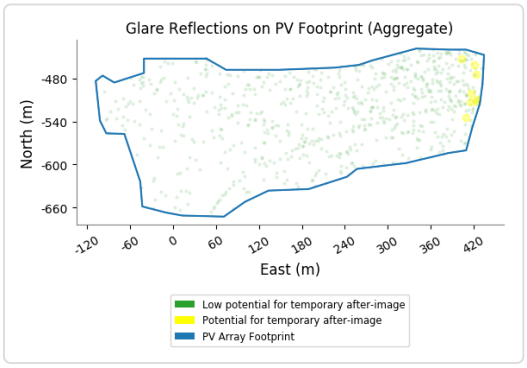
PV array 2 - OP Receptor (OP 25)

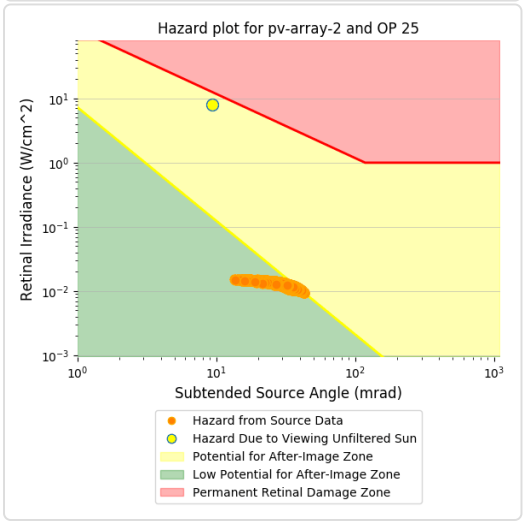
PV array is expected to produce the following glare for receptors at this location:

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





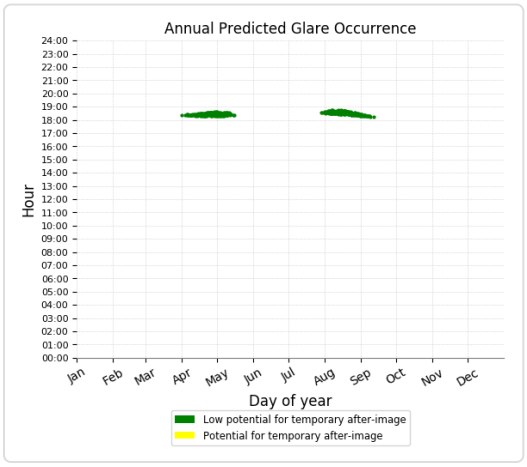


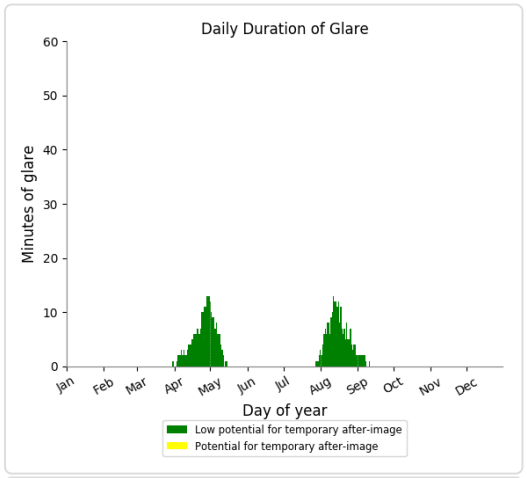


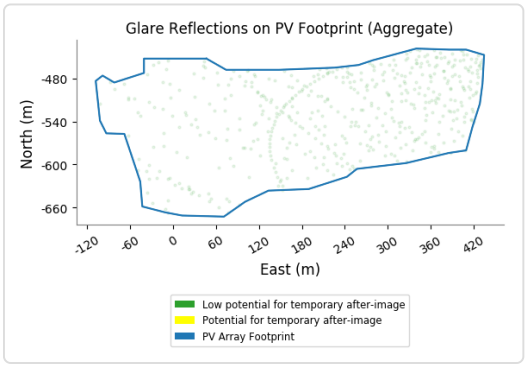
PV array 2 - OP Receptor (OP 26)

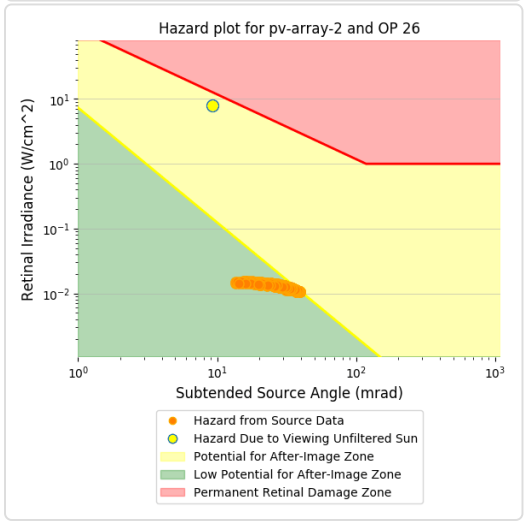
PV array is expected to produce the following glare for receptors at this location:

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





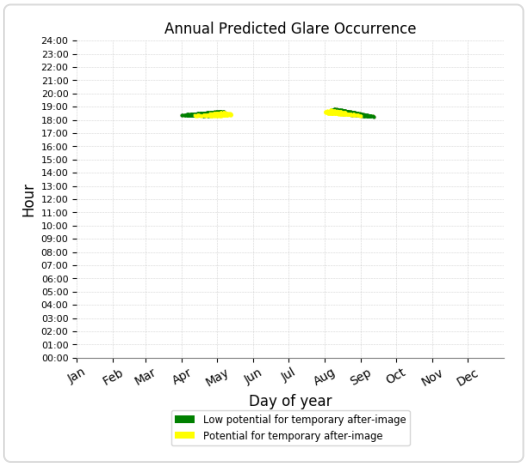


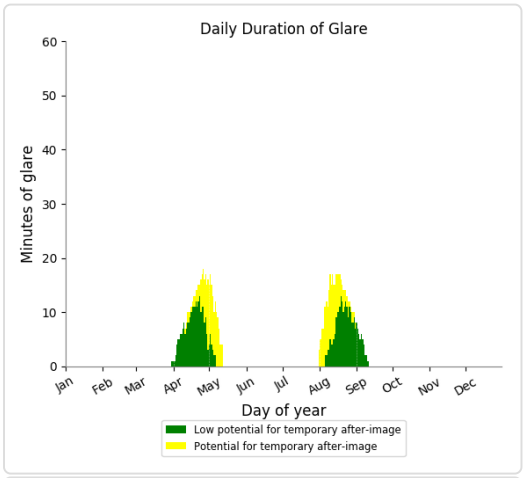


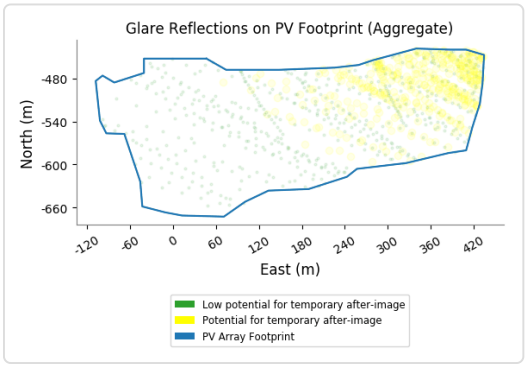
PV array 2 - OP Receptor (OP 27)

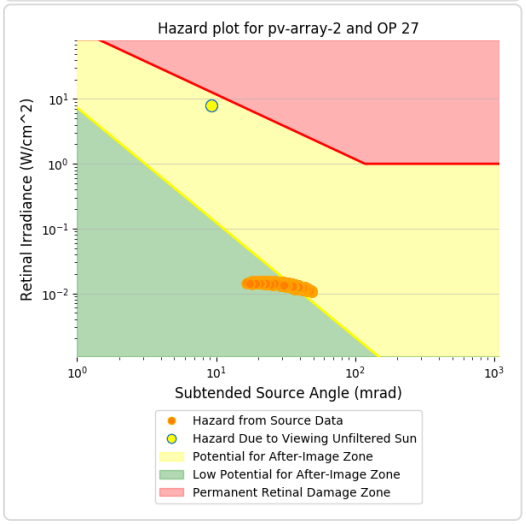
PV array is expected to produce the following glare for receptors at this location:

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





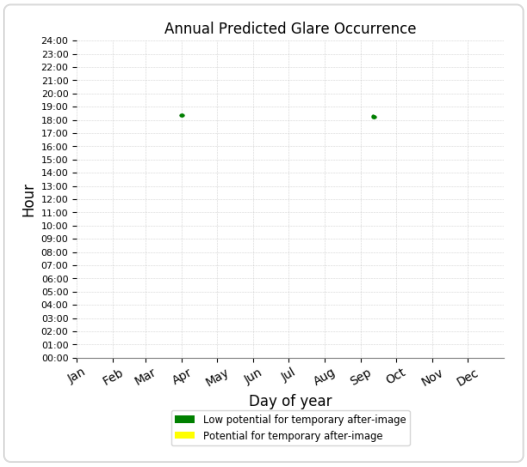


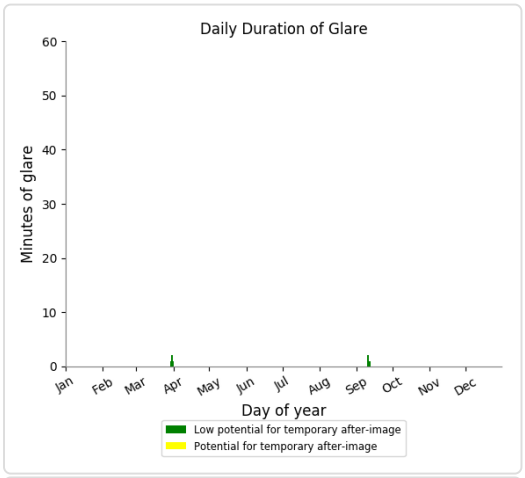


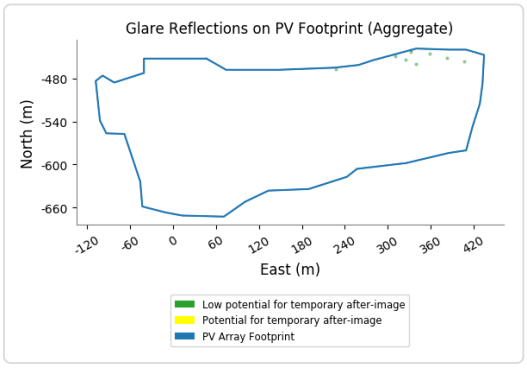
PV array 2 - OP Receptor (OP 28)

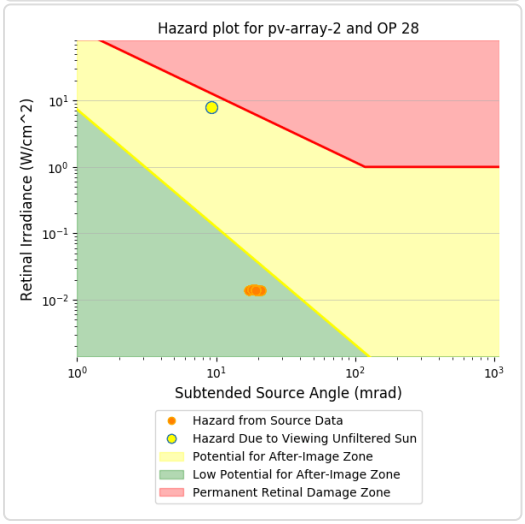
PV array is expected to produce the following glare for receptors at this location:

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





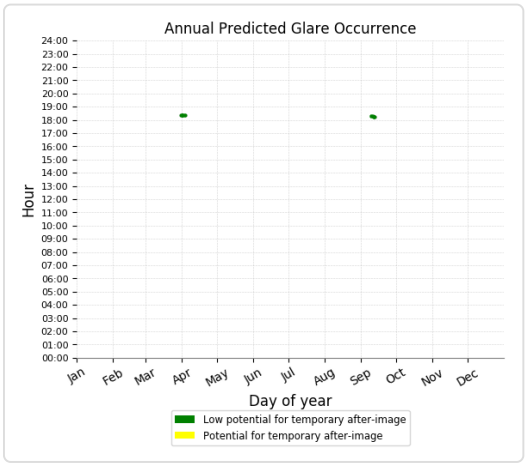


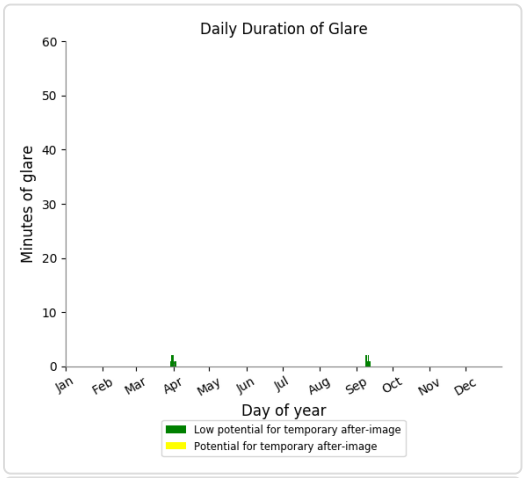


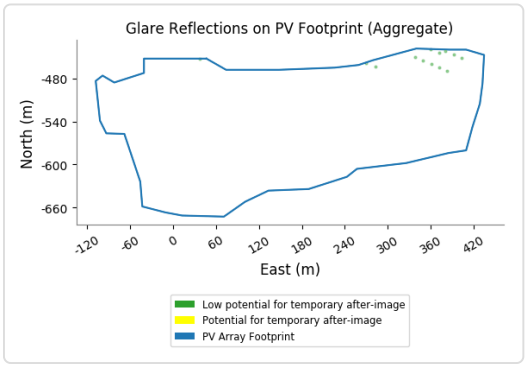
PV array 2 - OP Receptor (OP 29)

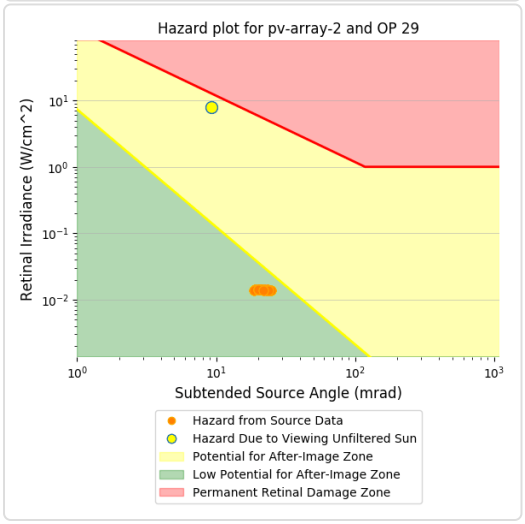
PV array is expected to produce the following glare for receptors at this location:

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





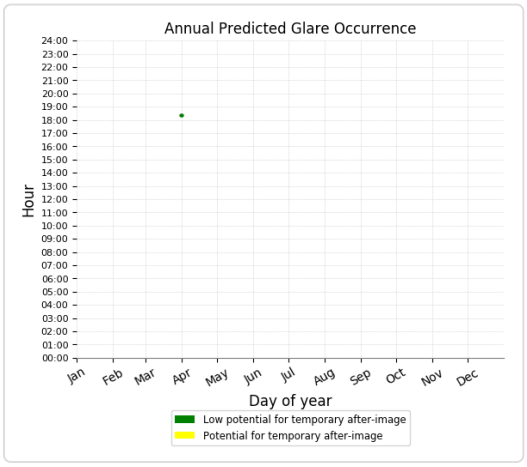


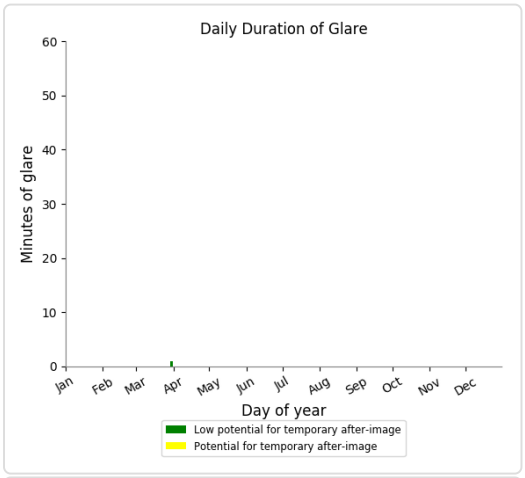


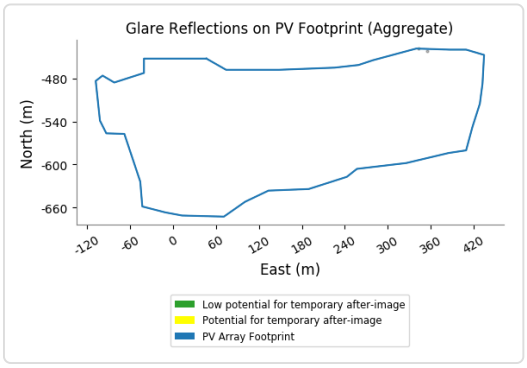
PV array 2 - OP Receptor (OP 30)

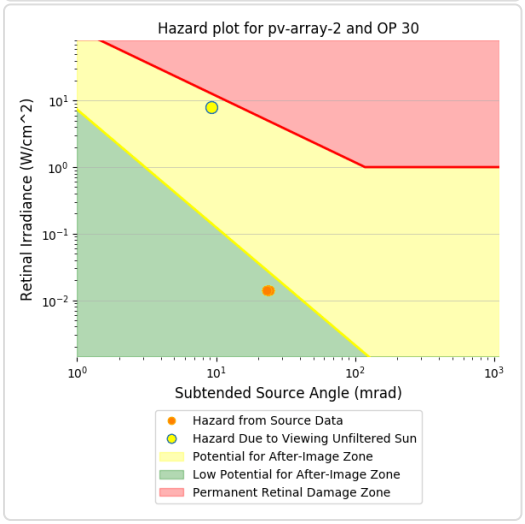
PV array is expected to produce the following glare for receptors at this location:

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









PV array 2 - OP Receptor (OP 31)

No glare found

PV array 2 - OP Receptor (OP 32)

No glare found

PV array 2 - OP Receptor (OP 33)

No glare found

PV array 2 - OP Receptor (OP 34)

No glare found

PV array 2 - OP Receptor (OP 35)

No glare found

PV array 2 - OP Receptor (OP 36)

No glare found

PV array 2 - OP Receptor (OP 37)

No glare found

PV array 2 - OP Receptor (OP 38)

No glare found

PV array 2 - OP Receptor (OP 39)

No glare found

PV array 2 - OP Receptor (OP 40)

No glare found

PV array 3 potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	9	357
OP: OP 6	11	181
OP: OP 7	14	859
OP: OP 8	1	2140
OP: OP 9	1	2689
OP: OP 10	0	1843
OP: OP 11	0	1319
OP: OP 12	0	184
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	129
OP: OP 16	0	3
OP: OP 17	0	411
OP: OP 18	0	285
OP: OP 19	0	287
OP: OP 20	0	528
OP: OP 21	0	598
OP: OP 22	0	922
OP: OP 23	1	928
OP: OP 24	3	923
OP: OP 25	34	1204
OP: OP 26	71	735
OP: OP 27	0	741
OP: OP 28	0	0
OP: OP 29	0	0
OP: OP 30	0	0
OP: OP 31	0	0
OP: OP 32	0	0
OP: OP 33	0	0
OP: OP 34	0	0
OP: OP 35	0	0
OP: OP 36	0	0
OP: OP 37	0	0
OP: OP 38	0	0
OP: OP 39	0	0

OP: OP 40	0	0

PV array 3 - OP Receptor (OP 1)

No glare found

PV array 3 - OP Receptor (OP 2)

No glare found

PV array 3 - OP Receptor (OP 3)

No glare found

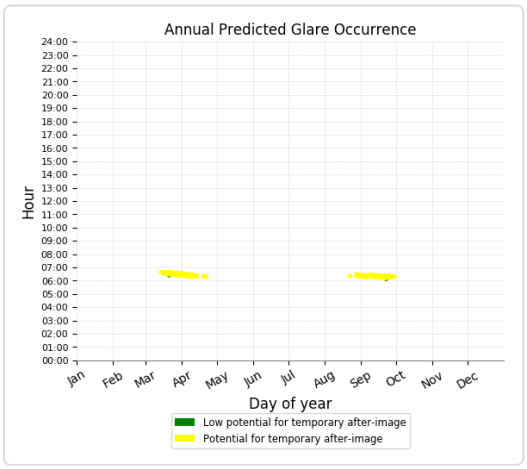
PV array 3 - OP Receptor (OP 4)

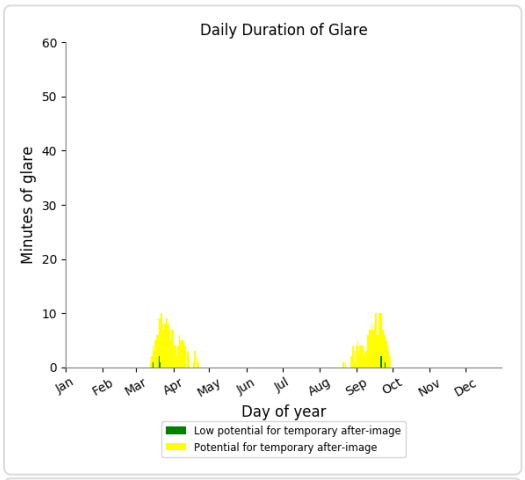
No glare found

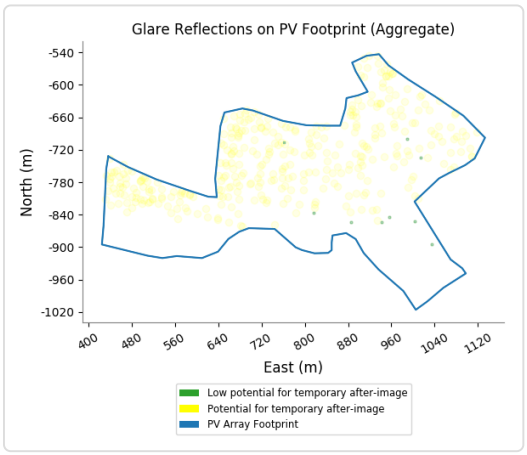
PV array 3 - OP Receptor (OP 5)

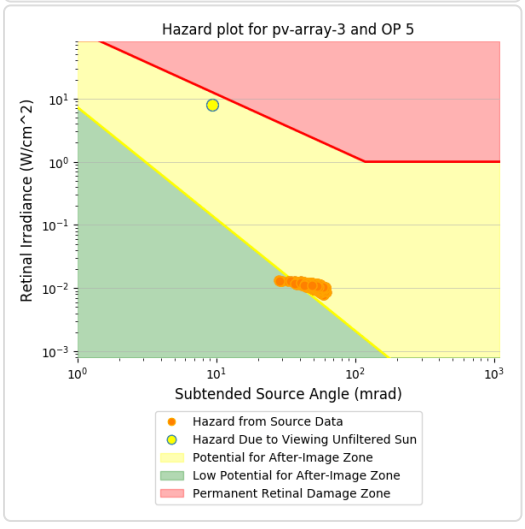
PV array is expected to produce the following glare for receptors at this location:

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





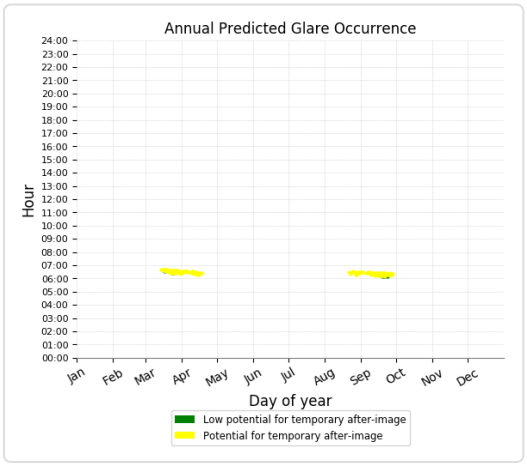


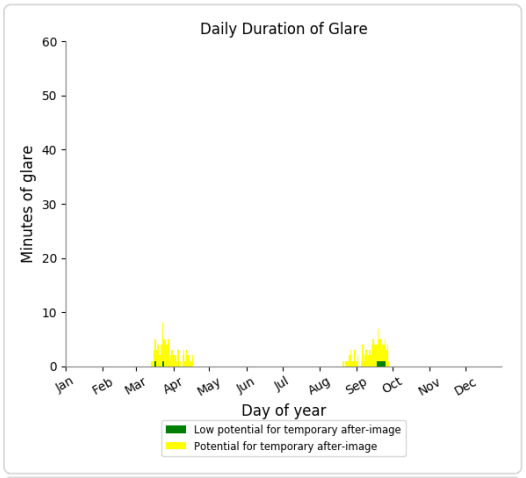


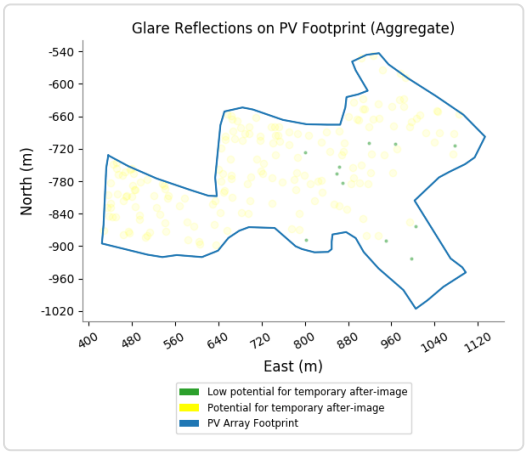
PV array 3 - OP Receptor (OP 6)

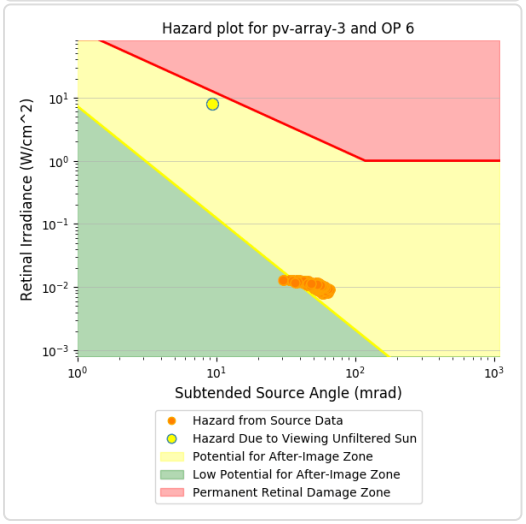
PV array is expected to produce the following glare for receptors at this location:

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





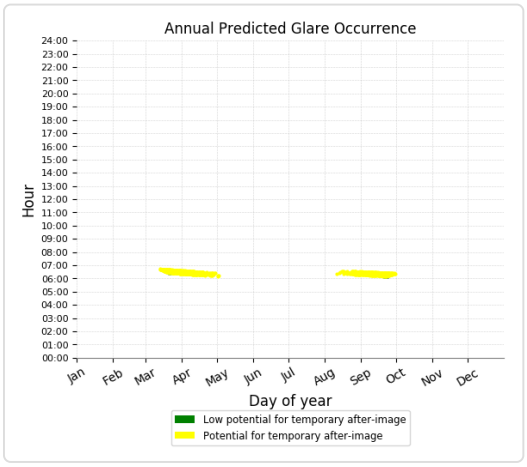


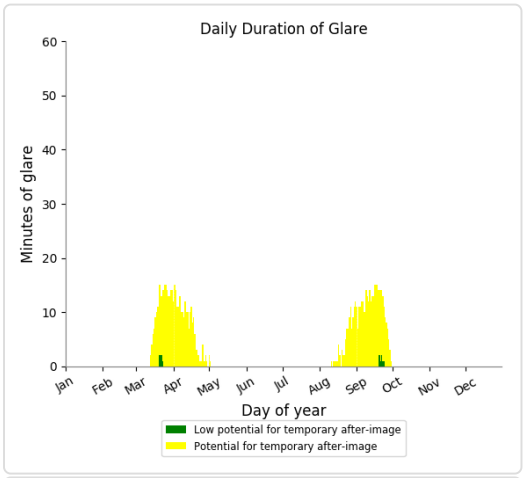


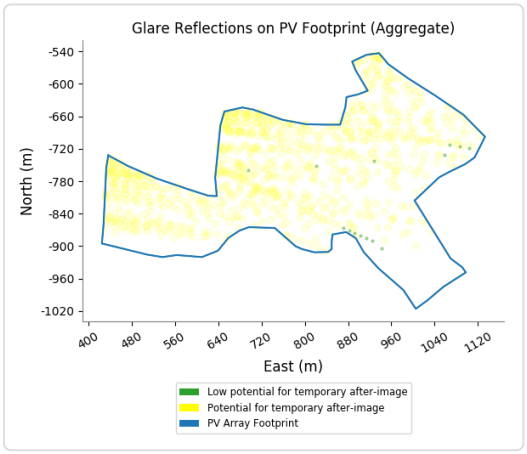
PV array 3 - OP Receptor (OP 7)

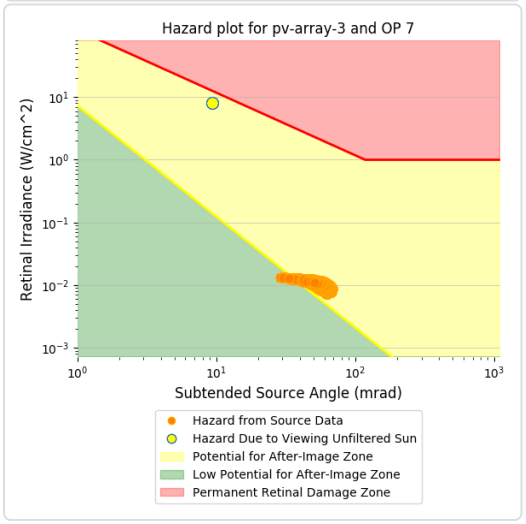
PV array is expected to produce the following glare for receptors at this location:

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





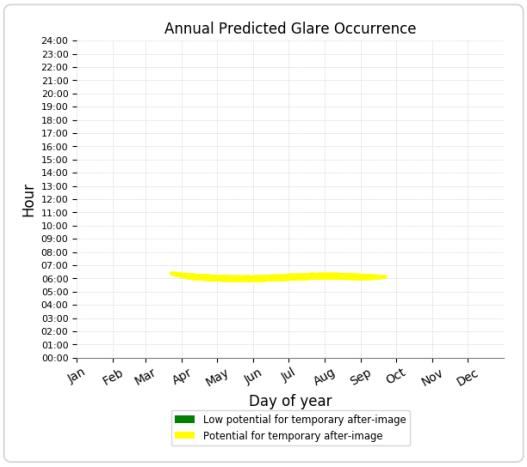


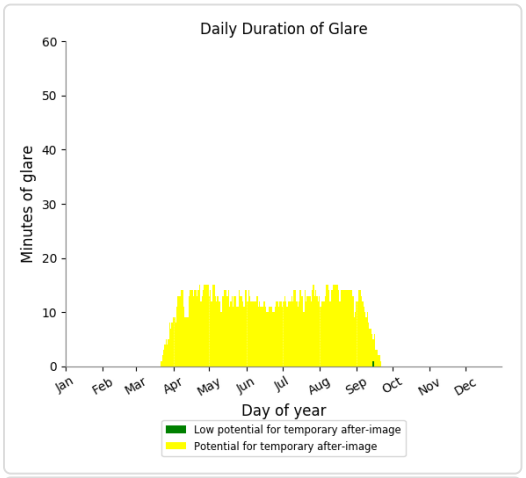


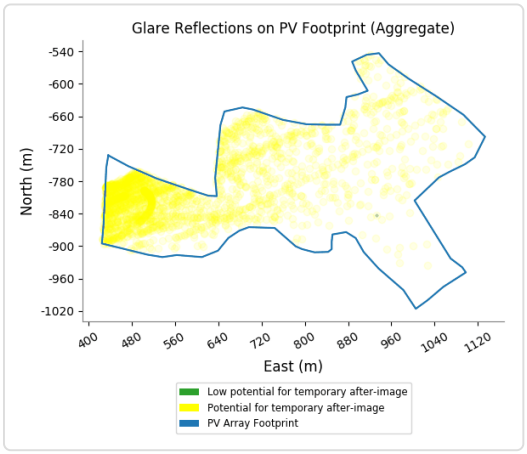
PV array 3 - OP Receptor (OP 8)

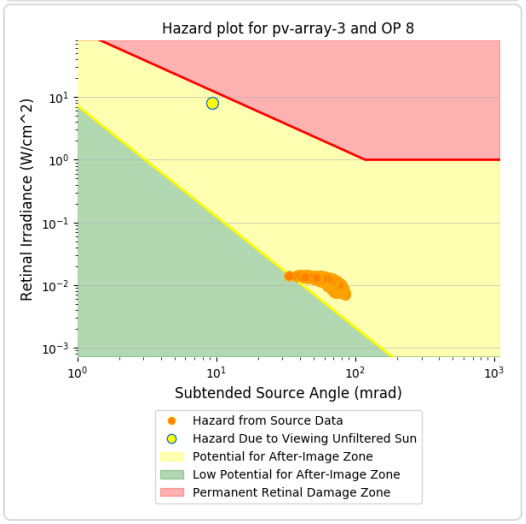
PV array is expected to produce the following glare for receptors at this location:

- 1 minutes of "green" glare with low potential to cause temporary after-image.
- 2,140 minutes of "yellow" glare with potential to cause temporary after-image.





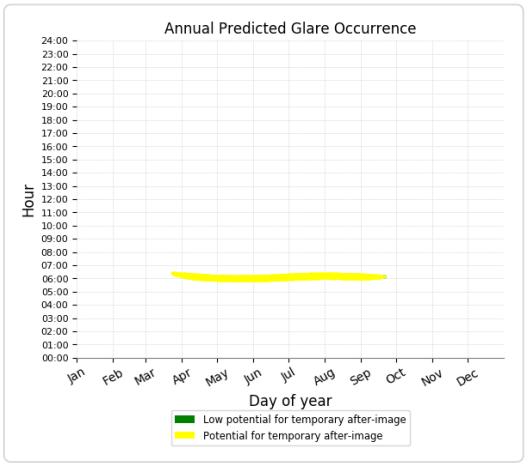


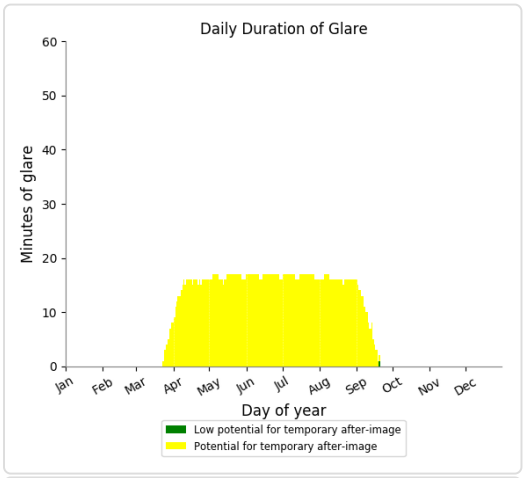


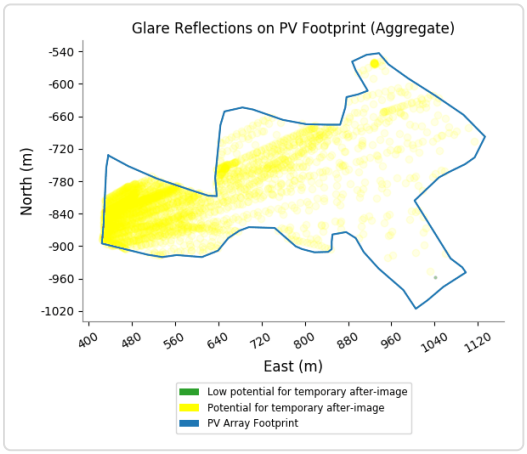
PV array 3 - OP Receptor (OP 9)

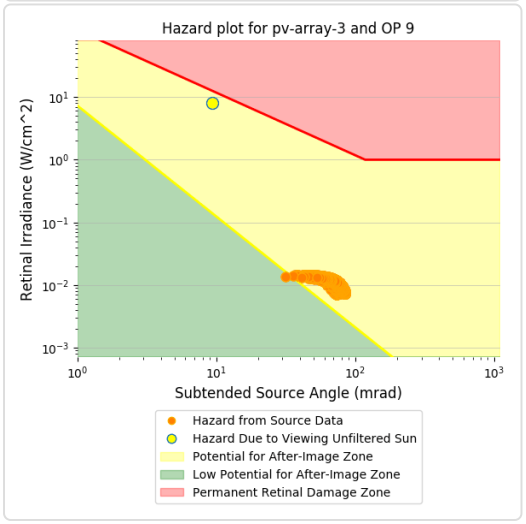
PV array is expected to produce the following glare for receptors at this location:

- 1 minutes of "green" glare with low potential to cause temporary after-image.
- 2,689 minutes of "yellow" glare with potential to cause temporary after-image.





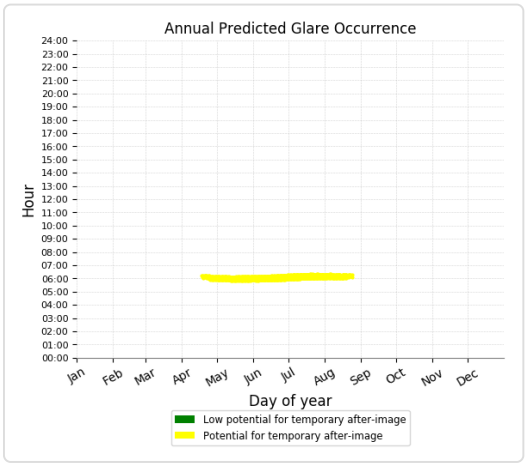


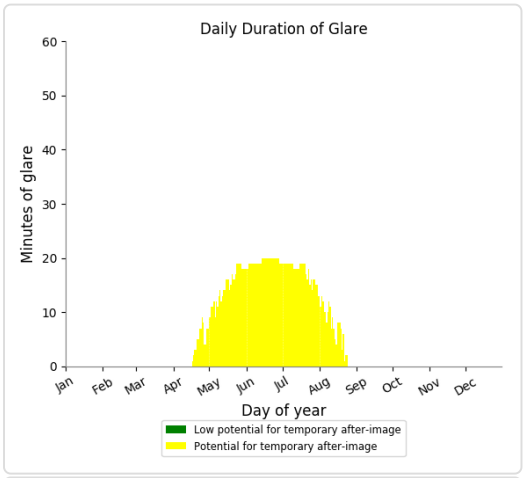


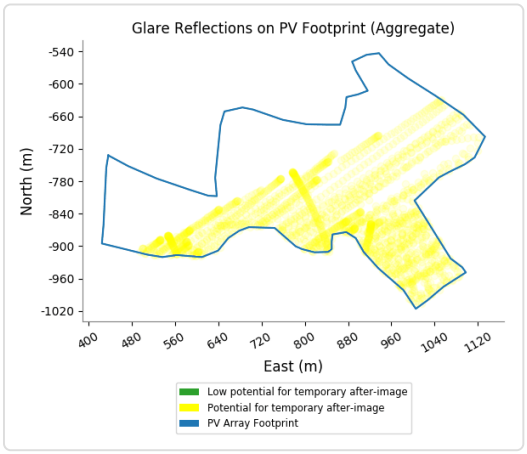
PV array 3 - OP Receptor (OP 10)

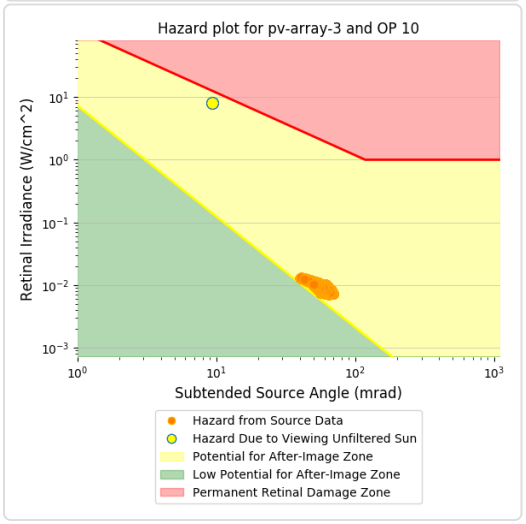
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,843 minutes of "yellow" glare with potential to cause temporary after-image.





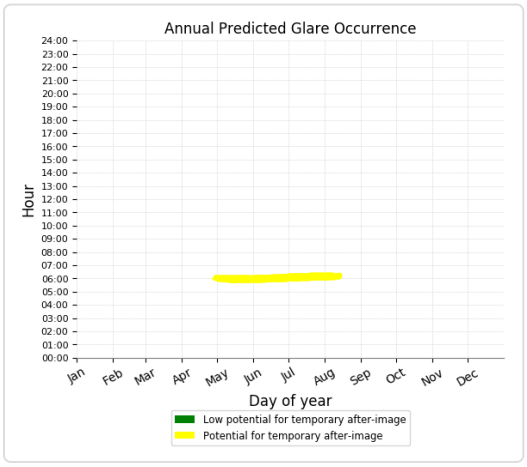


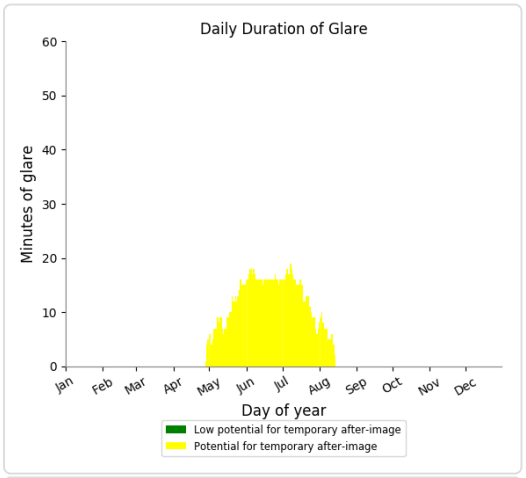


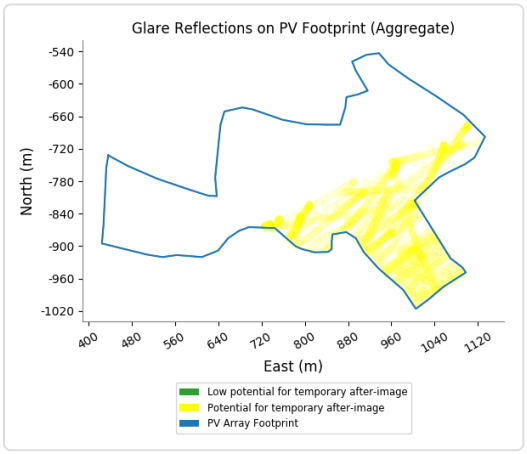
PV array 3 - OP Receptor (OP 11)

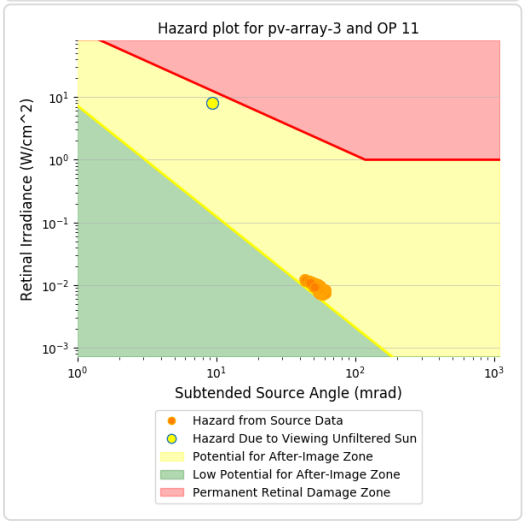
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,319 minutes of "yellow" glare with potential to cause temporary after-image.





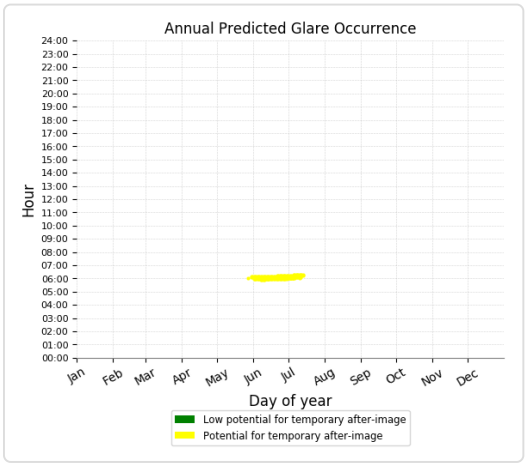


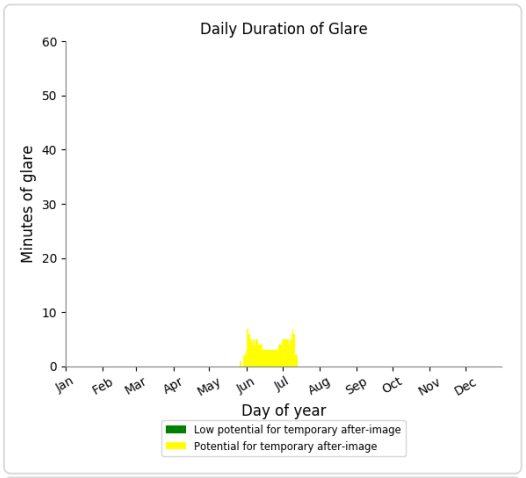


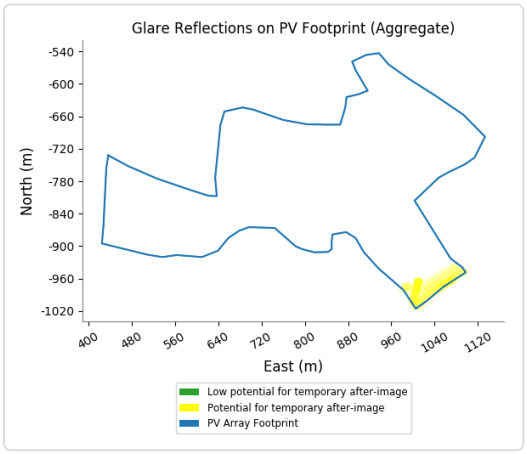
PV array 3 - OP Receptor (OP 12)

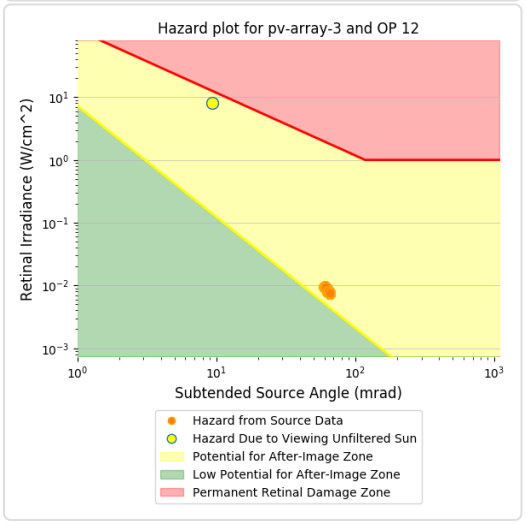
PV array is expected to produce the following glare for receptors at this location:

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









PV array 3 - OP Receptor (OP 13)

No glare found

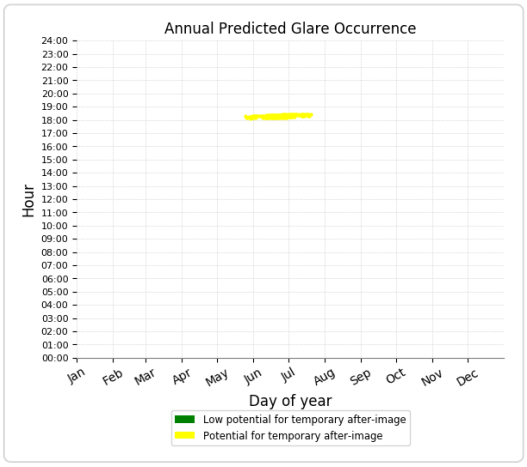
PV array 3 - OP Receptor (OP 14)

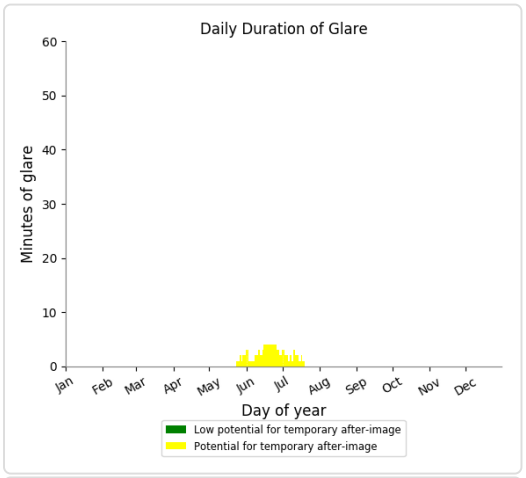
No glare found

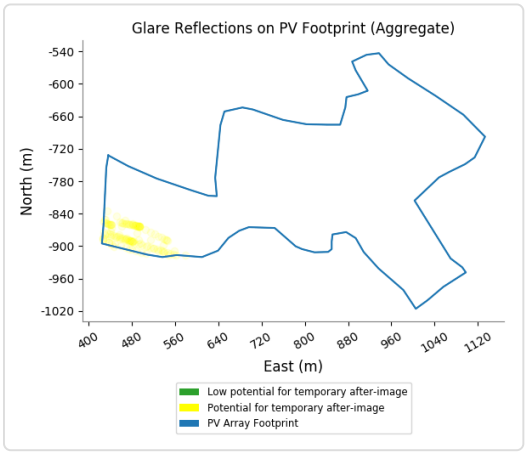
PV array 3 - OP Receptor (OP 15)

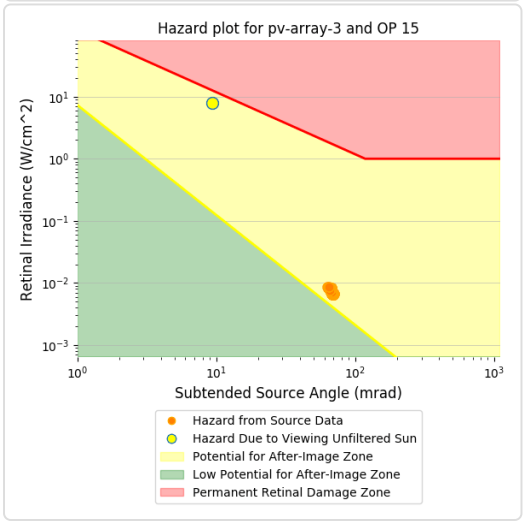
PV array is expected to produce the following glare for receptors at this location:

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





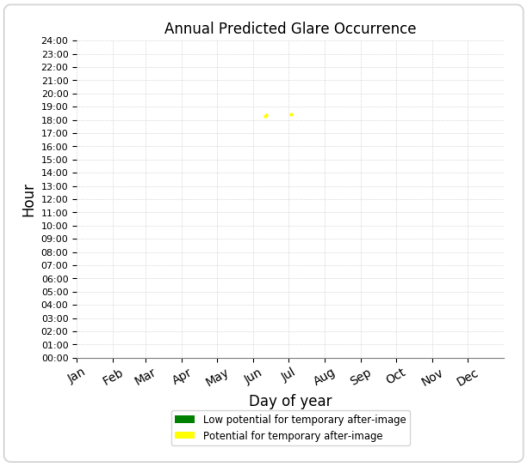


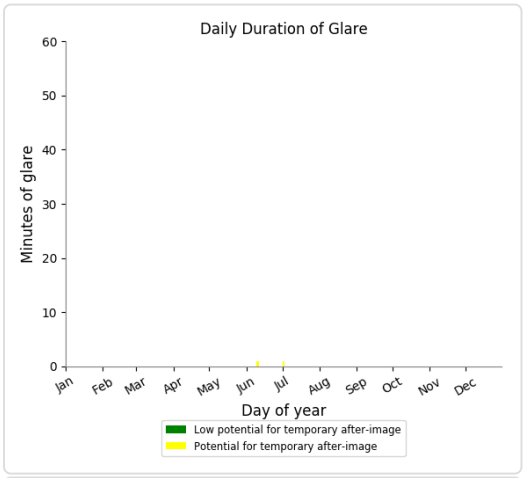


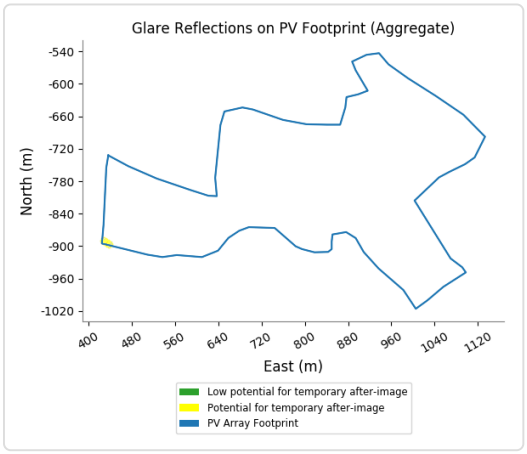
PV array 3 - OP Receptor (OP 16)

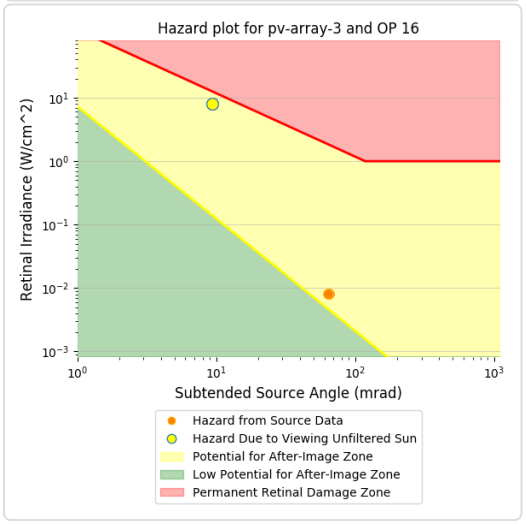
PV array is expected to produce the following glare for receptors at this location:

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





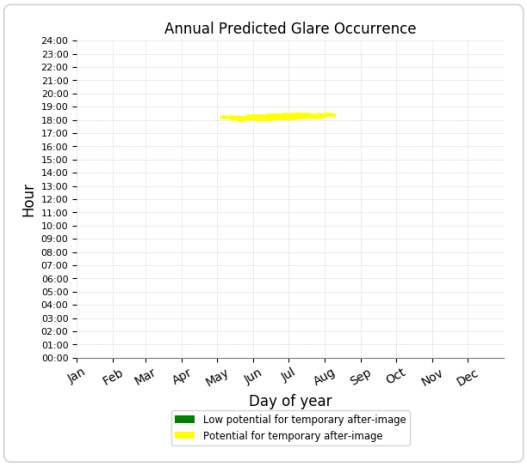


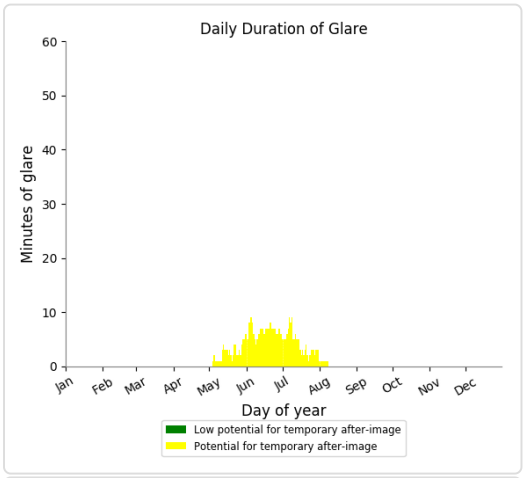


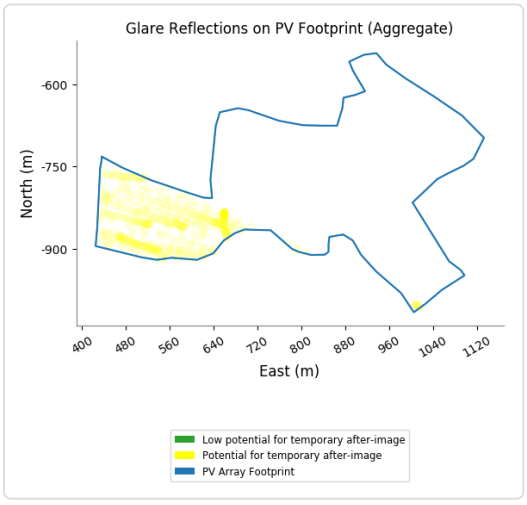
PV array 3 - OP Receptor (OP 17)

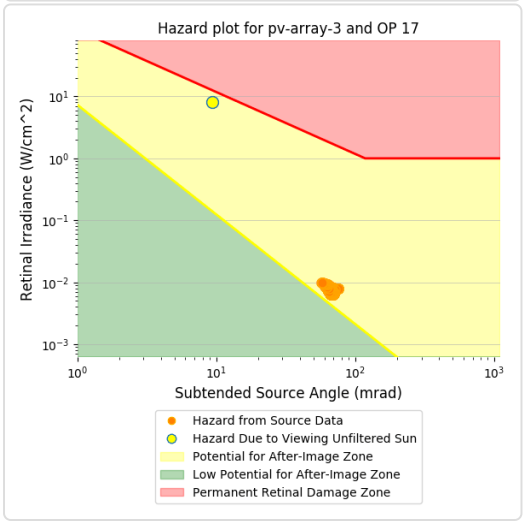
PV array is expected to produce the following glare for receptors at this location:

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





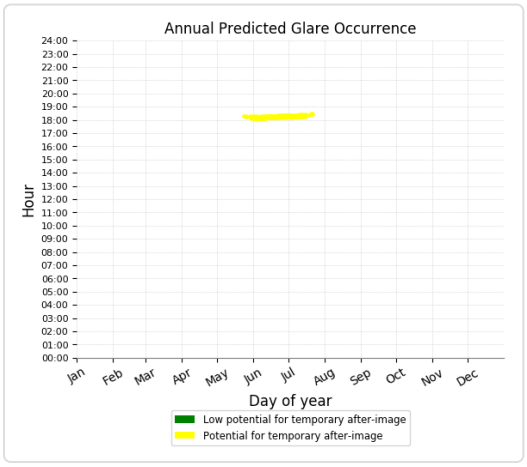


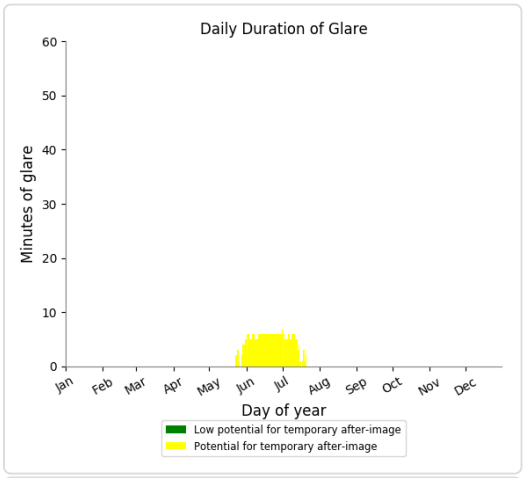


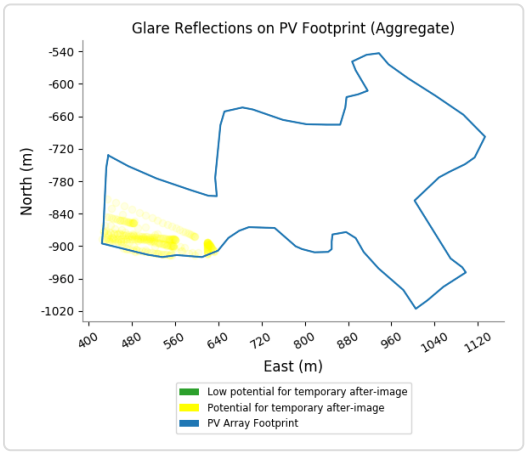
PV array 3 - OP Receptor (OP 18)

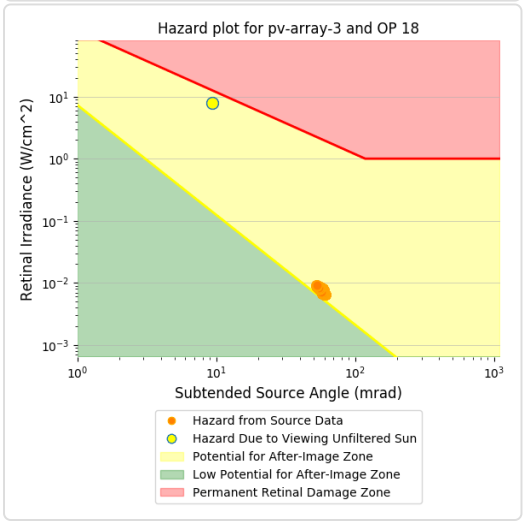
PV array is expected to produce the following glare for receptors at this location:

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





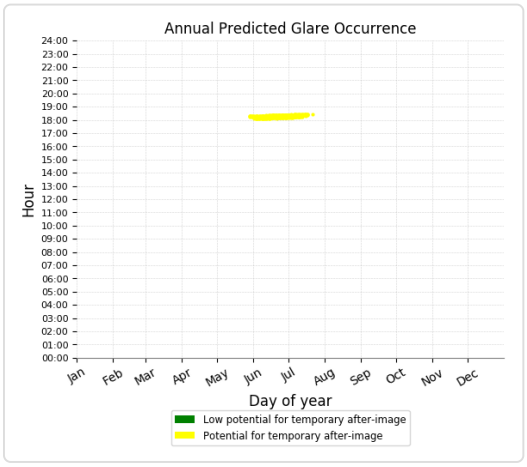


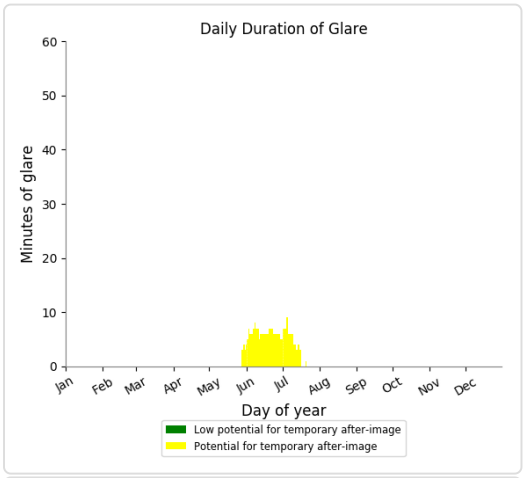


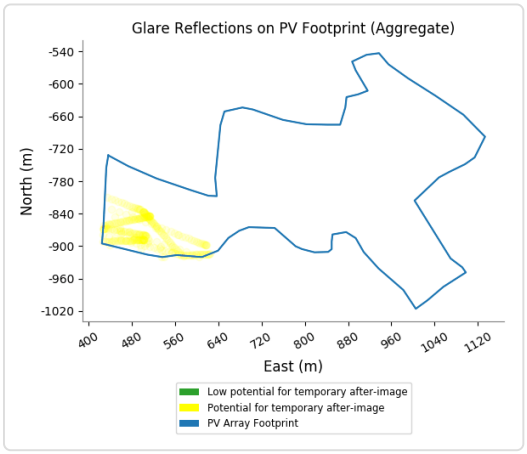
PV array 3 - OP Receptor (OP 19)

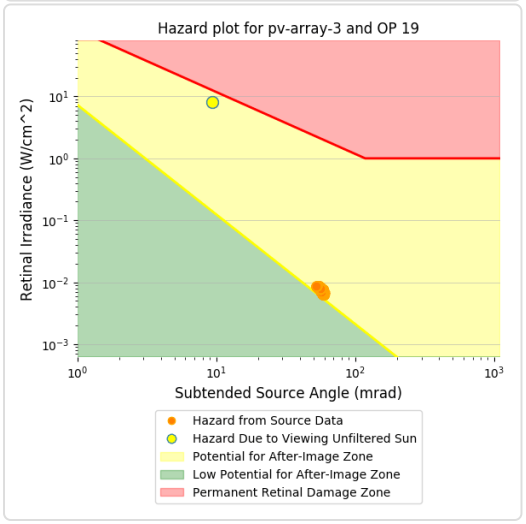
PV array is expected to produce the following glare for receptors at this location:

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





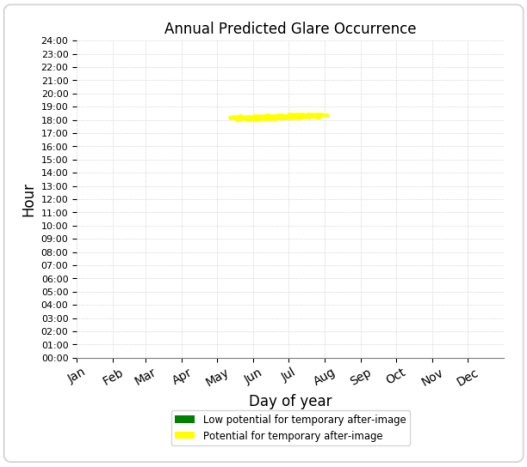


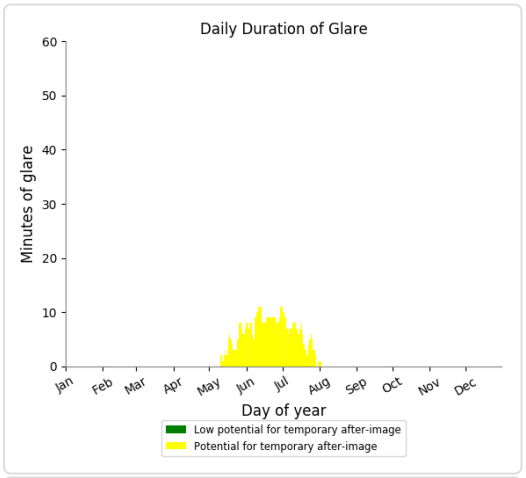


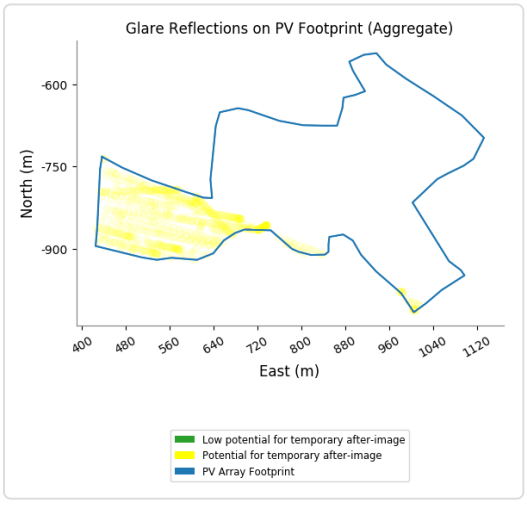
PV array 3 - OP Receptor (OP 20)

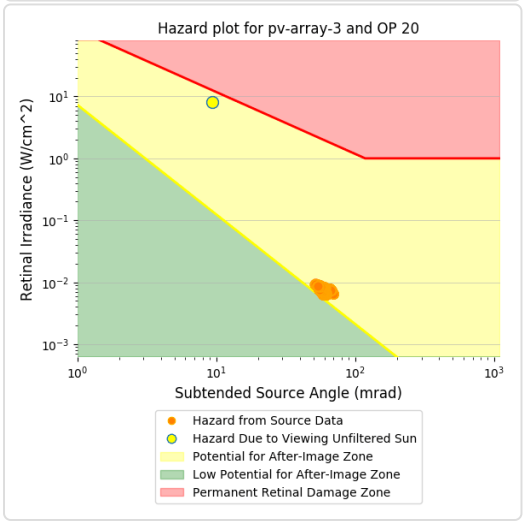
PV array is expected to produce the following glare for receptors at this location:

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





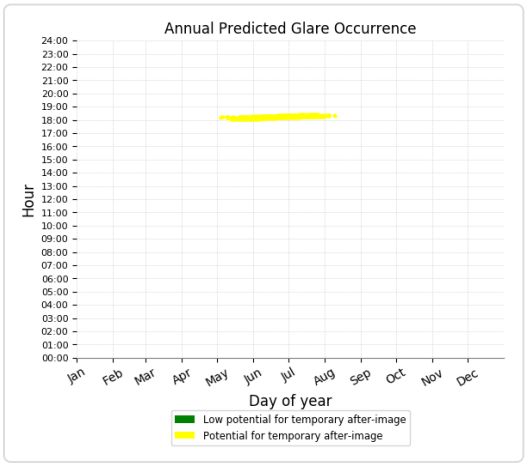


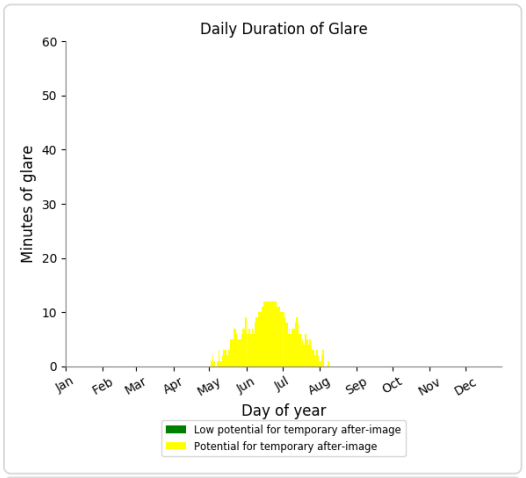


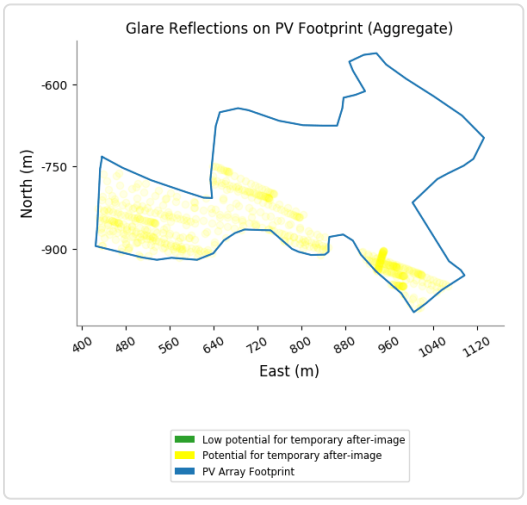
PV array 3 - OP Receptor (OP 21)

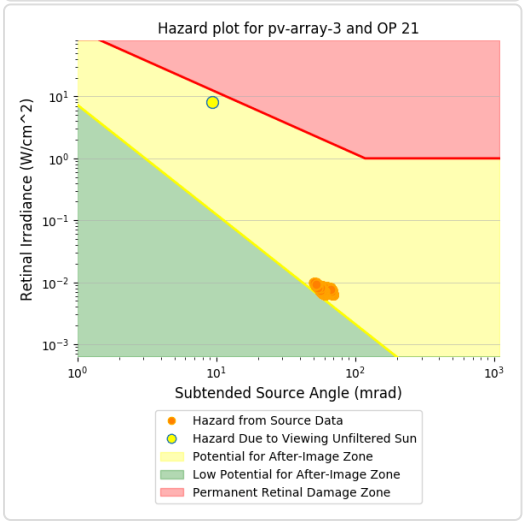
PV array is expected to produce the following glare for receptors at this location:

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





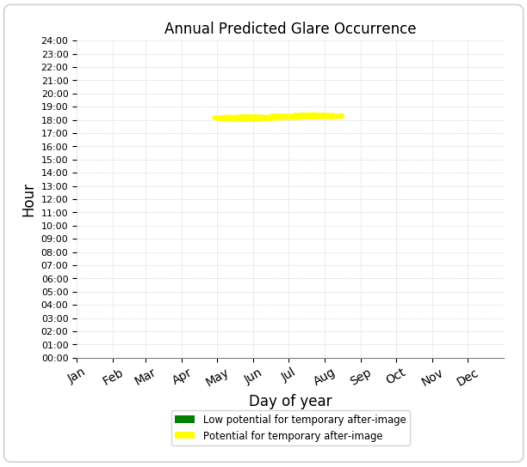


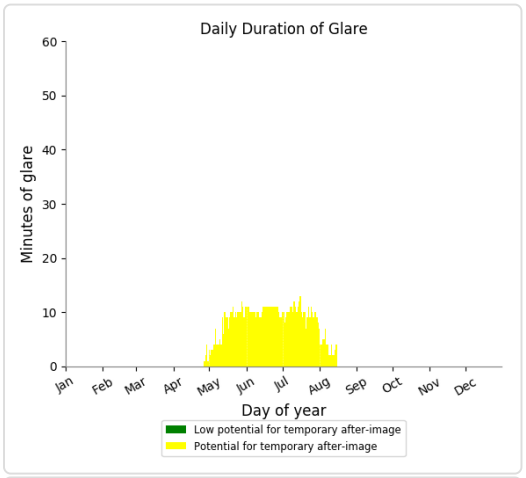


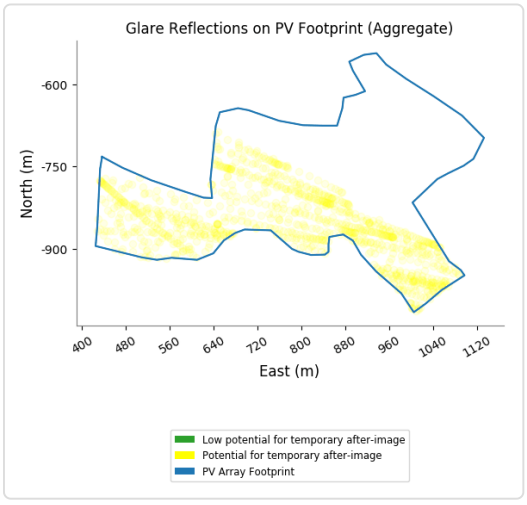
PV array 3 - OP Receptor (OP 22)

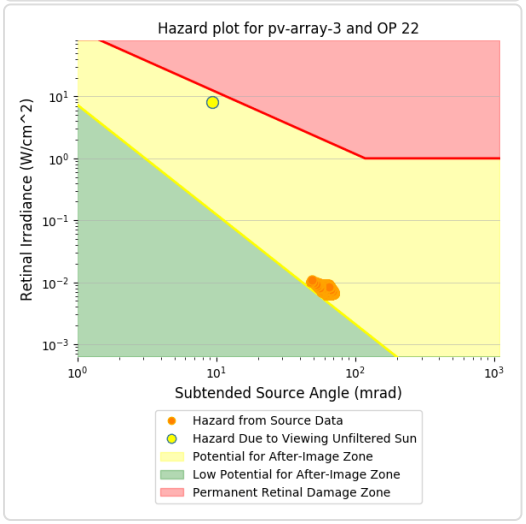
PV array is expected to produce the following glare for receptors at this location:

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





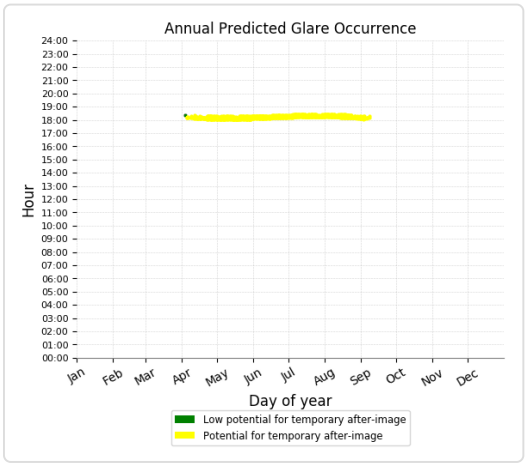


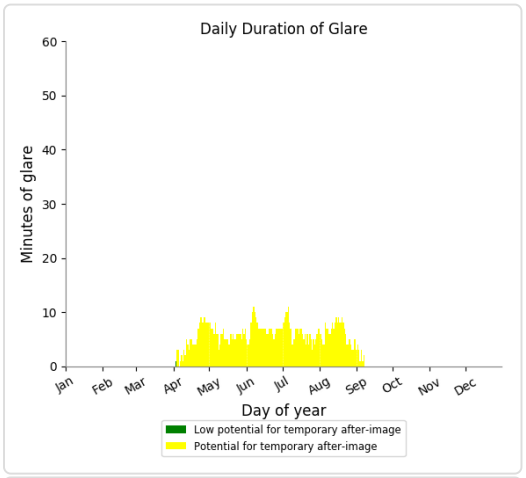


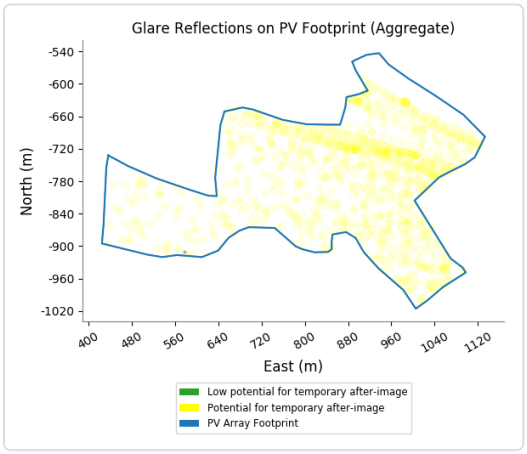
PV array 3 - OP Receptor (OP 23)

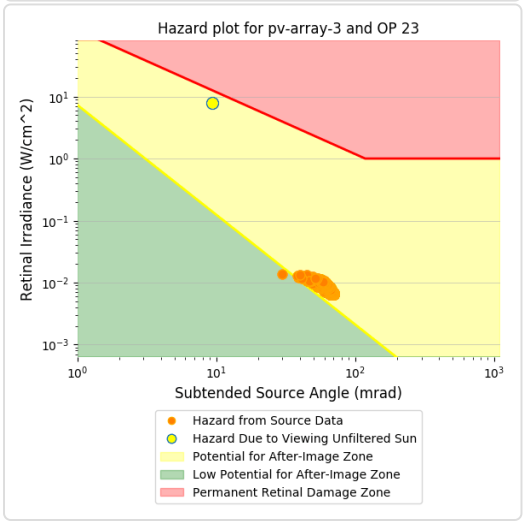
PV array is expected to produce the following glare for receptors at this location:

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





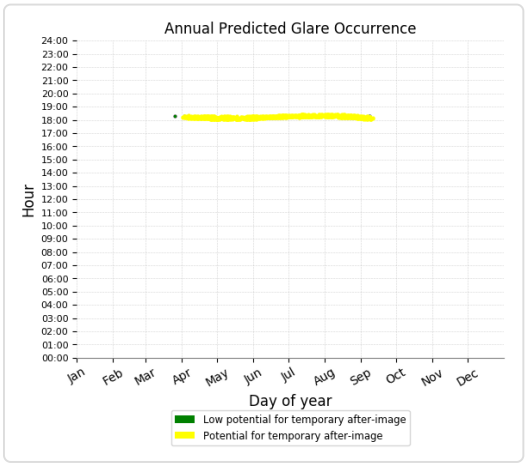


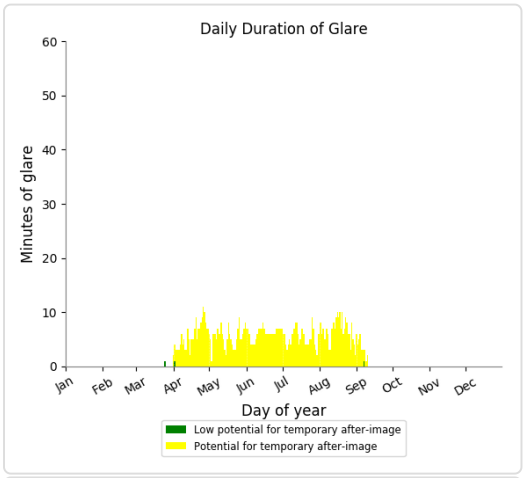


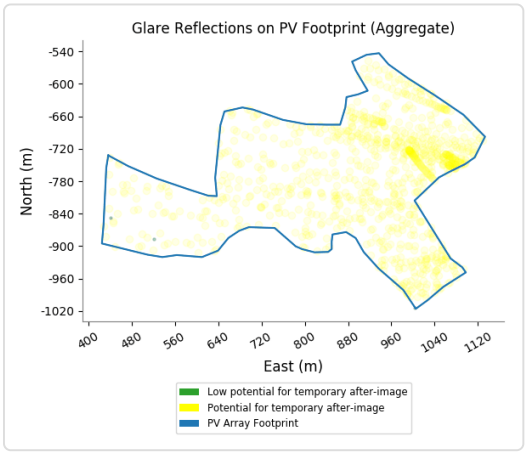
PV array 3 - OP Receptor (OP 24)

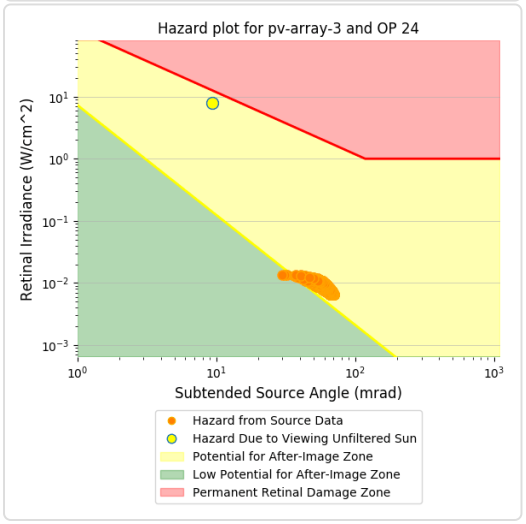
PV array is expected to produce the following glare for receptors at this location:

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





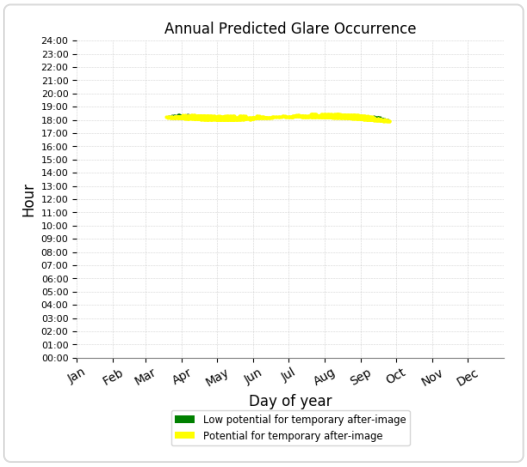


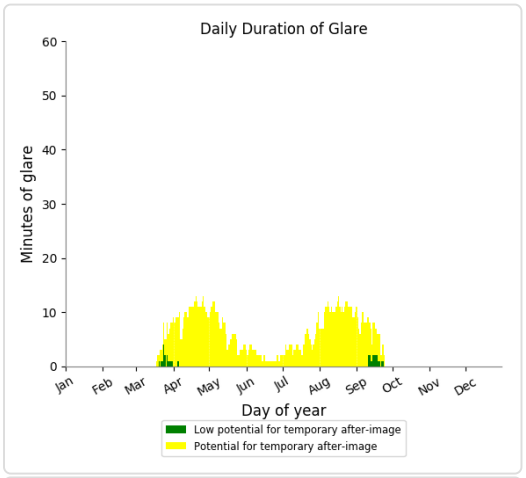


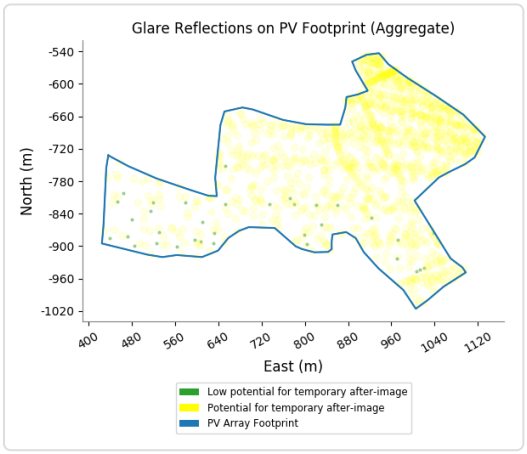
PV array 3 - OP Receptor (OP 25)

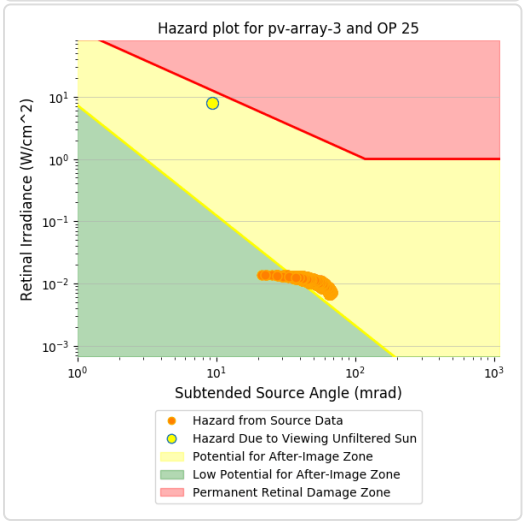
PV array is expected to produce the following glare for receptors at this location:

- 34 minutes of "green" glare with low potential to cause temporary after-image.
- 1,204 minutes of "yellow" glare with potential to cause temporary after-image.





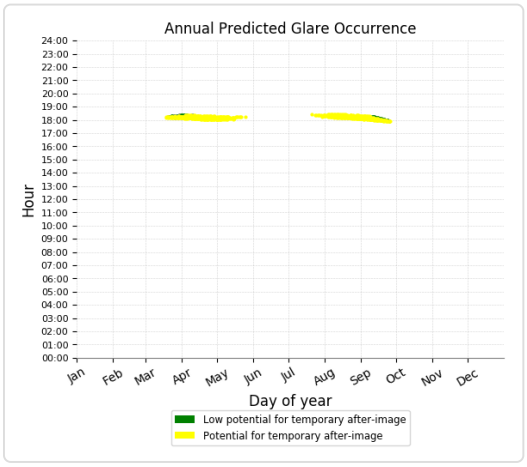


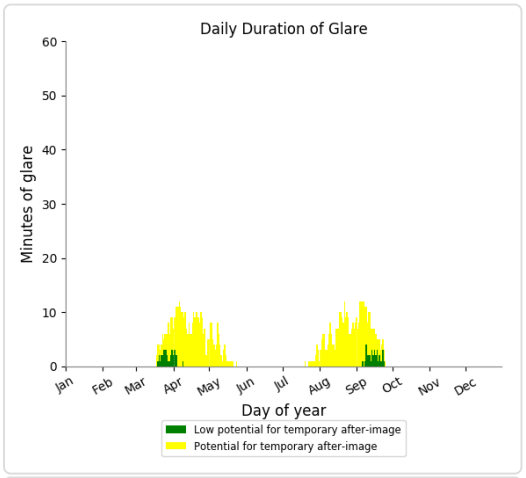


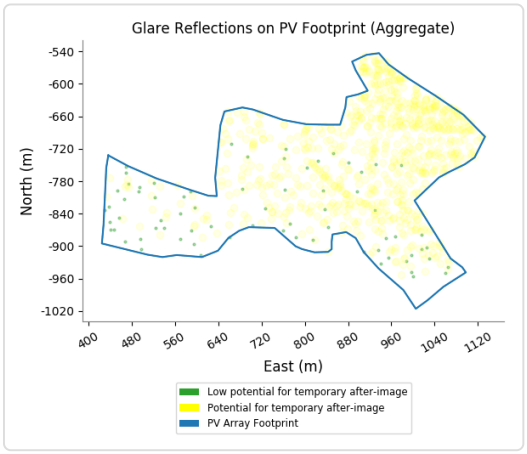
PV array 3 - OP Receptor (OP 26)

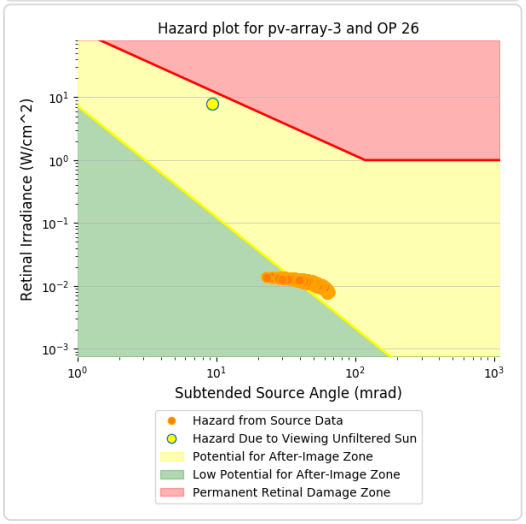
PV array is expected to produce the following glare for receptors at this location:

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





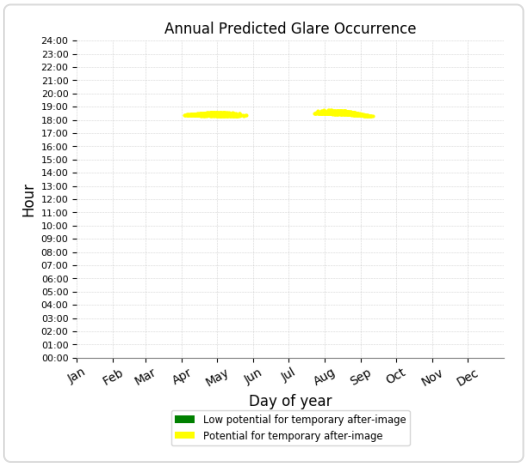


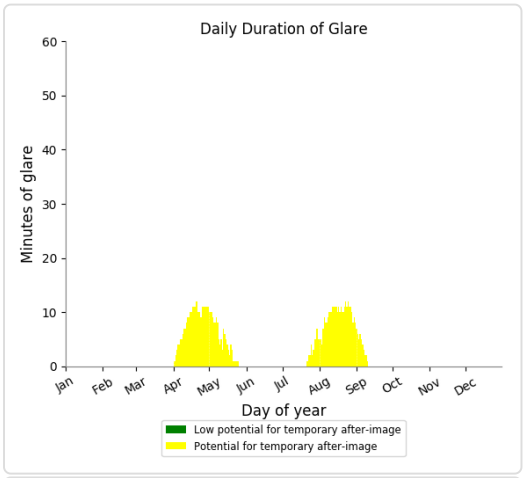


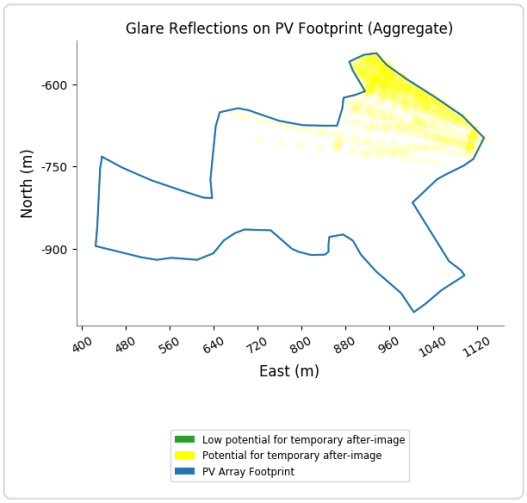
PV array 3 - OP Receptor (OP 27)

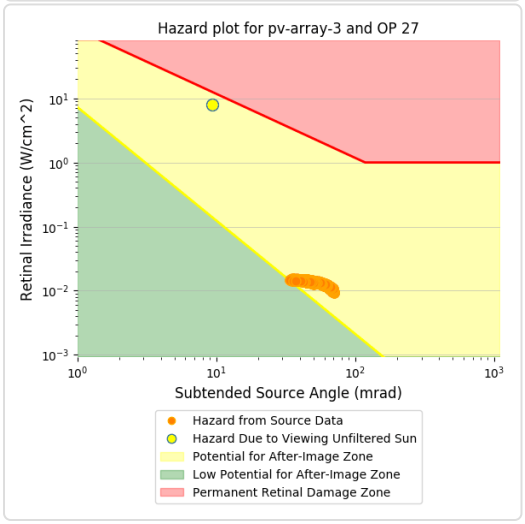
PV array is expected to produce the following glare for receptors at this location:

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









PV array 3 - OP Receptor (OP 28)

No glare found

PV array 3 - OP Receptor (OP 29)

No glare found

PV array 3 - OP Receptor (OP 30)

No glare found

PV array 3 - OP Receptor (OP 31)

No glare found

PV array 3 - OP Receptor (OP 32)

No glare found

PV array 3 - OP Receptor (OP 33)

No glare found

PV array 3 - OP Receptor (OP 34)

No glare found

PV array 3 - OP Receptor (OP 35)

No glare found

PV array 3 - OP Receptor (OP 36)

No glare found

PV array 3 - OP Receptor (OP 37)

No glare found

PV array 3 - OP Receptor (OP 38)

No glare found

PV array 3 - OP Receptor (OP 39)

No glare found

PV array 3 - OP Receptor (OP 40)

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for larg PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, nc discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

Appendix 7B: Road Receptor Glare Results

Penpergwm

Penpergwm Road

Created April 14, 2021
Updated April 14, 2021
Time-step 1 minute
Timezone offset UTC0
Site ID 52408.9145

Project type V1
Project status: active

Misc. Analysis Settings

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

Analysis Methodologies:

- Observation point: **Version 1**
- 2-Mile Flight Path: **Version 1**
- Route: **Version 1**

Summary of Results

Glare with potential for temporary after-image predicted

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	25.0	180.0	3,095	10,605	-
PV array 2	25.0	180.0	3,639	5,648	-
PV array 3	25.0	180.0	557	22,235	-

Component Data

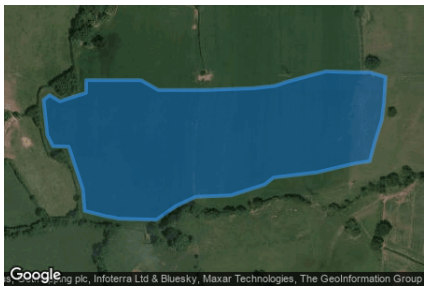
PV Array(s)

Total PV footprint area: 353,260 m^2

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 115,625 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.800092	-2.974531	116.92	2.80	119.72
2	51.799641	-2.975089	125.04	2.80	127.84
3	51.798752	-2.972643	111.83	2.80	114.63
4	51.798407	-2.972986	116.43	2.80	119.23
5	51.799296	-2.975518	129.09	2.80	131.89
6	51.798739	-2.975904	133.96	2.80	136.76
7	51.797611	-2.972514	116.57	2.80	119.37
8	51.797703	-2.972278	114.81	2.80	117.61
9	51.797664	-2.971999	113.64	2.80	116.44
10	51.797412	-2.971935	115.68	2.80	118.48
11	51.797451	-2.970647	110.29	2.80	113.09
12	51.797478	-2.969166	105.87	2.80	108.67
13	51.797637	-2.968415	103.57	2.80	106.37
14	51.797637	-2.967021	96.08	2.80	98.88
15	51.797611	-2.966441	92.02	2.80	94.82
16	51.797650	-2.965798	86.45	2.80	89.25
17	51.797743	-2.965562	84.26	2.80	87.06
18	51.797969	-2.965411	82.86	2.80	85.66
19	51.798301	-2.965347	81.62	2.80	84.42
20	51.798702	-2.965454	80.78	2.80	83.58
21	51.798760	-2.965548	81.02	2.80	83.82
22	51.798818	-2.965862	81.94	2.80	84.74
23	51.798898	-2.966205	83.36	2.80	86.16
24	51.798898	-2.966785	85.57	2.80	88.37
25	51.798911	-2.967171	86.22	2.80	89.02
26	51.798924	-2.968158	89.05	2.80	91.85
27	51.799150	-2.968823	91.61	2.80	94.41
28	51.799256	-2.969467	92.98	2.80	95.78
29	51.799336	-2.970154	95.84	2.80	98.64
30	51.799336	-2.970862	97.93	2.80	100.73
31	51.799495	-2.971570	100.24	2.80	103.04
32	51.799521	-2.972256	102.77	2.80	105.57
33	51.799734	-2.973201	107.62	2.80	110.42

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 86,272 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad



Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.796026	-2.973854	130.26	2.80	133.06
2	51.796026	-2.975120	131.96	2.80	134.76
3	51.795847	-2.975120	129.27	2.80	132.07
4	51.795727	-2.975721	127.97	2.80	130.77
5	51.795813	-2.975957	129.62	2.80	132.42
6	51.795747	-2.976096	129.09	2.80	131.89
7	51.795249	-2.976011	121.67	2.80	124.47
8	51.795090	-2.975882	119.77	2.80	122.57
9	51.795083	-2.975517	119.27	2.80	122.07
10	51.794486	-2.975195	114.08	2.80	116.88
11	51.794174	-2.975152	111.31	2.80	114.11
12	51.794101	-2.974691	110.52	2.80	113.32
13	51.794062	-2.974348	109.93	2.80	112.73
14	51.794048	-2.973500	110.45	2.80	113.25
15	51.794234	-2.973071	112.11	2.80	114.91
16	51.794373	-2.972599	113.92	2.80	116.72
17	51.794393	-2.971783	115.80	2.80	118.60
18	51.794546	-2.971011	117.25	2.80	120.05
19	51.794645	-2.970807	117.74	2.80	120.54
20	51.794718	-2.969809	116.53	2.80	119.33
21	51.794845	-2.968951	115.50	2.80	118.30
22	51.794878	-2.968597	113.92	2.80	116.72
23	51.795170	-2.968468	117.81	2.80	120.61
24	51.795462	-2.968318	120.46	2.80	123.26
25	51.795714	-2.968264	121.97	2.80	124.77
26	51.796072	-2.968232	123.02	2.80	125.82
27	51.796138	-2.968597	124.11	2.80	126.91
28	51.796138	-2.968930	123.64	2.80	126.44
29	51.796152	-2.969605	123.47	2.80	126.27
30	51.796006	-2.970485	125.00	2.80	127.80
31	51.795946	-2.970775	125.17	2.80	127.97
32	51.795913	-2.971258	125.60	2.80	128.40
33	51.795886	-2.972384	126.12	2.80	128.92
34	51.795886	-2.973457	128.50	2.80	131.30

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 151,362 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.793511	-2.968200	83.07	2.80	85.87
2	51.793332	-2.967664	78.70	2.80	81.50
3	51.793126	-2.966902	73.34	2.80	76.14
4	51.792933	-2.965990	69.15	2.80	71.95
5	51.792841	-2.965518	67.66	2.80	70.46
6	51.792834	-2.965292	66.38	2.80	69.18
7	51.793139	-2.965335	68.32	2.80	71.12
8	51.794015	-2.965196	76.58	2.80	79.38
9	51.794241	-2.965089	78.56	2.80	81.36
10	51.794307	-2.964606	76.84	2.80	79.64
11	51.794274	-2.964327	75.07	2.80	77.87
12	51.794101	-2.963522	71.25	2.80	74.05
13	51.794028	-2.962889	69.41	2.80	72.21
14	51.794022	-2.962342	68.42	2.80	71.22
15	51.794022	-2.961988	69.13	2.80	71.93
16	51.794307	-2.961849	69.43	2.80	72.23
17	51.794480	-2.961816	70.15	2.80	72.95
18	51.794526	-2.961505	69.34	2.80	72.14
19	51.794586	-2.961248	69.38	2.80	72.18
20	51.794924	-2.961570	69.81	2.80	72.61
21	51.795070	-2.961666	70.06	2.80	72.86
22	51.795183	-2.961280	69.22	2.80	72.02
23	51.795209	-2.960947	69.06	2.80	71.86
24	51.795024	-2.960690	68.80	2.80	71.60
25	51.794791	-2.960164	66.76	2.80	69.56
26	51.794499	-2.959424	65.26	2.80	68.06
27	51.794188	-2.958684	63.12	2.80	65.92
28	51.793823	-2.958104	61.50	2.80	64.30
29	51.793478	-2.958383	61.09	2.80	63.89
30	51.793365	-2.958641	61.23	2.80	64.03
31	51.793239	-2.959059	61.45	2.80	64.25
32	51.793146	-2.959338	61.68	2.80	64.48
33	51.792761	-2.959992	61.74	2.80	64.54
34	51.791799	-2.959027	65.96	2.80	68.76
35	51.791653	-2.958716	67.66	2.80	70.46
36	51.791566	-2.958619	68.29	2.80	71.09
37	51.791328	-2.959220	67.32	2.80	70.12
38	51.791102	-2.959649	66.46	2.80	69.26
39	51.790963	-2.959960	65.68	2.80	68.48
40	51.791274	-2.960293	64.72	2.80	67.52
41	51.791633	-2.960958	63.32	2.80	66.12
42	51.791905	-2.961355	62.51	2.80	65.31
43	51.792137	-2.961570	61.86	2.80	64.66
44	51.792237	-2.961827	61.80	2.80	64.60
45	51.792197	-2.962192	62.04	2.80	64.84
46	51.792080	-2.962213	61.68	2.80	64.48
47	51.791954	-2.962213	61.82	2.80	64.62
48	51.791907	-2.962310	61.91	2.80	64.71
49	51.791901	-2.962675	62.06	2.80	64.86
50	51.791954	-2.963007	62.19	2.80	64.99
51	51.792000	-2.963179	62.17	2.80	64.97
52	51.792305	-2.963742	62.00	2.80	64.80
53	51.792319	-2.964434	62.90	2.80	65.70
54	51.792259	-2.964692	62.97	2.80	65.77
55	51.792139	-2.964981	63.56	2.80	66.36
56	51.791927	-2.965260	64.13	2.80	66.93
57	51.791821	-2.965689	65.22	2.80	68.02
58	51.791854	-2.966365	65.69	2.80	68.49
59	51.791821	-2.966752	66.96	2.80	69.76
60	51.791861	-2.967149	68.44	2.80	71.24
61	51.792046	-2.968372	72.73	2.80	75.53
62	51.792358	-2.968329	74.26	2.80	77.06
63	51.793308	-2.968254	81.43	2.80	84.23

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	51.789751	-2.986332	65.49	1.50	66.99
OP 2	51.788530	-2.984637	62.66	1.50	64.16
OP 3	51.786897	-2.982727	53.79	1.50	55.29
OP 4	51.786088	-2.980560	51.84	1.50	53.34
OP 5	51.785530	-2.977942	50.84	1.50	52.34
OP 6	51.785716	-2.974981	47.85	1.50	49.35
OP 7	51.786048	-2.971934	45.41	1.50	46.91
OP 8	51.790030	-2.961355	64.29	1.50	65.79
OP 9	51.791211	-2.958887	68.34	1.50	69.84
OP 10	51.792153	-2.956763	68.14	1.50	69.64
OP 11	51.793228	-2.954596	61.79	1.50	63.29
OP 12	51.794874	-2.954167	57.69	1.50	59.19
OP 13	51.796360	-2.953029	65.09	1.50	66.59
OP 14	51.798059	-2.952343	69.37	1.50	70.87
OP 15	51.799665	-2.950455	95.49	1.50	96.99
OP 16	51.793056	-2.952278	52.49	1.50	53.99
OP 17	51.794330	-2.951098	54.00	1.50	55.50
OP 18	51.795471	-2.949167	60.98	1.50	62.48
OP 19	51.795272	-2.946485	60.57	1.50	62.07
OP 20	51.794237	-2.943953	60.59	1.50	62.09
OP 21	51.792220	-2.944618	52.51	1.50	54.01
OP 22	51.790654	-2.946013	48.34	1.50	49.84
OP 23	51.789114	-2.946785	47.88	1.50	49.38
OP 24	51.787508	-2.946657	46.51	1.50	48.01
OP 25	51.786167	-2.948566	50.00	1.50	51.50
OP 26	51.785782	-2.950969	49.88	1.50	51.38
OP 27	51.784654	-2.973522	41.24	1.50	42.74
OP 28	51.785013	-2.977384	43.84	1.50	45.34

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	25.0	180.0	3,095	10,605	-	-
PV array 2	25.0	180.0	3,639	5,648	-	-
PV array 3	25.0	180.0	557	22,235	-	-

Distinct glare per month

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

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pv-array-1 (green)	0	0	65	206	82	67	54	180	133	0	0	0
pv-array-1 (yellow)	0	0	21	201	417	609	523	229	93	0	0	0
pv-array-2 (green)	0	0	3	230	206	45	111	314	47	0	0	0
pv-array-2 (yellow)	0	0	0	9	200	754	400	33	0	0	0	0
pv-array-3 (green)	0	0	22	131	0	0	0	74	73	0	0	0
pv-array-3 (yellow)	0	0	287	1387	2077	2065	2088	1832	622	1	0	0

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 potential temporary after-image

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	412
OP: OP 12	0	1228
OP: OP 13	140	1744
OP: OP 14	277	625
OP: OP 15	265	26
OP: OP 16	0	394
OP: OP 17	9	1694
OP: OP 18	236	1541
OP: OP 19	524	1143
OP: OP 20	865	982
OP: OP 21	671	779
OP: OP 22	108	37
OP: OP 23	0	0

OP: OP 24	0	0
OP: OP 25	0	0
OP: OP 26	0	0
OP: OP 27	0	0
OP: OP 28	0	0

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)

No glare found

PV array 1 - OP Receptor (OP 5)

No glare found

PV array 1 - OP Receptor (OP 6)

No glare found

PV array 1 - OP Receptor (OP 7)

No glare found

PV array 1 - OP Receptor (OP 8)

No glare found

PV array 1 - OP Receptor (OP 9)

No glare found

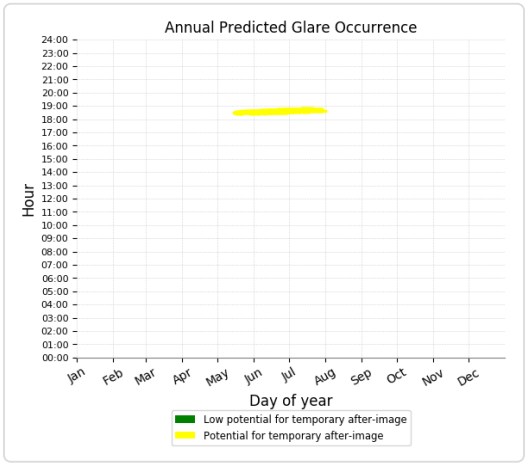
PV array 1 - OP Receptor (OP 10)

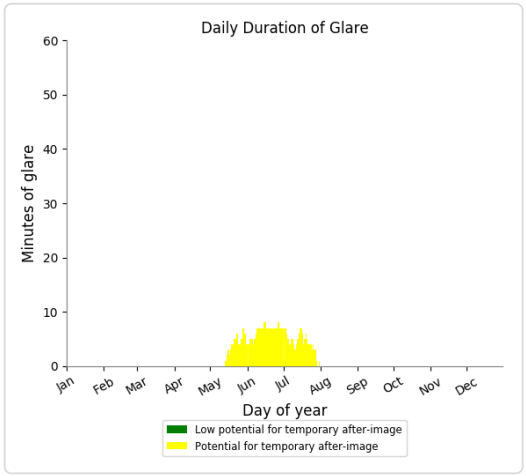
No glare found

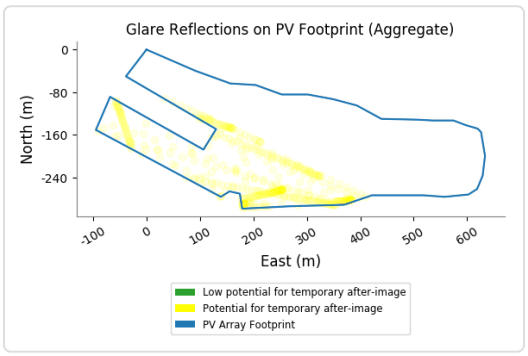
PV array 1 - OP Receptor (OP 11)

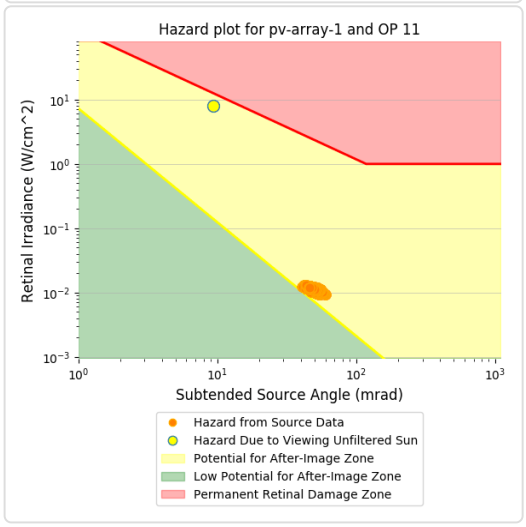
PV array is expected to produce the following glare for receptors at this location:

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





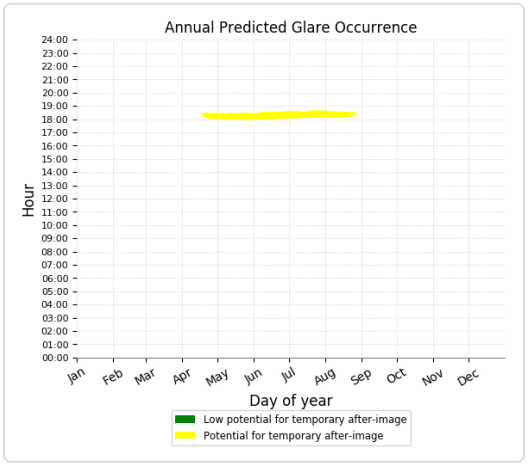


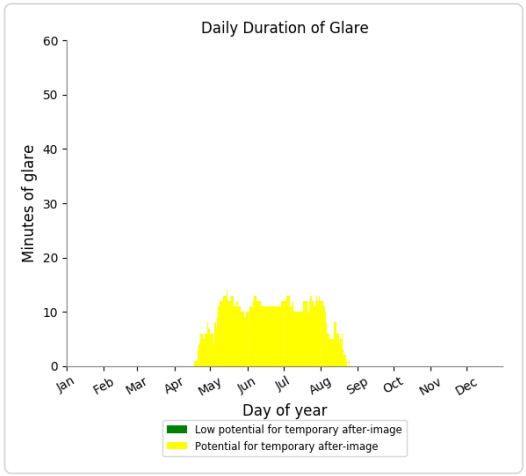


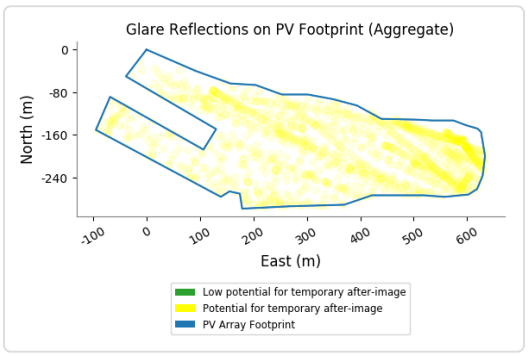
PV array 1 - OP Receptor (OP 12)

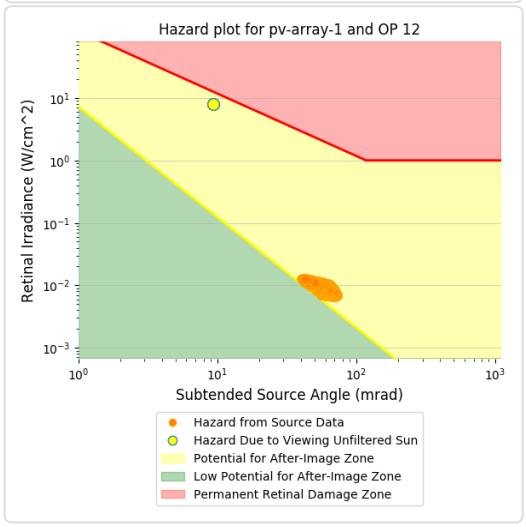
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,228 minutes of "yellow" glare with potential to cause temporary after-image.





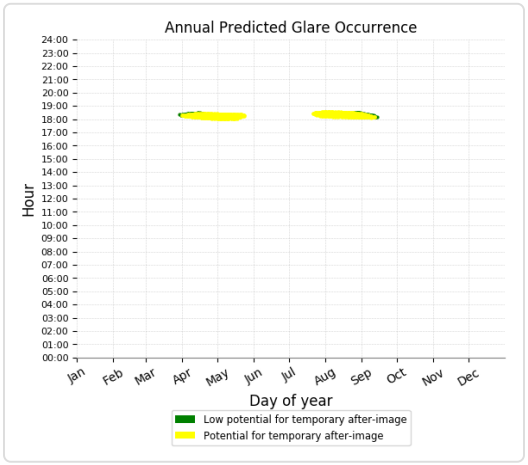


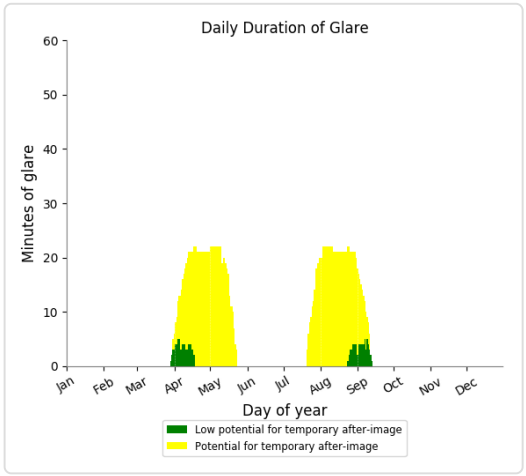


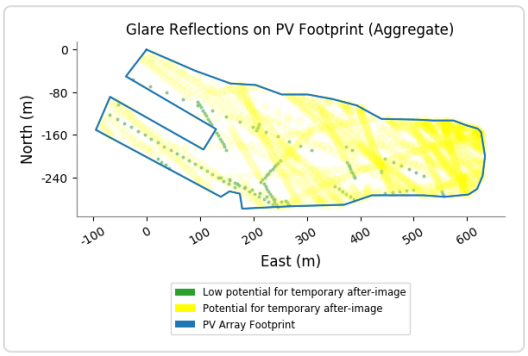
PV array 1 - OP Receptor (OP 13)

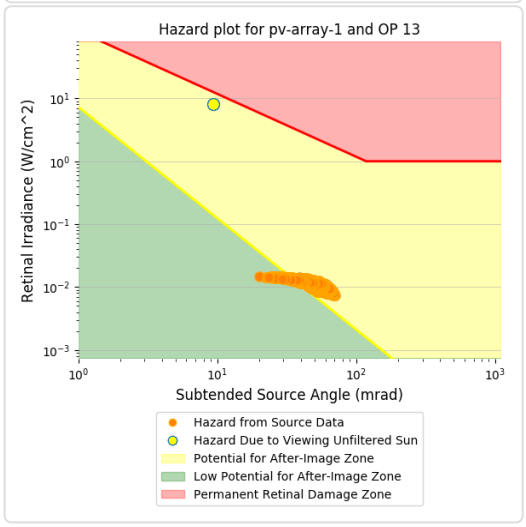
PV array is expected to produce the following glare for receptors at this location:

- 140 minutes of "green" glare with low potential to cause temporary after-image.
- 1,744 minutes of "yellow" glare with potential to cause temporary after-image.





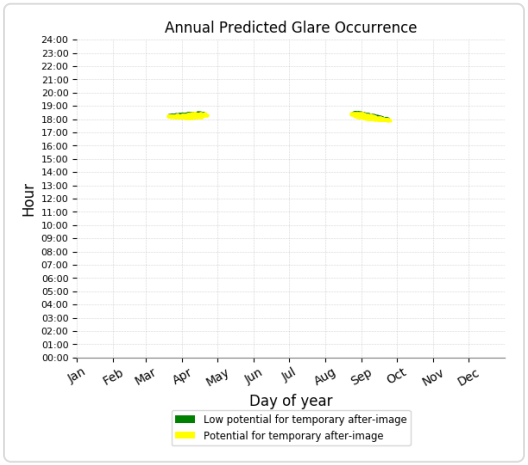


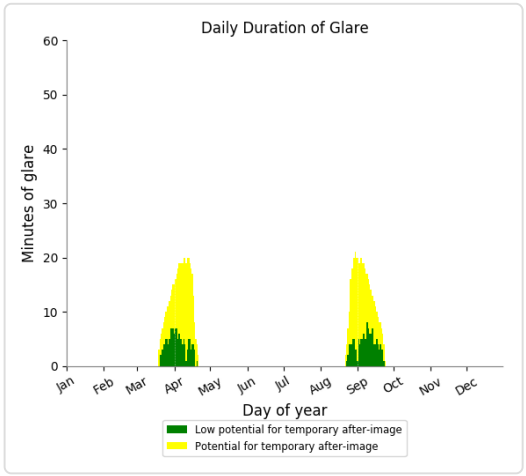


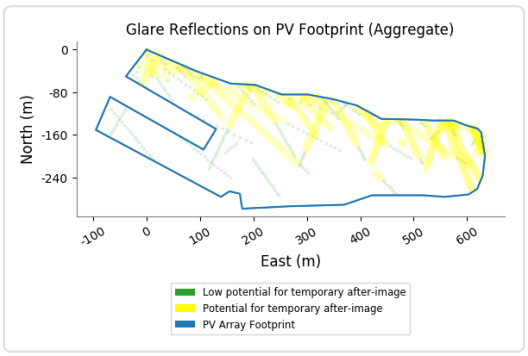
PV array 1 - OP Receptor (OP 14)

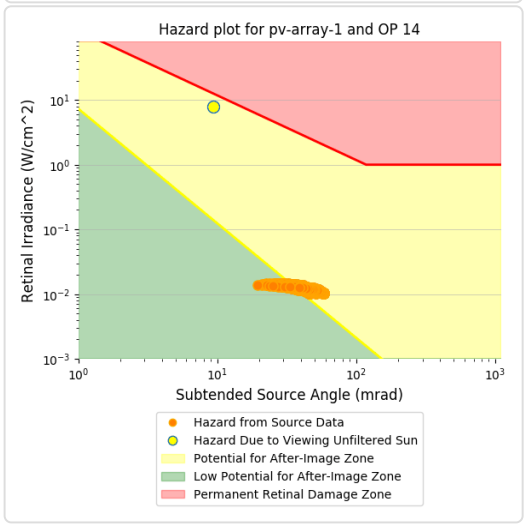
PV array is expected to produce the following glare for receptors at this location:

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





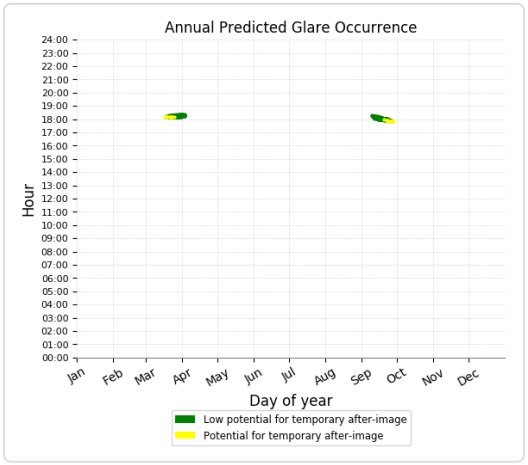


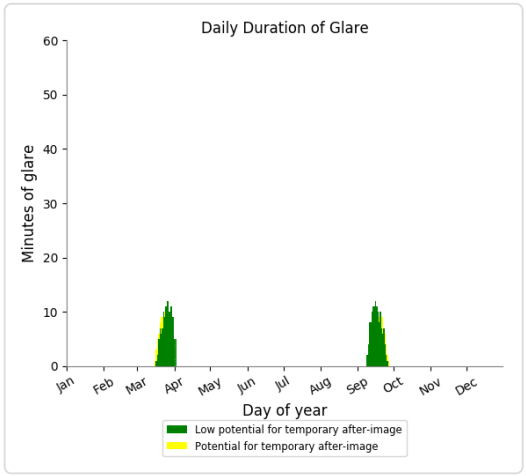


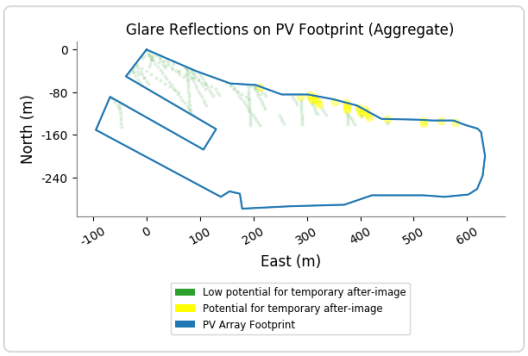
PV array 1 - OP Receptor (OP 15)

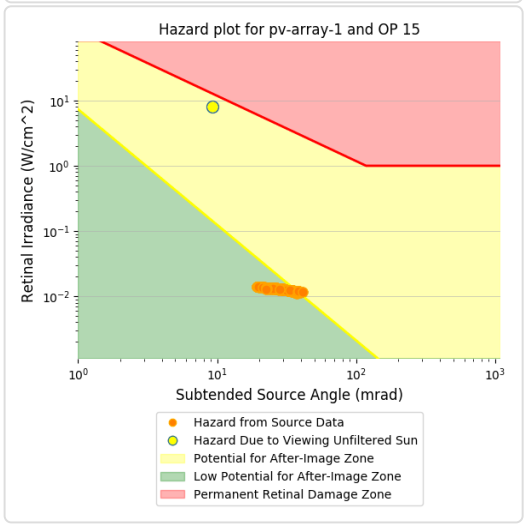
PV array is expected to produce the following glare for receptors at this location:

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





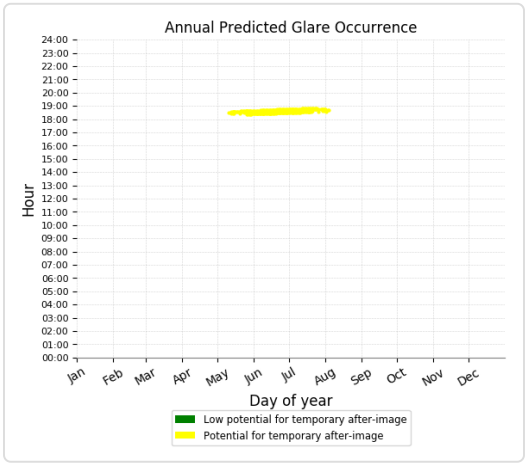


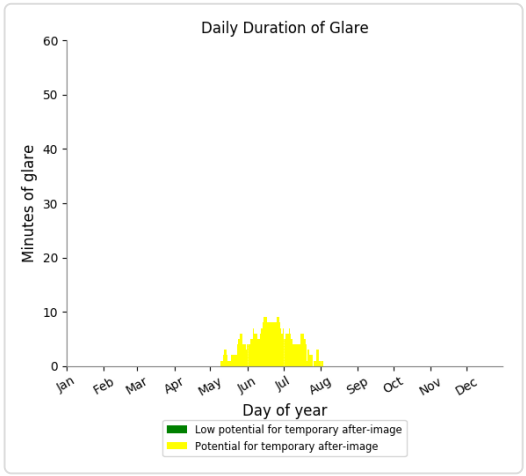


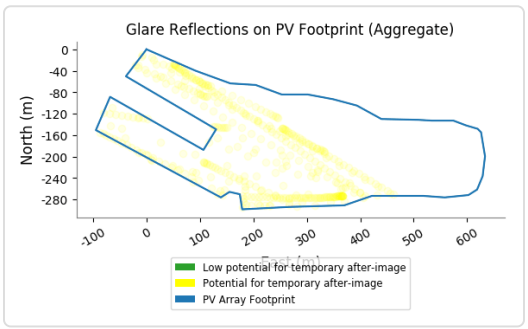
PV array 1 - OP Receptor (OP 16)

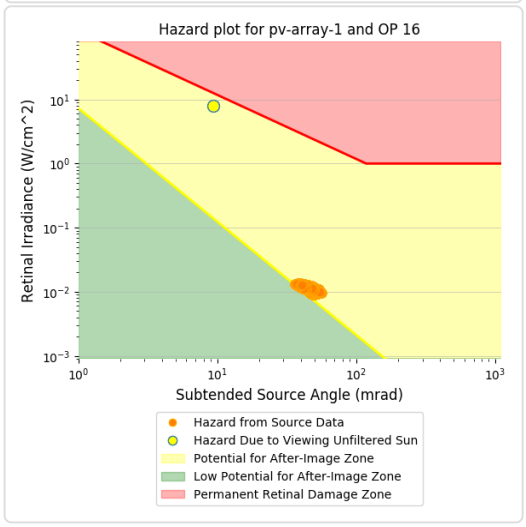
PV array is expected to produce the following glare for receptors at this location:

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





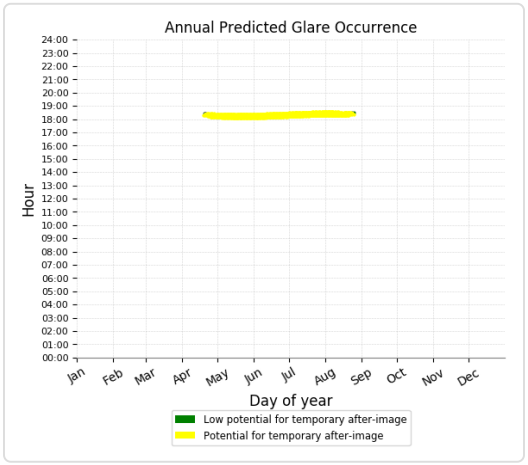


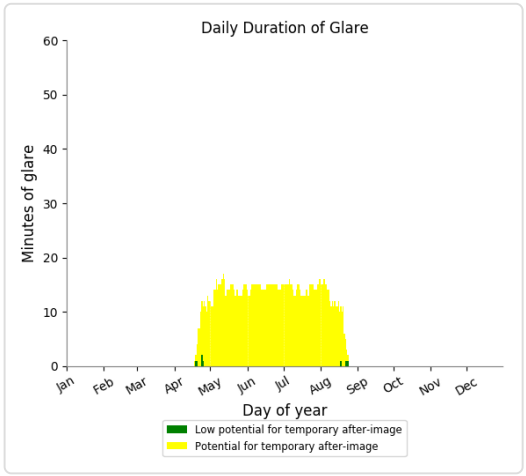


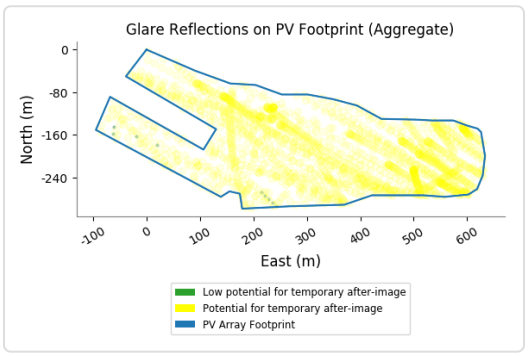
PV array 1 - OP Receptor (OP 17)

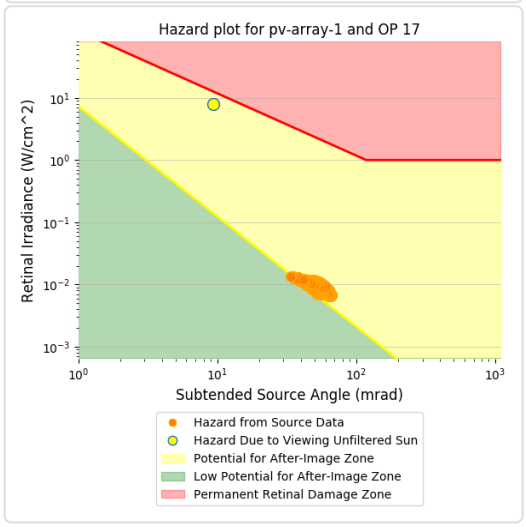
PV array is expected to produce the following glare for receptors at this location:

- 9 minutes of "green" glare with low potential to cause temporary after-image.
- 1,694 minutes of "yellow" glare with potential to cause temporary after-image.





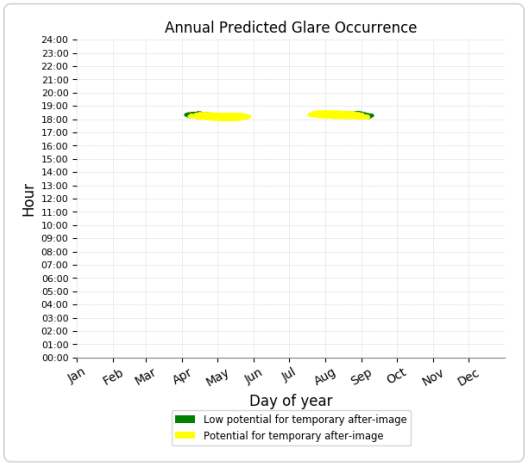


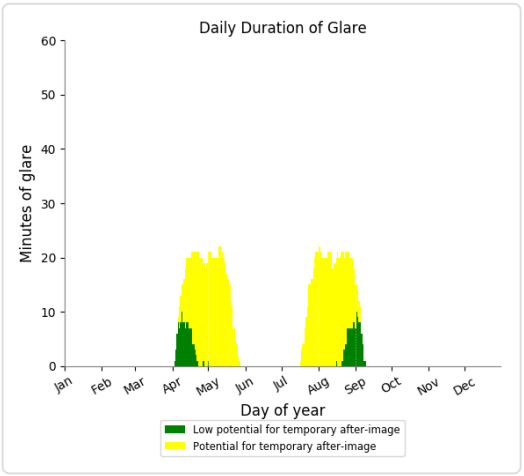


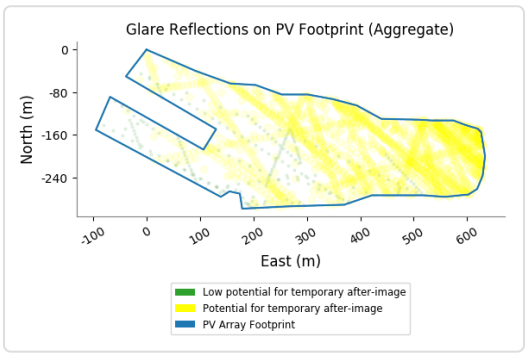
PV array 1 - OP Receptor (OP 18)

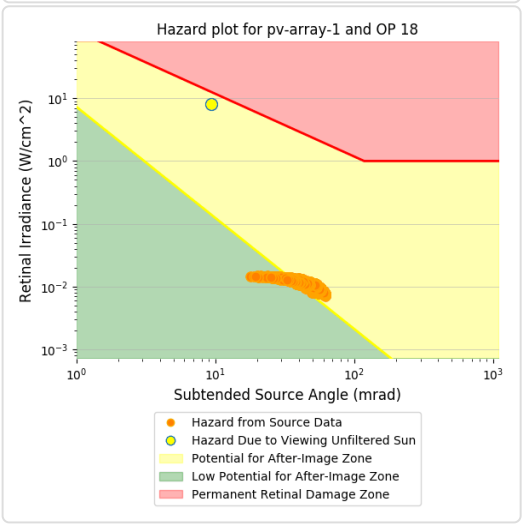
PV array is expected to produce the following glare for receptors at this location:

- 236 minutes of "green" glare with low potential to cause temporary after-image.
- 1,541 minutes of "yellow" glare with potential to cause temporary after-image.





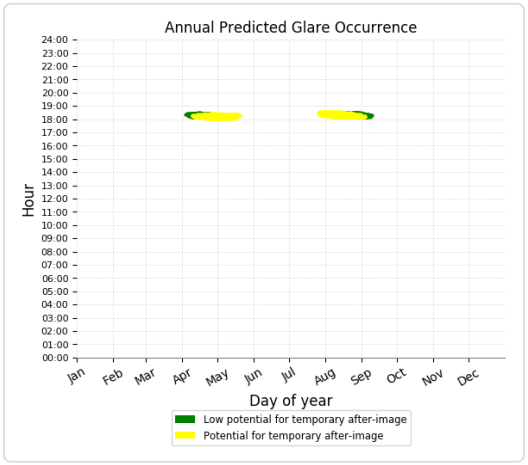


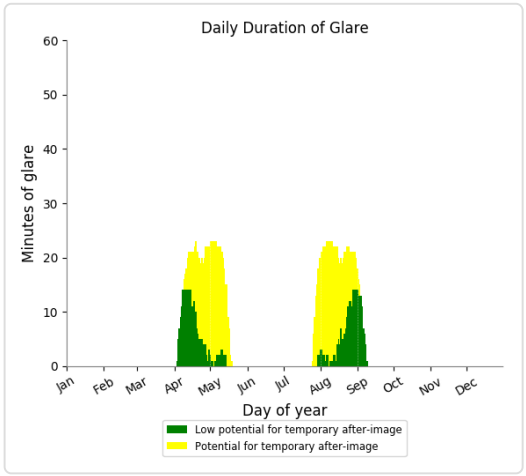


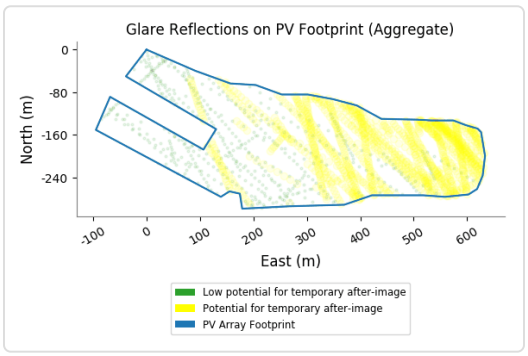
PV array 1 - OP Receptor (OP 19)

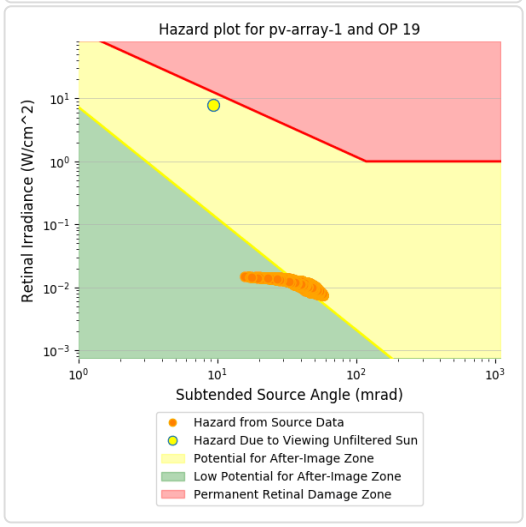
PV array is expected to produce the following glare for receptors at this location:

- 524 minutes of "green" glare with low potential to cause temporary after-image.
- 1,143 minutes of "yellow" glare with potential to cause temporary after-image.





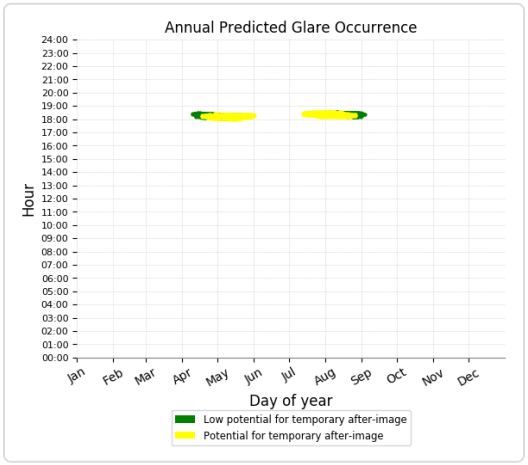


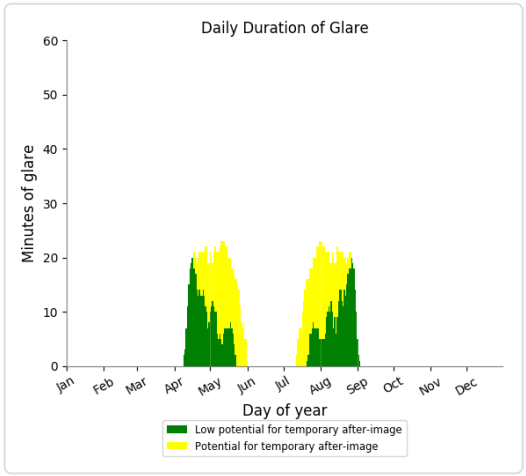


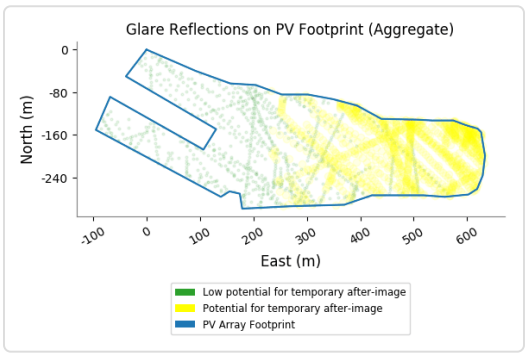
PV array 1 - OP Receptor (OP 20)

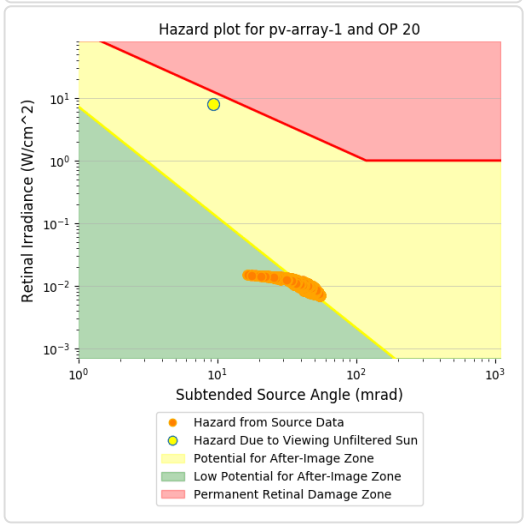
PV array is expected to produce the following glare for receptors at this location:

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





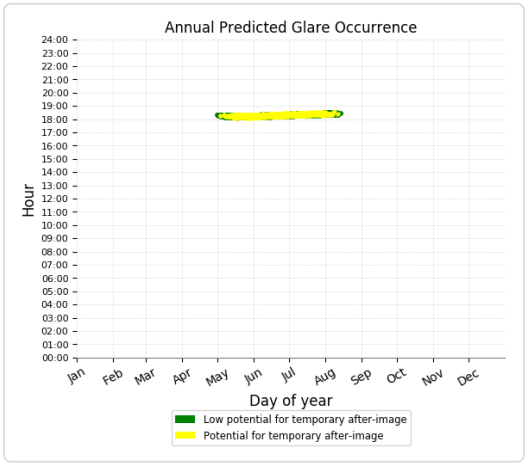


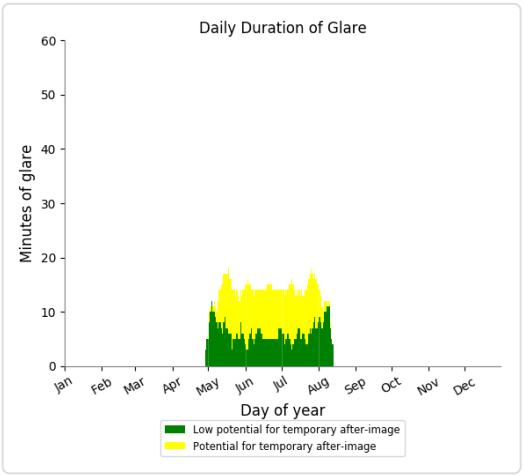


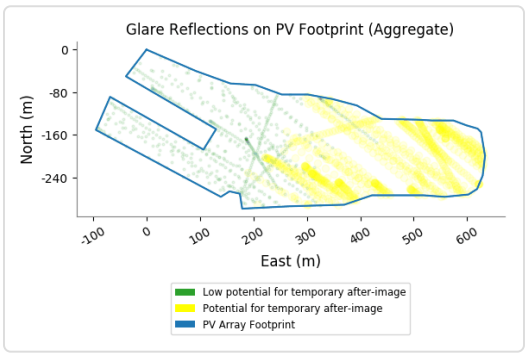
PV array 1 - OP Receptor (OP 21)

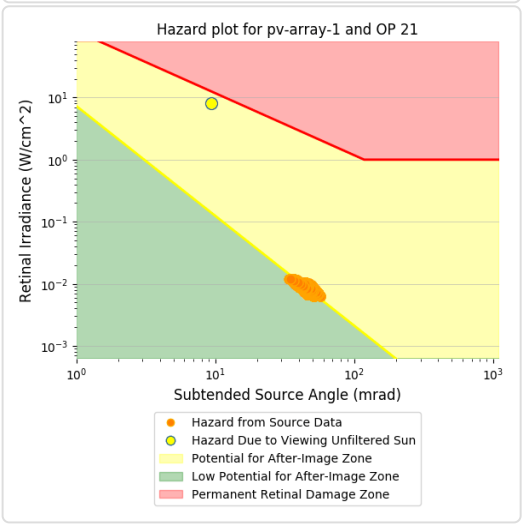
PV array is expected to produce the following glare for receptors at this location:

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





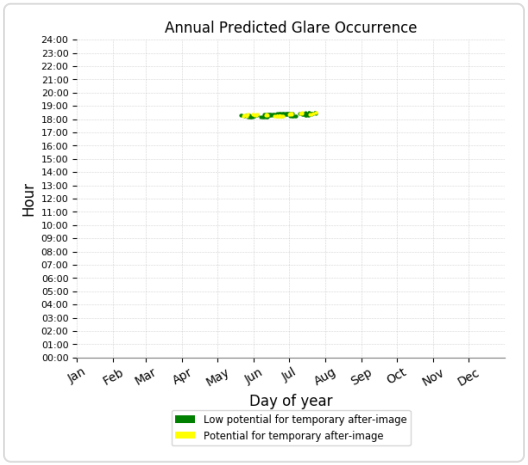


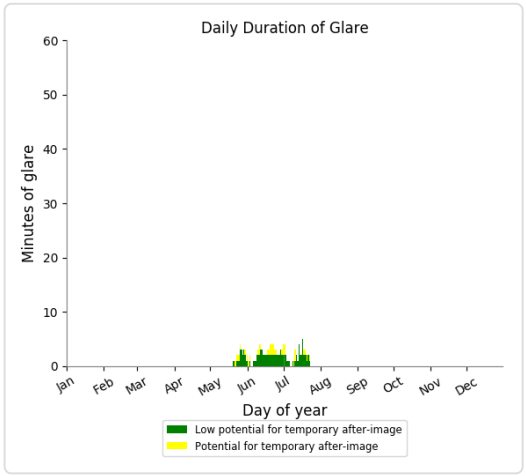


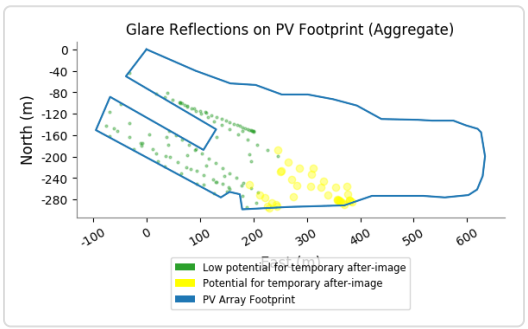
PV array 1 - OP Receptor (OP 22)

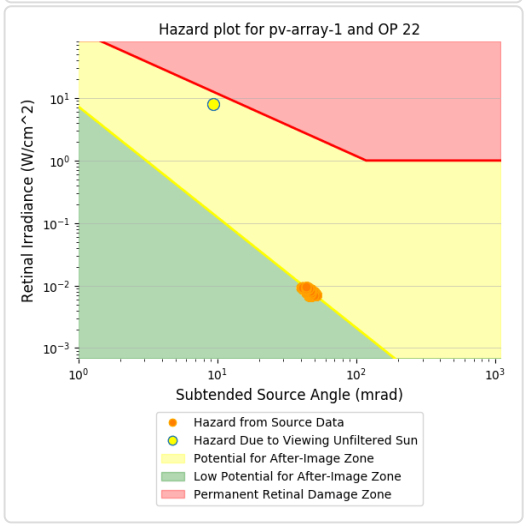
PV array is expected to produce the following glare for receptors at this location:

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









PV array 1 - OP Receptor (OP 23)

No glare found

PV array 1 - OP Receptor (OP 24)

No glare found

PV array 1 - OP Receptor (OP 25)

No glare found

PV array 1 - OP Receptor (OP 26)

No glare found

PV array 1 - OP Receptor (OP 27)

No glare found

PV array 1 - OP Receptor (OP 28)

No glare found

PV array 2 potential temporary after-image

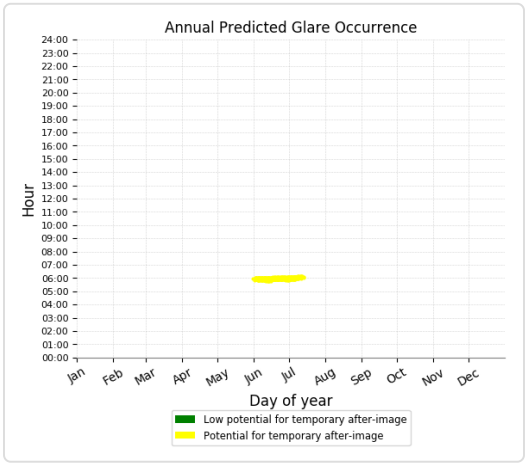
Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	377
OP: OP 2	0	0
OP: OP 3	0	0

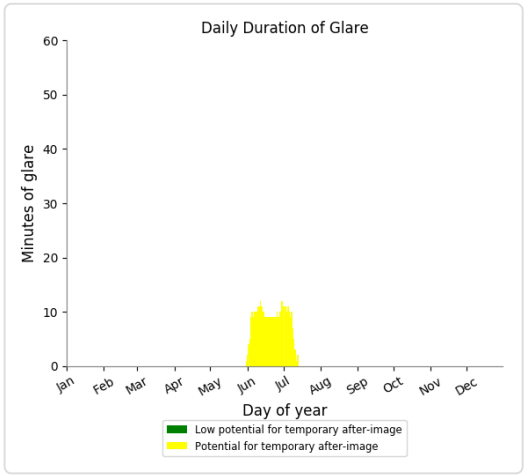
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	27
OP: OP 9	7	1202
OP: OP 10	190	2147
OP: OP 11	393	1057
OP: OP 12	167	101
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	468	519
OP: OP 17	254	79
OP: OP 18	42	0
OP: OP 19	43	0
OP: OP 20	166	0
OP: OP 21	525	0
OP: OP 22	881	100
OP: OP 23	445	39
OP: OP 24	48	0
OP: OP 25	10	0
OP: OP 26	0	0
OP: OP 27	0	0
OP: OP 28	0	0

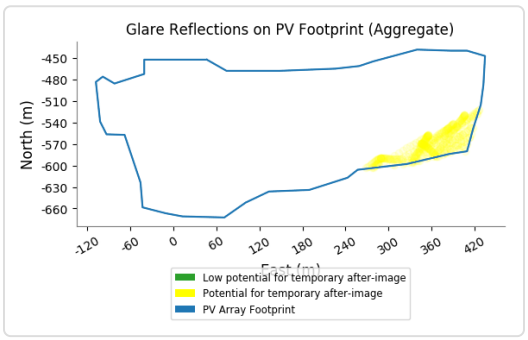
PV array 2 - OP Receptor (OP 1)

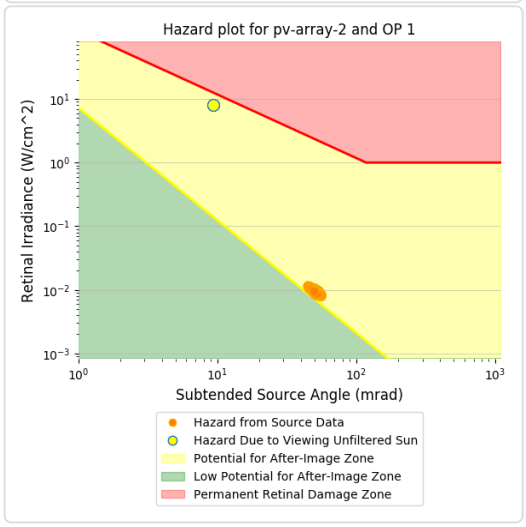
PV array is expected to produce the following glare for receptors at this location:

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









PV array 2 - OP Receptor (OP 2)

No glare found

PV array 2 - OP Receptor (OP 3)

No glare found

PV array 2 - OP Receptor (OP 4)

No glare found

PV array 2 - OP Receptor (OP 5)

No glare found

PV array 2 - OP Receptor (OP 6)

No glare found

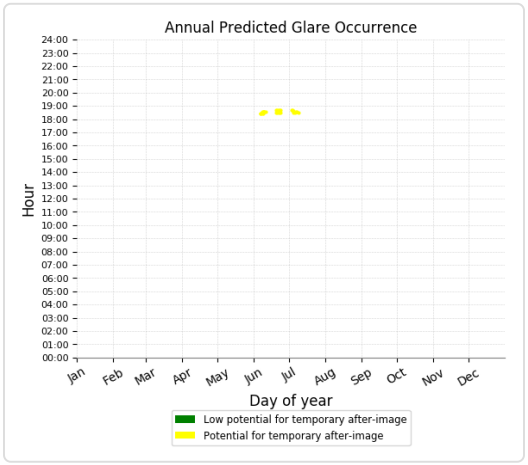
PV array 2 - OP Receptor (OP 7)

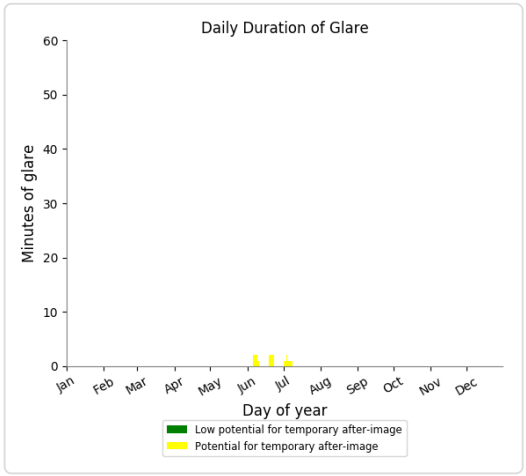
No glare found

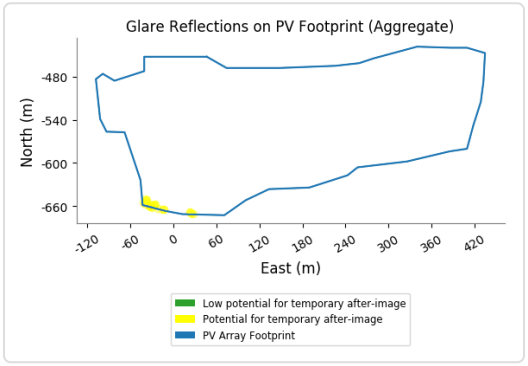
PV array 2 - OP Receptor (OP 8)

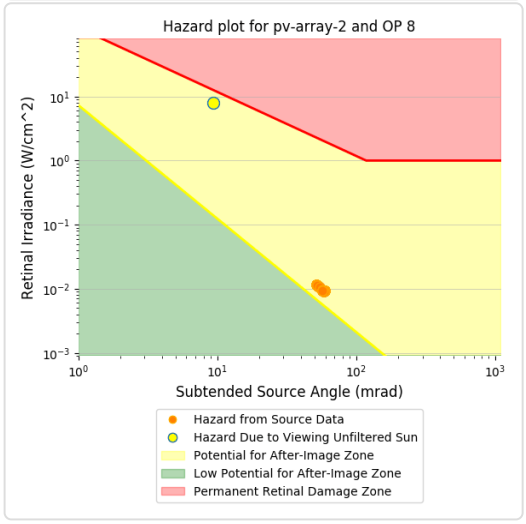
PV array is expected to produce the following glare for receptors at this location:

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





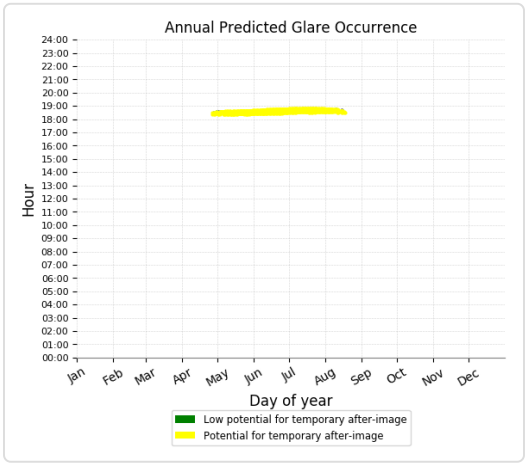


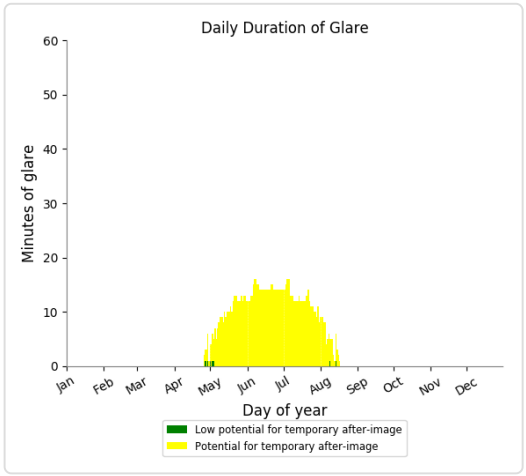


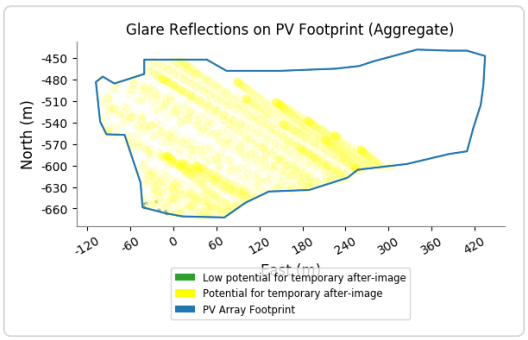
PV array 2 - OP Receptor (OP 9)

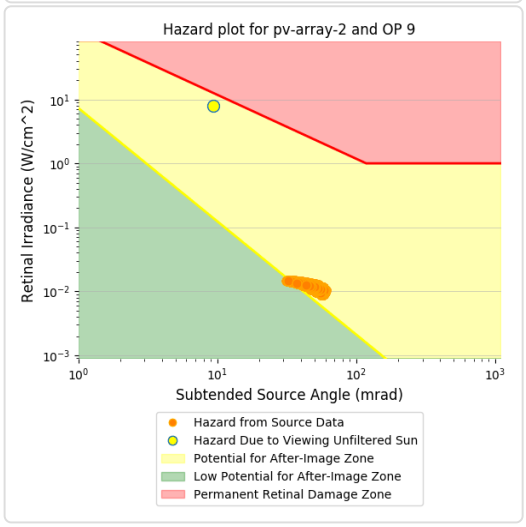
PV array is expected to produce the following glare for receptors at this location:

- 7 minutes of "green" glare with low potential to cause temporary after-image.
- 1,202 minutes of "yellow" glare with potential to cause temporary after-image.





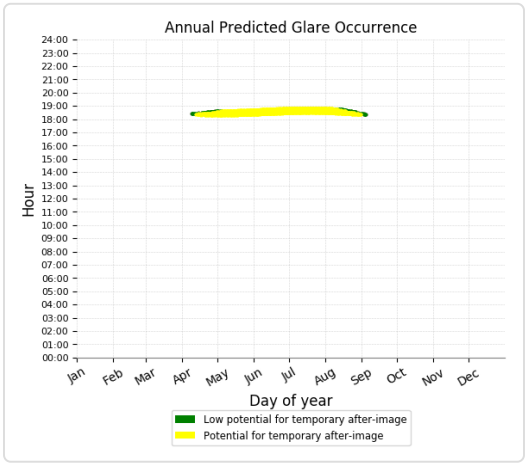


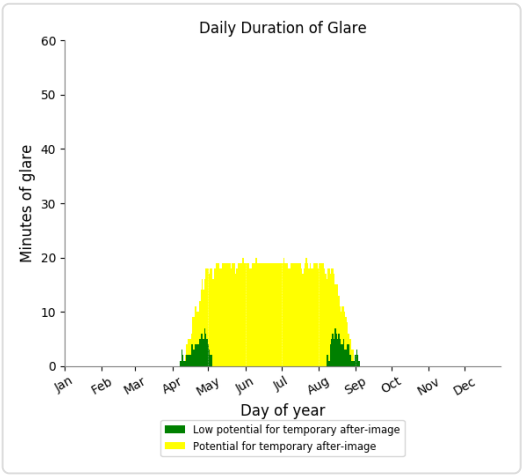


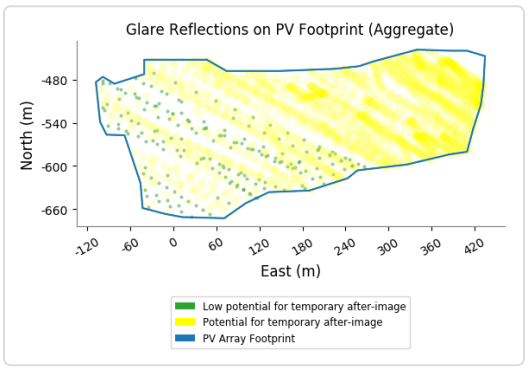
PV array 2 - OP Receptor (OP 10)

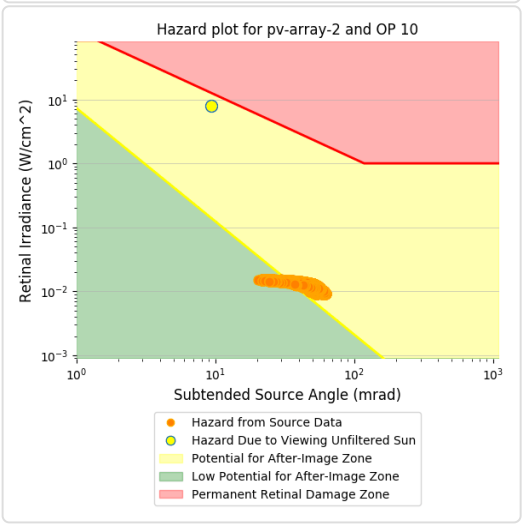
PV array is expected to produce the following glare for receptors at this location:

- 190 minutes of "green" glare with low potential to cause temporary after-image.
- 2,147 minutes of "yellow" glare with potential to cause temporary after-image.





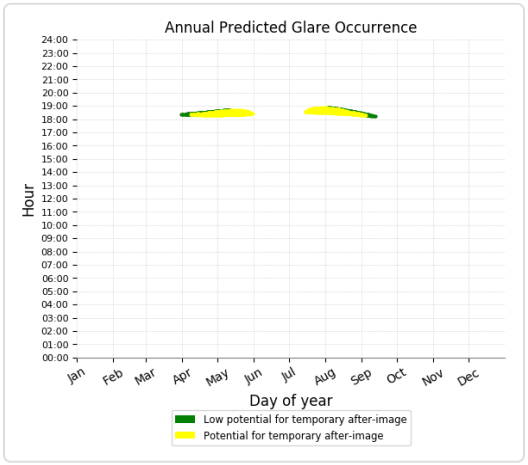


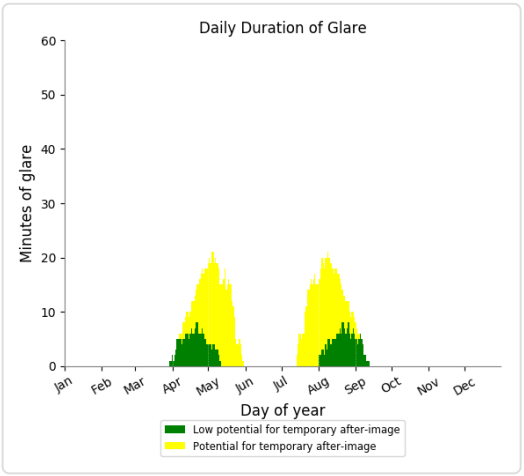


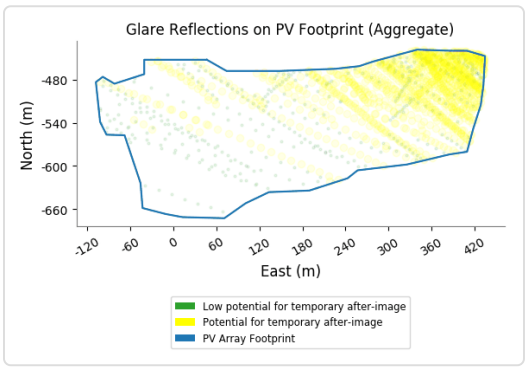
PV array 2 - OP Receptor (OP 11)

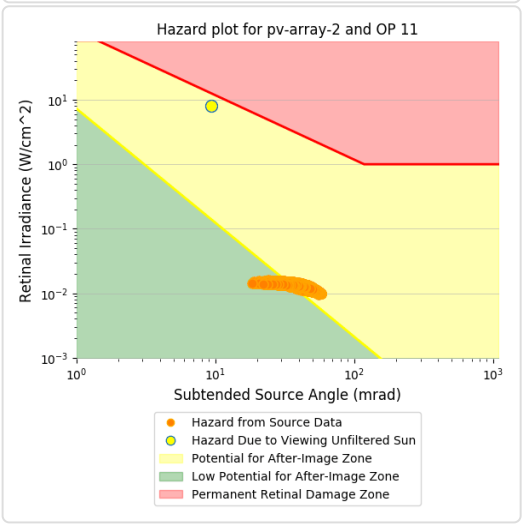
PV array is expected to produce the following glare for receptors at this location:

- 393 minutes of "green" glare with low potential to cause temporary after-image.
- 1,057 minutes of "yellow" glare with potential to cause temporary after-image.





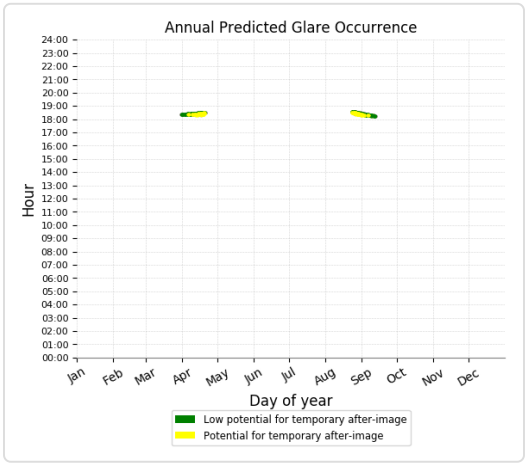


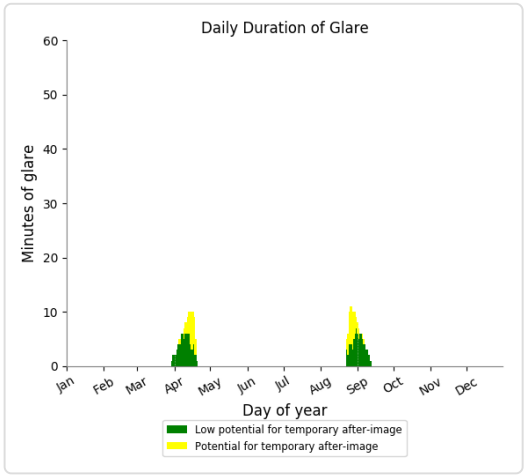


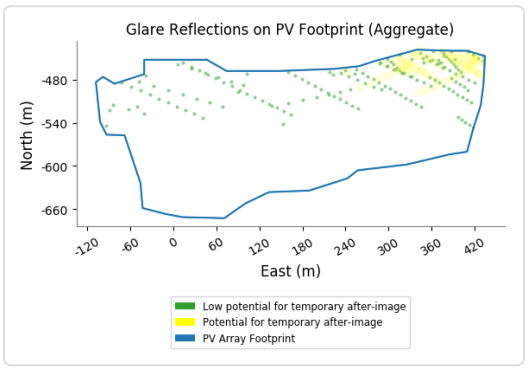
PV array 2 - OP Receptor (OP 12)

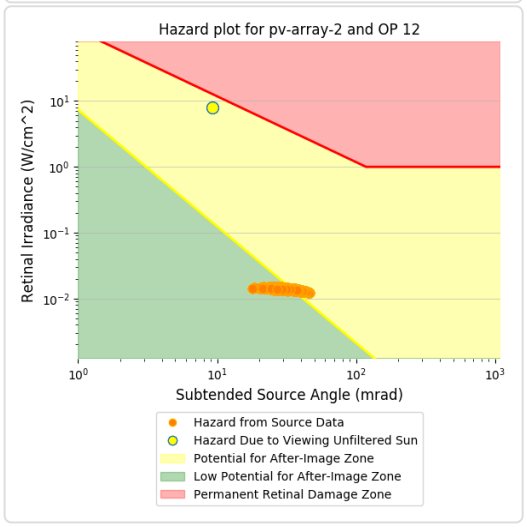
PV array is expected to produce the following glare for receptors at this location:

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









PV array 2 - OP Receptor (OP 13)

No glare found

PV array 2 - OP Receptor (OP 14)

No glare found

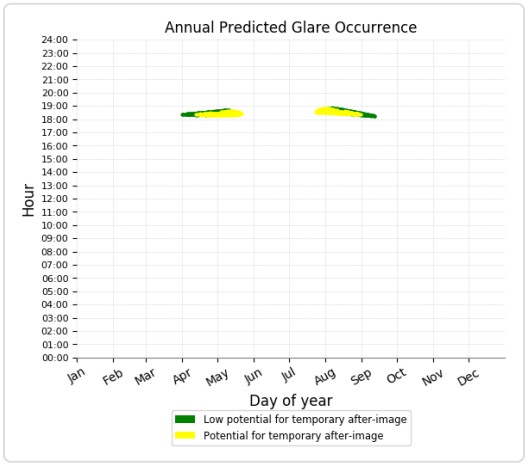
PV array 2 - OP Receptor (OP 15)

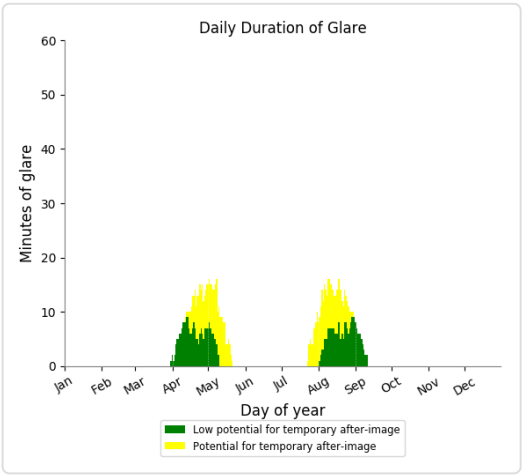
No glare found

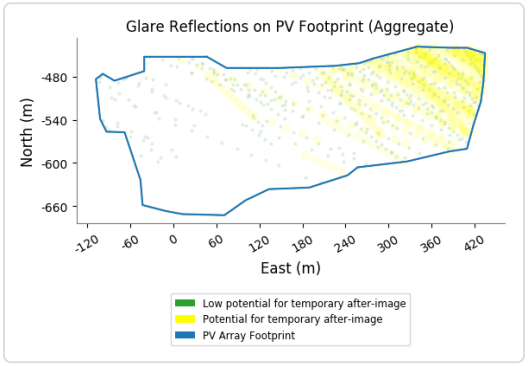
PV array 2 - OP Receptor (OP 16)

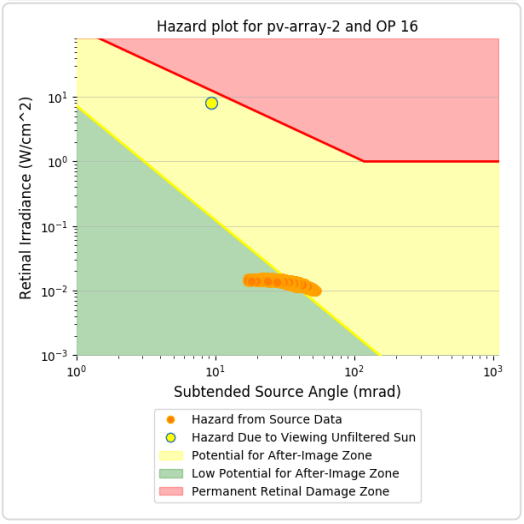
PV array is expected to produce the following glare for receptors at this location:

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





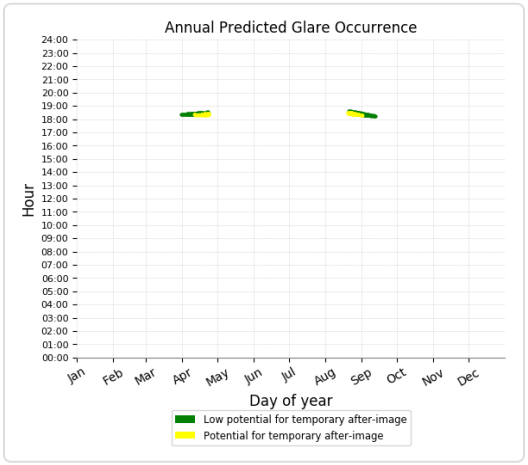


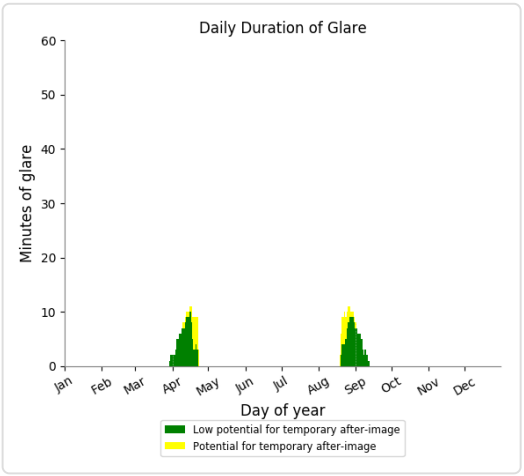


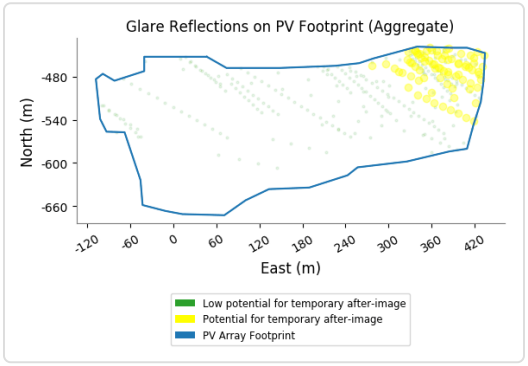
PV array 2 - OP Receptor (OP 17)

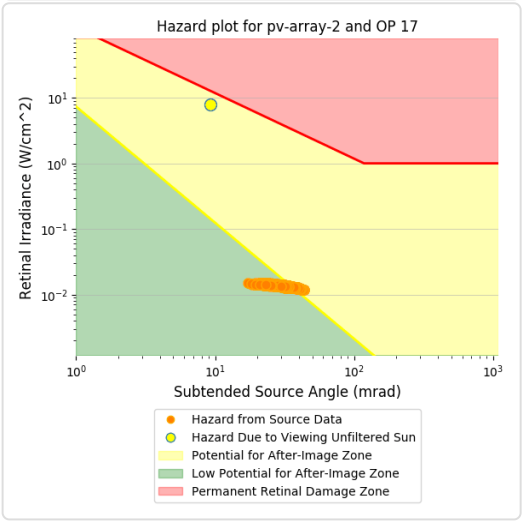
PV array is expected to produce the following glare for receptors at this location:

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





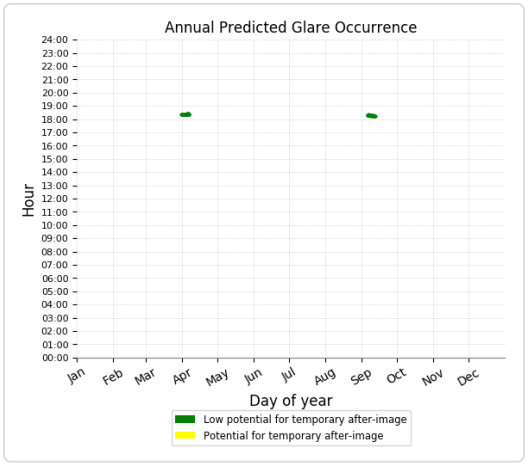


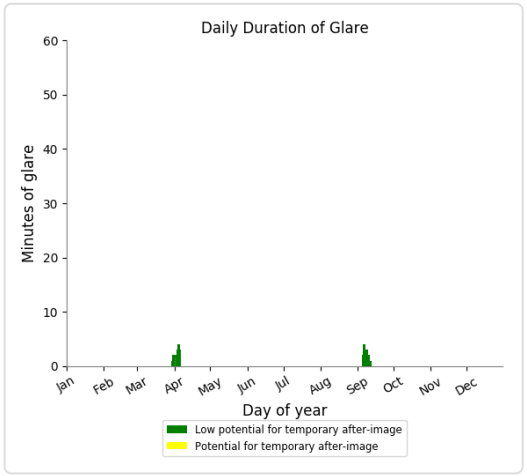


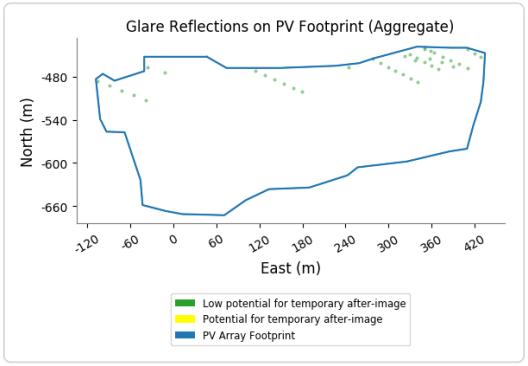
PV array 2 - OP Receptor (OP 18)

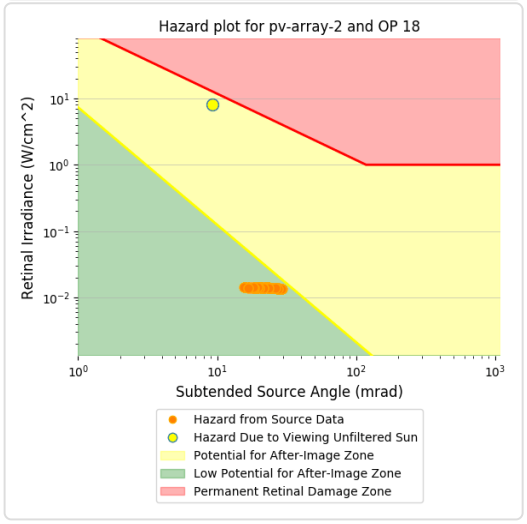
PV array is expected to produce the following glare for receptors at this location:

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





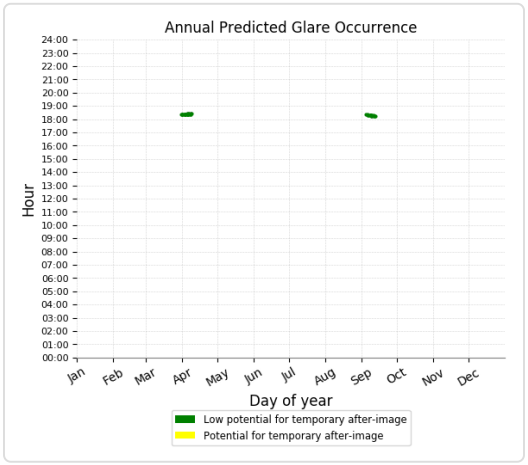


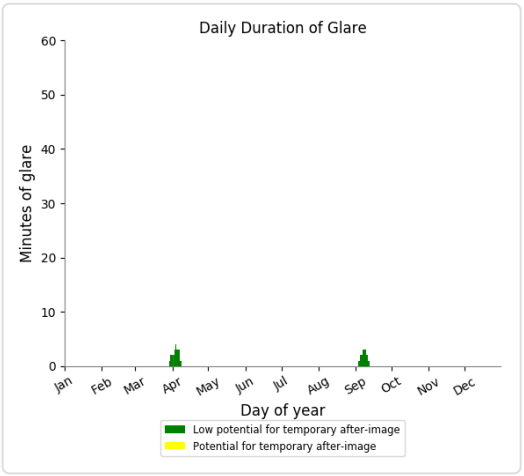


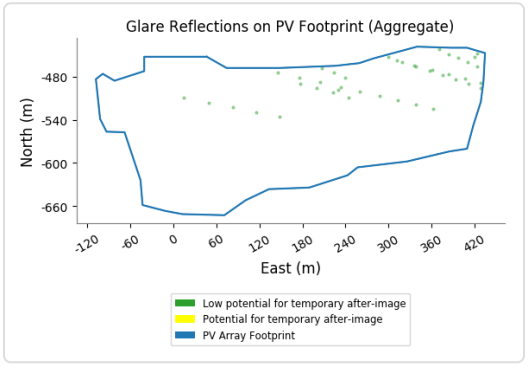
PV array 2 - OP Receptor (OP 19)

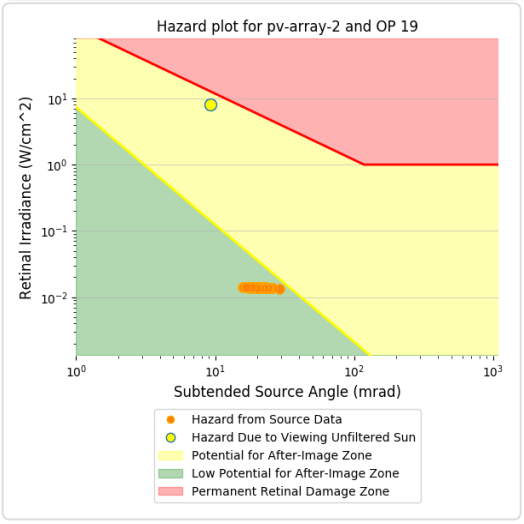
PV array is expected to produce the following glare for receptors at this location:

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





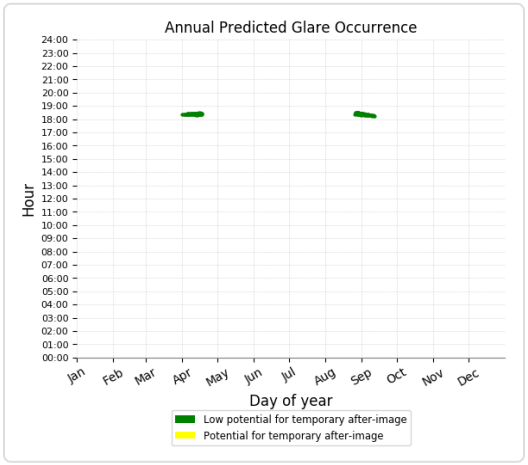


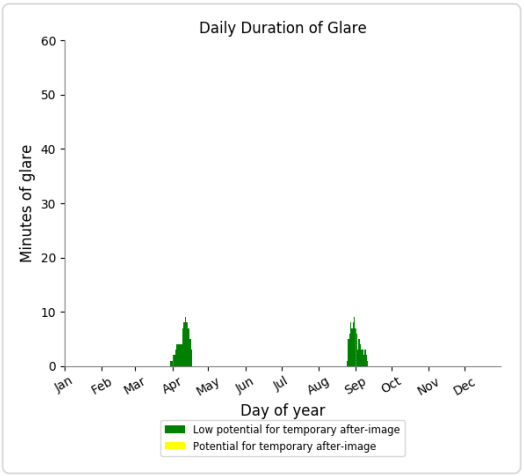


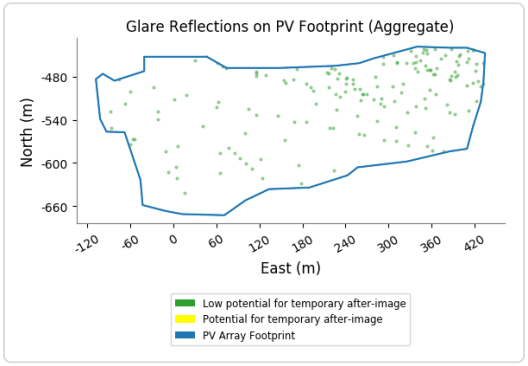
PV array 2 - OP Receptor (OP 20)

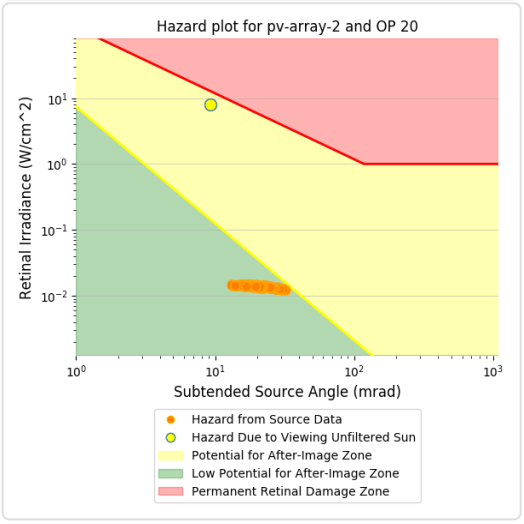
PV array is expected to produce the following glare for receptors at this location:

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





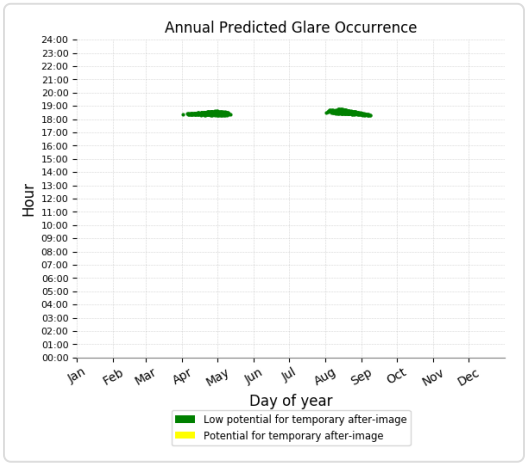


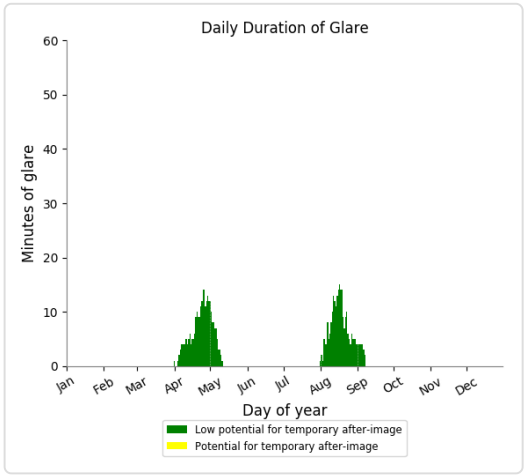


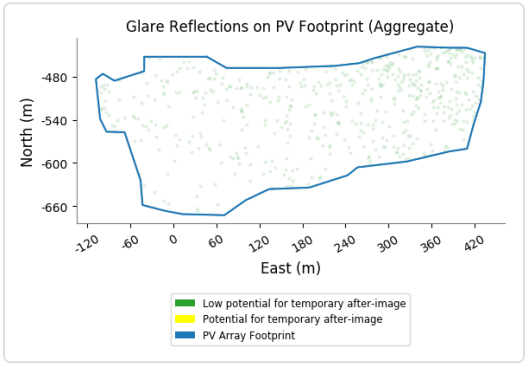
PV array 2 - OP Receptor (OP 21)

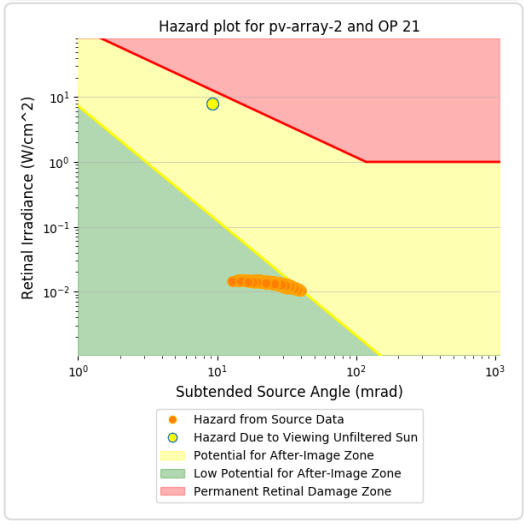
PV array is expected to produce the following glare for receptors at this location:

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





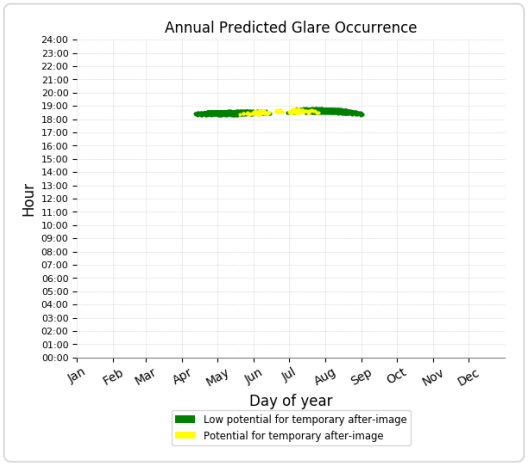


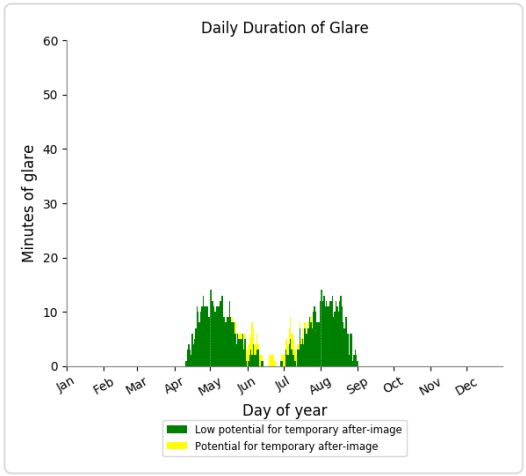


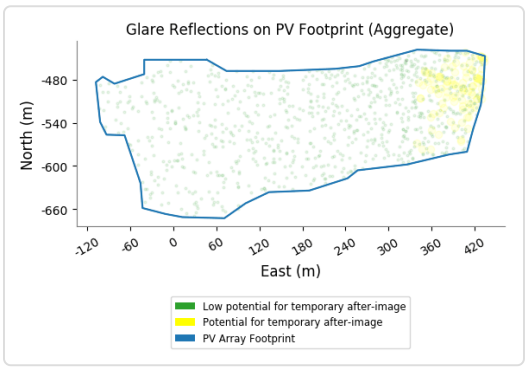
PV array 2 - OP Receptor (OP 22)

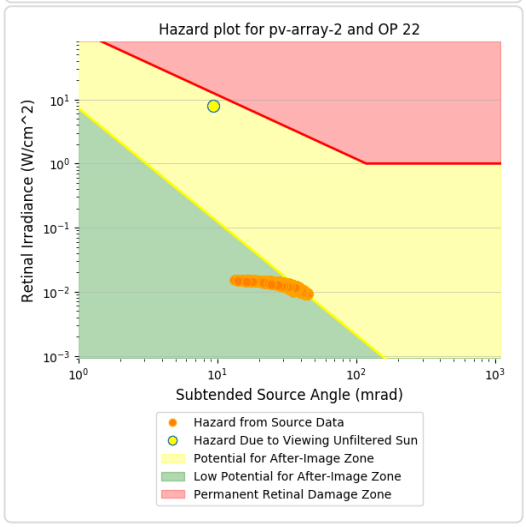
PV array is expected to produce the following glare for receptors at this location:

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





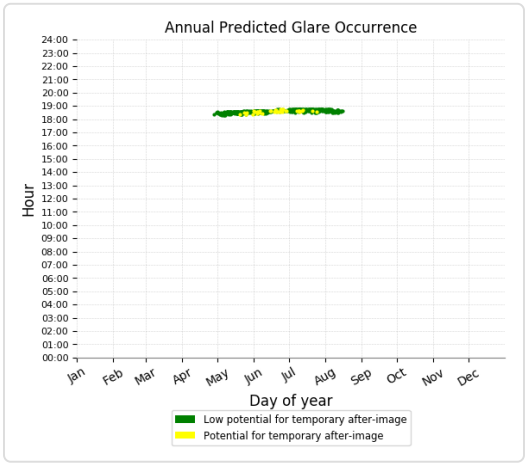


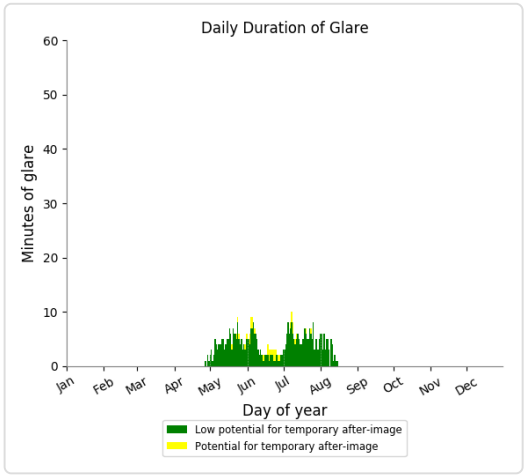


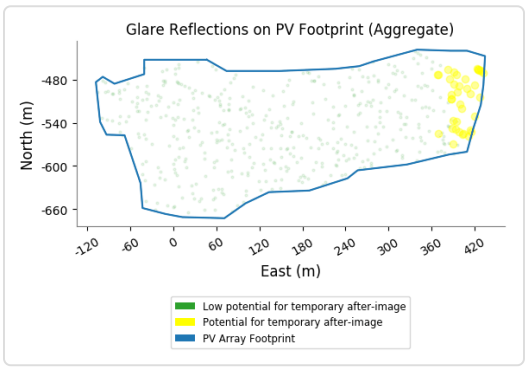
PV array 2 - OP Receptor (OP 23)

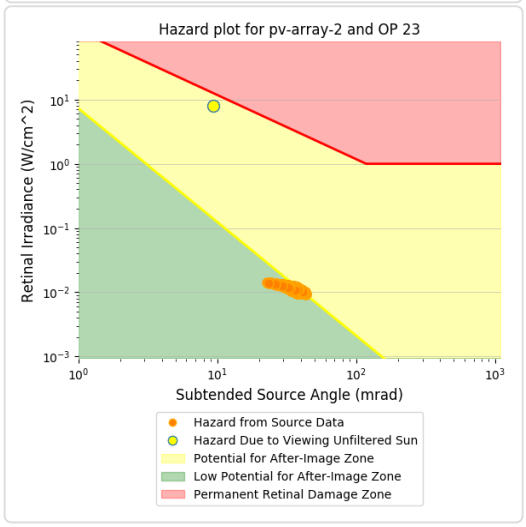
PV array is expected to produce the following glare for receptors at this location:

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





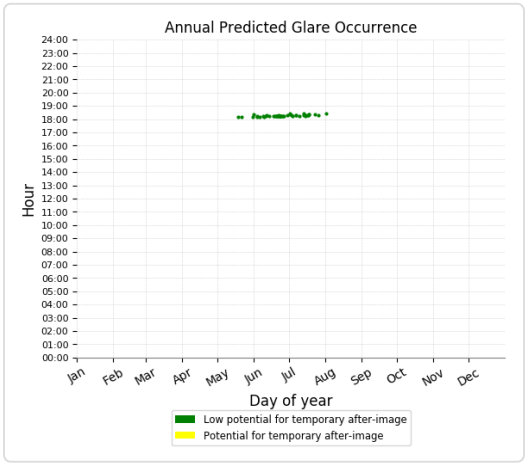


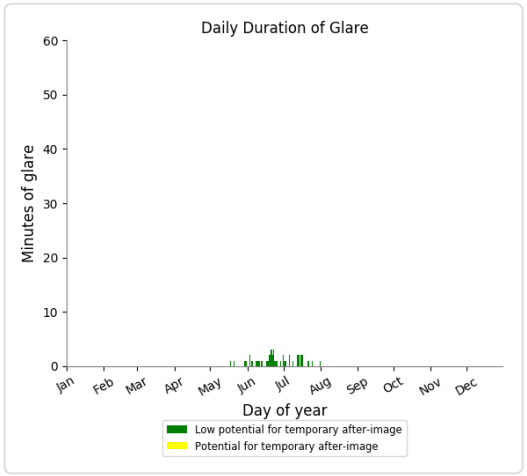


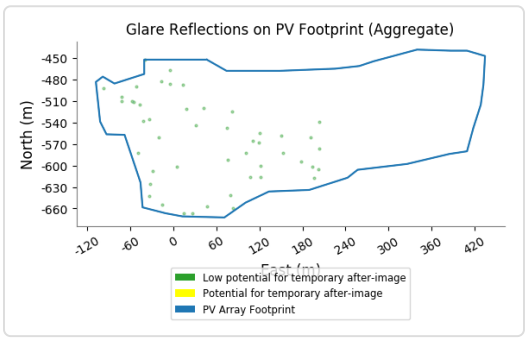
PV array 2 - OP Receptor (OP 24)

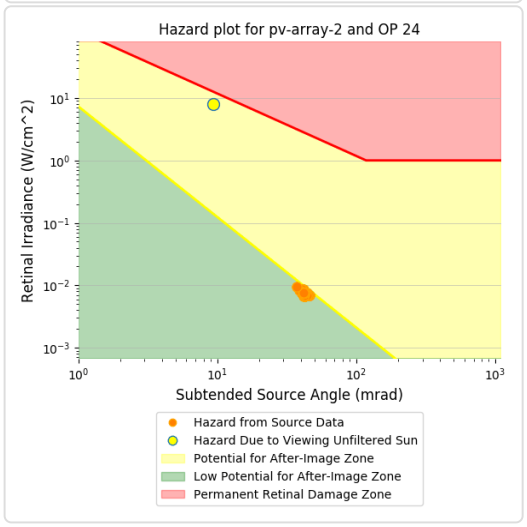
PV array is expected to produce the following glare for receptors at this location:

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





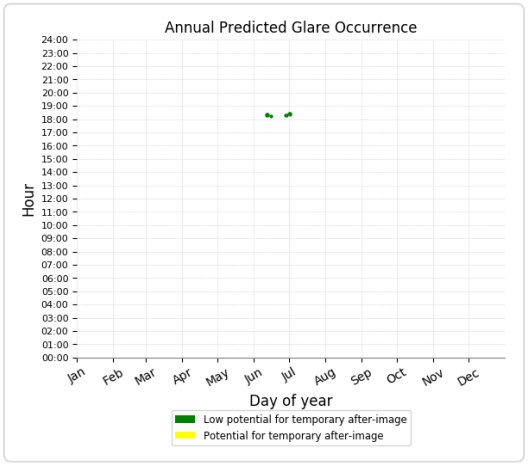


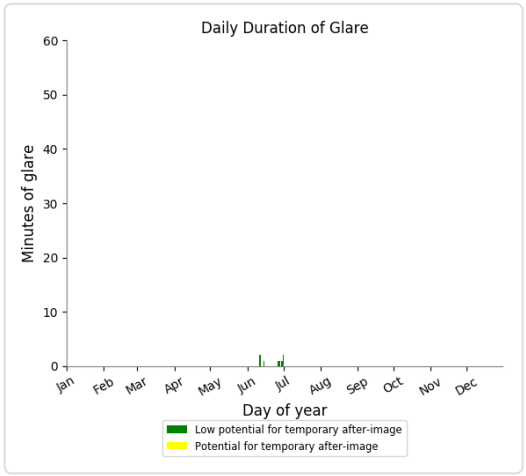


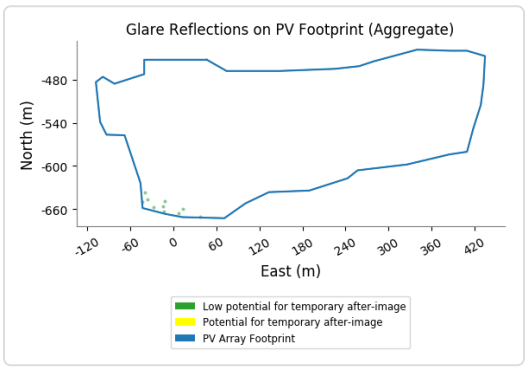
PV array 2 - OP Receptor (OP 25)

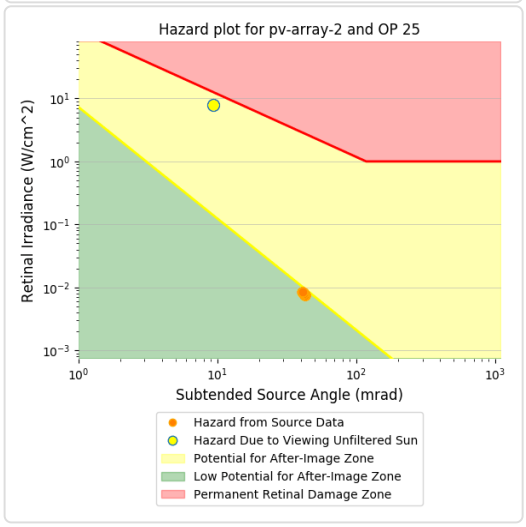
PV array is expected to produce the following glare for receptors at this location:

- 10 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 2 - OP Receptor (OP 26)

No glare found

PV array 2 - OP Receptor (OP 27)

No glare found

PV array 2 - OP Receptor (OP 28)

No glare found

PV array 3 potential temporary after-image

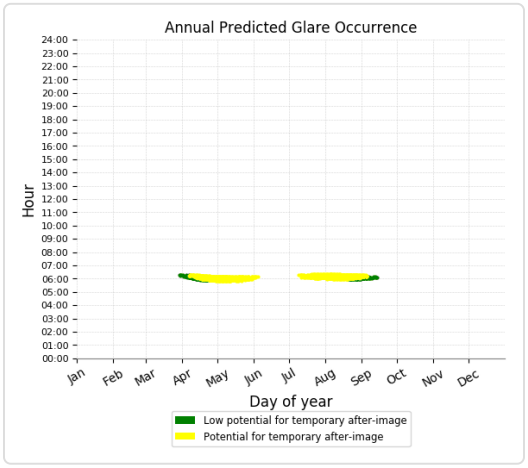
Component	Green glare (min)	Yellow glare (min)
OP: OP 1	291	1482
OP: OP 2	117	2483
OP: OP 3	0	1371
OP: OP 4	0	646
OP: OP 5	0	141
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	69
OP: OP 9	0	6004
OP: OP 10	2	3197
OP: OP 11	0	2217

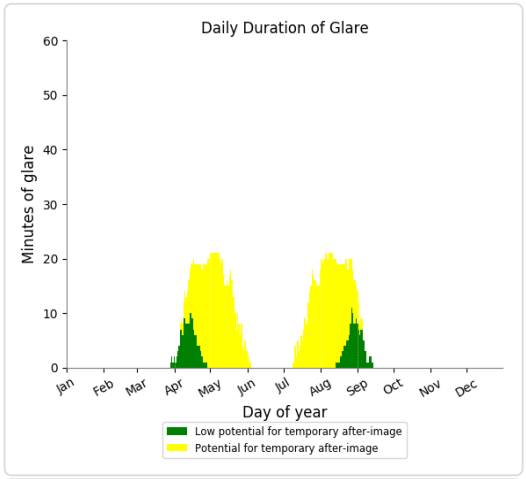
OP: OP 12	0	22
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	4	1551
OP: OP 17	3	66
OP: OP 18	0	0
OP: OP 19	6	14
OP: OP 20	62	169
OP: OP 21	66	610
OP: OP 22	6	722
OP: OP 23	0	826
OP: OP 24	0	619
OP: OP 25	0	26
OP: OP 26	0	0
OP: OP 27	0	0
OP: OP 28	0	0

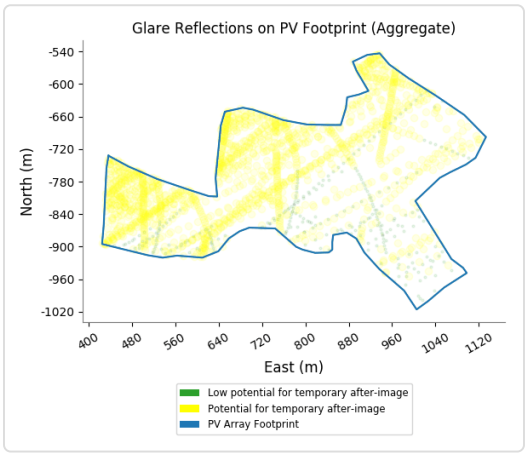
PV array 3 - OP Receptor (OP 1)

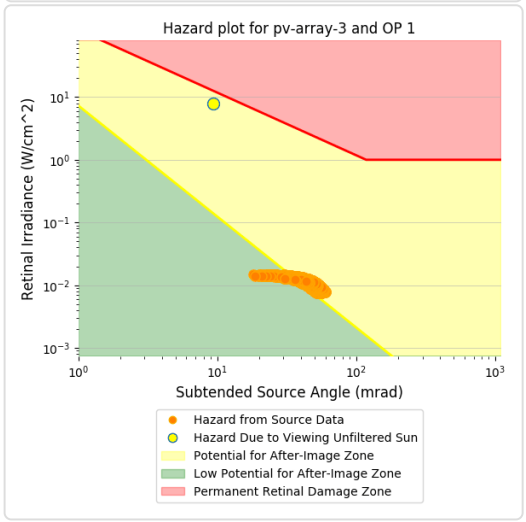
PV array is expected to produce the following glare for receptors at this location:

- 291 minutes of "green" glare with low potential to cause temporary after-image.
- 1,482 minutes of "yellow" glare with potential to cause temporary after-image.





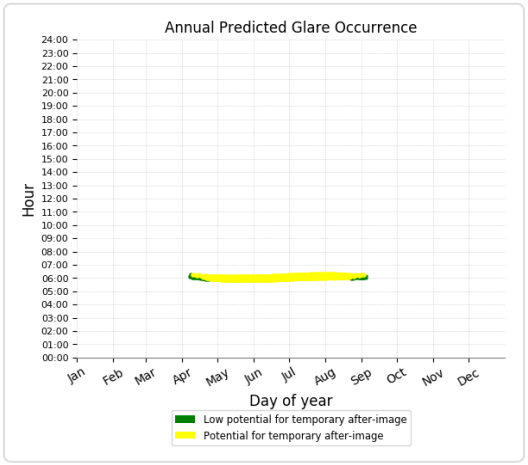


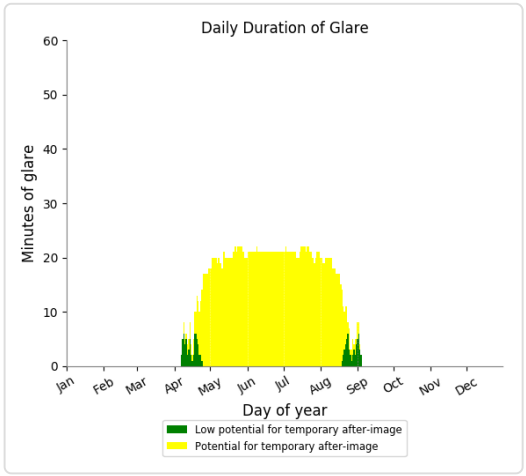


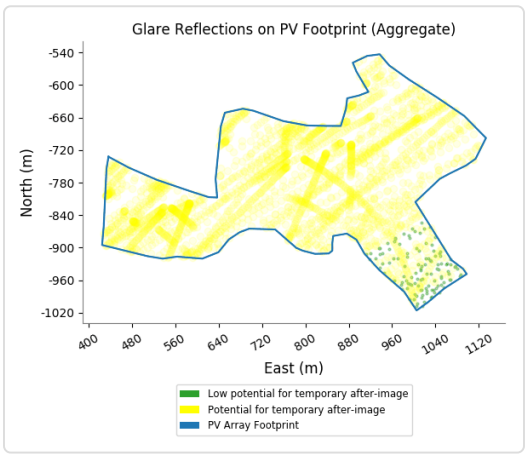
PV array 3 - OP Receptor (OP 2)

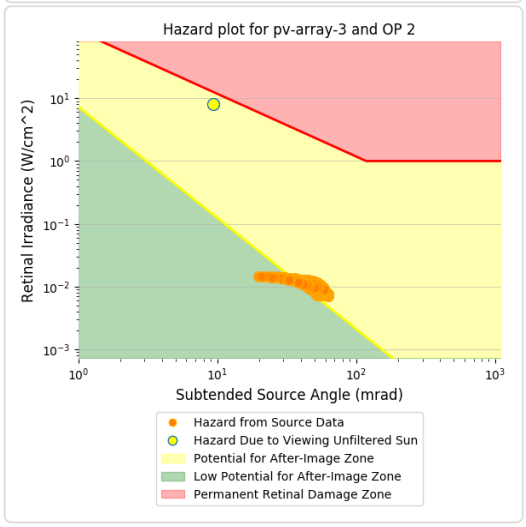
PV array is expected to produce the following glare for receptors at this location:

- 117 minutes of "green" glare with low potential to cause temporary after-image.
- 2,483 minutes of "yellow" glare with potential to cause temporary after-image.





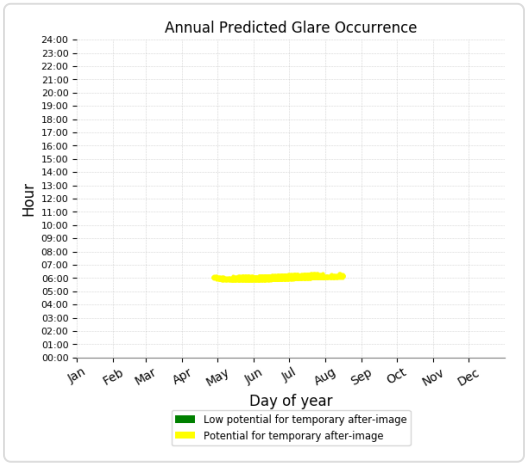


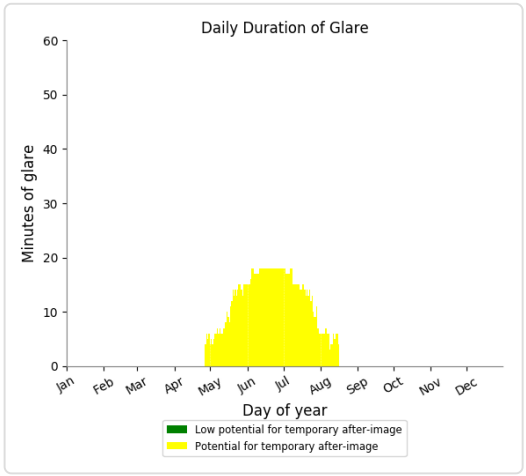


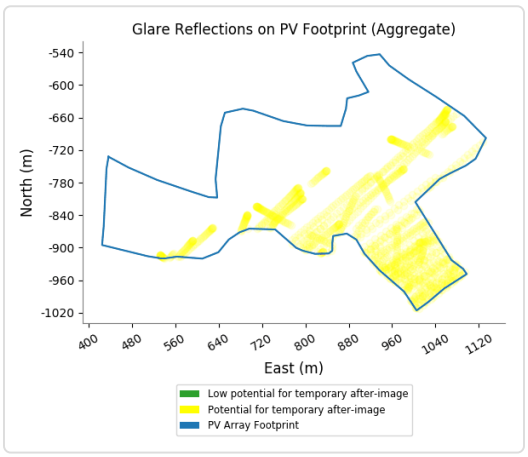
PV array 3 - OP Receptor (OP 3)

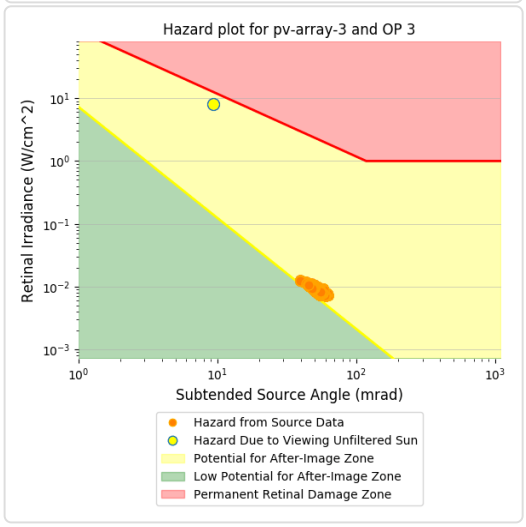
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,371 minutes of "yellow" glare with potential to cause temporary after-image.





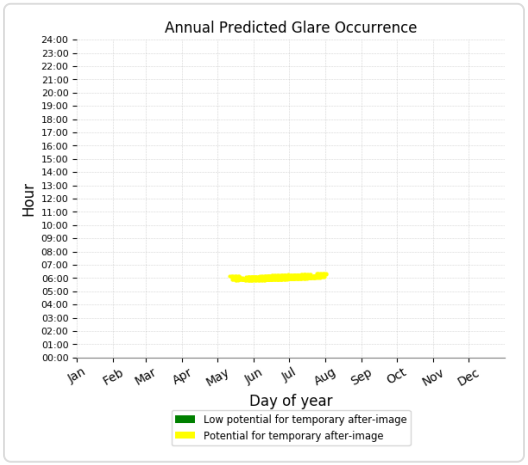


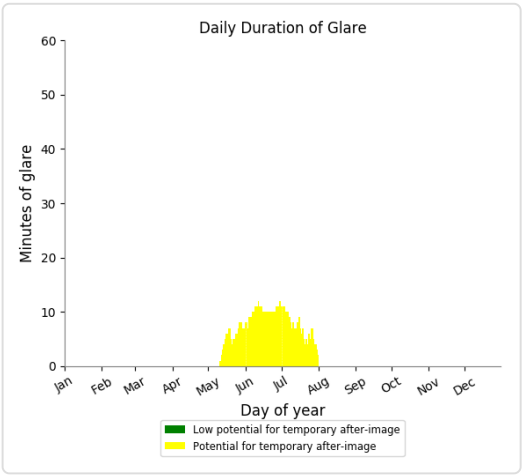


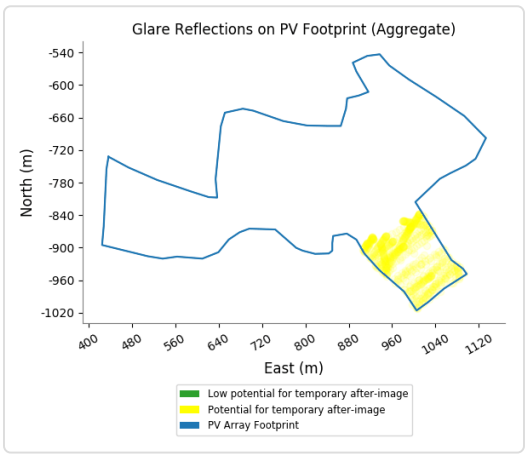
PV array 3 - OP Receptor (OP 4)

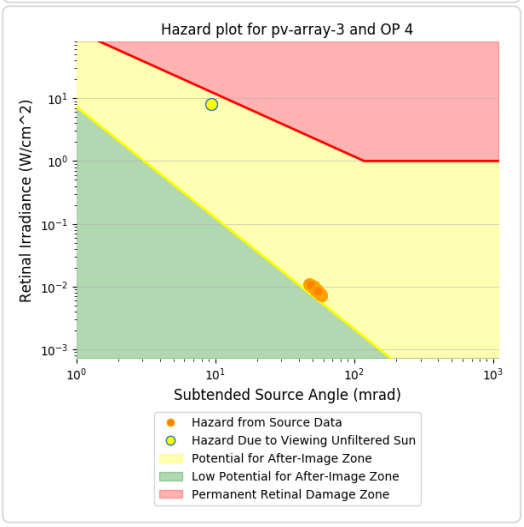
PV array is expected to produce the following glare for receptors at this location:

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





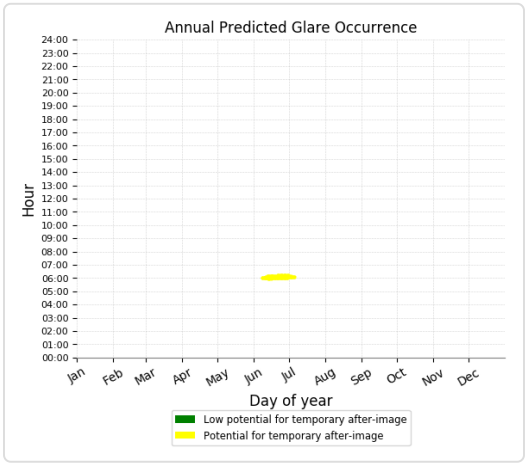


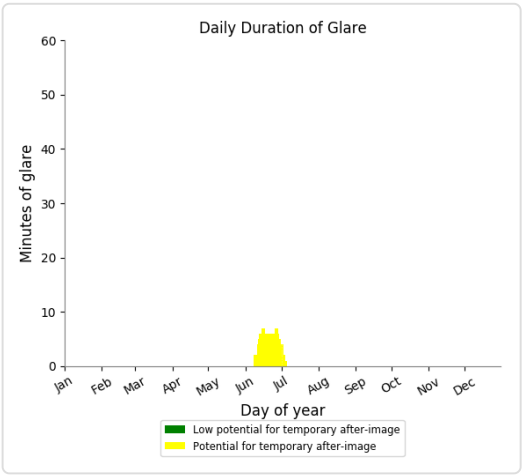


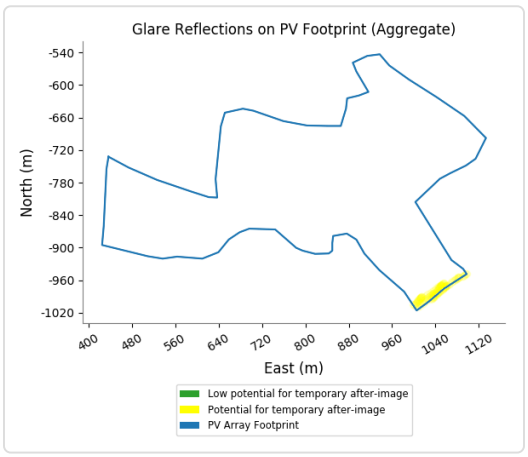
PV array 3 - OP Receptor (OP 5)

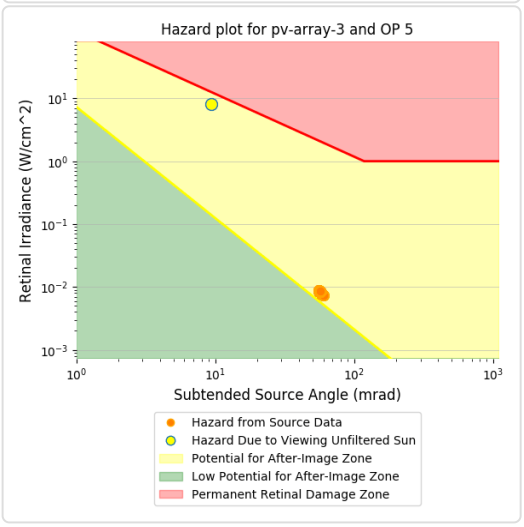
PV array is expected to produce the following glare for receptors at this location:

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









PV array 3 - OP Receptor (OP 6)

No glare found

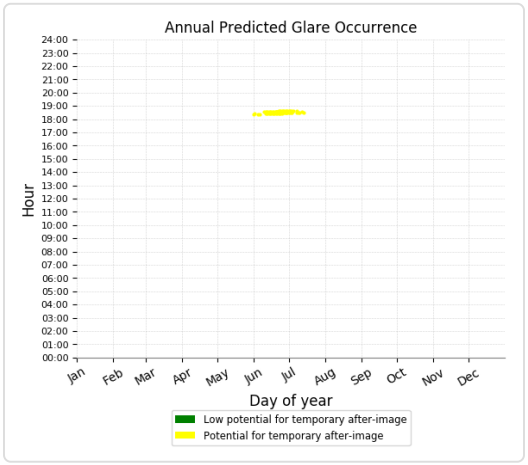
PV array 3 - OP Receptor (OP 7)

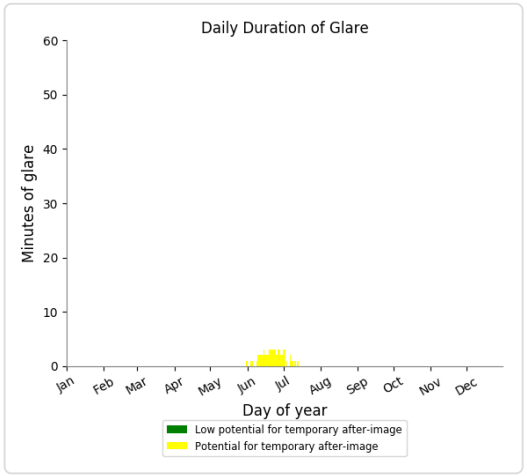
No glare found

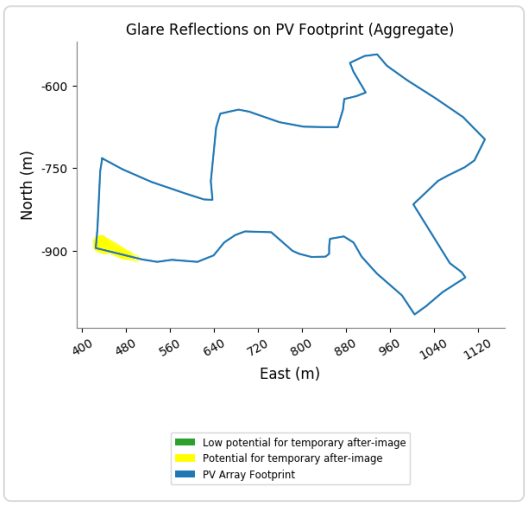
PV array 3 - OP Receptor (OP 8)

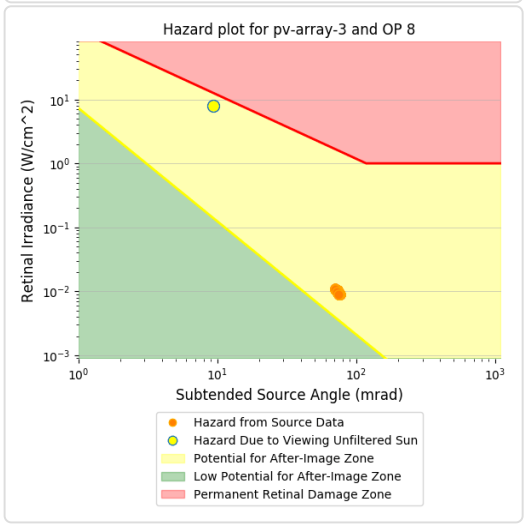
PV array is expected to produce the following glare for receptors at this location:

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





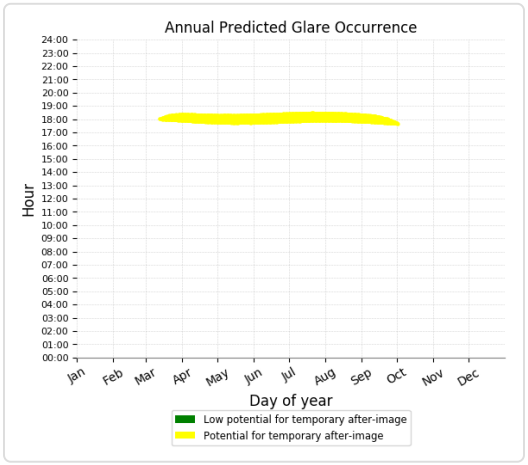


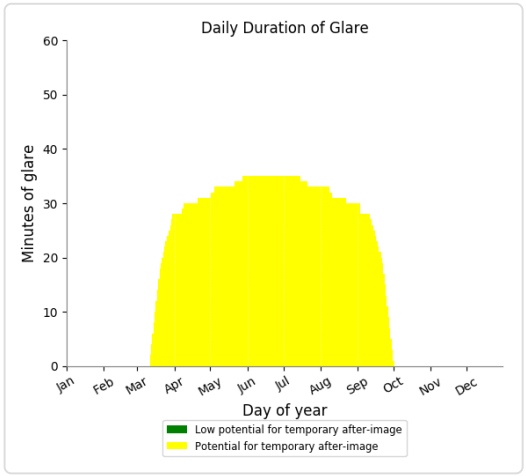


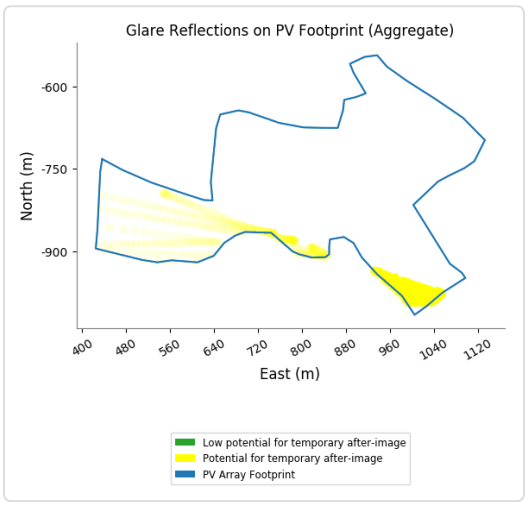
PV array 3 - OP Receptor (OP 9)

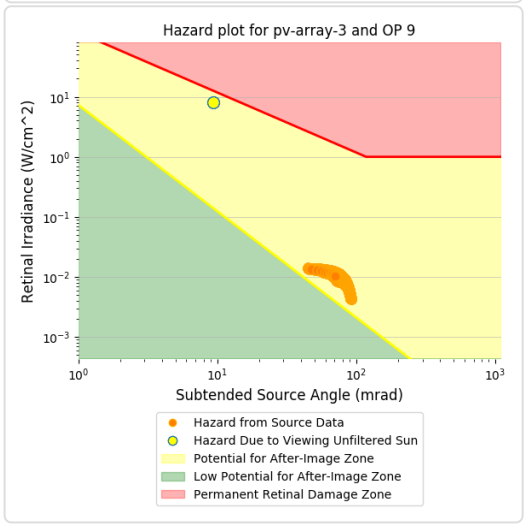
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 6,004 minutes of "yellow" glare with potential to cause temporary after-image.





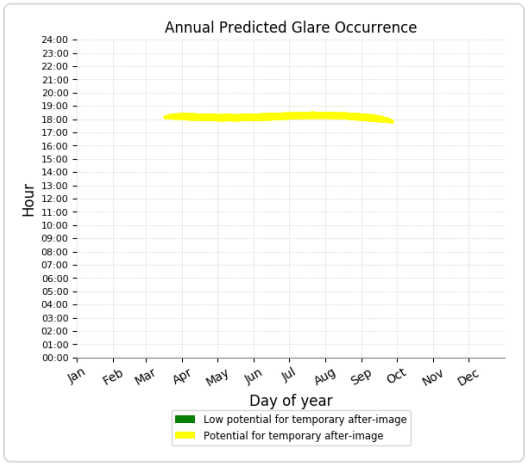


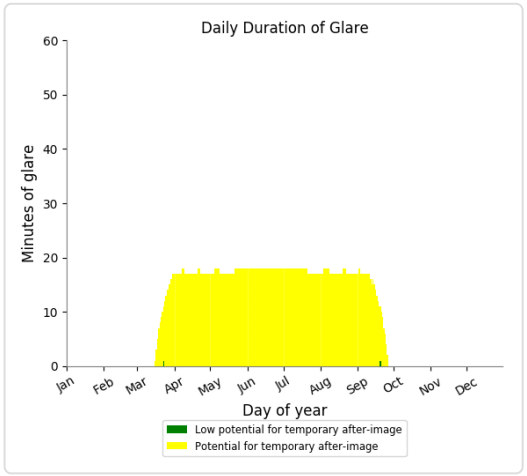


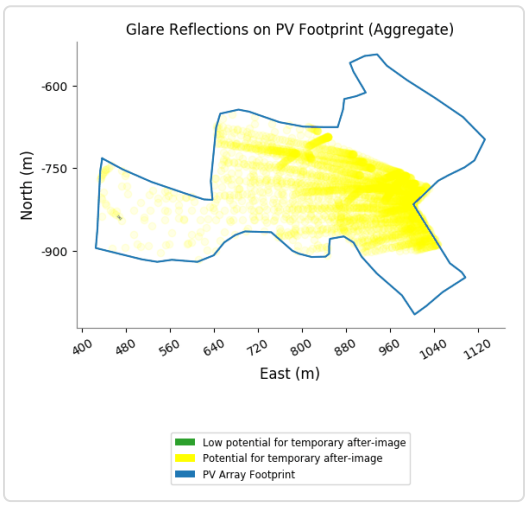
PV array 3 - OP Receptor (OP 10)

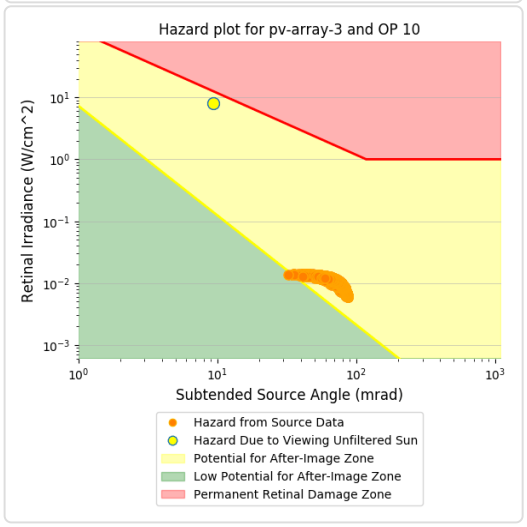
PV array is expected to produce the following glare for receptors at this location:

- 2 minutes of "green" glare with low potential to cause temporary after-image.
- 3,197 minutes of "yellow" glare with potential to cause temporary after-image.





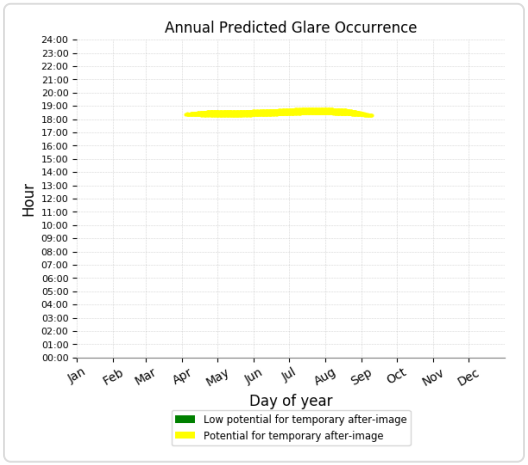


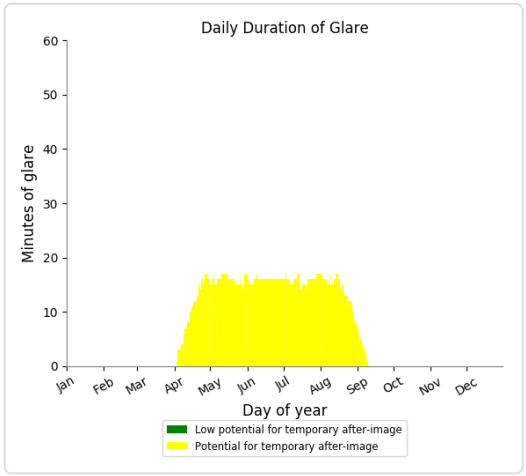


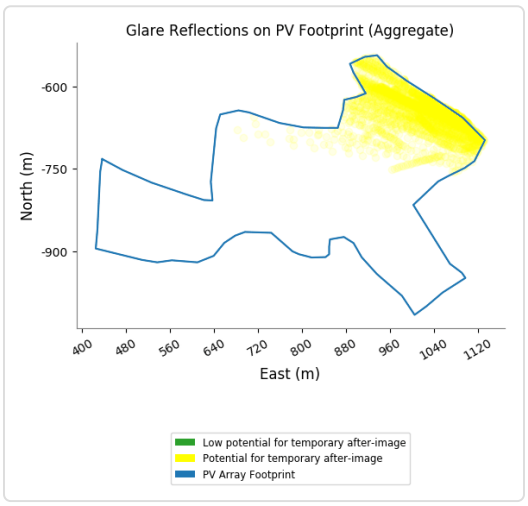
PV array 3 - OP Receptor (OP 11)

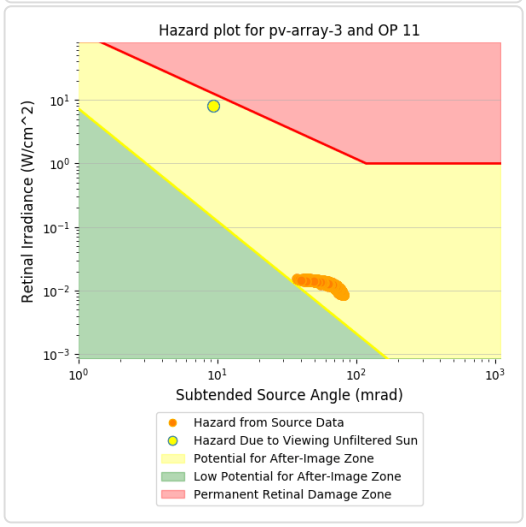
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,217 minutes of "yellow" glare with potential to cause temporary after-image.





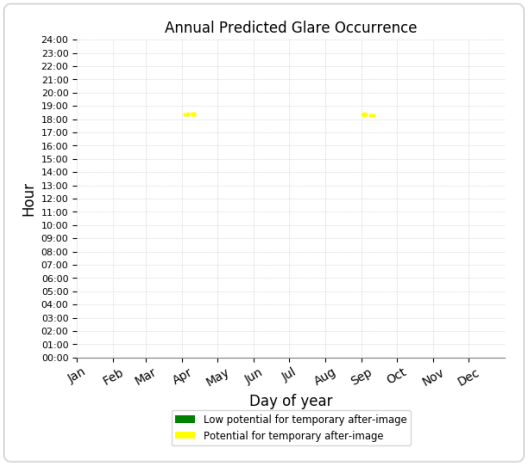


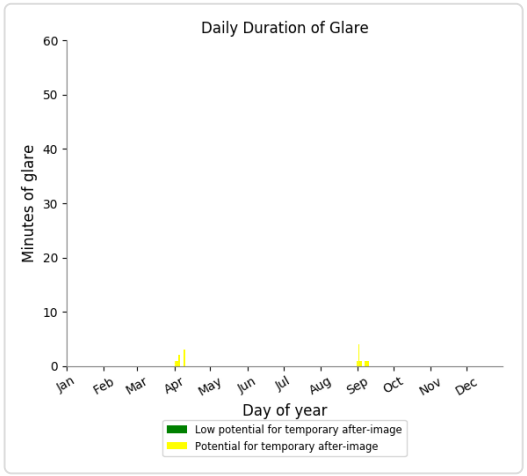


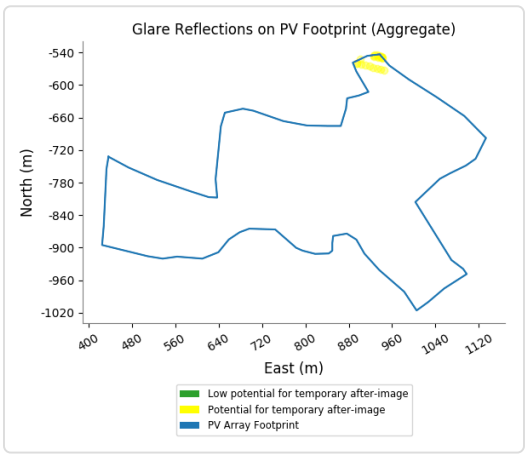
PV array 3 - OP Receptor (OP 12)

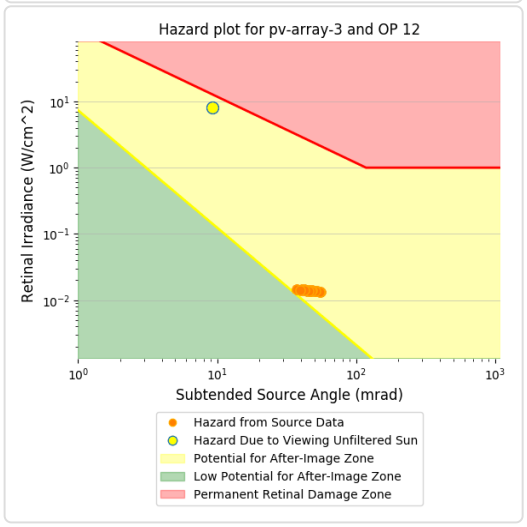
PV array is expected to produce the following glare for receptors at this location:

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









PV array 3 - OP Receptor (OP 13)

No glare found

PV array 3 - OP Receptor (OP 14)

No glare found

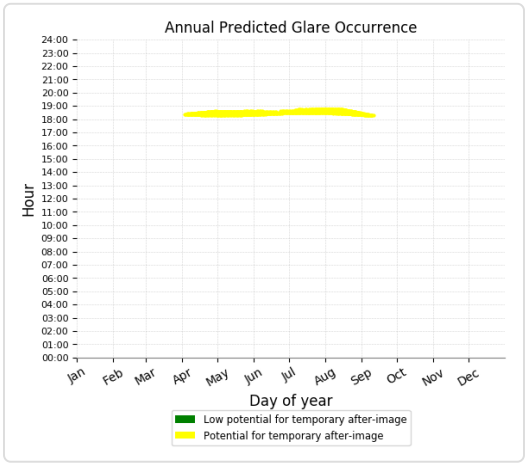
PV array 3 - OP Receptor (OP 15)

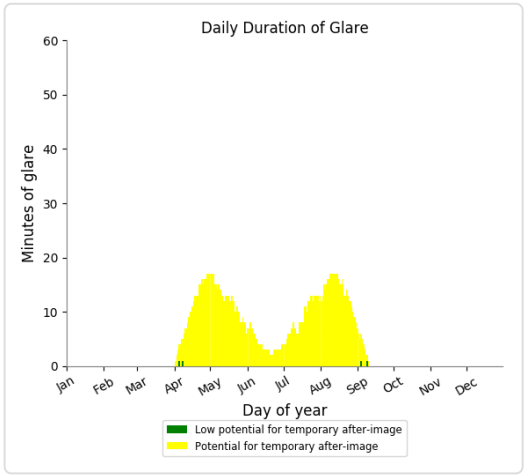
No glare found

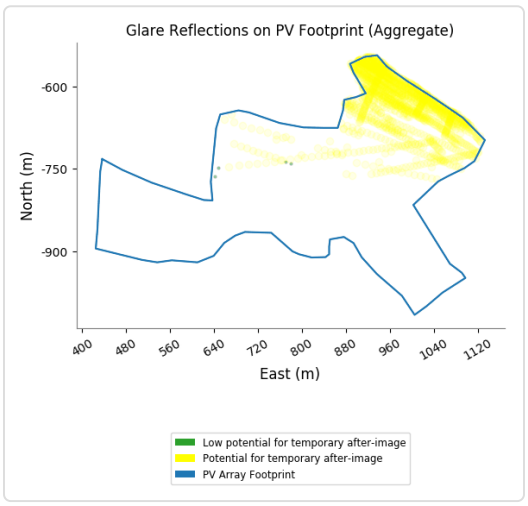
PV array 3 - OP Receptor (OP 16)

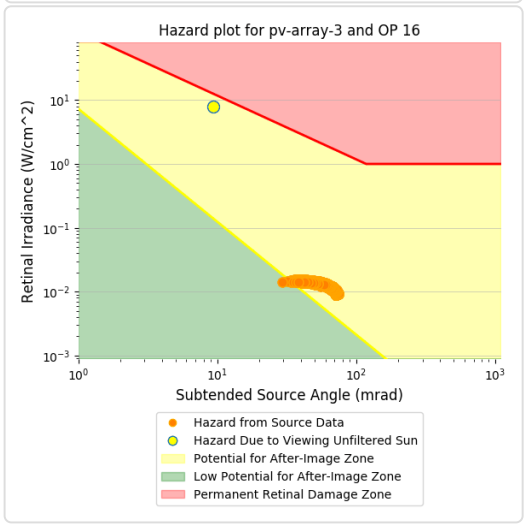
PV array is expected to produce the following glare for receptors at this location:

- 4 minutes of "green" glare with low potential to cause temporary after-image.
- 1,551 minutes of "yellow" glare with potential to cause temporary after-image.





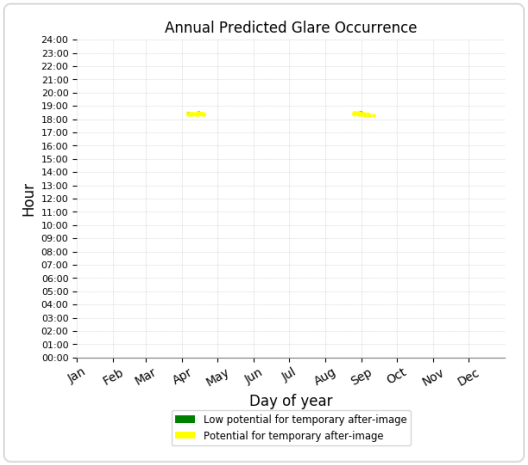


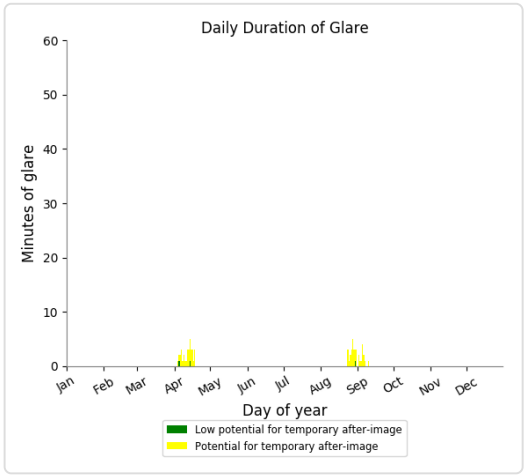


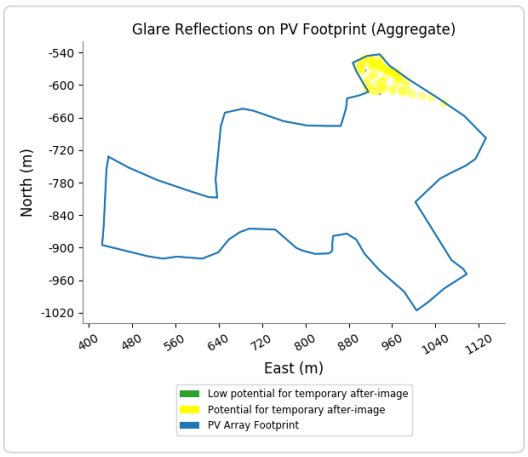
PV array 3 - OP Receptor (OP 17)

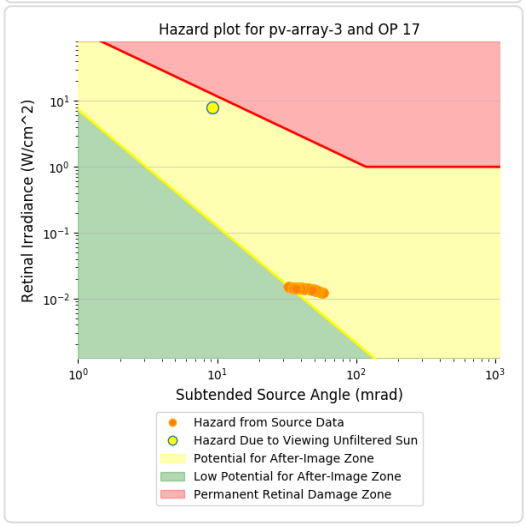
PV array is expected to produce the following glare for receptors at this location:

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









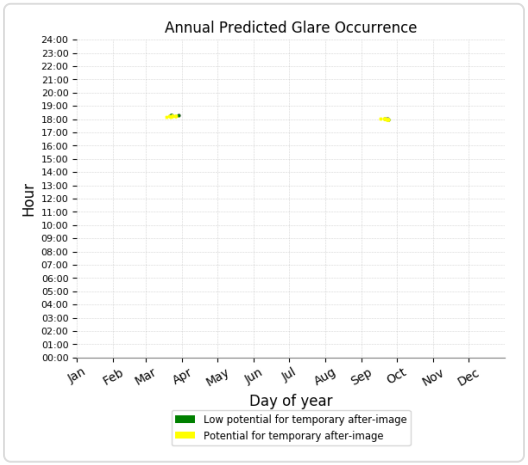
PV array 3 - OP Receptor (OP 18)

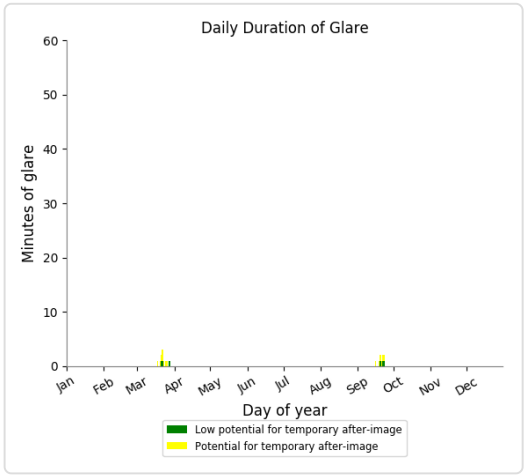
No glare found

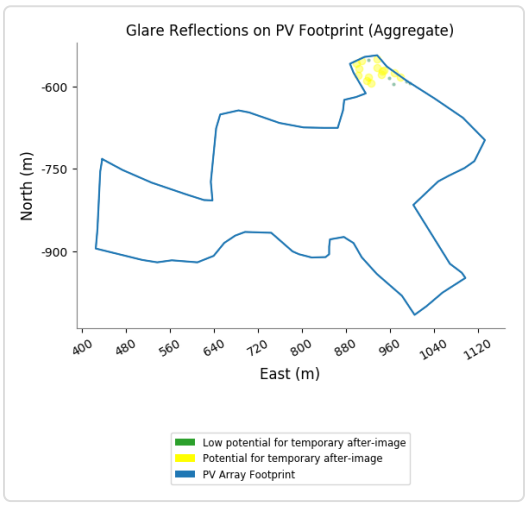
PV array 3 - OP Receptor (OP 19)

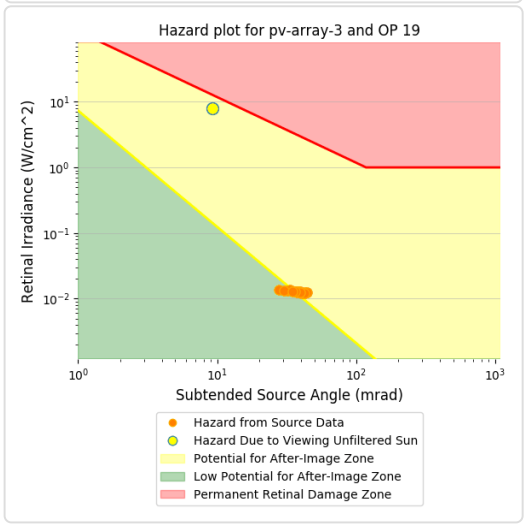
PV array is expected to produce the following glare for receptors at this location:

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





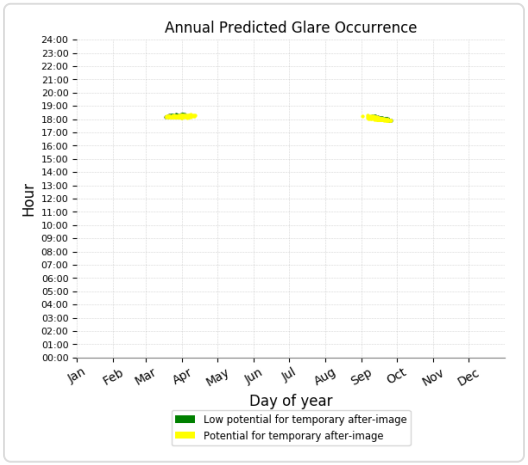


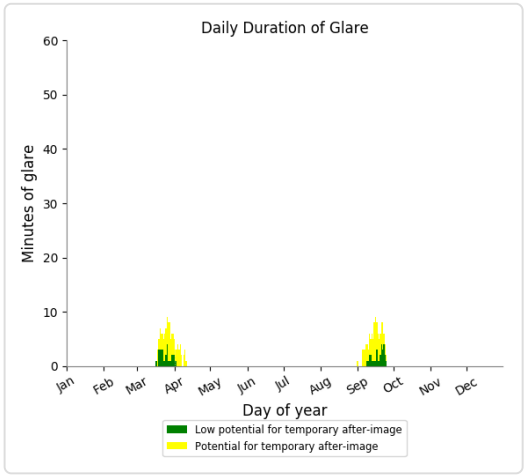


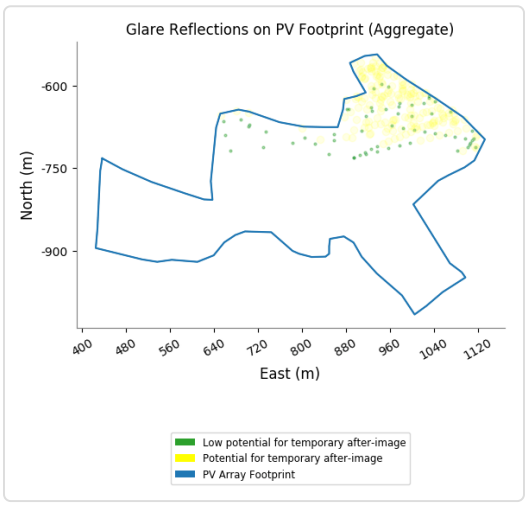
PV array 3 - OP Receptor (OP 20)

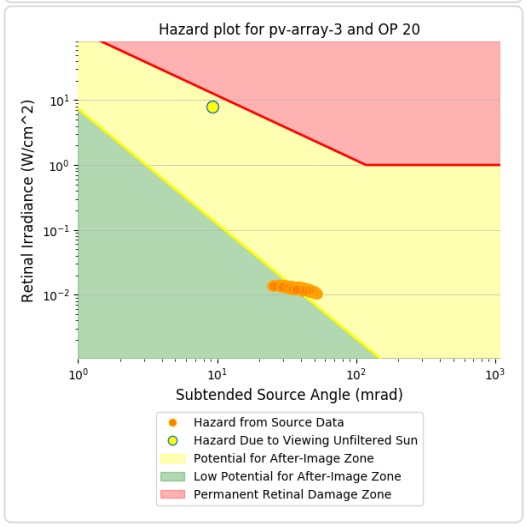
PV array is expected to produce the following glare for receptors at this location:

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





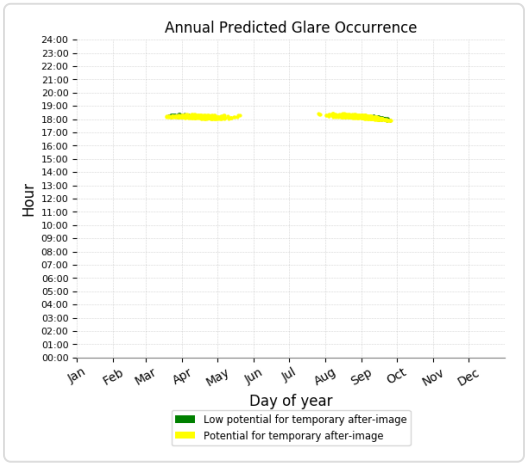


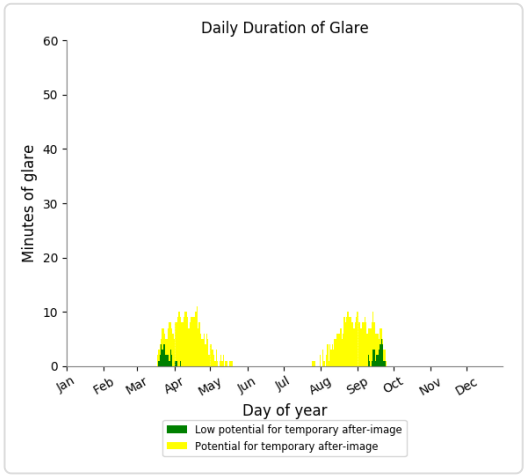


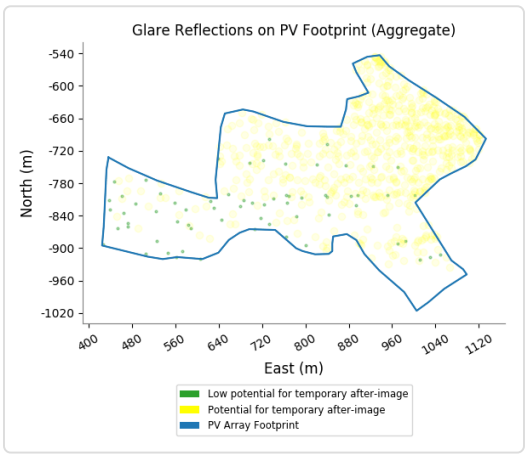
PV array 3 - OP Receptor (OP 21)

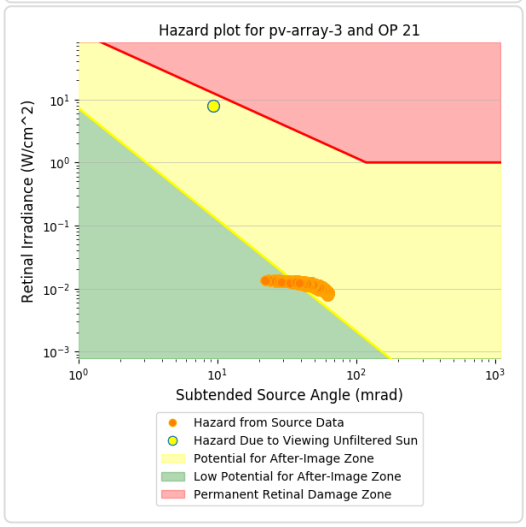
PV array is expected to produce the following glare for receptors at this location:

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





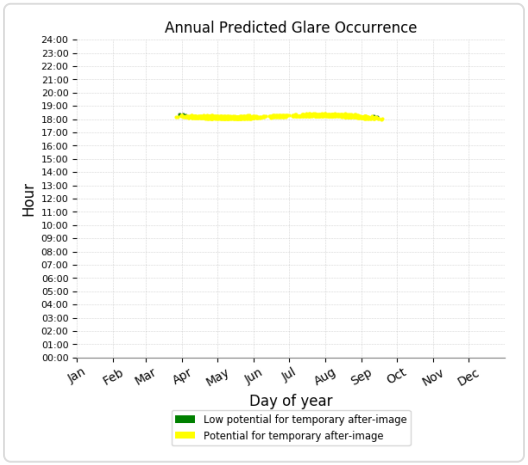


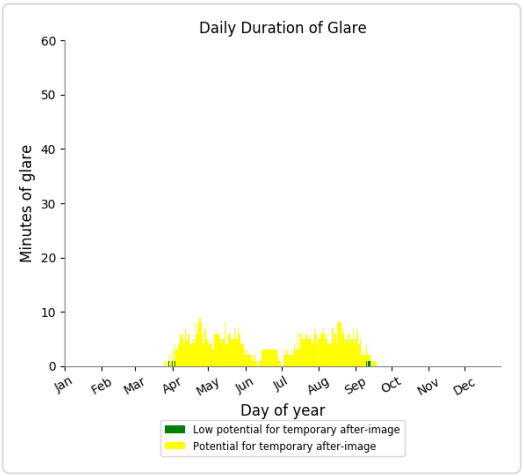


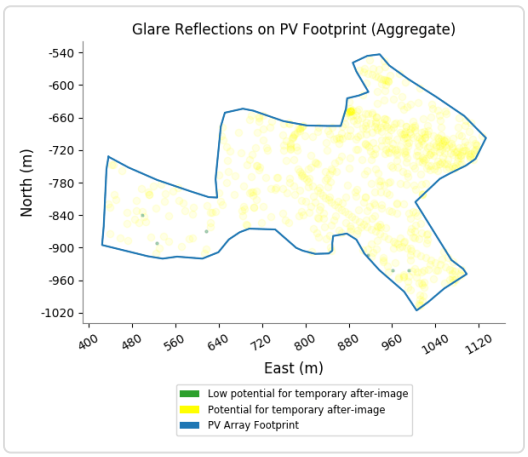
PV array 3 - OP Receptor (OP 22)

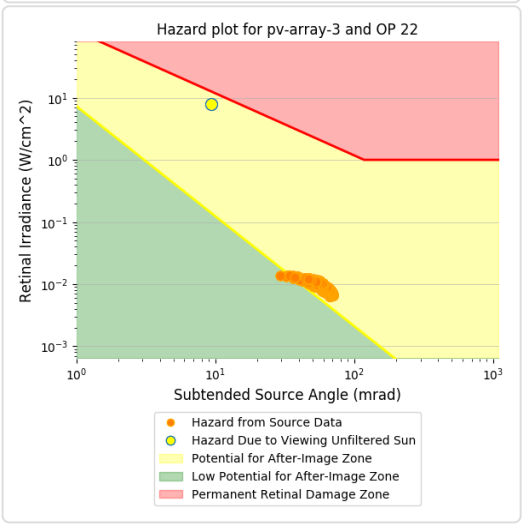
PV array is expected to produce the following glare for receptors at this location:

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





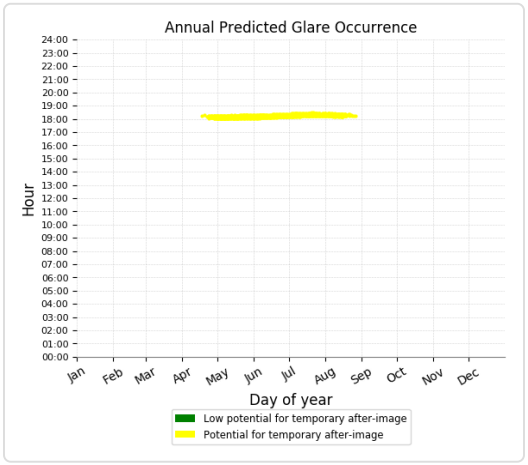


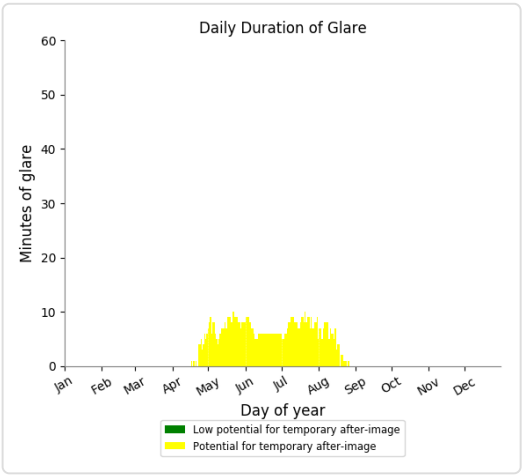


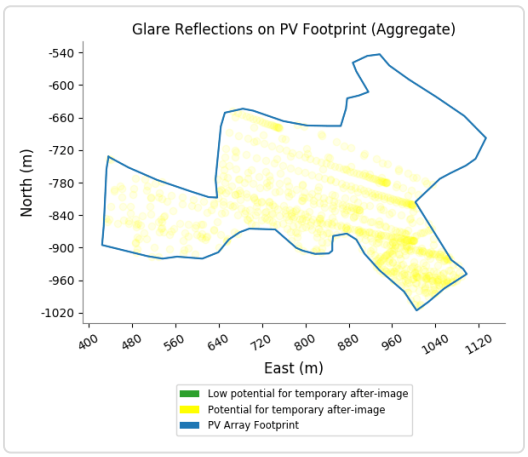
PV array 3 - OP Receptor (OP 23)

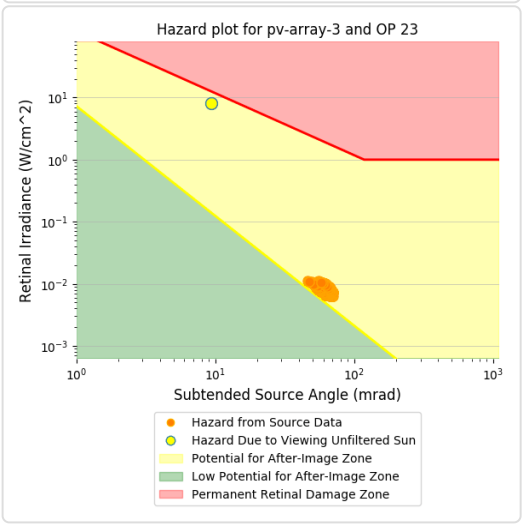
PV array is expected to produce the following glare for receptors at this location:

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





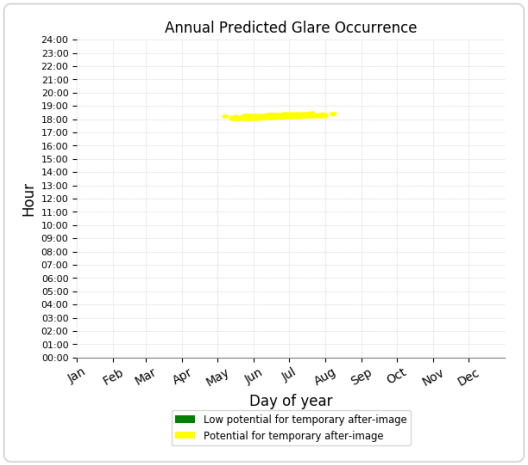


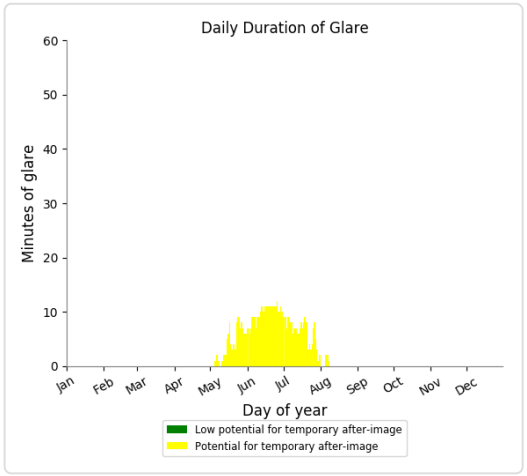


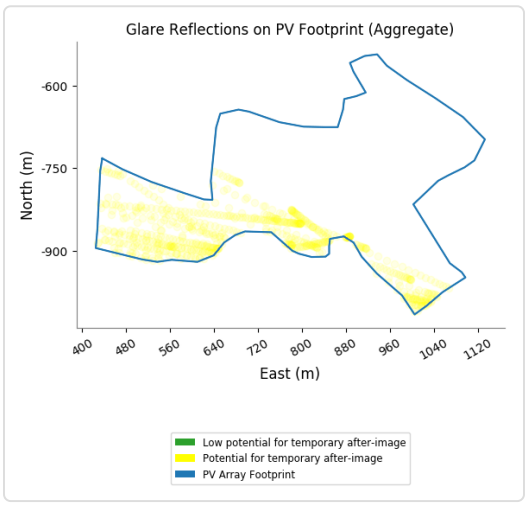
PV array 3 - OP Receptor (OP 24)

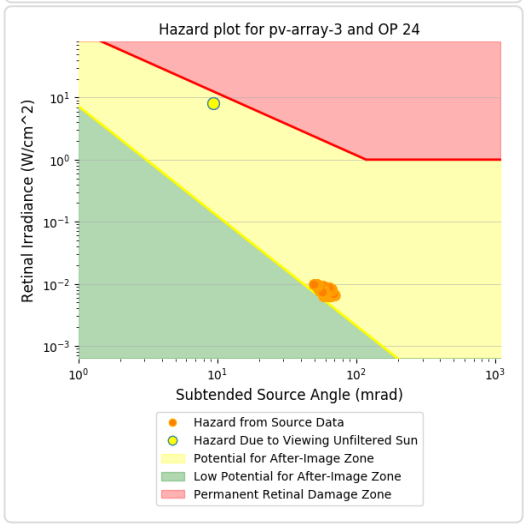
PV array is expected to produce the following glare for receptors at this location:

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





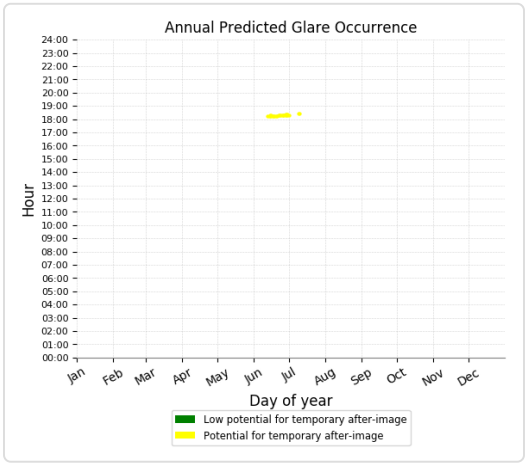


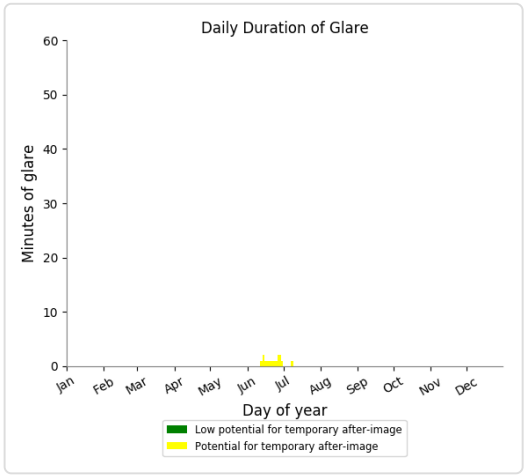


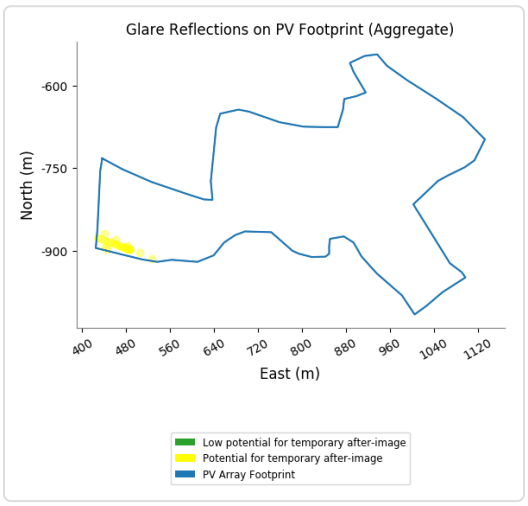
PV array 3 - OP Receptor (OP 25)

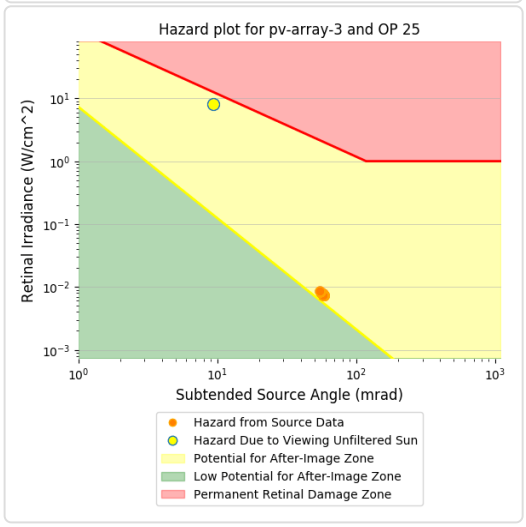
PV array is expected to produce the following glare for receptors at this location:

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









PV array 3 - OP Receptor (OP 26)

No glare found

PV array 3 - OP Receptor (OP 27)

No glare found

PV array 3 - OP Receptor (OP 28)

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results fo large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

Appendix 7D: Aviation Receptor Glare Results

ForgeSolar

Penpergwm

Penpergwm Aviation

Created April 20, 2021
Updated April 20, 2021
Time-step 1 minute
Timezone offset UTC0
Site ID 52702.9145

Project type V1
Project status: active

Misc. Analysis Settings

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

Analysis Methodologies:

- Observation point: **Version 1**
- 2-Mile Flight Path: **Version 1**
- Route: **Version 1**

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	25.0	180.0	0	0	-
PV array 2	25.0	180.0	0	0	-
PV array 3	25.0	180.0	0	0	-

Component Data

PV Array(s)

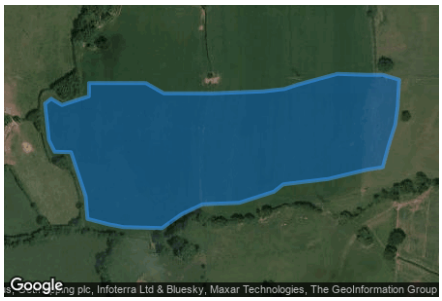
Total PV footprint area: 353,260 m^2

Note: PV array encompasses a large surface area (greater than 25 acres). Accuracy of path receptor glare analysis may be affected by footprint size. Additional analyses of array sub-sections may provide more information on expected glare.

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 115,625 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.800092	-2.974531	116.92	2.80	119.72
2	51.799641	-2.975089	125.04	2.80	127.84
3	51.798752	-2.972643	111.83	2.80	114.63
4	51.798407	-2.972986	116.43	2.80	119.23
5	51.799296	-2.975518	129.09	2.80	131.89
6	51.798739	-2.975904	133.96	2.80	136.76
7	51.797611	-2.972514	116.57	2.80	119.37
8	51.797703	-2.972278	114.81	2.80	117.61
9	51.797664	-2.971999	113.64	2.80	116.44
10	51.797412	-2.971935	115.68	2.80	118.48
11	51.797451	-2.970647	110.29	2.80	113.09
12	51.797478	-2.969166	105.87	2.80	108.67
13	51.797637	-2.968415	103.57	2.80	106.37
14	51.797637	-2.967021	96.08	2.80	98.88
15	51.797611	-2.966441	92.02	2.80	94.82
16	51.797650	-2.965798	86.45	2.80	89.25
17	51.797743	-2.965562	84.26	2.80	87.06
18	51.797969	-2.965411	82.86	2.80	85.66
19	51.798301	-2.965347	81.62	2.80	84.42
20	51.798702	-2.965454	80.78	2.80	83.58
21	51.798760	-2.965548	81.02	2.80	83.82
22	51.798818	-2.965862	81.94	2.80	84.74
23	51.798898	-2.966205	83.36	2.80	86.16
24	51.798898	-2.966785	85.57	2.80	88.37
25	51.798911	-2.967171	86.22	2.80	89.02
26	51.798924	-2.968158	89.05	2.80	91.85
27	51.799150	-2.968823	91.61	2.80	94.41
28	51.799256	-2.969467	92.98	2.80	95.78
29	51.799336	-2.970154	95.84	2.80	98.64
30	51.799336	-2.970862	97.93	2.80	100.73
31	51.799495	-2.971570	100.24	2.80	103.04
32	51.799521	-2.972256	102.77	2.80	105.57
33	51.799734	-2.973201	107.62	2.80	110.42

Name: PV array 2
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 86,272 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad



Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.796026	-2.973854	130.26	2.80	133.06
2	51.796026	-2.975120	131.96	2.80	134.76
3	51.795847	-2.975120	129.27	2.80	132.07
4	51.795727	-2.975721	127.97	2.80	130.77
5	51.795813	-2.975957	129.62	2.80	132.42
6	51.795747	-2.976096	129.09	2.80	131.89
7	51.795249	-2.976011	121.67	2.80	124.47
8	51.795090	-2.975882	119.77	2.80	122.57
9	51.795083	-2.975517	119.27	2.80	122.07
10	51.794486	-2.975195	114.08	2.80	116.88
11	51.794174	-2.975152	111.31	2.80	114.11
12	51.794101	-2.974691	110.52	2.80	113.32
13	51.794062	-2.974348	109.93	2.80	112.73
14	51.794048	-2.973500	110.45	2.80	113.25
15	51.794234	-2.973071	112.11	2.80	114.91
16	51.794373	-2.972599	113.92	2.80	116.72
17	51.794393	-2.971783	115.80	2.80	118.60
18	51.794546	-2.971011	117.25	2.80	120.05
19	51.794645	-2.970807	117.74	2.80	120.54
20	51.794718	-2.969809	116.53	2.80	119.33
21	51.794845	-2.968951	115.50	2.80	118.30
22	51.794878	-2.968597	113.92	2.80	116.72
23	51.795170	-2.968468	117.81	2.80	120.61
24	51.795462	-2.968318	120.46	2.80	123.26
25	51.795714	-2.968264	121.97	2.80	124.77
26	51.796072	-2.968232	123.02	2.80	125.82
27	51.796138	-2.968597	124.11	2.80	126.91
28	51.796138	-2.968930	123.64	2.80	126.44
29	51.796152	-2.969605	123.47	2.80	126.27
30	51.796006	-2.970485	125.00	2.80	127.80
31	51.795946	-2.970775	125.17	2.80	127.97
32	51.795913	-2.971258	125.60	2.80	128.40
33	51.795886	-2.972384	126.12	2.80	128.92
34	51.795886	-2.973457	128.50	2.80	131.30

Note: PV array encompasses a large surface area (greater than 25 acres). Accuracy of path receptor glare analysis may be affected by footprint size. Additional analyses of array sub-sections may provide more information on expected glare.

Name: PV array 3
Axis tracking: Fixed (no rotation)
Tilt: 25.0 deg
Orientation: 180.0 deg
Footprint area: 151,362 m^2
Rated power: -
Panel material: Light textured glass with AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 9.16 mrad

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	51.793511	-2.968200	83.07	2.80	85.87
2	51.793332	-2.967664	78.70	2.80	81.50
3	51.793126	-2.966902	73.34	2.80	76.14
4	51.792933	-2.965990	69.15	2.80	71.95
5	51.792841	-2.965518	67.66	2.80	70.46
6	51.792834	-2.965292	66.38	2.80	69.18
7	51.793139	-2.965335	68.32	2.80	71.12
8	51.794015	-2.965196	76.58	2.80	79.38
9	51.794241	-2.965089	78.56	2.80	81.36
10	51.794307	-2.964606	76.84	2.80	79.64
11	51.794274	-2.964327	75.07	2.80	77.87
12	51.794101	-2.963522	71.25	2.80	74.05
13	51.794028	-2.962889	69.41	2.80	72.21
14	51.794022	-2.962342	68.42	2.80	71.22
15	51.794022	-2.961988	69.13	2.80	71.93
16	51.794307	-2.961849	69.43	2.80	72.23
17	51.794480	-2.961816	70.15	2.80	72.95
18	51.794526	-2.961505	69.34	2.80	72.14
19	51.794586	-2.961248	69.38	2.80	72.18
20	51.794924	-2.961570	69.81	2.80	72.61
21	51.795070	-2.961666	70.06	2.80	72.86
22	51.795183	-2.961280	69.22	2.80	72.02
23	51.795209	-2.960947	69.06	2.80	71.86
24	51.795024	-2.960690	68.80	2.80	71.60
25	51.794791	-2.960164	66.76	2.80	69.56
26	51.794499	-2.959424	65.26	2.80	68.06
27	51.794188	-2.958684	63.12	2.80	65.92
28	51.793823	-2.958104	61.50	2.80	64.30
29	51.793478	-2.958383	61.09	2.80	63.89
30	51.793365	-2.958641	61.23	2.80	64.03
31	51.793239	-2.959059	61.45	2.80	64.25
32	51.793146	-2.959338	61.68	2.80	64.48
33	51.792761	-2.959992	61.74	2.80	64.54
34	51.791799	-2.959027	65.96	2.80	68.76
35	51.791653	-2.958716	67.66	2.80	70.46
36	51.791566	-2.958619	68.29	2.80	71.09
37	51.791328	-2.959220	67.32	2.80	70.12
38	51.791102	-2.959649	66.46	2.80	69.26
39	51.790963	-2.959960	65.68	2.80	68.48
40	51.791274	-2.960293	64.72	2.80	67.52
41	51.791633	-2.960958	63.32	2.80	66.12
42	51.791905	-2.961355	62.51	2.80	65.31
43	51.792137	-2.961570	61.86	2.80	64.66
44	51.792237	-2.961827	61.80	2.80	64.60
45	51.792197	-2.962192	62.04	2.80	64.84
46	51.792080	-2.962213	61.68	2.80	64.48
47	51.791954	-2.962213	61.82	2.80	64.62
48	51.791907	-2.962310	61.91	2.80	64.71
49	51.791901	-2.962675	62.06	2.80	64.86
50	51.791954	-2.963007	62.19	2.80	64.99
51	51.792000	-2.963179	62.17	2.80	64.97
52	51.792305	-2.963742	62.00	2.80	64.80
53	51.792319	-2.964434	62.90	2.80	65.70
54	51.792259	-2.964692	62.97	2.80	65.77
55	51.792139	-2.964981	63.56	2.80	66.36
56	51.791927	-2.965260	64.13	2.80	66.93

57	51.791821	-2.965689	65.22	2.80	68.02
58	51.791854	-2.966365	65.69	2.80	68.49
59	51.791821	-2.966752	66.96	2.80	69.76
60	51.791861	-2.967149	68.44	2.80	71.24
61	51.792046	-2.968372	72.73	2.80	75.53
62	51.792358	-2.968329	74.26	2.80	77.06
63	51.793308	-2.968254	81.43	2.80	84.23

2-Mile Flight Path Receptor(s)

Name: Runway 15
Description:
Threshold height : 15 m
Direction: 145.2 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	m	m	m
Threshold	51.796912	-2.996729	62.24	15.24	77.48
2-mile point	51.820653	-3.023442	48.99	197.18	246.17

Name: Runway 33
Description:
Threshold height : 15 m
Direction: 324.9 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	m	m	m
Threshold	51.792315	-2.991732	57.99	15.24	73.23
2-mile point	51.768660	-2.964821	75.37	166.54	241.91

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	25.0	180.0	0	0	-	-
PV array 2	25.0	180.0	0	0	-	-
PV array 3	25.0	180.0	0	0	-	-

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
FP: Runway 15	0	0
FP: Runway 33	0	0

No glare found

PV array 2 no glare found

Component	Green glare (min)	Yellow glare (min)
FP: Runway 15	0	0
FP: Runway 33	0	0

No glare found

PV array 3 no glare found

Component	Green glare (min)	Yellow glare (min)
FP: Runway 15	0	0
FP: Runway 33	0	0

No glare found

Assumptions

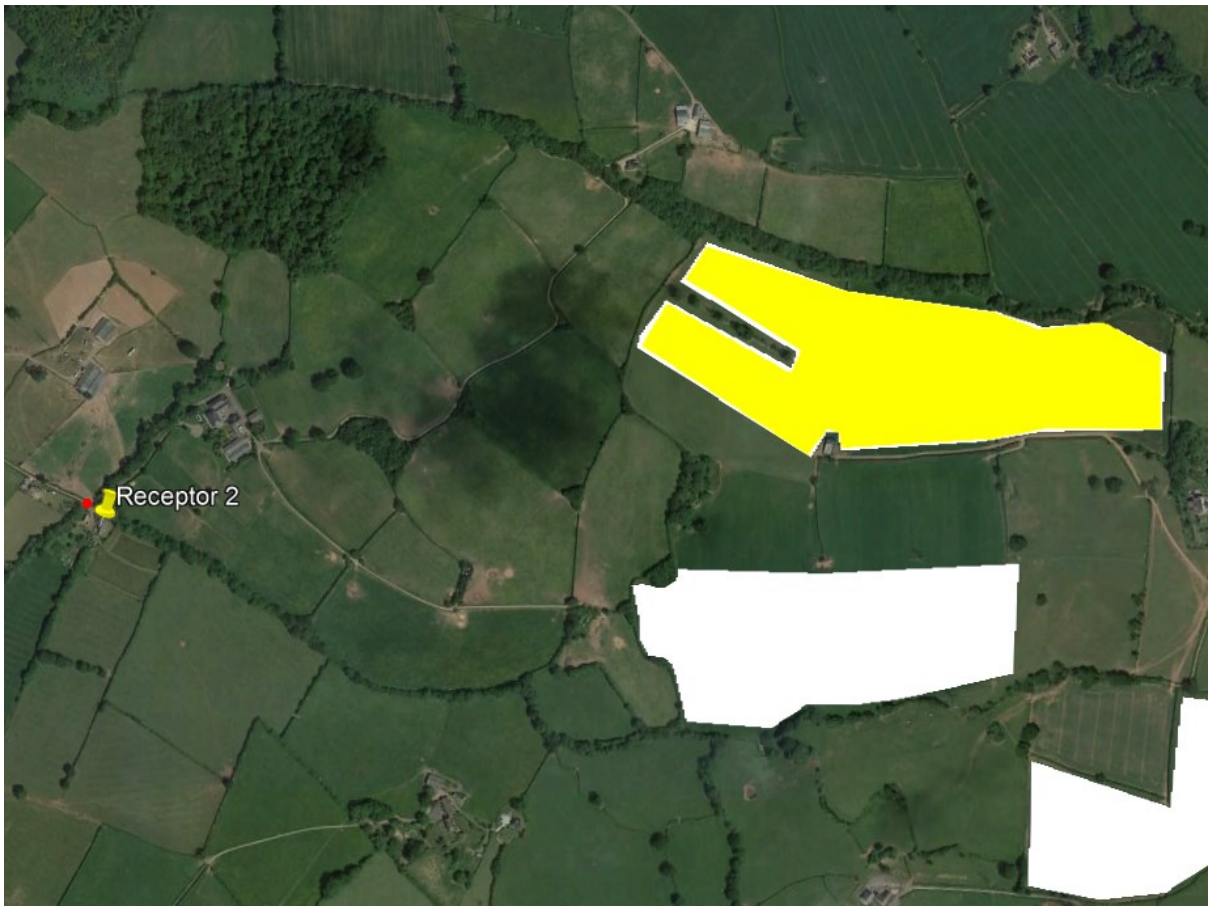
- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for larg PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, nc discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

Appendix 7E: Visibility Assessment Evidence

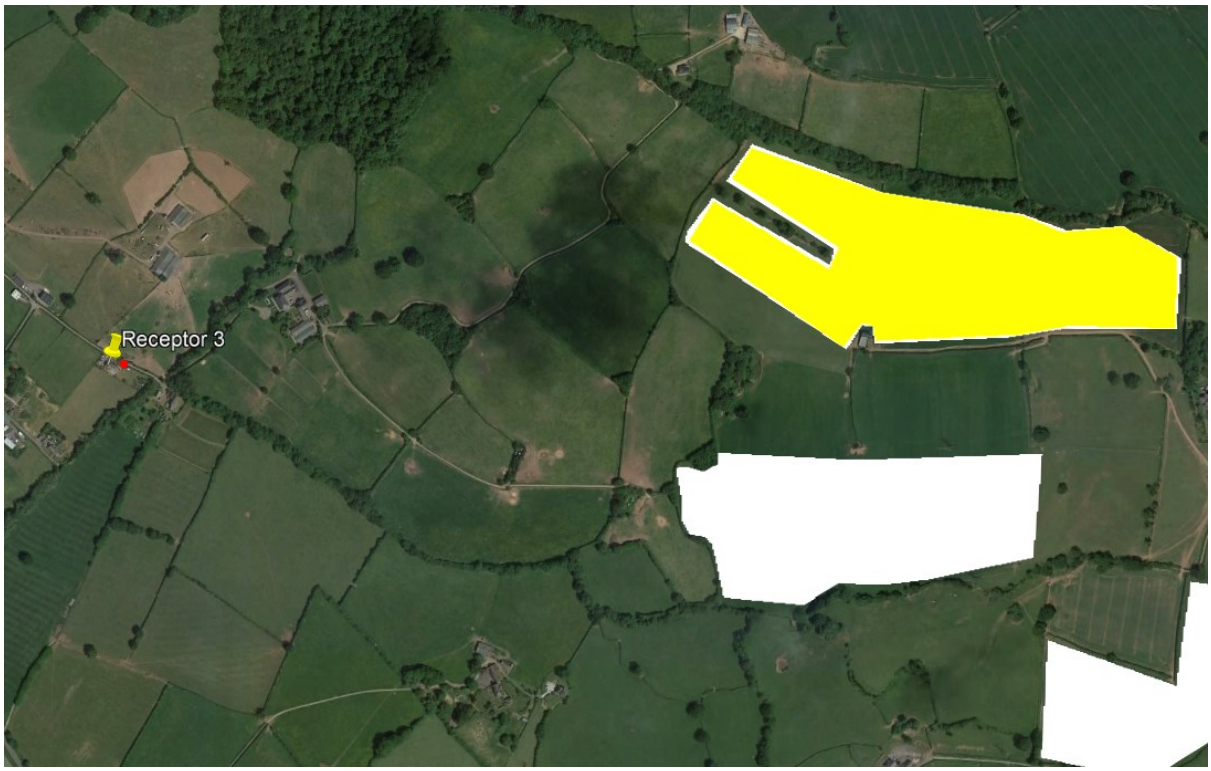
Residential Receptors

Receptor 1

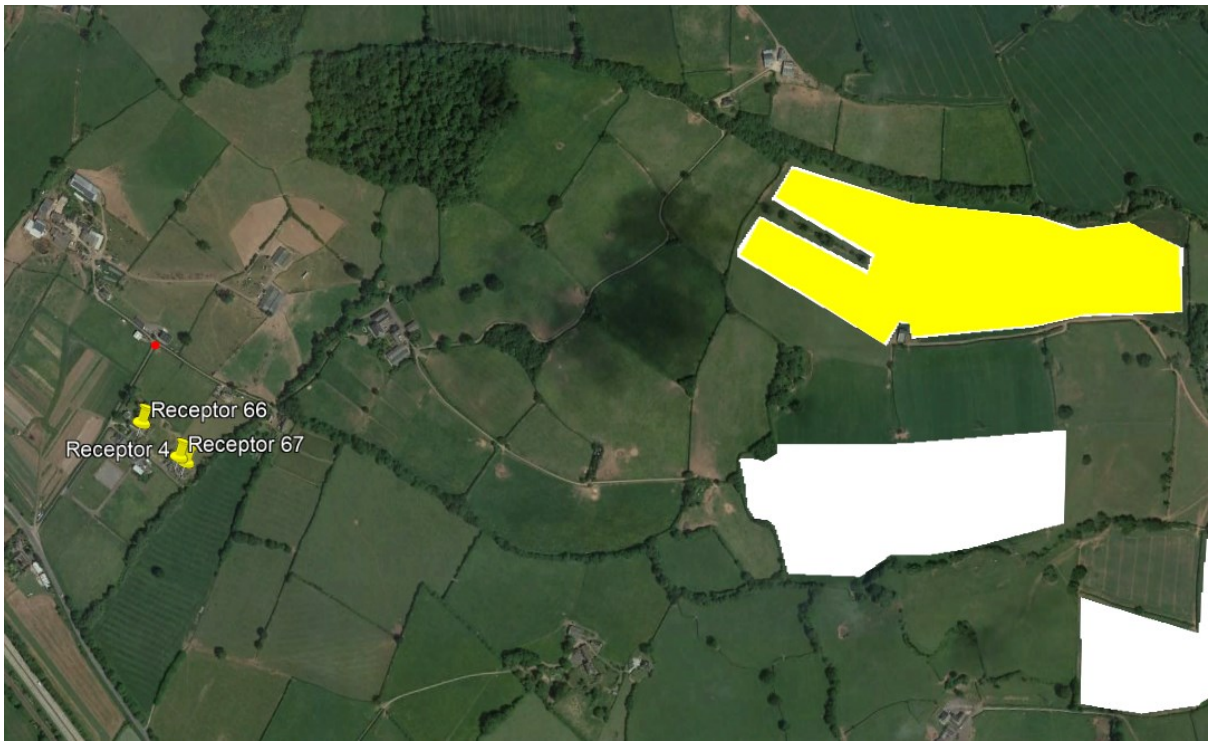
Receptor 2



Receptor 3



Receptor 4 (Including Receptors 66 and 67)

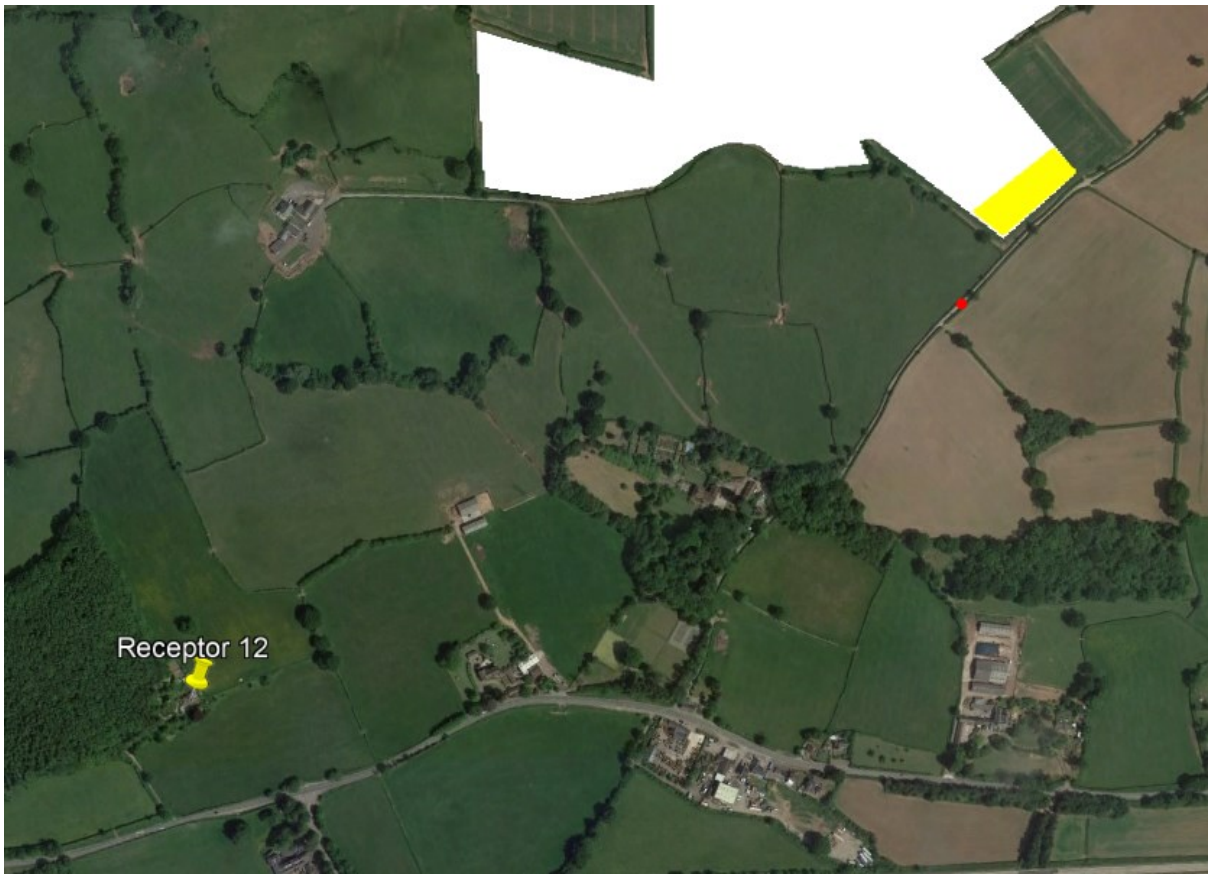


Receptors 5 - 7

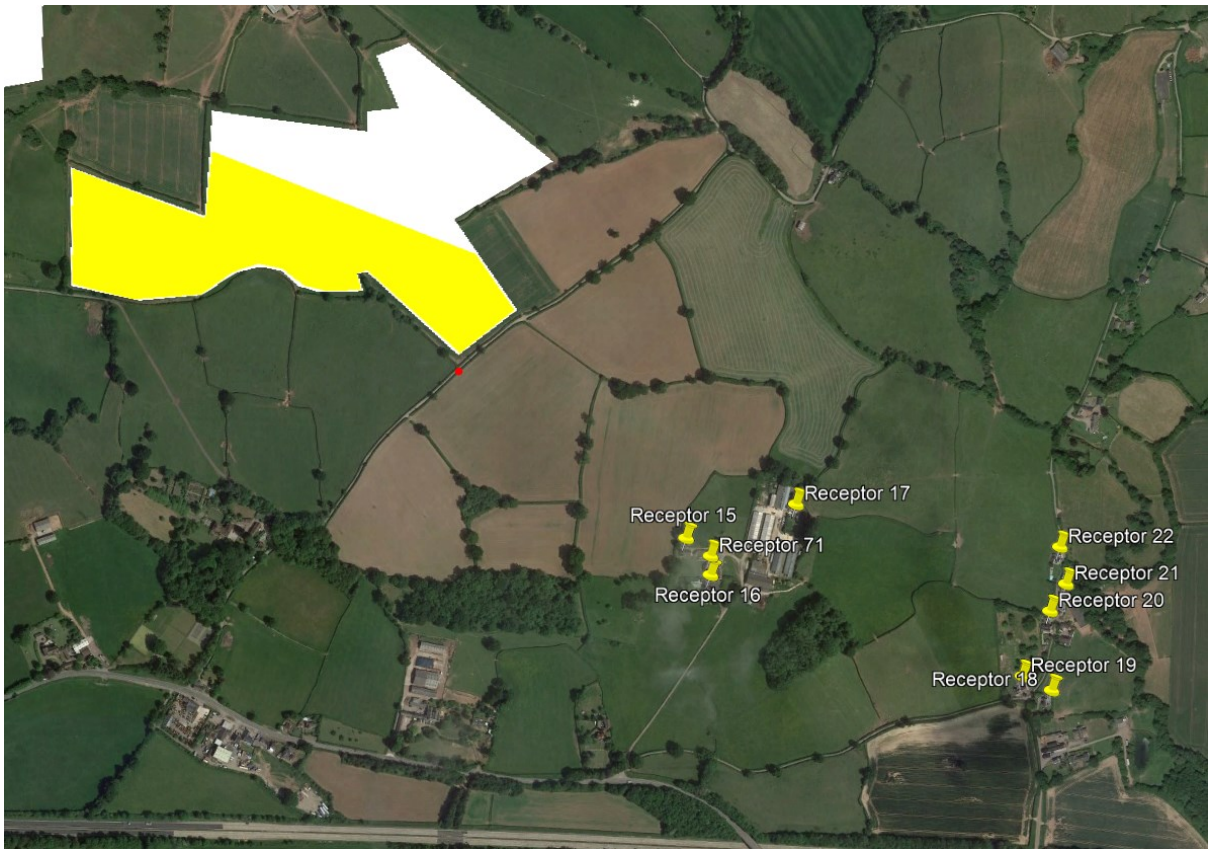
Receptors 8 - 9

Receptors 10 and 11 (Including Receptor 68)

Receptor 12

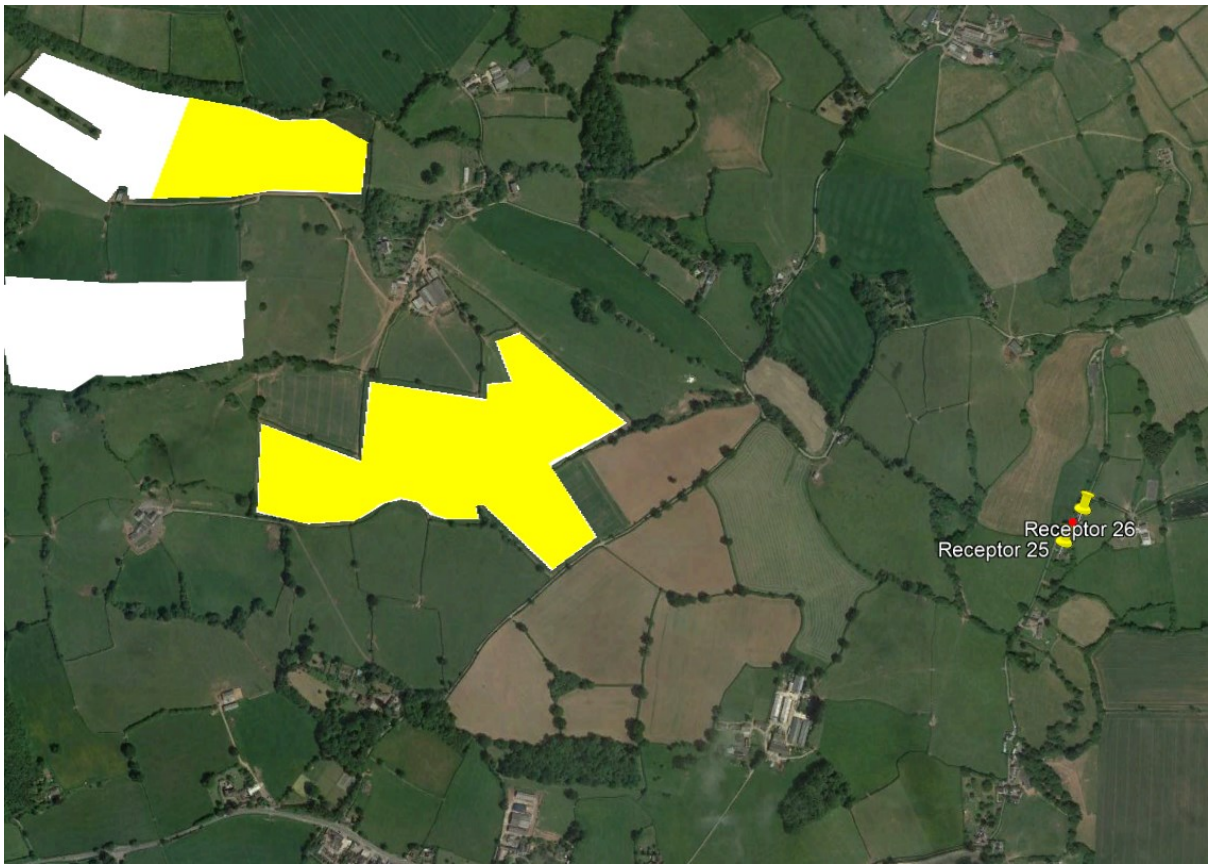


Receptors 15 – 22 (Including Receptor 71)



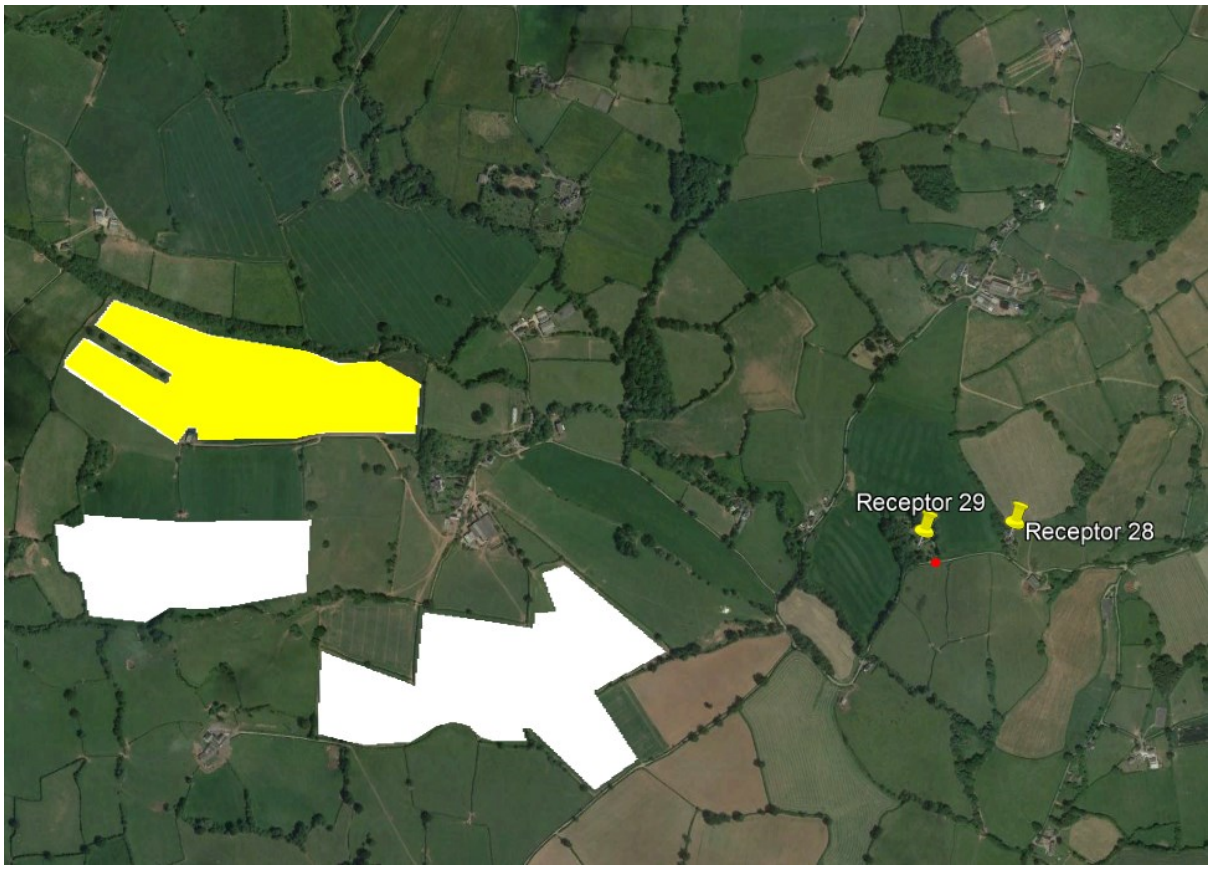
Receptors 23 and 24

Receptors 25 and 26

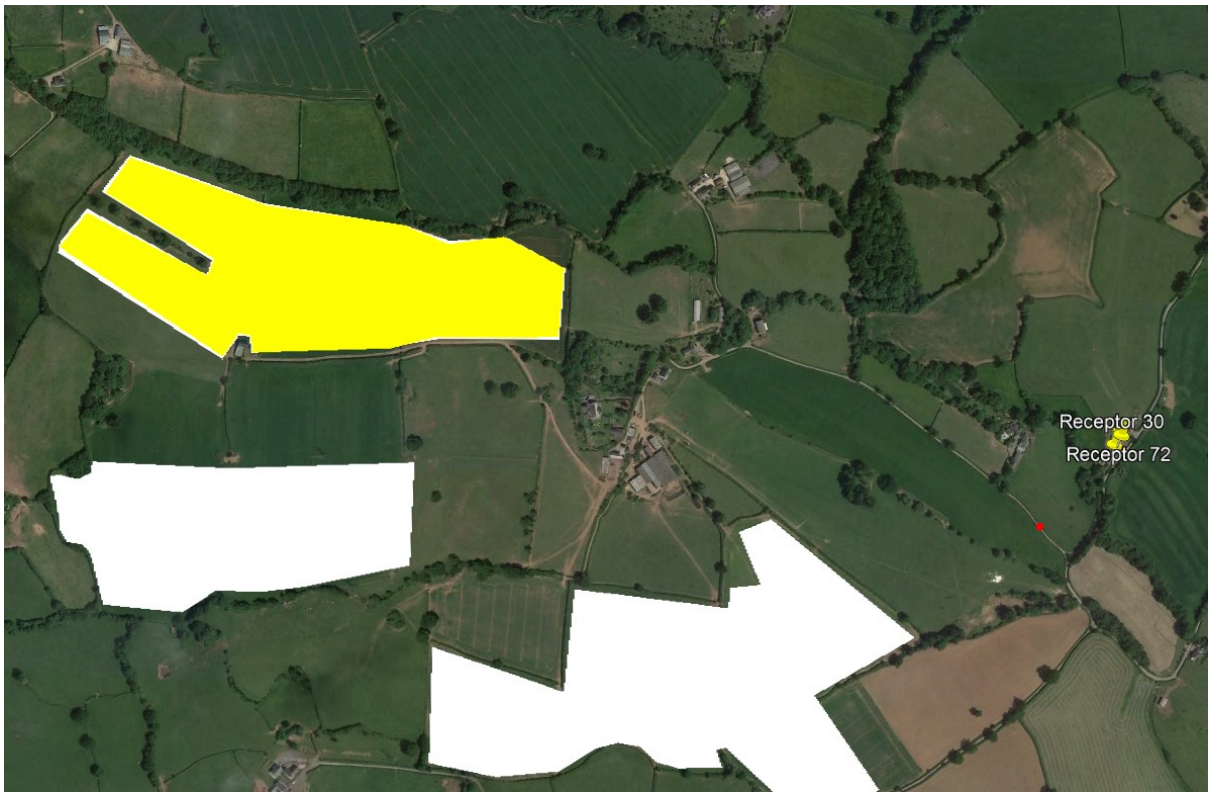


Receptor 27

Receptor 28 and 29

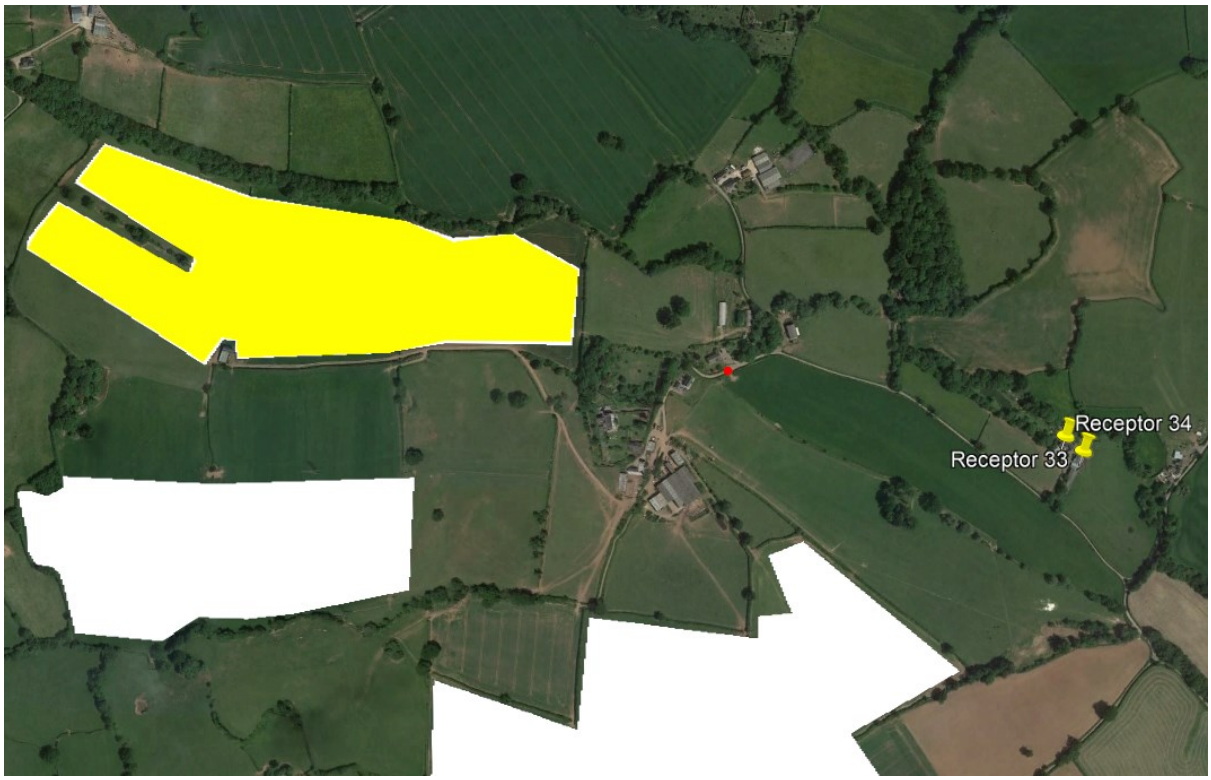


Receptor 30 (Including Receptor 72)



Receptor 31

Receptor 33 and 34



Receptor 35

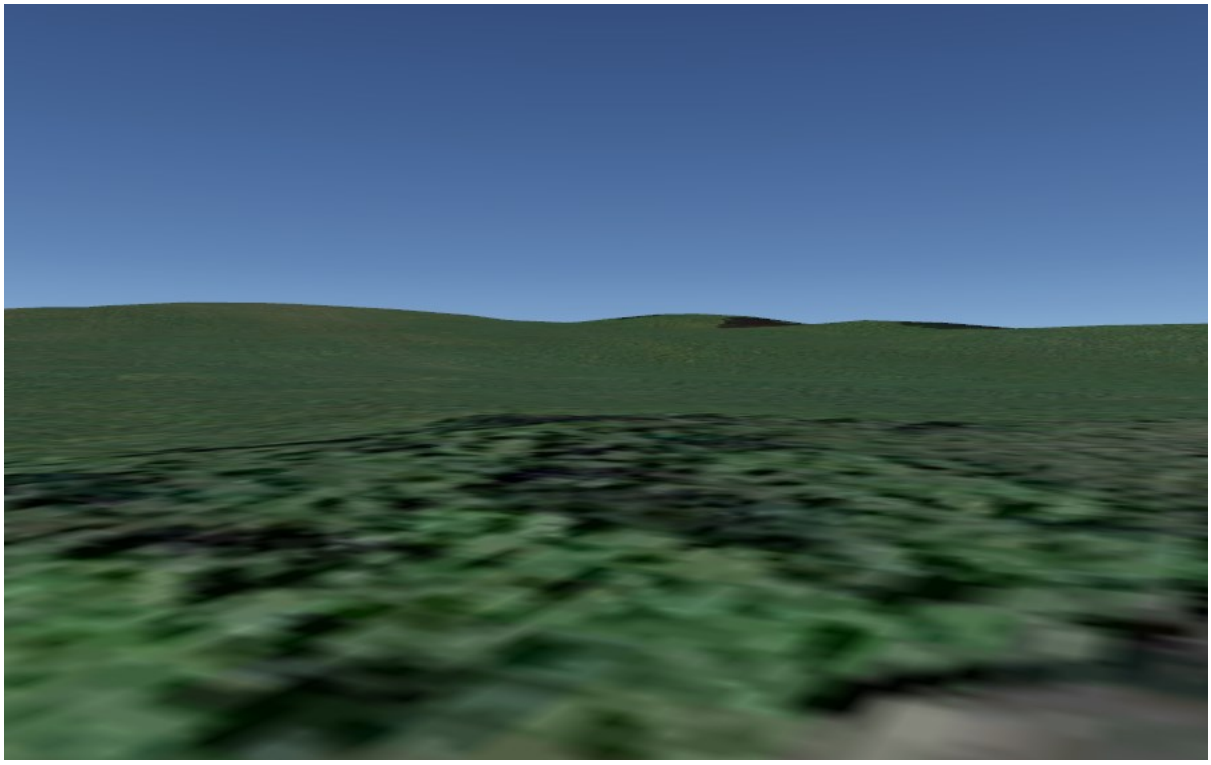
Receptor 36

Receptor 37

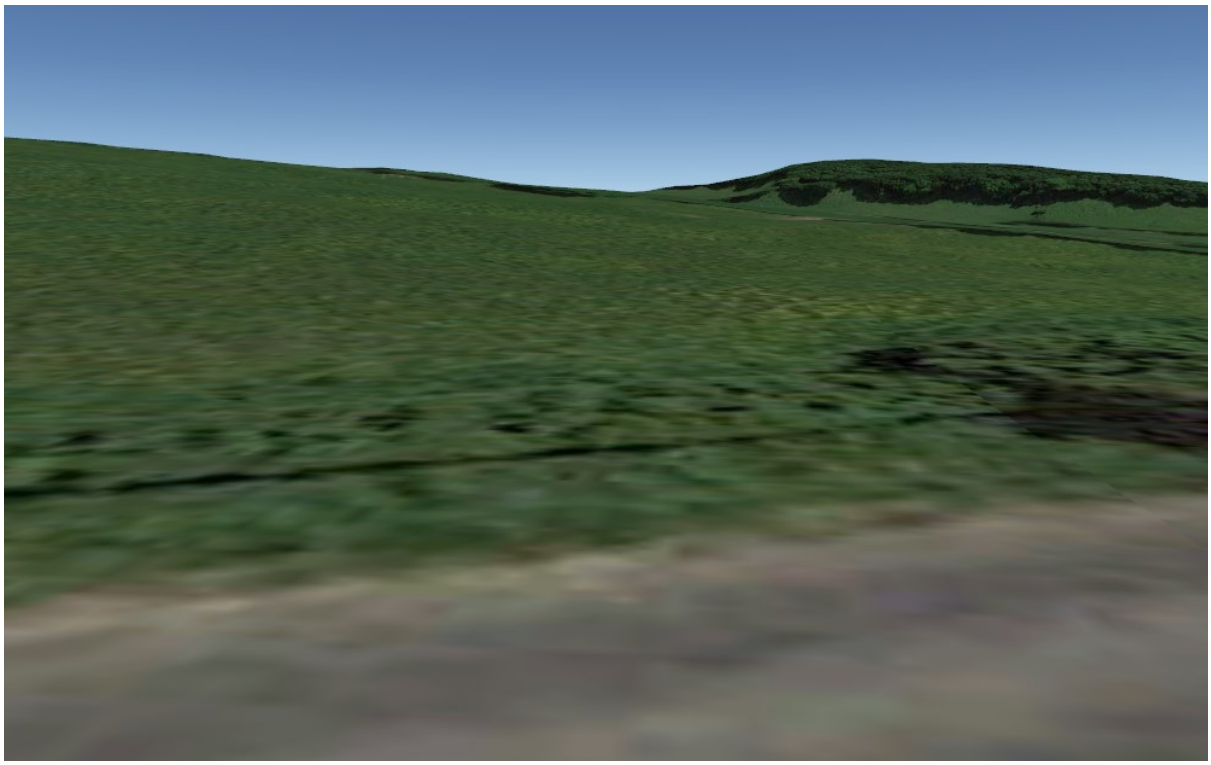
Receptor 38 (Including Receptor 73)

Road Receptors

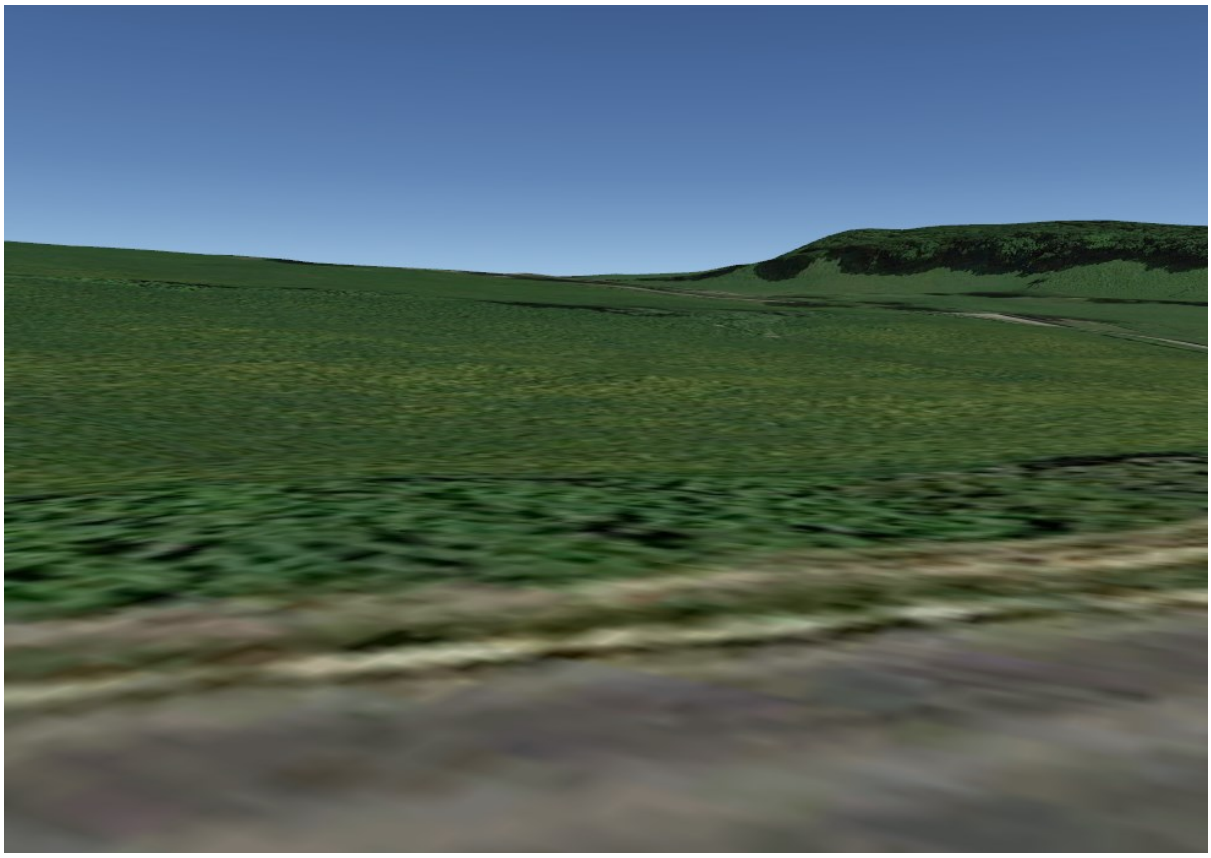
Receptor 1



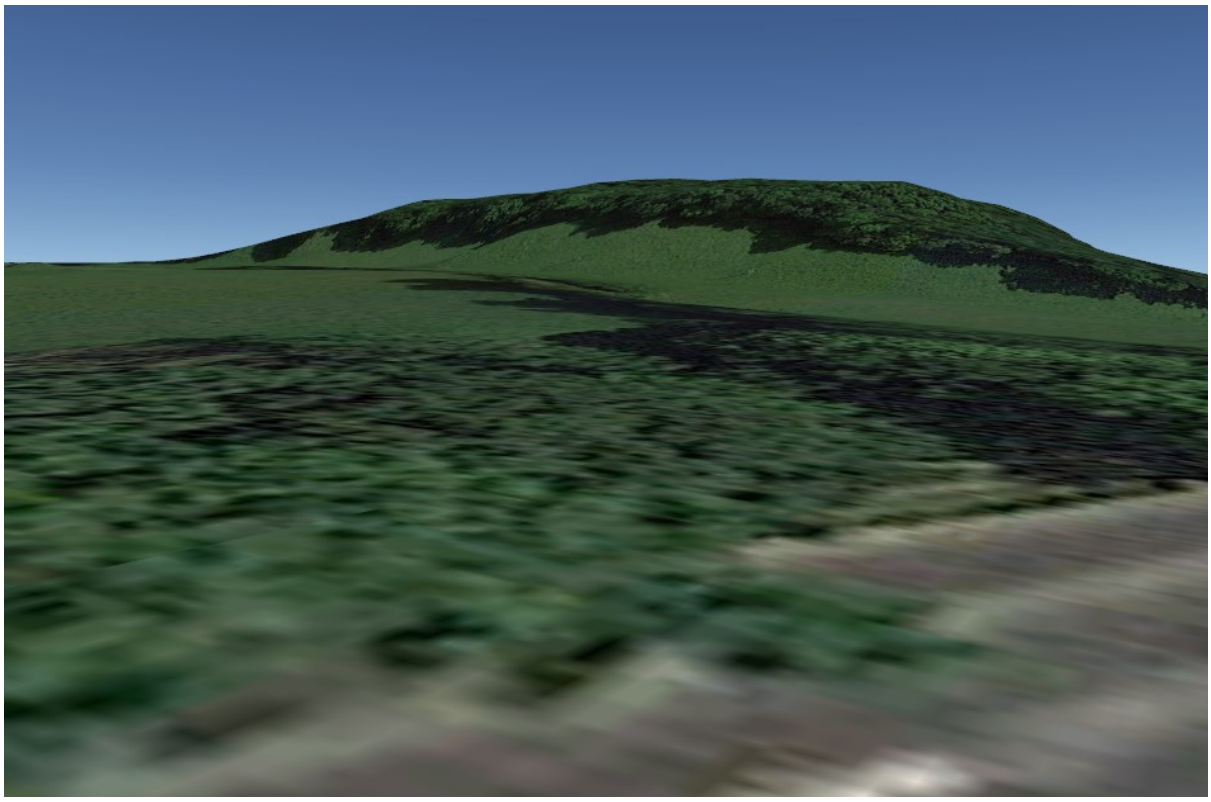
Receptor 2



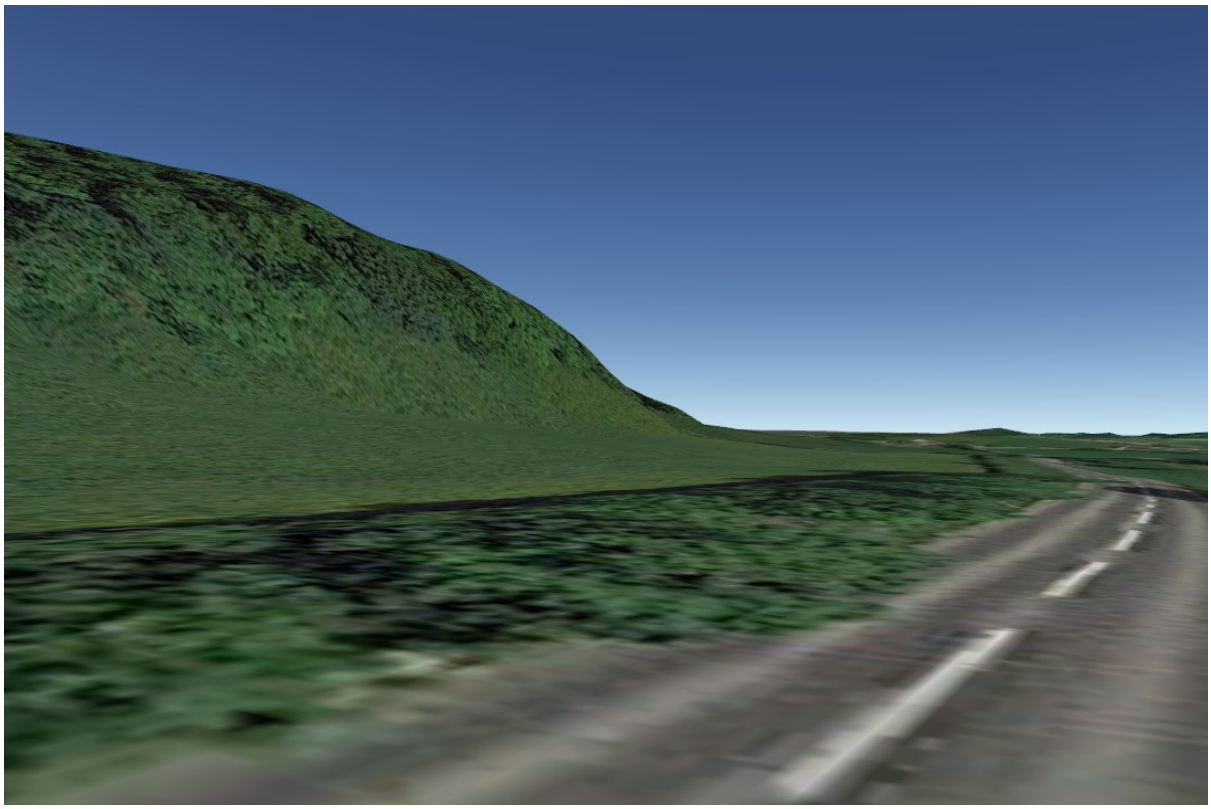
Receptor 3



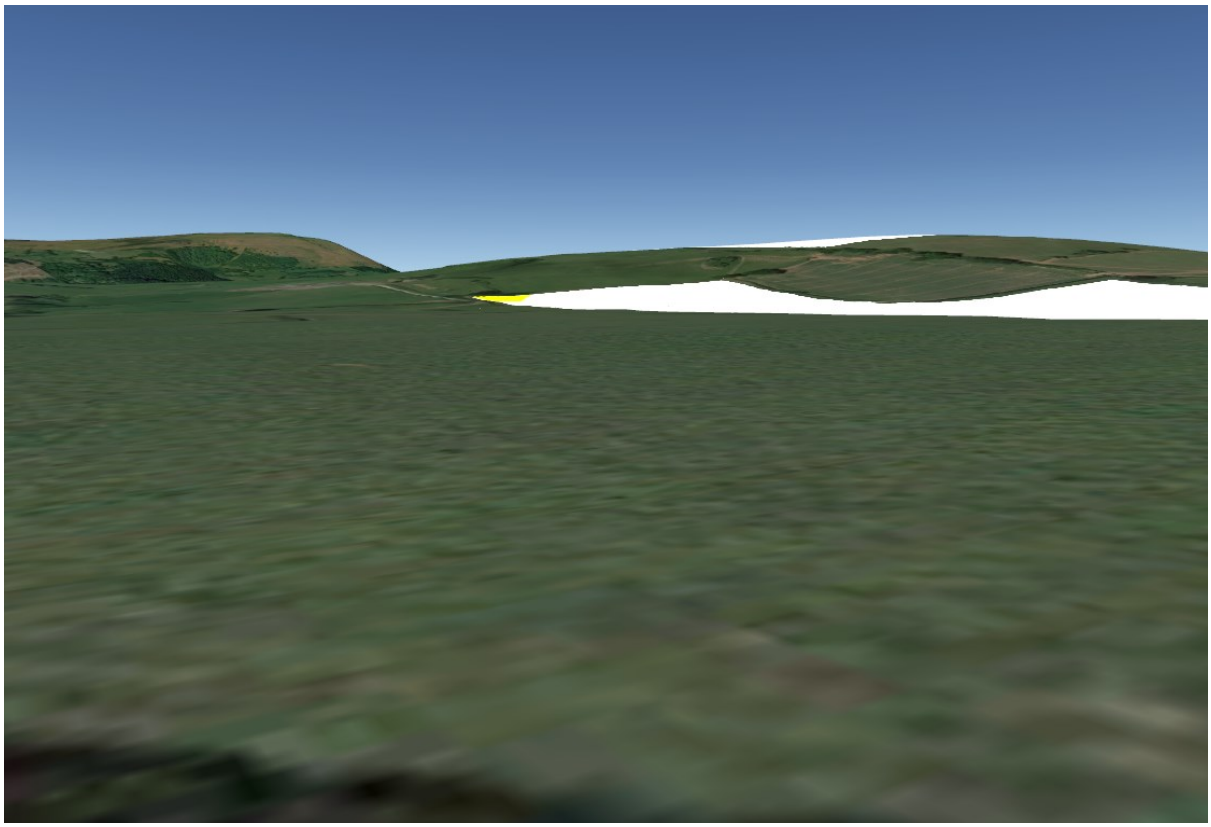
Receptor 4



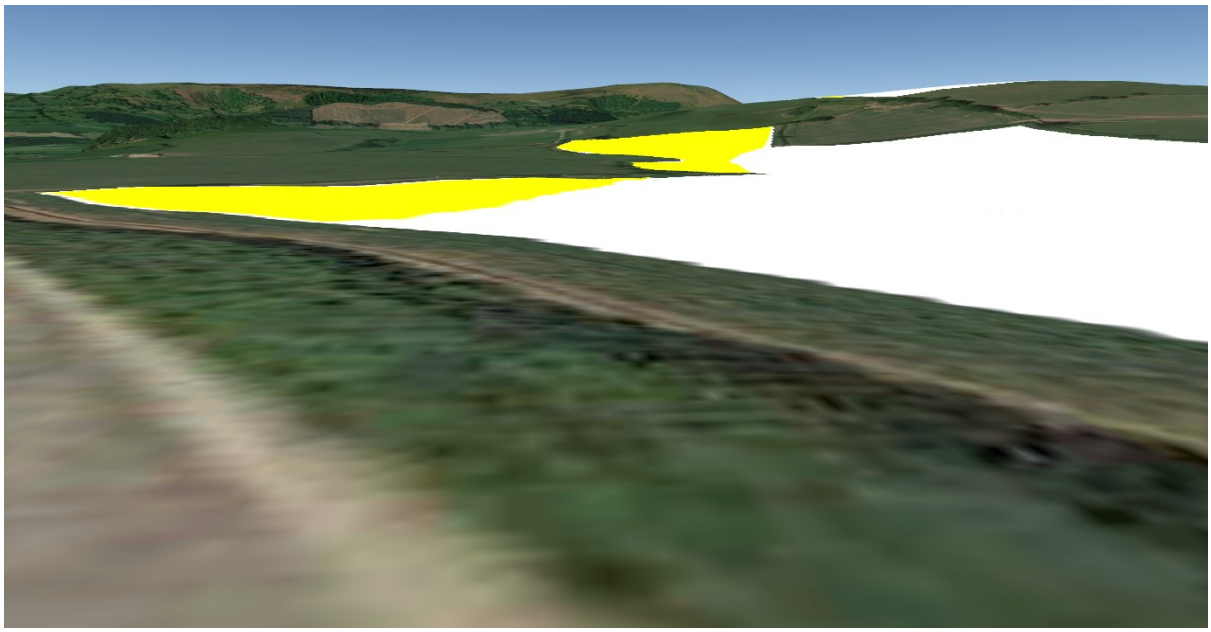
Receptor 5



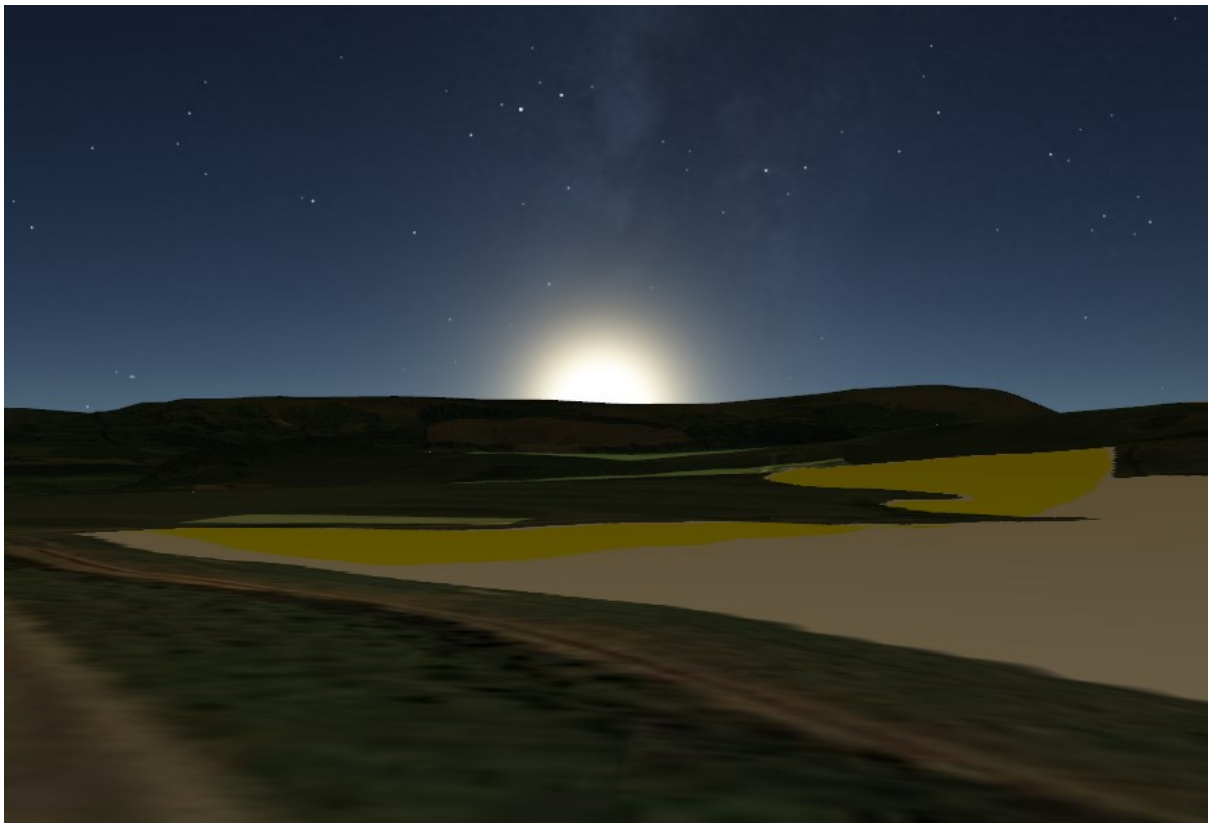
Receptor 8



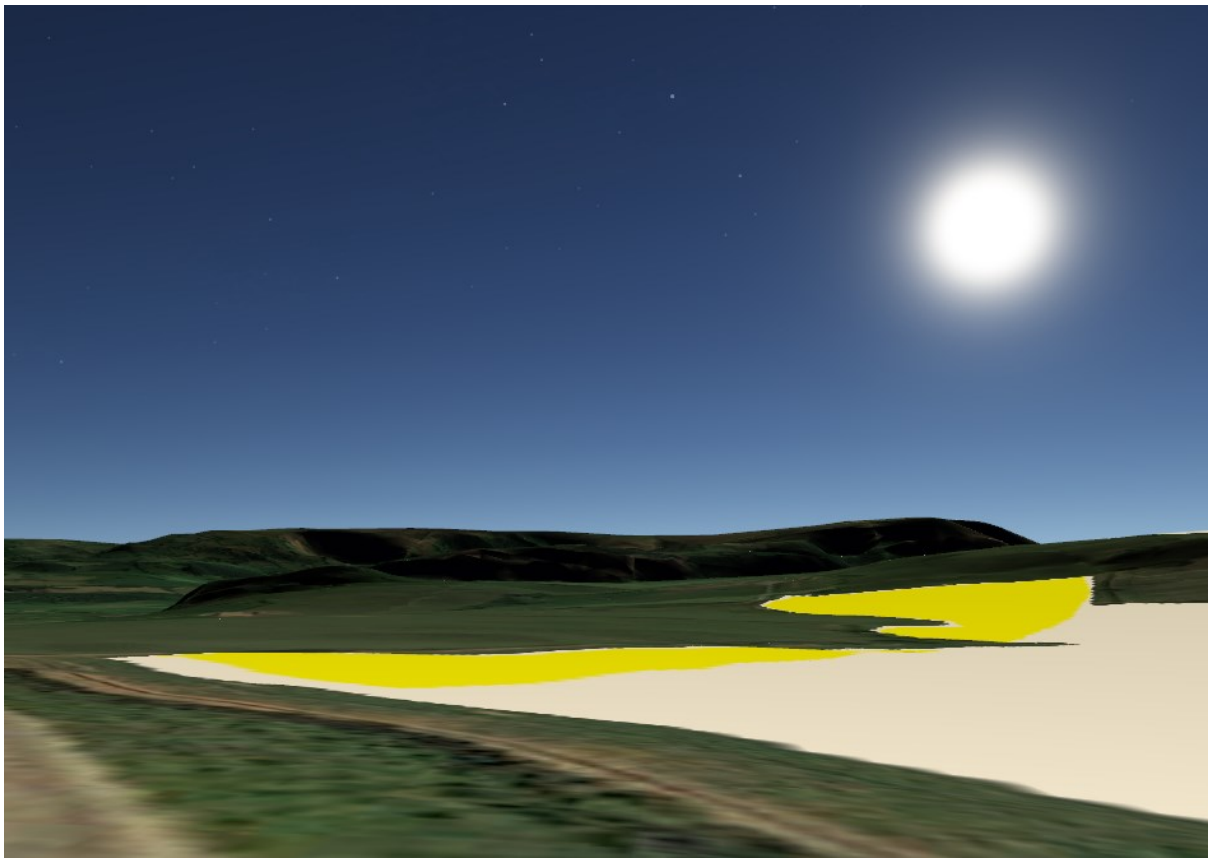
Receptor 9



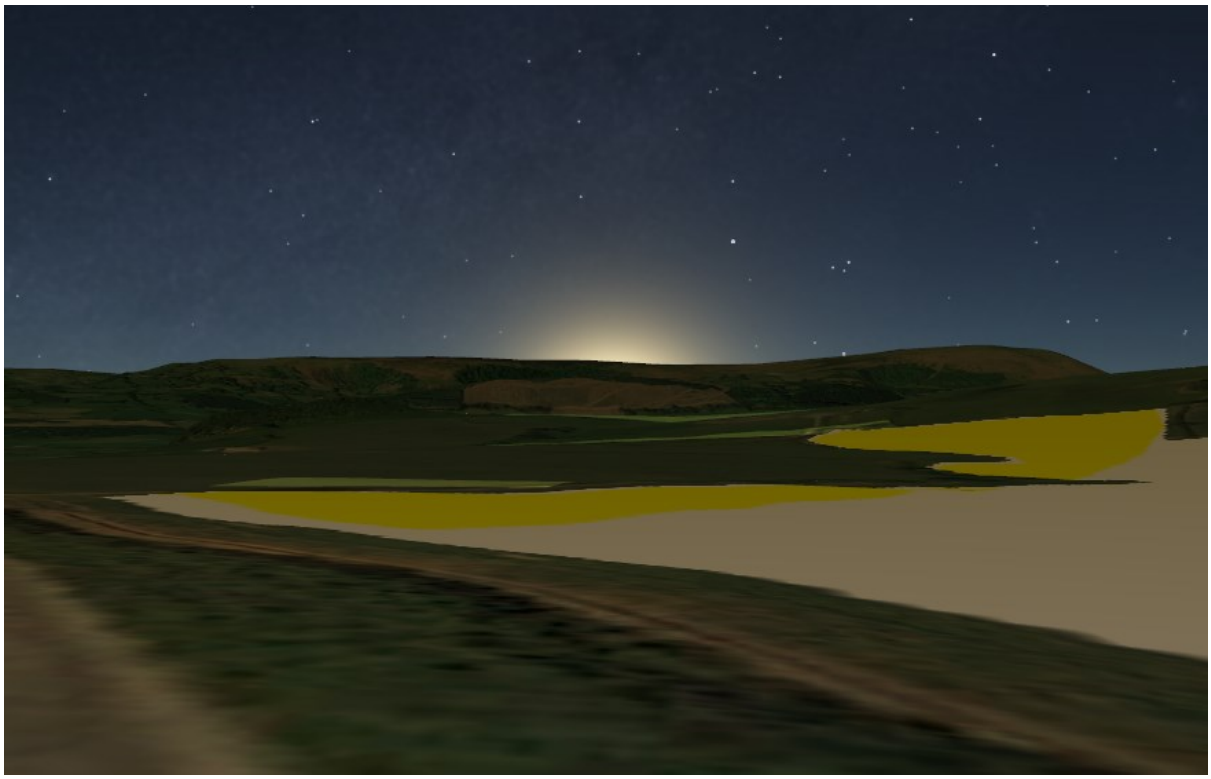
19th March 6pm UTC



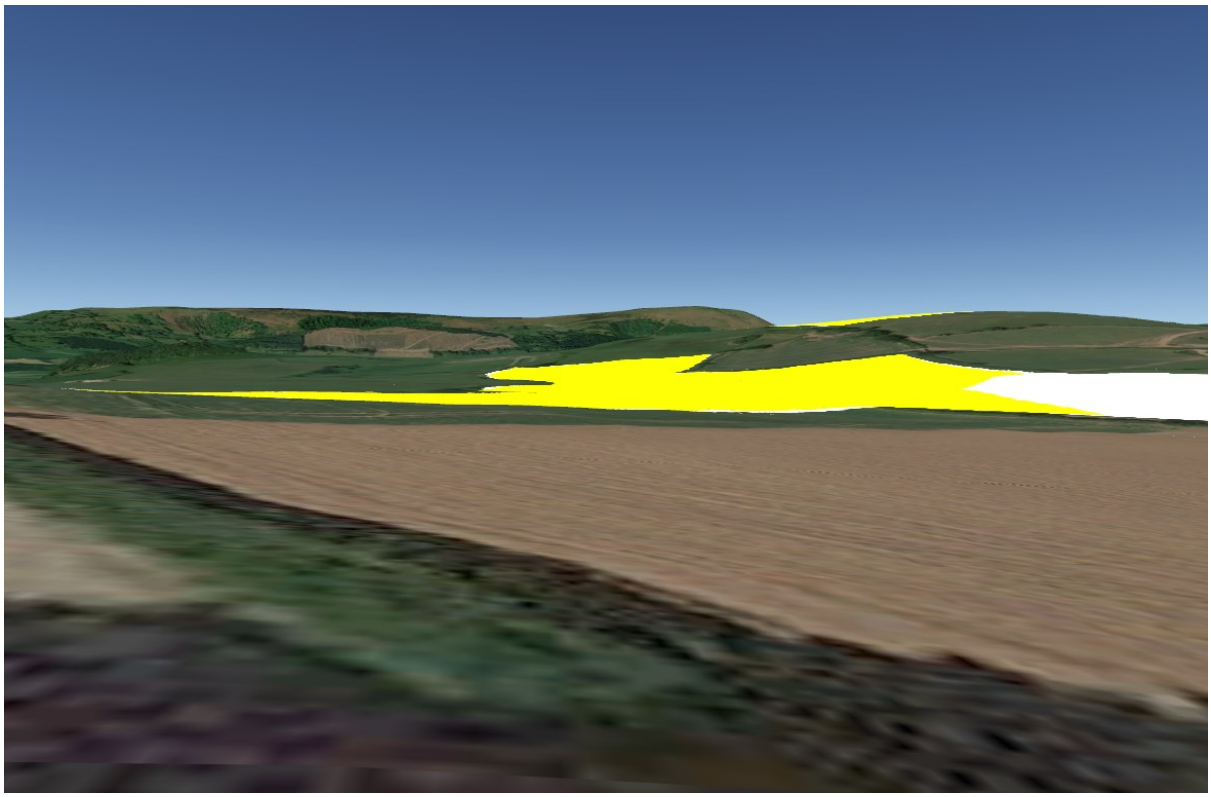
15th June 6:15pm UTC



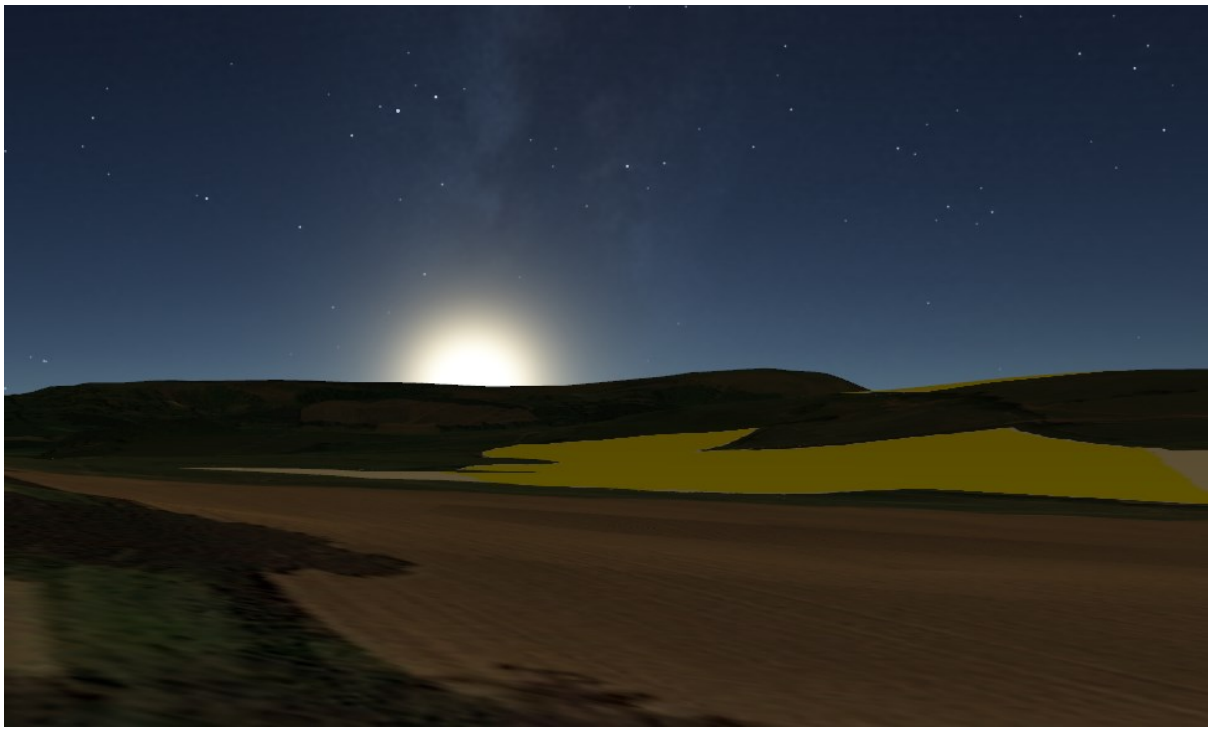
1st October 5:45pm UTC



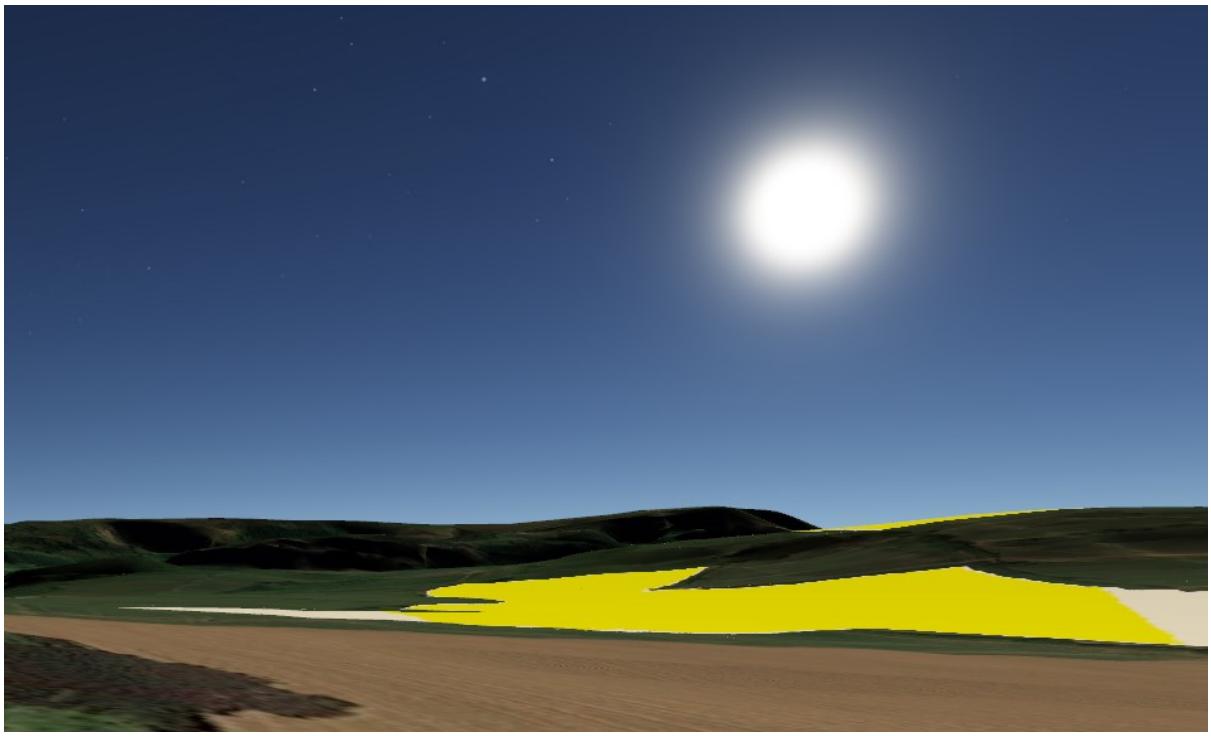
Receptor 10



19th March 6pm UTC

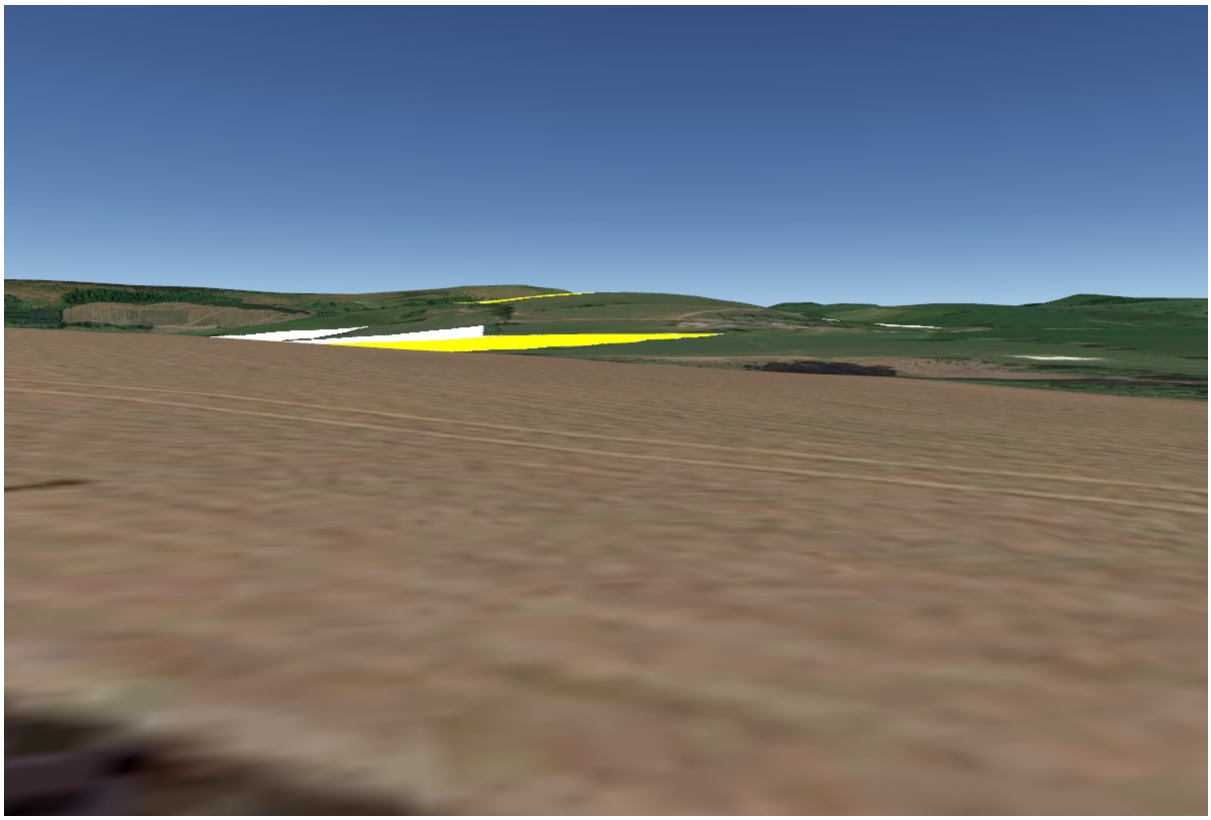


15th June 6:15pm UTC

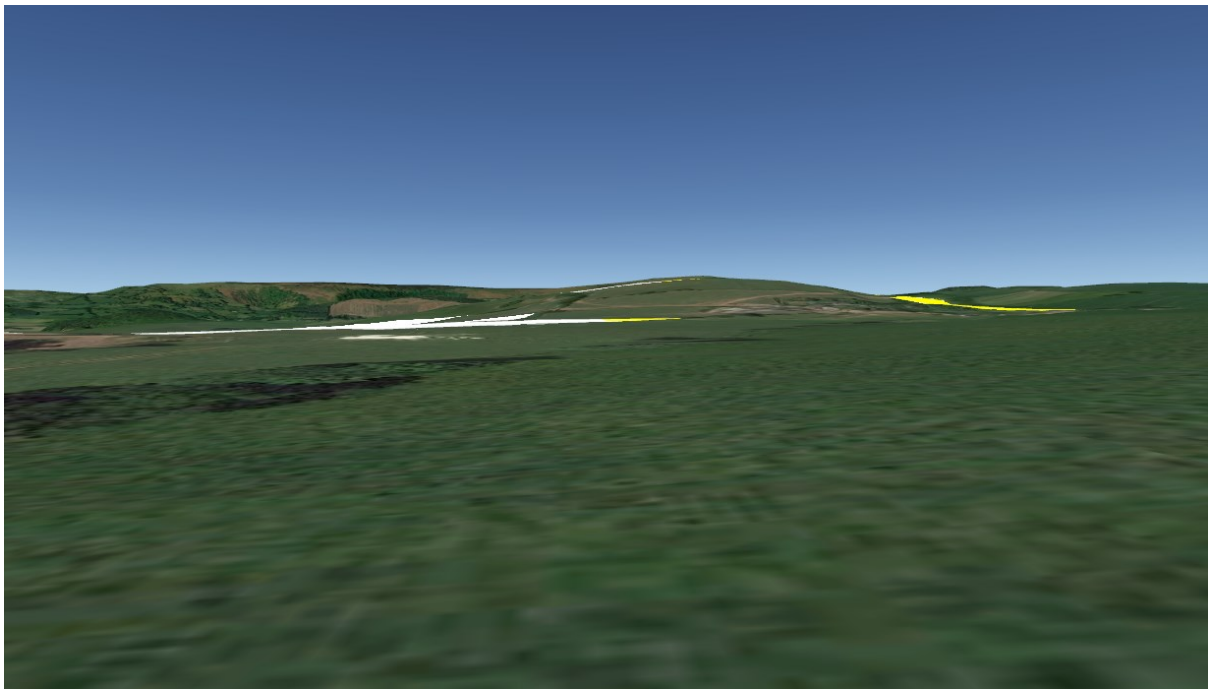


1st October 5:45pm UTC

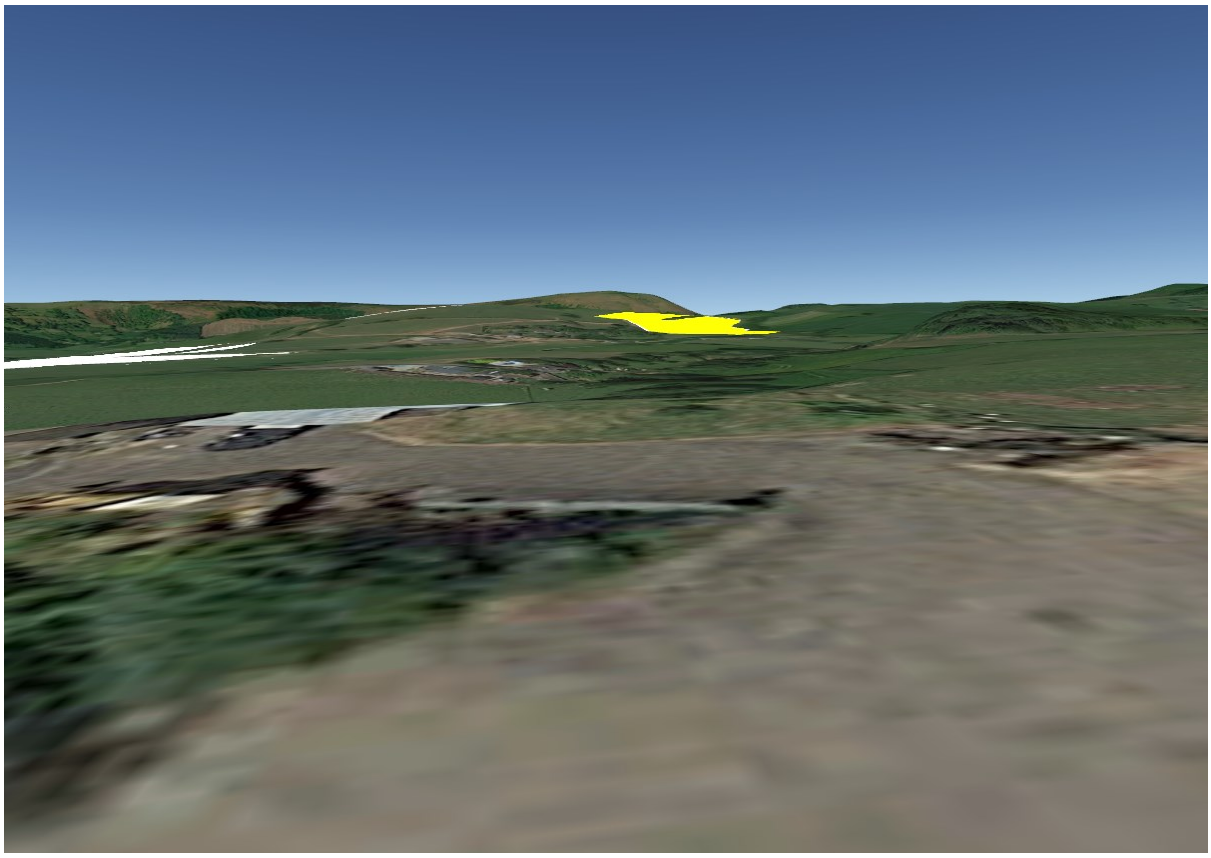
Receptor 11



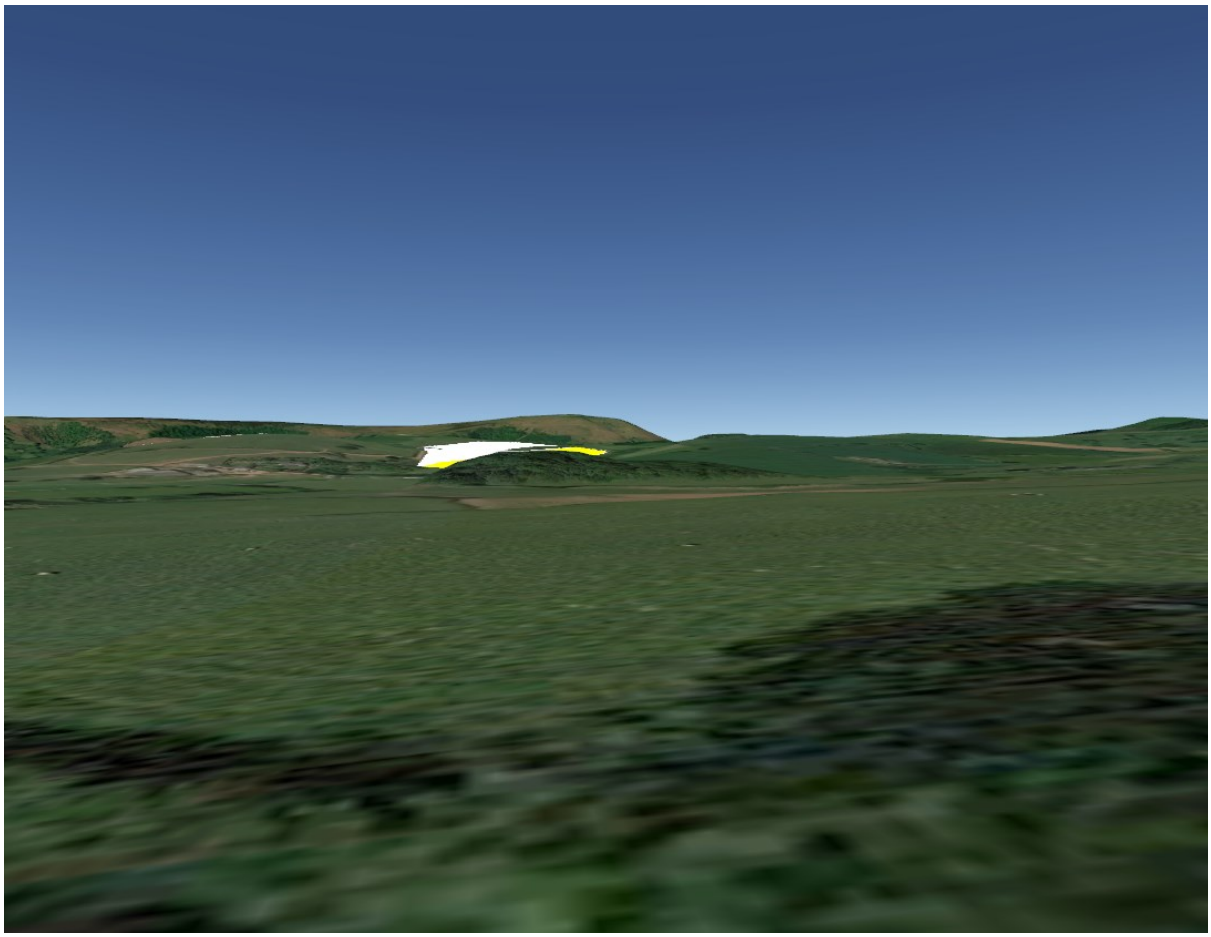
Receptor 12



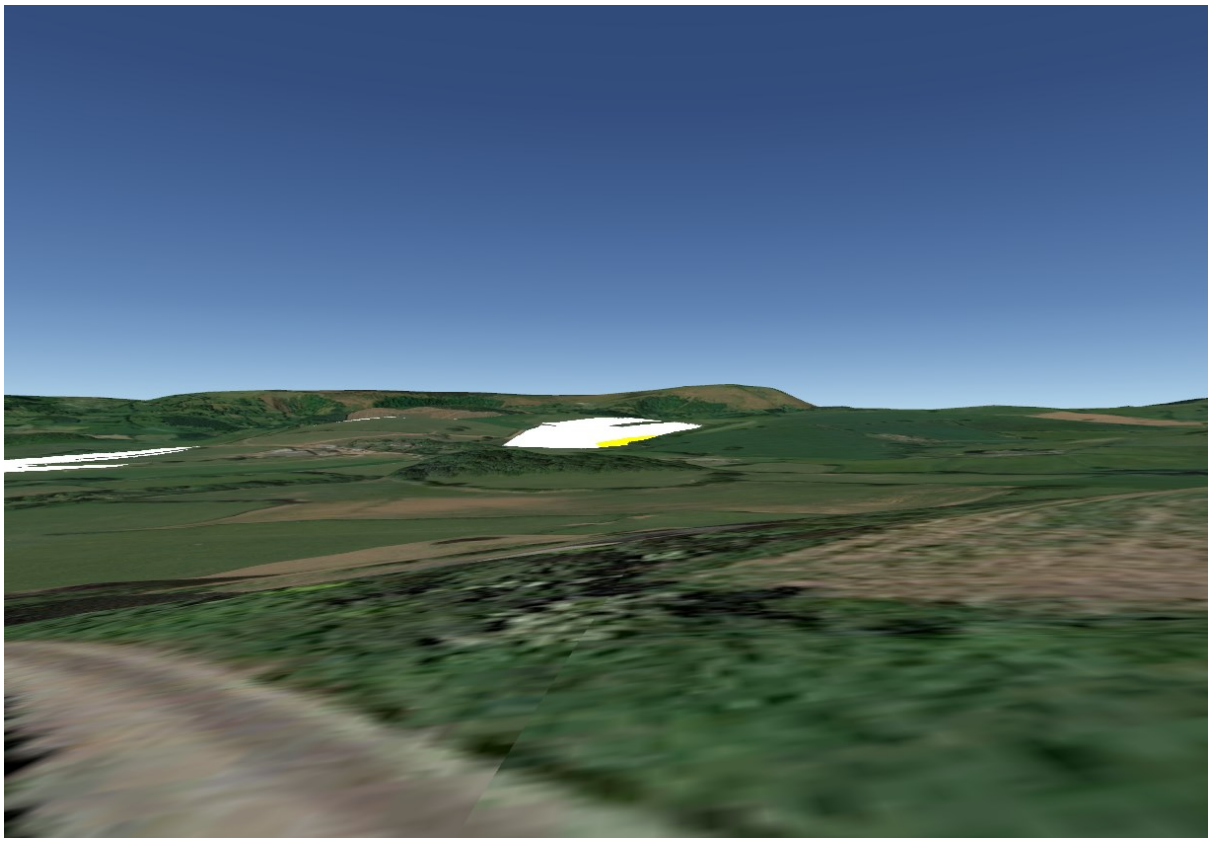
Receptor 13



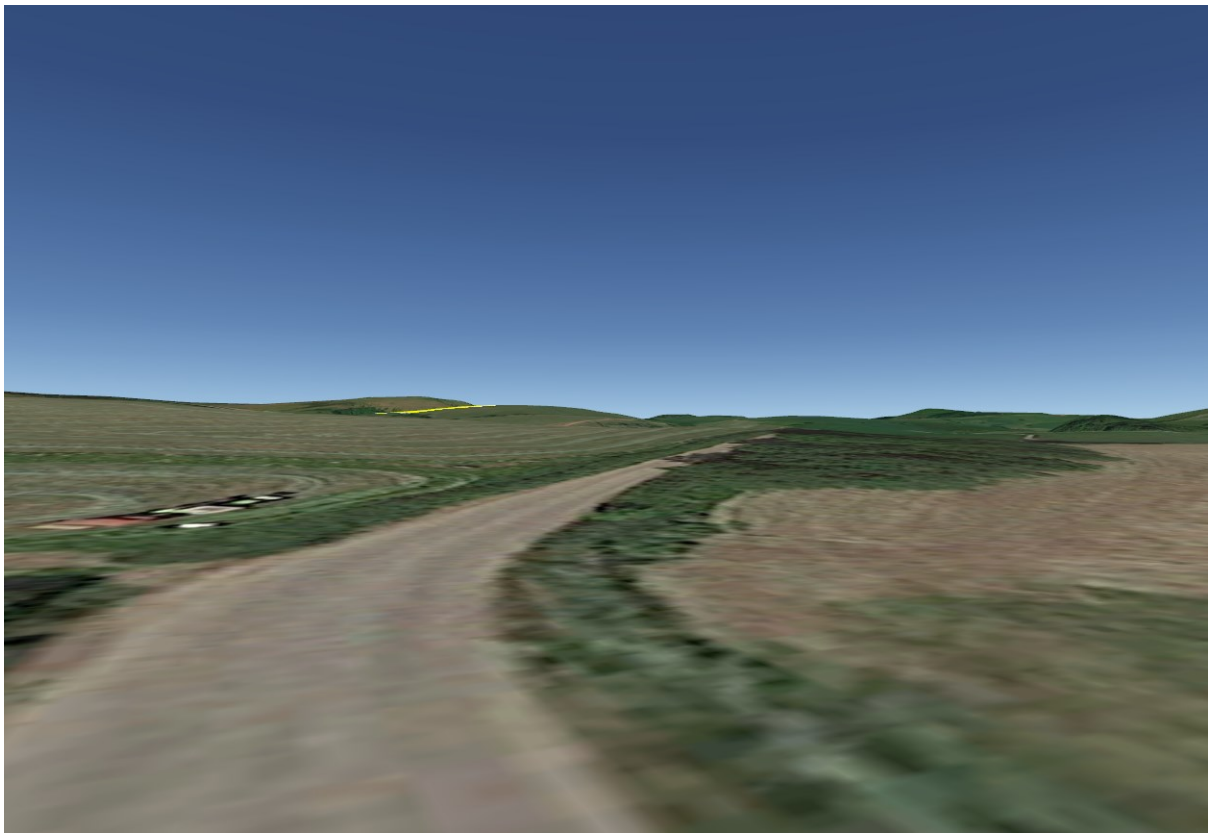
Receptor 14



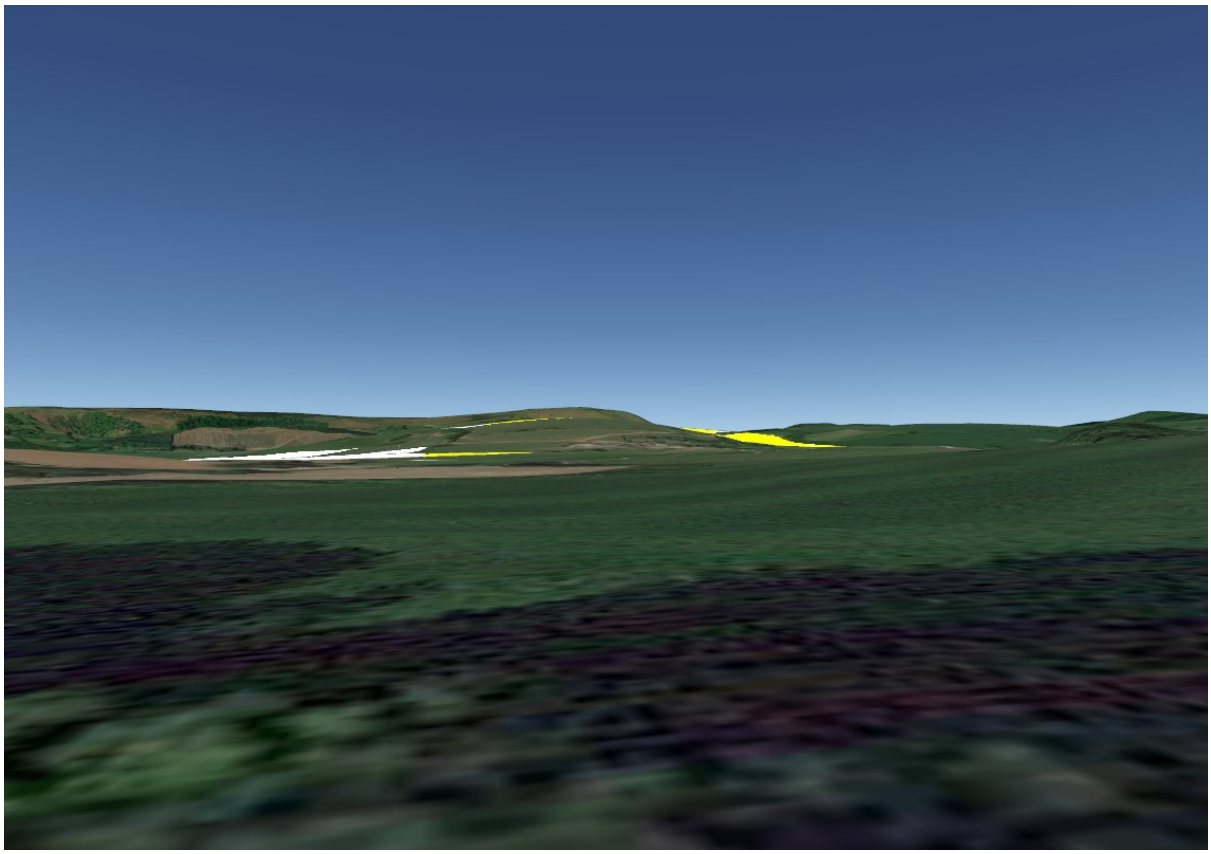
Receptor 15



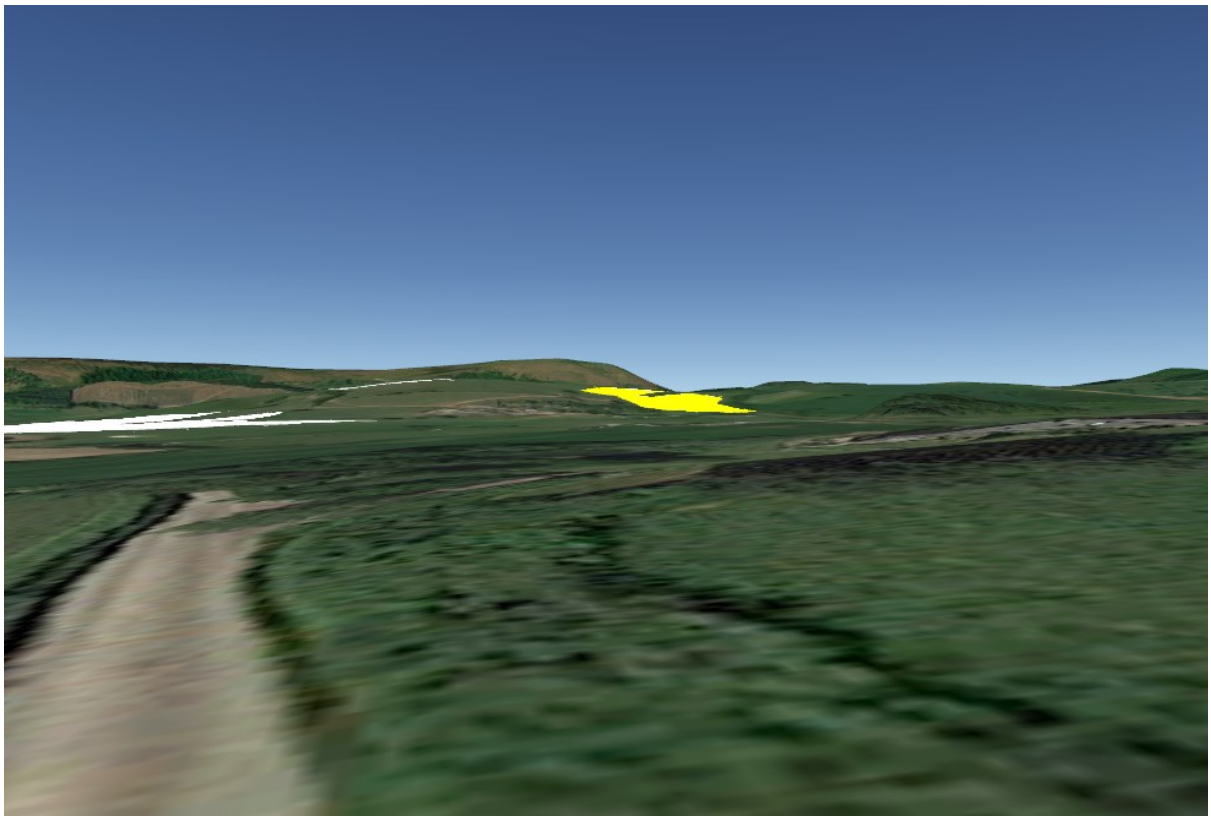
Receptor 16



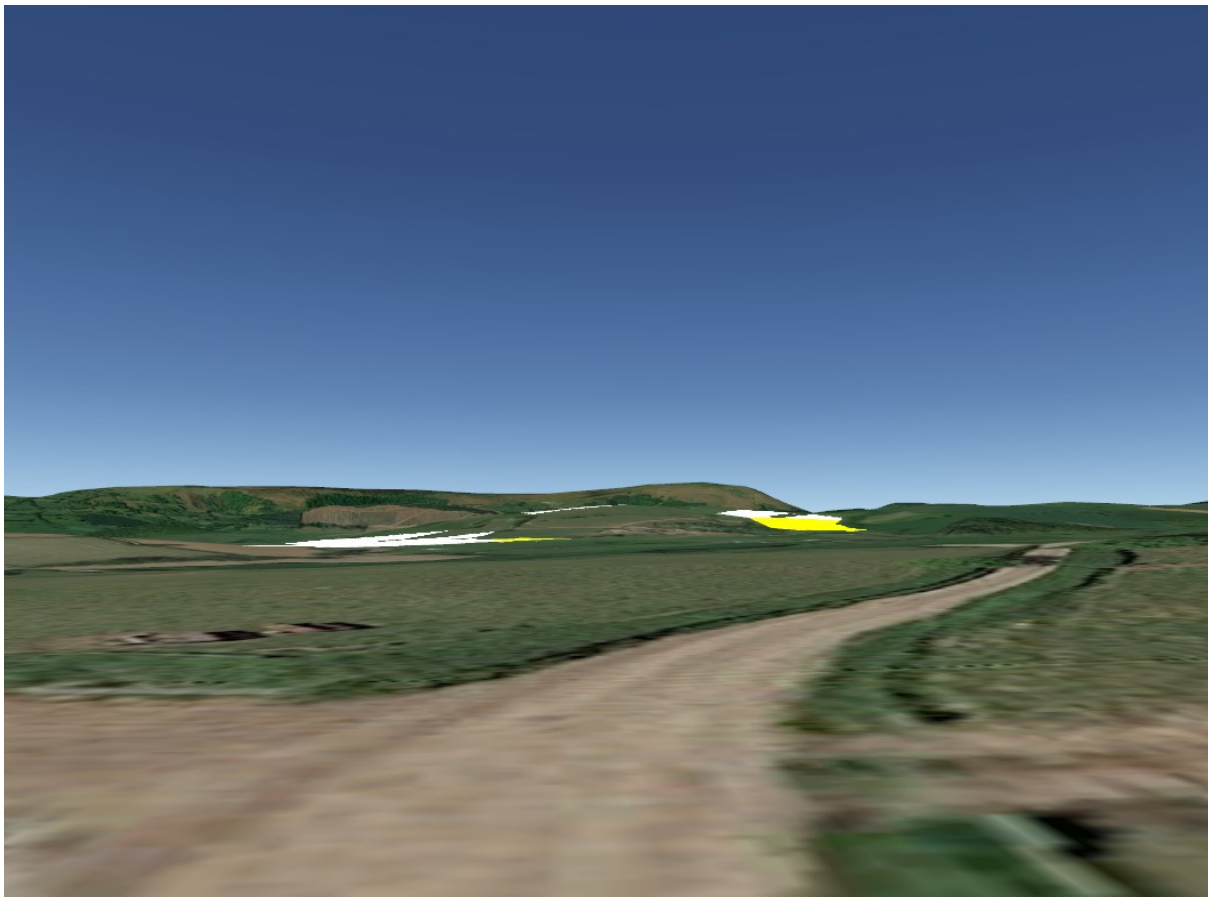
Receptor 17



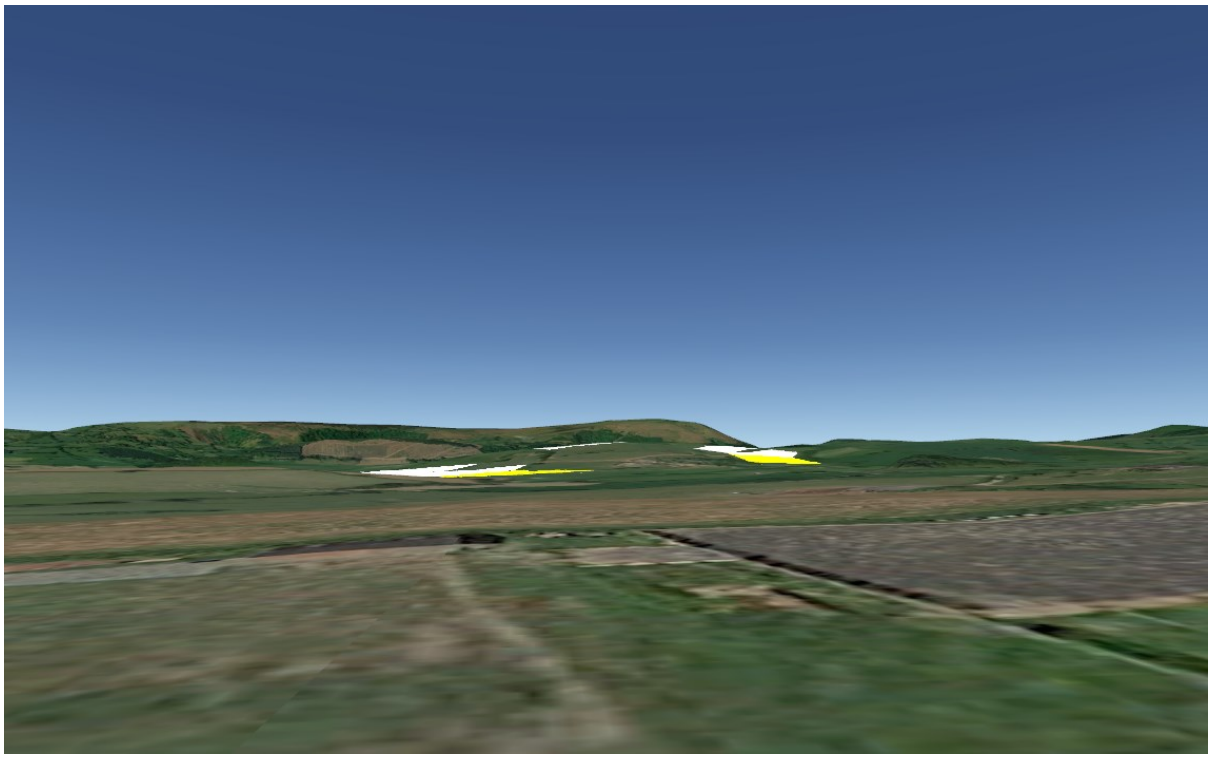
Receptor 18



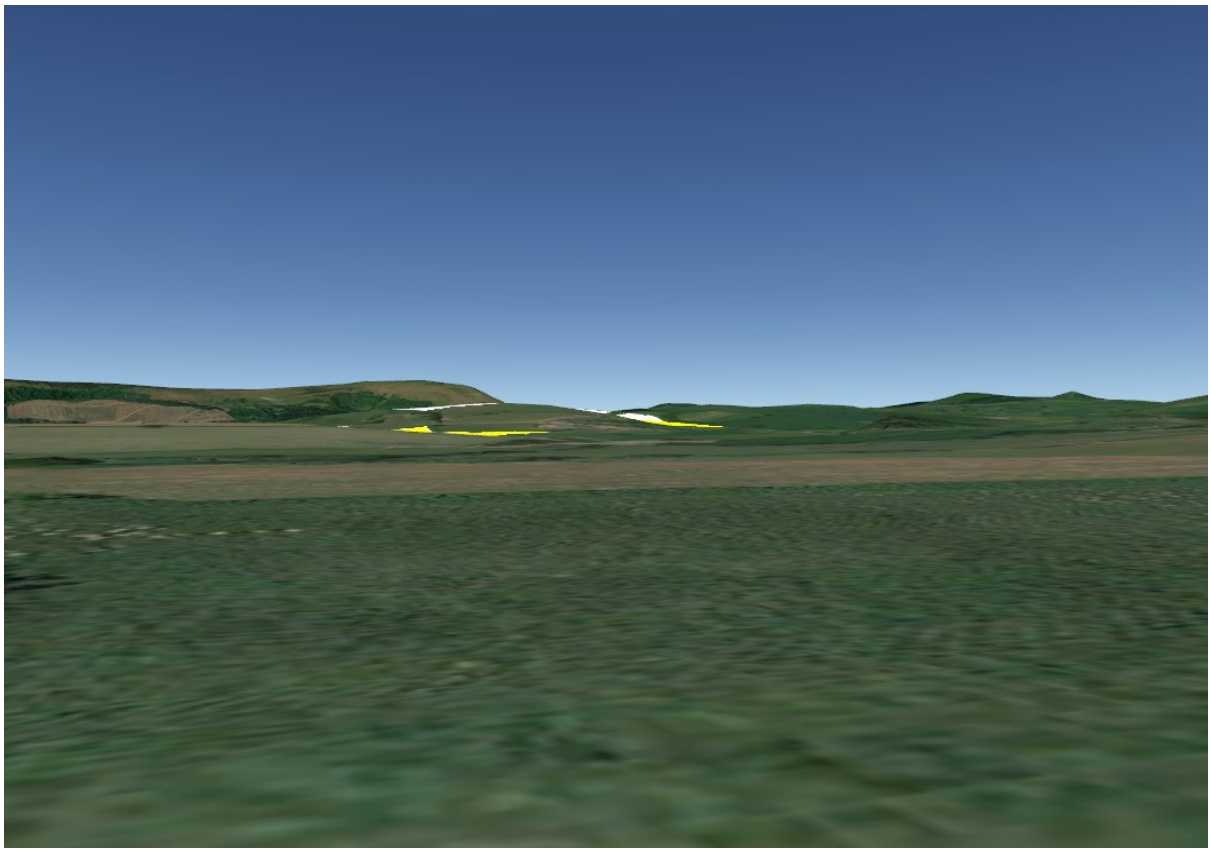
Receptor 19



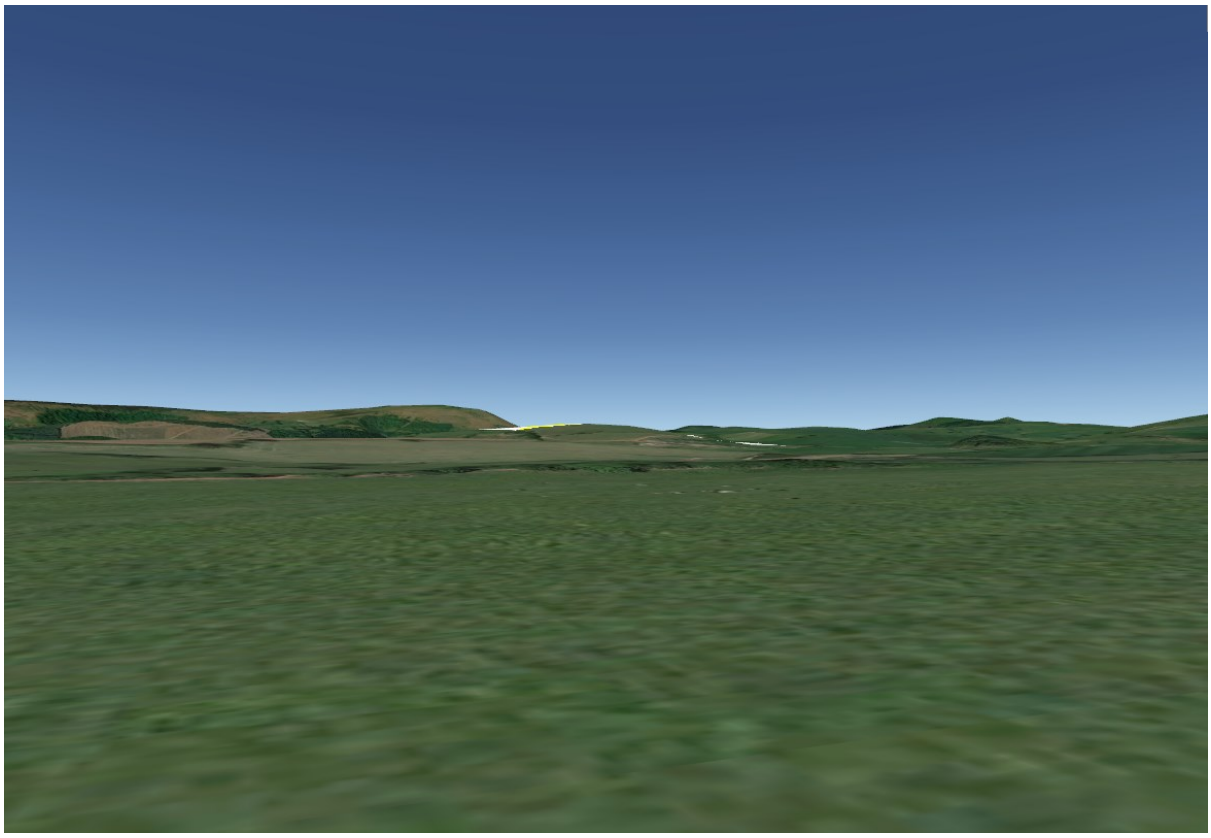
Receptor 20



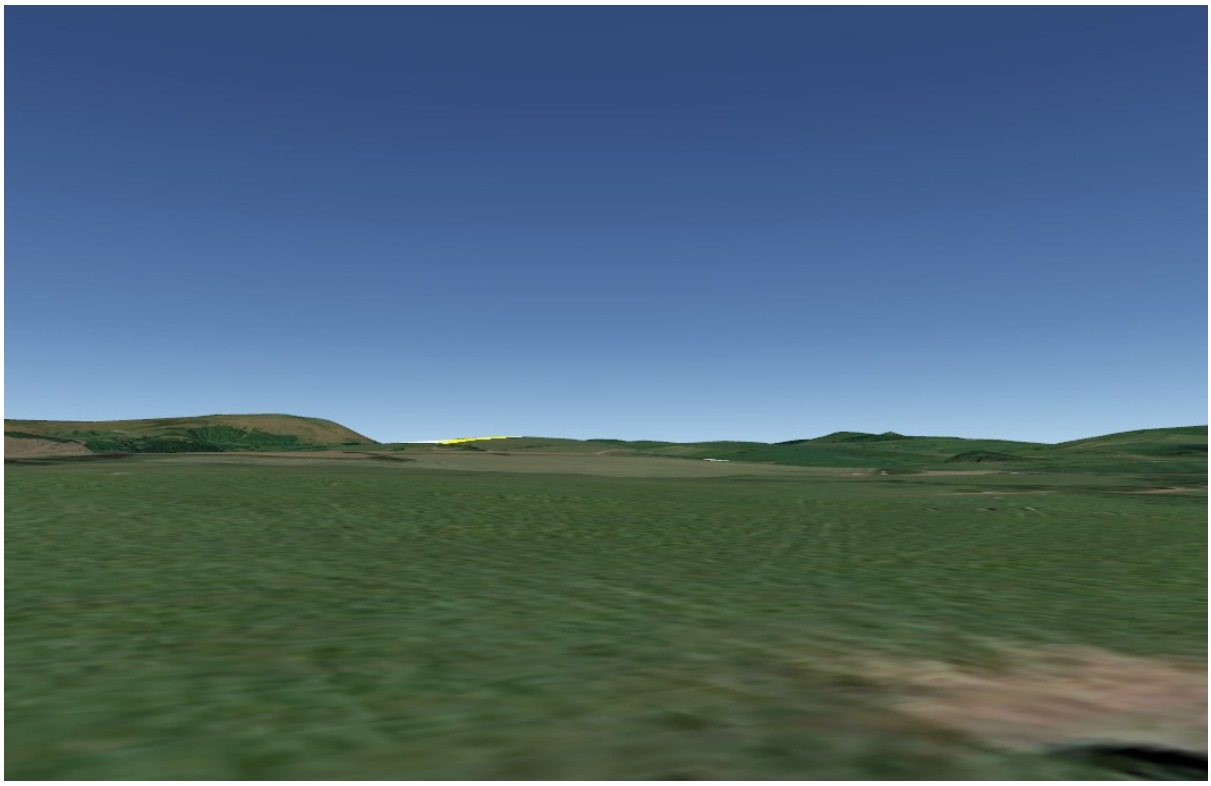
Receptor 21



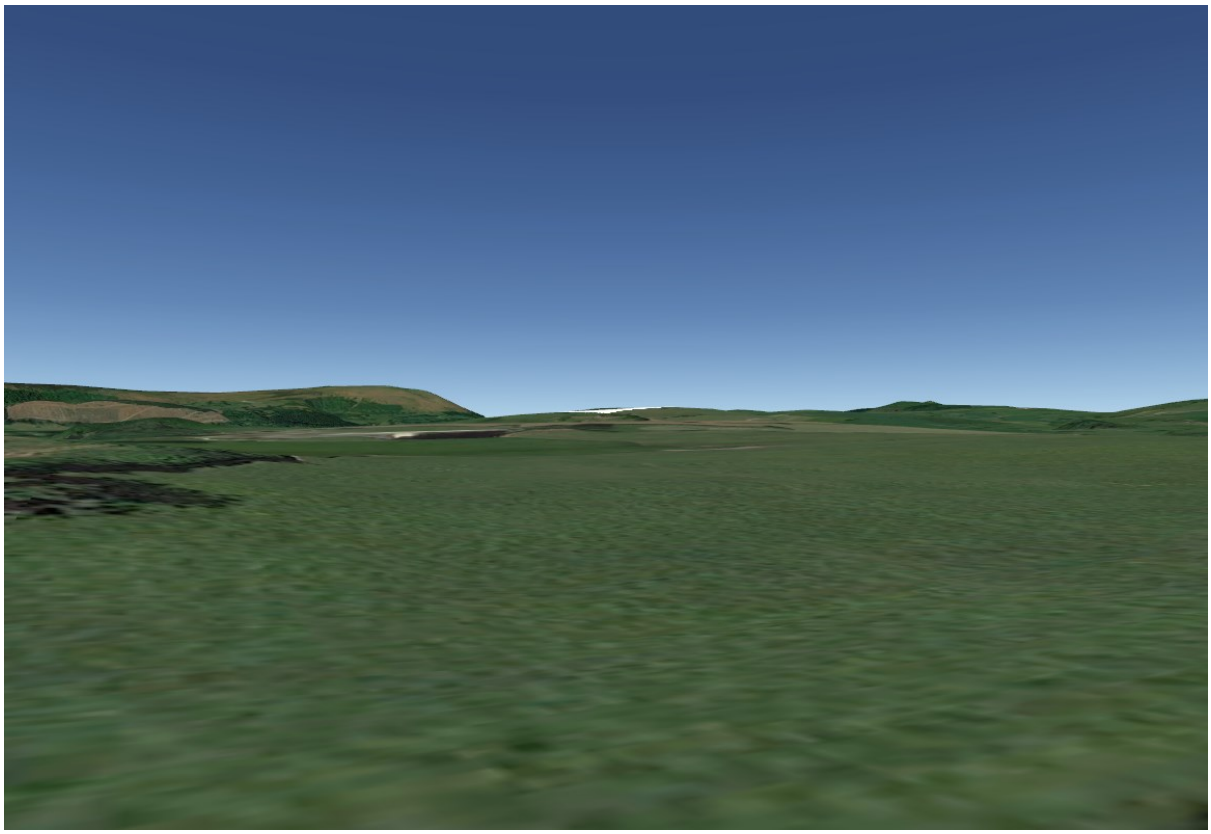
Receptor 22



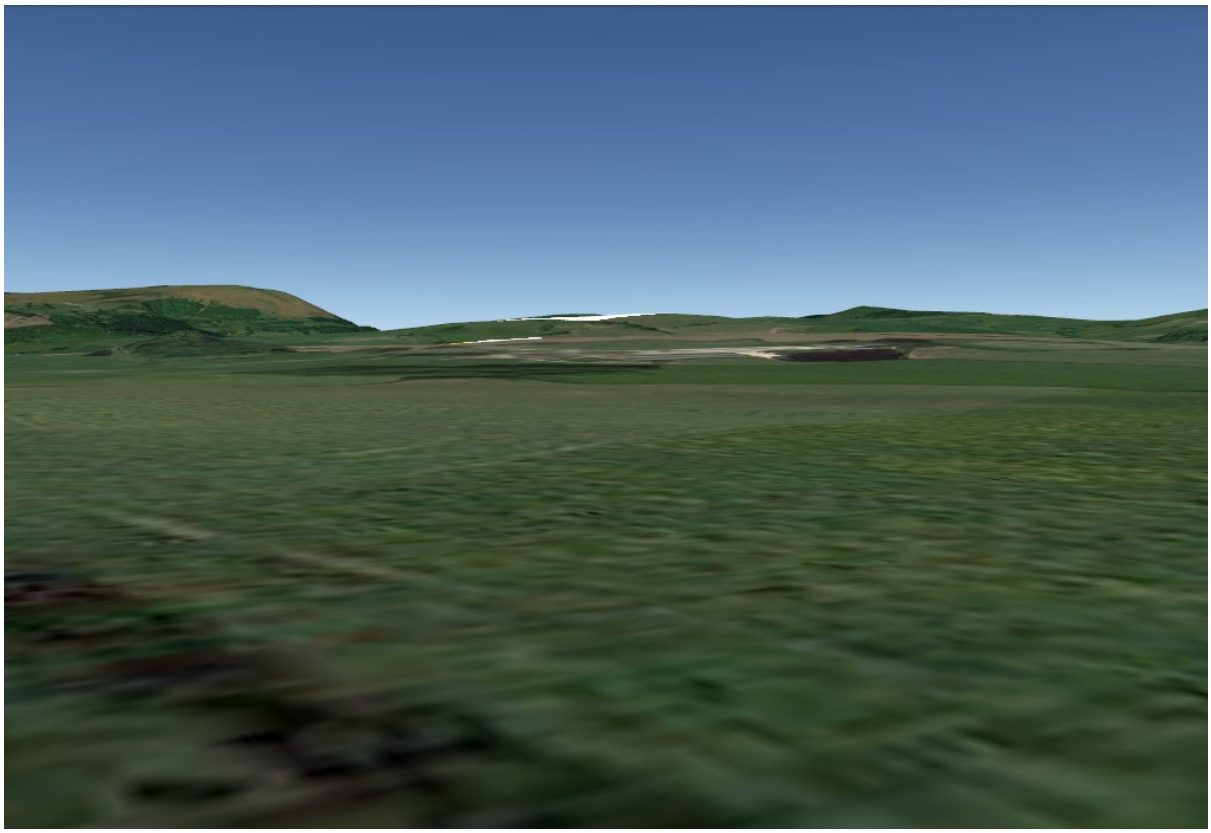
Receptor 23



Receptor 24



Receptor 25



Appendix 7F: Solar Module Glare and Reflectance Technical Memo

SUNPOWER®

Technical Notification

TITLE: SunPower Solar Module Glare and Reflectance
AUTHORS: Technical Support
APPLICATION: Residential/ Commercial
SCOPE: SunPower Modules

SUMMARY:

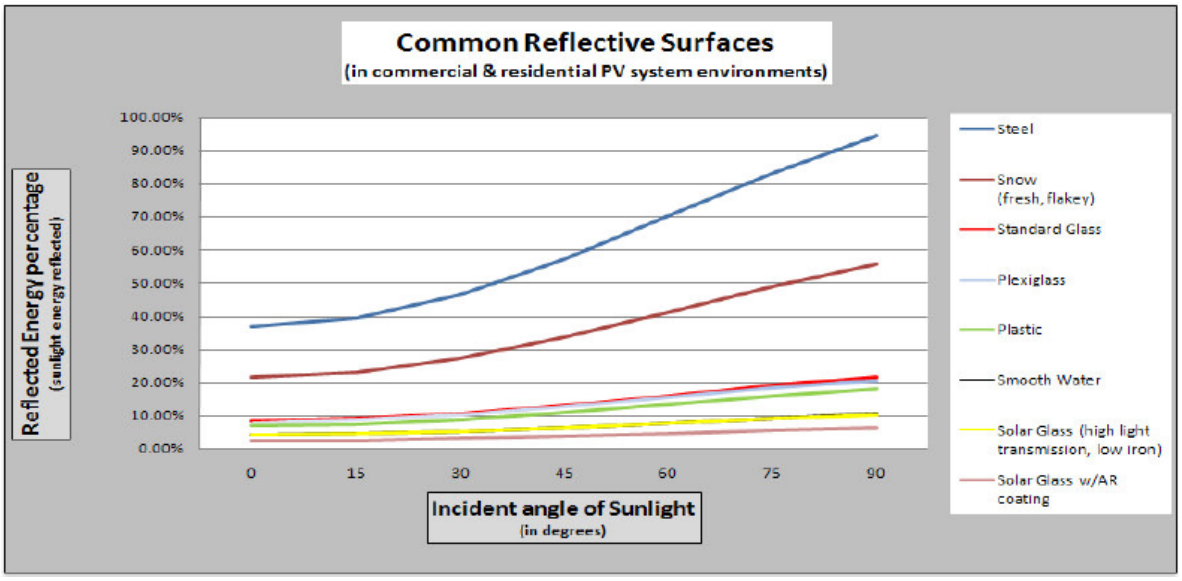
The objective of this document is to increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment.

The glare and reflectance levels from a given PV system are decisively lower than the glare and reflectance generated by the standard glass and other common reflective surfaces in the environments surrounding the given PV system. Concerning random glare and reflectance observed from the air: SunPower has several large projects installed near airports or on air force bases. Each of these large projects has passed FAA or Air Force standards and all projects have been determined as "No Hazard to Air Navigation". Although the possible glare and reflectance from PV systems are at safe levels and are usually decisively lower than other standard residential and commercial reflective surfaces, SunPower suggests that customers and installers discuss any possible concerns with the neighbors/cohabitants near the planned PV system installation.

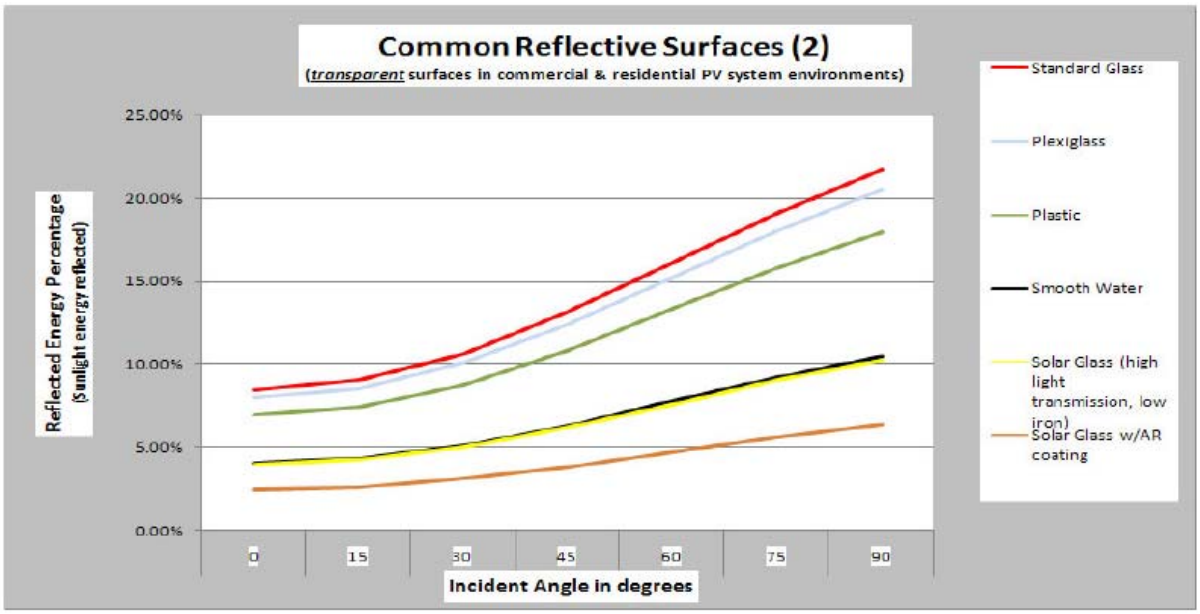
DETAILED EXPLANATION:

In general, since the whole concept of efficient solar power is to absorb as much light as possible while reflecting as little light as possible, standard solar module produces less glare and reflectance than standard window glass. This is pointed out very well in US Patent #6359212 which explains the differences in the refraction and reflection of solar module glass versus standard window glass. Solar modules use "high-transmission, low iron glass" which absorbs more light, producing small amounts of glare and reflectance than normal glass.

In the graph below, we show the reflected energy percentages of sunlight, of some common residential and commercial surfaces. The legend and the graph lists the items from top to bottom in order of the highest percentage of reflected energy.



It should be noted that the reflected energy percentage of Solar Glass is far below that of a standard glass and more on the level of smooth water. Also, below are the ratios of the common reflective surfaces:



Light beam physics resolves that the least amount of light is reflected when the beam is the normal, in other words, least light energy is reflected when the beam is at 0 degrees to the normal. The chart below is a result of light beam physics calculations:

Common Reflective Surfaces (in surrounding environments for PV systems)		Incident angle in degrees						
		0	15	30	45	60	75	90
Material Reflectivity (percent of incident light reflected)	Steel	36.73%	39.22%	46.34%	57.11%	70.02%	83.15%	94.40%
	Snow (fresh, flakey)	21.63%	23.09%	27.29%	33.63%	41.23%	48.96%	55.59%
	Standard Glass	8.44%	9.01%	10.65%	13.12%	16.09%	19.10%	21.69%
	Plexiglass	8.00%	8.54%	10.09%	12.44%	15.25%	18.11%	20.56%
	Plastic	6.99%	7.46%	8.82%	10.87%	13.33%	15.83%	17.97%
	Smooth Water	4.07%	4.35%	5.14%	6.33%	7.76%	9.22%	10.47%
	Solar Glass (high light transmission, low iron)	3.99%	4.26%	5.03%	6.20%	7.61%	9.03%	10.26%
	Solar Glass w/AR coating	2.47%	2.64%	3.12%	3.84%	4.71%	5.59%	6.35%

(Note: Index of refraction values may vary slightly depending on suppliers and reference documentation. The values for the above calculations are averages or single values obtained from the list of references for this document).

Important reference – "Stipples glass": In addition to the superior refractive/reflective properties of solar glass versus standard glass, SunPower uses stippled solar glass for our modules. Stippled glass is used with high powered telescopes and powerful beacons and lights. The basic concept behind stippling is for the surfaces of the glass to be textured with small types of indentations. As a result, stippling allows more light energy to be channeled/ transmitted through the glass while diffusing the reflected light energy. This concept is why the reflection of off a SunPower solar module will look hazy and less-defined than the reflection from standard glass, this occurs because the stippled SunPower glass is transmitting a larger percentage of light to the solar cell while breaking up the intensity of the reflected light energy.

SUMMARY / ACTION REQUIRED:

The studies, data and light beam physics behind the charts and graphs prove beyond a reasonable doubt that solar glass has less glare and reflectance than standard glass. The figures also make it clear that the difference is very decisive between solar glass and other common residential/commercial glasses. In addition, not to be lost in the standard light/glass equations and calculations, the SunPower solar glass is stippled and has a very photon-absorbent solar cell attached to the back side, contributing two additional factors which results in even less light energy being reflected.

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