APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

This section presents details regarding the relevant guidance and studies with respect to the considerations and effects of solar reflections from solar panels, known as 'Glint and Glare'.

This is not a comprehensive review of the data sources, rather it is intended to give an overview of the important parameters and considerations that have informed this assessment.

UK Planning Policy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[59] (specifically regarding the consideration of solar farms, paragraph 013) states:

'What are the particular planning considerations that relate to large scale ground-mounted solar photovoltaic Farms?

The deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively.

Particular factors a local planning authority will need to consider include:

…

- *the proposal's visual impact, the effect on landscape of glint and glare (see guidance on landscape assessment) and on **neighbouring uses and aircraft safety**;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun;*

…

The approach to assessing cumulative landscape and visual impact of large scale solar farms is likely to be the same as assessing the impact of wind turbines. However, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography the area of a zone of visual influence could be zero.'

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare are, however, provided for assessing the impact of solar reflections upon surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the relevant

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[59] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 17/06/2020

guidance/studies to determine whether the reflection is significant. The Pager Power approach has been informed by the policy presented above, current studies (presented in Appendix B) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document[60] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

Aviation Assessment Guidance

The UK Civil Aviation Authority (CAA) issued interim guidance relating to Solar Photovoltaic Systems (SPV) on 17 December 2010 and was subject to a CAA information alert 2010/53. The formal policy was cancelled on September 7th, 2012[61] however the advice is still applicable[62] until a formal policy is developed. The relevant aviation guidance from the CAA is presented in the section below.

CAA Interim Guidance

This interim guidance makes the following recommendations (p.2-3):

'8. It is recommended that, as part of a planning application, the SPV developer provide safety assurance documentation (including risk assessment) regarding the full potential impact of the SPV installation on aviation interests.

9. Guidance on safeguarding procedures at CAA licensed Airports is published within CAP 738 Safeguarding of Airports and advice for unlicensed Airports is contained within CAP 793 Safe Operating Practices at Unlicensed Airports.

10. Where proposed developments in the vicinity of Airports require an application for planning permission the relevant LPA normally consults Airport operators or NATS when aeronautical interests might be affected. This consultation procedure is a statutory obligation in the case of certain major airports, and may include military establishments and certain air traffic surveillance technical sites. These arrangements are explained in Department for Transport Circular 1/2003 and for Scotland, Scottish Government Circular 2/2003.

11. In the event of SPV developments proposed under the Electricity Act, the relevant government department should routinely consult with the CAA. There is therefore no requirement for the CAA to be separately consulted for such proposed SPV installations or developments.

12. If an installation of SPV systems is planned on-Airport (i.e. within its licensed boundary) then it is recommended that data on the reflectivity of the solar panel material should be included in any assessment before installation approval can be granted. Although approval for installation is the responsibility of the ALH[63], as part of a condition of a CAA Airport Licence, the ALH is required to obtain prior consent from CAA Airport Standards Department before any work is begun or approval

[60] Solar Photovoltaic Development – Glint and Glare Guidance, Second Edition 2, October 2018. Pager Power.

[61] Archived at Pager Power

[62] Reference email from the CAA dated 19/05/2014.

[63] Airport Licence Holder.

to the developer or LPA is granted, in accordance with the procedures set out in CAP 791 Procedures for Changes to Airport Infrastructure.

13. During the installation and associated construction of SPV systems there may also be a need to liaise with nearby Airports if cranes are to be used; CAA notification and permission is not required.

14. The CAA aims to replace this informal guidance with formal policy in due course and reserves the right to cancel, amend or alter the guidance provided in this document at its discretion upon receipt of new information.

15. Further guidance may be obtained from CAA's Airport Standards Department via Airports@caa.co.uk.'

FAA Guidance

The most comprehensive guidelines available for the assessment of solar developments near Airports were produced initially in November 2010 by the United States Federal Aviation Administration (FAA) and updated in 2013.

The 2010 document is entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'[64] and the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports*'[65]. In April 2018 the FAA released a new version (Version 1.1) of the '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'[66].

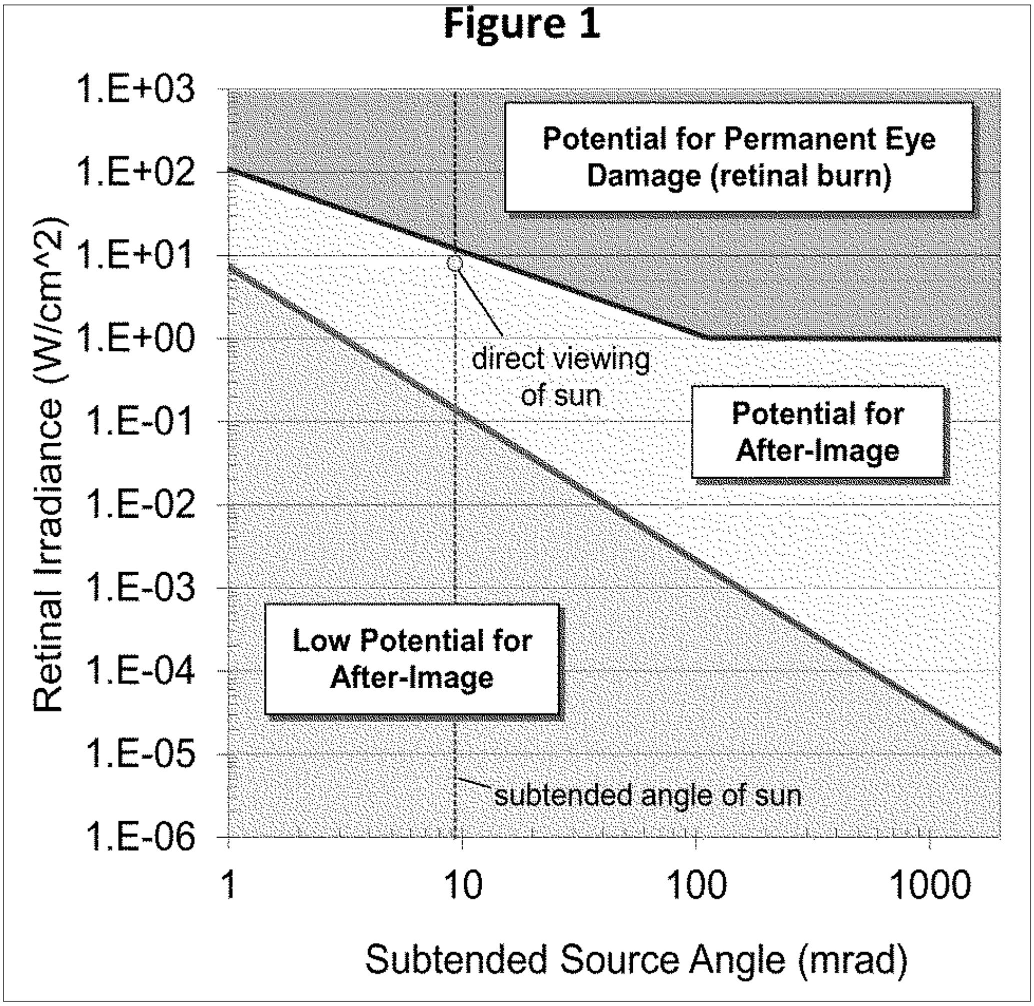
An overview of the methodology presented within the 2013 interim guidance and adopted by the FAA is presented below. This methodology is not presented within the 2018 guidance.

- *Solar energy systems located on an airport that is not federally-obligated or located outside the property of a federally-obligated airport are not subject to this policy.*
- *Proponents of solar energy systems located off-airport property or on non-federally-obligated airports are strongly encouraged to consider the requirements of this policy when siting such system.*
- *FAA adopts the Solar Glare Hazard Analysis Plot…. as the standard for measuring the ocular impact of any proposed solar energy system on a federally-obligated airport. This is shown in the figure below.*

[64] Archived at Pager Power

[65] Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports, Department of Transportation, Federal Aviation Administration (FAA), date: 10/2013, accessed on: 20/03/2019

[8] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019



Solar Glare Hazard Analysis Plot (FAA)

- *To obtain FAA approval to revise an airport layout plan to depict a solar installation and/or a "no objection" … the airport sponsor will be required to demonstrate that the proposed solar energy system meets the following standards:*
- *No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATC) cab, and*
- *No potential for glare or "low potential for after-image" … along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath.*
- *Ocular impact must be analysed over the entire calendar year in one (1) minute intervals from when the sun rises above the horizon until the sun sets below the horizon.*

The bullets highlighted above state there should be 'no potential for glare' at that ATC Tower and 'no' or 'low potential for glare' on the approach paths.

Key points from the 2018 FAA guidance are presented below.

- *Reflectivity refers to light that is reflected off surfaces. The potential effects of reflectivity are glint (a momentary flash of bright light) and glare (a continuous source of bright light). These two effects are referred to hereinafter as "glare," which can cause a brief loss of vision, also known as flash blindness*[67].
- *The amount of light reflected off a solar panel surface depends on the amount of sunlight hitting the surface, its surface reflectivity, geographic location, time of year, cloud cover, and solar panel orientation.*
- *As illustrated on Figure 16*[68]*, flat, smooth surfaces reflect a more concentrated amount of sunlight back to the receiver, which is referred to as specular reflection. The more a surface is polished, the more it shines. Rough or uneven surfaces reflect light in a diffused or scattered manner and, therefore, the light will not be received as bright.*
- *Because the FAA has no specific standards for airport solar facilities and potential glare, the type of glare analysis may vary. Depending on site specifics (e.g., existing land uses, location and size of the project) an acceptable evaluation could involve one or more of the following levels of assessment:*
    - *A qualitative analysis of potential impact in consultation with the Control Tower, pilots and airport officials;*
    - *A demonstration field test with solar panels at the proposed site in coordination with FAA Tower personnel;*
    - *A geometric analysis to determine days and times when an impact is predicted.*
- *The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and system design.*
- ***1. Assessing Baseline Reflectivity Conditions** – Reflection in the form of glare is present in current aviation operations. The existing sources of glare come from glass windows, auto surface parking, rooftops, and water bodies. At airports, existing reflecting surfaces may include hangar roofs, surface parking, and glassy office buildings. To minimize unexpected glare, windows of air traffic control towers and airplane cockpits are coated with anti-reflective glazing. Operators also wear polarized eye wear. Potential glare from solar panels should be viewed in this context. Any airport considering a solar PV project should first*

[67] Flash Blindness, as described in the FAA guidelines, can be described as a temporary visual interference effect that persists after the source of illumination has ceased. This occurs from many reflective materials in the ambient environment.

[68] First figure in Appendix B.

review existing sources of glare at the airport and the effectiveness of measures used to mitigate that glare.

- ***2. Tests in the Field*** *– Potential glare from solar panels can easily be viewed at the airport through a field test. A few airports have coordinated these tests with FAA Air Traffic Controllers to assess the significance of glare impacts. To conduct such a test, a sponsor can take a solar panel out to proposed location of the solar project, and tilt the panel in different directions to evaluate the potential for glare onto the air traffic control tower. For the two known cases where a field test was conducted, tower personnel determined the glare was not significant. If there is a significant glare impact, the project can be modified by ensuring panels are not directed in that direction.*
- ***3. Geometric Analysis*** *– Geometric studies are the most technical approach for reflectivity issues. They are conducted when glare is difficult to assess through other methods. Studies of glare can employ geometry and the known path of the sun to predict when sunlight will reflect off of a fixed surface (like a solar panel) and contact a fixed receptor (e.g., control tower). At any given site, the sun moves across the sky every day and its path in the sky changes throughout year. This in turn alters the destination of the resultant reflections since the angle of reflection for the solar panels will be the same as the angle at which the sun hits the panels. The larger the reflective surface, the greater the likelihood of glare impacts.*
- *Facilities placed in remote locations, like the desert, will be far from receptors and therefore potential impacts are limited to passing aircraft. Because the intensity of the light reflected from the solar panel decreases with increasing distance, an appropriate question is how far you need to be from a solar reflected surface to avoid flash blindness. It is known that this distance is directly proportional to the size of the array in question69 but still requires further research to definitively answer.*
- ***Experiences of Existing Airport Solar Projects*** *– Solar installations are presently operating at a number of airports, including megawatt-sized solar facilities covering multiple acres. Air traffic control towers have expressed concern about glint and glare from a small number of solar installations. These were often instances when solar installations were sited between the tower and airfield, or for installations with inadequate or no reflectivity analysis. Adequate reflectivity analysis and alternative siting addressed initial issues at those installations.*

Air Navigation Order (ANO) 2009

In some instances, an aviation stakeholder can refer to the ANO 2009 with regard to safeguarding. Key points from the document are presented below.

Endangering safety of an aircraft

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[69] Ho, Clifford, Cheryl Ghanbari, and Richard Diver. 2009. Hazard Analysis of Glint and Glare From Concentrating Solar Power Plants. SolarPACES 2009, Berlin Germany. Sandia National Laboratories.

137. A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft.

Lights liable to endanger

221.

(1) 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 from or landing at an Airport; or

(b) by reason of its liability to be mistaken for an aeronautical ground light is liable to endanger aircraft.

(2) If any light which appears to the CAA to be a light described in paragraph (1) is exhibited, the CAA may direct the person who is the occupier of the place where the light is exhibited or who has charge of the light, to take such steps within a reasonable time as are specified in the direction—

(a) to extinguish or screen the light; and

(b) to prevent in the future the exhibition of any other light which may similarly endanger aircraft.

(3) The direction may be served either personally or by post, or by affixing it in some conspicuous place near to the light to which it relates.

(4) In the case of a light which is or may be visible from any waters within the area of a general lighthouse authority, the power of the CAA under this article must not be exercised except with the consent of that authority.

Lights which dazzle or distract

222. 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.'

The document states that no 'light', 'dazzle' or 'glare' should be produced which will create a detrimental impact upon aircraft safety.

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

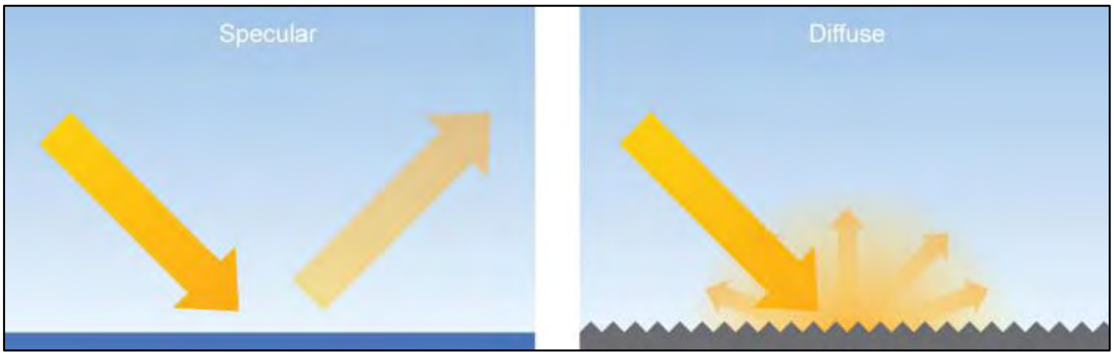
Overview

Studies have been undertaken assessing the type and intensity of solar reflections from various surfaces including solar panels and glass. An overview of these studies is presented below.

The guidelines presented are related to aviation safety. The results are applicable for the purpose of this analysis.

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance[70], illustrates the difference between the two types of reflections. Because solar panels are flat and have a smooth surface most of the light reflected is specular, which means that incident light from a specific direction is reradiated in a specific direction.



Specular and diffuse reflections

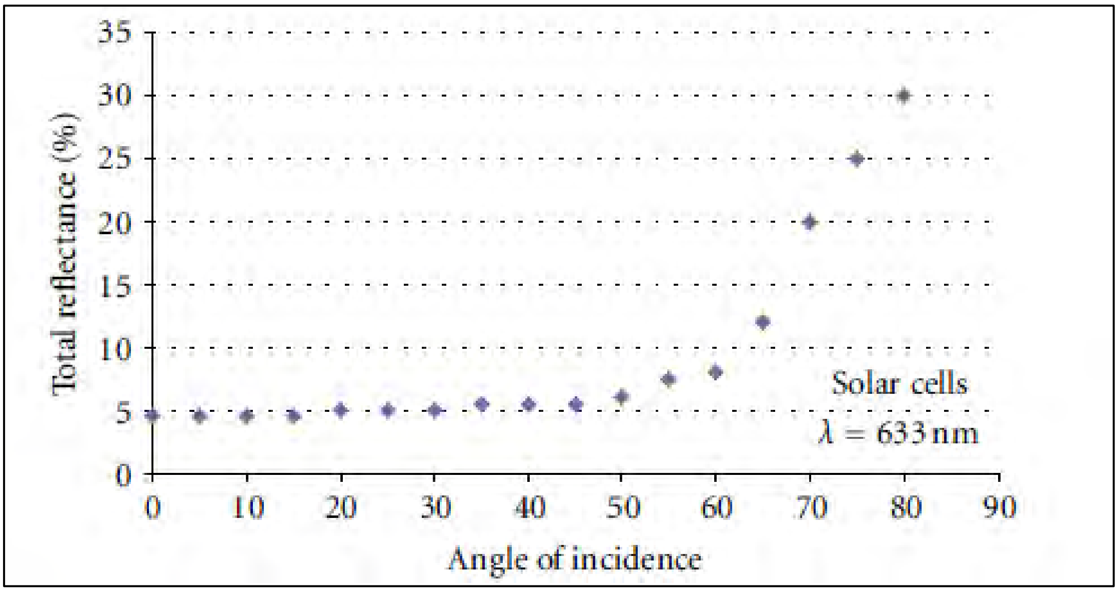
[70] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

Solar Reflection Studies

An overview of content from identified solar panel reflectivity studies is presented in the subsections below.

Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems"

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[71]". They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure below.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

- The potential for hazardous glare from flat-plate PV systems is similar to that of smooth water;
- Portland white cement concrete (which is a common concrete for runways), snow, and structural glass all have a reflectivity greater than water and flat plate PV modules.

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[71] Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems," ISRN Renewable Energy, vol. 2011, Article ID 651857, 6 pages, 2011. doi:10.5402/2011/651857

FAA Guidance – "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[72]

The 2010 FAA Guidance included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. A table of reflectivity values, sourced from the figure within the FAA guidance, is presented below.

Surface	Approximate Percentage of Light Reflected[73]
Snow	80
White Concrete	77
Bare Aluminium	74
Vegetation	50
Bare Soil	30
Wood Shingle	17
Water	5
Solar Panels	5
Black Asphalt	2

Relative reflectivity of various surfaces

Note that the data above does not appear to consider the reflection type (specular or diffuse).

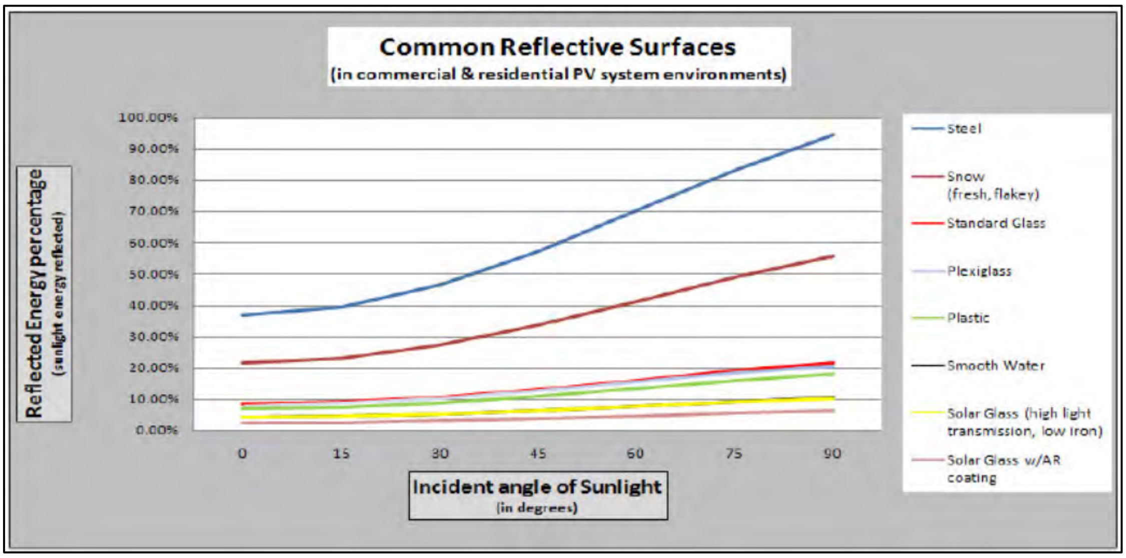
An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

[72] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.
[73] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

SunPower Technical Notification (2009)

SunPower published a technical notification[74] to '*increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment*'.

The figure presented below shows the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel.



Common reflective surfaces

The results, similarly to those from Riley and Olsen study (2011) and the FAA (2010), show that solar panels produce a reflection that is less intense than those of '*standard glass and other common reflective surfaces*'.

With respect to aviation and solar reflections observed from the air, SunPower has developed several large installations near airports or on Air Force bases. It is stated that these developments have all passed FAA or Air Force standards with all developments considered "No Hazard to Air Navigation". The note suggests that developers discuss any possible concerns with stakeholders near proposed solar farms.

[74] Source: Technical Support, 2009. SunPower Technical Notification – Solar Module Glare and Reflectance.

APPENDIX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

The Sun's position in the sky can be accurately described by its azimuth and elevation. Azimuth is a direction relative to true north (horizontal angle i.e. from left to right) and elevation describes the Sun's angle relative to the horizon (vertical angle i.e. up and down).

The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

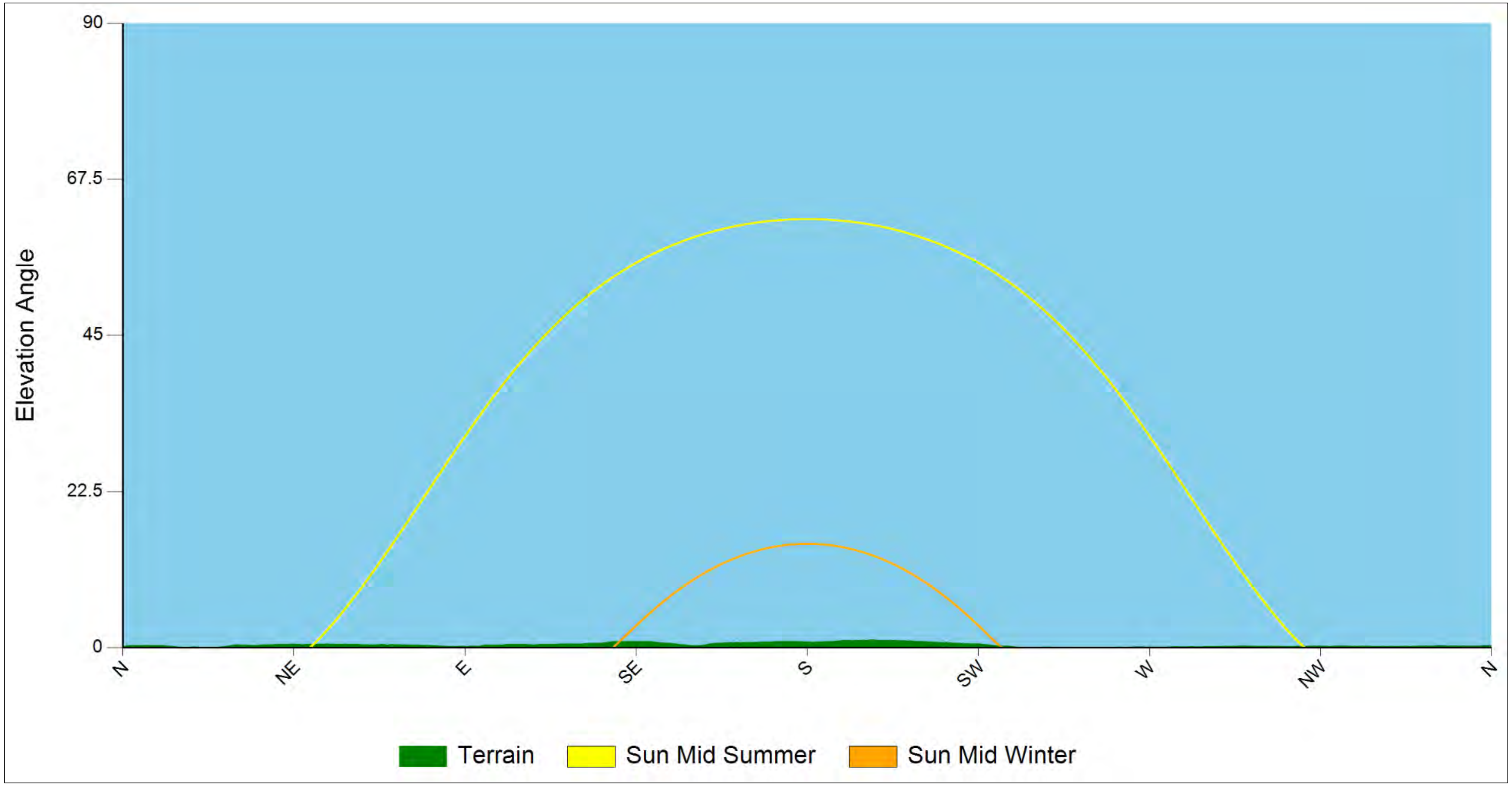
- Time;
- Date;
- Latitude;
- Longitude.

The following is true at the location of the solar development:

- The Sun is at its highest around midday and is to the south at this time;
- The Sun rises highest on 21 June reaching a maximum elevation of approximately 60-65 degrees (longest day);
- On 21 December, the maximum elevation reached by the Sun is approximately 10-15 degrees (shortest day).

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a reflector are shown in the figure on the following page.

Terrain Sun Curve - From lon: -0.324437 lat: 51.661118



APPENDIX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

The significance of glint and glare will vary for different receptors. The following section presents a general overview of the significance criteria with respect to experiencing a solar reflection.

Impact Significance Definition

The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

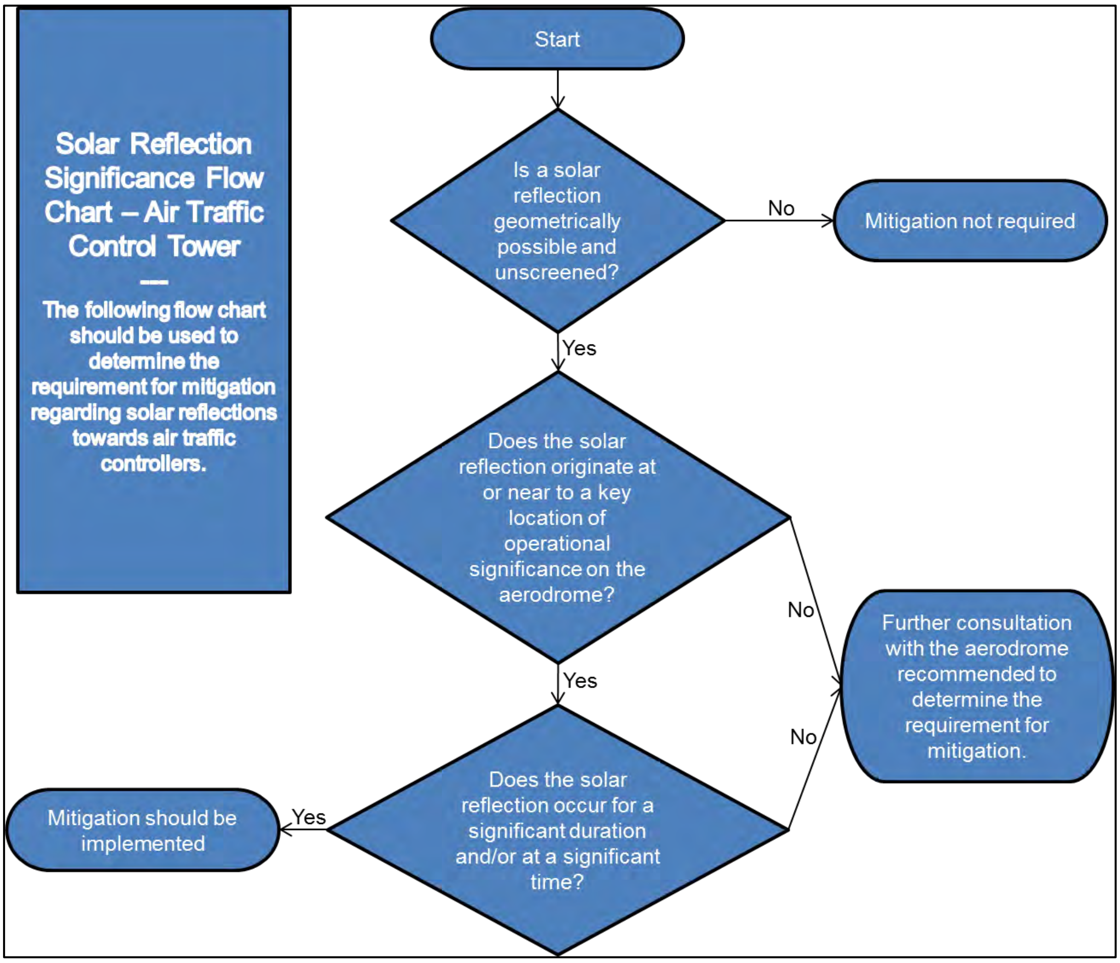
Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels.	No mitigation required.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case.	Whilst the impact may be acceptable, consultation and/or further analysis should be undertaken to determine the requirement for mitigation.
Major	A solar reflection is geometrically possible and visible under conditions that will produce a significant impact. Mitigation and consultation is recommended.	Mitigation will be required if the proposed development is to proceed.

Impact significance definition

The flow charts presented in the following sub-sections have been followed when determining the mitigation requirement for the assessed aviation receptors.

Assessment Process – ATC Tower

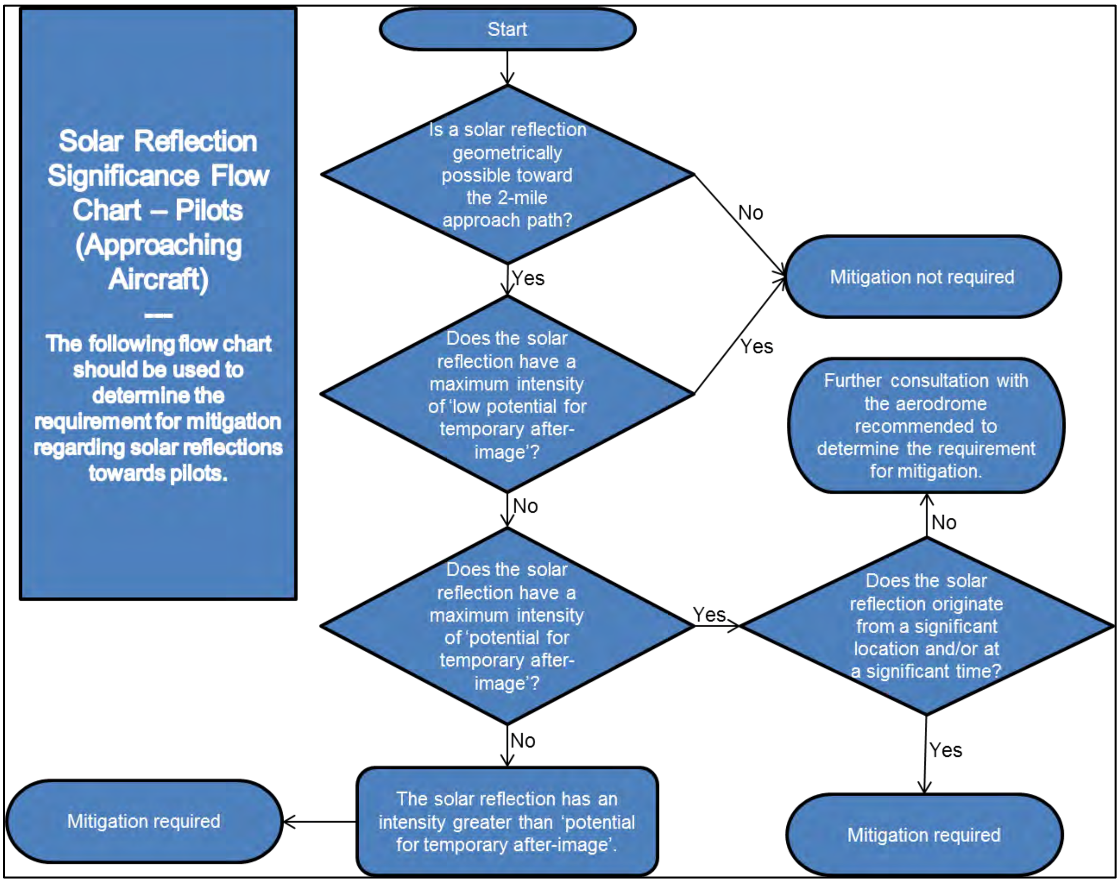
The charts relate to the determining the potential impact upon the ATC Tower. The flow chart is produced by Pager Power following the relative guidance.



ATC Tower mitigation requirement flow chart

Assessment Process – Approaching Aircraft

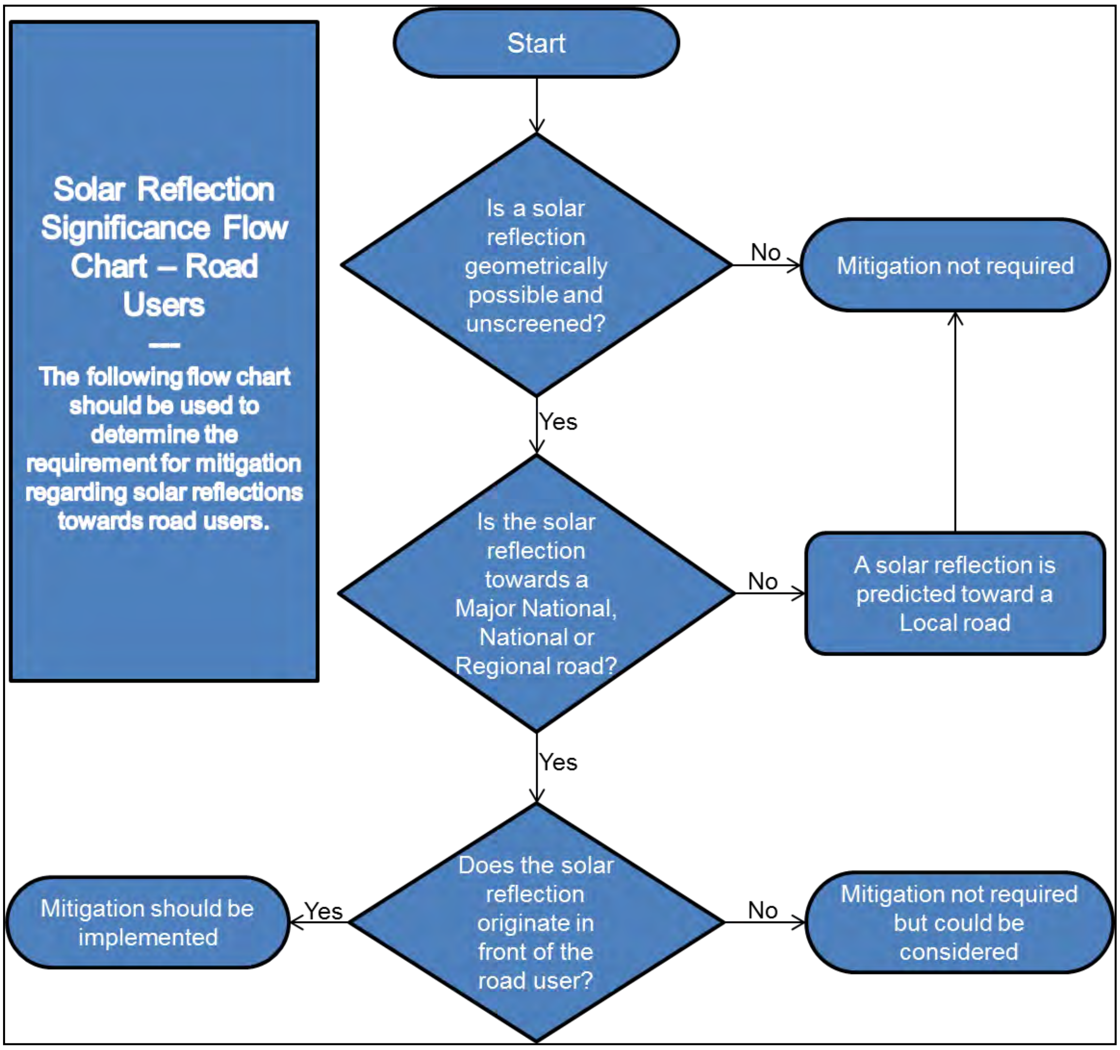
The charts relate to the determining the potential impact upon approaching aircraft. The flow chart is produced by Pager Power following the relative guidance.



Approaching aircraft receptor mitigation requirement flow chart

Assessment Process – Road Users

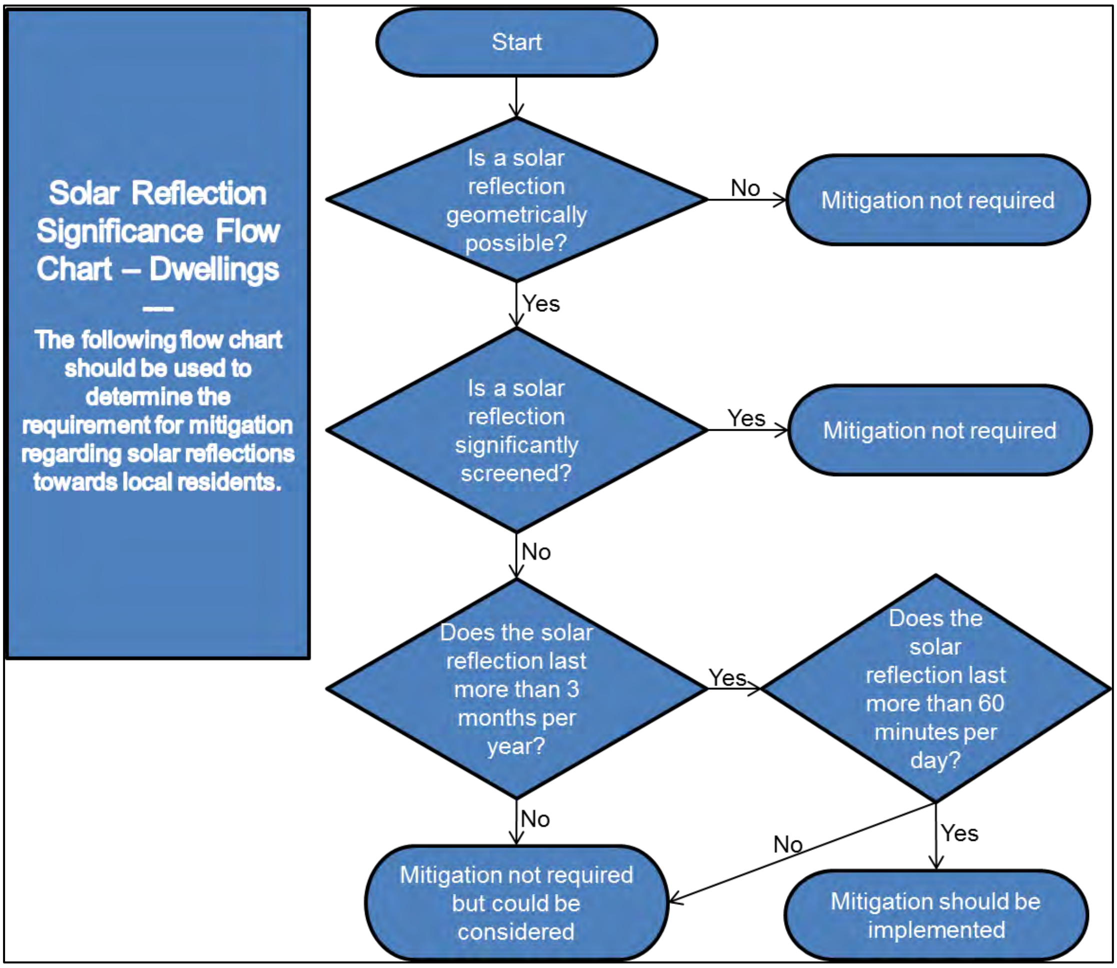
The flow chart presented below has been followed when determining the mitigation requirement for road receptors. The flow chart is produced by Pager Power following the relative guidance.



Road receptor mitigation requirement flow chart

Assessment Process – Dwellings

The flow chart presented below has been followed when determining the mitigation requirement for dwelling receptors. The flow chart is produced by Pager Power following the relative guidance.



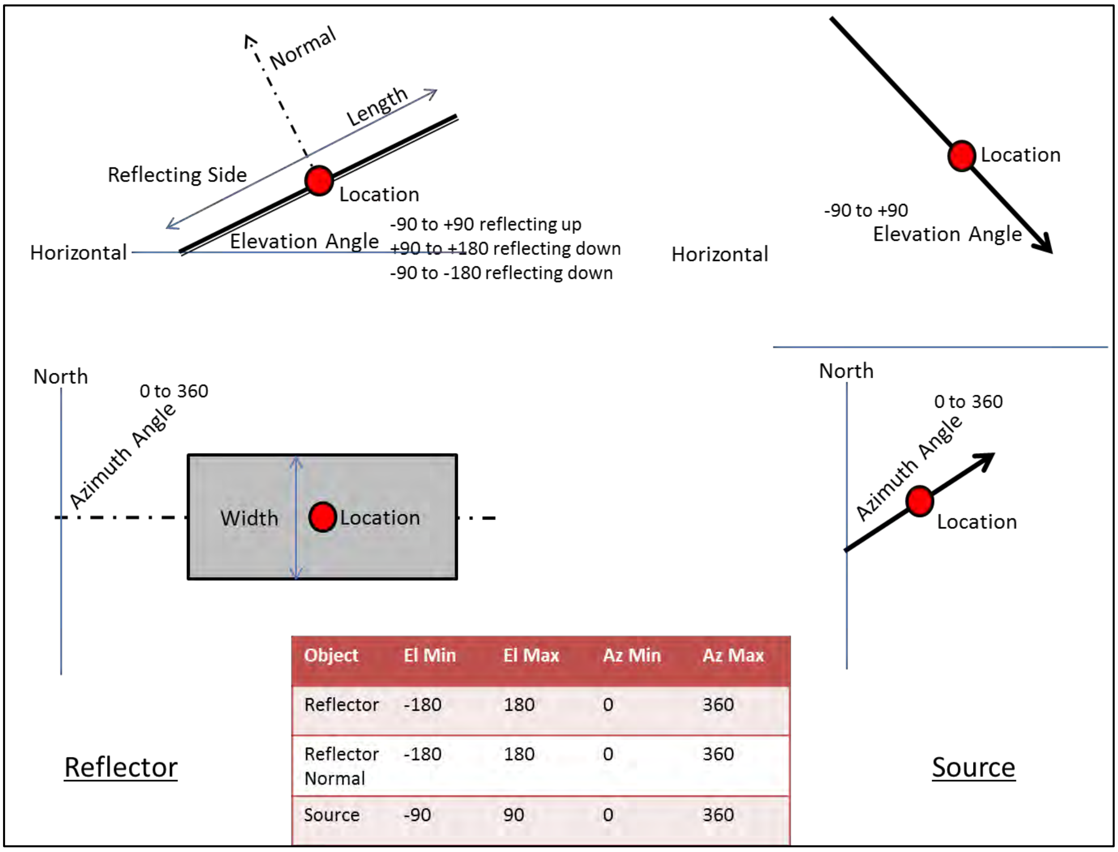
Dwelling receptor mitigation requirement flow chart

APPENDIX E – PAGER POWER'S REFLECTION CALCULATIONS METHODOLOGY

The calculations are three dimensional and complex, accounting for:

- The Earth's orbit around the Sun;
- The Earth's rotation;
- The Earth's orientation;
- The reflector's location;
- The reflector's 3D Orientation.

Reflections from a flat reflector are calculated by considering the normal which is an imaginary line that is perpendicular to the reflective surface and originates from it. The diagram below may be used to aid understanding of the reflection calculation process.



Object	El Min	El Max	Az Min	Az Max
Reflector	-180	180	0	360
Reflector Normal	-180	180	0	360
Source	-90	90	0	360

The following process is used to determine the 3D azimuth and elevation of a reflection:

- Use the Latitude and Longitude of reflector as the reference for calculation purposes;
- Calculate the Azimuth and Elevation of the normal to the reflector;

- Calculate the 3D angle between the source and the normal;
- If this angle is less than 90 degrees a reflection will occur. If it is greater than 90 degrees no reflection will occur because the source is behind the reflector;
- Calculate the Azimuth and Elevation of the reflection in accordance with the following:
    - The angle between source and normal is equal to angle between normal and reflection;
    - Source, Normal and Reflection are in the same plane.

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Pager Power's Model

It is assumed that the panel elevation angle provided by the developer represents the elevation angle for all of the panels within the solar development unless otherwise stated.

It is assumed that the panel azimuth angle provided by the developer represents the azimuth angle for all of the panels within the solar development unless otherwise stated.

Only a reflection from the face of the panel has been considered. The frame or the reverse of the solar panel has not been considered as it does not contribute to the model over and above the predominant source of reflection for assessment which is the face of the panel.

The model assumes that a receptor can view the face of every panel within the proposed development area whilst in reality this, in the majority of cases, will not occur. Therefore any predicted reflection from the face of a solar panel that is not visible to a receptor will not occur.

A finite number of points within the proposed development are chosen based on an assessment resolution so we can build a comprehensive understanding of the entire development. This will determine whether a reflection could ever occur at a chosen receptor. The calculations do not incorporate all of the possible panel locations within the development outline.

A single reflection point on the panel has been chosen for the geometric calculations. This will suitably determine whether a reflection can be experienced at a location and the general time of year and duration of this reflection. Increased accuracy could be achieved by increasing the number of heights assessed however this would only marginally change the results and is not considered significant.

Whilst line of sight to the development from receptors has been considered, only available street view imagery and satellite mapping has been used. In some cases this imagery may not be up to date and may not give the full perspective of the installation from the location of the assessed receptor.

Any screening in the form of trees, buildings etc. that may obstruct the Sun from view of the solar panels is not considered unless stated.

Sandia National Laboratories' (SGHAT) Model

The following text is taken from the Solar Glare Hazard Analysis Tool (SGHAT) Technical Reference Manual[75] which was previously freely available. The following is presented for reference.

3. Assumptions and Limitations

Below is a list of assumptions and limitations of the models and methods used in SGHAT:

- The software currently only applies to flat reflective surfaces. For curved surfaces (e.g., focused mirrors such as parabolic troughs or dishes used in concentrating solar power systems), methods and models derived by Ho et al. (2011) [1] can be used and are currently being evaluated for implementation into future versions SGHAT.
- When enabled, PV array single- or dual-axis tracking does not account for backtracking or the effects of panel shading and blocking.
- SGHAT does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
- SGHAT assumes that the PV array is aligned with a plane defined by the total heights of the coordinates outlined in the Google map. For more accuracy, the user should perform runs using minimum and maximum values for the vertex heights to bound the height of the plane containing the solar array. Doing so will expand the range of observed solar glare when compared to results using a single height value.
- SGHAT 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 variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm [2] and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
- The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

[75] https://share-ng.sandia.gov/glare-tools/references/SGHAT_Technical_Reference-v6.pdf

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

ATC Tower Receptor Details

The details are presented in the table below.

Longitude (°)	Latitude (°)	Ground Height (m amsl)	ATC Tower Cabin Height (m agl)	Overall Assessed Height (m amsl)
-0.32358	51.65467	95.31	5.00	100.31

ATC Tower receptor details

The Approach Path for Aircraft Landing on Runway 08

Table 2 below presents the data for the assessed locations for aircraft on approach to runway 08. The altitude of the aircraft is based on a 3-degree descent path referenced to 50 feet (15.2m) above the runway threshold.

No.	Longitude (°)	Latitude (°)	Distance from Runway Threshold (m)	Assessed Altitude (m amsl)
1	-0.33048	51.65530	Threshold	115.82
2	-0.33278	51.65504	0.1 miles	124.25
3	-0.33507	51.65478	0.2 miles	132.67
4	-0.33737	51.65452	0.3 miles	141.09
5	-0.33967	51.65426	0.4 miles	149.51
6	-0.34196	51.65400	0.5 miles	157.94
7	-0.34426	51.65374	0.6 miles	166.36
8	-0.34656	51.65348	0.7 miles	174.78
9	-0.34885	51.65322	0.8 miles	183.21
10	-0.35115	51.65296	0.9 miles	191.63
11	-0.35345	51.65270	1.0 mile	200.05
12	-0.35574	51.65244	1.1 miles	208.47
13	-0.35804	51.65218	1.2 miles	216.90
14	-0.36034	51.65192	1.3 miles	225.32
15	-0.36263	51.65166	1.4 miles	233.74
16	-0.36493	51.65140	1.5 miles	242.16
17	-0.36723	51.65114	1.6 miles	250.59
18	-0.36952	51.65088	1.7 miles	259.01
19	-0.37182	51.65062	1.8 miles	267.43
20	-0.37412	51.65036	1.9 miles	275.85
21	-0.37641	51.65010	2.0 miles	284.28

Assessed receptor (aircraft) locations on the approach path for runway 08

The Approach Path for Aircraft Landing on Runway 26

Table 3 below presents the data for the assessed locations for aircraft on approach to runway 26. The altitude of the aircraft is based on a 3-degree descent path referenced to 50 feet (15.2m) above the runway threshold.

No.	Longitude (°)	Latitude (°)	Distance from Runway Threshold (m)	Assessed Altitude (m amsl)
22	-0.32122	51.65635	Threshold	106.98
23	-0.31893	51.65661	0.1 miles	115.41
24	-0.31663	51.65687	0.2 miles	123.83
25	-0.31433	51.65713	0.3 miles	132.25
26	-0.31204	51.65739	0.4 miles	140.68
27	-0.30974	51.65765	0.5 miles	149.10
28	-0.30744	51.65791	0.6 miles	157.52
29	-0.30515	51.65817	0.7 miles	165.94
30	-0.30285	51.65843	0.8 miles	174.37
31	-0.30055	51.65869	0.9 miles	182.79
32	-0.29826	51.65895	1.0 mile	191.21
33	-0.29596	51.65921	1.1 miles	199.63
34	-0.29366	51.65947	1.2 miles	208.06
35	-0.29137	51.65973	1.3 miles	216.48
36	-0.28907	51.65999	1.4 miles	224.90
37	-0.28677	51.66025	1.5 miles	233.32
38	-0.28448	51.66051	1.6 miles	241.75
39	-0.28218	51.66076	1.7 miles	250.17
40	-0.27988	51.66102	1.8 miles	258.59
41	-0.27758	51.66128	1.9 miles	267.02
42	-0.27529	51.66154	2.0 miles	275.44

Assessed receptor (aircraft) locations on the approach path for runway 26

Dwelling Receptor Details

The details are presented in the table below.

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
0	-0.34798	51.65958	74.57
1	-0.34792	51.65953	74.77
2	-0.34775	51.65943	74.91
3	-0.34749	51.65942	75.40
4	-0.34679	51.65921	75.81
5	-0.34680	51.65900	74.70
6	-0.34614	51.65847	73.80
7	-0.34581	51.65557	80.88
8	-0.34573	51.65538	81.25
9	-0.34620	51.65121	92.80
10	-0.34463	51.65029	91.80
11	-0.34438	51.65011	91.80
12	-0.34359	51.64994	90.34
13	-0.34327	51.64994	90.31
14	-0.34342	51.64969	90.80
15	-0.34365	51.64945	90.80
16	-0.34386	51.64934	91.28
17	-0.34401	51.64917	91.63
18	-0.34419	51.64896	91.80
19	-0.34446	51.64870	92.06
20	-0.34482	51.64854	93.47
21	-0.34517	51.64835	93.80
22	-0.34540	51.64805	94.98
23	-0.33476	51.65070	89.80
24	-0.33659	51.65202	82.35

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
25	-0.33598	51.65313	91.65
26	-0.33640	51.65323	91.01
27	-0.33990	51.65524	82.33
28	-0.33891	51.65545	82.84
29	-0.34667	51.64775	96.19
30	-0.34710	51.64739	97.24
31	-0.34705	51.64714	98.51
32	-0.34640	51.64705	97.80
33	-0.34689	51.64687	98.50
34	-0.34696	51.64671	98.65
35	-0.34677	51.64656	98.90
36	-0.34673	51.64639	99.21
37	-0.34665	51.64627	99.51
38	-0.34656	51.64609	99.82
39	-0.34642	51.64593	100.19
40	-0.34625	51.64565	100.32
41	-0.34623	51.64549	100.57
42	-0.34613	51.64532	100.65
43	-0.34602	51.64517	100.94
44	-0.34589	51.64510	100.99
45	-0.34445	51.64548	99.20
46	-0.34432	51.64541	99.41
47	-0.34417	51.64531	99.58
48	-0.34414	51.64523	100.34
49	-0.34403	51.64519	100.32
50	-0.34400	51.64510	100.50
51	-0.34388	51.64504	100.60

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
52	-0.34381	51.64495	101.10
53	-0.34370	51.64489	101.54
54	-0.34365	51.64481	101.76
55	-0.34357	51.64470	102.21
56	-0.34341	51.64463	102.84
57	-0.34329	51.64458	102.99
58	-0.34326	51.64450	103.38
59	-0.34318	51.64442	103.90
60	-0.33249	51.66971	90.64
61	-0.33388	51.66875	86.82
62	-0.33429	51.66846	85.81
63	-0.33472	51.66821	85.60
64	-0.33493	51.66799	84.73
65	-0.33501	51.66781	83.33
66	-0.33519	51.66768	82.99
67	-0.33486	51.66747	81.62
68	-0.33513	51.66724	81.06
69	-0.33516	51.66705	80.58
70	-0.33487	51.66691	80.33
71	-0.33429	51.66678	80.80
72	-0.33466	51.66643	80.00
73	-0.33390	51.66608	80.09
74	-0.33388	51.66576	79.90
75	-0.33196	51.66568	79.80
76	-0.33237	51.66560	79.80
77	-0.33302	51.66533	79.80
78	-0.33313	51.66513	79.80

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
79	-0.33100	51.66456	83.23
80	-0.32990	51.66432	85.90
81	-0.32664	51.66433	92.71
82	-0.32720	51.66357	92.80
83	-0.32755	51.66325	92.80
84	-0.32708	51.66280	92.80
85	-0.32662	51.66268	92.80
86	-0.32508	51.66299	91.93
87	-0.32566	51.66267	91.80
88	-0.32491	51.66213	91.80
89	-0.32399	51.66107	90.80
90	-0.32270	51.66122	89.80
91	-0.32221	51.66038	89.98
92	-0.31770	51.65878	91.80
93	-0.31777	51.65854	91.80
94	-0.31857	51.65793	90.80
95	-0.32024	51.65505	93.80
96	-0.31944	51.65512	92.91
97	-0.31658	51.65849	91.80
98	-0.31601	51.65881	91.66
99	-0.30743	51.66482	86.80
100	-0.30768	51.66520	86.17
101	-0.30795	51.66539	85.06
102	-0.30785	51.66560	85.06
103	-0.30833	51.66798	82.80
104	-0.31391	51.66997	83.80
105	-0.31430	51.66987	83.66

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
106	-0.31461	51.67011	83.80
107	-0.31502	51.67023	84.15

Assessed receptor (dwellings) locations

Road Receptor Details

The details are presented in the table below.

M1

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
0	-0.34728	51.66034	76.12
1	-0.34595	51.65927	76.63
2	-0.34498	51.65809	76.55
3	-0.34433	51.65680	80.00
4	-0.34391	51.65549	80.66
5	-0.34364	51.65412	82.21
6	-0.34336	51.65280	84.51
7	-0.34281	51.65149	86.44
8	-0.34194	51.65023	88.31
9	-0.34072	51.64910	90.50
10	-0.33917	51.64816	91.50
11	-0.33743	51.64739	93.78
12	-0.33545	51.64677	97.74
13	-0.33356	51.64638	102.57
14	-0.33140	51.64599	107.03
15	-0.32938	51.64549	112.03
16	-0.32741	51.64486	114.48
17	-0.32562	51.64413	116.39

Assessed receptor (road) locations for M1

A41

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
18	-0.34509	51.65431	82.50
19	-0.34360	51.65333	83.32
20	-0.34211	51.65235	84.50
21	-0.34064	51.65137	85.69
22	-0.33915	51.65039	91.70
23	-0.33764	51.64940	92.50
24	-0.33617	51.64842	92.21
25	-0.33453	51.64754	95.78
26	-0.33269	51.64685	100.44
27	-0.33066	51.64641	105.43

Assessed receptor (road) locations for A41

Hilfield Lane

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
28	-0.34484	51.65935	78.88
29	-0.34361	51.65824	77.85
30	-0.34216	51.65723	79.50
31	-0.34081	51.65622	80.18
32	-0.33957	51.65516	82.23
33	-0.33879	51.65392	82.05
34	-0.33787	51.65264	81.22
35	-0.33658	51.65159	83.13
36	-0.33522	51.65050	89.96
37	-0.33432	51.64934	91.03
38	-0.33365	51.64810	94.32
39	-0.33325	51.64703	98.80

Assessed receptor (road) locations for Hilfield Lane

Aldenham Road

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
40	-0.33451	51.66592	79.50
41	-0.33315	51.66495	79.50
42	-0.33128	51.66424	82.76
43	-0.32957	51.66343	90.10
44	-0.32763	51.66283	92.50
45	-0.32571	51.66223	91.50
46	-0.32386	51.66147	90.10
47	-0.32217	51.66073	88.50
48	-0.32062	51.65968	88.57
49	-0.31957	51.65853	88.50
50	-0.31854	51.65739	90.50

Assessed receptor (road) locations for Aldenham Road

Butterfly Road

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
51	-0.31874	51.65765	90.50
52	-0.31717	51.65861	91.50
53	-0.31535	51.65934	90.50
54	-0.31353	51.66008	91.50
55	-0.31170	51.66081	91.50
56	-0.30989	51.66154	90.50
57	-0.30807	51.66224	91.41
58	-0.30597	51.66289	91.03

Assessed receptor (road) locations for Butterfly Road

A5183

No.	Longitude (°)	Latitude (°)	Assessed Altitude (m) (amsl)
59	-0.31118	51.67251	81.95
60	-0.31046	51.67129	78.75
61	-0.30981	51.66997	79.08
62	-0.30920	51.66864	80.39
63	-0.30843	51.66742	82.09
64	-0.30773	51.66615	84.22
65	-0.30703	51.66487	86.68
66	-0.30632	51.66360	88.36
67	-0.30560	51.66228	91.13
68	-0.30496	51.66106	91.50

Assessed receptor (road) locations for A5183

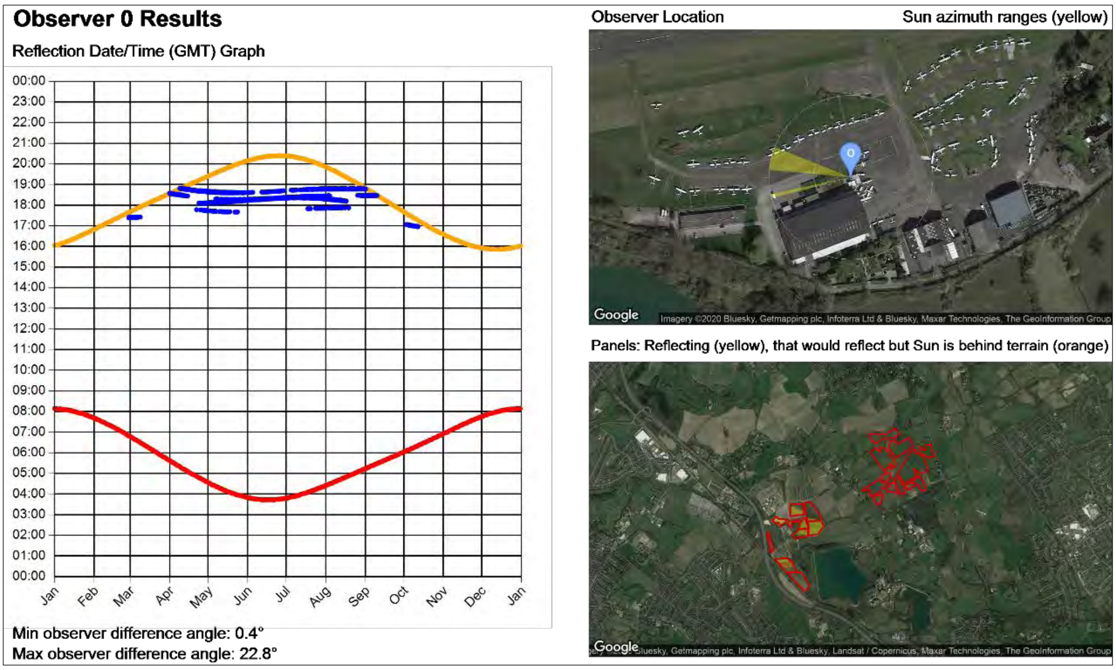
APPENDIX H – GEOMETRIC CALCULATION RESULTS – PAGER POWER RESULTS

Where a solar reflection has been found, a chart is produced. Each chart shows:

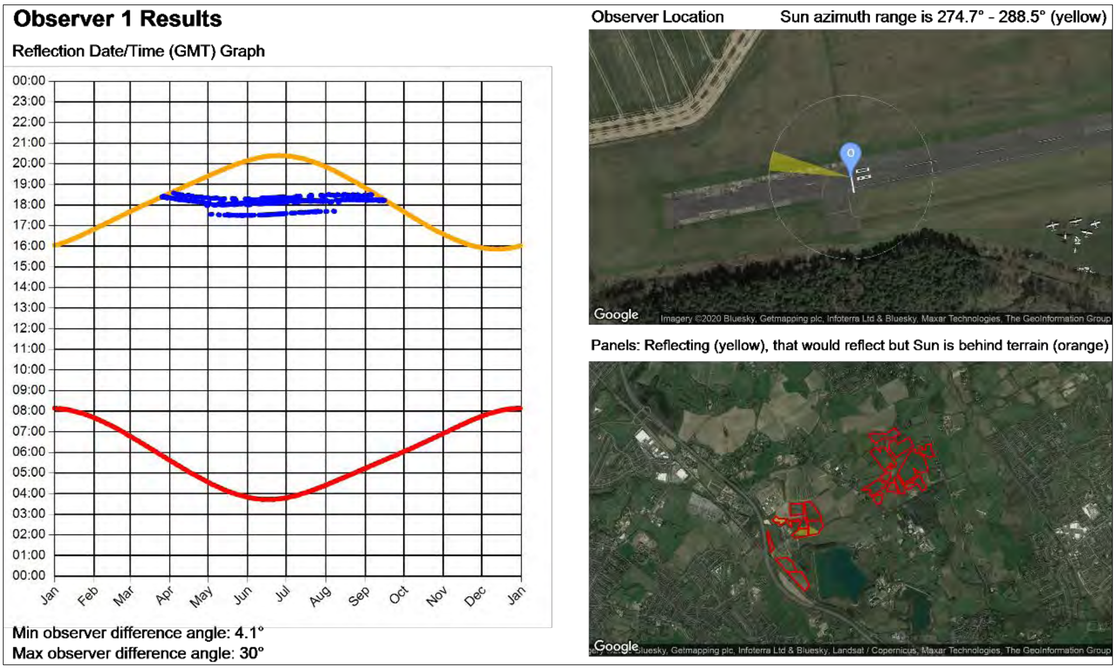
- The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible. If sunlight is experienced from the same direction as the reflecting panels, the overall impact of the reflection is reduced as discussed within the body of the report;
- The reflecting areas – bottom right image. The reflecting area is shown in yellow. If the yellow panels are not visible from the observer location, no issues will occur in practice. Additional obstructions which may obscure the reflector area from view are considered separately within the analysis;
- The reflection date/time graph – left hand side of the page. The blue line indicates the dates and times at which geometric reflections are possible. This relates to reflections from the yellow areas only;
- The red and yellow lines show the sunrise and sunset times respectively throughout the year.

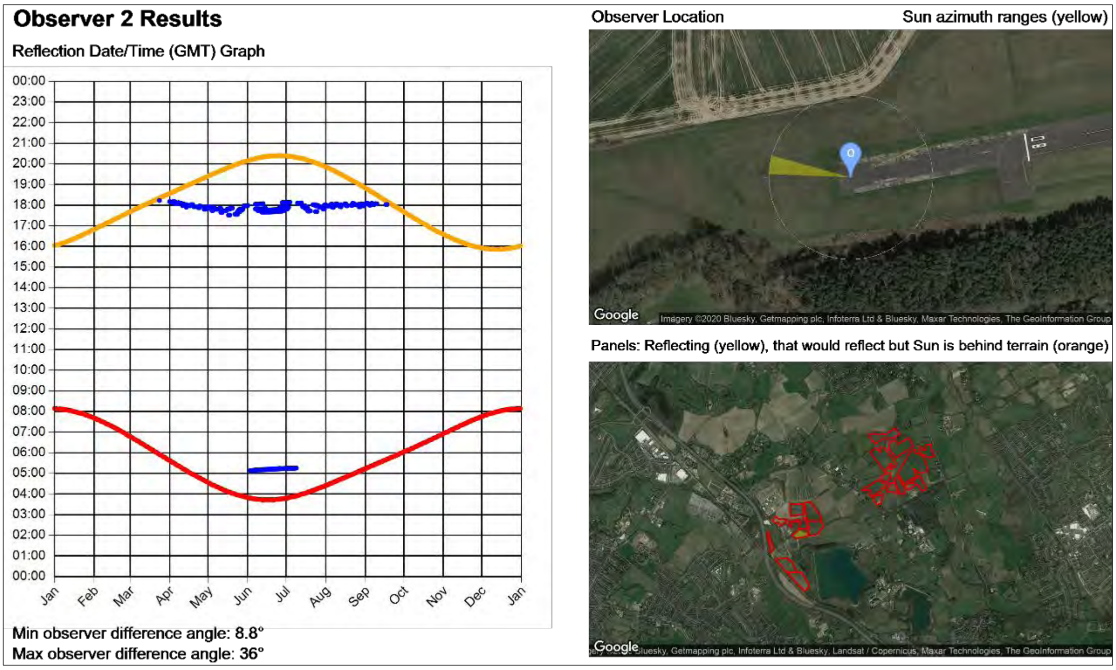
Aviation

ATC Tower



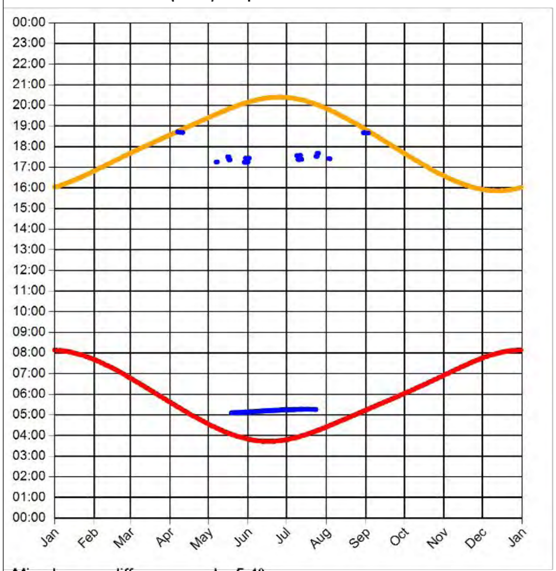
Approach 08


Observer 1 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 4.1°
Max observer difference angle: 30°
Observer Location
Sun azimuth range is 274.7° - 288.5° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 2 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 8.8°
Max observer difference angle: 36°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Observer 3 Results

Reflection Date/Time (GMT) Graph



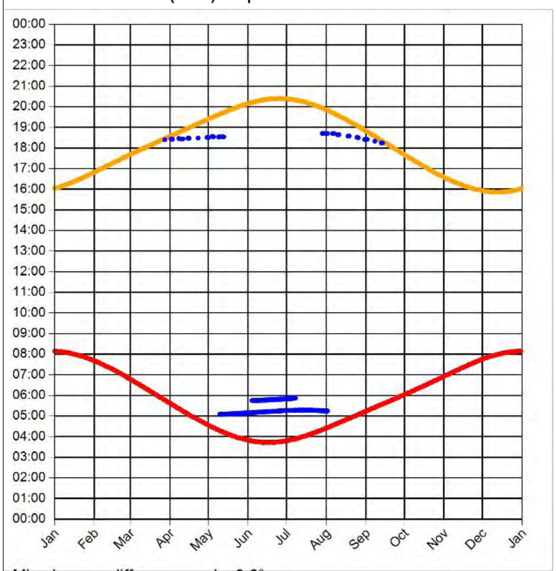
Min observer difference angle: 5.4°
Max observer difference angle: 44.9°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 4 Results

Reflection Date/Time (GMT) Graph



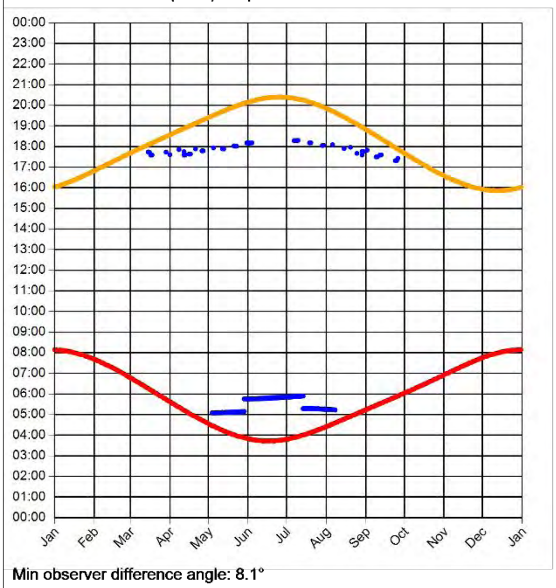
Min observer difference angle: 9.6°
Max observer difference angle: 18.5°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 5 Results

Reflection Date/Time (GMT) Graph



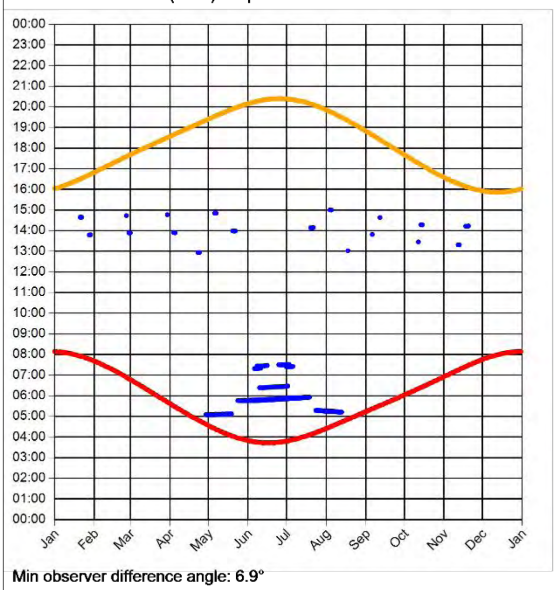
Min observer difference angle: 8.1°
Max observer difference angle: 34.6°

Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 6 Results

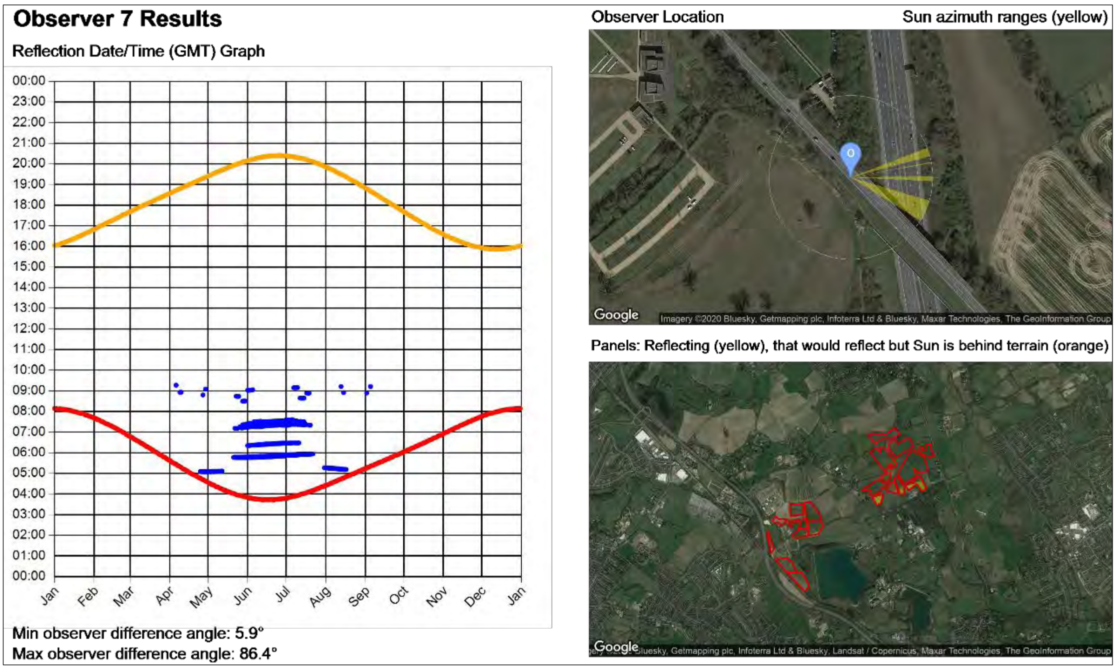
Reflection Date/Time (GMT) Graph

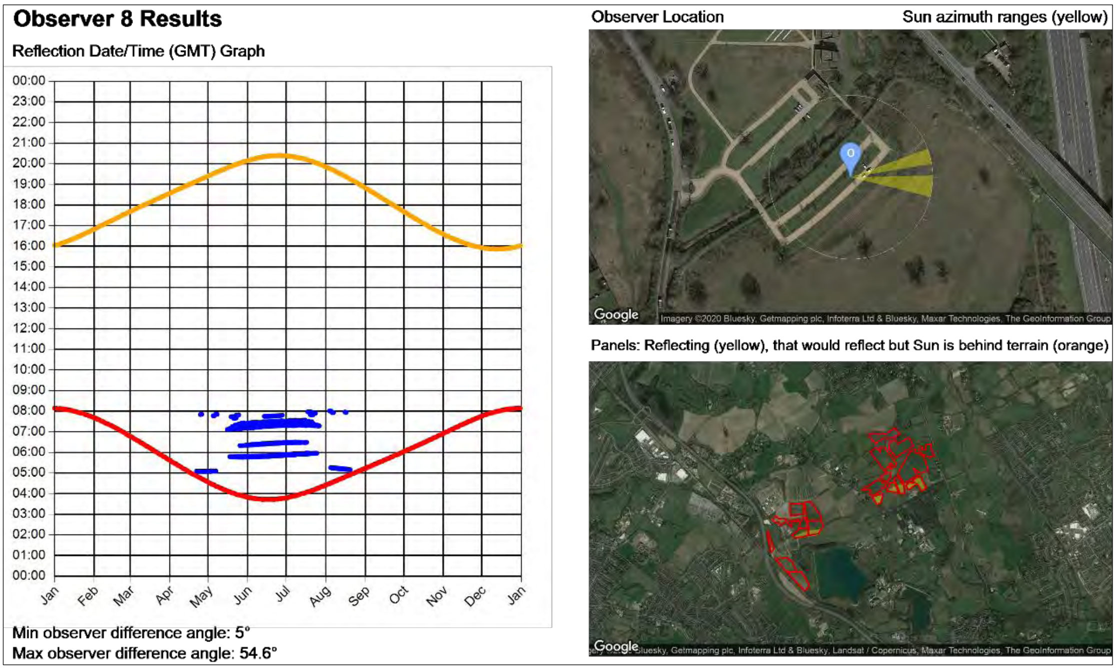


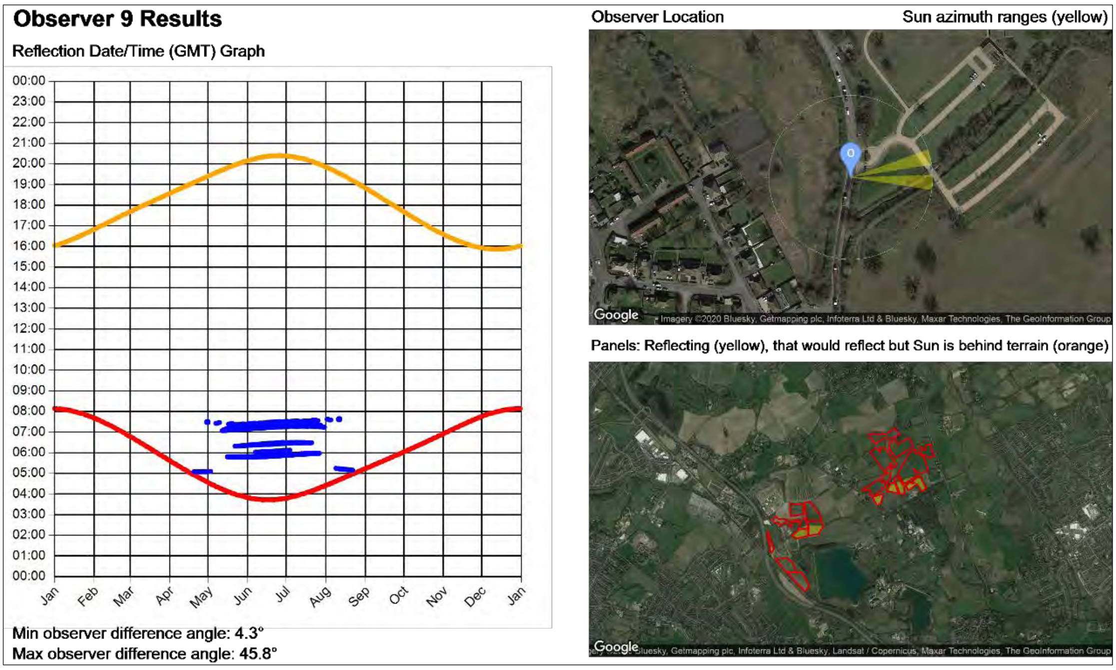
Min observer difference angle: 6.9°
Max observer difference angle: 98.5°

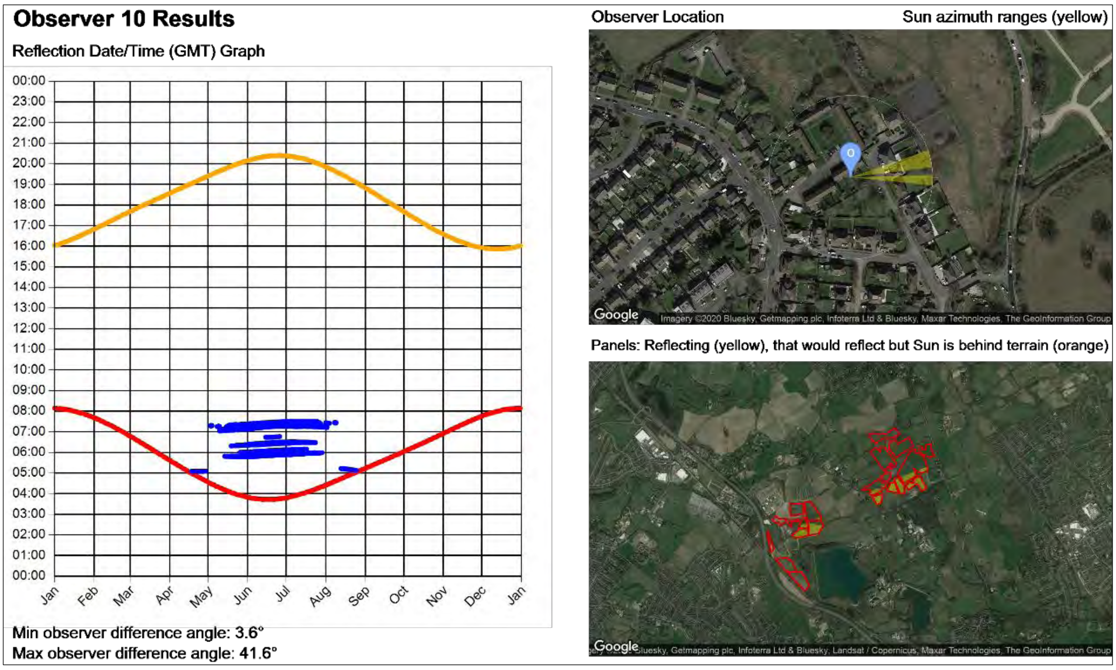
Observer Location — Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)


Observer 7 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 5.9°
Max observer difference angle: 86.4°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

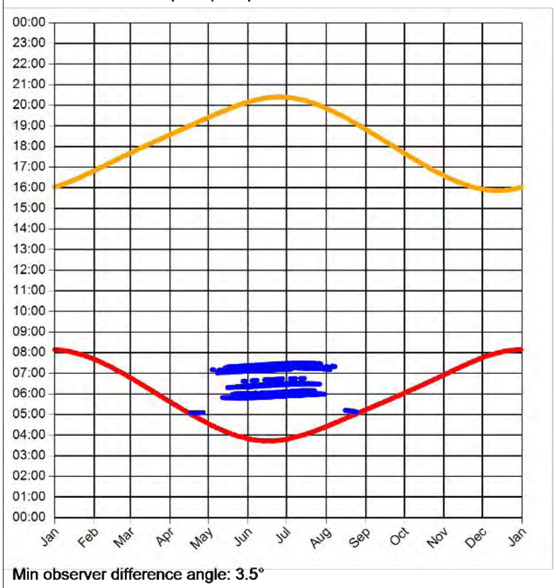

Observer 8 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 5°
Max observer difference angle: 54.6°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 9 Results
Reflection Date/Time (GMT) Graph
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 4.3°
Max observer difference angle: 45.8°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 10 Results
Reflection Date/Time (GMT) Graph
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 3.6°
Max observer difference angle: 41.6°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Observer 11 Results

Reflection Date/Time (GMT) Graph



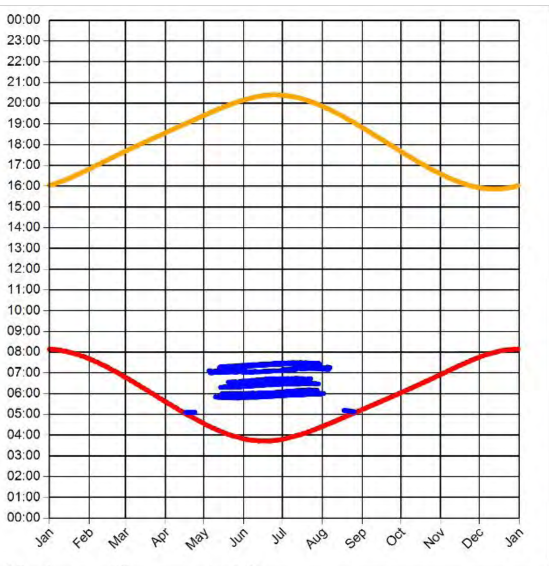
Min observer difference angle: 3.5°
Max observer difference angle: 40.2°

Observer Location — Sun azimuth range is 71.1° - 94° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 12 Results

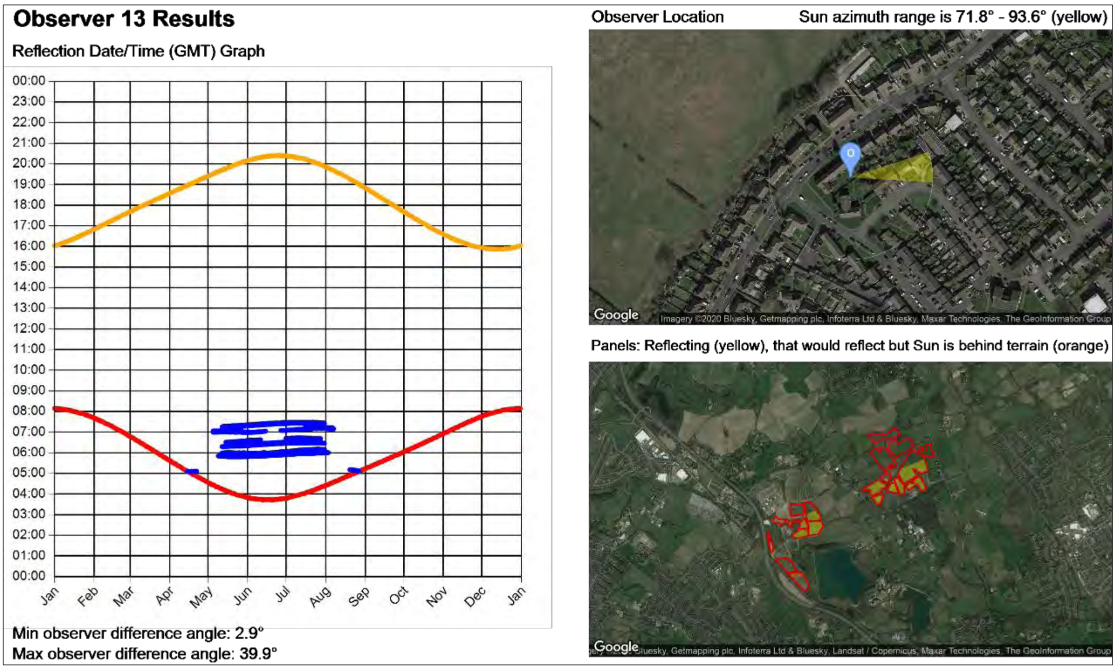
Reflection Date/Time (GMT) Graph

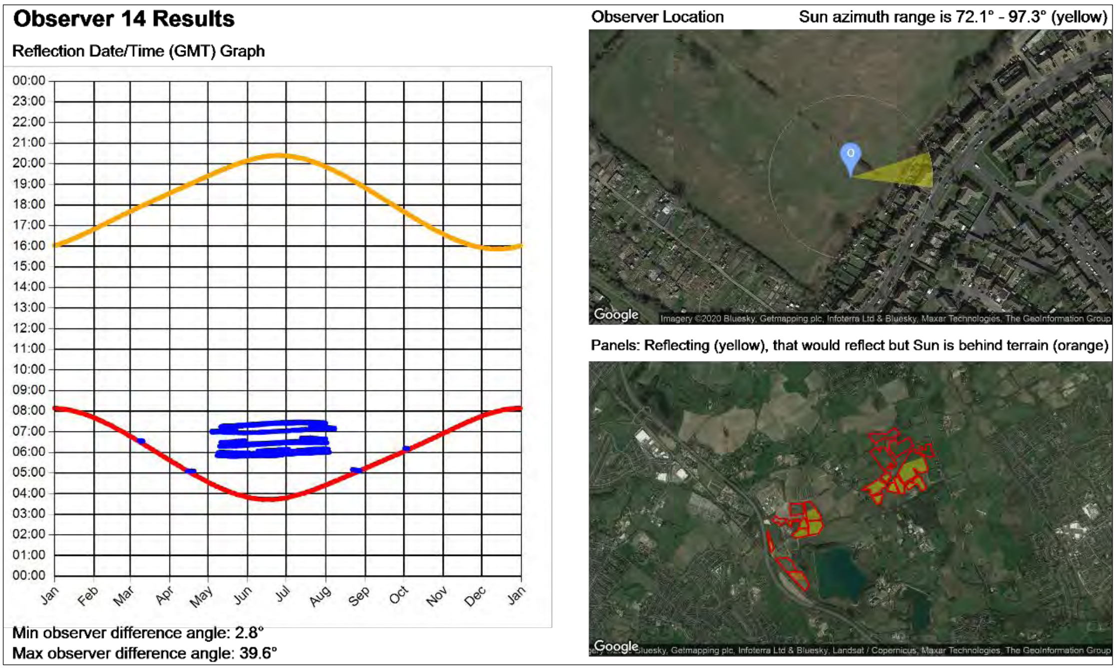


Min observer difference angle: 3.4°
Max observer difference angle: 40°

Observer Location — Sun azimuth range is 71.5° - 93.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

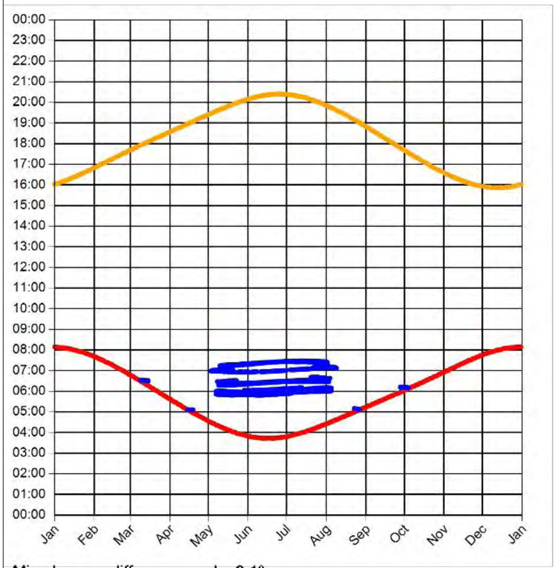

Observer 13 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 2.9°
Max observer difference angle: 39.9°
Observer Location
Sun azimuth range is 71.8° - 93.6° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 14 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 2.8°
Max observer difference angle: 39.6°
Observer Location
Sun azimuth range is 72.1° - 97.3° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

PAGERPOWER
Urban & Renewables

Observer 15 Results

Reflection Date/Time (GMT) Graph



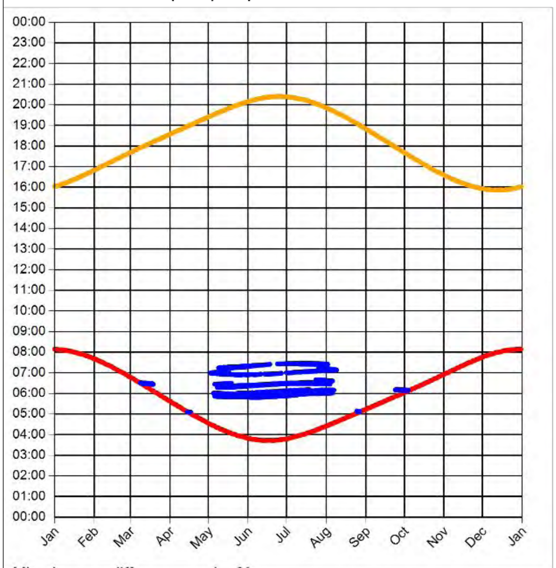
Min observer difference angle: 3.1°
Max observer difference angle: 39.3°

Observer Location — Sun azimuth range is 72.4° - 96.8° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 16 Results

Reflection Date/Time (GMT) Graph



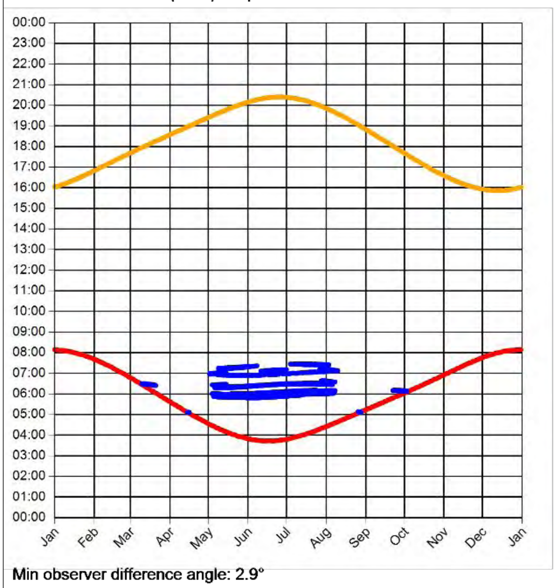
Min observer difference angle: 3°
Max observer difference angle: 39.2°

Observer Location — Sun azimuth range is 72.6° - 96.6° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 17 Results

Reflection Date/Time (GMT) Graph



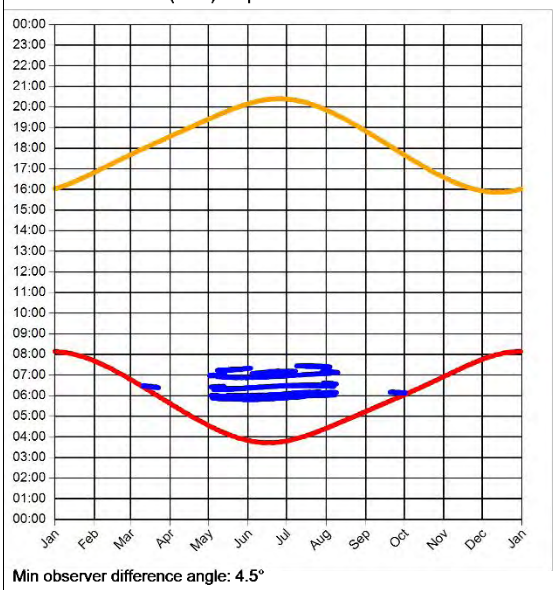
Min observer difference angle: 2.9°
Max observer difference angle: 38.5°

Observer Location — Sun azimuth range is 72.7° - 96° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 18 Results

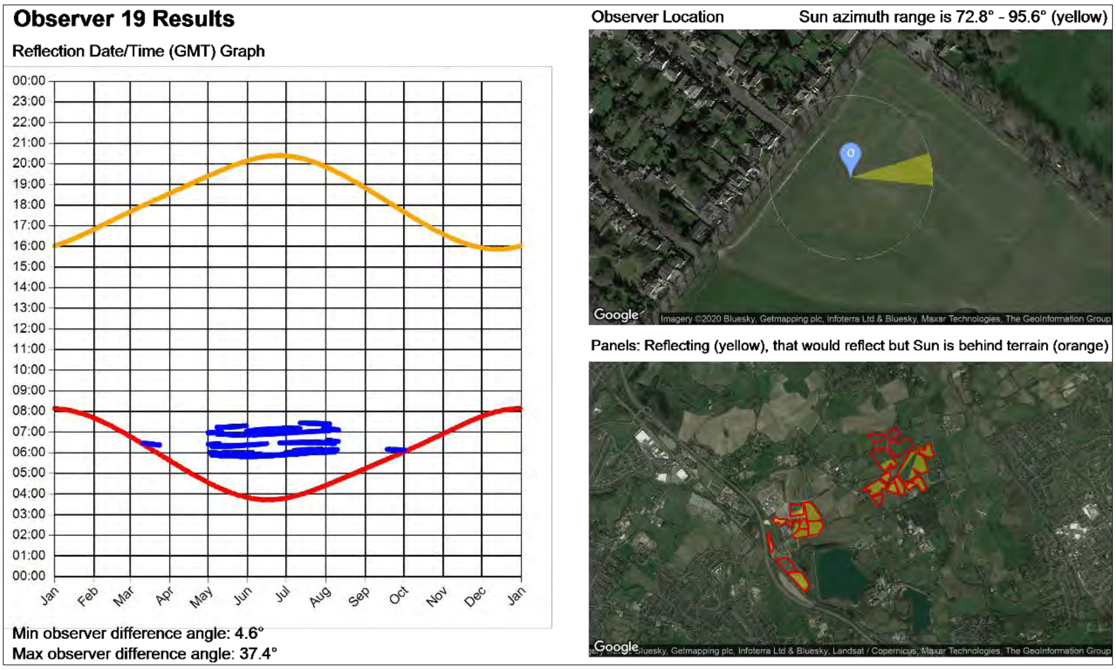
Reflection Date/Time (GMT) Graph

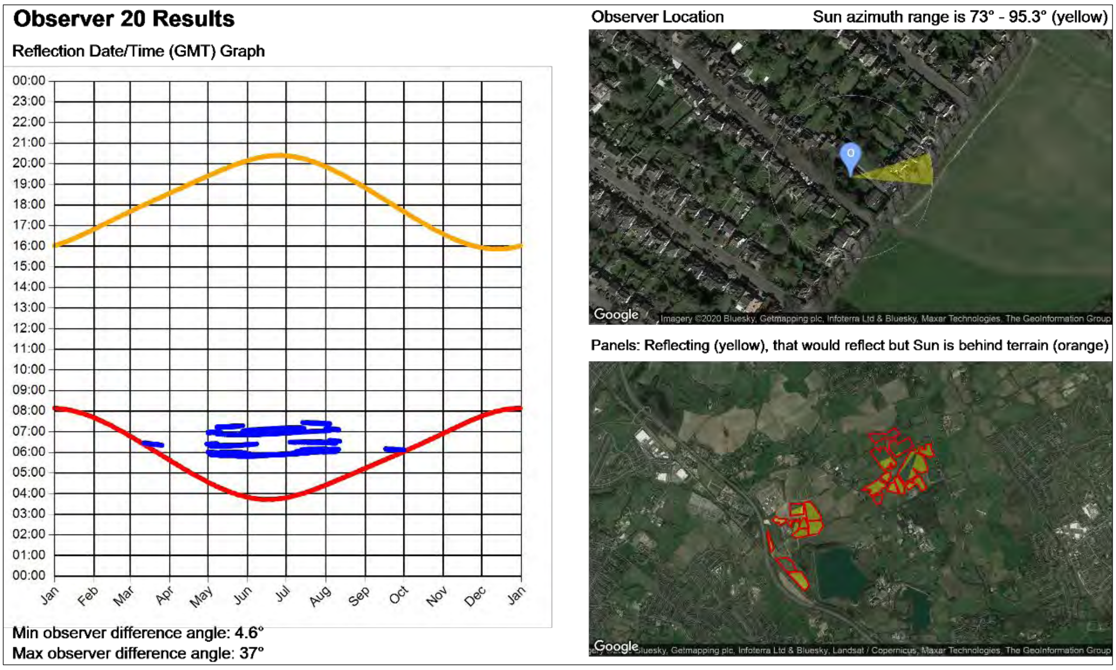


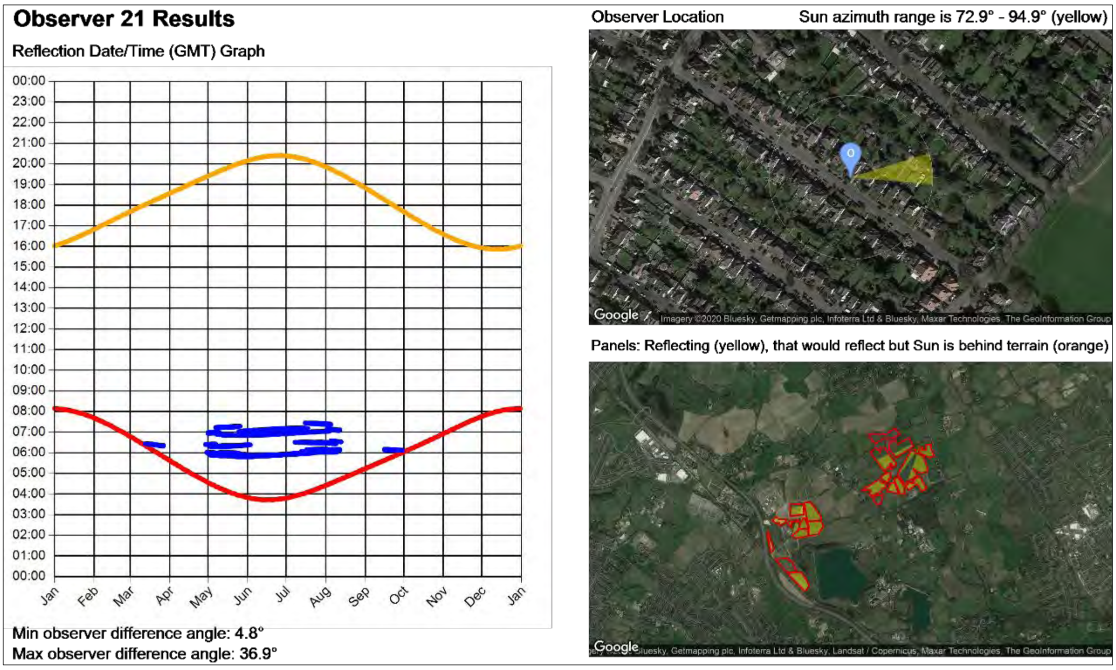
Min observer difference angle: 4.5°
Max observer difference angle: 37.9°

Observer Location — Sun azimuth range is 72.8° - 95.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)


Observer 19 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 4.6°
Max observer difference angle: 37.4°
Observer Location
Sun azimuth range is 72.8° - 95.6° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

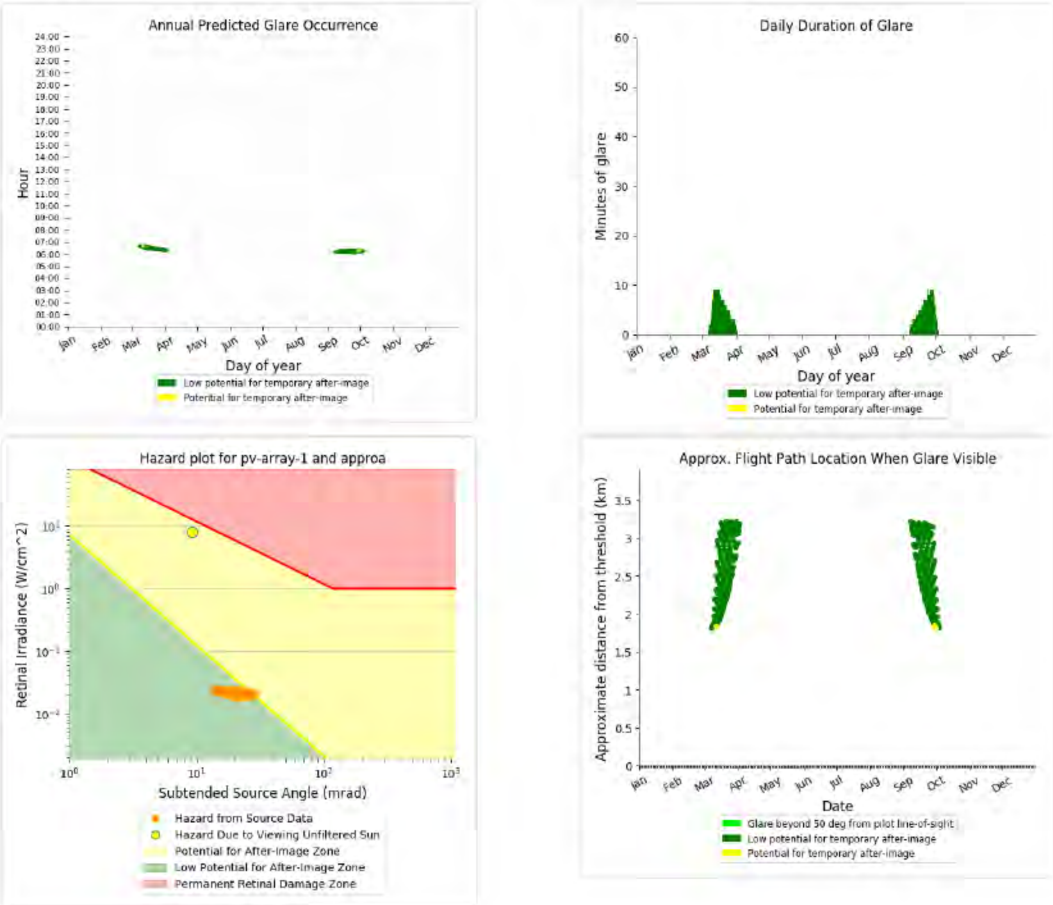

Observer 20 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 4.6°
Max observer difference angle: 37°
Observer Location
Sun azimuth range is 73° - 95.3° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 21 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 4.8°
Max observer difference angle: 36.9°
Observer Location
Sun azimuth range is 72.9° - 94.9° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

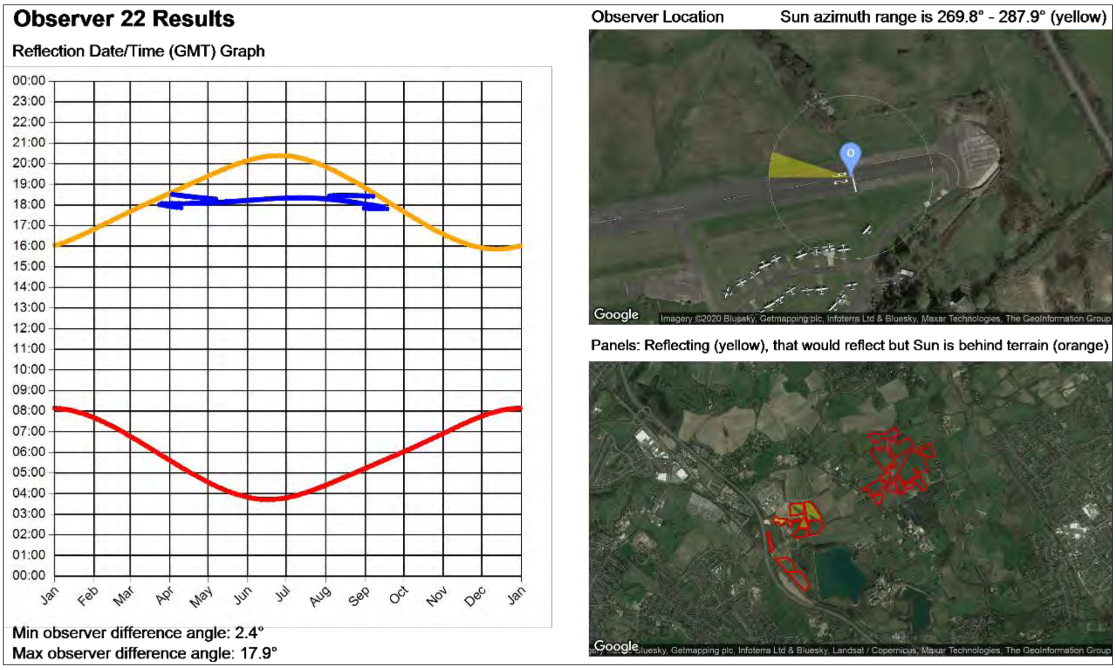
PV array 1 - Receptor (Approach 08)

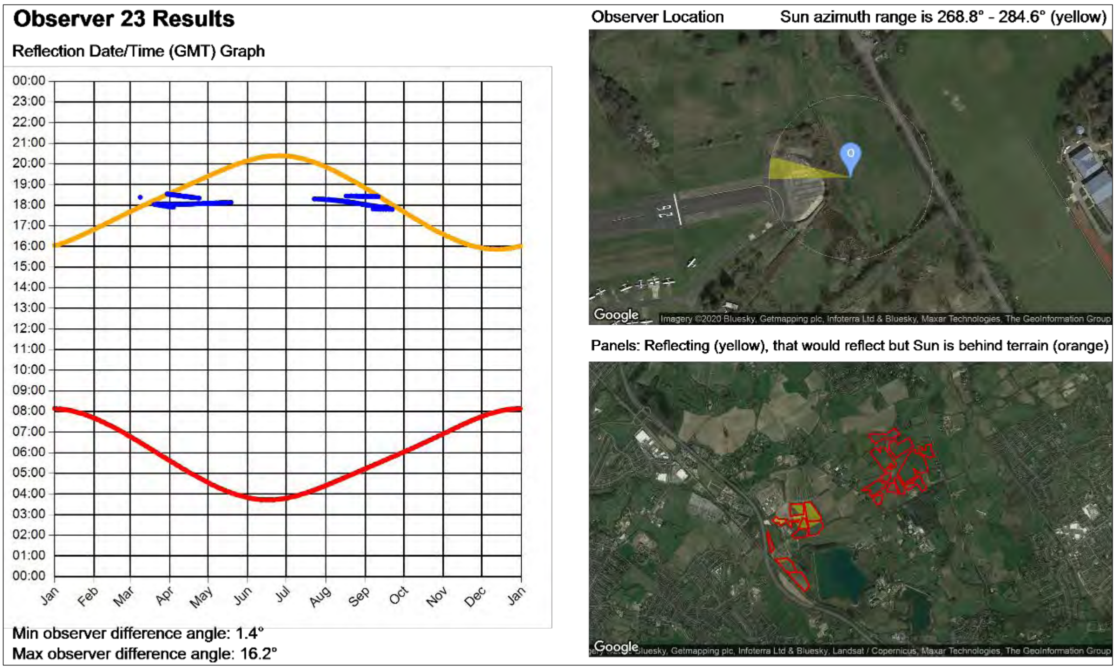
PV array is expected to produce the following glare for observers on this flight path:

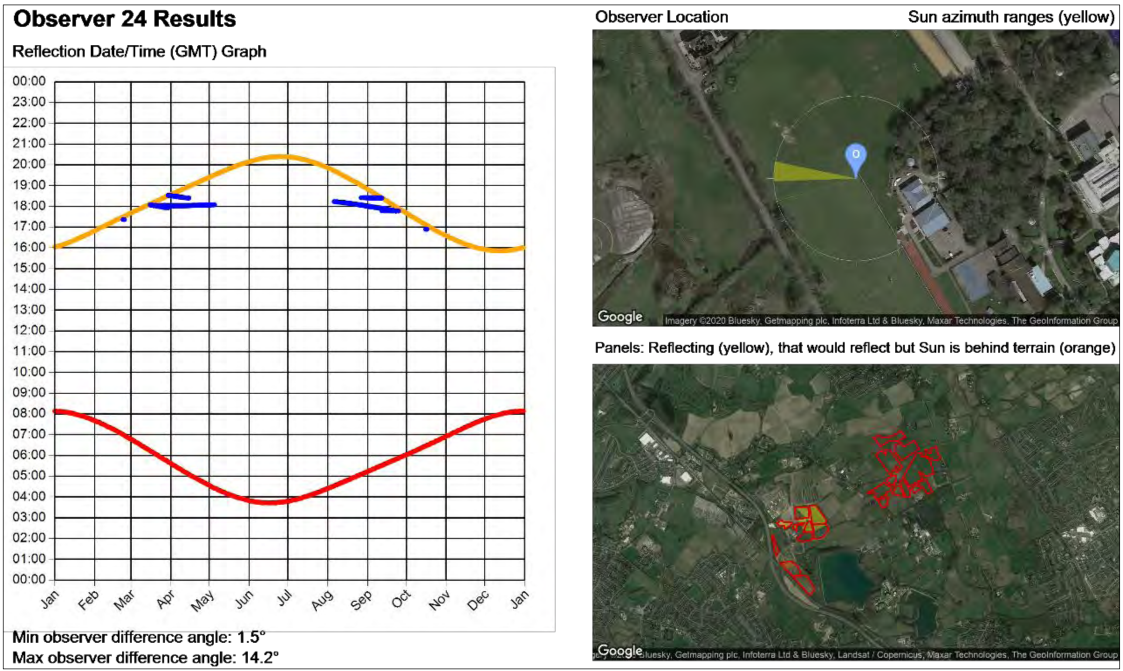
- 290 minutes of "green" glare with low potential to cause temporary after-image.
- 3 minutes of "yellow" glare with potential to cause temporary after-image.

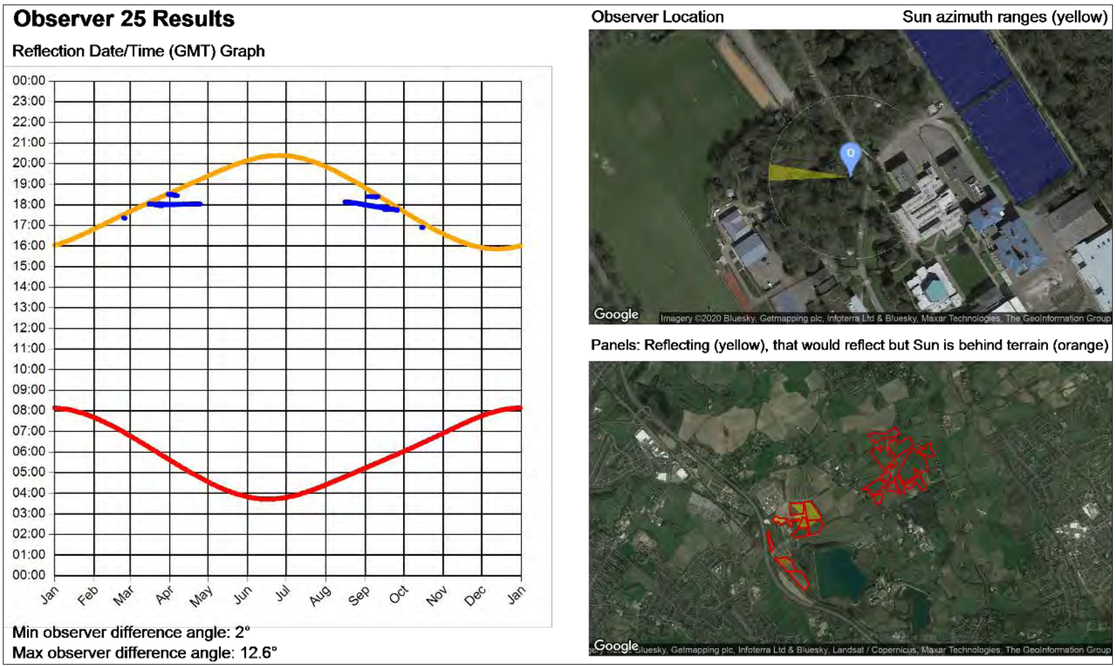


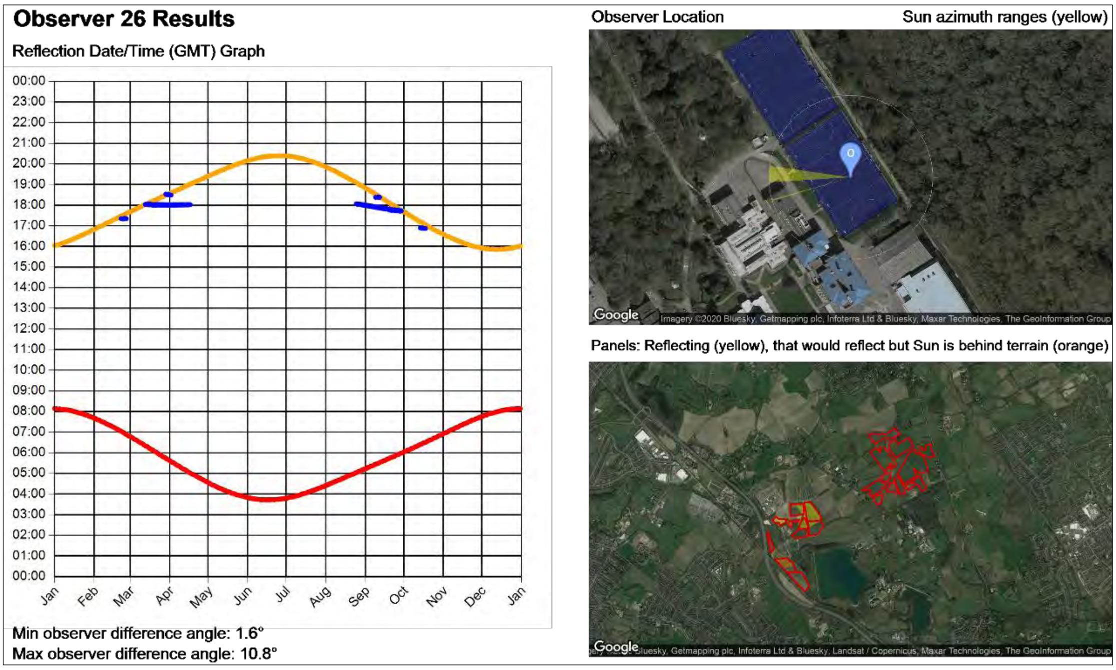
Approach 26

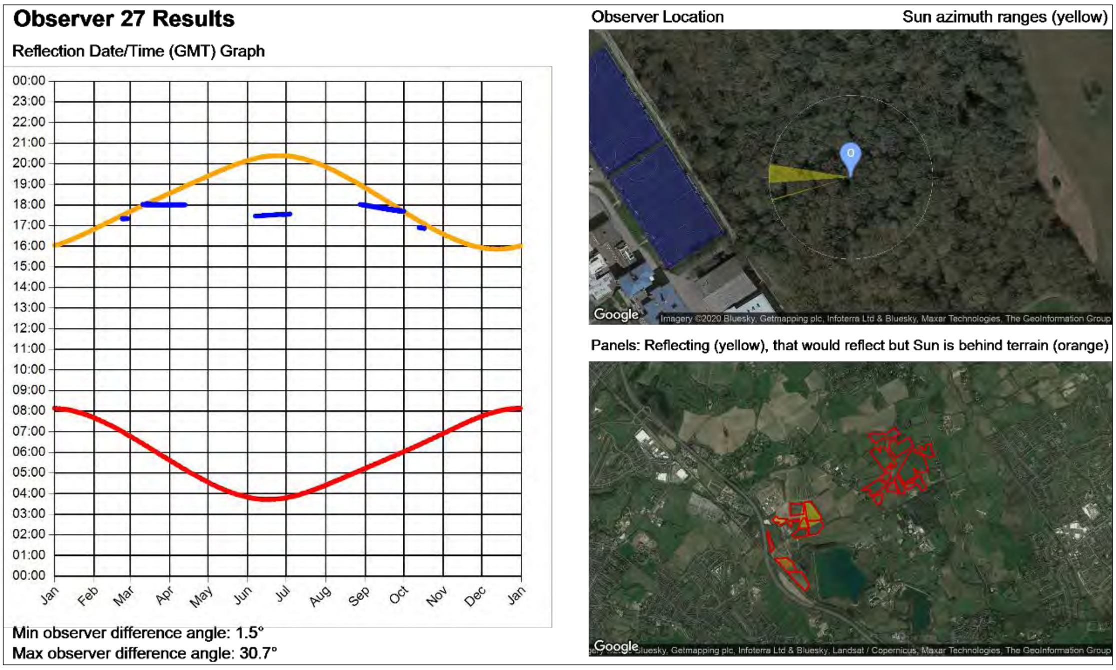

Observer 22 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 2.4°
Max observer difference angle: 17.9°
Observer Location
Sun azimuth range is 269.8° - 287.9° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

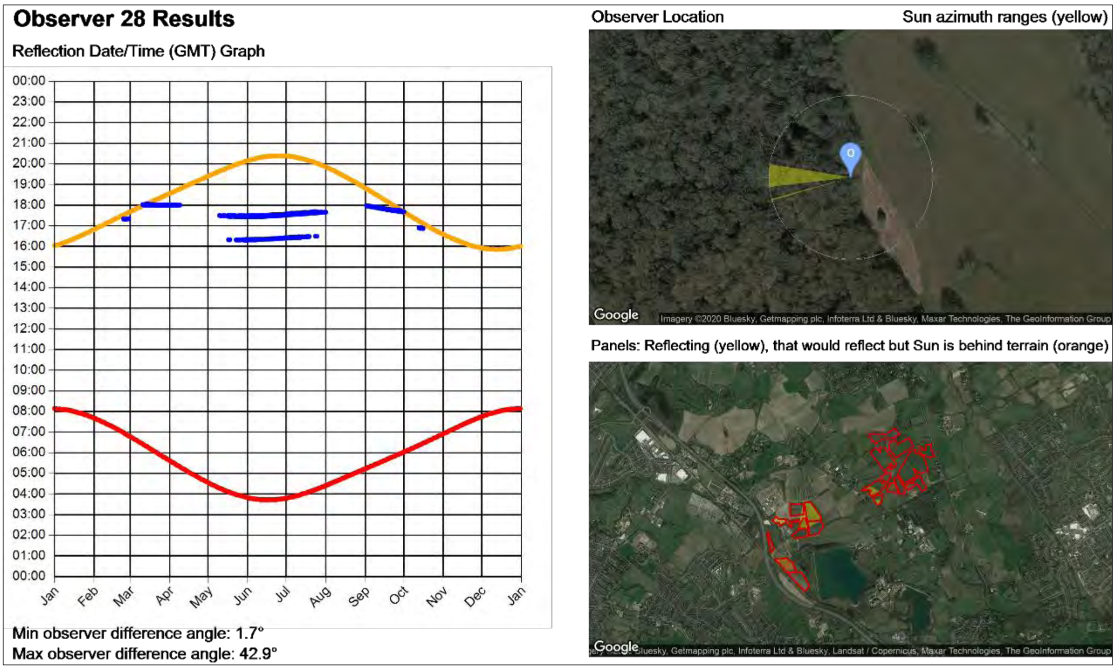

Observer 23 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 1.4°
Max observer difference angle: 16.2°
Observer Location
Sun azimuth range is 268.8° - 284.6° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

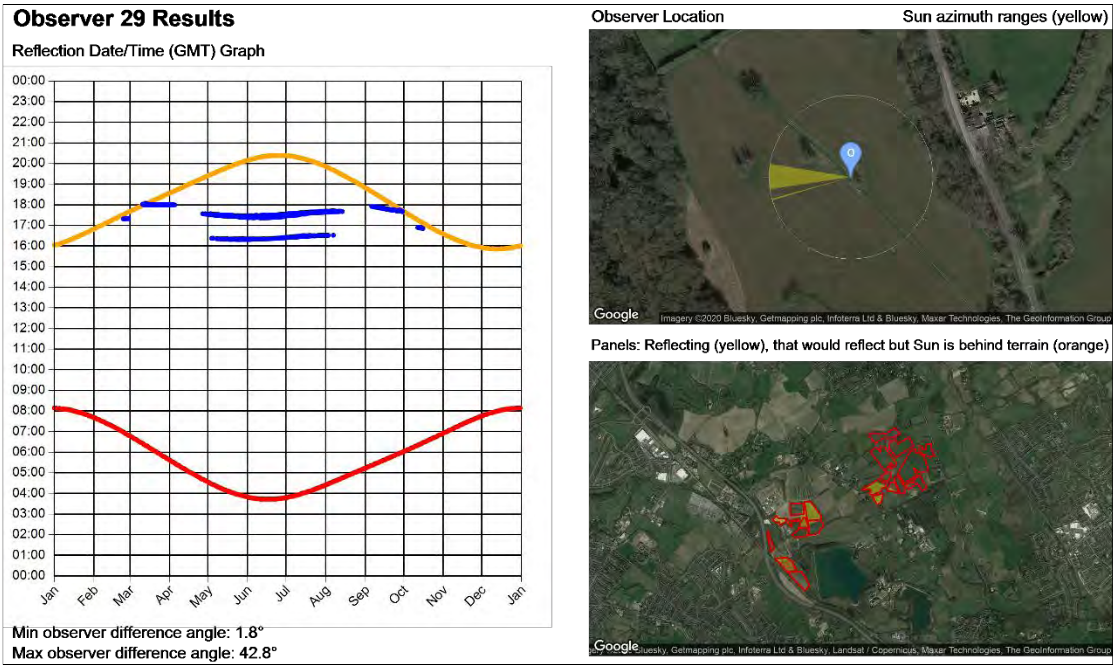

Observer 24 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 1.5°
Max observer difference angle: 14.2°


Observer 25 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 2°
Max observer difference angle: 12.6°


Observer 26 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 1.6°
Max observer difference angle: 10.8°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

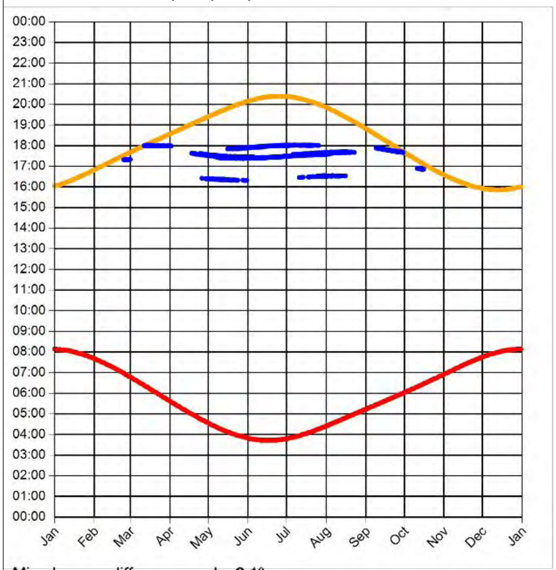

Observer 27 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 1.5°
Max observer difference angle: 30.7°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 28 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 1.7°
Max observer difference angle: 42.9°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 29 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 1.8°
Max observer difference angle: 42.8°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Observer 30 Results

Reflection Date/Time (GMT) Graph



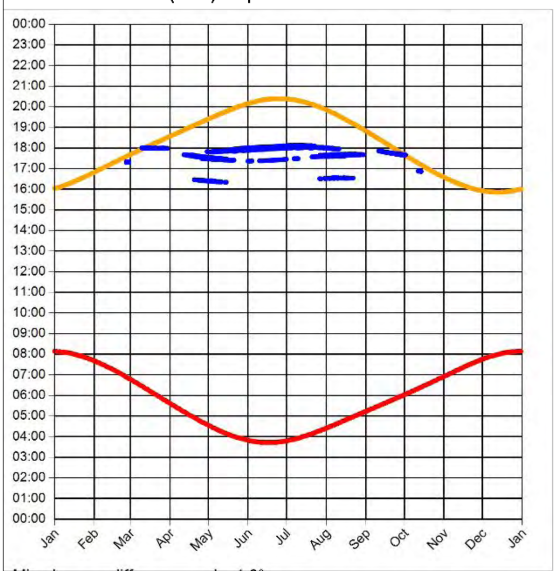
Min observer difference angle: 2.1°
Max observer difference angle: 41.3°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 31 Results

Reflection Date/Time (GMT) Graph



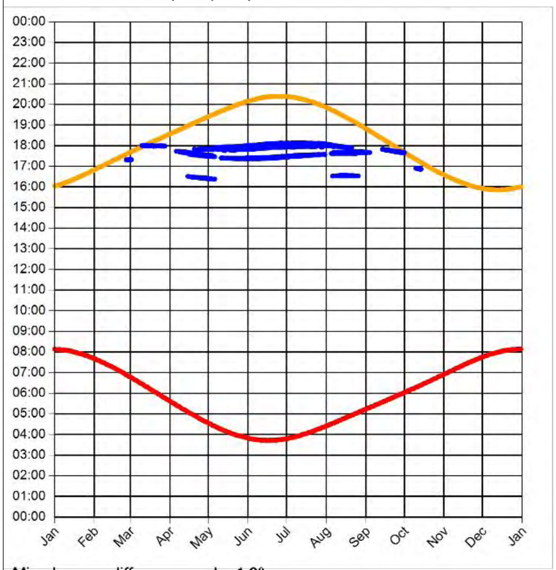
Min observer difference angle: 1.8°
Max observer difference angle: 38.4°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 32 Results

Reflection Date/Time (GMT) Graph



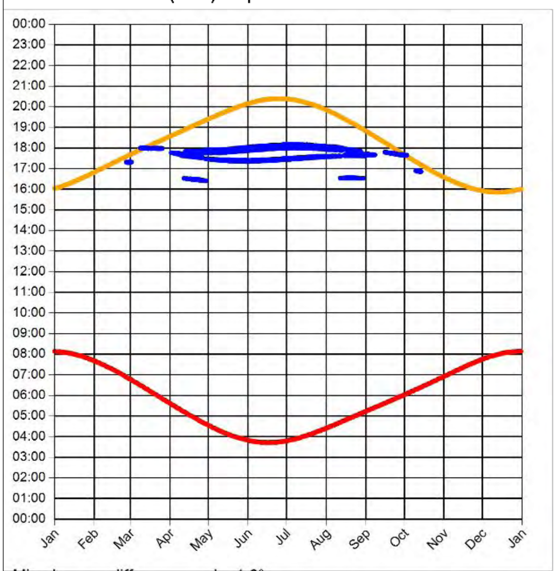
Min observer difference angle: 1.9°
Max observer difference angle: 36.1°

Observer Location | Sun azimuth range is 253.9° - 285.7° (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 33 Results

Reflection Date/Time (GMT) Graph



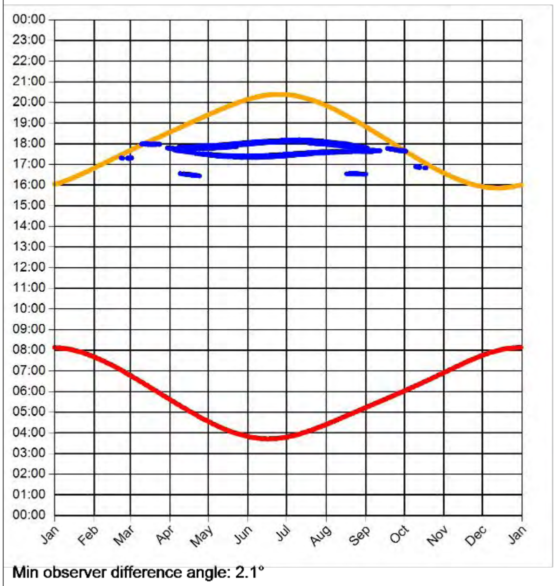
Min observer difference angle: 1.6°
Max observer difference angle: 34.1°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 34 Results

Reflection Date/Time (GMT) Graph



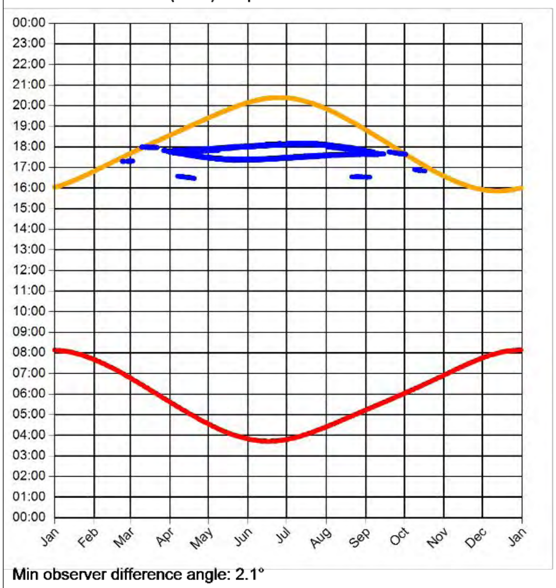
Min observer difference angle: 2.1°
Max observer difference angle: 34.2°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 35 Results

Reflection Date/Time (GMT) Graph



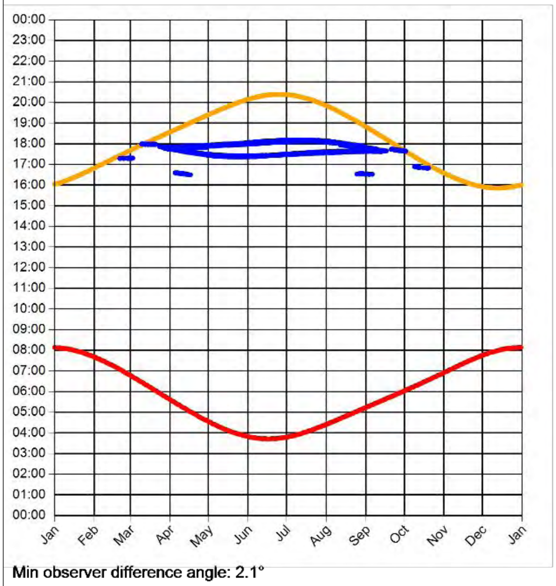
Min observer difference angle: 2.1°
Max observer difference angle: 33.5°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 36 Results

Reflection Date/Time (GMT) Graph



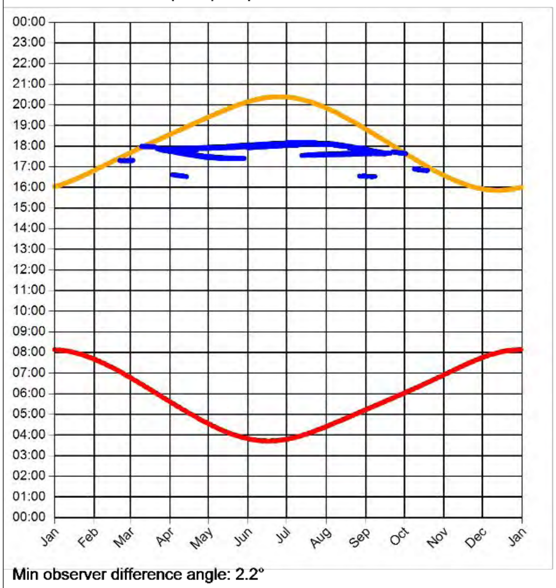
Min observer difference angle: 2.1°
Max observer difference angle: 32.6°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 37 Results

Reflection Date/Time (GMT) Graph



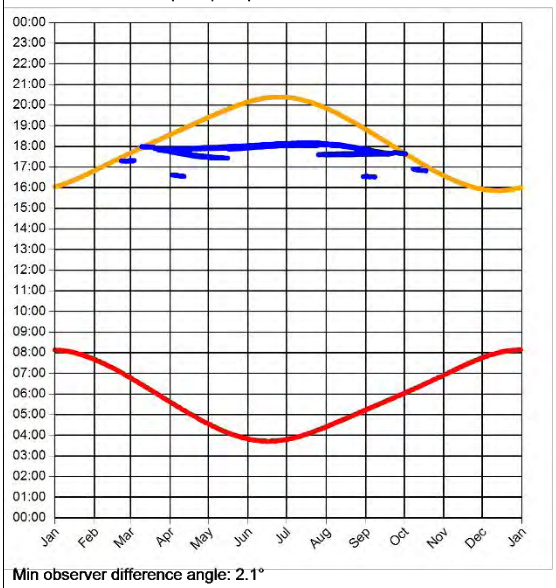
Min observer difference angle: 2.2°
Max observer difference angle: 30.5°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 38 Results

Reflection Date/Time (GMT) Graph



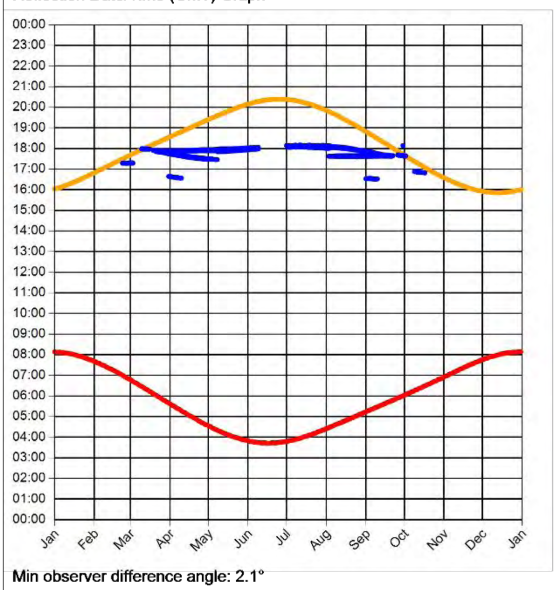
Min observer difference angle: 2.1°
Max observer difference angle: 28°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Observer 39 Results

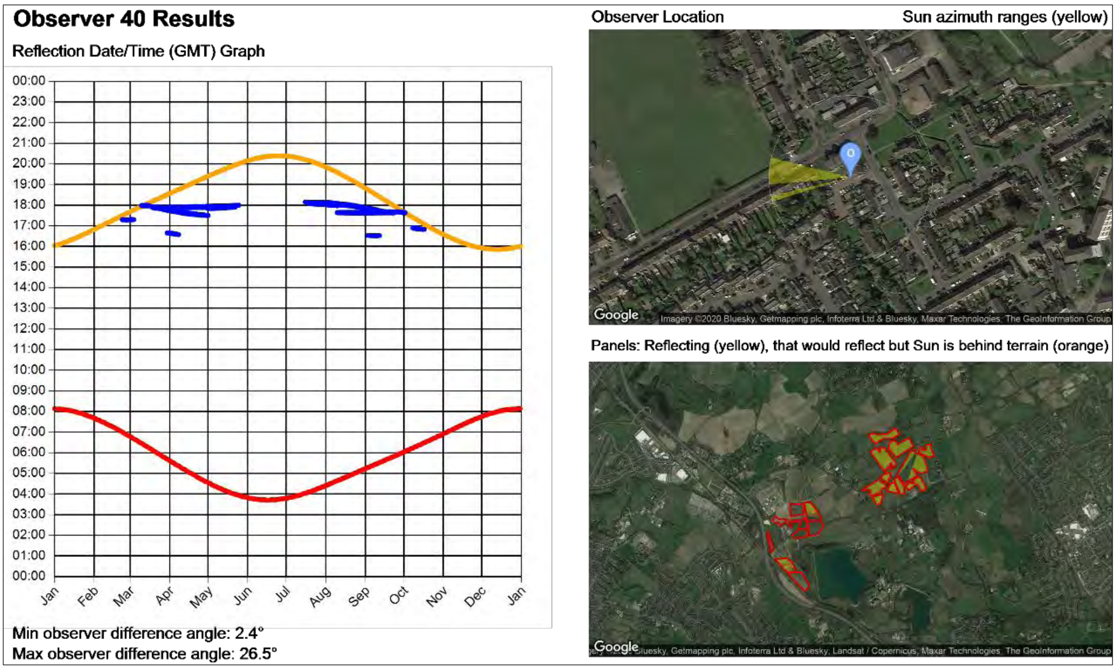
Reflection Date/Time (GMT) Graph

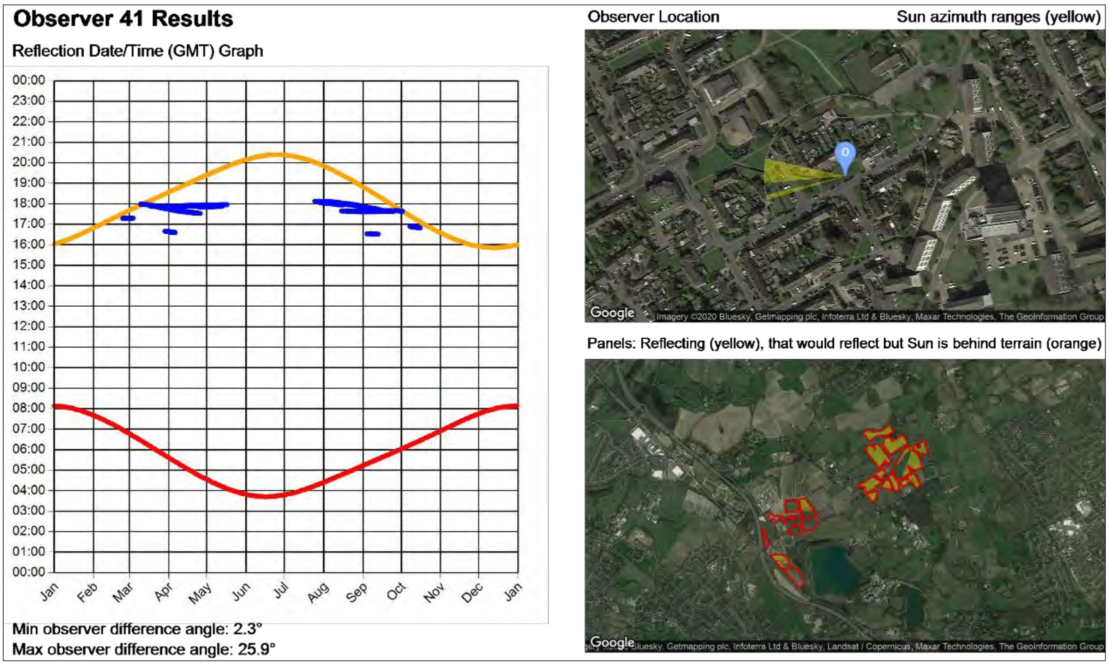


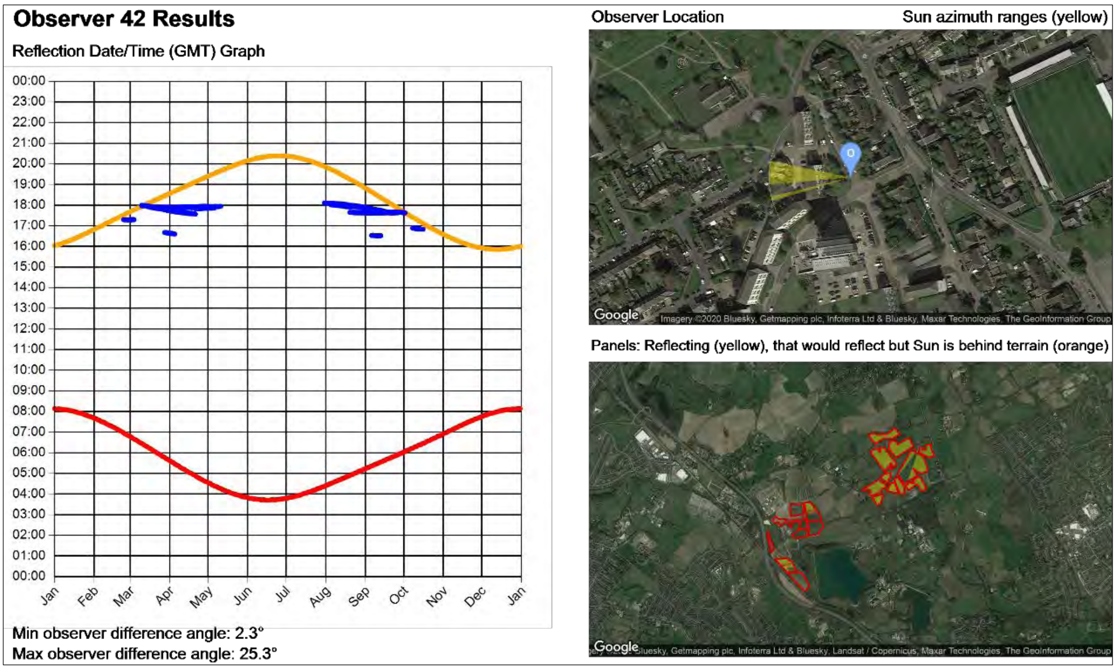
Min observer difference angle: 2.1°
Max observer difference angle: 27.2°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)


Observer 40 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 2.4°
Max observer difference angle: 26.5°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

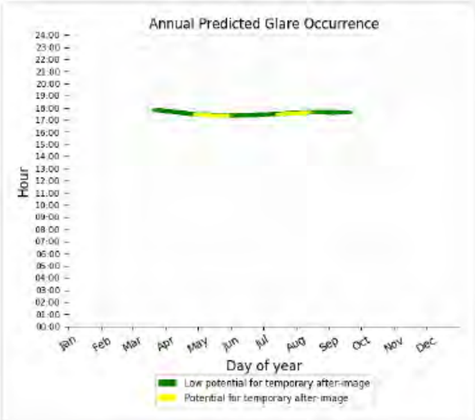

Observer 41 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 2.3°
Max observer difference angle: 25.9°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

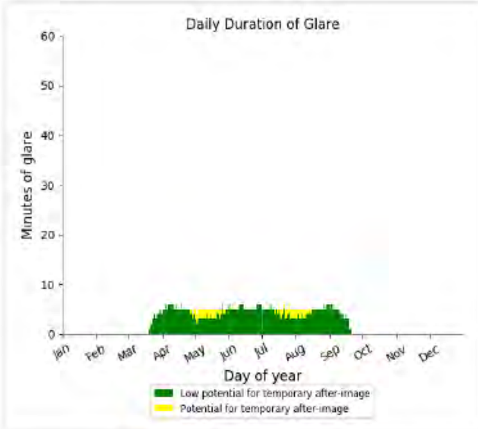

Observer 42 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 2.3°
Max observer difference angle: 25.3°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

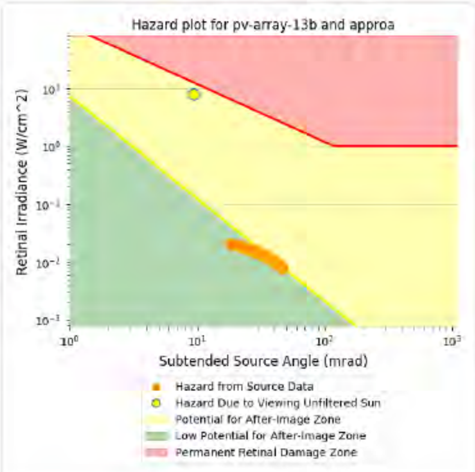
PV array 13b - Receptor (Approach 26)

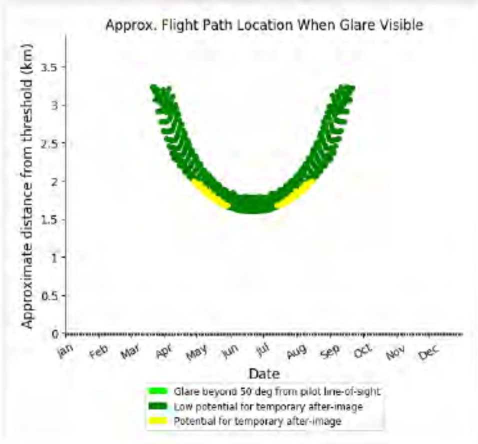
PV array is expected to produce the following glare for observers on this flight path:

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





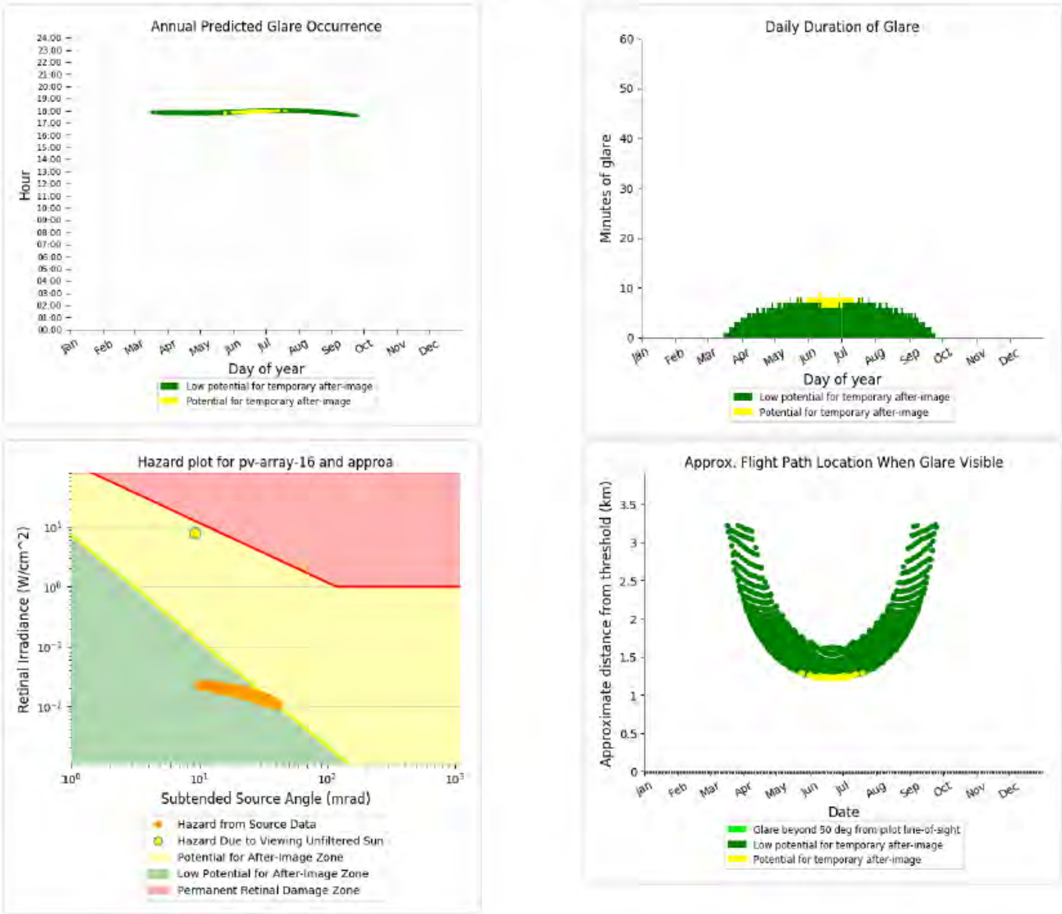




PV array 16 - Receptor (Approach 26)

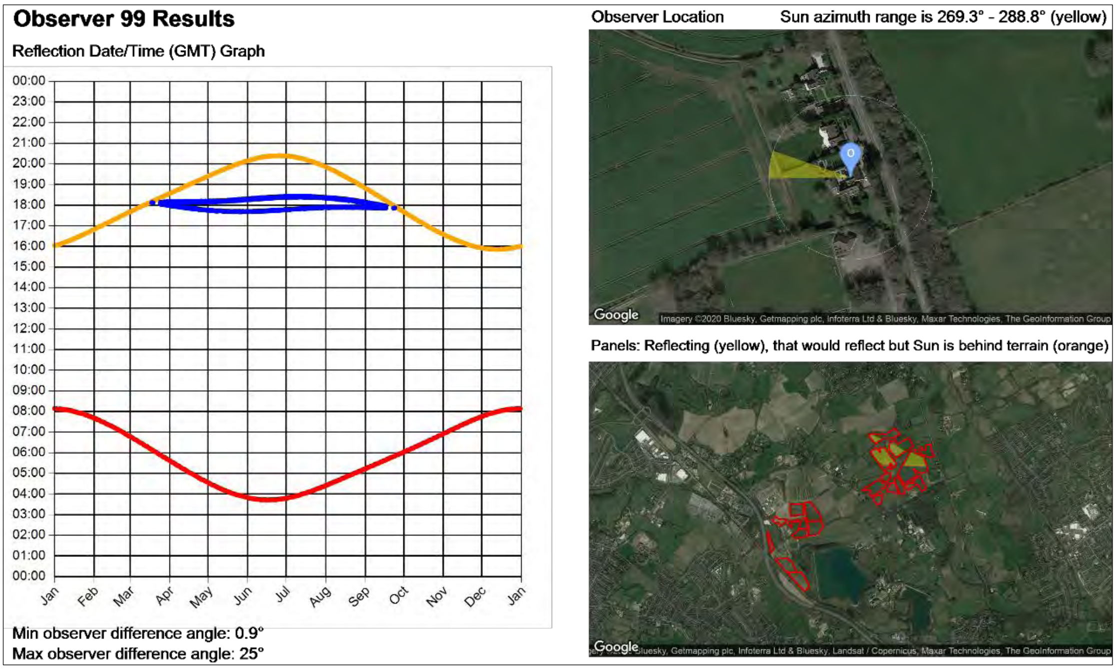
PV array is expected to produce the following glare for observers on this flight path:

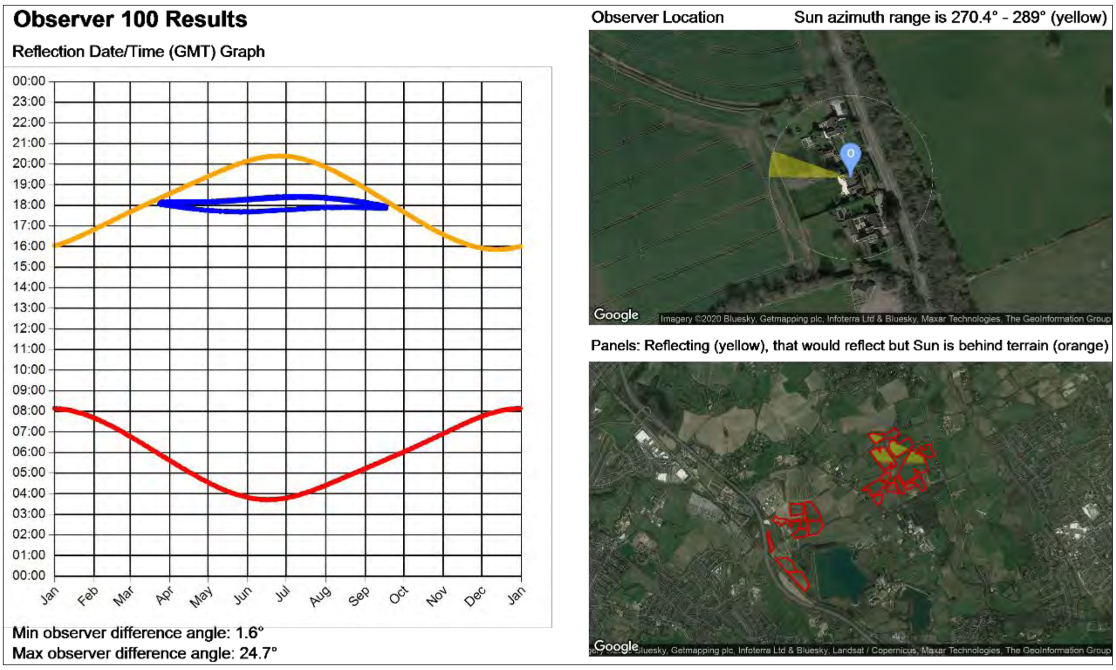
- 1,067 minutes of "green" glare with low potential to cause temporary after-image.
- 70 minutes of "yellow" glare with potential to cause temporary after-image.

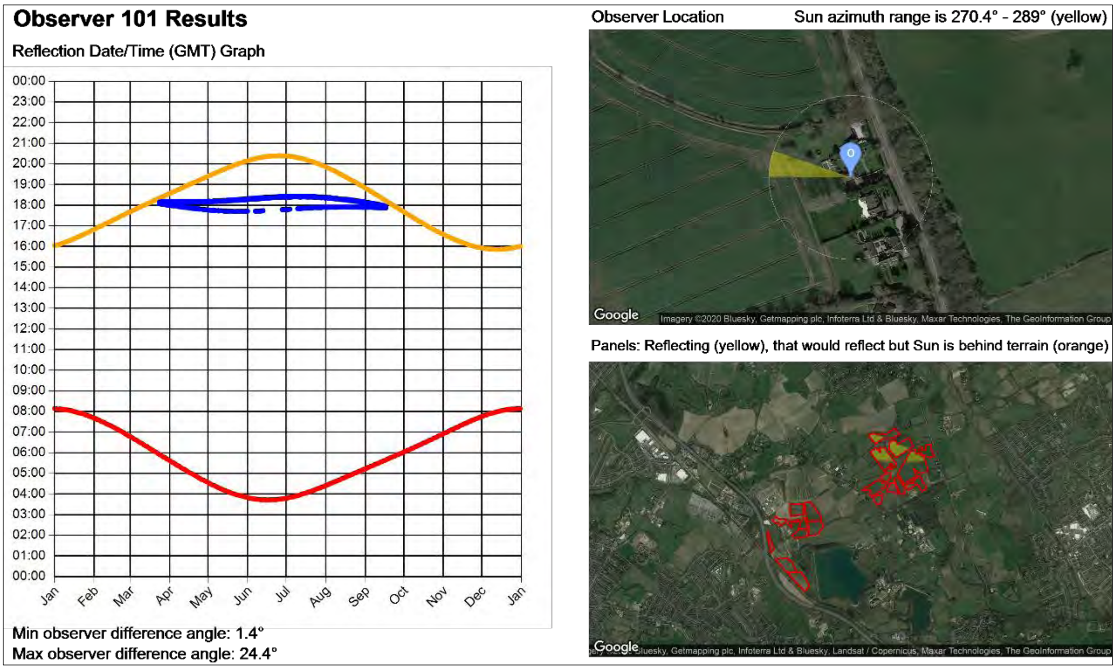


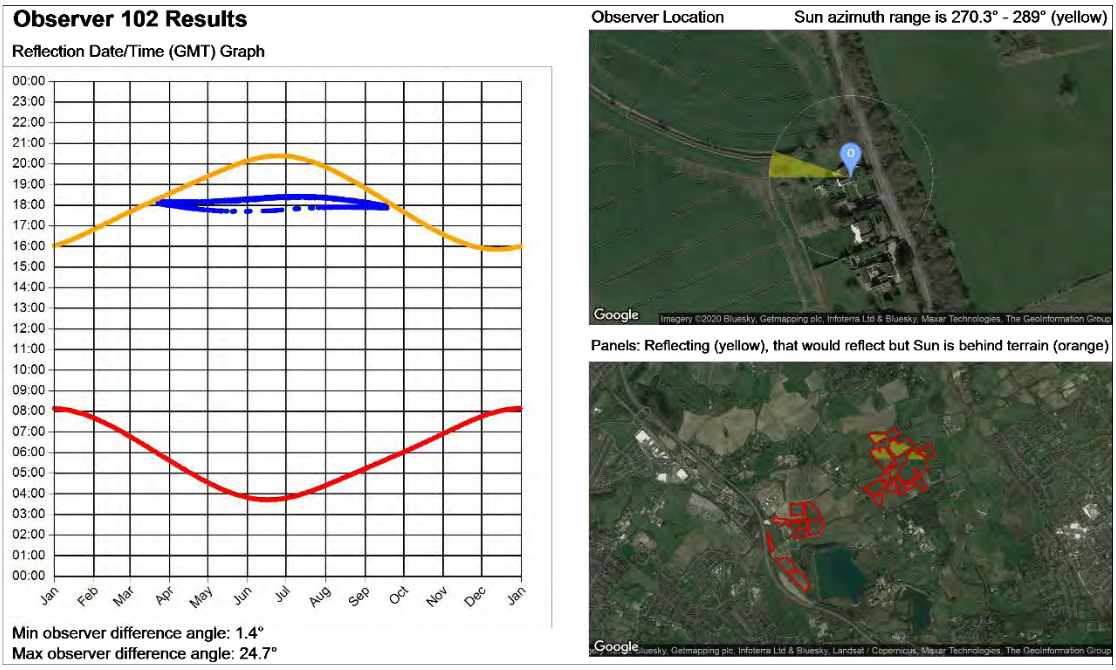
Dwellings

Only the reflection charts of dwelling experiencing moderate impact are presented below. Other can be provided upon request.





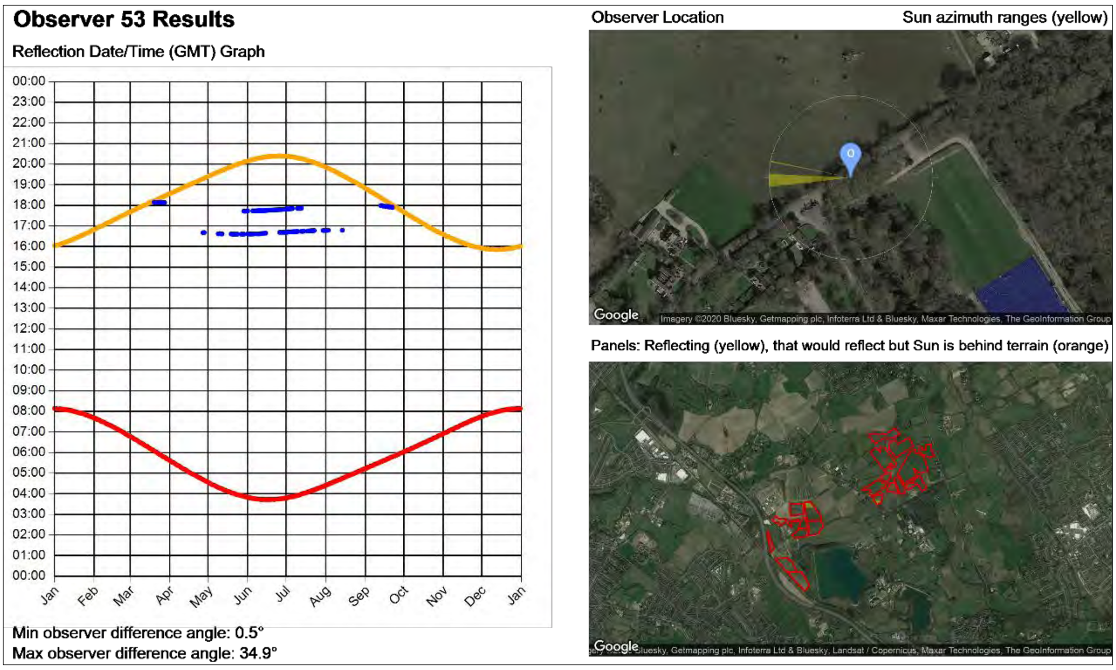

Observer 101 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 1.4°
Max observer difference angle: 24.4°
Observer Location
Sun azimuth range is 270.4° - 289° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

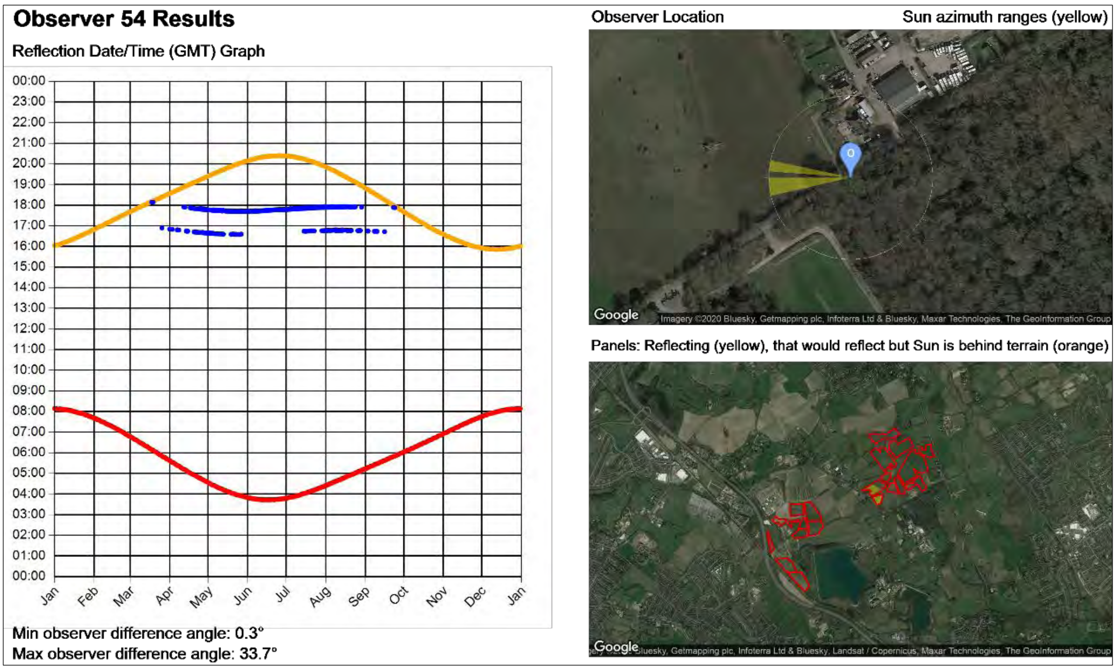

Observer 102 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 1.4°
Max observer difference angle: 24.7°
Observer Location
Sun azimuth range is 270.3° - 289° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Roads

Butterfly lane

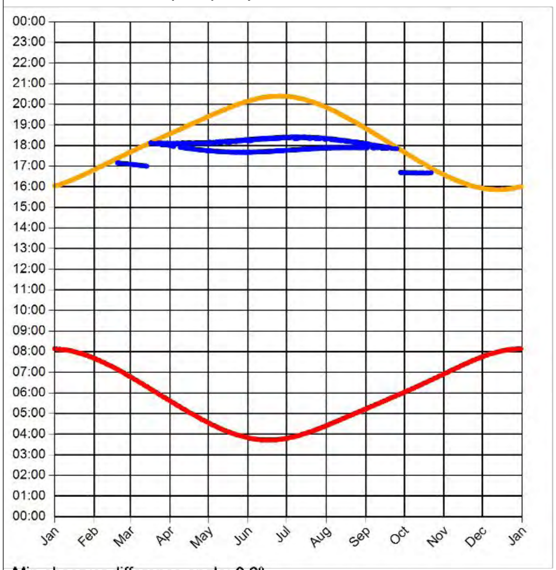
Only the reflection charts of road receptors experiencing moderate impact are presented below. Other can be provided upon request





Observer 57 Results

Reflection Date/Time (GMT) Graph



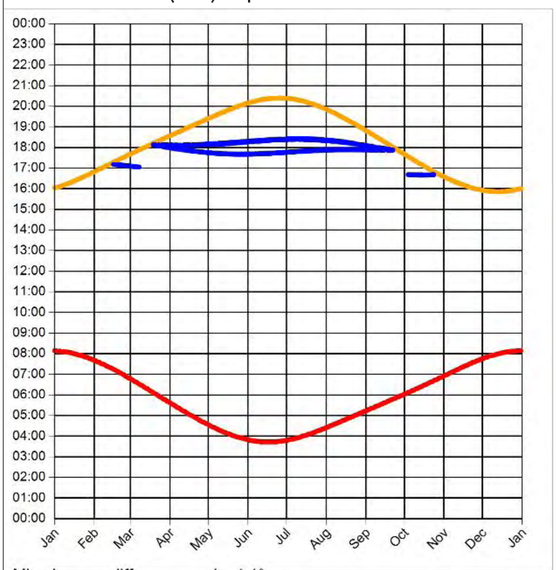
Min observer difference angle: 0.6°
Max observer difference angle: 25.4°

Observer Location | Sun azimuth ranges (yellow)

Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

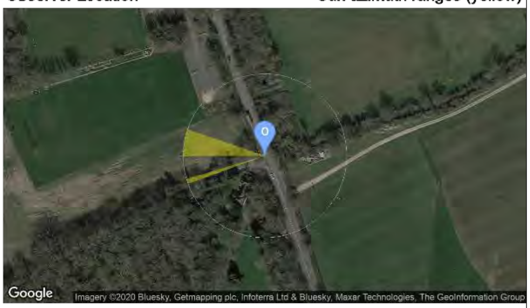
Observer 58 Results

Reflection Date/Time (GMT) Graph



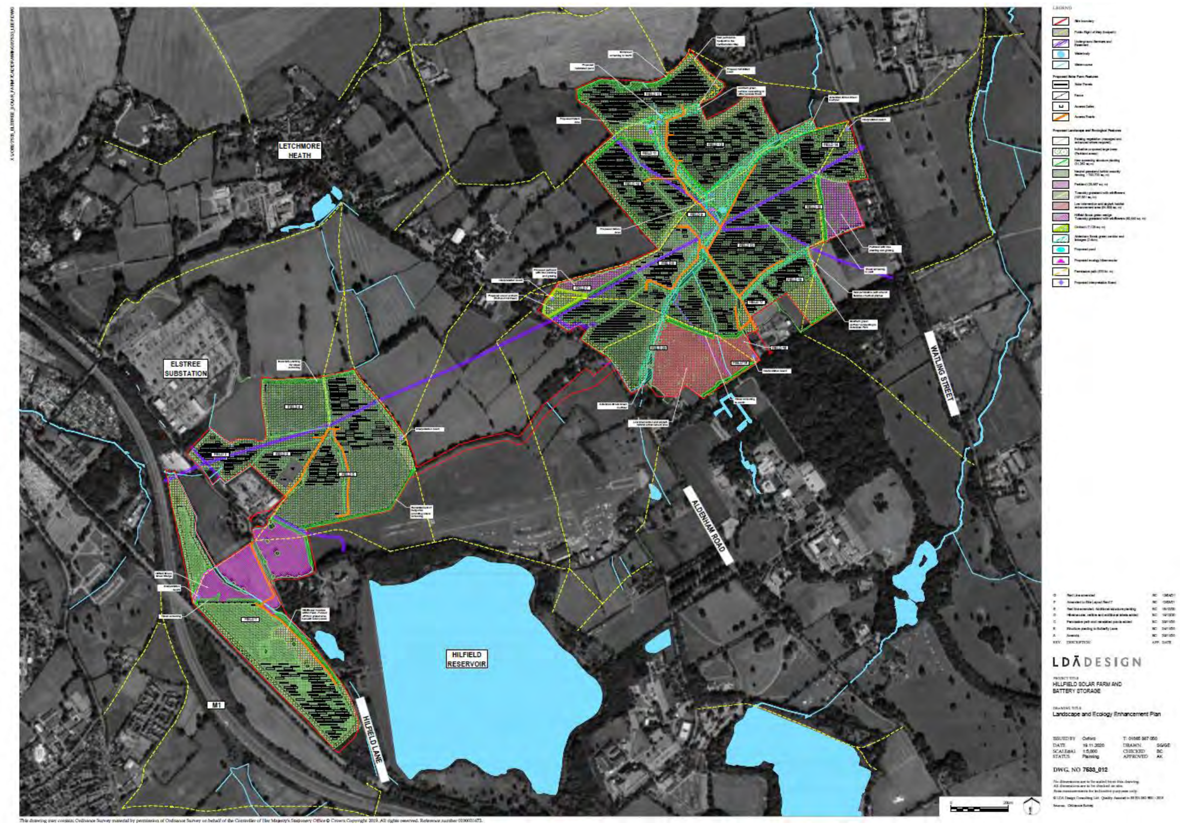
Min observer difference angle: 1.1°
Max observer difference angle: 25.3°

Observer Location | Sun azimuth ranges (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

APPENDIX I – LEEP PLAN



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