Candwr Solar Farm

Pre Application Consultation

Environmental Statement

Appendix 7.1 Solar Photovoltaic Glint and Glare Study

2 July 2026

TotalEnergies

PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

Pegasus Planning Group Ltd

Candwr Solar Farm

June 2026

ADMINISTRATION PAGE

Job Reference:	11532A3
Author:	Jacob Cunningham
Telephone:	01787 319001
Email:	jacob@pagerpower.com

Reviewed By:	Phillip Charhill; Michael Sutton
Email:	phillip@pagerpower.com; michael@pagerpower.com

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1	December 2025	Initial issue
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Stour Valley Business Centre, Brundon Lane, Sudbury, CO10 7GB

T:+44 (0)1787 319001 E: *info@pagerpower.com* W: *www.pagerpower.com*

EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the potential effects of glint and glare from a ground-mounted solar photovoltaic (PV) development located near Ponthir, Monmouthshire, Wales. This assessment pertains to the potential impacts upon road safety, residential amenity, and aviation activity.

Overall Conclusions

No significant impacts are predicted upon road safety, residential amenity, and aviation activity. Mitigation is not recommended.

Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. The UK CAA guidance is relatively high-level and does not prescribe a formal methodology. There is no formal planning guidance for the assessment of solar reflections from solar panels towards roads and nearby dwellings. Pager Power has however produced guidance for glint and glare and solar photovoltaic developments, which was published in early 2017, with the fourth edition[1] published in 2022. This methodology defines a comprehensive process for determining the impact upon road safety, residential amenity, and aviation activity.

Pager Power's approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels. For aviation activity, where appropriate, solar intensity calculations are undertaken in line with the Sandia National Laboratories' FAA methodology[2]. The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that the reflections produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel[3].

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[1] Pager Power Glint and Glare Guidance, Fourth Edition, September 2022.

[2] Formerly mandatory for on-airfield solar developments in the USA under the FAA's interim policy, superseded in 2021 with a policy that effectively requires individual airports to sign off on their on-airfield development as they see fit.

[3] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).

Assessment Conclusions – Grange Hospital Helipad

Solar reflections with an intensity of 'low potential for temporary after-image' are geometrically possible towards the 2-mile helicopter approach paths. This category of glare intensity is acceptable in accordance with the associated guidance (Appendix D) and industry best practice.

A low impact is predicted and mitigation is not recommended.

Assessment Conclusions – Park Farm Airfield

Solar reflections with an intensity of 'low potential for temporary after-image' are geometrically possible towards sections of the splayed approach paths and the final sections of the visual circuits for runway 06/24. This intensity of glare is considered acceptable in accordance with the associated guidance (Appendix D) and industry best practice.

A low impact is predicted and mitigation is not recommended.

Assessment Conclusions – Road Safety

Solar reflections are geometrically possible towards a 2.8km section of the B4236 and a 1.95km section of Usk Road.

For all sections of the B4236 and Usk Road, existing vegetation, buildings, and/or intervening terrain are predicted to significantly obstruct views of the reflecting panels such that solar reflections are not predicted to be experienced in practice. No impact is predicted and mitigation is not required.

Assessment Conclusions – Residential Amenity

Solar reflections are geometrically possible towards 132 of the 153 assessed dwellings.

For six dwellings, solar reflections are predicted to occur for more than three months a year but less than 60 minutes on any given day. Existing vegetation and/or buildings have been identified that partially obstructs views of the reflecting panels, however residual views are considered possible. Mitigating factors which reduce the level of impact have been identified and are presented in Section 5.4.2. Therefore, a low impact is predicted and mitigation is not recommended.

For the remaining 126 dwellings, existing vegetation, buildings, and/or intervening terrain have been identified that are predicted to significantly obstruct views of the reflecting panels, such that views are not predicted to be experienced in practice. No impact is predicted and mitigation is not required.

High-Level Assessment Conclusions – Aviation

Croes-Carn-Einion Farm Airfield, Upfield Farm Airfield, and Kemeys Commander Airfield

The development size, distance between the aerodromes and the development, modelling for Park Farm Airfield, and industry experience have been considered to determine the impact during the assessment.

Solar reflections towards the splayed approaches and final sections of visual circuits at Croes-Carn-Einion Farm Airfield, Upfield Farm Airfield, and Kemeys Commander Airfield are predicted to occur outside a pilot's field-of-view (50 degrees on either side relative to the runway threshold bearing) or have intensities no greater than 'low potential for temporary after-image'.

Overall, no significant impact upon aviation activity associated with Croes-Carn-Einion Farm Airfield, Upfield Farm Airfield, and Kemeys Commander Airfield is predicted. Detailed modelling is not recommended and mitigation is not required.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 63 countries internationally.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects;
- Building developments;
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny, and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the potential effects of glint and glare from a ground-mounted solar photovoltaic (PV) development located near Ponthir, Monmouthshire, Wales. This assessment pertains to the potential impacts upon road safety, residential amenity, and aviation activity.

This report contains the following:

- Solar development details;
- Explanation of glint and glare;
- Overview of relevant guidance and studies;
- Assessment methodology;
- Identification of receptors;
- Glint and glare assessment for identified receptors;
- High-level assessment of aviation activity;
- Results discussion;
- Overall conclusions and recommendations.

1.2 Pager Power's Experience

Pager Power has undertaken over 1,700 Glint and Glare assessments in the UK and internationally. The studies have included assessment of civil and military aerodromes, railway infrastructure and other ground-based receptors including roads and dwellings.

1.3 Glint and Glare Definition

The definition[4] of glint and glare is as follows:

- Glint – a momentary flash of bright light typically received by moving receptors or from moving reflectors;
- Glare – a continuous source of bright light typically received by static receptors or from large reflective surfaces.

The term 'solar reflection' is used in this report to refer to both reflection types i.e. glint and glare.

[4]These definitions are aligned with those presented within the National Policy Statement for Renewable Energy Infrastructure (EN-3) – published by the Department for Energy Security and Net Zero in January 2024 and the Federal Aviation Administration in the USA.

2 DEVELOPMENT LOCATION AND DETAILS

2.1 Overview

The following sections present key details pertaining to the development and this assessment.

2.2 Development Site Layout Plan

Figure 1 below shows the site layout[5] plans for the proposed development. Blue rectangles show the location of solar panels.

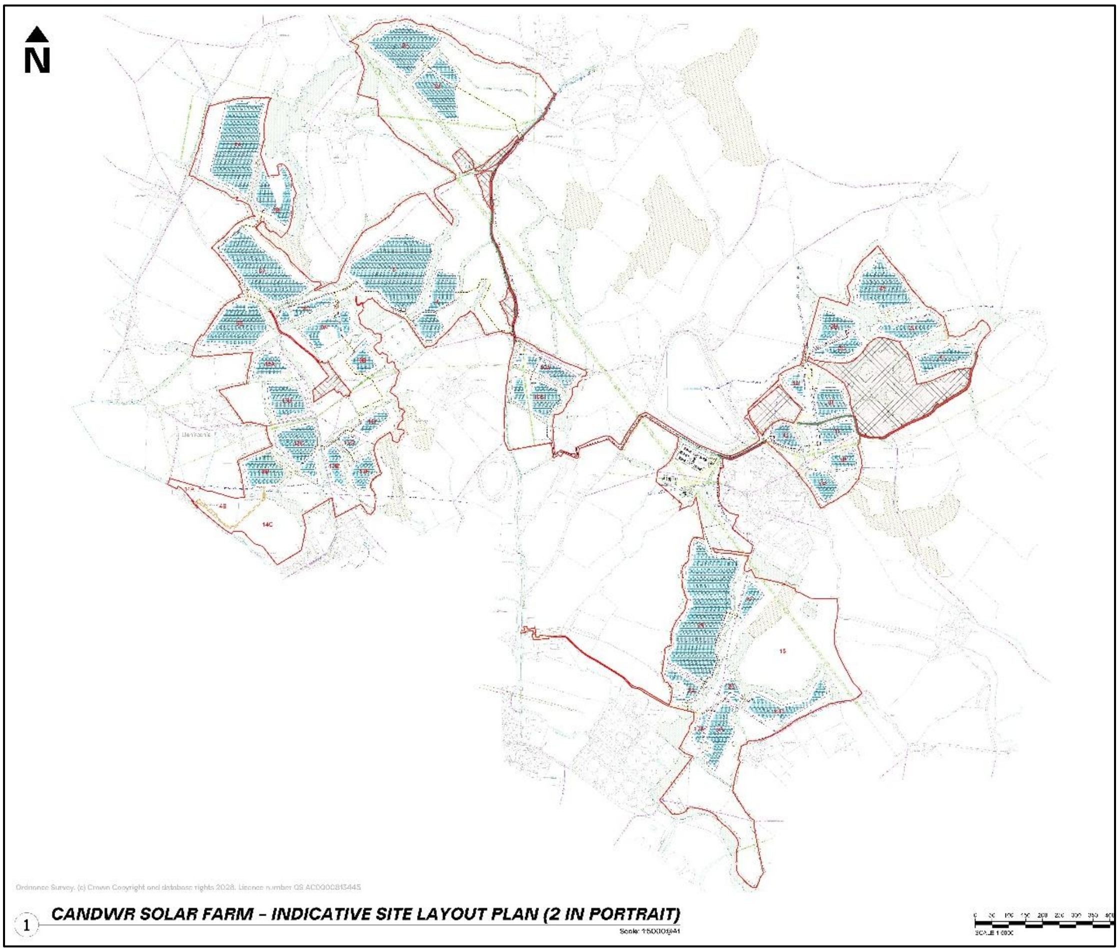

Figure 1 *Proposed development site layout*

2.3 Reflector Areas

The bounding coordinates for the proposed development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 2 on the following page shows the modelled reflector areas that has been used for modelling purposes.

[5] Source: PEG002-PL-01.1_rev11 - Proposed Site Layout Plan.pdf (cropped).

Figure 2 *Assessed reflector areas*

The Pager Power model has used a resolution of 10m for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 10m from within the defined area. This resolution is sufficiently high to maximise the accuracy of the results – increasing the resolution further would not significantly change the modelling output. If a reflection is experienced from an assessed panel location, then it is likely that a reflection will be viewable from similarly located panels within the solar development.

2.4 Solar Panel Technical Information

Table 1 below summarises the technical information of the modelled solar panels used in this assessment.

Azimuth angle[6]	Elevation angle[7]	Assessed centre height[8] (agl[9])
180°	25°	1.8m

Table 1 *Solar panel technical information*

[6] Direction the panels are facing, measured as an absolute value clockwise from true north.
[7] Solar panel tilt relative to the horizontal.
[8] Based upon the minimum (0.8 metre) and maximum height (2.8 metres) of the panels above ground level, small changes to this height are not expected to significantly change the results of modelling. A maximum height of 3m may be utilised for this development, this is not expected to significantly change the modelling results, but has been considered when determining visibility of the panels.
[9] Above ground level.

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Guidance and Studies

Appendices A and B present a review of relevant guidance and independent studies with regard to glint and glare issues from solar panels. The overall conclusions from the available studies are as follows:

- Specular reflections of the Sun from solar panels are possible;
- The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence;
- Published guidance shows that the intensity of solar reflections from solar panels are equal to or less than those from water. It also shows that reflections from solar panels are significantly less intense than many other reflecting surfaces, which are common in an outdoor environment.

3.2 Background

Details of the Sun's movements and solar reflections are presented in Appendix C.

3.3 Methodology

3.3.1 Pager Power's Methodology

The glint and glare assessment methodology has been derived from the information provided to Pager Power through consultation with stakeholders and by reviewing the available guidance, studies and Pager Power's practical experience. The methodology for this glint and glare assessment is as follows:

- Identify receptors in the area surrounding the Proposed Development;
- Consider direct solar reflections from the proposed development towards the identified receptors by undertaking geometric calculations;
- Consider the visibility of the reflectors from the receptor's location. If the reflectors are not visible from the receptor then no reflection can occur;
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur;
- Consider the solar reflection intensity, if appropriate;
- Consider both the solar reflection from the Proposed Development and the location of the direct sunlight with respect to the receptor's position;
- Consider the solar reflection with respect to the published studies and guidance;
- Determine whether a significant detrimental impact is expected in line with Appendix D.

Within the Pager Power model, the reflector area is defined, as well as the relevant receptor locations. The result is a chart that states whether a reflection can occur, the duration and the panels that can produce the solar reflection towards the receptor.

Where a solar reflection is identified for an aviation approach path receptor, intensity calculations are completed in line with the Sandia National Laboratories methodology.

3.3.2 Sandia National Laboratories' Methodology

Sandia National Laboratories developed the Solar Glare Hazard Analysis Tool (SGHAT), which is no longer freely available however it is now licensed for use by Forge Solar. Pager Power uses this model where required for aviation receptors. Whilst strictly applicable in the USA and to solar photovoltaic developments only, the methodology is widely used by aviation stakeholders internationally.

3.4 Assessment Methodology and Limitations

Further technical details regarding the methodology of the geometric calculations and limitations are presented in Appendices E and F.

4 IDENTIFICATION OF RECEPTORS

4.1 Overview

The following sections present the relevant receptors assessed within this report.

4.2 Aviation Receptors

4.2.1 Grange Hospital Heliport

Grange Hospital Heliport is a hospital heliport operating emergency service flights, located northwest of the proposed development.

The development's relative location to Grange Hospital Heliport is shown in Figure 3 on the following page.

Figure 4 on page 20 shows the helicopter paths. The helicopter approach paths have been placed every 45 degrees within a 360-degree azimuth, using a 5-degree descent gradient. Locations have been selected every 0.1-miles along the helicopter approach paths out to a distance of 2 miles.

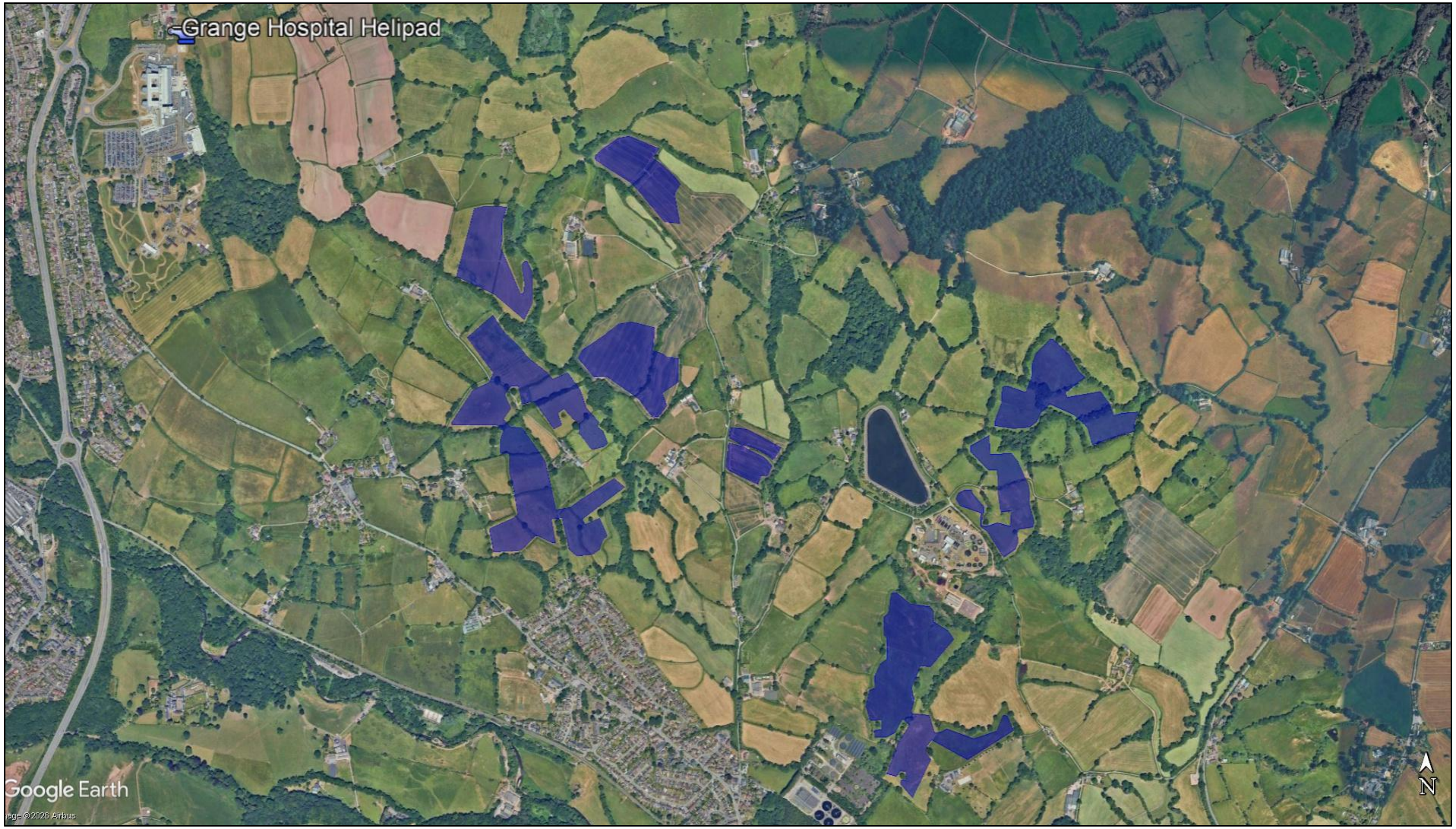

Figure 3 *Grange Hospital Heliport relative to the proposed development*

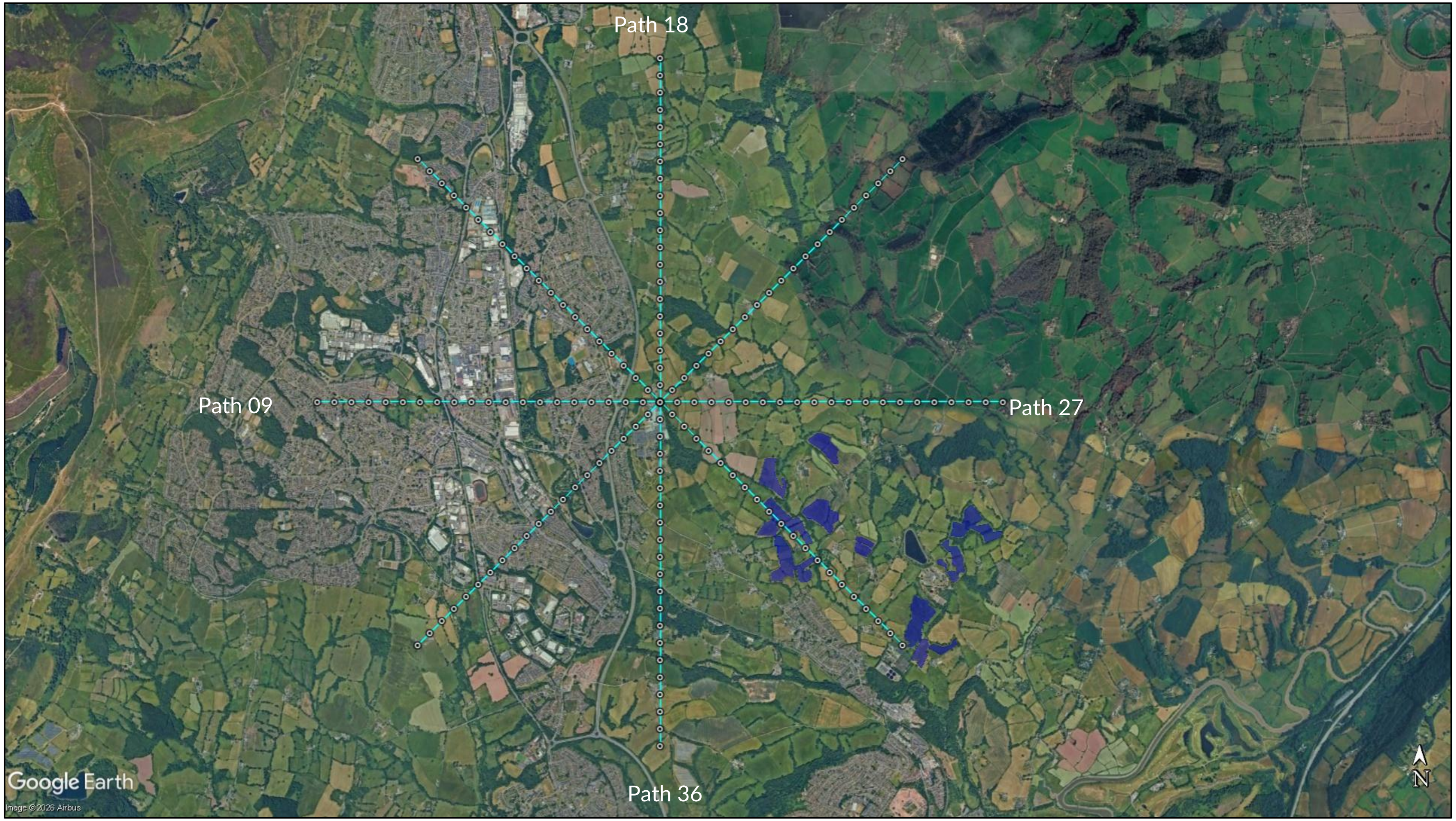

Figure 4 *Grange Hospital Heliport approach paths – aerial image*

4.2.2 Park Farm Airfield

Park Farm Airfield is an unlicensed General Aviation (GA) airfield, situated approximately 1.45km southwest of the nearest solar panel area, as shown in Figure 5 below. It is understood not to have an Air Traffic Control (ATC) Tower. It has one operational runway, the details[10] of which are presented below:

- 06/24 measuring 300m by 15m (grass).

Figure 5 *Park Farm Airfield in relation to the proposed development*

4.2.3 Runway Approach Paths and Final Sections of Visual Circuits and Joins

Park Farm Airfield is a GA airfield where aviation activity is dynamic and does not necessarily follow the typical approaches / flight paths of a larger licensed aerodrome or airport. It is not possible to assess every single location of airspace that an aircraft travels in flight around an aerodrome, however, it is possible to assess the most frequently flown flight paths and the most critical stages of flight, which cover most, or all, of the relevant locations.

As such, Pager Power's methodology is to assess whether a solar reflection can be experienced on a 5-degree splayed approach path based on the extended runway centreline, and the final sections of the visual circuits and joins on approach to the corresponding runway thresholds.

The assessed receptors are based on the following characteristics:

- 1-mile approach path with a splay angle of 5 degrees, considering 2.5 degrees either side of the extended runway centreline;
- A descent angle of 5 degrees;
- Circuit width of 1 nautical mile from runway centreline;

[10] Aerial imagery.

- Maximum altitude of 500 feet above the average threshold altitude.

Figure 6 below illustrates the splayed approach and final sections of the visual circuits.

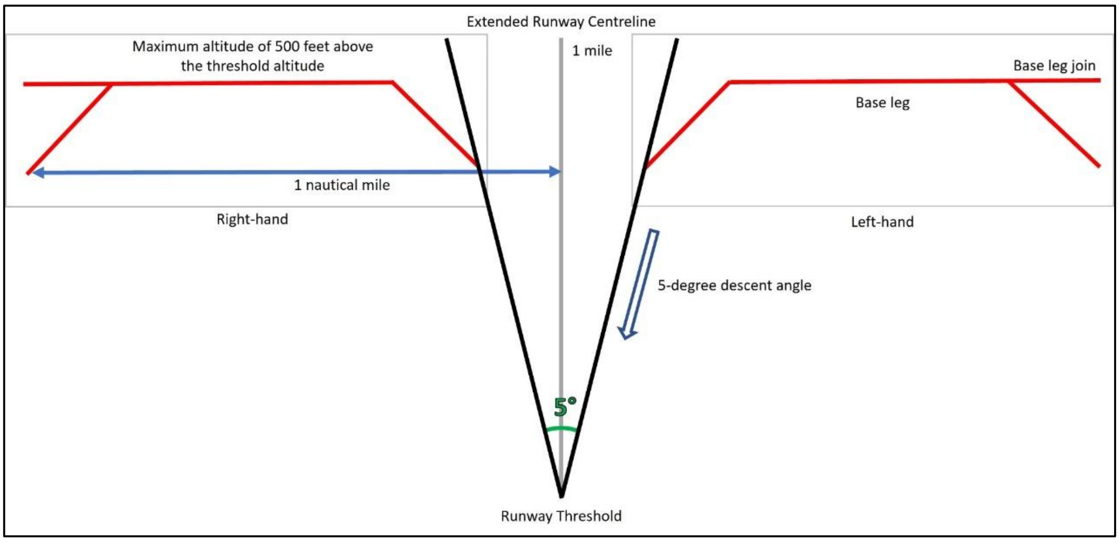

Figure 6 *Splayed approach and final sections of visual circuits and joins*

Figure 7 on the following page show the assessed aircraft receptor points of the splayed approach paths and final sections of the visual circuits and joins at Park Farm Airfield.

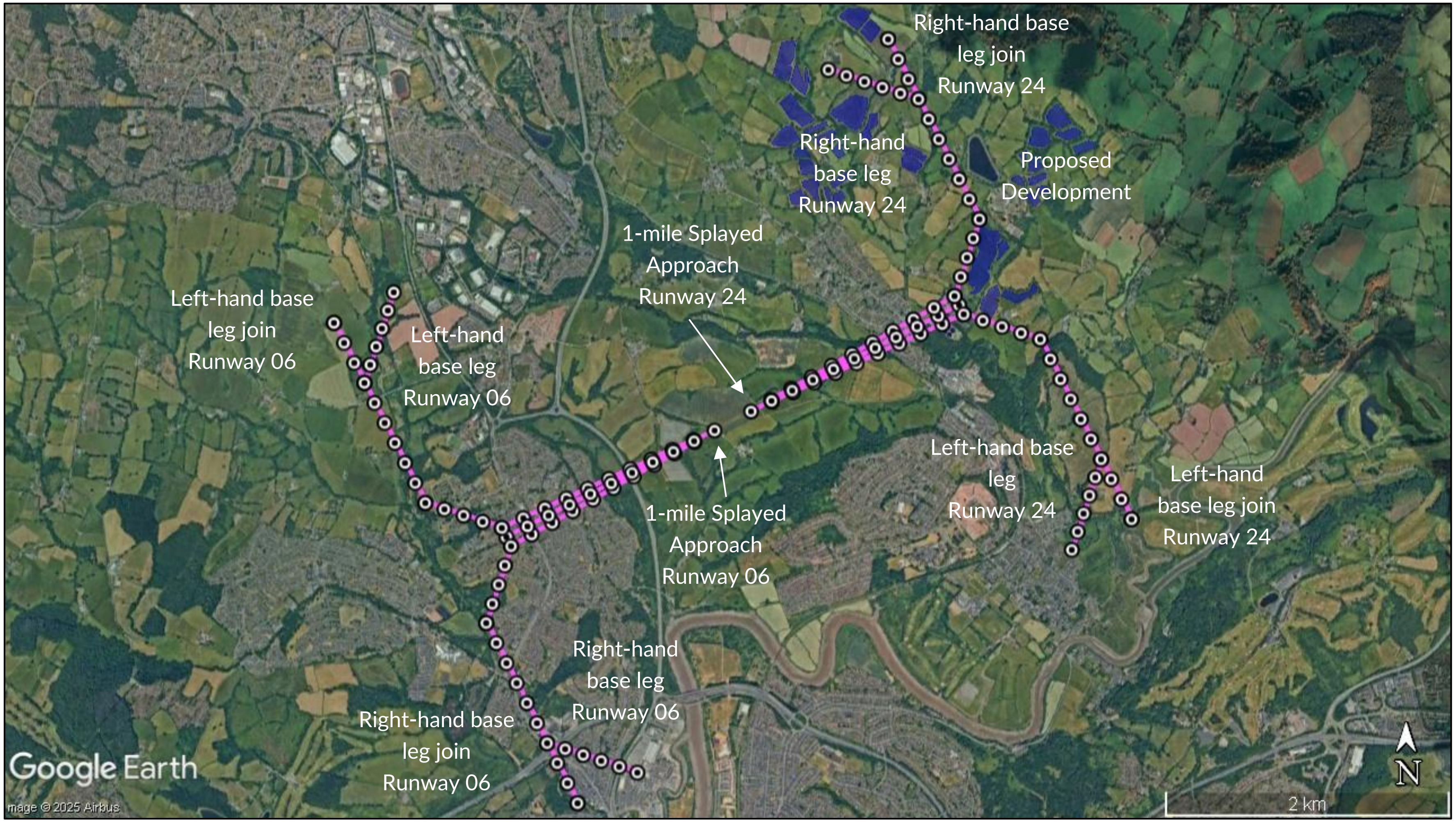

Figure 7 *Park Farm Airfield receptors for runway 06/24 – aerial image*

4.3 Ground-Based Receptors Overview

There is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. From a technical perspective, there is no maximum distance for potential reflections. The significance of a reflection, however, decreases with distance because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases. Terrain and shielding by vegetation are also more likely to obstruct an observer's view at longer distances.

The above parameters and industry experience over a significant number of glint and glare assessments undertaken, shows that a 1km assessment area from the proposed development is considered appropriate for glint and glare effects on road users and dwellings. Reflections towards ground-based receptors located further north than any proposed panel are highly unlikely[11]. Therefore, receptors north of the most northern panel areas have not been modelled. The assessment area (white outlined area in the following figures) has been designed accordingly as 1km from the proposed development, disregarding the area to the north of the north-most solar panels.

Potential receptors within the associated assessment area are identified based on mapping and aerial photography of the region. The initial judgement is made based on high-level consideration of aerial photography and mapping i.e. receptors are excluded if it is clear from the outset that no visibility would be possible. A more detailed assessment is made if the modelling reveals a reflection would be geometrically possible.

4.4 Road Receptors

4.4.1 Road Receptors Overview

Road types can generally be categorised as:

- Major National – Typically a road with a minimum of two carriageways with a maximum speed limit of up to 70mph. These roads typically have fast moving vehicles with busy traffic;
- National – Typically a road with a one or more carriageways with a maximum speed limit 60mph or 70mph. These roads typically have fast moving vehicles with moderate to busy traffic density;
- Regional – Typically a single carriageway with a maximum speed limit of up to 60mph. The speed of vehicles will vary with a typical traffic density of low to moderate;
- Local – Typically roads and lanes with the lowest traffic densities. Speed limits vary.

Technical modelling is not recommended for local roads, where traffic densities are likely to be relatively low. Any solar reflections from the Proposed Development that are experienced by a road user along a local road would be considered low impact in the worst-case in accordance with the guidance presented in Appendix D.

The analysis has also considered major national, national, and regional roads that:

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[11] For fixed, south-facing panels at this latitude.

- Are within the one-kilometre assessment area;
- Have a potential view of the panels.

4.4.2 Identified Road Receptors

A section of the B4236 totalling 3.7km and a section of Usk Road totalling 1.95km have been identified in the 1km assessment area, and are shown in Figures 8 and 9 on the following pages.

An additional height of 1.5m is added above ground level to account for the eye-level[12] of a typical road user. Receptors are placed approximately 100m apart along the identified road, and are also shown in Figures 8 and 9 on the following pages.

All other roads within the assessment area have either been determined to be local roads, or that view of the proposed development are not predicted from them, and thus have not been taken forward for technical modelling.

[12] This fixed height for the road receptors is for modelling purposes. Small changes to the modelling height by a few metres is not expected to significantly change the modelling results. Views for elevated drivers are also considered in the results discussion, where appropriate.

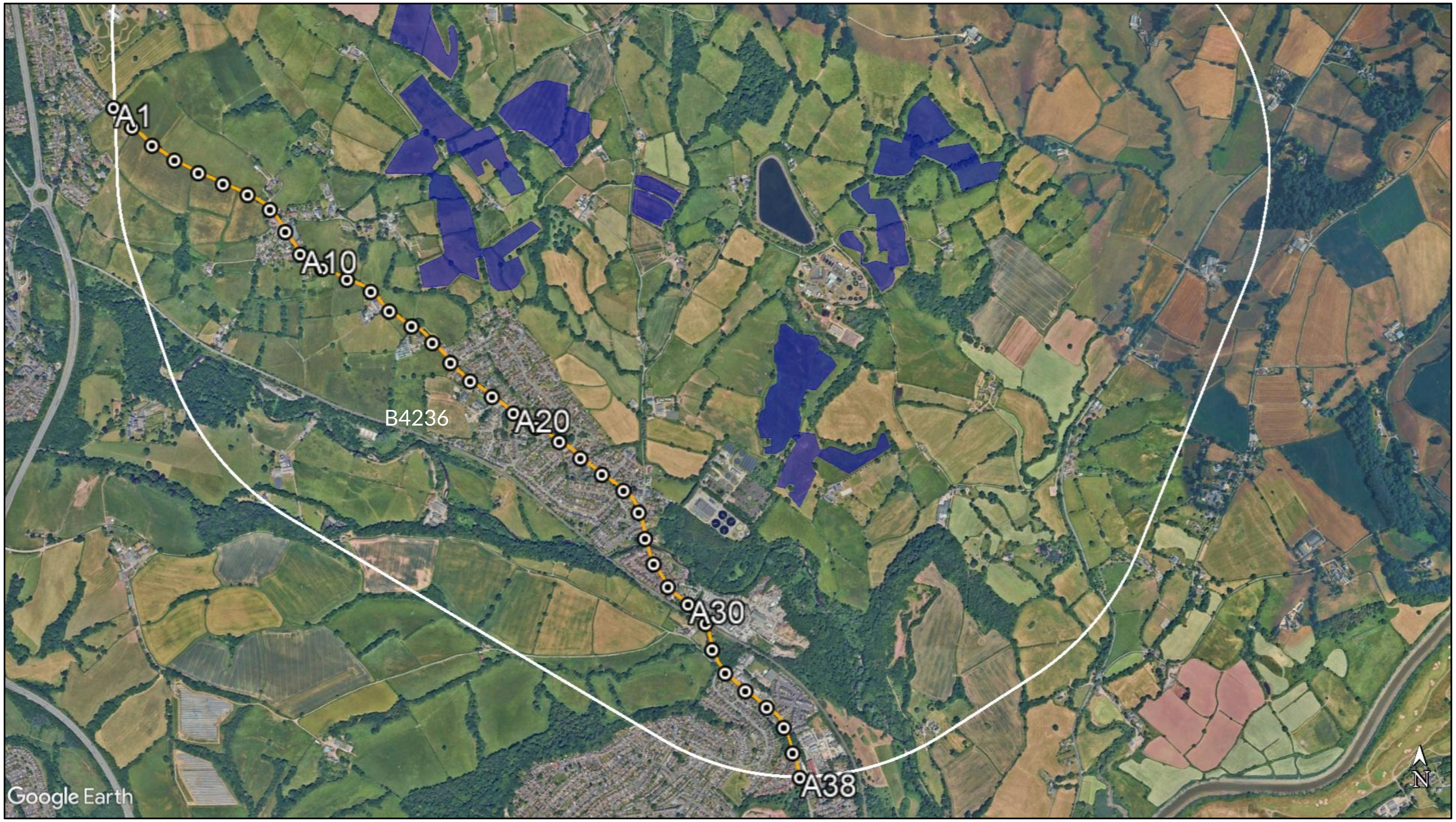

Figure 8 *Road receptors – B4236*

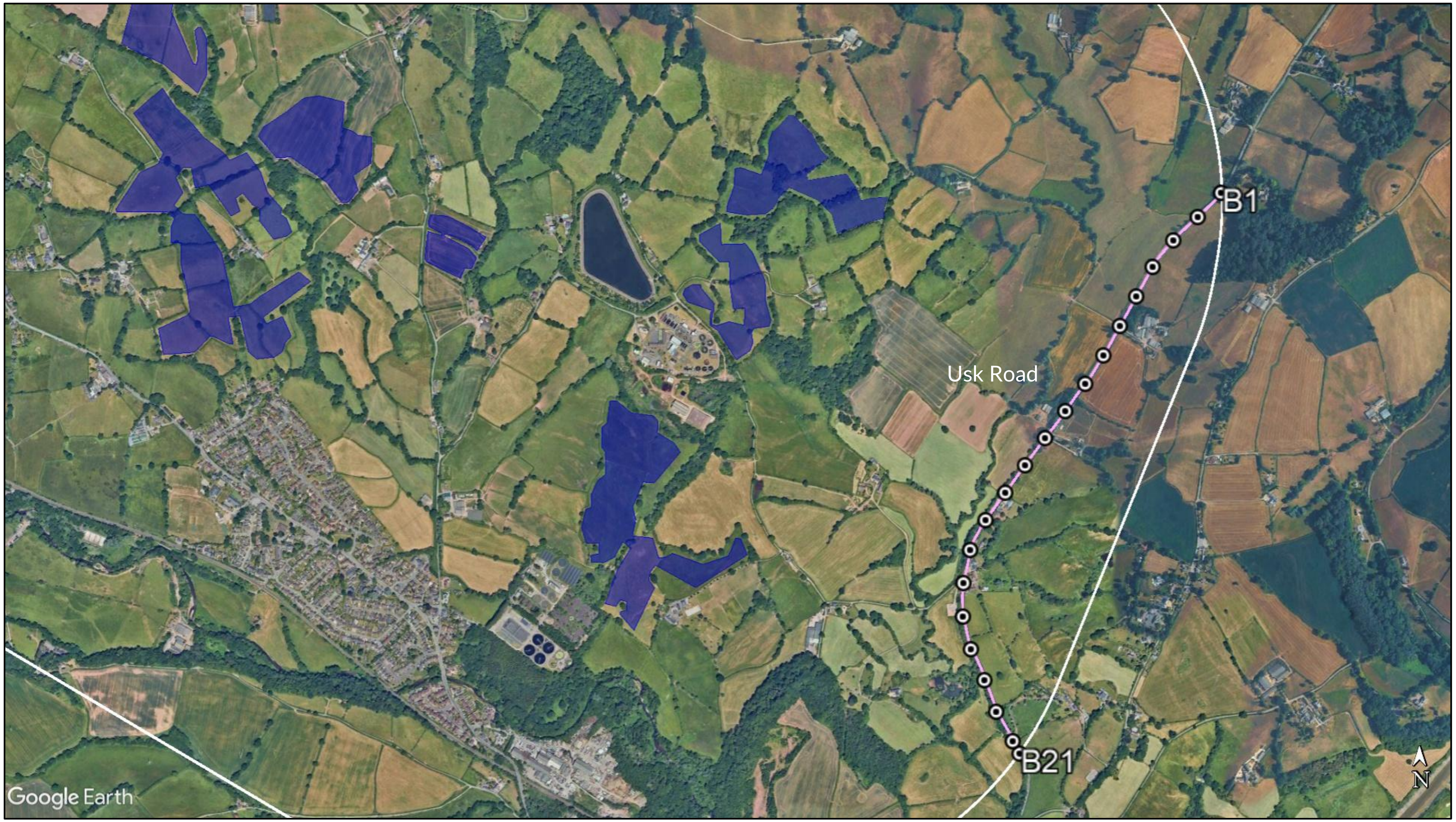

Figure 9 *Road receptors – Usk Road*

4.5 Dwelling Receptors

4.5.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

- Are within the one-kilometre assessment area; and
- Have a potential view of the panels.

In residential areas with multiple layers of dwellings, only the outer dwellings have been considered for assessment. This is because they will mostly obscure views of the solar panels to the dwellings behind them, which will therefore not be impacted by the proposed development because line of sight will be removed, or they will experience, at worst, comparable effects to the closest assessed dwelling.

Additionally, in some cases, a single receptor point may be used to represent a small number of separate addresses. In such cases, the results for the receptor will be representative of the adjacent observer locations, such that the overall level of effect in each area is captured reliably.

4.5.2 Identified Dwelling Receptors

The assessed dwelling receptors are shown in Figures 10 to 14 on the following pages. In total, 153 dwellings have been assessed. An additional 1.8m height above ground is used in the modelling to simulate the typical viewing height of an observer on the ground floor[13].

[13] Small changes to this height are not significant, and views above the ground floor are considered where appropriate.

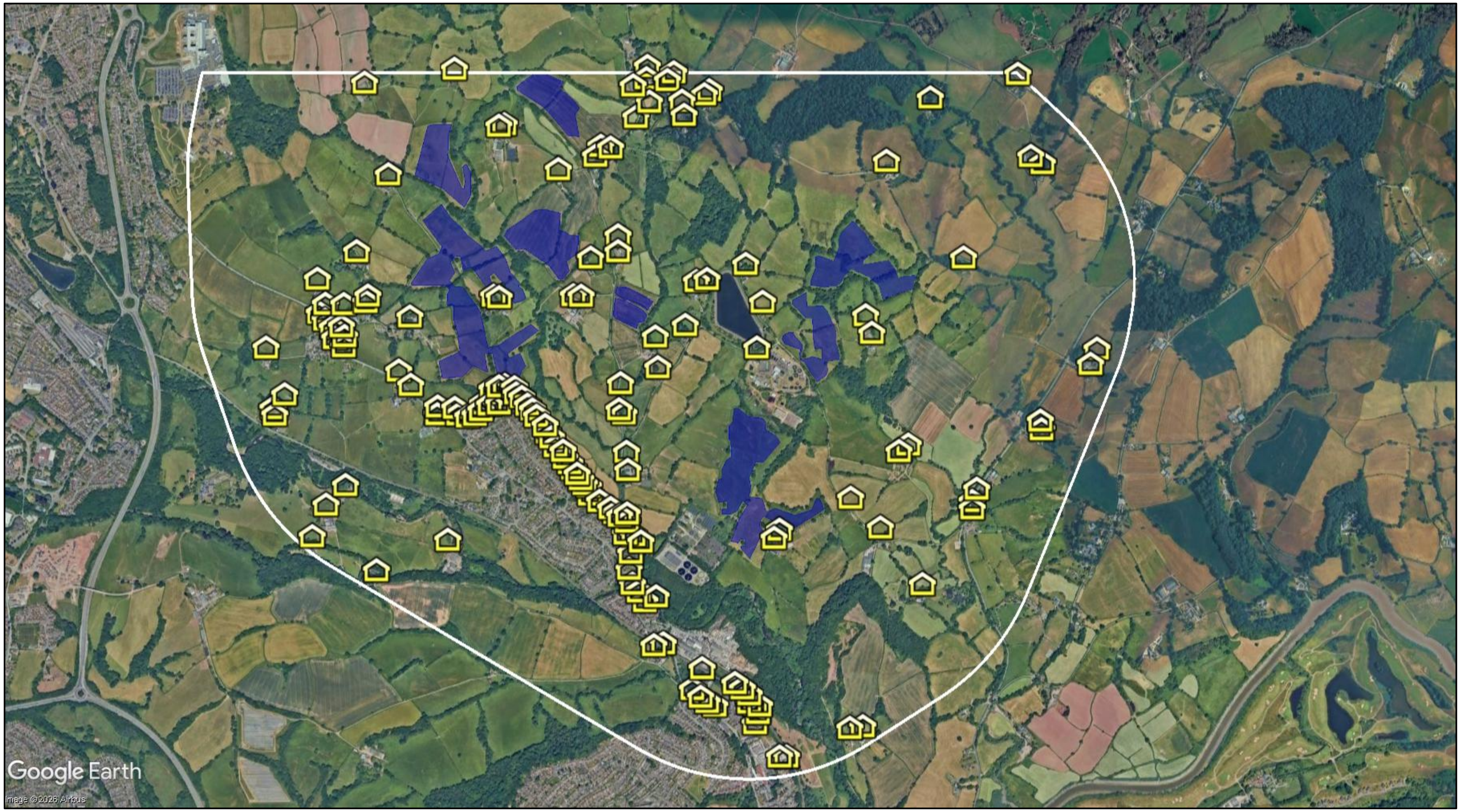

Figure 10 *Dwelling receptors within 1km assessment area*

Figure 11 *Dwelling receptors 1 to 5*

Figure 12 *Dwellings 6 to 73*

Figure 13 *Dwellings 74 to 100*

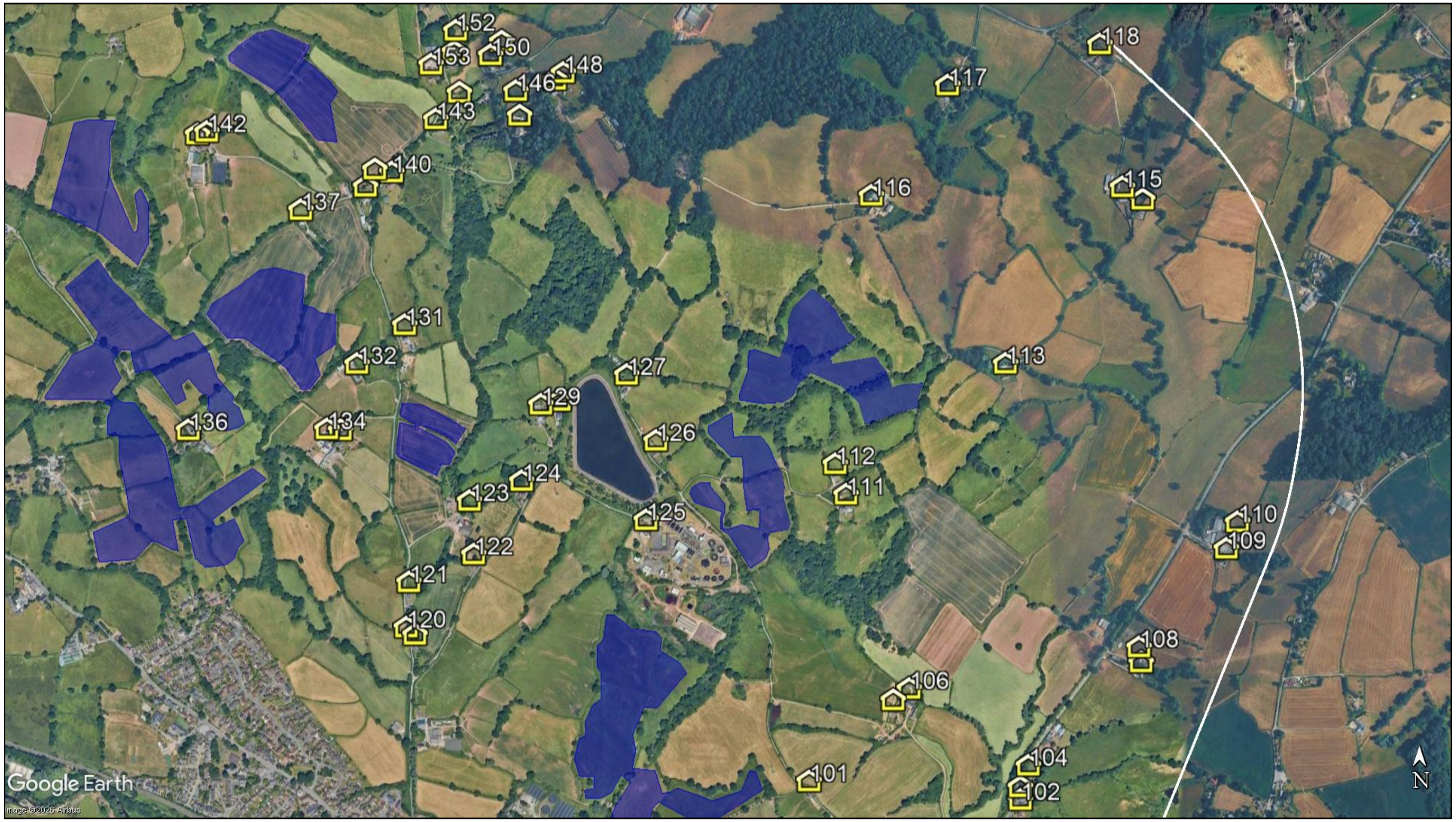

Figure 14 *Dwellings 101 to 152*

5 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

5.1 Overview

The following sub-sections summarise the results of the assessment:

- The key considerations for each receptor type. The criteria are determined by the assessment process for each receptor, which are set out in Appendix D;
- Geometric modelling results of the assessment based solely on bare-earth terrain i.e., without consideration of screening in the form of buildings, dwellings, (existing or proposed) vegetation, and/or terrain. The modelling output for receptors, shown in Appendix H, presents the precise predicted times and the reflecting panel areas;
- Whether a reflection will be experienced in practice. When determining the visibility of the reflecting panels for an observer, a conservative review of the available imagery, landscape strategy plan, Google Earth viewshed (high-level terrain analysis), and/or site photography (if available) is undertaken, whereby it is assumed views of the panels are possible if it cannot be reliably determined that existing and/or proposed screening will remove effects. Detailed screening analysis may be undertaken to determine visibility, where appropriate;
- The impact significance and any mitigation recommendations/requirements;
- The desk-based review of the available imagery, where appropriate.

5.2 Aviation Receptors

5.2.1 Glare Intensity Categorisation

The Pager Power and Forge models have been used to determine whether reflections are possible for aviation receptors. Intensity calculations (Forge Model) in line with the Sandia National Laboratories methodology have been undertaken. These calculations are routinely required for solar photovoltaic developments on or near aerodromes. The intensity model calculates the expected intensity of a reflection with respect to the potential for an after-image (or worse) occurring. The designation used by the model is presented in Table 2 below along with the associated colour coding.

Coding Used	Intensity Key
Glare beyond 50°	'Glare occurs outside of a pilot's primary field-of-view (50 degrees horizontally either side of the direction of travel)'
'Green' glare	'Low potential for temporary after-image'
'Yellow' glare	'Potential for temporary after-image'
'Red' glare	'Potential for permanent eye damage'

Table 2 *Glare intensity designation*

This coding has been used in the table where a reflection has been calculated and is in accordance with Sandia National Laboratories' methodology. In addition, the intensity model allows for the assessment of a variety of solar panel surface materials. This assessment has considered solar panels with a surface material of 'smooth glass with an anti-reflective coating'. It is understood that this is the most commonly used solar panel surface material. Other surfaces that could be modelled include:

- Smooth glass without an anti-reflective coating;
- Light textured glass without an anti-reflective coating;
- Light textured glass with an anti-reflective coating; or
- Deeply textured glass.

Appendix H presents the results charts showing specific times and dates.

The tables in the following subsections summarise the results of the assessment. The predicted glare times are based solely on bare-earth terrain i.e. without consideration of screening from buildings and vegetation. The final column summarises the predicted impact considering the level of predicted screening based on a desk-based review of the available imagery. The significance of any predicted impact is discussed in the subsequent report sections.

The modelling output showing the precise predicted times and the reflecting panel areas are shown in Appendix H.

5.2.2 Key Considerations – Runway Approach Paths

The process for determining impact significance is defined in Appendix D. For the runway approach paths, the key considerations are:

- Whether a reflection is predicted to be experienced in practice;
- The location of glare relative to a pilot's primary field of view (50 degrees either side of the approach bearing).
- The intensity of glare for the solar reflections:
    - Glare with 'low potential for temporary after-image' (green glare);
    - Glare with 'potential for temporary after-image' (yellow glare);
    - Glare with 'potential for permanent eye damage' (red glare).
- Whether a reflection is predicted to be operationally significant in practice or not.

Where no solar reflections are geometrically possible or where solar reflections are predicted to be significantly screened, no impact is predicted, and mitigation is not required.

Where solar reflections are of an intensity no greater than 'low potential for temporary after-image' (green glare) or occur outside of a pilot's primary field-of-view, the impact significance is low, and mitigation is not recommended.

Glare with 'potential for a temporary after-image' (yellow glare) was formerly not permissible under the interim guidance provided by the Federal Aviation Administration in the USA[14] for on-airfield solar. Whilst this guidance was never formally applicable outside of the USA, it has been a common point of reference internationally. Pager Power recommends a pragmatic approach whereby instances of 'yellow' glare are evaluated in a technical and operational context. As per Pager Power's glint and glare guidance document[15], where solar reflections are of an intensity categorisation of 'potential for temporary after-image', an expert assessment of the following mitigating factors is required to determine the impact significance[16]:

- The likely traffic volumes and level of safeguarding at the aerodrome. Licensed aerodromes typically have higher traffic volumes and are formally safeguarded. Unlicensed aerodromes have greater capacity for operational acceptance;
- The time of day at which glare is predicted. Will the aerodrome be operational such that pilots can be on the approach at the time of day at which glare is predicted?;
- The duration of any predicted glare. Glare that occurs for low durations throughout the year is less likely to be experienced than glare that occurs for longer durations throughout the year;
- The location of the source of glare relative to a pilot's primary field-of-view (50 degrees either side of the approach bearing). Do solar reflections occur directly in front of a pilot?;
- The relative size of the reflecting panel area. Does the reflecting panel area make up a large percentage of a pilot's primary field of view?;
- The location of the source of glare relative to the position of the Sun at the times and dates in which solar reflections are geometrically possible. Effects that coincide with direct sunlight appear less prominent than those that do not;
- The intensity of the predicted glare. Is the intensity of glare close to the green/yellow glare threshold on the intensity chart?;
- The level of predicted effect relative to existing sources of glare. A solar reflection is less noticeable by pilots when there are existing reflective surfaces in the surrounding environment.

Following consideration of these mitigating factors, where the solar reflection is deemed not significant, a low impact is predicted, and mitigation is not recommended; however, consultation with the aerodrome is recommended to understand their position along with any feedback or comments regarding the proposed development. Where the solar reflection is deemed significant, the impact significance is moderate, and mitigation is recommended.

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[14] This FAA guidance from 2013 has since been superseded by the FAA guidance in 2021 whereby airports are tasked with determining safety requirements themselves.

[15] Pager Power Glint and Glare Guidance, Fourth Edition, September 2022.

[16] This approach taken is reflective of the changes made in the 2021 FAA guidance; however, it should be noted that this guidance states that it is up to the airport to determine the safety requirements themselves. Therefore, an airport may not accept any yellow glare towards approach paths.

Where the solar reflection is of an intensity greater than 'potential for temporary after-image', the impact significance is high, and mitigation is required.

5.2.3 Assessment Results – Grange Hospital Helipad

Table 3 on the following page presents the following:

- Geometric modelling results;
- Glare intensity;
- Relevant factors, visibility and predicted impact significance.

Reference to a pilot's primary field-of-view is made when analysing the geometric results. A pilot's primary field-of-view is defined as 50 degrees either side of the approach bearing.

Approach/Circuit	Geometric Modelling Result	Glare Coding	Comment	Impact Classification
Helicopter Approach paths 32, 36 and 05	Solar reflections are geometrically possible towards the splayed approach path	'Green'	Solar reflections have glare intensities no greater than 'low potential for temporary after-image', which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice	Low impact
Helicopter Approach paths 09, 14, 18, 22 and 27	Solar reflections are not geometrically possible	N/A	N/A	No impact

Table 3 *Geometric modelling results – Grange Hospital Helipad receptors*

5.2.4 Assessment Results – Park Farm Airfield

Table 4 on the following page presents the following:

- Geometric modelling results;
- Glare intensity;
- Relevant factors, visibility and predicted impact significance.

Reference to a pilot's primary field-of-view is made when analysing the geometric results. A pilot's primary field-of-view is defined as 50 degrees either side of the approach bearing.

Approach/Circuit	Geometric Modelling Result	Glare Coding	Comment	Impact Classification
Runway 06 Splayed Approach	Solar reflections are geometrically possible towards the splayed approach path	'Green'	Solar reflections have glare intensities no greater than 'low potential for temporary after-image', which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice	Low impact
Runway 24 Splayed Approach	Solar reflections are geometrically possible towards the splayed approach path	'Green'	Solar reflections have glare intensities no greater than 'low potential for temporary after-image', which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice	Low impact
Runway 06 Visual Circuits	Solar reflections are geometrically possible along the left and right hand base legs and associated joins	'Green'	Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, which states this level of glare is acceptable, it can reliably be concluded that this level of glare is also acceptable for the visual circuits	Low impact
Runway 24 Visual Circuits	Solar reflections are geometrically possible along the left and right hand base legs and associated joins	'Green'	Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, which states this level of glare is acceptable, it can reliably be concluded that this level of glare is also acceptable for the visual circuits	Low impact

Table 4 *Geometric modelling results – Park Farm Airfield receptors*

5.3 Assessment Results – Road Receptors

5.3.1 Key Considerations

The key considerations for road users along major national, national, and regional roads are:

- Whether a reflection is predicted to be experienced in practice; and
- The location of the reflecting panel relative to a road user's direction of travel.

Where solar reflections are not geometrically possible, or the reflecting panels are predicted to be significantly obstructed from view, no impact is predicted, and mitigation is not required.

Where solar reflections originate from outside of a road user's primary field of view (50 degrees either side relative to the direction of travel), or the closest reflecting panel is over 1km from the road user, the impact significance is low, and mitigation is not recommended.

Where solar reflections are predicted to be experienced from inside of a road user's primary field of view, expert assessment of the following factors is required to determine the impact significance and mitigation requirement:

- Whether the solar reflection originates from directly in front of a road user – a solar reflection that is directly in front of a road user is more hazardous than a solar reflection to one side;
- Whether visibility is likely for elevated drivers (relevant to dual carriageways and motorways[17]);
- The separation distance to the panel area. Larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- Whether a solar reflection is fleeting in nature. Small gap/s in screening, e.g. an access point to the site, may not result in a sustained reflection for a road user;
- The position of the Sun. Effects that coincide with direct sunlight appear less prominent than those that do not. The Sun is a far more significant source of light.

Following consideration of these relevant factors, where the solar reflection does not remain significant, a low impact is predicted, and mitigation is not recommended. Where the solar reflection remains significant, the impact significance is moderate, and mitigation is recommended.

Where solar reflections originate from directly in front of a road user and there are no mitigating factors, the impact significance is high, and mitigation is required.

[17] There is typically a higher density of elevated drivers (such as HGVs) along dual carriageways and motorways compared to other types of roads.

5.3.2 Geometric Modelling Results and Discussion

Table 5 on the following pages presents the following:

- Geometric modelling results (bare earth terrain i.e. without consideration of screening);
- Desk-based review of identified screening;
- Consideration of relevant factors where appropriate;
- Predicted impact significance.

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[18]	Mitigating Factors	Predicted Impact Classification
A1 – A8	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV[19]	Existing vegetation, buildings, Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact
A9 – A10	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation and buildings Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact

[18] Assessment scenario may include an initial conservative qualitative consideration of screening. The reflecting area of the solar development may be partially screened such that it does not meet the key criteria i.e. whether the solar reflection occurs within a road users' main field of view.
[19] Reference to a driver's field-of-view (FOV) is made when analysing the geometric modelling results and overall predicted impact significance, which is defined as 50 degrees horizontally either side, relative to the direction of travel.

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[18]	Mitigating Factors	Predicted Impact Classification
A11 – A16	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation, buildings, and/or intervening terrain Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact
A17	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact
A18 – A25	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[18]	Mitigating Factors	Predicted Impact Classification
A26 – A28	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact
A29 – A38	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact
B1	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact
B2	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[18]	Mitigating Factors	Predicted Impact Classification
B3 – B16	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation and intervening terrain Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact
B17 – B21	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	N/A	N/A	No impact

Table 5 *Geometric modelling results - road receptors*

5.3.3 Desk-Based Review of Available Imagery

A desk-based review of the available imagery is presented in Figures 15 to 18 on the following pages for road receptors. The cumulative reflecting panel areas are indicated by regions of yellow. The identified screening in the form of existing vegetation and buildings are outlined in pink and blue, respectively. High-level Zones of Theoretical Visibility (ZTV Viewshed) generated[20] by Google Earth have been used to show the intervening terrain between the proposed development and relevant road receptors, areas of green show terrain predicted to be visible from the receptor.

[20] From a height above ground of 2m, the closest available height to the assessed height of 1.5m.

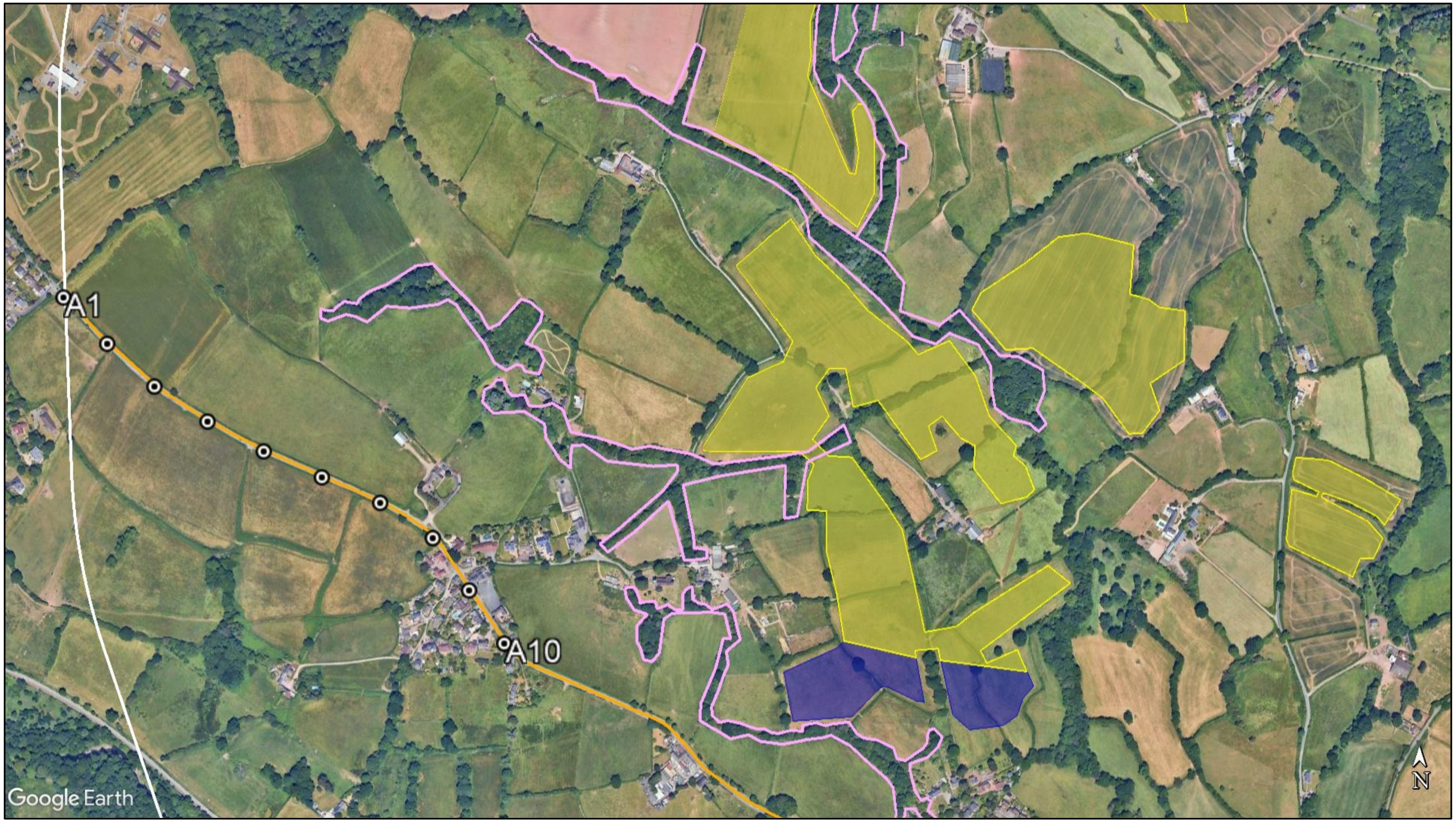

Figure 15 *Screening for road receptors A1 to A10*

Figure 16 *Screening for road receptors A11 to A28, with ZTV from A13*

Figure 17 *Screening for road receptors B1 to B16, with ZTV from B8*

Figure 18 *Screening for road receptors B17 to B21*

5.4 Assessment Results – Dwelling Receptors

5.4.1 Key Considerations

The key considerations for residential dwellings are:

- Whether a reflection is predicted to be experienced in practice;
- The duration of the predicted effects, relative to thresholds of:
  - Three months per year;
  - 60 minutes on any given day.

Where solar reflections are not geometrically possible, or the reflecting panels are predicted to be significantly obstructed from view, no impact is predicted, and mitigation is not required.

Where effects occur for **less** than three months per year and **less** than 60 minutes on any given day, or the closest reflecting panel is over 1km from the dwelling, the impact significance is low, and mitigation is not recommended.

Where reflections are predicted to be experienced for **more** than three months per year and/or for **more** than 60 minutes on any given day, expert assessment of the following factors is required to determine the impact significance and mitigation requirement:

- The separation distance to the panel area – larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not;
- Whether visibility is likely from all storeys – the ground floor is typically considered the main living space and has a greater significance with respect to residential amenity;
- Whether the dwelling appears to have windows facing the reflecting area – factors that restrict potential views of a reflecting area reduce the level of impact.

Following consideration of these mitigating factors, where the solar reflection is not deemed significant, a low impact is predicted, and mitigation is not recommended. Where the solar reflection is deemed significant, the impact significance is moderate, and mitigation is recommended.

If effects last for **more** than 3 months per year and for **more** than 60 minutes on any given day, and there are no mitigating factors, the impact significance is high, and mitigation is required.

5.4.2 Geometric Modelling Results and Discussion

Solar reflections are geometrically possible towards 132 of the 151 assessed dwellings.

Table 6 on the following pages presents the geometric modelling results and predicted impact significance for the assessed dwelling receptors.

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[21]	Mitigating Factors	Predicted Impact Classification
1 – 2	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
3 – 21	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
22 - 23	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels from the ground floor	**More** than three months **Less** than 60 minutes	Remaining views are only possible for an observer above the ground floor Reflections coincide with direct sunlight	Low impact

[21] Assessment scenario may include an initial conservative qualitative consideration of screening in determining the duration of predicated effects in practice. The reflecting area of the solar development may be partially screened such that it does not meet the two key criteria i.e. 1) The solar reflection occurs for more than three months per year 2) and/or for more than 60 minutes on any given day.

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[21]	Mitigating Factors	Predicted Impact Classification
24 - 73	Solar reflections **are geometrically possible** for: More than three months Less than 60 minutes	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
74 – 75	Solar reflections **are geometrically possible** for: Less than three months Less than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
76 - 96	Solar reflections **are not** geometrically possible	N/A	N/A	N/A	No impact
97	Solar reflections **are geometrically possible** for: More than three months Less than 60 minutes	Existing vegetation and buildings Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[21]	Mitigating Factors	Predicted Impact Classification
98 - 99	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation and buildings Predicted to significantly obstruct views of reflecting panels from the ground floor	**More** than three months **Less** than 60 minutes	Remaining views are only possible for an observer above the ground floor Reflections coincide with direct sunlight	Low impact
100 - 113	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
114 – 118	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[21]	Mitigating Factors	Predicted Impact Classification
119 – 125	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
126 - 127	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels from the ground floor	**More** than three months **Less** than 60 minutes	Remaining views are only possible for an observer above the ground floor Reflections coincide with direct sunlight	Low impact
128 – 138	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[21]	Mitigating Factors	Predicted Impact Classification
139 – 140	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
141 – 146	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels from the ground floor	None	N/A	No impact
147 - 153	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation and/or buildings Predicted to significantly obstruct views of reflecting panels	None	N/A	No impact

Table 6 *Geometric modelling results - dwelling receptors*

5.4.3 Desk-Based Review of Available Imagery

A desk-based review of the available imagery is presented in Figures 18 to 26 on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow. The identified screening in the form of existing vegetation and buildings is outlined in pink and blue, respectively.

Figure 19 *Screening for dwellings 1 to 2*

Figure 20 *Screening for dwellings 3 to 5*

Figure 21 *Screening for dwellings 6 to 23*

Figure 22 *Screening for dwellings 24 to 75*

Figure 23 *Screening for dwellings 97 to 104*

Figure 24 *Screening for dwellings 105 to 113*

Figure 25 *Screening for dwellings 114 to 118*

Figure 26 *Screening for dwellings 119 to 125*

Figure 27 *Screening for dwellings 126 to 129*

Figure 28 *Screening for dwellings 130 to 136*

Figure 29 *Screening for dwellings 137 to 144*

Figure 30 *Screening for dwellings 145 to 153*

6 HIGH-LEVEL AVIATION ASSESSMENTS

6.1 Overview

There is no formal buffer distance within which aviation effects must be modelled. However, in practice, concerns are most often raised for developments within 10km of a licensed aerodrome. Technical modelling for general aviation (GA) unlicensed aerodromes is typically required within 5km of a proposed solar development. At ranges of 10-20km, the requirement for assessment is much less common, with typically an assessment only being undertaken for licensed aerodromes at these ranges. Assessment of any aviation effects for developments over 20km is not a usual requirement.

A high-level aviation assessment has been undertaken considering the nearest airfield and airport to the proposed development.

6.2 High-Level Assessment of Croes-Carn-Einion Farm Airfield

Croes-Carn-Einion Farm Airfield is an unlicensed GA airfield approximately 9.6km southwest of the development with one operational runway and is understood not to have an ATC Tower. The runway details[22] are presented below:

- 04/22 measuring 550 metres x 20 metres (grass).

The location of Croes-Carn-Einion Farm Airfield and 1-mile splayed approach paths for each runway threshold relative to the development is shown in Figure 31 below.

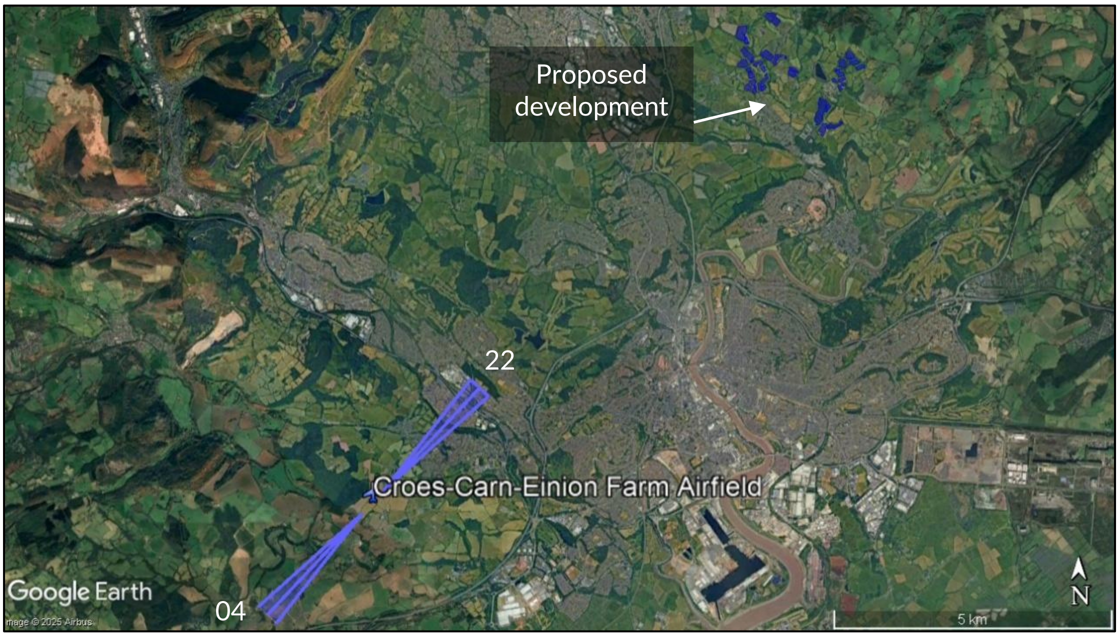

Figure 31 *Croes-Carn-Einion Farm Airfield relative to the proposed development*

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[22] As determined from aerial imagery.

6.2.1 Assessment

The development size, distance between the aerodromes and the development, modelling for Park Farm Airfield, and industry experience have been considered to determine the impact during the assessment.

The following can be concluded for Croes-Carn-Einion Farm Airfield with regards to the development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 22 will be outside a pilot's primary field-of-view (50 degrees horizontally either side of the direction of travel), and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths;
- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 04 is expected to have glare intensities no greater than 'low potential for temporary after-image', which is considered acceptable in accordance with the associated guidance (Appendix D) and industry best practice;
- Solar reflections towards the visual circuits for runway thresholds 04 and 22 are expected to have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, which states this level of glare is acceptable, it can be reliably concluded that this level of glare is also acceptable for the visual circuits.

6.2.2 Conclusions

Overall, no significant impact upon aviation activity associated with Croes-Carn-Einion Farm Airfield is predicted. Detailed modelling of Croes-Carn-Einion Farm Airfield is not recommended, and mitigation is not required.

6.3 High-Level Assessment of Upfield Farm Airfield

Upfield Farm Airfield is an unlicensed GA airfield approximately 9.5km southeast of the development with one operational runway and is understood not to have an ATC Tower. The runway details[23] are presented below:

- 05/23 measuring 575 metres x 25 metres (grass).

The location of Upfield Farm Airfield and 1-mile splayed approach paths for each runway threshold relative to the development is shown in Figure 32 on the following page.

[23] As determined from aerial imagery.

Figure 32 *Upfield Farm Airfield relative to the proposed development*

6.3.1 Assessment

The development size, distance between the aerodromes and the development, modelling for Park Farm Airfield, and industry experience have been considered to determine the impact during the assessment.

The following can be concluded for Upfield Farm Airfield with regards to the development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway thresholds 05 and 23 will be outside a pilot's primary field-of-view (50 degrees horizontally either side of the direction of travel), and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths;
- Solar reflections towards the visual circuits for runway thresholds 05 and 23 are expected to have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, which states this level of glare is acceptable, it can be reliably concluded that this level of glare is also acceptable for the visual circuits.

6.3.2 Conclusions

Overall, no significant impact upon aviation activity associated with Upfield Farm Airfield is predicted. Detailed modelling of Upfield Farm Airfield is not recommended, and mitigation is not required.

6.4 High-Level Assessment of Kemeys Commander Airfield

Kemeys Commander Airfield is an unlicensed GA airfield approximately 9.9km north of the development with one operational runway and is understood not to have an ATC Tower. The runway details[24] are presented below:

- 13/31 measuring 475 metres x 40 metres (grass).

The location of Kemeys Commander Airfield and 1-mile splayed approach paths for each runway threshold relative to the development is shown in Figure 33 below.

Figure 33 *Kemeys Commander Airfield relative to the proposed development*

6.4.1 Assessment

The development size, distance between the aerodromes and the development, modelling for Park Farm Airfield, and industry experience have been considered to determine the impact during the assessment.

The following can be concluded for Kemeys Commander Airfield with regards to the development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 31 will be outside a pilot's primary field-of-view (50 degrees horizontally either side of the direction of travel), and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths;
- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 13 are expected to have glare intensities no greater

[24] As determined from aerial imagery.

than 'low potential for temporary after-image', which is considered acceptable in accordance with the associated guidance (Appendix D) and industry best practice;

- Solar reflections towards the visual circuits for runway thresholds 13 and 31 are expected to have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, which states this level of glare is acceptable, it can be reliably concluded that this level of glare is also acceptable for the visual circuits.

6.4.2 Conclusions

Overall, no significant impact upon aviation activity associated with Kemeys Commander Airfield is predicted. Detailed modelling of Kemeys Commander Airfield is not recommended, and mitigation is not required.

7 OVERALL CONCLUSIONS

7.1 Assessment Conclusions – Grange Hospital Helipad

Solar reflections with an intensity of 'low potential for temporary after-image' are geometrically possible towards the 2-mile helicopter approach paths. This category of glare intensity is acceptable in accordance with the associated guidance (Appendix D) and industry best practice.

A low impact is predicted and mitigation is not recommended.

7.2 Assessment Conclusions – Park Farm Airfield

Solar reflections with an intensity of 'low potential for temporary after-image' are geometrically possible towards sections of the splayed approach paths and the final sections of the visual circuits for runway 06/24. This intensity of glare is considered acceptable in accordance with the associated guidance (Appendix D) and industry best practice.

A low impact is predicted and mitigation is not recommended.

7.3 Assessment Conclusions – Road Safety

Solar reflections are geometrically possible towards a 2.8km section of the B4236 and a 1.95km section of Usk Road.

For all sections of the B4236 and Usk Road, existing vegetation, buildings, and/or intervening terrain are predicted to significantly obstruct views of the reflecting panels such that solar reflections are not predicted to be experienced in practice. No impact is predicted and mitigation is not required.

7.4 Assessment Conclusions – Residential Amenity

Solar reflections are geometrically possible towards 132 of the 153 assessed dwellings.

For six dwellings, solar reflections are predicted to occur for more than three months a year but less than 60 minutes on any given day. Existing vegetation and/or buildings have been identified that partially obstructs views of the reflecting panels, however residual views are considered possible. Mitigating factors which reduce the level of impact have been identified and are presented in Section 5.4.2. Therefore, a low impact is predicted and mitigation is not recommended.

For the remaining 126 dwellings, existing vegetation, buildings, and/or intervening terrain have been identified that are predicted to significantly obstruct views of the reflecting panels, such that views are not predicted to be experienced in practice. No impact is predicted and mitigation is not required.

7.5 High-Level Assessment Conclusions – Aviation

Croes-Carn-Einion Farm Airfield, Upfield Farm Airfield, and Kemeys Commander Airfield

The development size, distance between the aerodromes and the development, modelling for Park Farm Airfield, and industry experience have been considered to determine the impact during the assessment.

Solar reflections towards the splayed approaches and final sections of visual circuits at Croes-Carn-Einion Farm Airfield, Upfield Farm Airfield, and Kemeys Commander Airfield are predicted to occur outside a pilot's field-of-view (50 degrees on either side relative to the runway threshold bearing) or have intensities no greater than 'low potential for temporary after-image'.

Overall, no significant impact upon aviation activity associated with Croes-Carn-Einion Farm Airfield, Upfield Farm Airfield, and Kemeys Commander Airfield is predicted. Detailed modelling is not recommended and mitigation is not required.

7.6 Overall Conclusions

No significant impacts are predicted upon road safety, residential amenity, and aviation activity. Mitigation is not recommended .

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

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[25] (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.'

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[25] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 14 August 2023, accessed on: 14/08/2023.

National Policy Statement for Renewable Energy Infrastructure

The National Policy Statement for Renewable Energy Infrastructure (EN-3)[26] sets out the primary policy for decisions by the Secretary of State for nationally significant renewable energy infrastructure. Sections 2.10.102-106 state:

'2.10.102 Solar panels are specifically designed to absorb, not reflect, irradiation.[27] However, solar panels may reflect the sun's rays at certain angles, causing glint and glare. Glint is defined as a momentary flash of light that may be produced as a direct reflection of the sun in the solar panel. Glare is a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from the face of the panel. The effect occurs when the solar panel is stationed between or at an angle of the sun and the receptor.

2.10.103 Applicants should map receptors to qualitatively identify potential glint and glare issues and determine if a glint and glare assessment is necessary as part of the application.

2.10.104 When a quantitative glint and glare assessment is necessary, applicants are expected to consider the geometric possibility of glint and glare affecting nearby receptors and provide an assessment of potential impact and impairment based on the angle and duration of incidence and the intensity of the reflection.

2.10.105 The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and design. This may need to account for 'tracking' panels if they are proposed as these may cause differential diurnal and/or seasonal impacts.

2.10.106 When a glint and glare assessment is undertaken, the potential for solar PV panels, frames and supports to have a combined reflective quality may need to be assessed, although the glint and glare of the frames and supports is likely to be significantly less than the panels.'

The EN-3 does not state which receptors should be considered as part of a quantitative glint and glare assessment. Based on Pager Power's extensive project experience, typical receptors include residential dwellings, road users, aviation infrastructure, and railway infrastructure.

Sections 2.10.134-136 state:

'2.10.134 Applicants should consider using, and in some cases the Secretary of State may require, solar panels to comprise of (or be covered with) anti-glare/anti-reflective coating with a specified angle of maximum reflection attenuation for the lifetime of the permission.

2.10.135 Applicants may consider using screening between potentially affected receptors and the reflecting panels to mitigate the effects.

2.10.136 Applicants may consider adjusting the azimuth alignment of or changing the elevation tilt angle of a solar panel, within the economically viable range, to alter the angle of incidence.

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[26] National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Energy Security & Net Zero, date: January 2024, accessed on: 17/01/2024.

[27] *'Most commercially available solar panels are designed with anti-reflective glass or are produced with anti-reflective coating and have a reflective capacity that is generally equal to or less hazardous than other objects typically found in the outdoor environment, such as bodies of water or glass buildings.'*

In practice this is unlikely to remove the potential impact altogether but in marginal cases may contribute to a mitigation strategy.'

The mitigation strategies listed within the EN-3 are relevant strategies that are frequently utilised to eliminate or reduce glint and glare effects towards surrounding observers. The most common form of mitigation is the implementation of screening along the site boundary.

Sections 2.10.158-159 state:

2.10.158 Solar PV panels are designed to absorb, not reflect, irradiation. However, the Secretary of State should assess the potential impact of glint and glare on nearby homes, motorists, public rights of way, and aviation infrastructure (including aircraft departure and arrival flight paths).

2.10.159 Whilst there is some evidence that glint and glare from solar farms can be experienced by pilots and air traffic controllers in certain conditions, there is no evidence that glint and glare from solar farms results in significant impairment on aircraft safety. Therefore, unless a significant impairment can be demonstrated, the Secretary of State is unlikely to give any more than limited weight to claims of aviation interference because of glint and glare from solar farms.

The EN-3 goes some way in acknowledging that the issue is more complex than presented in the early draft issues; though, this is still unlikely to be welcomed by aviation stakeholders, who will still request a glint and glare assessment on the basis that glare may lead to a potentially significant impact upon aviation safety.

Finally, the EN-3 relates solely to nationally significant renewable energy infrastructure and therefore does not apply to all planning applications for solar farms.

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[28] however the advice is still applicable[29] 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.

[28] Archived at Pager Power.

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

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

10. Where proposed developments in the vicinity of aerodromes require an application for planning permission the relevant LPA normally consults aerodrome 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-aerodrome (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[30], as part of a condition of a CAA Aerodrome Licence, the ALH is required to obtain prior consent from CAA Aerodrome Standards Department before any work is begun or approval to the developer or LPA is granted, in accordance with the procedures set out in CAP 791 Procedures for Changes to Aerodrome Infrastructure.

13. During the installation and associated construction of SPV systems there may also be a need to liaise with nearby aerodromes 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 Aerodrome Standards Department via aerodromes@caa.co.uk.'

FAA Guidance

The most comprehensive guidelines available for the assessment of solar developments near aerodromes has been produced by the United States Federal Aviation Administration (FAA). The first guidelines were produced initially in November 2010 and updated in 2013. A final policy was released in 2021, which superseded the interim guidance.

The 2010 document is entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports'*[31], the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects*

[30] Aerodrome Licence Holder.
[31] Archived at Pager Power.

on Federally Obligated Airports'[32], and the 2021 final policy is entitled '*Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports'*[33].

Key excerpts from the final policy are presented below:

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

The policy in this document updates and replaces the previous policy by encouraging airport sponsors to conduct an ocular analysis of potential impacts to ATCT cabs prior to submittal of a Notice of Proposed Construction or Alteration Form 7460-1 (hereinafter Form 7460-1). Airport sponsors are no longer required to submit the results of an ocular analysis to FAA. Instead, to demonstrate compliance with 14 CFR 77.5(c), FAA will rely on the submittal of Form 7460-1 in which the sponsor confirms that it has analyzed the potential for glint and glare and determined there is no potential for ocular impact to the airport's ATCT cab. This process will enable FAA to evaluate the solar energy system project, with assurance that the system will not impact the ATCT cab.

FAA encourages airport sponsors of federally-obligated towered airports to conduct a sufficient analysis to support their assertion that a proposed solar energy system will not result in ocular impacts. There are several tools available on the open market to airport sponsors that can analyze potential glint and glare to an ATCT cab. For proposed systems that will clearly not impact ATCT cabs (e.g., on-airport solar energy systems that are blocked from the ATCT cab's view by another structure), the use of such tools may not be necessary to support the assertion that a proposed solar energy system will not result in ocular impacts.

The excerpt above states where a solar PV development is to be located on a federally obligated aerodrome with an ATC Tower, it will require a glint and glare assessment to accompany its application. It states that pilots on approach are no longer a specific assessment requirement due to effects from solar energy systems being similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features. Ultimately it comes down to the specific aerodrome to ensure it is adequately safeguarded, and it is on this basis that glint and glare assessments are routinely still requested.

The policy also states that several different tools and methodologies can be used to assess the impacts of glint and glare, which was previously required to be undertaken by the Solar Glare Hazard Analysis Tool (SGHAT) using the Sandia National Laboratories methodology.

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[32] 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: 08/12/2021.

[33] Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports, Federal Aviation Administration, date: May 2021, accessed on: 08/12/2021.

In 2018, the FAA released the latest version (Version 1.1) of the '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'[34]. Whilst the 2021 final policy also supersedes this guidance, many of the points are still relevant because aerodromes are still safeguarding against glint and glare irrespective of the FAA guidance. The key points are presented below for reference:

- *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*[35].
- *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*[36]*, 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*

[34] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

[35] 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.

[36] 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 question*[37] *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) 2016

In some instances, an aviation stakeholder can refer to the ANO 2016[38] with regard to safeguarding. Key points from the document are presented below.

Lights liable to endanger

224. (1) A person must not exhibit in the United Kingdom any light which—

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[37] 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.
[38] The Air Navigation Order 2016. [online] Available at: <https://www.legislation.gov.uk/uksi/2016/765/contents/made> [Accessed 4 February 2022].

(a) by reason of its glare is liable to endanger aircraft taking off from or landing at an aerodrome; 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

225. 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.

Endangering safety of an aircraft

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

Endangering safety of any person or property

241. A person must not recklessly or negligently cause or permit an aircraft to endanger any person or property.

Civil Aviation Authority consolidation of UK Regulation 139/2014

The Civil Aviation Authority (CAA) published a consolidating document[39] of UK regulations, (Implementing Rules, Acceptable Means of Compliance and Guidance Material), in 2023. A summary of material relevant to aerodrome safeguarding is presented below:

(a) The aerodrome operator should have procedures to monitor the changes in the obstacle environment, marking and lighting, and in human activities or land use on the aerodrome and the areas around the aerodrome, as defined in coordination with the CAA. The scope, limits, tasks and responsibilities for the monitoring should be defined in coordination with the relevant air traffic services providers, and with the CAA and other relevant authorities.

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[39] https://regulatorylibrary.caa.co.uk/139-2014-pdf/PDF.pdf.

(b) The limits of the aerodrome surroundings that should be monitored by the aerodrome operator are defined in coordination with the CAA and should include the areas that can be visually monitored during the inspections of the manoeuvring area.

(c) The aerodrome operator should have procedures to mitigate the risks associated with changes on the aerodrome and its surroundings identified with the monitoring procedures. The scope, limits, tasks, and responsibilities for the mitigation of risks associated to obstacles or hazards outside the perimeter fence of the aerodrome should be defined in coordination with the relevant air traffic services providers, and with the CAA and other relevant authorities.

(d) The risks caused by human activities and land use which should be assessed and mitigated should include:

1. obstacles and the possibility of induced turbulence;
2. the use of hazardous, confusing, and misleading lights;
3. <u>the dazzling caused by large and highly reflective surfaces;</u>
4. sources of non-visible radiation, or the presence of moving, or fixed objects which may interfere with, or adversely affect, the performance of aeronautical communications, navigation and surveillance systems;
5. and non-aeronautical ground light near an aerodrome which may endanger the safety of aircraft and which should be extinguished, screened, or otherwise modified so as to eliminate the source of danger.

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare has been determined when 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 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[40] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

[40] Solar Photovoltaic Development Glint and Glare Guidance, Fourth Edition, March 2022. Pager Power.

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

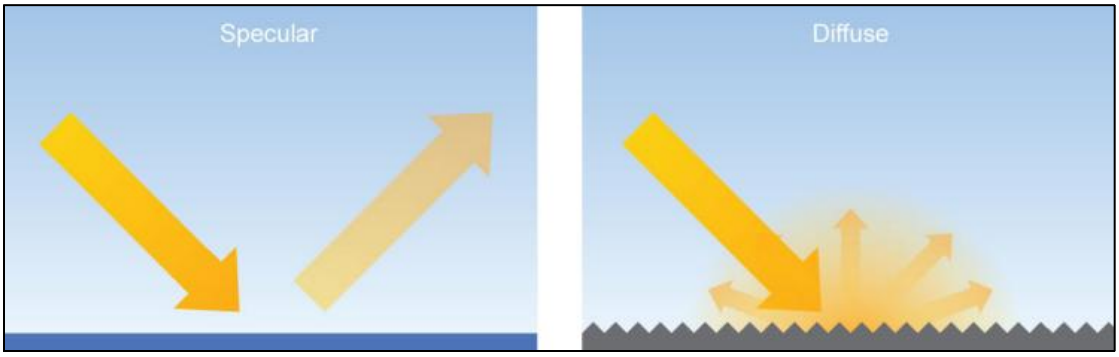
Overview

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[41], 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

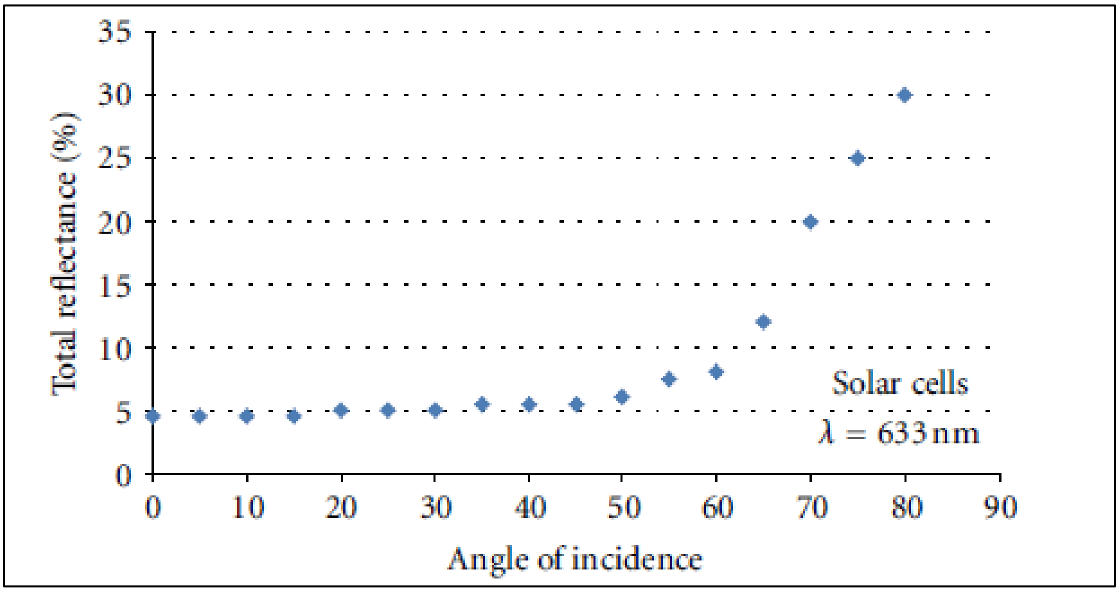
[41]Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

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*[42]". 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.

[42] 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"[43]

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[44]
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).

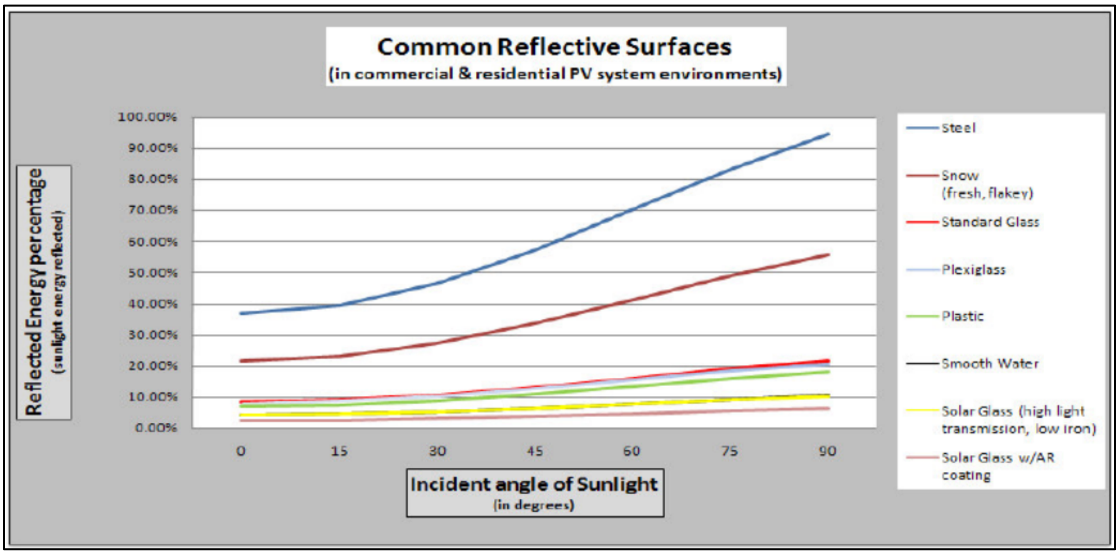
An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

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

SunPower Technical Notification (2009)

SunPower published a technical notification[45] 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.

[45] 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).

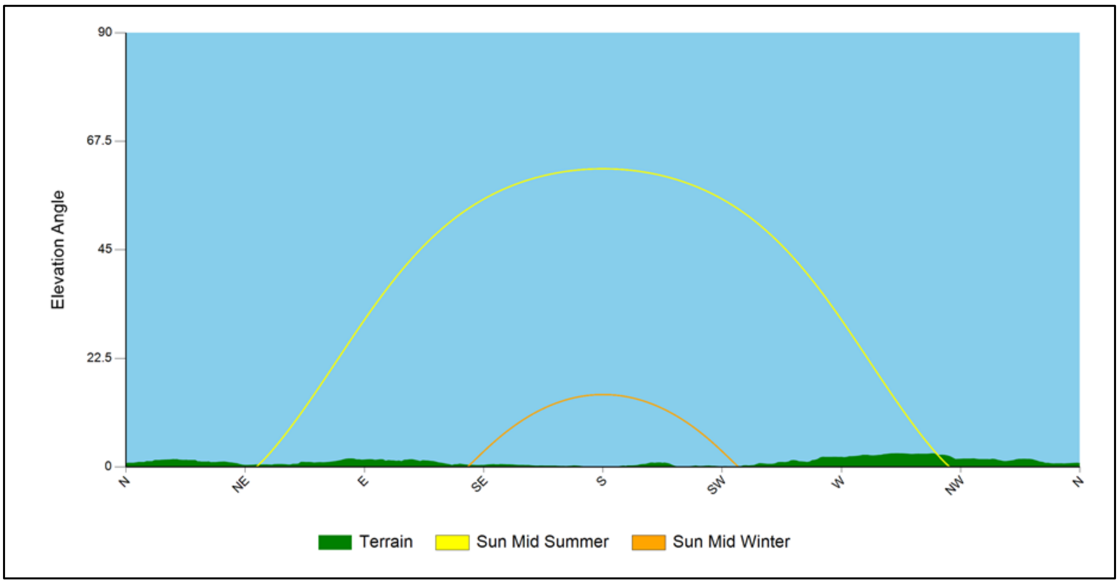
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- 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 (longest day);
- On 21 December, the maximum elevation reached by the Sun is at its lowest (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. The figure below shows terrain at the horizon as well as the sunrise and sunset curves throughout the year from the location of the proposed development.



Terrain at the visible horizon and sun paths

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

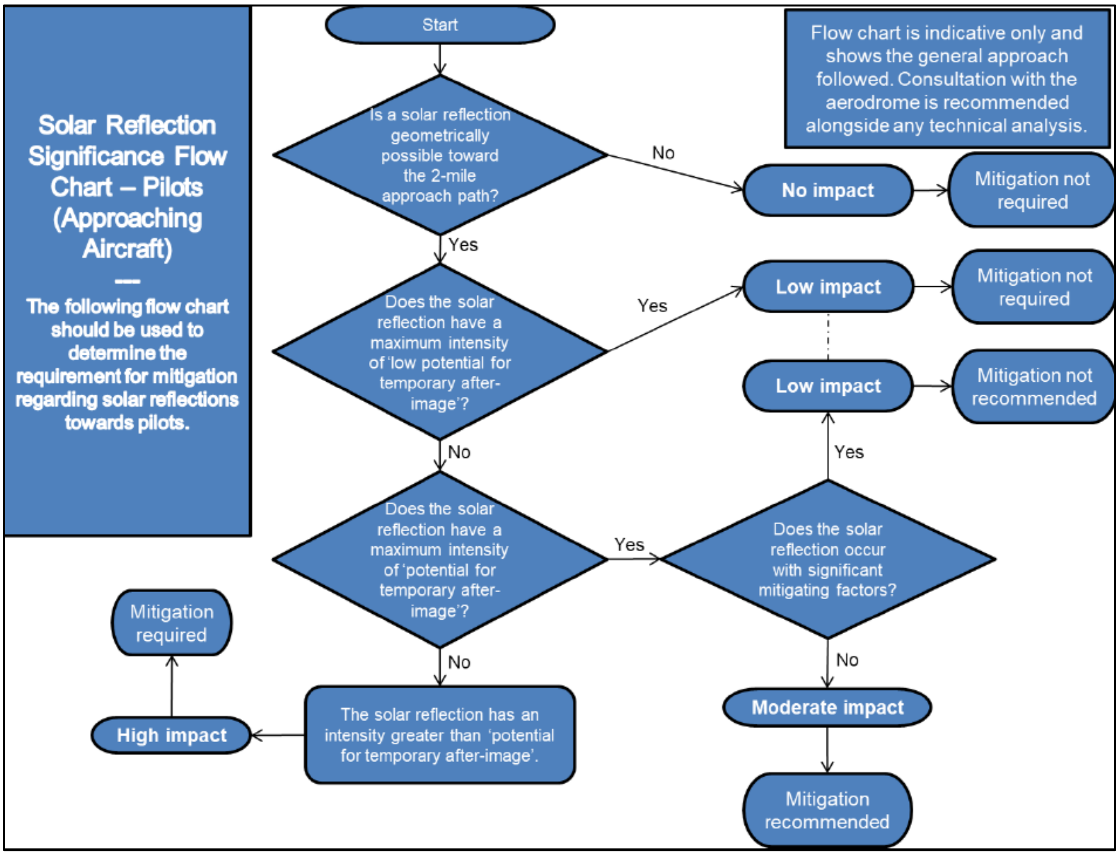
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation
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 significantly.	No mitigation recommended.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case given individual receptor criteria.	Mitigation recommended.
High	A solar reflection is geometrically possible and visible under worst-case conditions that will produce a significant impact given individual receptor criteria	Mitigation will be required if the proposed development is to proceed.

Impact significance definition

Impact Significance Determination for Approaching Aircraft

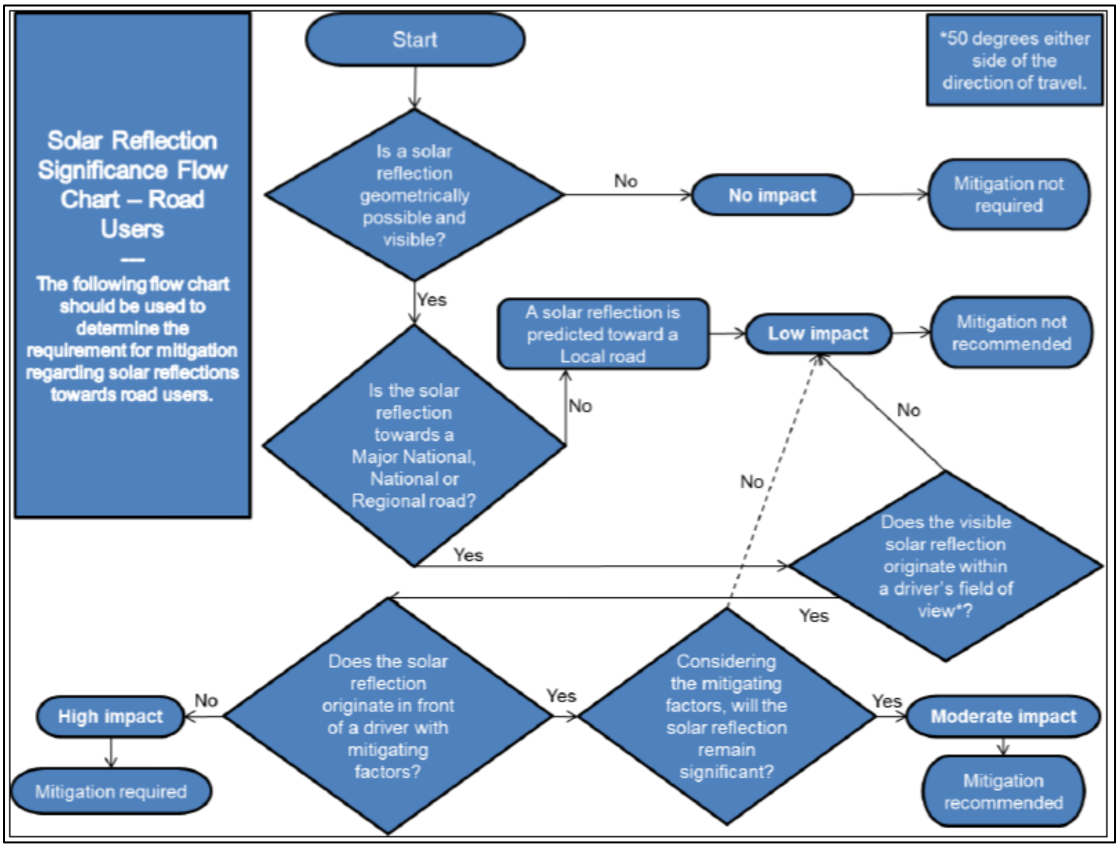
The flow chart presented below has been followed when determining the mitigation requirement for approaching aircraft.



Approach path receptor mitigation requirement flow chart

Impact Significance Determination for Road Receptors

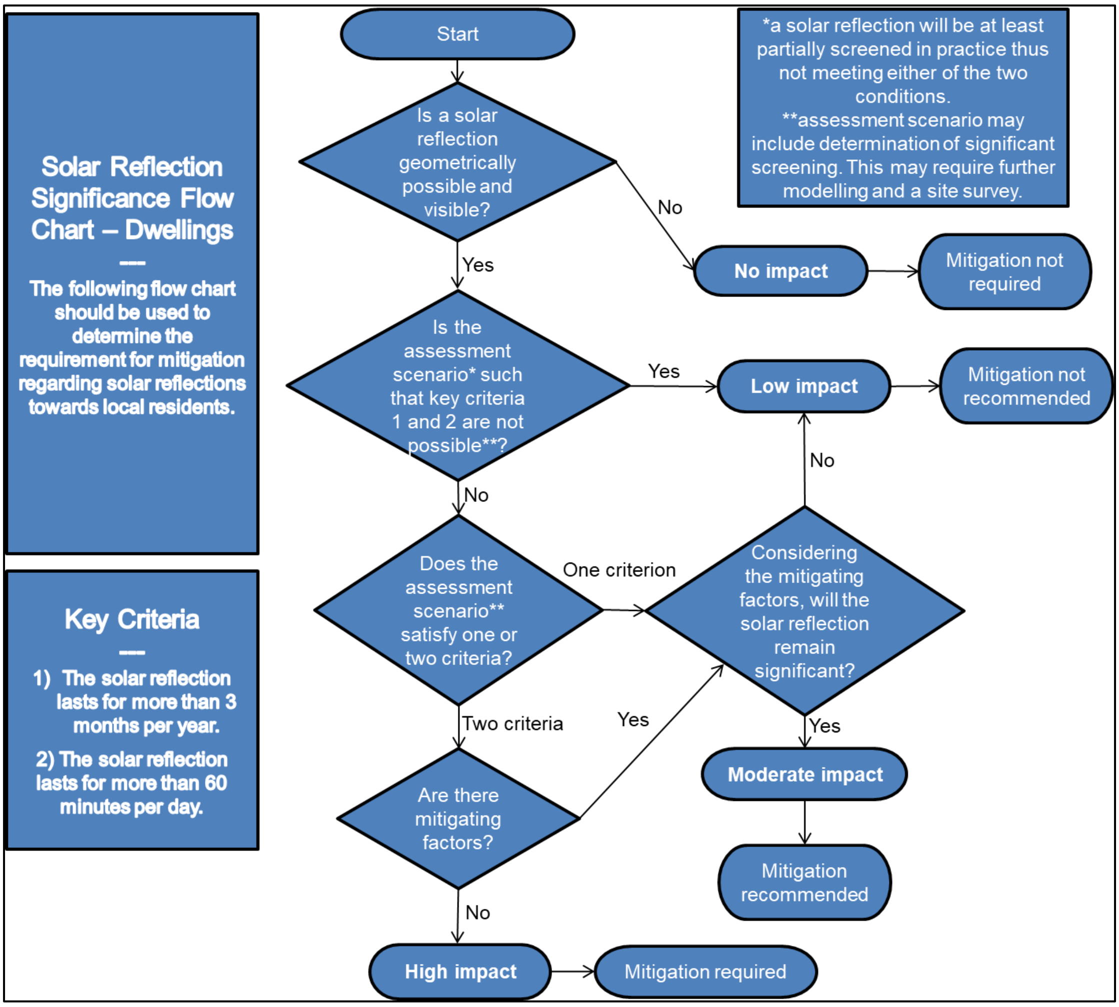
The flow chart presented below has been followed when determining the impact significance for road receptors.



Road receptor impact significance flow chart

Impact Significance Determination for Dwelling Receptors

The flow chart presented below has been followed when determining the impact significance for dwelling receptors.



Dwelling receptor impact significance flow chart

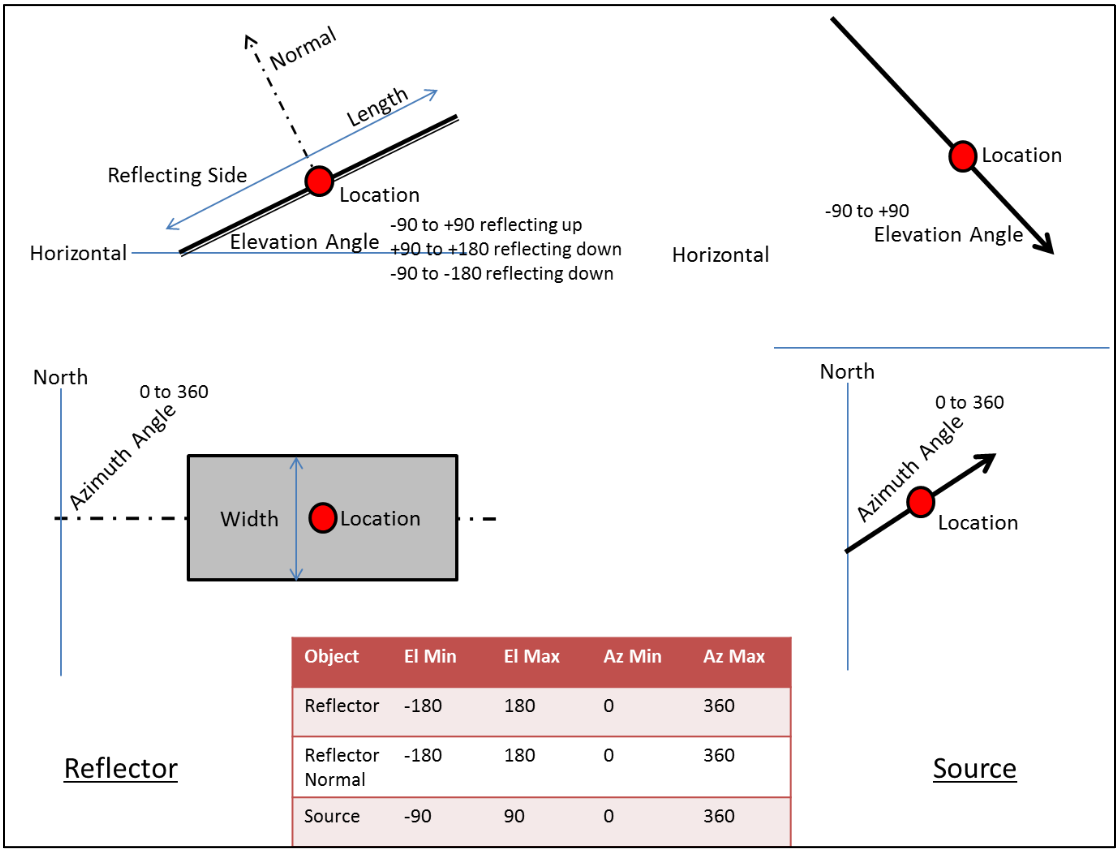
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power 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

Reflection calculation process

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;

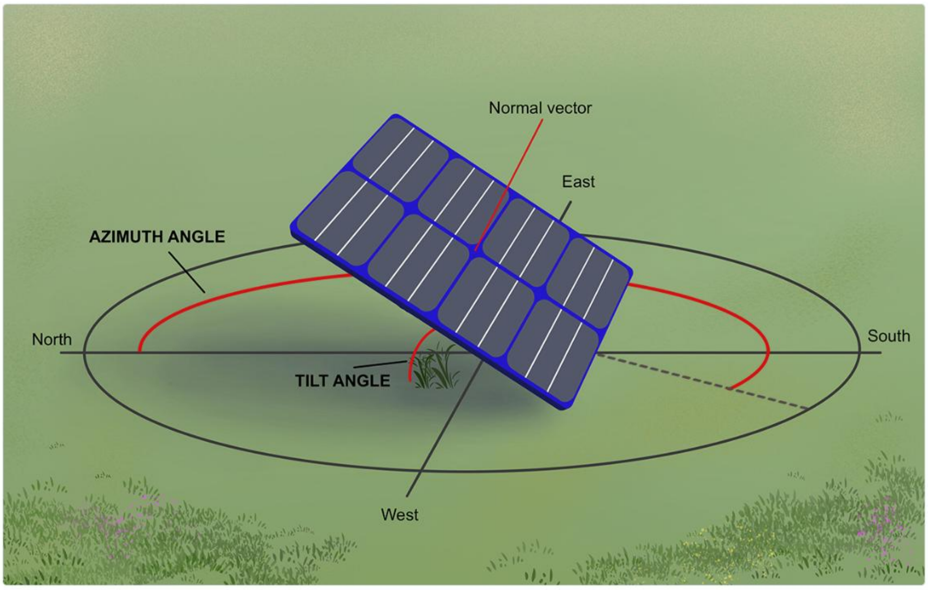
- If this angle is less than 90 degrees a reflection will occur. If it is greater than 90 degrees no reflection will occur because the source is behind the reflector;
- Calculate the Azimuth and Elevation of the reflection in accordance with the following:
    - The angle between source and normal is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

Forge Reflection Calculations Methodology

Extracts taken from the Forge Solar Model are shown in the figures below and on the following page.

Fixed-Mount Parameters

Fixed-mount PV panels are described by a tilt and orientation. These parameters are referred to as the **module configuration** of the PV array.



PV module orientation/azimuth and tilt. Sample illustrates south-facing module typical in northern hemisphere

Module orientation/azimuth (°)
The azimuthal facing or direction toward which the PV panels are positioned. Orientation is measured clockwise from true north. Panels which face north, which is typical in the southern hemisphere, have an orientation of 0°. Panels which face south, which is typical in the northern hemisphere, have an orientation of 180°. If a known orientation is based on magnetic north, the location-specific declination must be used to determine the orientation from true north.

Module tilt (°)
The elevation angle of the panels, measured up from flat ground. Panels lying flat on the ground (facing up) have a tilt of 0°. Tilt values between 0° and 40° are typical.

Fixed System Parameters

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Pager Power's Model

The model considers 100% sunlight during daylight hours, which is highly conservative.

The model does not account for terrain between the reflecting solar panels and the assessed receptor where a solar reflection is geometrically possible.

The model considers terrain between the reflecting solar panels and the visible horizon (where the sun may be obstructed from view of the panels)[46].

It is assumed that the panel elevation angle assessed represents the elevation angle for all of the panels within each solar panel area defined.

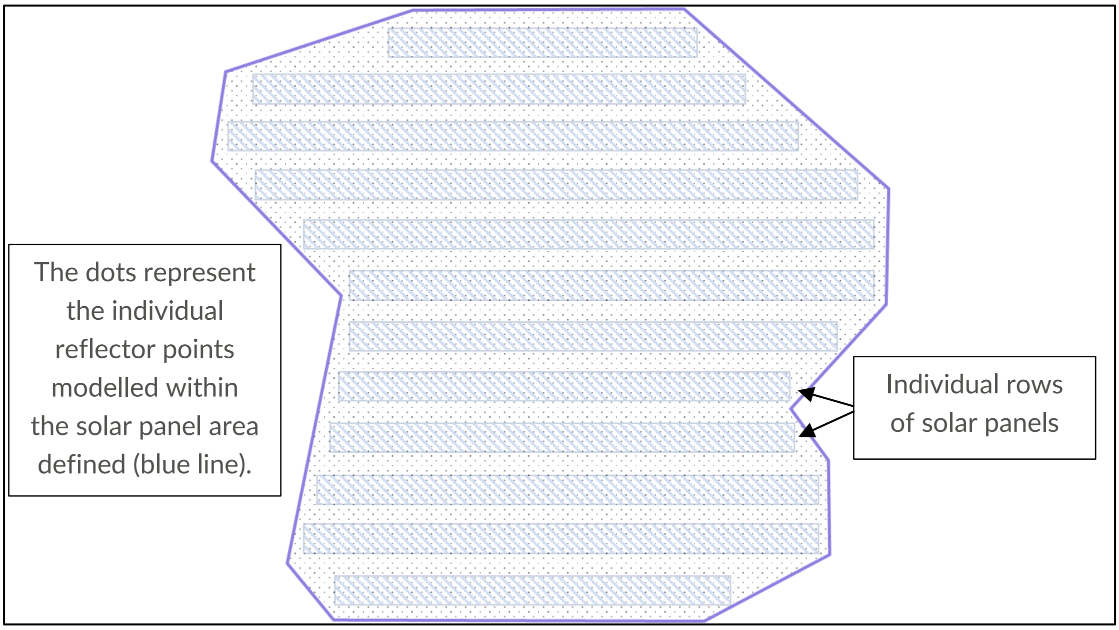
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

Only a reflection from the face of the panel has been considered. The frame or the reverse or frame of the solar panel has not been considered.

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

A finite number of points within each solar panel area defined is chosen based on an assessment resolution so that a comprehensive understanding of the entire development can be formed. This determines whether a solar reflection could ever occur at a chosen receptor. The model does not consider the specific panel rows or the entire face of the solar panel within the development outline, rather a single point is defined every 'x' metres (based on the assessment resolution) with the geometric characteristics of the panel. A panel area is however defined to encapsulate all possible panel locations. See the figure on the following page, which illustrates this process.

[46] UK only.



Solar panel area modelling overview

A single reflection point is chosen for the geometric calculations. This suitably determines whether a solar reflection can be experienced at a receptor location and the time of year and duration of the solar 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.

The available street view imagery, satellite mapping, terrain and any site imagery provided by the developer has been used to assess line of sight from the assessed receptors to the modelled solar panel area, unless stated otherwise. 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 within the modelling unless stated otherwise. The terrain profile at the horizon is considered if stated.

Forge's Sandia National Laboratories' (SGHAT) Model[47]

Summary of assumptions and abstractions required by the SGHAT/ForgeSolar analysis methodology

1. Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
2. Result data files and plots are now retained for two years after analysis completion. Files should be downloaded and saved if additional persistence is required.
3. The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
4. Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects analyses of path receptors.
5. Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
6. 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.)
7. The algorithm 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.
8. The algorithm 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.
9. The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
10. 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.
11. 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.
12. 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.
13. Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
14. Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
15. PV array tracking assumes the modules move instantly when tracking the sun, and when reverting to the rest position.

[47] https://www.forgesolar.com/help/#assumptions.

APPENDIX G – REFLECTOR AREA AND RECEPTOR DETAILS

Overview

Coordinate data and terrain heights are ascertained from OSGB 36 and 50 DTM data.

Airport Receptors – Grange Hospital Helipad

Threshold	Longitude (°)	Latitude (°)	Elevation (m amsl)
Helipad	-2.99561	51.65046	96

Aviation Receptor Data – Grange Hospital Heliport

Airport Receptors – Park Farm Airfield

The table below presents the runway details for Park Farm Airfield. Full receptor details can be provided upon request.

Runway	Longitude (°)	Latitude (°)	Threshold Altitude (m) (amsl)
06	-2.98810	51.62130	52
24	-2.9844	51.62250	49

Runway details for Park Farm Airfield

Road Receptor Data

The road receptor data is presented in the table below. An additional 1.5m height has been added to the terrain elevation to account for the eye-level of road user.

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
A1	-2.99709	51.64138	85.50	A31	-2.96524	51.62417	15.64
A2	-2.99609	51.64072	86.19	A32	-2.96488	51.62330	17.48
A3	-2.99501	51.64012	85.57	A33	-2.96419	51.62252	19.02
A4	-2.99380	51.63963	84.87	A34	-2.96310	51.62192	19.86
A5	-2.99252	51.63920	82.36	A35	-2.96196	51.62137	19.82
A6	-2.99120	51.63884	81.57	A36	-2.96103	51.62070	19.93

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
A7	-2.98987	51.63848	77.43	A37	-2.96056	51.61985	18.81
A8	-2.98867	51.63798	72.24	A38	-2.96018	51.61903	18.11
A9	-2.98784	51.63724	67.49	B1	-2.93498	51.63971	26.48
A10	-2.98704	51.63649	62.98	B2	-2.93598	51.63906	24.20
A11	-2.98585	51.63601	59.32	B3	-2.93703	51.63844	22.87
A12	-2.98453	51.63565	57.51	B4	-2.93792	51.63773	23.78
A13	-2.98324	51.63525	50.54	B5	-2.93862	51.63695	21.67
A14	-2.98225	51.63460	46.17	B6	-2.93933	51.63616	20.36
A15	-2.98105	51.63409	41.90	B7	-2.94004	51.63537	20.34
A16	-2.97993	51.63354	37.24	B8	-2.94082	51.63462	21.35
A17	-2.97896	51.63287	31.00	B9	-2.94167	51.63389	20.00
A18	-2.97790	51.63226	29.13	B10	-2.94254	51.63317	17.81
A19	-2.97672	51.63174	25.63	B11	-2.94340	51.63245	18.50
A20	-2.97557	51.63119	22.71	B12	-2.94425	51.63172	18.65
A21	-2.97434	51.63072	21.32	B13	-2.94510	51.63099	18.39
A22	-2.97311	51.63024	18.26	B14	-2.94576	51.63019	17.11
A23	-2.97197	51.62969	14.54	B15	-2.94605	51.62931	11.67
A24	-2.97082	51.62915	11.73	B16	-2.94607	51.62842	13.50
A25	-2.96965	51.62861	13.62	B17	-2.94573	51.62755	17.89
A36	-2.96884	51.62788	18.85	B18	-2.94515	51.62672	16.72

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
A27	-2.96850	51.62701	15.89	B19	-2.94464	51.62588	14.28
A28	-2.96803	51.62616	14.50	B20	-2.94393	51.62510	13.31
A29	-2.96727	51.62540	15.50	B21	-2.94364	51.62477	14.62
A30	-2.96618	51.62481	15.43				

Road Receptor Data – B4236 and Usk Road

Dwelling Receptor Data

The dwelling receptor data is presented in the table below. An additional 1.8m height has been added to the terrain elevation to account for the eye-level of an observer at these dwellings.

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
1	51.64744	-2.97968	51.70	78	51.62393	-2.96656	18.20
2	51.64687	-2.98559	66.67	79	51.62401	-2.96595	17.49
3	51.64313	-2.98403	48.40	80	51.62300	-2.96339	17.45
4	51.64000	-2.98611	64.91	81	51.62215	-2.96403	20.82
5	51.63887	-2.98869	75.72	82	51.62183	-2.96349	21.20
6	51.63819	-2.98537	67.79	83	51.62162	-2.96306	21.52
7	51.63793	-2.98550	70.72	84	51.62147	-2.96256	20.58
8	51.63784	-2.98695	68.95	85	51.62239	-2.96124	15.77
9	51.63785	-2.98816	71.80	86	51.62217	-2.96075	14.80
10	51.63748	-2.98857	70.98	87	51.62193	-2.96029	14.52
11	51.63721	-2.98818	68.83	88	51.62159	-2.96030	14.89
12	51.63688	-2.98771	65.85	89	51.62152	-2.95989	13.80

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
13	51.63694	-2.98711	67.79	90	51.62148	-2.95961	13.80
14	51.63645	-2.98755	62.14	91	51.62117	-2.95973	14.51
15	51.63654	-2.98690	63.88	92	51.62076	-2.95991	14.80
16	51.63612	-2.98695	60.59	93	51.61939	-2.95830	11.64
17	51.63607	-2.99206	53.04	94	51.61939	-2.95784	9.28
18	51.63733	-2.98260	63.32	95	51.62056	-2.95368	28.08
19	51.63416	-2.99084	39.43	96	51.62063	-2.95283	37.75
20	51.63360	-2.99161	33.48	97	51.62643	-2.94892	14.80
21	51.63333	-2.99149	31.83	98	51.62831	-2.95866	28.20
22	51.63513	-2.98334	50.30	99	51.62864	-2.95831	31.69
23	51.63454	-2.98255	45.74	100	51.62873	-2.95167	25.86
24	51.63046	-2.98684	23.17	101	51.62995	-2.95363	32.05
25	51.62966	-2.98812	23.10	102	51.62951	-2.94564	18.35
26	51.62837	-2.98902	27.12	103	51.62981	-2.94565	18.65
27	51.62698	-2.98480	32.16	104	51.63032	-2.94534	16.88
28	51.62823	-2.98011	20.80	105	51.63185	-2.95045	19.21
29	51.63367	-2.98078	38.55	106	51.63212	-2.94984	17.39
30	51.63335	-2.98081	35.91	107	51.63274	-2.94108	29.29
31	51.63361	-2.97965	36.82	108	51.63309	-2.94116	25.87
32	51.63334	-2.97942	34.63	109	51.63540	-2.93786	36.74
33	51.63326	-2.97880	33.86	110	51.63603	-2.93743	38.40

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
34	51.63333	-2.97832	33.88	111	51.63667	-2.95224	60.81
35	51.63352	-2.97794	35.31	112	51.63739	-2.95264	62.84
36	51.63379	-2.97783	35.76	113	51.63974	-2.94621	20.99
37	51.63375	-2.97736	34.76	114	51.64359	-2.94102	28.05
38	51.63379	-2.97675	35.21	115	51.64388	-2.94178	22.90
39	51.63438	-2.97721	39.59	116	51.64368	-2.95128	72.09
40	51.63449	-2.97675	39.20	117	51.64627	-2.94839	32.54
41	51.63454	-2.97636	39.90	118	51.64723	-2.94263	33.87
42	51.63445	-2.97573	37.61	119	51.63338	-2.96853	21.37
43	51.63420	-2.97562	35.72	120	51.63355	-2.96886	21.98
44	51.63405	-2.97525	33.93	121	51.63462	-2.96876	28.23
45	51.63374	-2.97488	32.77	122	51.63527	-2.96631	42.11
46	51.63354	-2.97455	32.71	123	51.63652	-2.96647	30.80
47	51.63329	-2.97428	30.82	124	51.63699	-2.96450	50.95
48	51.63291	-2.97372	25.46	125	51.63607	-2.95979	60.74
49	51.63260	-2.97354	23.76	126	51.63793	-2.95942	72.18
50	51.63241	-2.97330	22.27	127	51.63948	-2.96053	66.95
51	51.63205	-2.97302	22.58	128	51.63887	-2.96307	69.00
52	51.63186	-2.97254	21.80	129	51.63878	-2.96377	62.97
53	51.63158	-2.97243	21.55	130	51.64000	-2.96892	61.96
54	51.63136	-2.97210	21.02	131	51.64065	-2.96892	62.80

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
55	51.63113	-2.97188	20.47	132	51.63974	-2.97072	52.55
56	51.63092	-2.97161	19.26	133	51.63818	-2.97135	37.99
57	51.63182	-2.96837	18.20	134	51.63820	-2.97186	35.30
58	51.63108	-2.96828	17.58	135	51.63812	-2.97674	41.09
59	51.63071	-2.97138	18.01	136	51.63818	-2.97710	42.09
60	51.63051	-2.97114	15.81	137	51.64334	-2.97285	81.63
61	51.63042	-2.97087	14.81	138	51.64389	-2.97040	84.81
62	51.63007	-2.97077	14.09	139	51.64429	-2.97005	84.20
63	51.62981	-2.97014	13.80	140	51.64423	-2.96941	81.34
64	51.62953	-2.96941	13.80	141	51.64511	-2.97676	67.49
65	51.62932	-2.96911	15.05	142	51.64518	-2.97641	69.14
66	51.62921	-2.96881	16.80	143	51.64547	-2.96775	80.80
67	51.62930	-2.96832	17.54	144	51.64609	-2.96686	82.42
68	51.62897	-2.96834	17.43	145	51.64556	-2.96458	91.84
69	51.62849	-2.96843	18.41	146	51.64614	-2.96472	93.79
70	51.62842	-2.96790	19.08	147	51.64640	-2.96325	99.86
71	51.62816	-2.96742	14.68	148	51.64656	-2.96293	98.44
72	51.62771	-2.96808	16.80	149	51.64729	-2.96526	93.27
73	51.62705	-2.96820	16.02	150	51.64697	-2.96568	92.26
74	51.62644	-2.96797	14.80	151	51.64705	-2.96706	89.70
75	51.62613	-2.96756	15.05	152	51.64755	-2.96699	91.37

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
76	51.62573	-2.96715	15.80	153	51.64675	-2.96793	82.46
77	51.62593	-2.96642	8.89				

Dwelling Receptor Data

Modelled Panel Data

The modelled panel area data can be provided upon request.

APPENDIX H – DETAILED MODELLING RESULTS

Overview

The Pager Power charts for a selection of receptors are shown below and on the following pages. 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 panels – 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 panels 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.
- The sunrise and sunset curves throughout the year (red and yellow lines).

The Forge charts for the receptors are shown on the following pages. Each chart shows:

- The annual predicted solar reflections;
- The daily duration of the solar reflections;
- The location of the proposed development where glare will originate;
- The calculated intensity of the predicted solar reflections

Full modelling results can be provided upon request.

Aviation Receptors

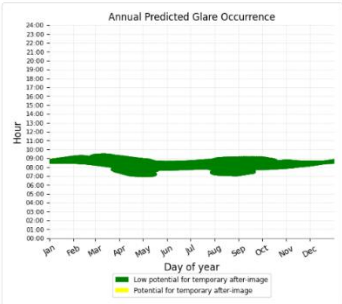
Results have been included for selective receptors where glare with 'low potential for temporary after-image' (green) has been predicted.

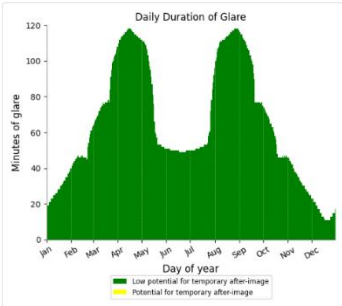
Forge

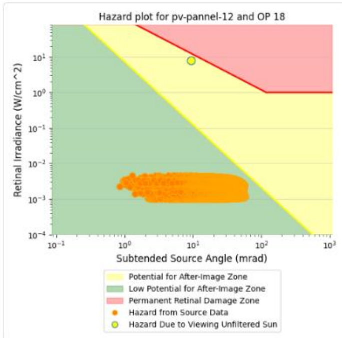
PV Pannel 12a b and c: OP 18

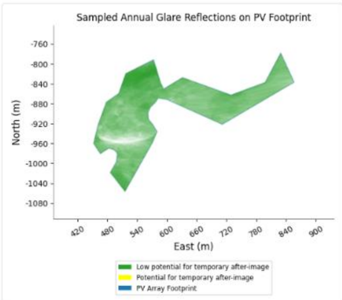
PV array is expected to produce the following glare for this receptor:

- 23,572 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.





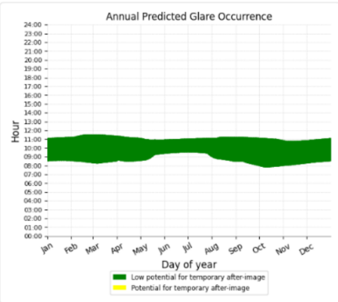


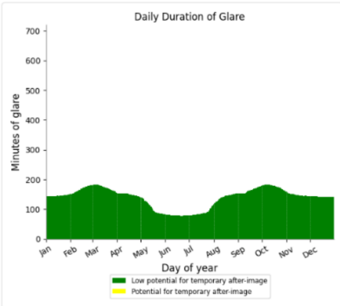


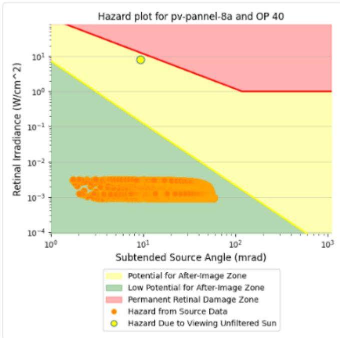
PV Pannel 8a and b: OP 40

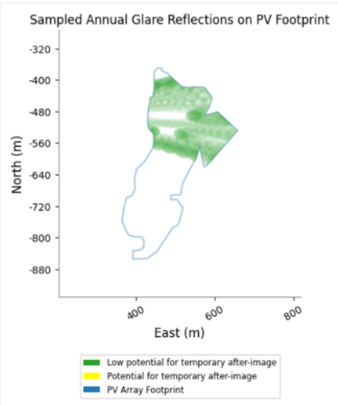
PV array is expected to produce the following glare for this receptor:

- 51,028 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



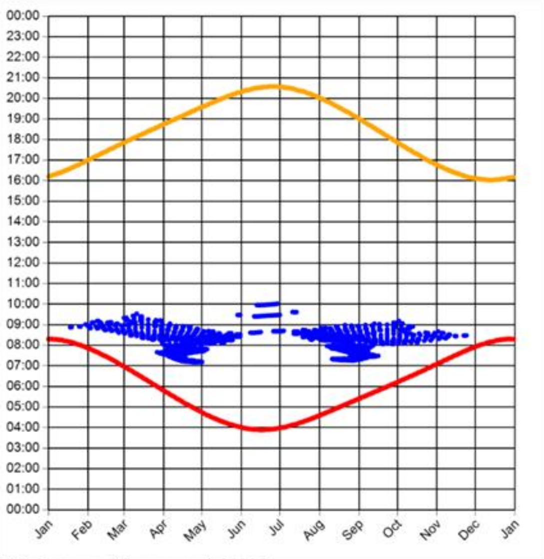






Observer 2011 Approach 24 TCR11 Results

Reflection Date/Time (GMT) Graph



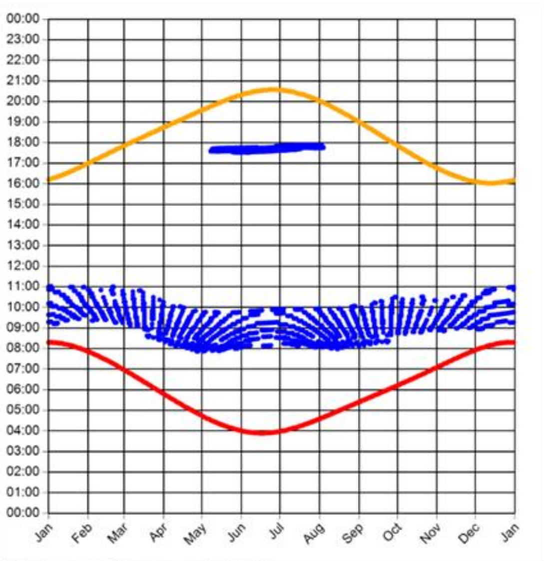
Min observer difference angle: 36.8°
Max observer difference angle: 105.6°

Observer Location

Sun azimuth range is 92.5° - 132.5° (yellow)

Observer 2034 Approach 24 KCN3 Results

Reflection Date/Time (GMT) Graph



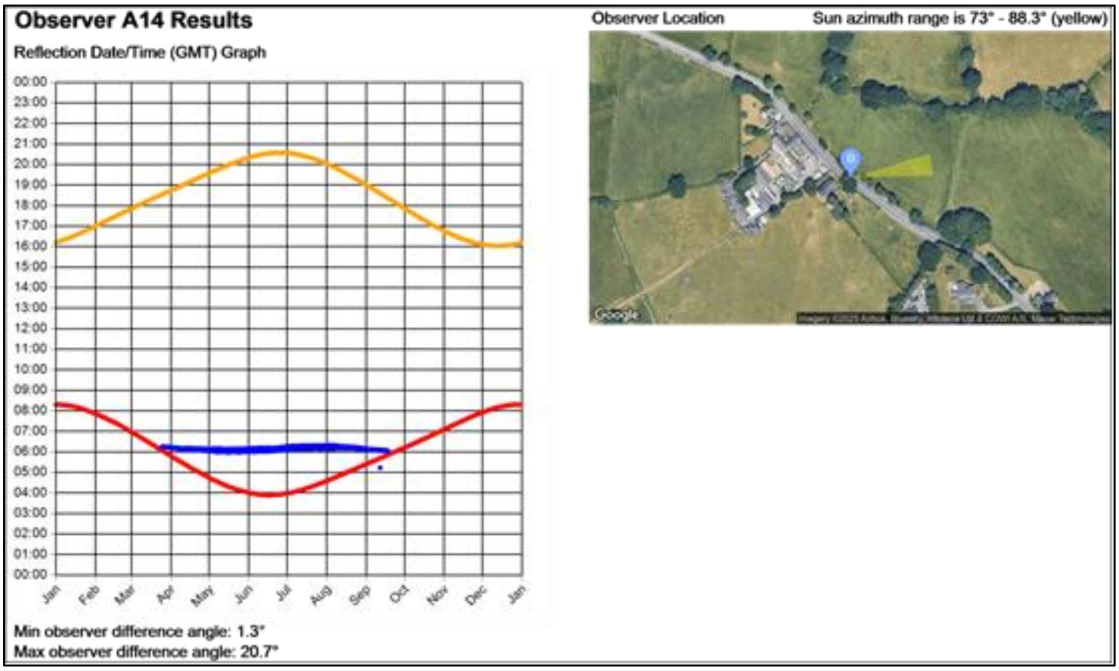
Min observer difference angle: 26.7°
Max observer difference angle: 105°

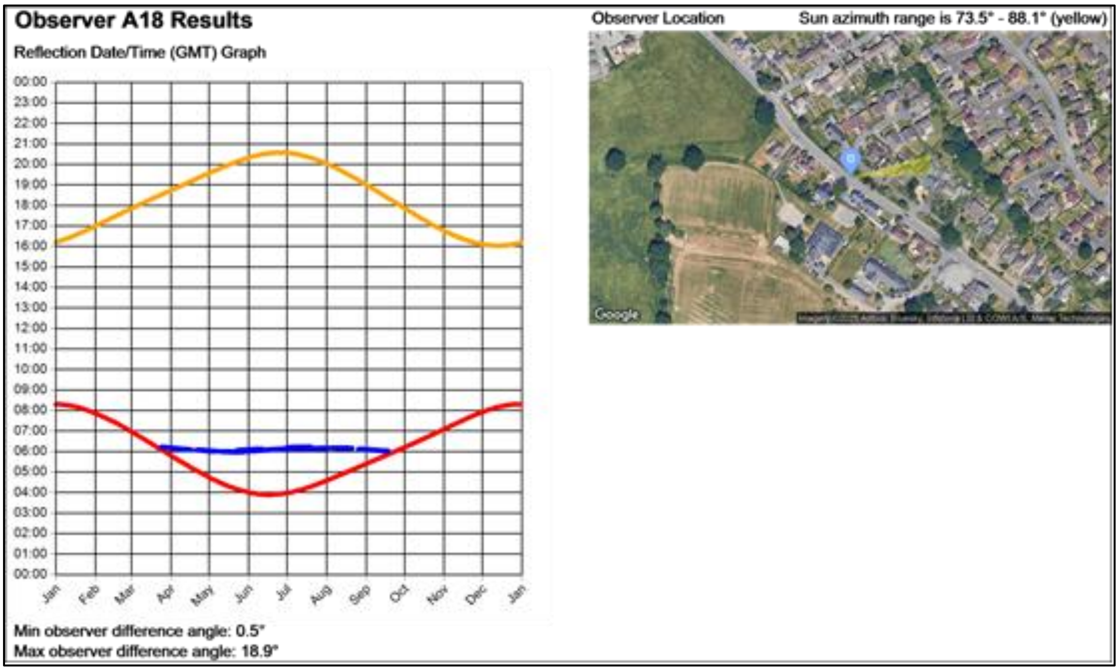
Observer Location

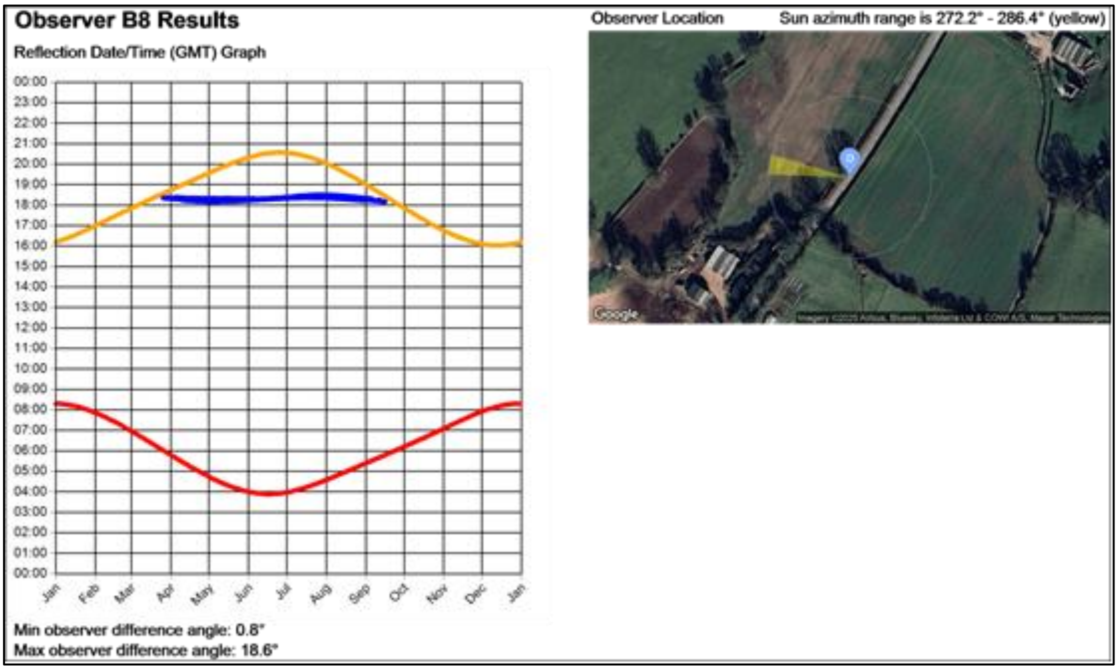
Sun azimuth ranges (yellow)

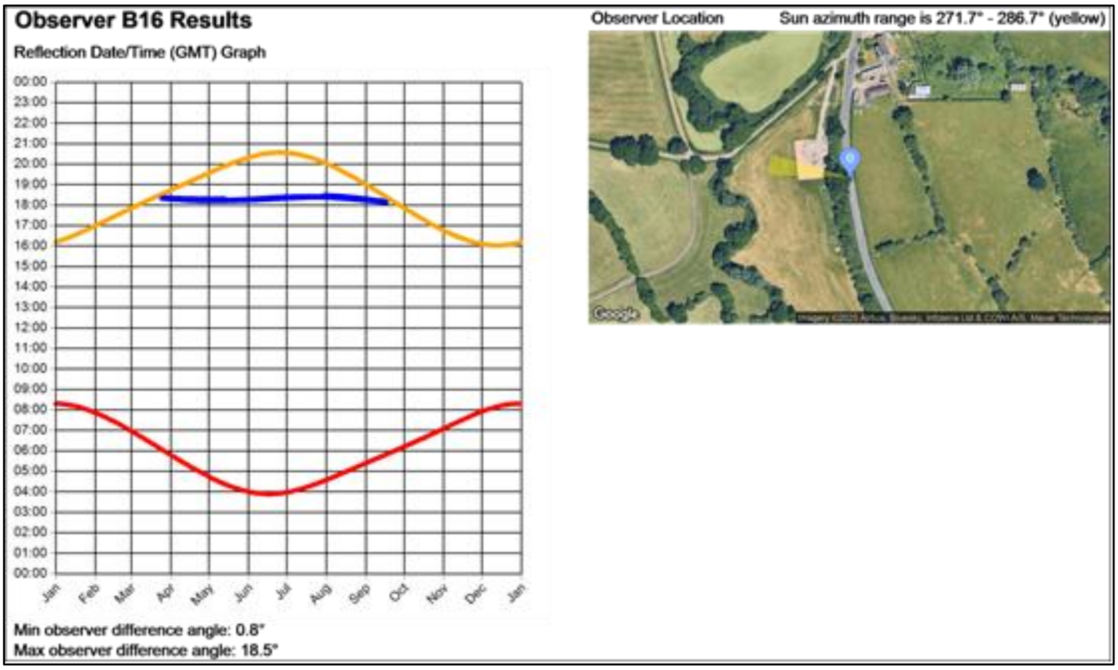
Road Receptors

Results have been included for selective receptors.



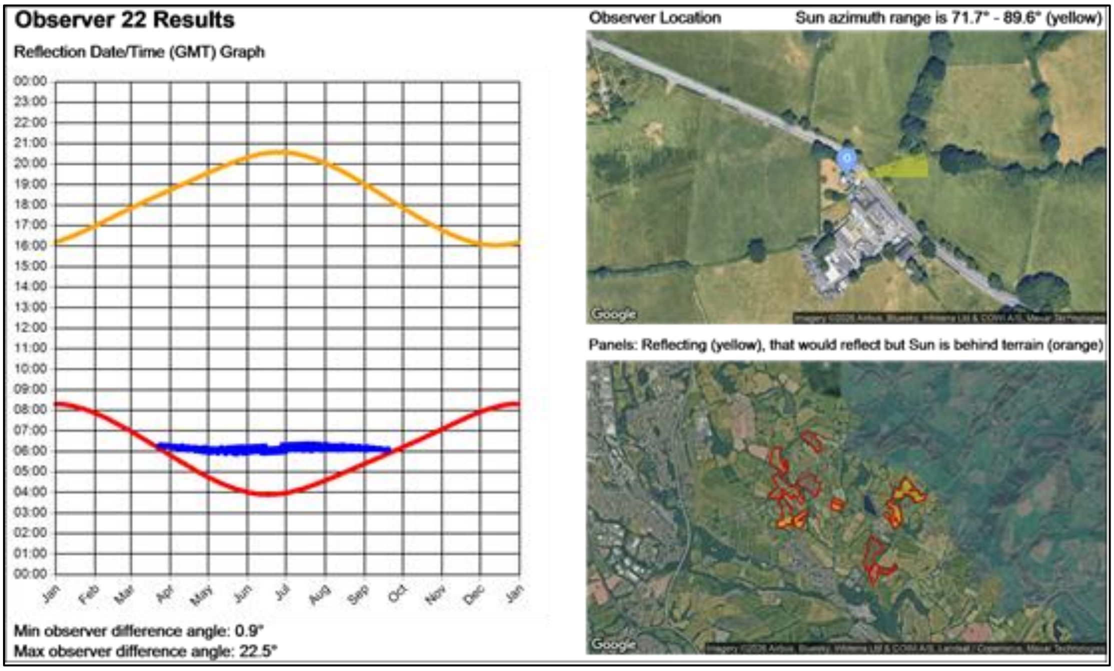


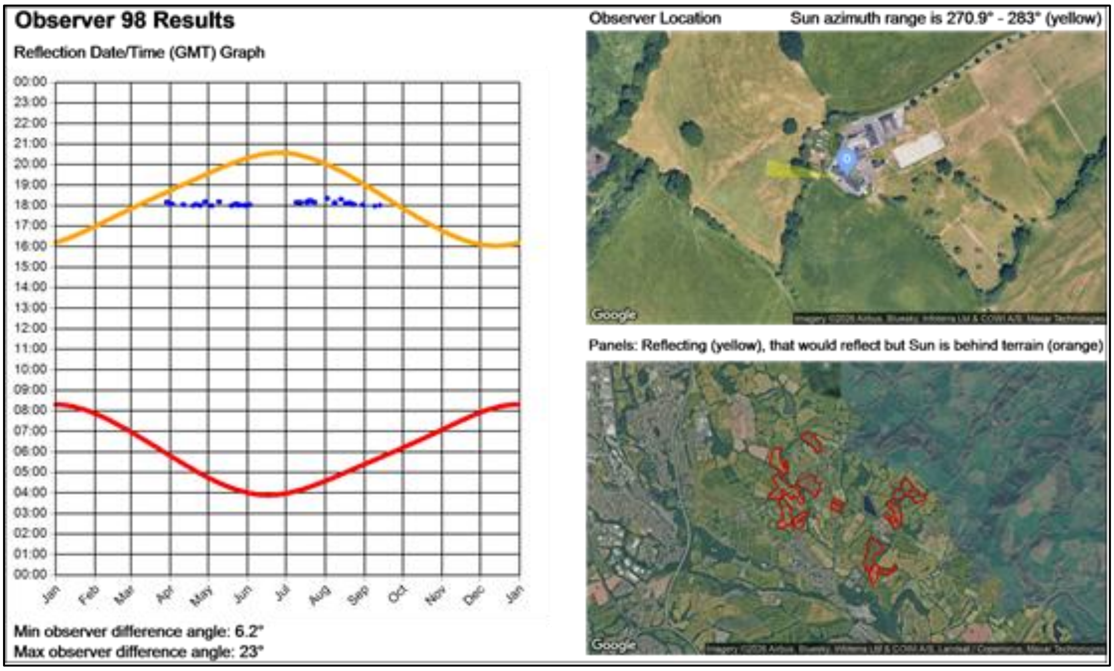

Observer B8 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0.8°
Max observer difference angle: 18.6°
Observer Location
Sun azimuth range is 272.2° - 286.4° (yellow)
Google

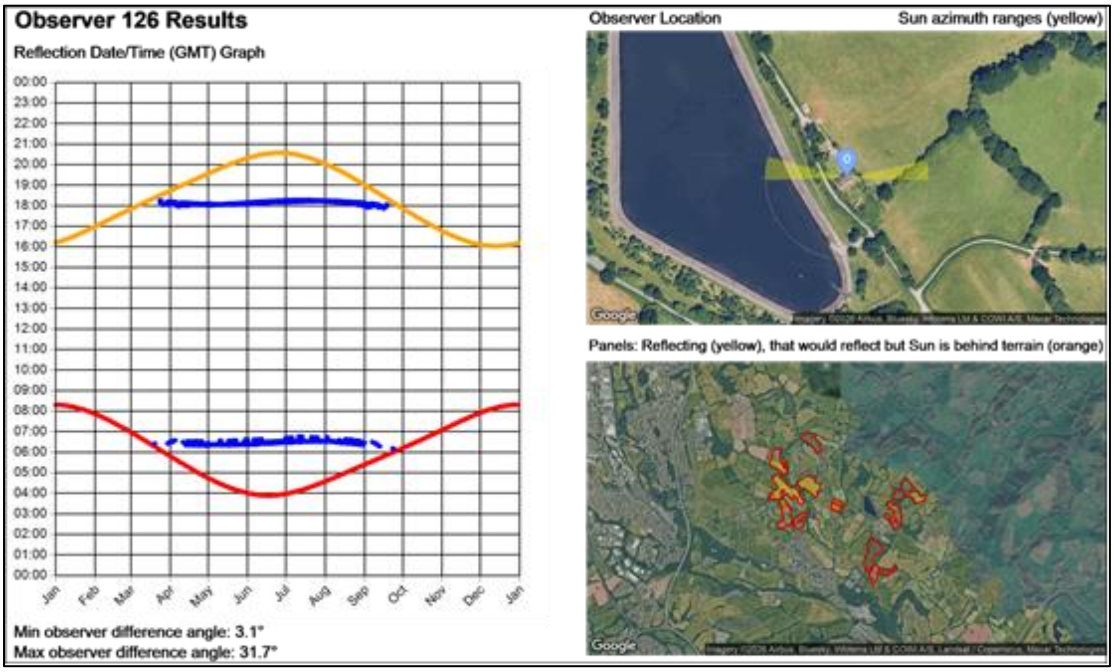

Observer B16 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0.8°
Max observer difference angle: 18.5°
Observer Location
Sun azimuth range is 271.7° - 286.7° (yellow)
Google

Dwelling Receptors

Results have been included for a selection of receptors for which a low impact has been predicted.




Observer 98 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 6.2°
Max observer difference angle: 23°
Observer Location
Sun azimuth range is 270.9° - 283° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)


Observer 126 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 3.1°
Max observer difference angle: 31.7°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

Urban & Renewables

Pager Power Limited
Stour Valley Business Centre
Sudbury
Suffolk
CO10 7GB

Tel: +44 1787 319001 **Email:** info@pagerpower.com **Web:** www.pagerpower.com