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Solar Photovoltaic Glint and Glare Study

Renewable Energy Systems Ltd

Beane Solar Farm

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ADMINISTRATION PAGE

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a ground mounted solar photovoltaic development, located near Cottered, Buntingford, UK. This assessment pertains to the potential impact upon road safety, residential amenity, and aviation activity associated with Graveley Airfield, Benington Airport, Rush Green Airfield, Wisbridge Farm Airfield, Notley Green Airfield and Newnham Airfield.

Overall Conclusions

A moderate impact is predicted on road safety and residential amenity, mitigation in the form of screening along the site boundary is recommended. Review of the Landscape Mitigation Plan shows significant screening proposed, such that there will be no significant impacts remaining. No further mitigation is required.

A maximum of low impact is predicted on aviation activity associated with Graveley Airfield, Bonnington Airfield, Rush Green Airfield, Wisbridge Farm Airfield, Notley Green Airfield and Newnham Airfield.

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. A specific national guidance policy for determining the impact of glint and glare on road safety, and residential amenity has also not been produced to date. Therefore, in the absence of this, Pager Power reviewed more general existing planning guidelines and the available studies (discussed below) in the process of defining its own glint and glare assessment guidance and methodology[1]. This methodology defines the 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.

[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.

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].

Assessment Conclusions – Roads

Solar reflections are geometrically possible towards a 1.9km section of the A507 and a 2.9km section of the B1037.

Screening in the form of existing vegetation, existing buildings or intervening terrain is predicted to significantly obstruct views of reflecting panels such that solar reflections will not be experienced by road users along a 1.3km section of the A507 and a 2.4km of the B1037. No impact is predicted along these sections, and accordingly mitigation is not required.

For 200m of the B1037, partial screening in the form of existing vegetation is predicted to only allow for short, fleeting views of the reflecting panels. A low impact is predicted, mitigation is not recommended.

For the remaining 600m section of the A507 and 300m section of the B1037, no relevant screening has been identified. A moderate impact is predicted, and mitigation is recommended.

Review of the Landscape Mitigation Plan shows significant screening proposed, such that there will be no significant impacts remaining. No further mitigation is required (see Section 5.5.1).

Assessment Conclusions – Dwellings

Solar reflections are geometrically possible towards 48 of the 53 assessed dwellings.

For 44 of the dwellings, screening in the form of existing vegetation and/or intervening terrain is predicted to significantly obstruct views of reflecting panels such that solar reflections will not be experienced by residents. No impact is predicted, and mitigation is not required.

For two of the dwellings, existing vegetation or intervening terrain is predicted to partially obstruct views of reflecting panels for an observer on the ground floor, the remaining visible reflecting panels will have a separation distance of over 900m. A low impact is predicted, and mitigation is not recommended.

For the remaining two dwellings, reflections are predicted to occur for less than an hour on any given day, and for more than three months of the year. No significant screening has been identified. A moderate impact is predicted, and mitigation is recommended.

Review of the Landscape Mitigation Plan shows significant screening proposed, such that there will be no significant impacts remaining. No further mitigation is required (see Section 5.5.1).

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

Assessment Conclusions – Aviation

Graveley Airfield

Solar reflections with 'low-potential for temporary after-image' ('green' glare) are geometrically possible towards the 1-mile splayed approach paths for runway thresholds 01 and 19 and will occur outside the pilot's primary field of view (50 degrees either side of direction of travel). This intensity of glare is acceptable in accordance with the associated guidance and industry best practice. A low impact is predicted, and mitigation is not required.

Solar reflections with 'low-potential for temporary after-image' ('green' glare) are geometrically possible towards the final sections of the visual circuit and base leg joins for runway thresholds 01 and 19. This intensity of glare is acceptable in accordance with the associated guidance and industry best practice. A low impact is predicted, and mitigation is not required.

Benington Airfield

No solar reflections are geometrically possible towards the approach paths and final sections of the visual circuits for runways at Benington Airfield. No impact is predicted, and no mitigation is required.

High Level Aviation Assessment Conclusions

For aviation activity associated with Rush Green Airfield, Wisbridge Farm Airfield, Notley Green Airfield and Newnham Airfield any solar reflections are predicted to be acceptable in accordance with the associated guidance due to the following two factors:

- Glare intensities towards approaches towards thresholds in the direction of the proposed development are predicted to be no greater than 'low potential for temporary after-image';
- Any possible solar reflections will be outside the pilot's field-of-view for pilots approaching runway thresholds directed away from the proposed development.

Therefore, no significant impacts are predicted upon aviation activity Rush Green Airfield, Wisbridge Farm Airfield, Notley Green Airfield and Newnham Airfield and detailed modelling is not recommended.

Energy Storage Facility

The proposed energy storage facility will comprise 24 storage units grouped in pairs and located throughout the site. Each pair of units resembles a large shipping container in appearance. There are no solar panels or other reflective elements associated with this part of the project and therefore it has been excluded from further assessment.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 59 countries within Europe, Africa, America, Asia and Australasia.

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 possible effects of glint and glare from a ground mounted solar photovoltaic development, located near Cottered, Buntingford, UK. This assessment pertains to the potential impact upon road safety, residential amenity, and aviation activity associated with Graveley Airfield, Benington Airport, Rush Green Airfield, Wisbridge Farm Airfield and Newnham Airfield.

This report contains the following:

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

The relevant technical analysis is presented in each section. Following the assessment, conclusions and recommendations are made.

1.2 Pager Power's Experience

Pager Power has undertaken over 1,300 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 of glint and glare is as follows[4]:

- 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 of the National Policy Statement for Renewable Energy Infrastructure and the Federal Aviation Administration (FAA) in the United States of America.

2 SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Layout

Figure 1 on the following pager shows the boundary and solar layout of the proposed development[5].

[5] 05003-RES-LAY-DR-PT-003 PDF [Edited]

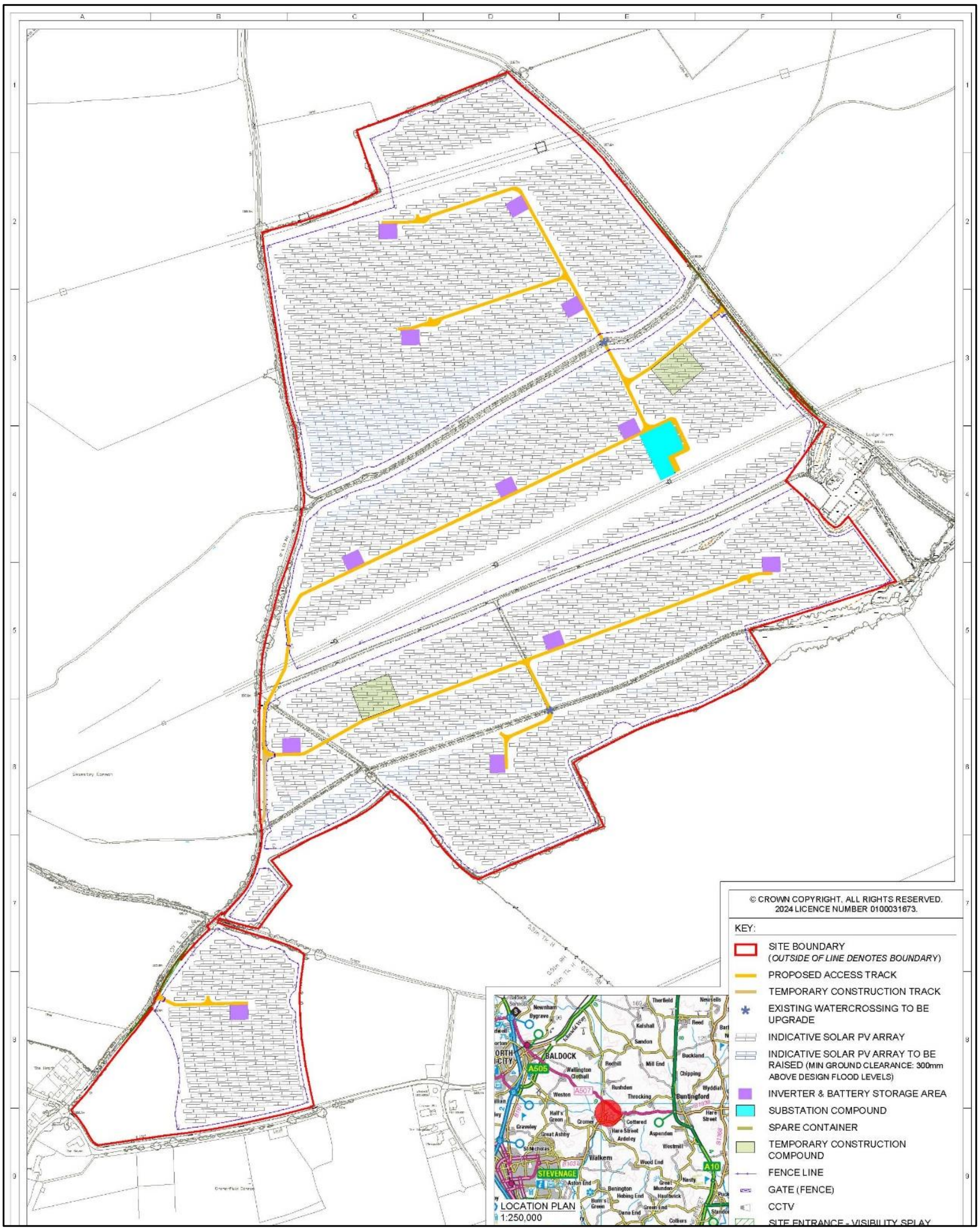

Figure 1 *Proposed solar array boundary*

This assessment has considered the boundary of the proposed development for modelling purposes, this is the most conservative approach.

The proposed energy storage facility will comprise 24 storage units grouped in pairs and located throughout the site. Each pair of units resembles a large shipping container in appearance. There are no solar panels or other reflective elements associated with this part of the project and therefore it has been excluded from further assessment.

2.2 Reflector Area

The bounding coordinates for the proposed development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 2 below shows the assessed reflector area that has been used for modelling purposes. To reiterate, the assessed area comprises that within the entire red-line boundary which is significantly greater than the area covered by panels as shown in Figure 1 which is the layout brought forward on which permission is sought. Further the panels are separated by between 2-8m in practice. Accordingly, and once again, this is a conservative assessment.

Figure 2 *Assessed reflector area*

The Pager Power model has used a resolution of 20m for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 20m from within the defined areas. 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 proposed solar development.

2.3 Solar Panel Technical Information

The technical information used for the modelled panels in this assessment are presented in Table 1 below. The centre of the solar panel has been used as the assessed height in metres above ground level (agl)[6].

Solar Panel Technical Information	
Azimuth angle[7]	180°
Elevation angle (tilt)[8]	15°
Assessed centre height	2.2m agl

Table 1 *Solar panel information*

[6] Minimum height = 0.8m agl, maximum height = 3.5m agl.
[7] Relative to true north.
[8] Relative to the horizontal.

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[9] 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 reflective 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 and studies. The methodology for this glint and glare assessment is as follows:

- Identify receptors in the area surrounding the solar development. The method for identifying relevant receptors is explained in Section 4 of this report;
- Consider direct solar reflections from the solar development towards the identified receptors by undertaking geometric calculations;
- Consider the visibility of the panels from the receptor's location. If the panels 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 both the solar reflection from the solar 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 - including intensity calculations where appropriate;
- Determine whether a significant detrimental impact is expected in line with the process presented in Appendix D.

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[9] See Appendix A: Aviation Assessment Guidance

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 developed 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 Appendix E and F.

4 IDENTIFICATION OF RECEPTORS

4.1 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.

A 1km assessment area is considered appropriate for glint and glare effects on ground-based receptors, identified within the yellow outlined areas in Figure 3 below. Receptors within this distance are identified based on mapping and aerial photography of the region. Receptors to the north of the development are not included because solar reflections would not be geometrically possible towards the north when the azimuth angle is considered[10].

The receptor details are presented in Appendix G and the terrain elevations have been interpolated based on OS Terrain 50 DTM[11] data.

Figure 3 *1km assessment area*

[10] For fixed, south-facing panels at this latitude, reflections towards ground-based receptors located further north than any proposed panel are highly unlikely

[11] Digital Terrain Model

4.2 Road Receptors

4.2.1 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 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 therefore considered major national, national, and regional roads that:

- Are within the 1km assessment area;
- Have a potential view of the panels.

4.2.2 Identified Road Receptors

The assessed receptors along 2km of the A507 [A1 –A21] and 3.4km of the B1037 [B1 – B35] are shown in Figures 4 and 5 on the following page. A height of 1.5 metres above ground level has been taken as the typical eye level of a road user[12].

[12] This fixed height for the road receptors is for modelling purposes. 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 4 *Assessed road receptors A1 to A21*

Figure 5 *Assessed road receptors B1 to B35*

4.3 Dwelling Receptors

4.3.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

- Are situated within the 1km 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 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.

4.3.2 Identified Dwelling Receptors

The assessed dwelling receptors are shown in Figure 6 below. In total, 53 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].

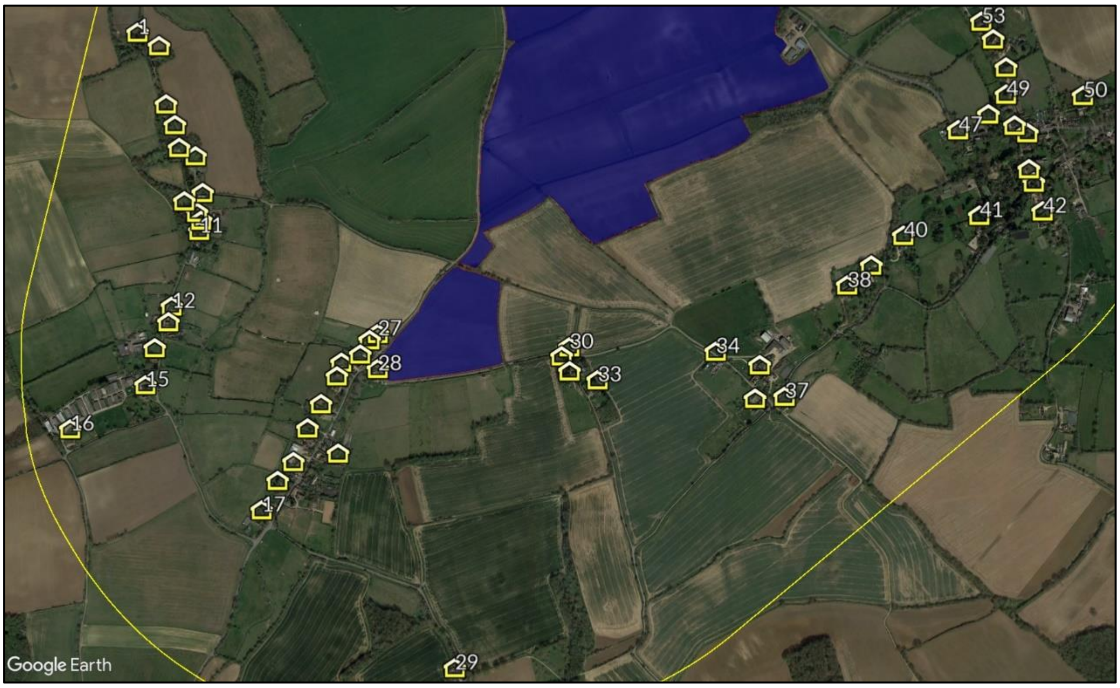

Figure 6 *Overview of all dwellings receptors*

[13] This fixed height for the dwelling receptors is for modelling purposes. Changes to the modelling height by a few metres is not expected to significantly change the modelling results. Views above ground floor are considered in the results discussion where necessary.

4.4 Aviation Details

4.4.1 Graveley Airfield Runway Details

Graveley Airfield is an unlicensed General Aviation (GA) aerodrome that has one operational runway, and is not understood to have an Air Traffic Control (ATC) Tower. Details of the runways are presented below[14]:

- 01/19 measuring 430 x 20m (grass).

4.4.2 Benington Airfield Runway Details

Benington Airfield is an unlicensed GA aerodrome that has three runways and is not understood to have an ATC Tower. Details of the runways are presented below[13]:

- 05/23 measuring 440 x 20m (grass).

The locations of Graveley Airfield and Benington Airfield relative to the proposed development are shown in Figure 7 below.

Figure 7 *Location of Graveley Airfield and Benington Airfield relative to the proposed development*

[14] As determined from aerial view

4.4.3 Aviation Receptors

Graveley Airfield and Benington Airfield are GA airfields 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 would 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;
- Maximum altitude of 500 feet above the aerodrome threshold altitude.

Figure 8 below illustrates the splayed approach and final sections of the visual circuits.

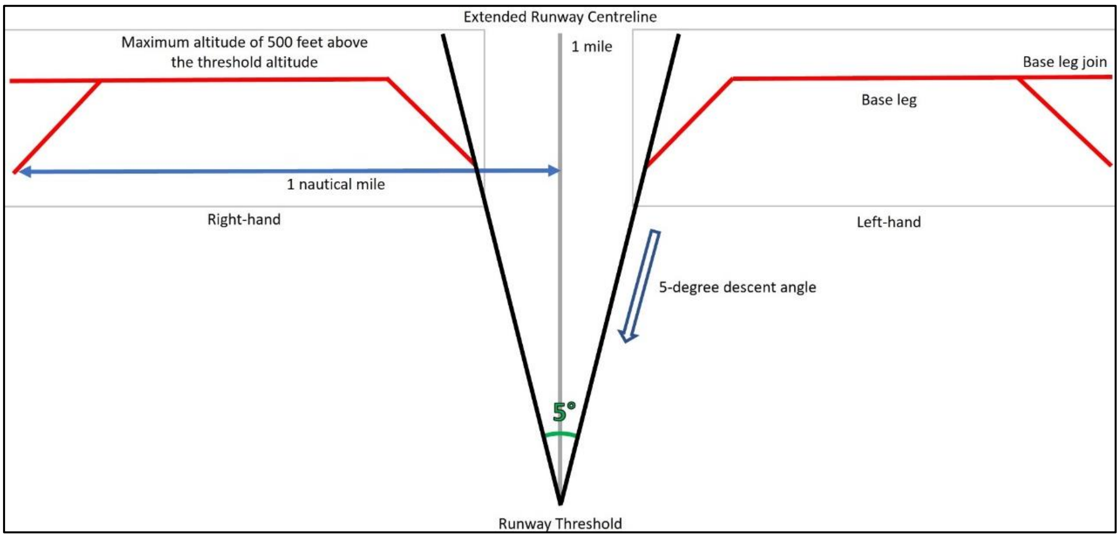

Figure 8 *Splayed approach and final sections of visual circuits*

Figure 9 below illustrates the assessed splayed approach and final sections of the visual circuits for both Graveley Airfield and Benington Airfield.

Figure 9 *Graveley Airfield and Benington Airfield aviation receptors*

5 GLINT AND GLARE ASSESSMENT – TECHNICAL RESULTS

5.1 Overview

The following section presents the geometric modelling results and summarises the results of the assessment. Each sub-section includes:

- 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 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 screening will remove effects;
- The impact significance and any mitigation recommendations/requirements;
- The desk-based review of the available imagery.

The Pager Power and Forge model has been used to determine whether reflections are possible. For aviation receptors, intensity calculations in line with the Sandia National Laboratories methodology have been undertaken for aviation receptors. 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 beyond a pilot's typical field-of-view (50 degrees either side of the direction of travel)'
'Green'	'Low potential for temporary after-image'
'Yellow'	'Potential for temporary after-image'
'Red'	'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 Road Results

5.2.1 Key Considerations

The process for quantifying impact significance is defined in the report appendices. The key considerations for road users along major national, national, and regional roads are:

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

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 reflections originate from outside of a road user's main field of view (50 degrees either side of the direction of travel), or where the separation distance to the nearest visible reflecting panel is over 1km, the impact significance is low, and mitigation is not recommended.

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

- Whether visibility is likely for elevated drivers (applicable to dual carriageways and motorways only) – there is typically a higher density of elevated drivers (such as HGVs) along dual carriageways and motorways compared to other types of road;
- 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 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 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.

Following consideration of these relevant 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.

Where 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.

5.2.2 Geometric Modelling Results Overview

The results of the modelling indicate that solar reflections are geometrically possible towards an approximately 2km section of the A507 and a 2.6km section of the B1037.

Table 3 on the following pages presents the following:

- Geometric modelling results (without consideration of screening);
- Review of identified screening (presented in more detail in the following sub-section);
- Consideration of any mitigating factors (where appropriate);
- Predicted impact significance.

Results where mitigation has been recommended are highlighted in red for ease of reference.

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)	Mitigating Factors	Predicted Impact Classification
A1	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact
A2 – A8	Solar reflections are **geometrically possible.** Solar reflections occur **inside** a road user's primary FOV	No screening identified	N/A	Reflections will not occur directly in front of road user	Moderate impact Mitigation recommended (see Section 5.5.1)
A9 – A12	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)	Mitigating Factors	Predicted Impact Classification
A12 – A21	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
B1 – B8	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact
B9 – B10	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)	Mitigating Factors	Predicted Impact Classification
B11 – B15	Solar reflections are **geometrically possible.** Solar reflections occur **inside** a road user's primary FOV	No screening identified	N/A	Reflections will not occur directly in front of road user	Moderate impact Mitigation recommended (see Section 5.5.1)
B16 – B17	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to partially obstruct views of reflecting panels	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Only fleeting views of reflecting panels will be possible due to inconsistent vegetation screening	Low impact
B18 – B21	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Intervening terrain 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)	Mitigating Factors	Predicted Impact Classification
B22 – B35	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 3 *Geometric modelling results and assessment of impact significance – road receptors*

5.2.3 Review of Imagery

The identified screening in the form of existing vegetation and buildings – referred to as preventing/reducing views to road receptors in the above table - is outlined and green and blue respectively, with cumulative reflecting panel areas shown in yellow in Figures 10 to 16 on the following pages. Street view imagery represents views of the proposed development along the sections of road where the reflecting panels are predicted to be significantly obstructed. Where terrain screening is a significant mitigating factor, high-level zones of theoretical visibility (ZTV Viewshed) generated by Google Earth are used[15].

[15] The green highlighted areas denote sections that are potentially visible to the observer at a height of 2m agl

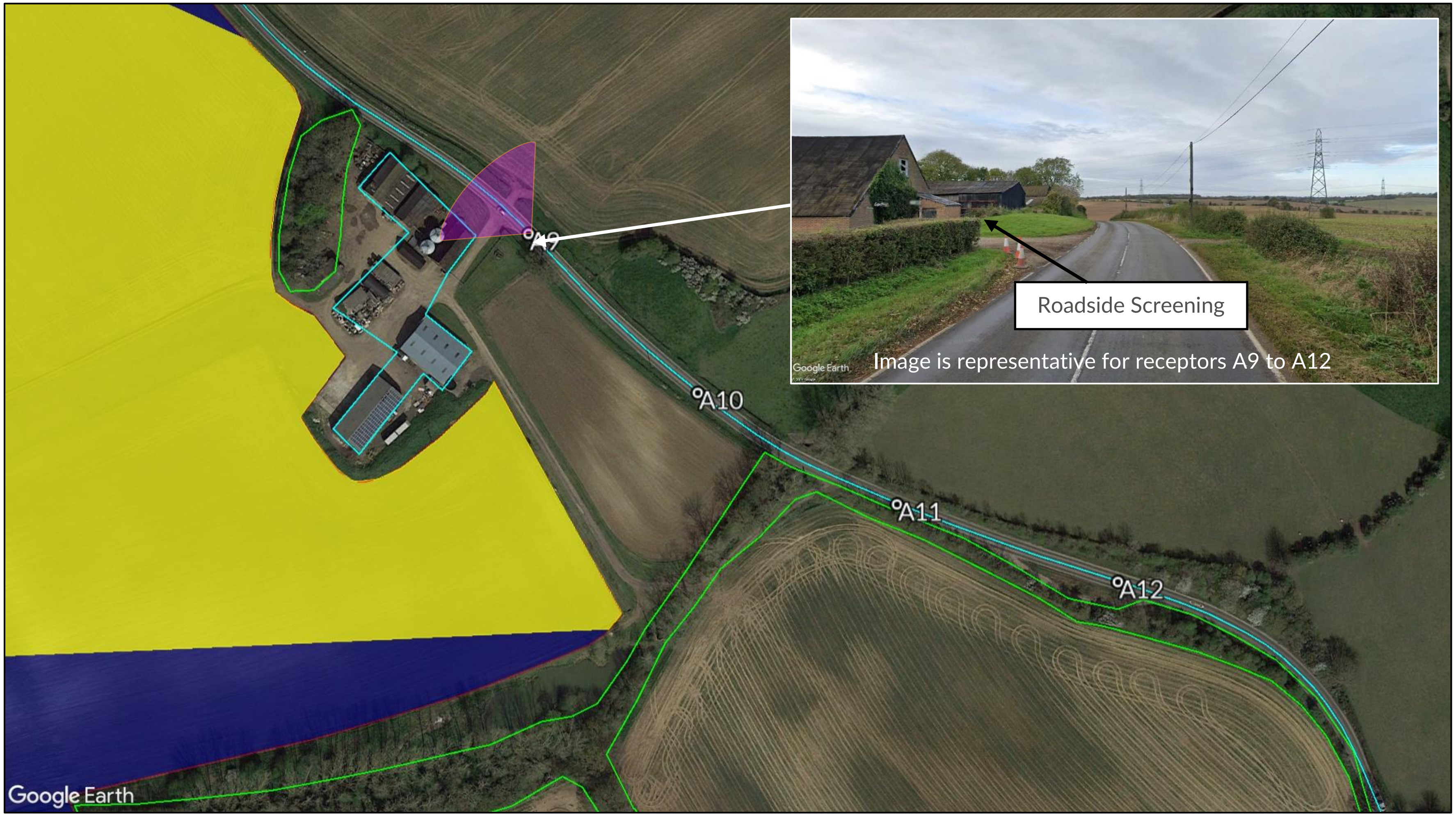

Figure 10 *Screening relevant to road receptors A9 to A12, and street view imagery from receptor A9*

Figure 11 *Screening relevant to road receptors A13 to A21, and street view imagery from receptor A13*

Figure 12 *Screening relevant to road receptors B9 and B10, and street view imagery from receptor B10*

Figure 13 *Screening relevant to road receptors B16 and B17, and street view imagery from receptor B17*

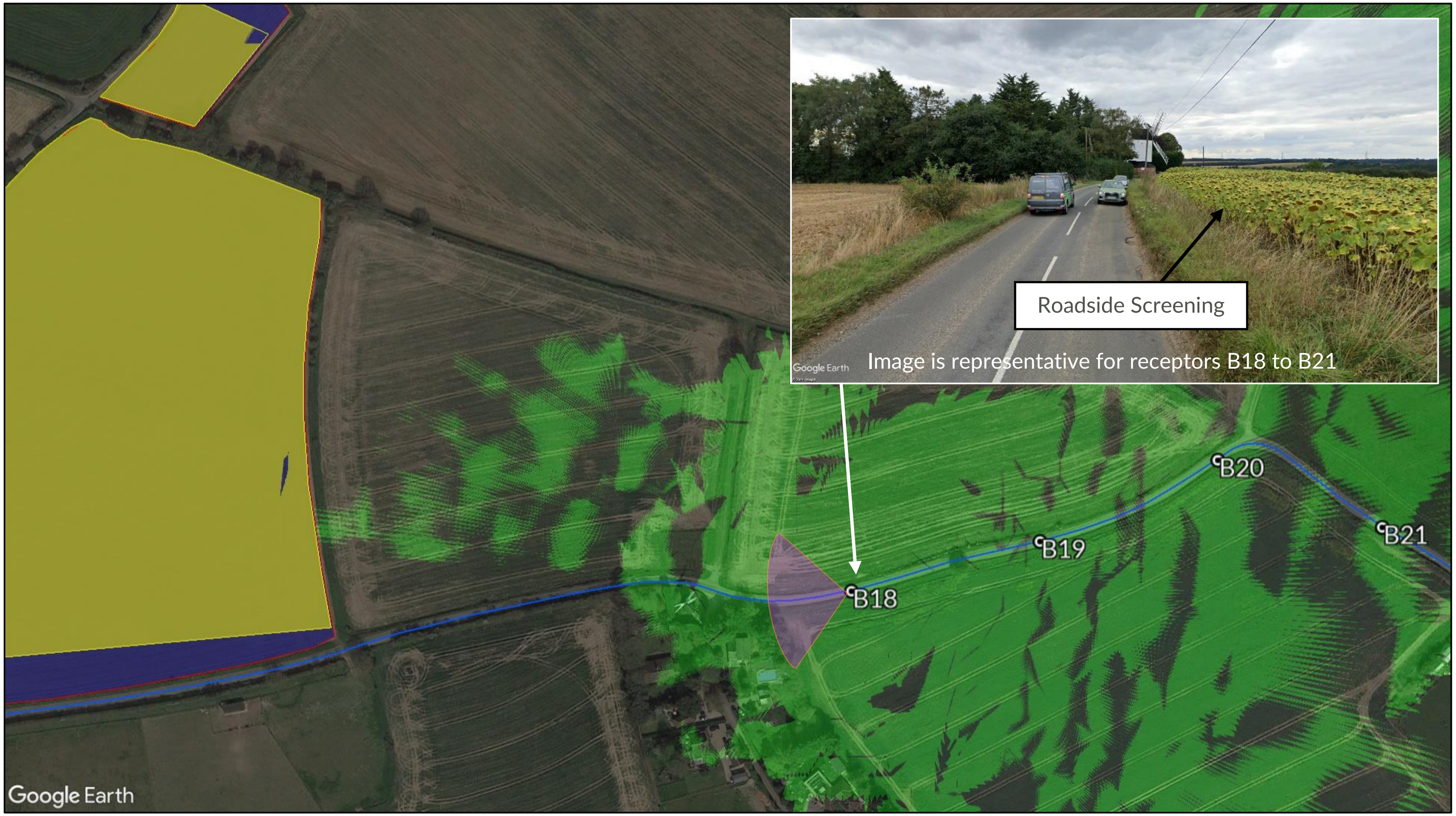

Figure 14 *Screening relevant to road receptors B18 to B21, and street view imagery and terrain mapping from receptor B18*

Figure 15 *Screening relevant to road receptors B22 to B26, and street view imagery from receptor B22*

Figure 16 *Screening relevant to road receptors B37 to B35, and street view imagery from receptor B29*

5.3 Dwelling Results

5.3.1 Key Considerations

The key considerations for quantifying the impact significance for dwelling receptors 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 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 effects are predicted to be experienced for **less** than three months per year and **less** than 60 minutes on any given day, or where the separation distance to the nearest visible reflecting panel is over 1km, the impact significance is low, and mitigation is not recommended.

Where effects 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 relevant factors is required to determine the impact significance:

- Whether solar reflections will be experienced from all storeys. The ground floor is typically considered the main living space and therefore has a greater significance with respect to residential amenity;
- 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. The Sun is a far more significant source of light;
- Whether the dwelling appears to have windows facing the reflecting areas. An observer may need to look from a wide angle to observe the reflecting areas.

Following consideration of these relevant 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.

Where effects are predicted to be experienced for **more** than three months per year and **more** than 60 minutes on any given day and there are no mitigating factors, the impact significance is high, and mitigation is required.

5.3.2 Geometric Modelling Results Overview

Solar reflections are geometrically possible towards dwelling receptors 1 to 16, 21 to 28 and 30 to 53, totalling 48 of the 53 assessed dwelling receptors.

Table 4 on the following pages presents the following:

- Geometric modelling results (without consideration of screening);
- Review of identified screening (presented in more detail in the following sub-section);
- Consideration of relevant mitigating factors (where appropriate);
- Predicted impact significance.

Results where mitigation has been recommended are highlighted in red for ease of reference.

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)	Relevant Factors	Predicted Impact Classification
1 – 11	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation screening Predicted to significantly obstruct views of reflecting panels such that views are **not possible** in practice	None	N/A	No impact
12 - 15	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Intervening terrain Predicted to significantly obstruct views of reflecting panels such that views are **not possible** in practice for observers on the ground floor	None	N/A	Low impact
16	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation screening Predicted to partially obstruct views of reflecting panels for an observer on the ground floor	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Separation distance of over 1km to closest visible reflecting panel	Low 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)	Relevant Factors	Predicted Impact Classification
17 - 20	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact
21	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation screening Predicted to significantly obstruct views of reflecting panels such that views are **not possible** in practice	None	N/A	No impact
22 – 25	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation screening Predicted to significantly obstruct views of reflecting panels such that views are **not possible** in practice	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)	Relevant Factors	Predicted Impact Classification
26 – 27	Solar reflections <u>**are geometrically possible**</u> for: **<u>More</u>** than 3 months **<u>Less</u>** than 60 minutes	Existing vegetation screening Views of the reflecting panels may be possible despite the partial screening.	**<u>More</u>** than three months **<u>Less</u>** than 60 minutes	None identified	Moderate impact Mitigation recommended (see Section 6.4.1)
28	Solar reflections <u>**are geometrically possible**</u> for: **<u>More</u>** than three months **<u>Less</u>** than 60 minutes	Existing vegetation screening Predicted to significantly obstruct views of reflecting panels such that views are **<u>not possible</u>** in practice	None	N/A	No impact
29	Solar reflections are <u>**not geometrically possible**</u>	N/A	N/A	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)	Relevant Factors	Predicted Impact Classification
30 - 33	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation screening Predicted to significantly obstruct views of reflecting panels such that views are **not possible** in practice	None	N/A	No impact
34 - 37	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Intervening terrain Predicted to significantly obstruct views of reflecting panels such that views are **not possible** in practice	None	N/A	No impact
38	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Intervening terrain Predicted to partially obstruct views of reflecting panels for an observer on the ground floor	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Separation distance of over 900m to closest visible reflecting panel	Low 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)	Relevant Factors	Predicted Impact Classification
39 - 53	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation screening Predicted to significantly obstruct views of reflecting panels such that views are **not possible** in practice	None	N/A	No impact

Table 4 *Geometric modelling results and assessment of impact significance - dwelling receptors*

5.3.3 Desk-Based Review of Imagery

The identified screening in the form of existing vegetation is outlined in green, with cumulative reflecting panel areas shown in yellow, within Figures 17 to 27 on the following page. Where terrain screening is a significant mitigating factor, high-level zones of theoretical visibility (ZTV Viewshed) generated by Google Earth are used[16].

[16] The green highlighted areas denote sections that are potentially visible to the observer at a height of 5m agl

Figure 17 *Screening relevant to dwelling receptors 1 to 11*

Figure 18 *Screening relevant to dwelling receptors 12 to 15, including terrain mapping from receptor 14*

Figure 19 *Screening relevant to dwelling receptor 16*

Figure 20 *Screening relevant to dwelling receptors 21 to 24*

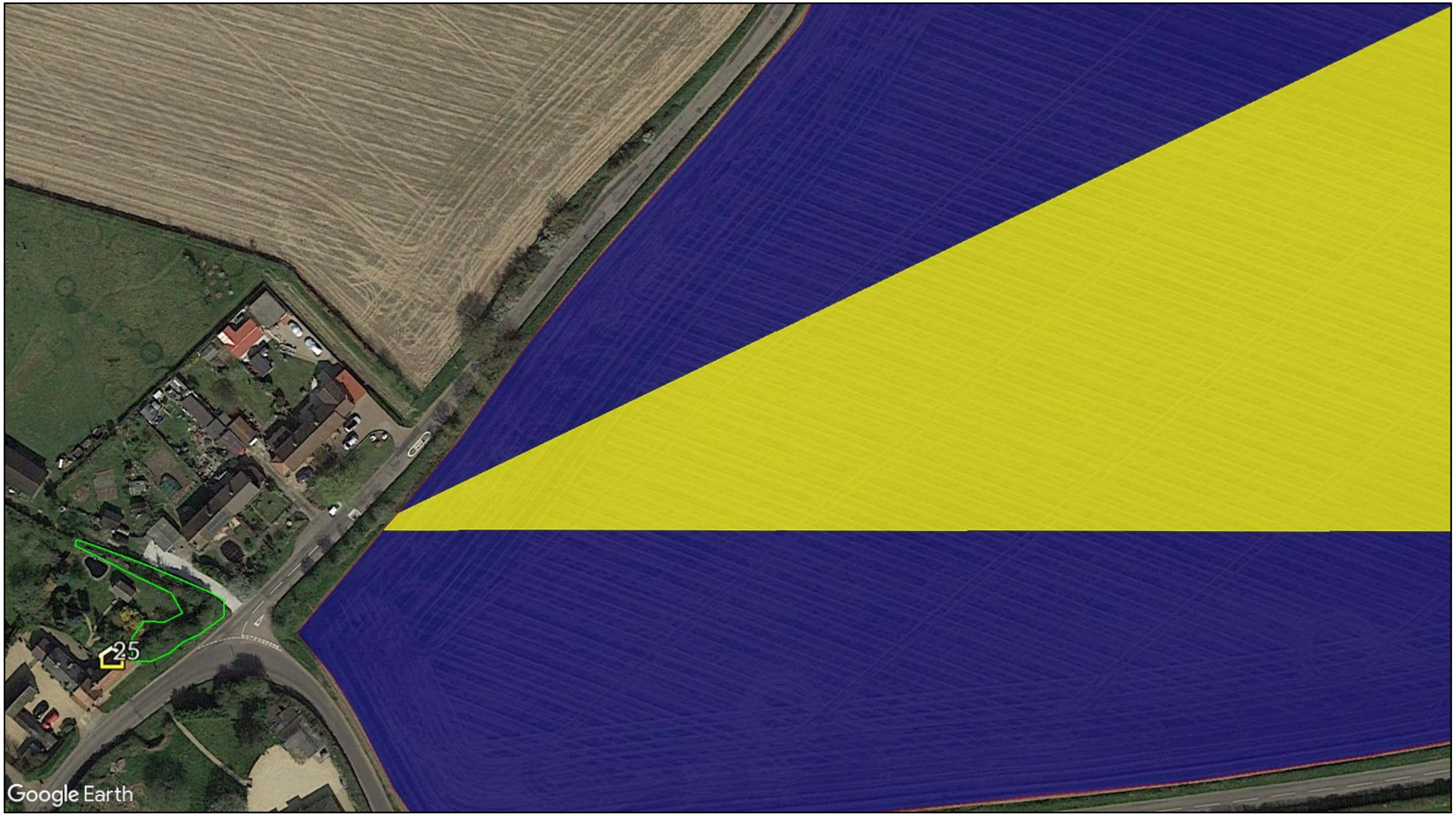

Figure 21 *Screening relevant to dwelling receptor 25*

Figure 22 *Screening relevant to dwelling receptor 28*

Figure 23 *Screening relevant to dwelling receptors 30 to 33*

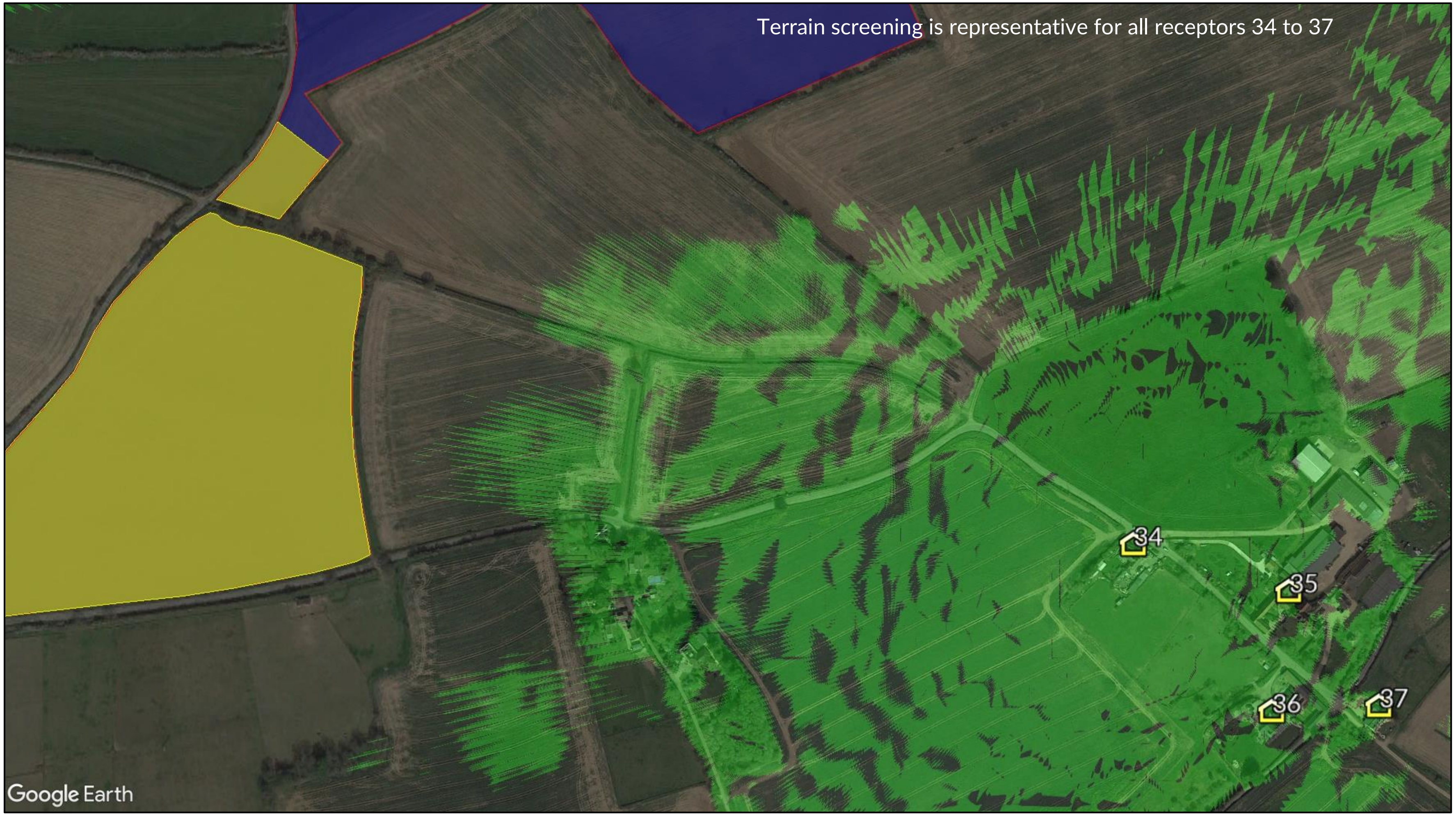

Figure 24 *Screening relevant to dwelling receptors 34 to 37, including terrain mapping from receptor 34*

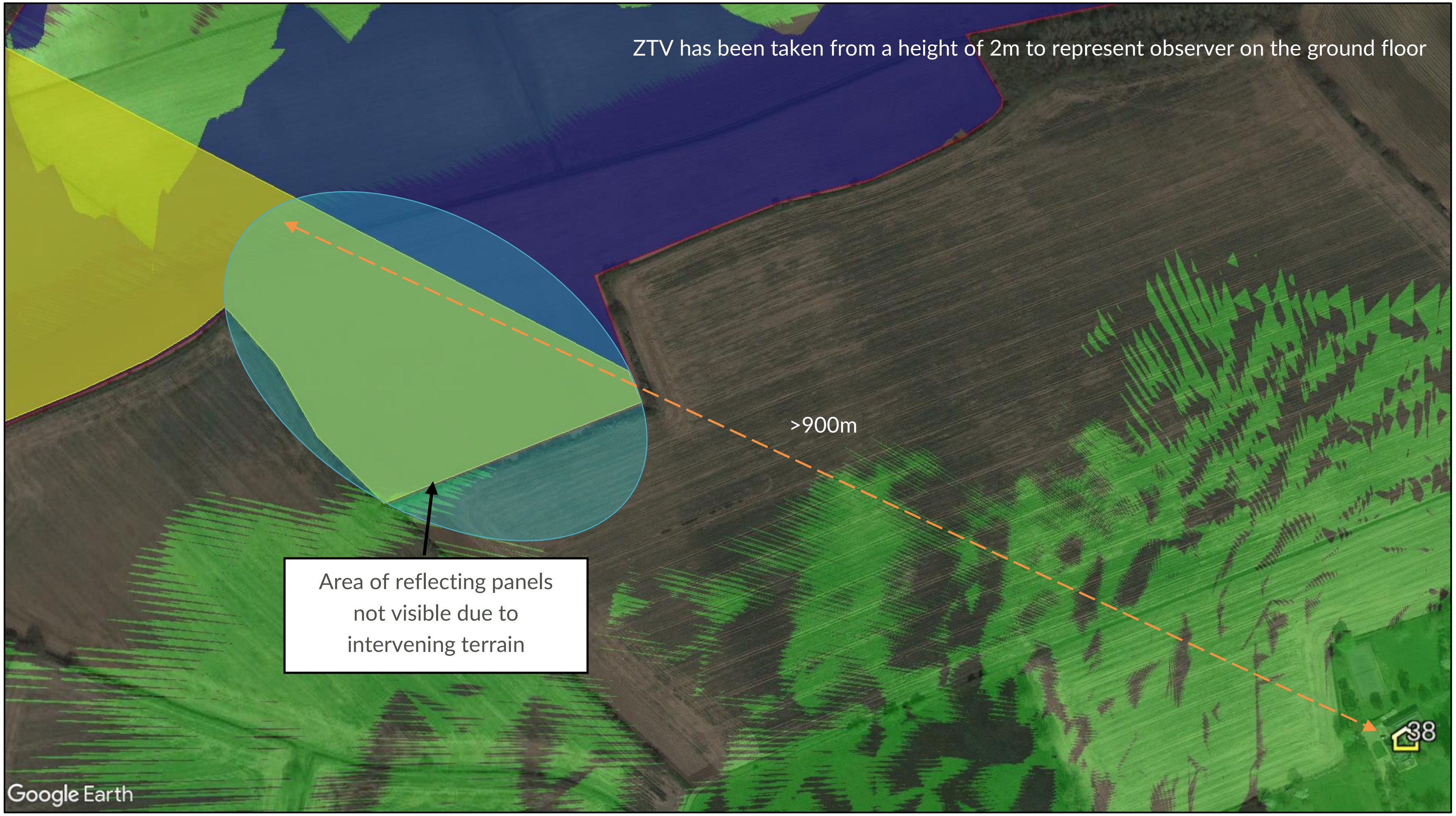

Figure 25 *Screening relevant to dwelling receptor 38, including terrain mapping from receptor 38*

Figure 26 *Screening relevant to dwelling receptors 39 to 47*

Figure 27 *Screening relevant to dwelling receptors 48 to 53*

5.4 Aviation Results

5.4.1 Key Considerations

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 (50 degrees either side of the runway approach relative to the runway threshold), the impact significance is low, and mitigation is not required.

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[17] for on-airfield solar towards 2-mile approach paths for runway thresholds[18]. Pager Power recommends a pragmatic approach whereby instances of 'yellow' glare are evaluated in a technical and operational context. Where solar reflections are of an intensity no greater than 'low potential for temporary after-image' expert assessment of the following relevant factors is required to determine the impact significance[19]:

- The likely traffic volumes and level of safeguarding at the aerodrome – licensed aerodromes typically have higher traffic volumes and are formally safeguarded;
- The time of day at which glare is predicted and whether the aerodrome will be operational such that pilots can be on the approach at these times;
- 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;

[17] This FAA guidance from 2013 has since been superseded by the FAA guidance in 2021 whereby airports are tasked with determining safety requirements themselves.
[18] This technical context is applicable towards the 10NM approach and departure paths as per MAG requirements
[19] 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.

- The location and size of the reflecting panel area relative to 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 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 relevant factors, where the solar reflection is not deemed 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 at least moderate, and mitigation is recommended. Where solar reflections are of an intensity greater than 'potential for temporary after-image', the impact significance is high, and mitigation is required.

In all cases, however, consultation with the aerodrome is recommended to understand their position pertaining to solar reflections towards the approach paths, along with any feedback or comments regarding the proposed development.

5.4.2 Graveley Airfield Aviation Results

The results of the geometric calculations for Graveley Airfield are presented in Table 5 below.

Receptor/Runway	Geometric Modelling Result	Glare Intensity	Comment	Impact Classification	Mitigation Recommended?
Runway 01 1 Mile Splayed Approach	Solar reflections geometrically possible from the threshold to 1 mile from the threshold		Solar reflections will be outside the pilot's primary field-of-view and are therefore considered acceptable in accordance with the associated guidance and industry best practice	Low impact	No
Runway 01 Visual Circuits and Joins	Solar reflections are geometrically possible towards the final sections of the circuit and base-leg join for runway 01		Solar reflections with a maximum intensity of 'low potential for temporary after-image' are possible towards the approach path and therefore considered acceptable in accordance with the associated guidance and industry best practice	Low impact	No
Runway 19 1 Mile Splayed Approach	Solar reflections geometrically possible from the threshold to 1 mile from the threshold		Solar reflections will be outside the pilot's primary field-of-view and are therefore considered acceptable in accordance with the associated guidance and industry best practice	Low impact	No

Receptor/Runway	Geometric Modelling Result	Glare Intensity	Comment	Impact Classification	Mitigation Recommended?
Runway 19 Visual Circuits and Joins	Solar reflections are geometrically possible towards the final sections of the circuit and base-leg join for runway 19		Solar reflections with a maximum intensity of 'low potential for temporary after-image' are possible towards the approach path and therefore considered acceptable in accordance with the associated guidance and industry best practice	Low impact	No

Table 5 *Geometric modelling results and assessment of impact significance – Graveley Airfield*

5.4.3 Benington Airfield Aviation Results

The results of the geometric calculations for Benington Airfield are presented in Table 6 below.

Receptor/Runway	Geometric Modelling Result	Glare Intensity	Comment	Impact Classification	Mitigation Recommended?
Runway 05 1 Mile Splayed Approach	No solar reflections geometrically possible	N/A	N/A	No impact	No
Runway 05 Visual Circuits and Joins	No solar reflections geometrically possible	N/A	N/A	No impact	No
Runway 23 1 Mile Splayed Approach	No solar reflections geometrically possible	N/A	N/A	No impact	No
Runway 23 Visual Circuits and Joins	No solar reflections geometrically possible	N/A	N/A	No impact	No

Table 6 *Geometric modelling results and assessment of impact significance – Benington Airfield*

5.5 Mitigation Strategy

5.5.1 Road Mitigation

A moderate impact has been predicted upon a 600m section of the A507 and a 300m section of the B1037.

The locations identified for proposed screening is shown as the pink line in Figures 28 and 29 on the following pages. This screening could be in the form of planting or a fence and should be of a height such that views of the reflecting panels are obscured from the view of the affected sections of road for a typical road user.

If vegetation is used, it should be ensured that the screening significantly obstructs the reflecting panels during the periods when solar reflections are geometrically possible.

Review of the latest Landscape Mitigation Plan[20] shows proposed screening of sufficient height between the reflecting panels and the affected receptors such that the impact will be reduced to low, or no, impact.

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[20] 2747.5.01 to 2747.5.07_Landscape Mitigation Plan_Rev E PDF

Figure 28 *Reflective panel area and proposed screening for road receptors A2 to A8*

Figure 29 *Reflective panel area and proposed screening for road receptors B11 to B15*

5.5.2 Dwelling Mitigation

A moderate impact has been predicted upon two dwelling receptors.

The locations identified for proposed screening is shown as the pink line in Figure 30 on the following page. This screening could be in the form of planting or a fence and should be of a height such that views of the reflecting panels are obscured from the view of the affected dwellings.

If vegetation is used, it should be ensured that the screening significantly obstructs the reflecting panels during the periods when solar reflections are geometrically possible, early-April until late-September.

The panels directly adjacent to the impacted dwellings have been removed in the most recent Site Layout, therefore reducing the total potential impact on these dwellings.

Review of the latest Landscape Mitigation Plan[21] shows proposed screening of sufficient height between the reflecting panels and the affected receptors such that the impact will be reduced to low, or no, impact.

[21] 2747.5.01 to 2747.5.07_Landscape Mitigation Plan_Rev E PDF

Figure 30 *Reflective panel area and proposed screening for dwelling receptors 26 and 27*

6 HIGH-LEVEL AVIATION CONSIDERATIONS

6.1 Overview

Glint and glare assessment for aviation receptors are typically undertaken for licensed aerodromes within 10km of a proposed solar development. Geometric modelling for GA aerodromes is typically required within 5km of a proposed development. At ranges of 10-20km, the requirement for assessment is much less common particularly for unlicensed aerodromes. Assessment of any aviation effects for developments over 20km is not a usual requirement.

The following section presents an overview of the possible effects of glint and glare concerning aviation activity at Rush Green Airfield, Wisbridge Farm Airfield, Notley Green Airfield and Newnham Airfield.

The approximate distances of the airfields relative to the proposed development are listed below:

- Rush Green Airfield: 10km southwest;
- Wisbridge Farm Airfield: 7.7km northeast;
- Notley Green Airfield: 5km north
- Newnham Airfield: 8.4km northwest.

6.2 Aerodrome Details

6.2.1 Rush Green Airifeld

Rush Green Airfield is an unlicenced airfield and not understood to have an ATC Tower. The aerodrome has one runway, the details of which are presented below[22]:

- 16/34 measuring 560 x 15 metres (grass).

6.2.2 Wisbridge Farm Airifeld

Wisbridge Farm Airfield is an unlicenced airfield and not understood to have an ATC Tower. The aerodrome has one runway, the details of which are presented below[18]:

- 02/20 measuring 750 x 35 metres (grass).

6.2.3 Notley Green Airifeld

Notley Green Airfield is an unlicenced airfield and not understood to have an ATC Tower. The aerodrome has one runway, the details of which are presented below[18]:

- 04/22 measuring 500 x 40 metres (grass).

[22] As determined by aerial imagery.

6.2.4 Newnham Airifeld

Newnham Airfield is an unlicenced airfield and not understood to have an ATC Tower. The aerodrome has one runway, the details of which are presented below[18]:

- 08/26 measuring 600 x 15 metres (asphalt).

The locations of the aerodromes relative to the proposed development and splayed 1-mile runway approach paths are shown in Figure 31 on the following page.

Figure 31 *Location of the aerodromes relative to the proposed solar development*

6.3 High-Level Assessment Conclusions

The proposed development size, distance between the aerodrome and proposed development, geometric results for Graveley Airfield and Benington Airfield assessed in this report, and industry experience are considered during the assessment.

6.3.1 Rush Green Airfield

For aviation activity associated with Rush Green Airfield, the following can be concluded:

- Any solar reflections towards pilots approaching runway thresholds 16 and 34 will be outside a pilot's primary field-of-view. This level of glare is acceptable in accordance with the associated guidance and industry best practice.

No significant impacts are predicted upon aviation activity associated with Rush Green Airfield. Mitigation is not required, and detailed modelling is not recommended.

6.3.2 Wisbridge Farm Airfield

For aviation activity associated with Wisbridge Farm Airfield, the following can be concluded:

- Any solar reflections towards pilots approaching runway thresholds 02 will be outside a pilot's primary field-of-view. This level of glare is acceptable in accordance with the associated guidance and industry best practice;
- It is also predicted that any solar reflections towards pilots approaching runway threshold 20 would have intensities no greater than 'low potential for temporary after image'. This level of glare is acceptable in accordance with the associated guidance and industry best practice.

No significant impacts are predicted upon aviation activity associated with Wisbridge Farm Airfield. Mitigation is not required, and detailed modelling is not recommended.

6.3.3 Notley Green Airfield

For aviation activity associated with Notley Green Airfield, the following can be concluded:

- Any solar reflections towards pilots approaching runway threshold 04 will be outside a pilot's primary field-of-view. This level of glare is acceptable in accordance with the associated guidance and industry best practice;
- It is also predicted that any solar reflections towards pilots approaching runway threshold 22 would have intensities no greater than 'low potential for temporary after image'. This level of glare is acceptable in accordance with the associated guidance and industry best practice.

No significant impacts are predicted upon aviation activity associated with Notley Green Airfield. Mitigation is not required, and detailed modelling is not recommended.

6.3.4 Newnham Airfield

For aviation activity associated with Newnham Airfield, the following can be concluded:

- Any solar reflections towards pilots approaching runway thresholds 08 and 26 will be outside a pilot's primary field-of-view. This level of glare is acceptable in accordance with the associated guidance and industry best practice.

No significant impacts are predicted upon aviation activity associated with Newnham Airfield. Mitigation is not required, and detailed modelling is not recommended.

7 OVERALL CONCLUSIONS

7.1 Assessment Conclusions – Roads

Solar reflections are geometrically possible towards a 1.9km section of the A507 and a 2.9km section of the B1037.

Screening in the form of existing vegetation, existing buildings or intervening terrain is predicted to significantly obstruct views of reflecting panels such that solar reflections will not be experienced by road users along a 1.3km section of the A507 and a 2.4km of the B1037. No impact is predicted along these sections, and accordingly mitigation is not required.

For 200m of the B1037, partial screening in the form of existing vegetation is predicted to only allow for short, fleeting views of the reflecting panels. A low impact is predicted, mitigation is not recommended.

For the remaining 600m section of the A507 and 300m section of the B1037, no relevant screening has been identified. A moderate impact is predicted, and mitigation is recommended.

7.2 Assessment Conclusions – Dwellings

Solar reflections are geometrically possible towards 48 of the 53 assessed dwellings.

For 44 of the dwellings, screening in the form of existing vegetation and/or intervening terrain is predicted to significantly obstruct views of reflecting panels such that solar reflections will not be experienced by residents. No impact is predicted, and mitigation is not required.

For two of the dwellings, existing vegetation or intervening terrain is predicted to partially obstruct views of reflecting panels for an observer on the ground floor, the remaining visible reflecting panels will have a separation distance of over 900m. A low impact is predicted, and mitigation is not recommended.

For the remaining two dwellings, reflections are predicted to occur for less than an hour on any given day, and for more than three months of the year. No significant screening has been identified. A moderate impact is predicted, and mitigation is recommended.

7.3 Assessment Conclusions – Aviation

7.3.1 Graveley Airfield

Solar reflections with 'low-potential for temporary after-image' ('green' glare) are geometrically possible towards the 1-mile splayed approach paths for runway thresholds 01 and 19 and will occur outside the pilots primary field of view. This intensity of glare is acceptable in accordance with the associated guidance and industry best practice. A low impact is predicted, and mitigation is not required.

Solar reflections with 'low-potential for temporary after-image' ('green' glare) are geometrically possible towards the final sections of the visual circuit and base leg joins for runway thresholds 01 and 19. This intensity of glare is acceptable in accordance with the associated guidance and industry best practice. A low impact is predicted, and mitigation is not required.

7.3.2 Benington Airfield

No solar reflections are geometrically possible towards the approach paths and final sections of the visual circuits for runways at Benington Airfield. No impact is predicted, and no mitigation is required.

7.4 High Level Aviation Assessment Conclusions

For aviation activity associated with Rush Green Airfield, Wisbridge Farm Airfield, Notley Green Airfield and Newnham Airfield any solar reflections are predicted to be acceptable in accordance with the associated guidance due to the following two factors:

- Glare intensities towards approaches towards thresholds in the direction of the proposed development are predicted to be no greater than 'low potential for temporary after-image';
- Any possible solar reflections will be outside the pilot's field-of-view for pilots approaching runway thresholds directed away from the proposed development.

Therefore, no significant impacts are predicted upon aviation activity Rush Green Airfield, Wisbridge Farm Airfield, Notley Green Airfield and Newnham Airfield and detailed modelling is not recommended.

Energy Storage Facility

The proposed energy storage facility will comprise 24 storage units grouped in pairs and located throughout the site. Each pair of units resembles a large shipping container in appearance. There are no solar panels or other reflective elements associated with this part of the project and therefore it has been excluded from further assessment.

7.5 Overall Conclusions

A moderate impact is predicted on road safety and residential amenity, mitigation is recommended.

A maximum of low impact is predicted on aviation activity associated with Graveley Airfield, Bonnington Airfield, Rush Green Airfield, Wisbridge Farm Airfield, Notley Green Airfield and Newnham Airfield.

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[23] (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.'

[23] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 01/11/2021

National Policy Statement for Renewable Energy Infrastructure

The National Policy Statement for Renewable Energy Infrastructure (EN-3)[24] 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.[25] 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.

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[24] National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Energy Security & Net Zero, date: November 2023, accessed on: 21/12/2023.

[25] *'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.'*

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. 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.

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[26] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

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

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[27] however the advice is still applicable[28] until a formal policy is developed. The relevant aviation guidance from the CAA is presented in the section below.

CAA Interim Guidance

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

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

9. Guidance on safeguarding procedures at CAA licensed 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[29], 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.

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[27] Archived at Pager Power

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

[29] Aerodrome Licence Holder.

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'[30], the 2013 update is entitled 'Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports'[31], and the 2021 final policy is entitled 'Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports'[32].

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.

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[30] Archived at Pager Power

[31] 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.

[32] 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.

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.

In 2018, the FAA released the latest version (Version 1.1) of the 'Technical Guidance for Evaluating Selected Solar Technologies on Airports'[33]. 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[34].
- 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[35], 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.

[33] National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Energy Security & Net Zero, date: November 2023, accessed on: 21/12/2023.

[34] 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.

[35] First figure in Appendix B.

- 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 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[36] 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.

[36] 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.

Air Navigation Order (ANO) 2016

In some instances, an aviation stakeholder can refer to the ANO 2016[37] 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—

(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

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

Civil Aviation Authority consolidation of UK Regulation 139/2014

The Civil Aviation Authority (CAA) published a consolidating document[38] 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.

(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. the dazzling caused by large and highly reflective surfaces;
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; and
5. 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.

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

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

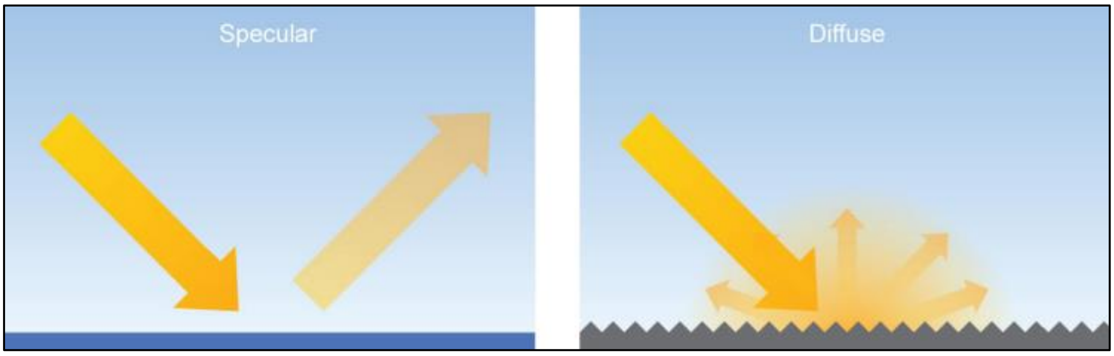
Overview

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[39], 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

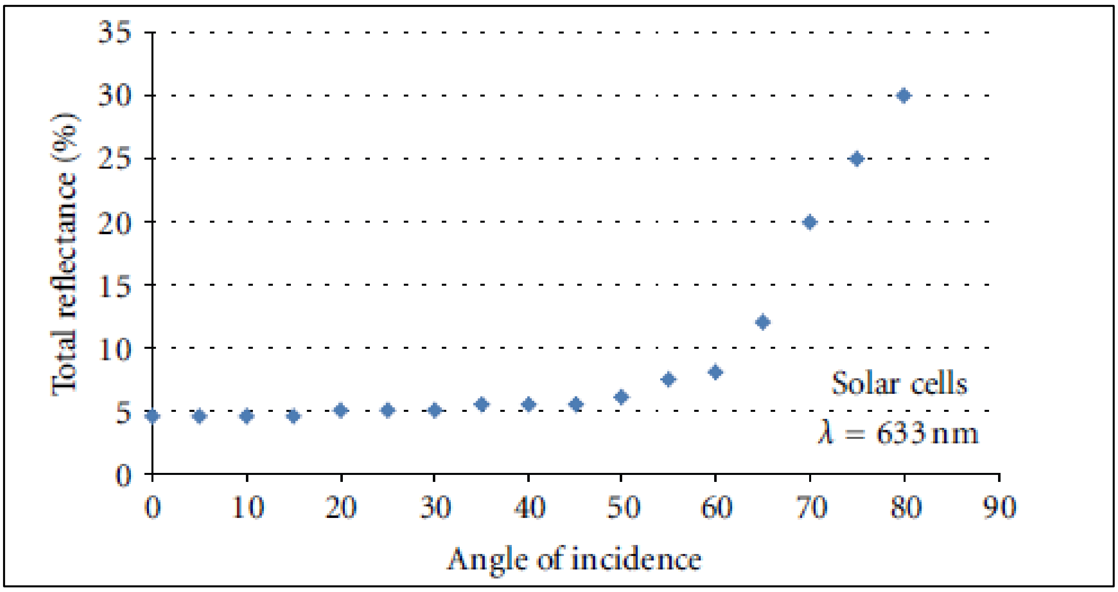
[39] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

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[40]". They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure below.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

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

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[40] 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"[41]

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[42]
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).

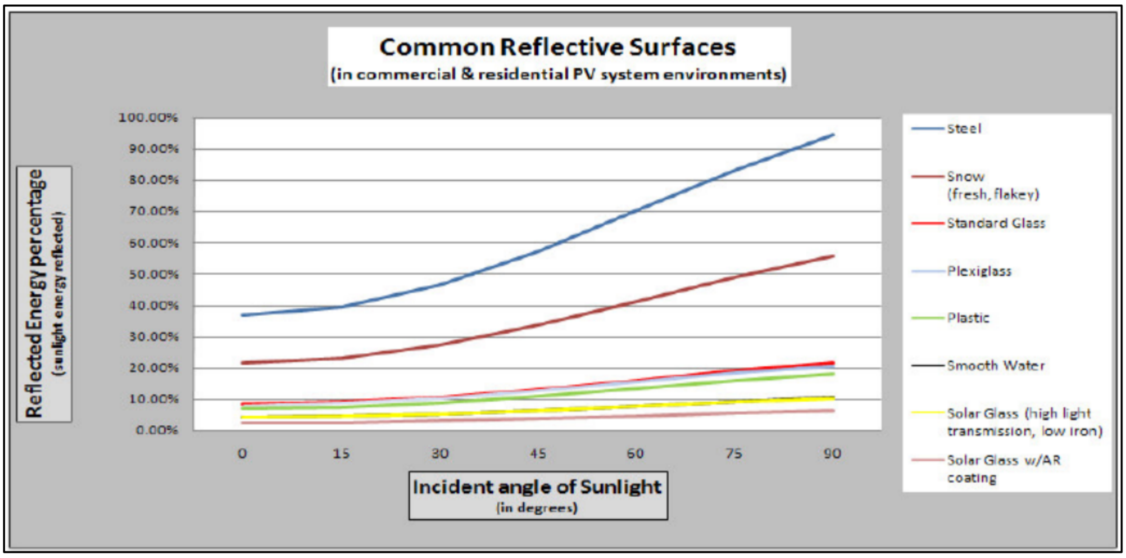
An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

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

SunPower Technical Notification (2009)

SunPower published a technical notification[43] 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.

[43] 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).

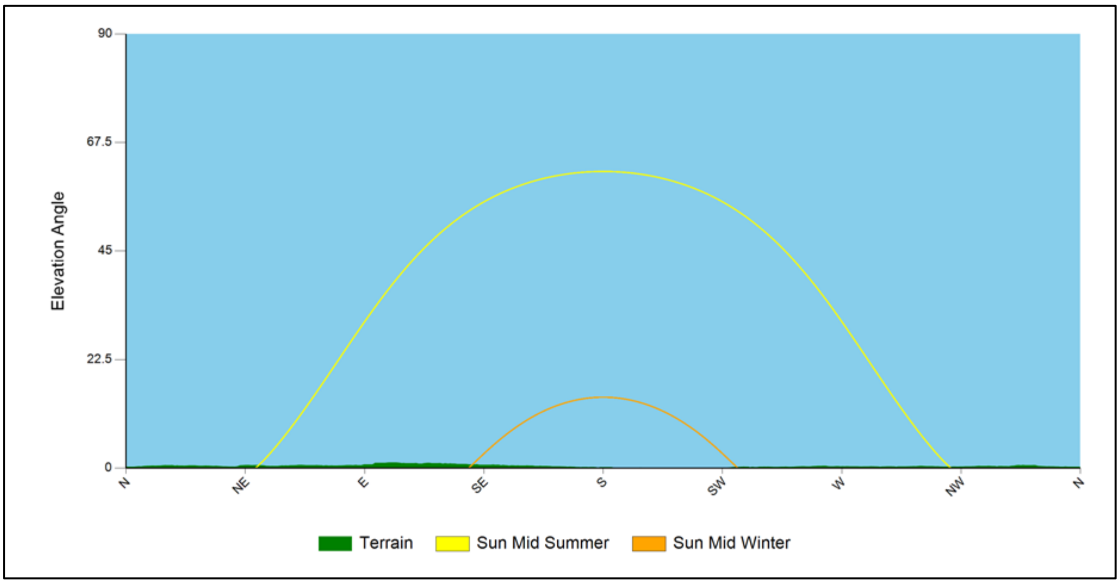
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- 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 from the proposed development location as well as the sunrise and sunset curves throughout the year.



Sunrise and sunset curves

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

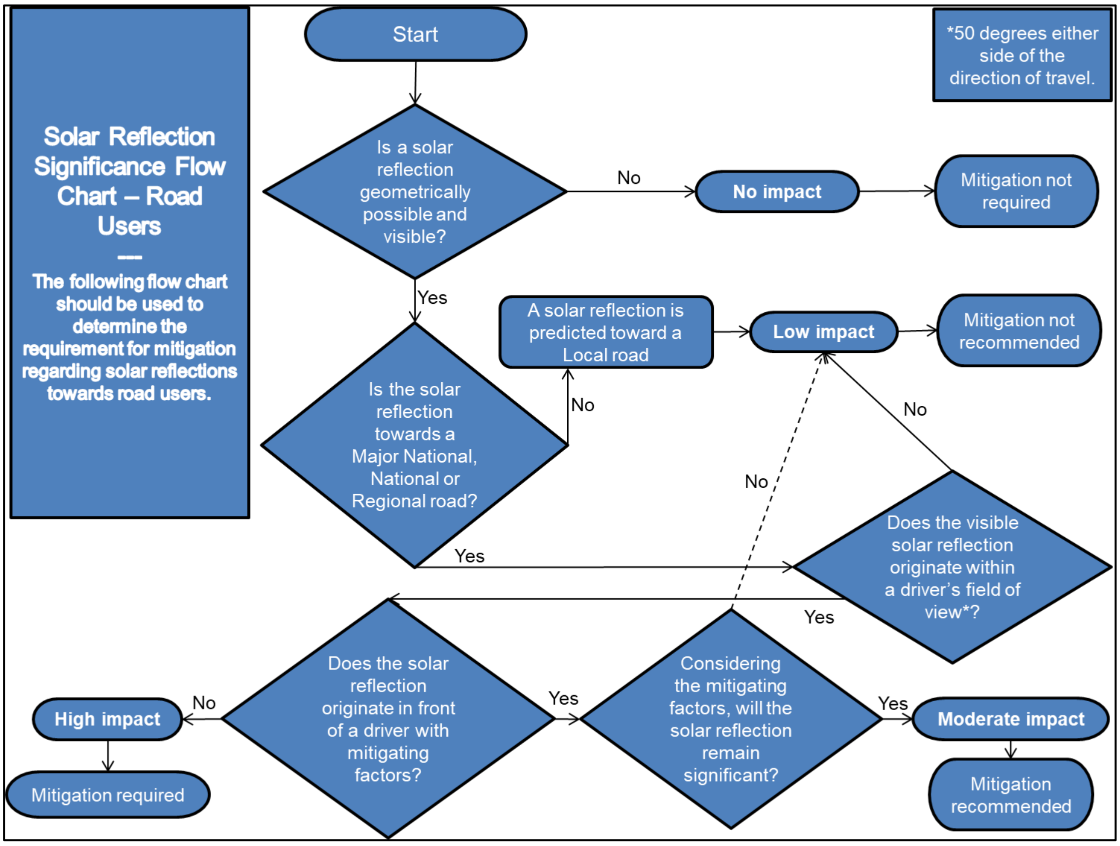
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

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 Road Receptors

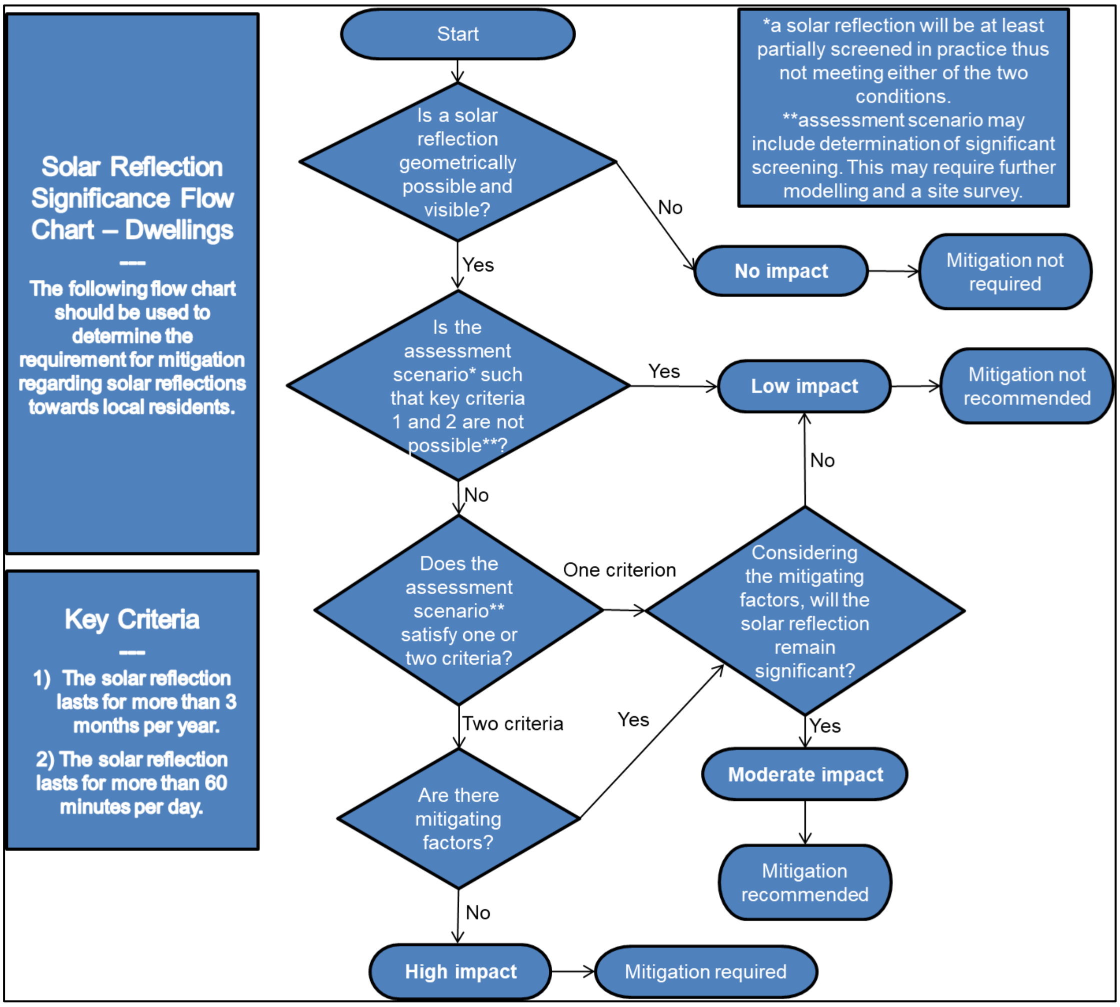
The flow chart presented below has been followed when determining the impact significance for road receptors.



Road user impact significance flow chart

Impact Significance Determination for Dwelling Receptors

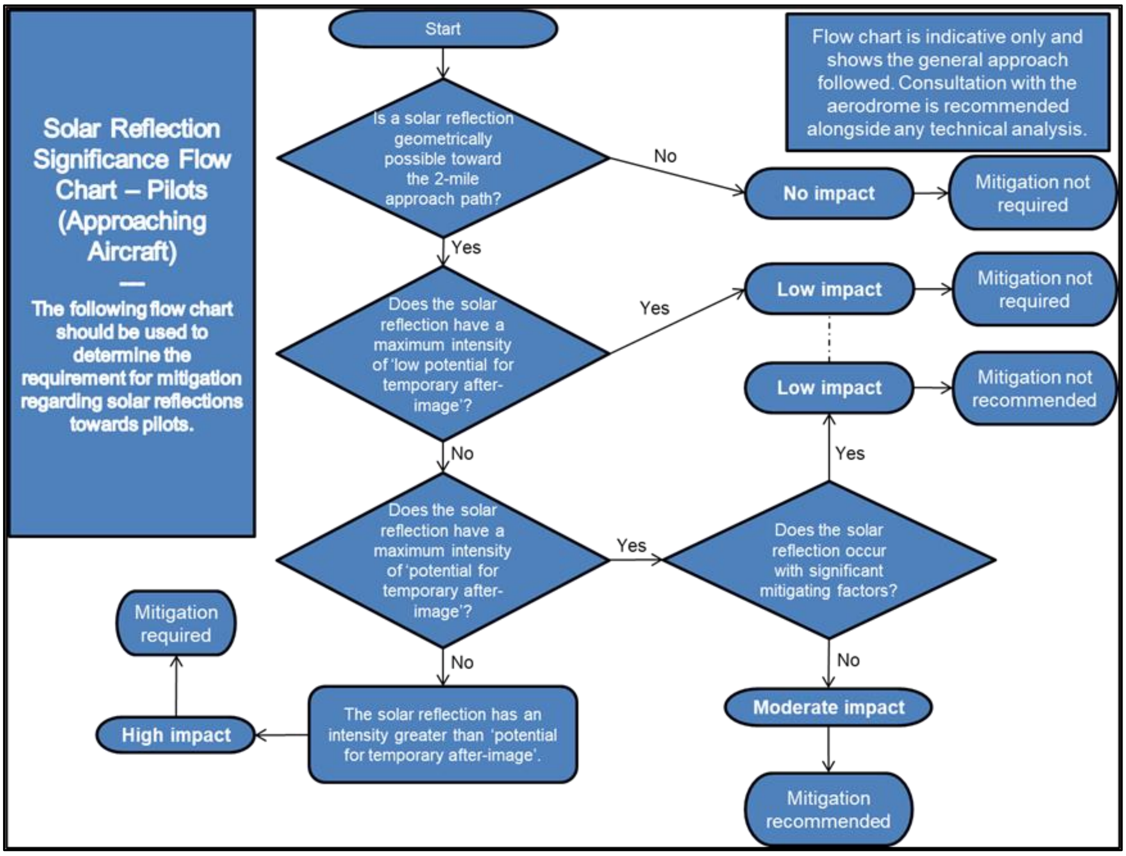
The flow chart presented below has been followed when determining the impact significance for dwelling receptors.



Dwelling impact significance flow chart

Impact Significance Determination for Approaching Aircraft

The flow chart presented below has been followed when determining the impact significance for approaching aircraft.



Approaching aircraft receptor impact significance flow chart

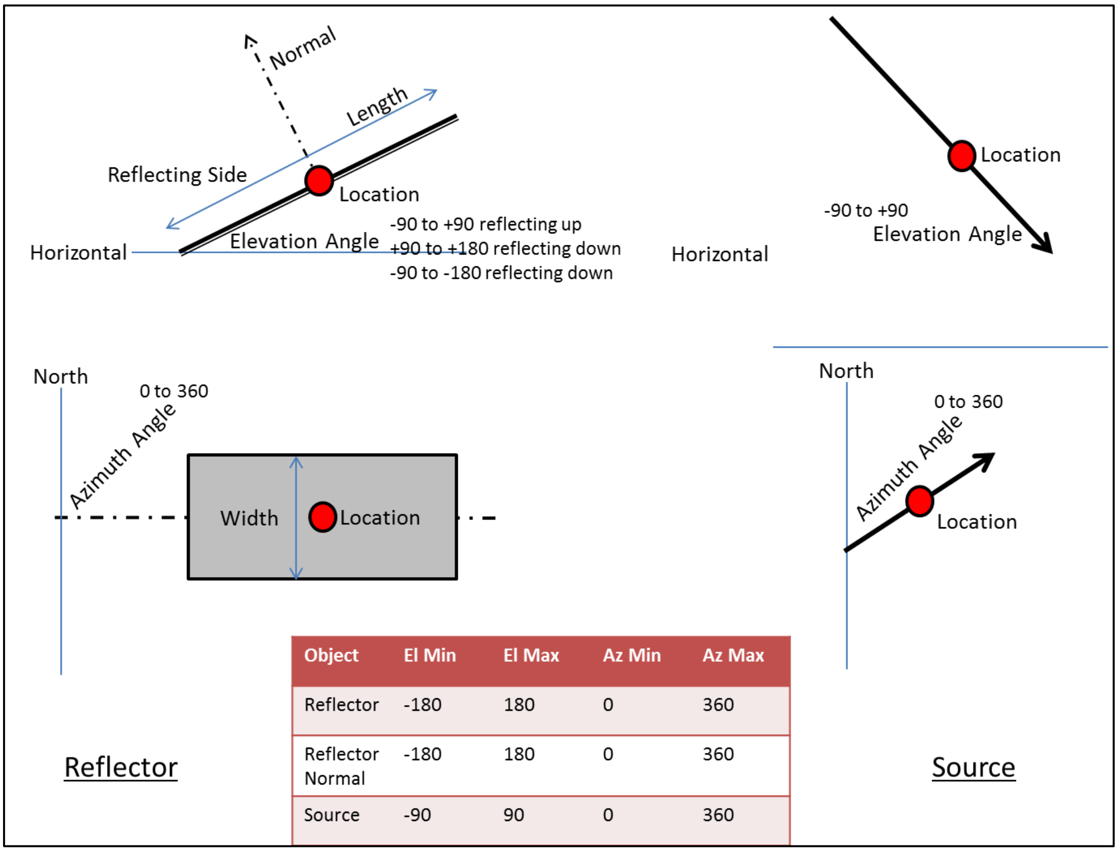
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

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.

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)[44].

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

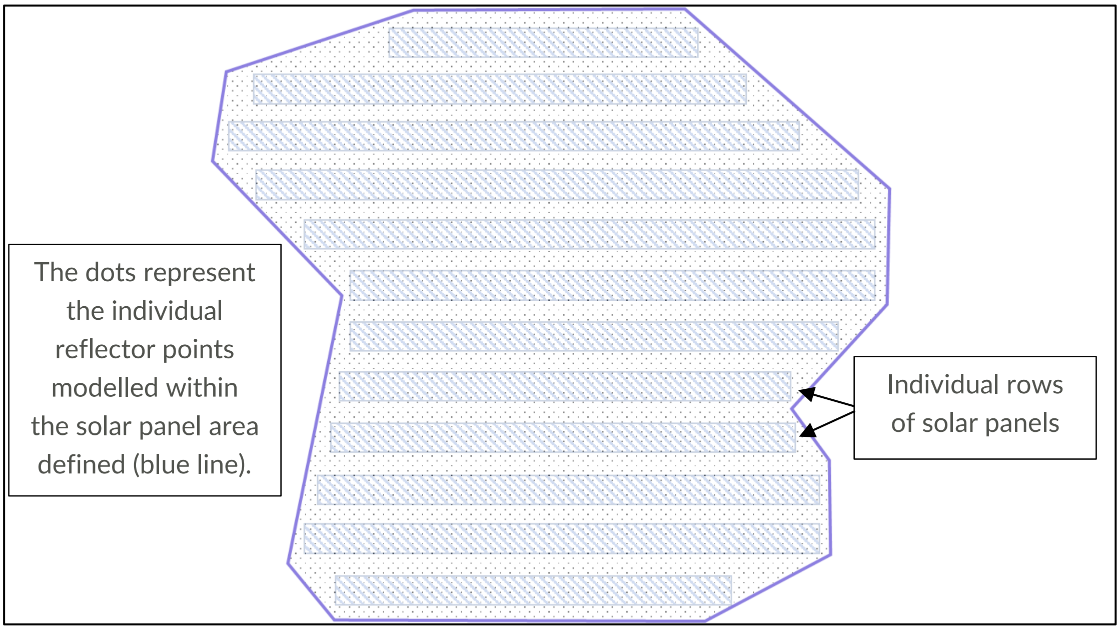
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

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 below which illustrates this process.

[44] 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

The following text is taken from Forge[45] and is presented for reference.

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.

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

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Road Receptor Data

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

A507

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
A1	51.95459	-0.10134	115.72	A12	51.94793	-0.08985	123.99
A2	51.95398	-0.10026	110.55	A13	51.94748	-0.08862	130.65
A3	51.95334	-0.09924	108.22	A14	51.94668	-0.08797	132.36
A4	51.95262	-0.09835	103.41	A15	51.94655	-0.08663	133.45
A5	51.95190	-0.09749	100.85	A16	51.94662	-0.08518	132.50
A6	51.95117	-0.09662	104.85	A17	51.94669	-0.08373	132.18
A7	51.95045	-0.09576	110.93	A18	51.94669	-0.08227	132.17
A8	51.94982	-0.09473	121.66	A19	51.94687	-0.08084	133.50
A9	51.94928	-0.09356	121.92	A20	51.94693	-0.07939	134.50
A10	51.94866	-0.09250	120.86	A21	51.94690	-0.07851	135.50
A11	51.94822	-0.09123	120.83				

A507 receptor data

B1037

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
B1	51.93283	-0.11895	86.92	B19	51.94127	-0.10100	125.72
B2	51.93358	-0.11814	86.73	B20	51.94164	-0.09968	127.38
B3	51.93438	-0.11750	88.53	B21	51.94133	-0.09845	130.42
B4	51.93526	-0.11716	87.98	B22	51.94084	-0.09723	131.37
B5	51.93609	-0.11665	87.07	B23	51.94024	-0.09615	130.85
B6	51.93683	-0.11581	90.02	B24	51.93999	-0.09504	130.54
B7	51.93759	-0.11502	92.50	B25	51.94076	-0.09430	132.50
B8	51.93834	-0.11423	97.28	B26	51.94131	-0.09316	132.61
B9	51.93910	-0.11346	99.68	B27	51.94182	-0.09196	133.50
B10	51.93991	-0.11280	101.13	B28	51.94251	-0.09108	133.50
B11	51.94066	-0.11206	104.16	B29	51.94245	-0.08980	133.50
B12	51.94032	-0.11101	106.11	B30	51.94230	-0.08850	133.50
B13	51.94038	-0.10957	111.50	B31	51.94295	-0.08751	133.50
B14	51.94050	-0.10812	114.50	B32	51.94371	-0.08674	133.50
B15	51.94067	-0.10669	119.50	B33	51.94436	-0.08573	133.50
B16	51.94092	-0.10528	122.50	B34	51.94511	-0.08493	133.50
B17	51.94108	-0.10385	123.50	B35	51.94577	-0.08396	133.50
B18	51.94104	-0.10241	125.22				

B1037 receptor data

Dwelling Receptor Data

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

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
1	51.94885	-0.12127	104.96	28	51.94036	-0.11144	104.48
2	51.94852	-0.12039	103.02	29	51.93277	-0.10830	94.80
3	51.94704	-0.12008	105.02	30	51.94091	-0.10359	123.80
4	51.94652	-0.11973	104.25	31	51.94069	-0.10390	123.80
5	51.94595	-0.11957	100.80	32	51.94032	-0.10358	123.80
6	51.94575	-0.11892	98.92	33	51.94009	-0.10244	123.64
7	51.94482	-0.11864	99.92	34	51.94080	-0.09764	130.56
8	51.94460	-0.11937	102.03	35	51.94047	-0.09586	131.80
9	51.94432	-0.11886	100.38	36	51.93963	-0.09605	130.10
10	51.94412	-0.11869	98.56	37	51.93967	-0.09485	130.10
11	51.94386	-0.11876	97.41	38	51.94247	-0.09233	133.80
12	51.94194	-0.11994	91.52	39	51.94296	-0.09136	133.80
13	51.94155	-0.12009	90.63	40	51.94370	-0.09006	133.80
14	51.94089	-0.12065	91.29	41	51.94420	-0.08700	133.80
15	51.93995	-0.12104	91.03	42	51.94430	-0.08444	133.80
16	51.93884	-0.12399	111.17	43	51.94503	-0.08480	133.80
17	51.93677	-0.11627	88.88	44	51.94537	-0.08500	133.80
18	51.93753	-0.11559	91.80	45	51.94627	-0.08505	133.48
19	51.93801	-0.11494	95.21	46	51.94646	-0.08556	133.44

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
20	51.93823	-0.11309	99.24	47	51.94635	-0.08783	133.24
21	51.93887	-0.11434	98.96	48	51.94674	-0.08662	133.50
22	51.93948	-0.11378	100.97	49	51.94723	-0.08588	132.80
23	51.94018	-0.11312	101.65	50	51.94721	-0.08275	131.48
24	51.94053	-0.11293	101.80	51	51.94793	-0.08587	131.82
25	51.94074	-0.11216	103.66	52	51.94863	-0.08639	128.43
26	51.94110	-0.11178	106.80	53	51.94907	-0.08685	125.26
27	51.94124	-0.11144	106.80				

Dwelling receptor data

Graveley Airfield Runway

The tables below present data for the thresholds of runway 01/19.

Receptor	Longitude (°)	Latitude (°)	Assessed Altitude (m amsl)
01 Threshold	-0.203995	51.938459	98
19 Threshold	-0.202966	51.942305	101

Gravely Airfield Threshold Data

Details of approach path and visual circuit receptors can be provided upon request.

Benington Airfield Runway

The tables below present data for the thresholds of runway 05/23.

Receptor	Longitude (°)	Latitude (°)	Assessed Altitude (m amsl)
05 Threshold	-0.125955	51.881703	108
23 Threshold	-0.121035	51.884157	113

Benington Airfield Threshold Data

Details of approach path and visual circuit receptors can be provided upon request.

Modelled Reflector Areas

The modelled reflector areas are presented in the tables below.

North Area (177 Acres)

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.09996	51.94449	68	-0.10553	51.95275
2	-0.10053	51.94533	69	-0.10575	51.95269
3	-0.09928	51.94568	70	-0.10588	51.95264
4	-0.09858	51.94586	71	-0.10605	51.95261
5	-0.09762	51.94602	72	-0.10618	51.95262
6	-0.09665	51.94632	73	-0.10639	51.95261
7	-0.09631	51.94647	74	-0.10663	51.95258
8	-0.09623	51.94654	75	-0.10682	51.95253
9	-0.09621	51.94660	76	-0.10692	51.95246
10	-0.09660	51.94705	77	-0.10684	51.95213
11	-0.09544	51.94722	78	-0.10647	51.95047
12	-0.09499	51.94728	79	-0.10643	51.95030
13	-0.09454	51.94736	80	-0.10641	51.95023
14	-0.09404	51.94746	81	-0.10631	51.94999
15	-0.09352	51.94758	82	-0.10627	51.94987
16	-0.09320	51.94766	83	-0.10624	51.94970
17	-0.09310	51.94771	84	-0.10616	51.94935
18	-0.09299	51.94778	85	-0.10617	51.94921
19	-0.09378	51.94871	86	-0.10616	51.94913
20	-0.09383	51.94866	87	-0.10614	51.94905
21	-0.09413	51.94849	88	-0.10609	51.94901
22	-0.09427	51.94842	89	-0.10600	51.94898

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
23	-0.09438	51.94837	90	-0.10590	51.94897
24	-0.09450	51.94833	91	-0.10584	51.94897
25	-0.09459	51.94831	92	-0.10583	51.94893
26	-0.09464	51.94831	93	-0.10599	51.94884
27	-0.09468	51.94832	94	-0.10611	51.94875
28	-0.09477	51.94835	95	-0.10617	51.94868
29	-0.09493	51.94848	96	-0.10620	51.94862
30	-0.09501	51.94857	97	-0.10641	51.94812
31	-0.09472	51.94880	98	-0.10665	51.94758
32	-0.09491	51.94895	99	-0.10679	51.94727
33	-0.09495	51.94898	100	-0.10685	51.94714
34	-0.09500	51.94899	101	-0.10705	51.94688
35	-0.09506	51.94900	102	-0.10705	51.94688
36	-0.09512	51.94903	103	-0.10709	51.94677
37	-0.09518	51.94905	104	-0.10712	51.94651
38	-0.09520	51.94913	105	-0.10712	51.94642
39	-0.09521	51.94925	106	-0.10707	51.94638
40	-0.09518	51.94941	107	-0.10716	51.94633
41	-0.09512	51.94958	108	-0.10719	51.94628
42	-0.09503	51.94973	109	-0.10722	51.94611
43	-0.09501	51.94978	110	-0.10725	51.94564
44	-0.09503	51.94981	111	-0.10728	51.94534
45	-0.09508	51.94986	112	-0.10729	51.94504
46	-0.09515	51.94991	113	-0.10728	51.94472

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
47	-0.09538	51.95004	114	-0.10727	51.94458
48	-0.09544	51.95008	115	-0.10725	51.94453
49	-0.09568	51.95024	116	-0.10725	51.94446
50	-0.09608	51.95054	117	-0.10729	51.94430
51	-0.09661	51.95099	118	-0.10732	51.94414
52	-0.09730	51.95156	119	-0.10737	51.94407
53	-0.09745	51.95174	120	-0.10747	51.94391
54	-0.09761	51.95187	121	-0.10755	51.94381
55	-0.09864	51.95274	122	-0.10773	51.94363
56	-0.09925	51.95324	123	-0.10817	51.94335
57	-0.09951	51.95343	124	-0.10742	51.94320
58	-0.09975	51.95359	125	-0.10671	51.94376
59	-0.10100	51.95431	126	-0.10716	51.94411
60	-0.10150	51.95458	127	-0.10585	51.94448
61	-0.10478	51.95386	128	-0.10517	51.94470
62	-0.10478	51.95380	129	-0.10473	51.94488
63	-0.10458	51.95344	130	-0.10442	51.94505
64	-0.10439	51.95314	131	-0.10382	51.94468
65	-0.10430	51.95305	132	-0.10331	51.94421
66	-0.10451	51.95297	133	-0.10256	51.94380
67	-0.10507	51.95285			

North Panel Area

South Area (18 Acres)

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-0.11140	51.94073	20	-0.10642	51.94285
2	-0.11131	51.94063	21	-0.10739	51.94308
3	-0.11118	51.94048	22	-0.10780	51.94314
4	-0.11107	51.94038	23	-0.10791	51.94315
5	-0.11095	51.94035	24	-0.10809	51.94320
6	-0.11080	51.94035	25	-0.10815	51.94323
7	-0.11029	51.94039	26	-0.10823	51.94325
8	-0.10920	51.94047	27	-0.10838	51.94320
9	-0.10847	51.94052	28	-0.10863	51.94308
10	-0.10788	51.94058	29	-0.10900	51.94283
11	-0.10695	51.94069	30	-0.10933	51.94260
12	-0.10645	51.94077	31	-0.10954	51.94239
13	-0.10629	51.94082	32	-0.10977	51.94211
14	-0.10639	51.94111	33	-0.11008	51.94188
15	-0.10649	51.94152	34	-0.11047	51.94161
16	-0.10653	51.94182	35	-0.11072	51.94143
17	-0.10653	51.94209	36	-0.11095	51.94123
18	-0.10651	51.94235	37	-0.11152	51.94082
19	-0.10643	51.94267			

South Panel Area

APPENDIX H – DETAILLED MODELLING RESULTS

Overview

The Pager Power charts for receptors are shown on the following pages. Further modelling charts can be provided upon request. 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 image. 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).

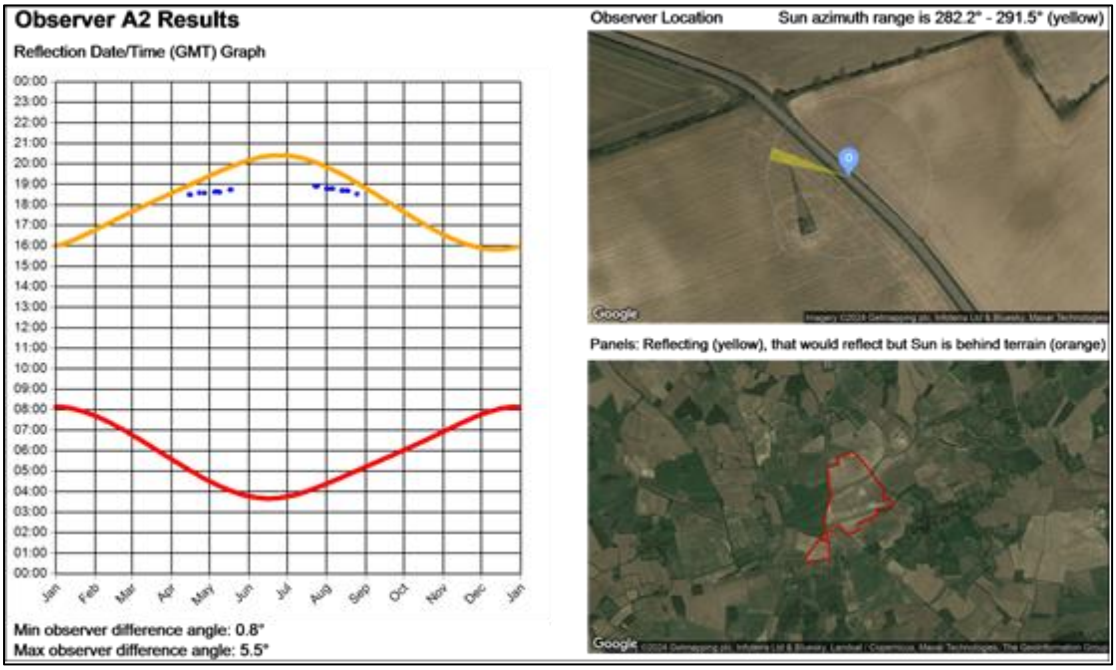
The Forge charts for the receptors are shown on the following pages. Each chart shows:

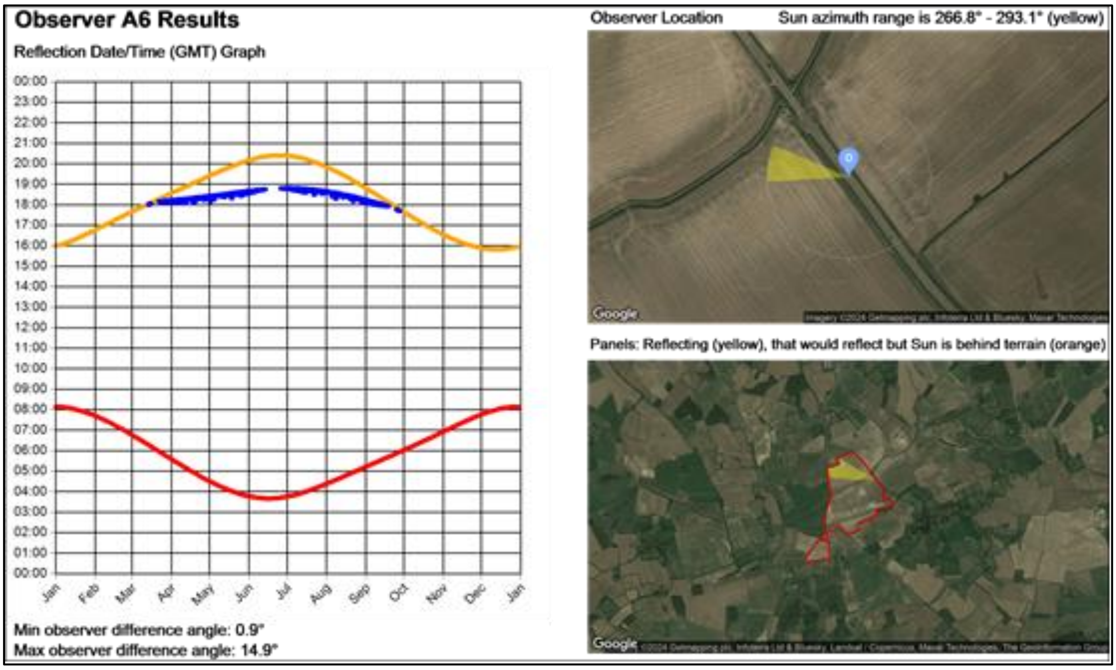
- The annual predicted solar reflections.
- The daily duration of the solar reflections.
- The location of the proposed development where glare will originate.
- The calculated intensity of the predicted solar reflections.

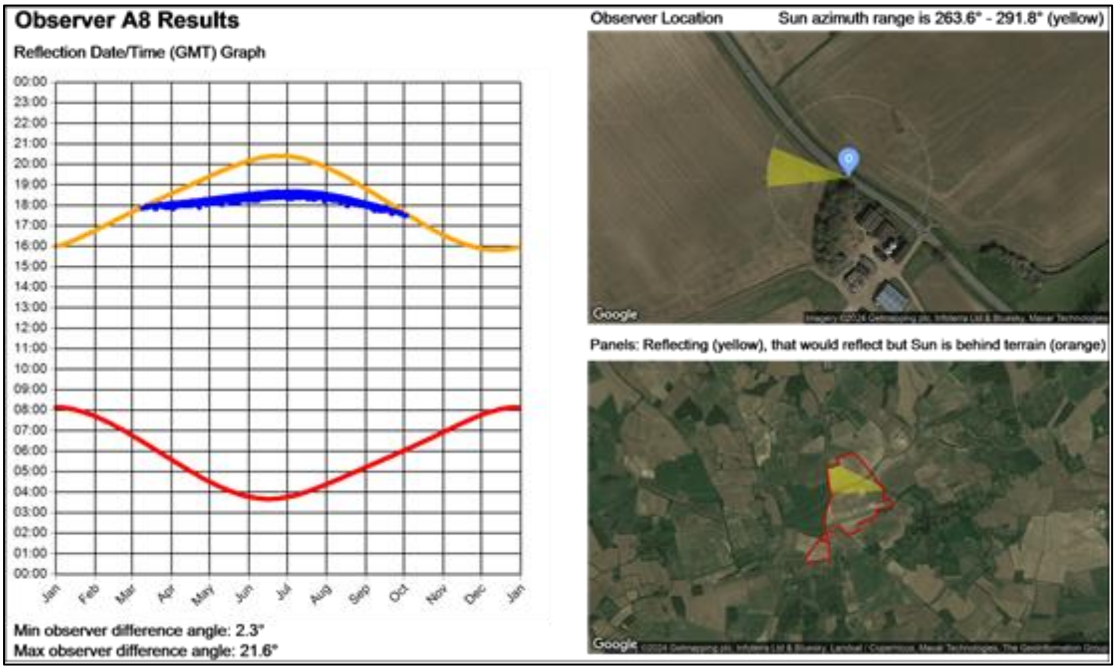
Full modelling results can be provided upon request.

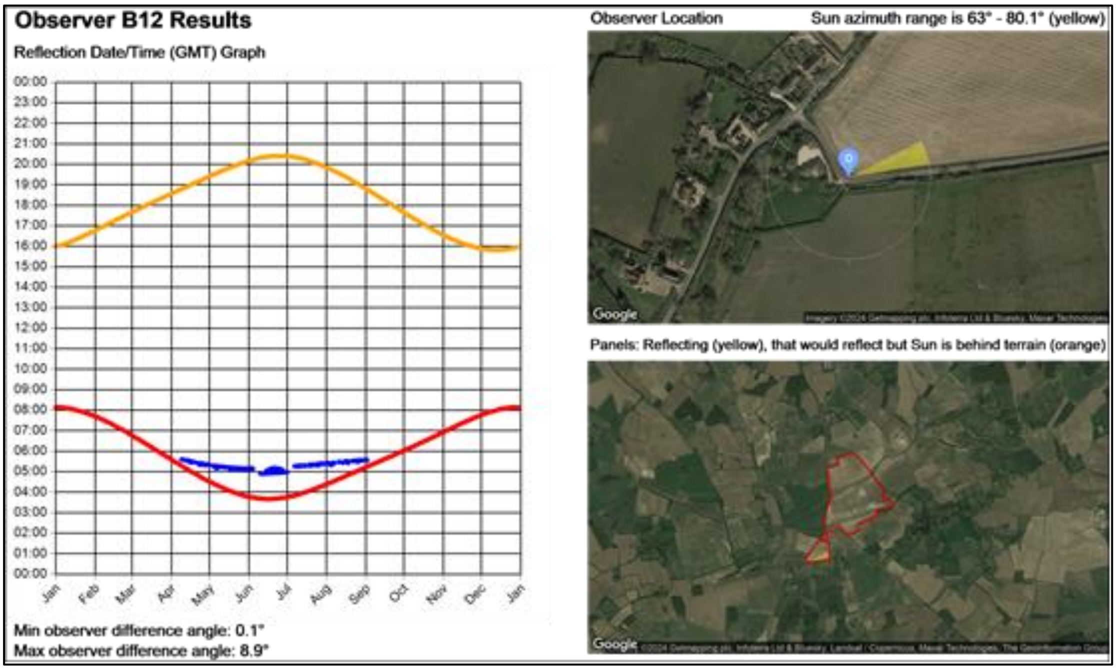
Road Receptors

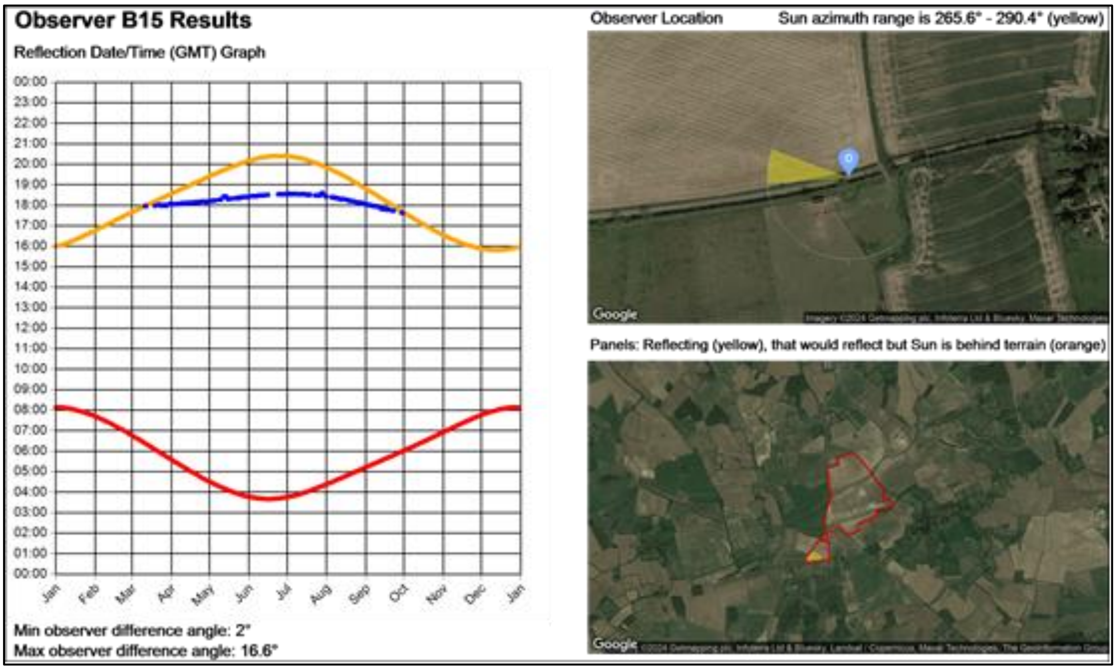
A representative selection of results have been included for road receptors where a moderate impact has been predicted.

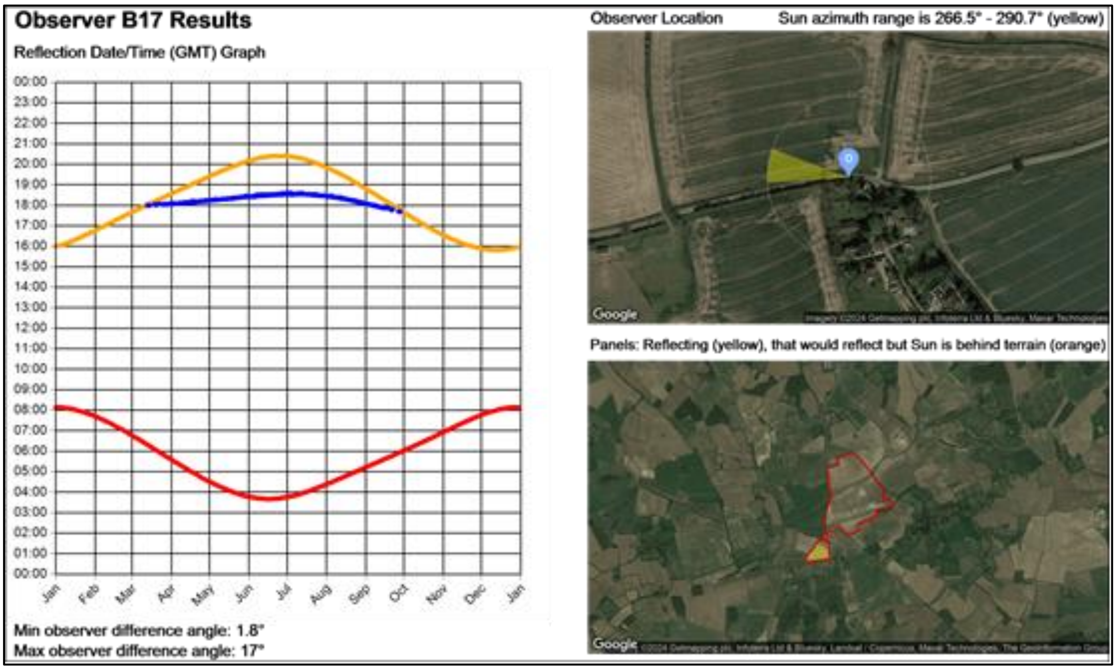





Observer A8 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 263.6° - 291.8° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 2.3°
Max observer difference angle: 21.6°
Google

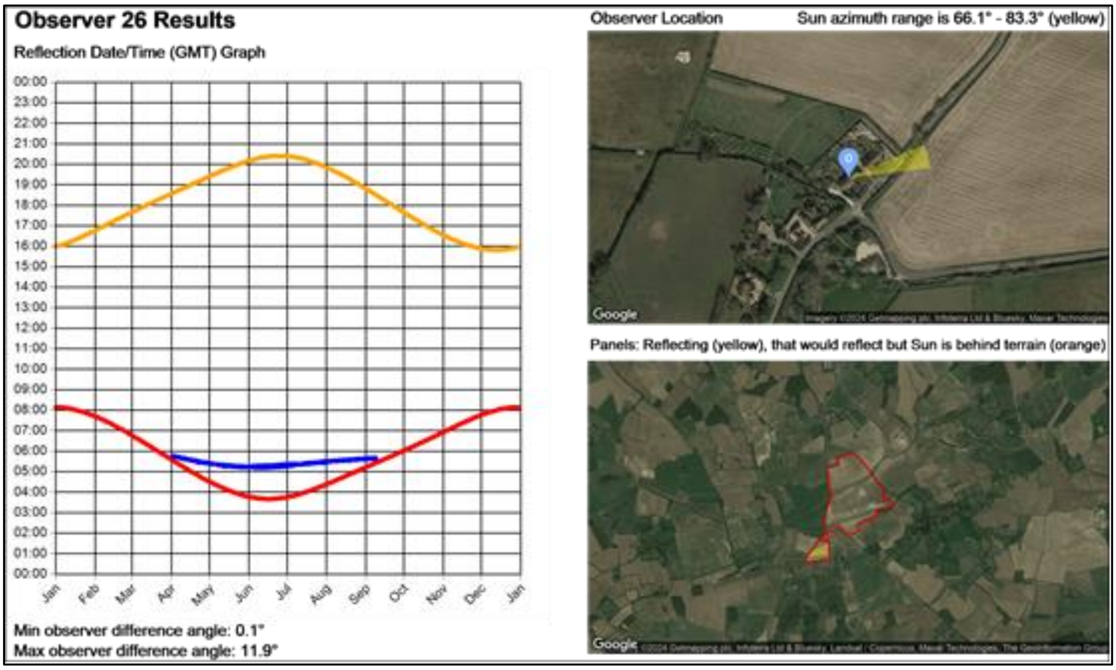

Observer B12 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 63° - 80.1° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 0.1°
Max observer difference angle: 8.9°
Google

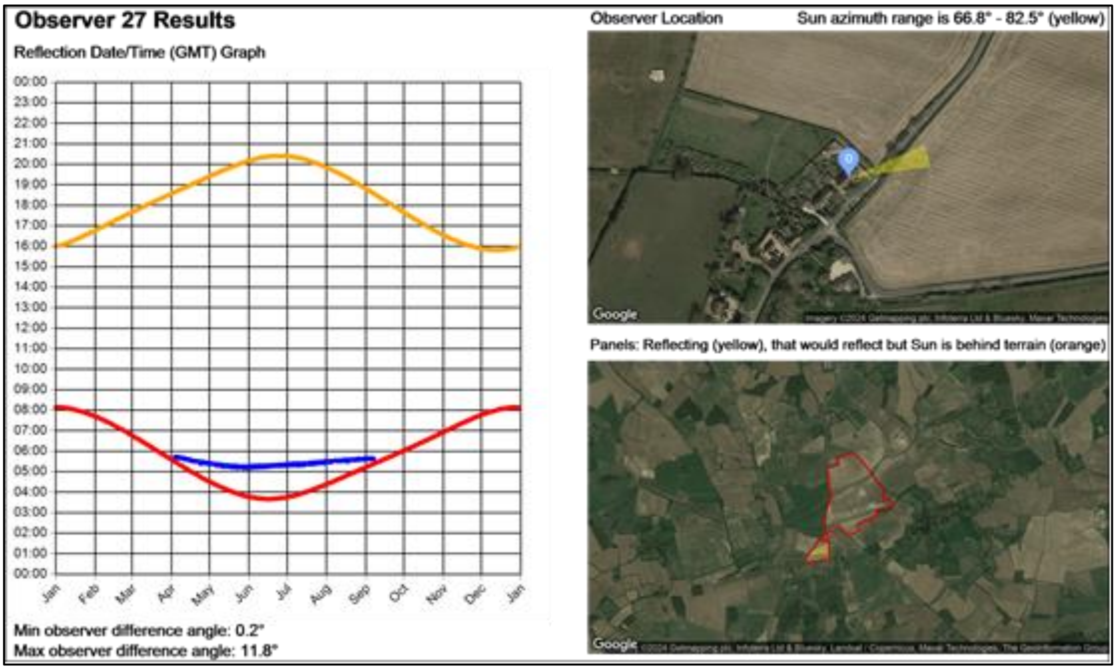

Observer B15 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 265.6° - 290.4° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Min observer difference angle: 2°
Max observer difference angle: 16.6°


Observer B17 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 266.5° - 290.7° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Min observer difference angle: 1.8°
Max observer difference angle: 17°

Dwelling Receptors

Results have been included for dwelling receptors where a moderate impact is predicted.





Approach Paths

Forge Results for Gravely Airfield Runway Approaches

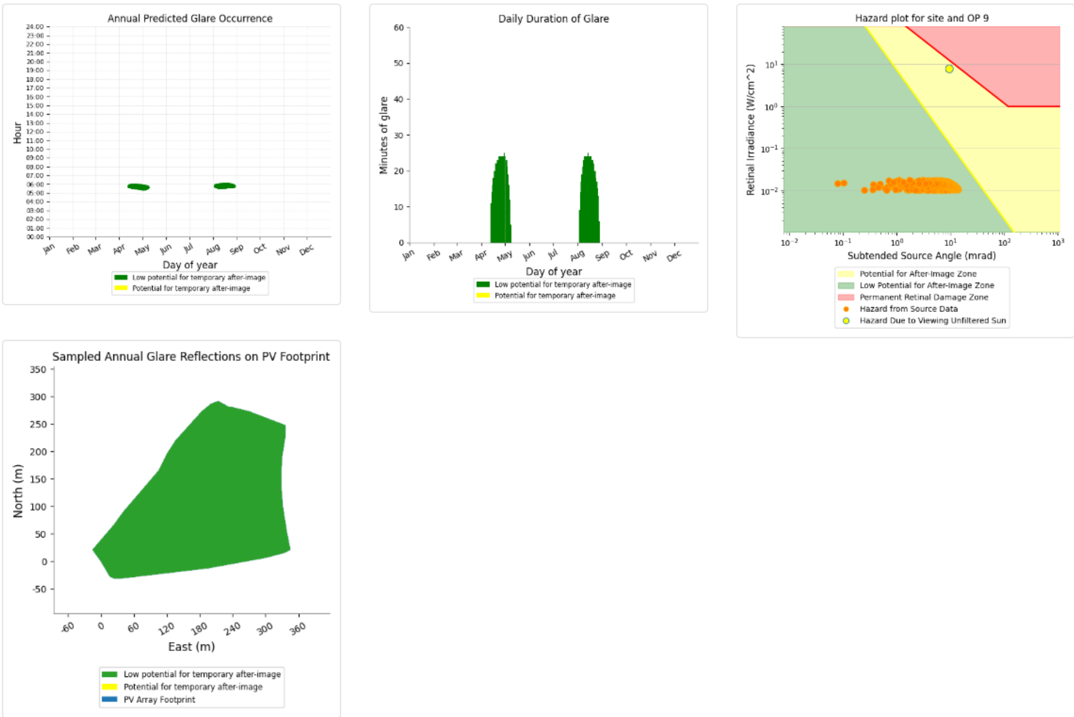
A selection of results for Graveley airfield approach paths are shown to be representative of all results towards the approaches.

Runway 01 Approach

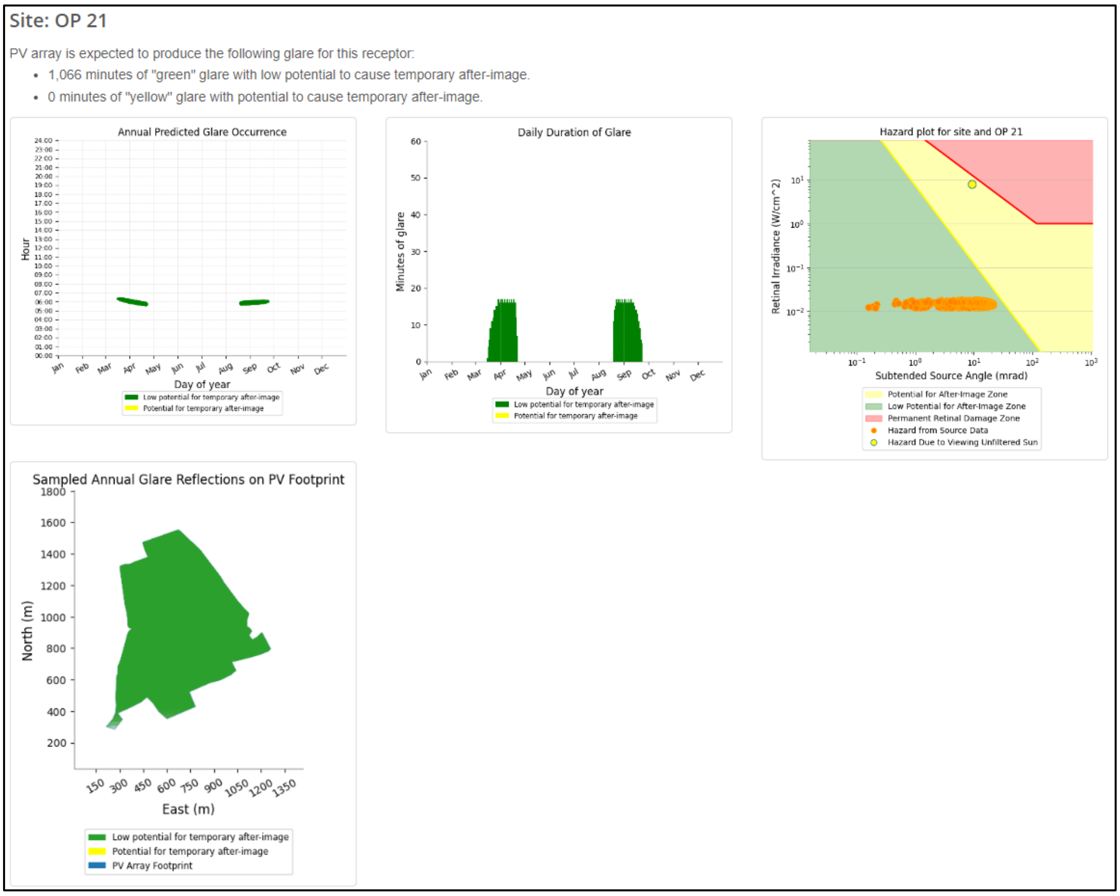
Site: OP 9

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

- 1,046 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



Runway 19 Approach



Forge Results for Beningotn Airfield Runway Approaches

No reflections geometrically possible.

Visual Circuits and Joins

Forge Results for Graveley Airfield Runway Visual Circuits and Joins

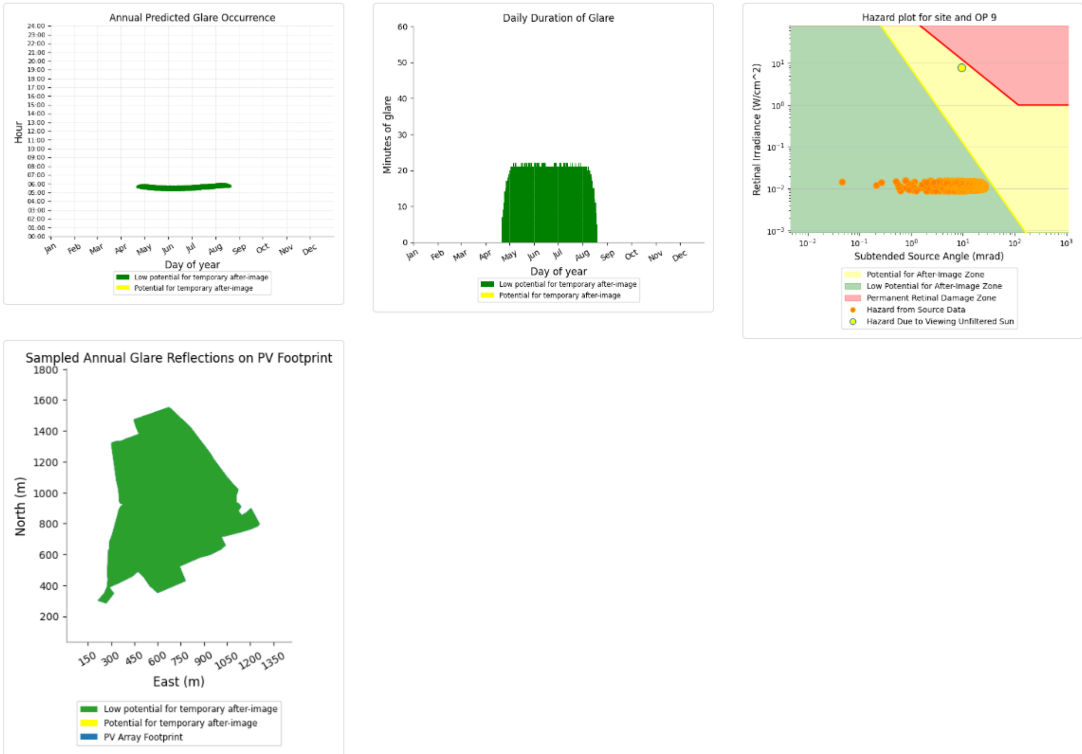
A selection of results for Brook Farm airfield visual circuits and joins are shown to be representative of all results towards the visual circuits and joins.

Runway 01

Site: OP 9

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

- 2,425 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.

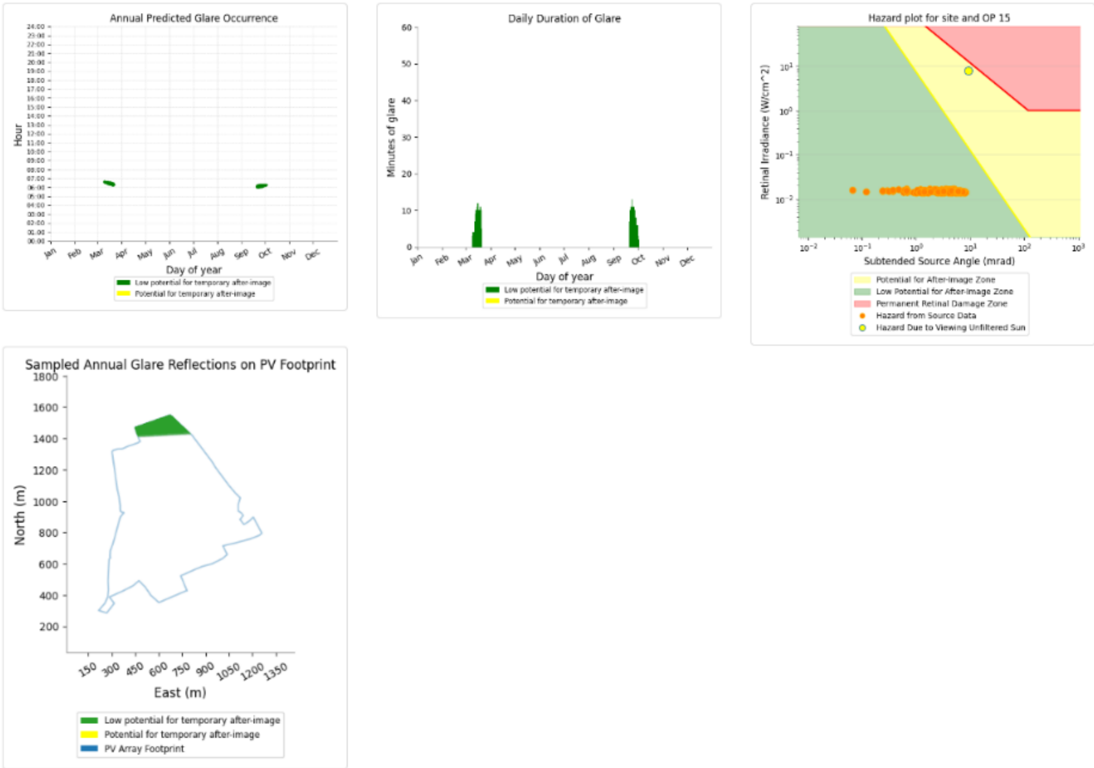


Runway 19

Site: OP 15

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

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



Forge Results for Benington Airfield Runway Visual Circuits

No reflections geometrically possible.

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