Stonestreet Green Solar

Environmental Statement
Volume 4: Appendices
Chapter 16: Other Topics
Appendix 16.2: Solar Photovoltaic Glint and Glare Study

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APFP Regulation 5(2)(a)
Planning Act 2008
The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

EXECUTIVE SUMMARY

Report Purpose

This Glint and Glare assessment has been prepared on behalf of EPL 001 Limited ('the Applicant') to assess the potential effects of glint and glare in relation to the Development Consent Order (DCO) application for Stonestreet Green Solar ('the Project'). This assessment pertains to the potential impact upon road safety, residential amenity, railway infrastructure and operations, and aviation activity associated with surrounding airfields.

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 national policy for determining the impact of glint and glare on road safety, residential amenity and railway infrastructure and operations has not been produced to date. Therefore, in the absence of this, Pager Power reviewed more general existing planning guidelines and the available studies in the process of defining its own glint and glare assessment guidance and methodology. This methodology defines the process for determining the impact upon road safety, residential amenity, railway infrastructure and operations, 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. The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that the reflections produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel[1]. Reflections from solar panels are less intense than those from glass or steel because solar panels are designed in order to absorb light, rather than reflect it, as panels are more efficient when they reflect less light.

Assessment Conclusions – Aviation

Hamilton Farm Airstrip

Solar reflections are predicted towards the approach path and visual circuits for runways 04 and 22. Solar reflections towards the approach path for runway 22 will be outside of a pilot's primary field-of-view (50 degrees either side of the direction of travel). This is deemed acceptable in line

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

with the associated guidance and industry standards; a low impact is predicted, and mitigation is not required.

Solar reflections towards the visual circuits for runways 04 and 22 are predicted to have 'potential for temporary after-image'. This is considered to be operationally accommodatable, given the size and expected usage of the airstrip; as such a low impact is predicted and no mitigation is recommended.

Solar reflections towards the approach path for runway 04 are predicted to have 'potential for temporary after-image', also known as 'yellow' glare. Considering the glare scenario, primarily the effects occurring outside the typical scheduled flight times of the airfield and the ability of the pilots to accommodate the glare, a low impact is predicted.

On the basis that the 'Hamilton Farm Airstrip Glint and Glare' report (see Appendix I) has been made available to the airfield, no further mitigation is recommended.

Meadow Farm Airstrip

Solar reflections are predicted towards the approach path and visual circuits for runway 18. Solar reflections towards the approach path will be outside of a pilot's primary field-of-view. This is deemed acceptable in line with the associated guidance and industry standards; a low impact is predicted, and mitigation is not required.

Solar reflections towards the visual circuits are predicted to be of an intensity no greater than 'potential for temporary after-image'. This is considered to be operationally accommodatable; as such a low impact is predicted and no mitigation is recommended.

No solar reflections are geometrically possible towards the approach path and visual circuits for runway 36. No impact is predicted, and no mitigation is required.

Overall, a low impact is predicted, and no mitigation is recommended.

Harringe Airfield

Solar reflections are predicted towards the approach path and visual circuits for runways 02 and 20. Solar reflections towards the approach paths for runways 02 and 20 will be outside of a pilot's primary field-of-view. This is deemed acceptable in line with the associated guidance and industry standards; a low impact is predicted, and mitigation is not required.

Solar reflections towards the visual circuits for runways 02 and 20 are predicted to be of an intensity no greater than 'potential for temporary after-image'. This is considered to be operationally accommodatable; as such a low impact is predicted and no mitigation is recommended.

Overall, a low impact is predicted, and no mitigation is recommended.

Bonnington Airstrip

No solar reflections are predicted towards the approach paths and visual circuits for runways 06 and 24.

No impact is predicted, and mitigation is not required.

Pent Farm Airstrip

Solar reflections are predicted towards the approach path and visual circuits for runway 05 and the visual circuits for runway 23. Solar reflections towards the splayed approach for runway 05 and visual circuit for runway 23 will be outside of a pilot's primary field-of-view. This is deemed acceptable in line with the associated guidance and industry standards; a low impact is predicted, and mitigation is not required.

Solar reflections towards the visual circuit for runway 05 are predicted to be of an intensity no greater than 'potential for temporary after-image'. This is considered to be operationally accommodatable; as such a low impact is predicted and no mitigation is recommended.

No solar reflections are geometrically possible towards the splayed approach path for runway 23. No impact is predicted, and no mitigation is required.

Overall, a low impact is predicted, and no mitigation is recommended.

Assessment Conclusions – Roads

Solar reflections are geometrically possible towards approximately 2.2km of Goldwell Lane, 1.8km of Roman Road, 900m of Forge Hill, 2.3km of Frith Road, and 700m of Chequer Tree Lane.

Existing screening, proposed landscaping, and intervening terrain is predicted to significantly obstruct views of reflecting panels along most of Goldwell Lane and all of Forge Hill, Roman Road, Frith Road and Chequer Tree Lane. No impact is predicted, and no further mitigation is required.

Partial views of the reflecting panels cannot be ruled out along a small section of Goldwell Lane, which is a local road with low traffic densities. A low impact is predicted and no further mitigation is recommended.

Assessment Conclusions – Dwellings

Solar reflections are geometrically possible towards 246 of the 267 assessed dwellings within the study area.

For 198 dwellings, screening in the form of existing and proposed landscaping and/or intervening terrain is predicted to significantly obstruct views of reflecting panels. No impact is predicted, and no further mitigation is required.

For 47 dwellings, effects are predicted to occur for less than three months per year and less than 60 minutes per day or the glare scenario sufficiently reduces the level of impact. A low impact is predicted, and no further mitigation is recommended.

For the remaining dwelling, a moderate impact is predicted. Provided that suitable mitigation is implemented, as outlined in Section 7.5.1, during detailed design, a negligible to low impact will remain.

Assessment Conclusions – Railway

Only a small section of the nearby HS1 Line between Ashford International and the Channel Tunnel touches the 500m study area, considering that solar reflections would not be geometrically possible north of the Project. Therefore, railway impacts are not predicted.

Network Rail have been consulted on the Project and have not raised any specific concerns relating to glint and glare.

High-Level Conclusions – Public Rights of Way

No significant impacts are predicted upon public rights of way. No mitigation is recommended.

High-Level Conclusions – Little Engeham Farm Airstrip

Any solar reflections towards Little Engeham Farm Airstrip are predicted to be acceptable in accordance with the associated guidance. Any possible solar reflections towards runway 03 would have an intensity no greater than 'low potential for temporary after-image', which is acceptable in line with the associated guidance and industry standards. Solar reflections would be outside a pilot's primary field-of-view (50 degrees either side of the approach bearing) for pilots on approach to runway 21.

Therefore, a low impact is predicted upon aviation activity at Little Engeham Farm Airstrip and detailed modelling is not recommended.

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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

This Glint and Glare assessment has been prepared on behalf of EPL001 Limited ('the Applicant') to assess the potential effects of glint and glare in relation to the Development Consent Order (DCO) application for Stonestreet Green Solar ('the Project'). This assessment pertains to the potential impact upon road safety, residential amenity, railway infrastructure and operations, and aviation activity associated with surrounding airfields.

This report contains the following:

- Project details;
- Explanation of glint and glare;
- Overview of relevant guidance and relevant studies;
- Assessment methodology;
- Identification of receptors;
- Glint and glare assessment for identified receptors;
- High-level assessment of public rights of way (PRoW);
- High-level assessment of aviation considerations associated with Little Engeham Airstrip;
- 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[2] of glint and glare is as follows:

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

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

[2] These definitions are aligned with those of the National Policy Statement for Renewable Energy Infrastructure (EN-3) and the Federal Aviation Administration (FAA) in the United States of America.

2 SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Project Site Layout

The Illustrative Site Layout in the Illustrative Project Drawings – Not for Approval (Doc Ref. 2.6) shows the illustrative site layout for the Project. Figure 1 below shows an illustrative site overview, with the blue areas showing the illustrative panel layout.

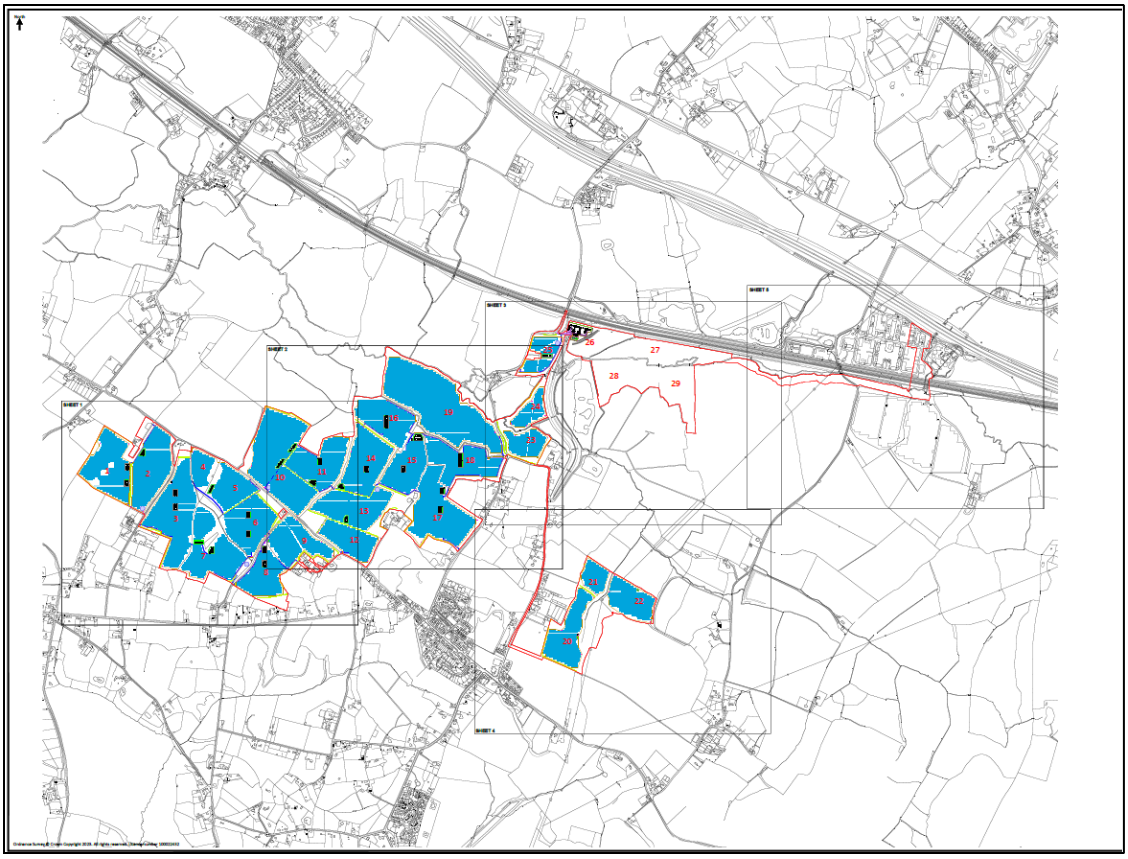

Figure 1 *Illustrative Site Overview*

2.2 Solar Panel Technical Information

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

Panel Information	
Mounting structure	Fixed panels
Azimuth angle[3]	180° (south-facing)
Elevation angle[4]	22°
Assessed centre height[5]	2m agl[6]

Table 1 *Solar panel technical information*

The elevation angle of the solar panels will be between 20 and 25 degrees. The elevation angle of 22 degrees has therefore been assessed as this is close to the middle of the range and represents a small variation from the minimum and maximum angles. Any changes in panel angle within this range is predicted to slightly change the time in the day in which reflections occur and is not predicted to change duration of effects or the intensity of any reflections.

[3] Relative to true north
[4] Inclination above the horizontal
[5] This is the midpoint of 0.8m and 3.2m
[6] Above ground level

3 RAILWAYS AND GLINT AND GLARE

3.1 Overview

A railway stakeholder (such as Network Rail) may request further information regarding the potential effects of glint and glare from reflective surfaces when a development is located adjacent to a railway line (typically 50-100m from its infrastructure). The request may depend on the scale, percentage of reflective surfaces and the complexity of the nearby railway, for example. The following section presents details regarding the most common concerns relating to glint and glare.

3.2 Glint and Glare Definition

As well as the glint and glare definition presented in Section 1.3, glare can also be categorised as causing visual discomfort whereby an observer would instinctively look away, or cause disability whereby objects become difficult to see. The guidance produced by the Commission Internationale de L'Eclairage (CIE)[7] describes disability glare as:

'Disability glare is glare that impairs vision. It is caused by scattering of light inside the eye…The veiling luminance of scattered light will have a significant effect on visibility when intense light sources are present in the peripheral visual field and contrast of objects is seen to be low.'

'Disability glare is most often of importance at night when contrast sensitivity is low and there may well be one or more bright light sources near to the line of sight, such as car headlights, streetlights or floodlights. But even in daylight conditions disability glare may be of practical significance: think of traffic lights when the sun is close to them, or the difficulty viewing paintings hanging next to windows.'

These types of glare are of particular importance in the context of railway operations as they may cause a distraction to a train driver (discomfort) or may cause railway signals to be difficult to see (disability).

3.3 Common Concerns and Signal Overview

Typical reasons stated by a railway stakeholder for requesting a glint and glare assessment often relate to the following:

1. The development producing solar reflections towards train drivers.
2. The development producing solar reflections, which causes a train driver to take action.
3. The development producing solar reflections that affect railway signals.

With respect to point 1, a reflective panel could produce solar reflections towards a train driver. If this reflection occurs where a railway signal, crossing etc., is present, or where the driver's workload is particularly high, the solar reflection may affect operations. This is deemed to be the most concern with respect to solar reflections.

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[7] CIE 146:2002 & CIE 147:2002 Collection on glare (2002).

Following from point 1, point 2 identifies whether a modelled solar reflection could be significant by determining its intensity. Only where a solar reflection occurs under certain conditions and is of a particular intensity may it cause a reaction from a train driver and thus potentially affect safe operations. Therefore intensity calculations are undertaken where a solar reflection is identified and where its presence could potentially affect the safety of operations. Points 1 and 2 are completed in a 2-step approach.

With respect to all points, railway lines use light signals to manage trains on approach towards particular sections of track. If a signal is passed when not permitted, a SPAD (Signal Passed At Danger) is issued. The concerns will relate specifically to the possibility of the reflections appearing to illuminate signals that are not switched on (known as a phantom aspect illusion) or a distraction caused by the glare itself, both of which could lead to a SPAD. The definition is presented below:

'Light emitted from a Signal lens assembly that has originated from an external source (usually the sun) and has been internally reflected within the Signal Head in such a way that the lens assembly gives the appearance of being lit.[8] *'*

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[8] Source: Glossary of Signalling Terms, Railway Group Guidance Note GK/GN0802. Issue One. Date April 2004.

4 GLINT AND GLARE ASSESSMENT METHODOLOGY

4.1 Guidance and Studies

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

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

4.2 Background

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

4.3 Methodology

4.3.1 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;
- 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.

4.3.2 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.

4.4 Assessment Methodology and Limitations

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

5 IDENTIFICATION OF RECEPTORS

5.1 Aviation Receptors

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

The following subsections present the relevant data and receptors associated with the airfields modelled in this report. The locations of the airfields relative to the Project are shown in Figure 3 on page 24, and summarised below:

- Hamilton Farm Airstrip: approximately 2.0km east of the Project;
- Meadow Farm Airstrip: approximately 4.9km south-east of the Project;
- Harringe Airfield: approximately 2.2km west of the Project;
- Bonnington Airstrip: approximately 3.6km south of the Project;
- Pent Farm Airstrip: approximately 6.3km west of the Project.

Little Engeham Farm Airstrip is not mentioned in this section as it is assessed at a high-level (without modelling) in Section 9.

5.1.1 Hamilton Farm Airstrip Information

Hamilton Farm Airstrip is an unlicensed aerodrome and is not understood to have an Air Traffic Control (ATC) Tower. It has one operational runway, the details[9] of which are presented below:

- 04/22 measuring 610m by 25m (grass).

5.1.2 Meadow Farm Airstrip Information

Meadow Farm Airstrip is an unlicensed aerodrome and is not understood to have an ATC Tower. It has one operational runway, the details[10] of which are presented below:

- 18/36 measuring 320m by 10m (grass).

5.1.3 Harringe Airfield Information

Harringe Airfield is an unlicensed aerodrome and is not understood to have an ATC Tower. It has one operational runway, the details[10] of which are presented below:

- 02/20 measuring 420m by 10m (grass).

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[9] As determined by available aerial imagery

5.1.4 Bonnington Airstrip Information

Bonnington Airstrip is an unlicensed aerodrome and is not understood to have an ATC Tower. It has one operational runway, the details[10] of which are presented below:

- 06/24 measuring 430m by 12m (grass).

5.1.5 Pent Farm Airstrip Information

Pent Farm Airstrip is an unlicensed aerodrome and is not understood to have an ATC Tower. It has one operational runway, the details[10] of which are presented below:

- 05/23 measuring 1,010m by 15m (grass).

5.1.6 Runway Approach Paths and Visual Circuits

All of the assessed airfields are general aviation (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 2 on the following page illustrates the splayed approach and final sections of the visual circuits.

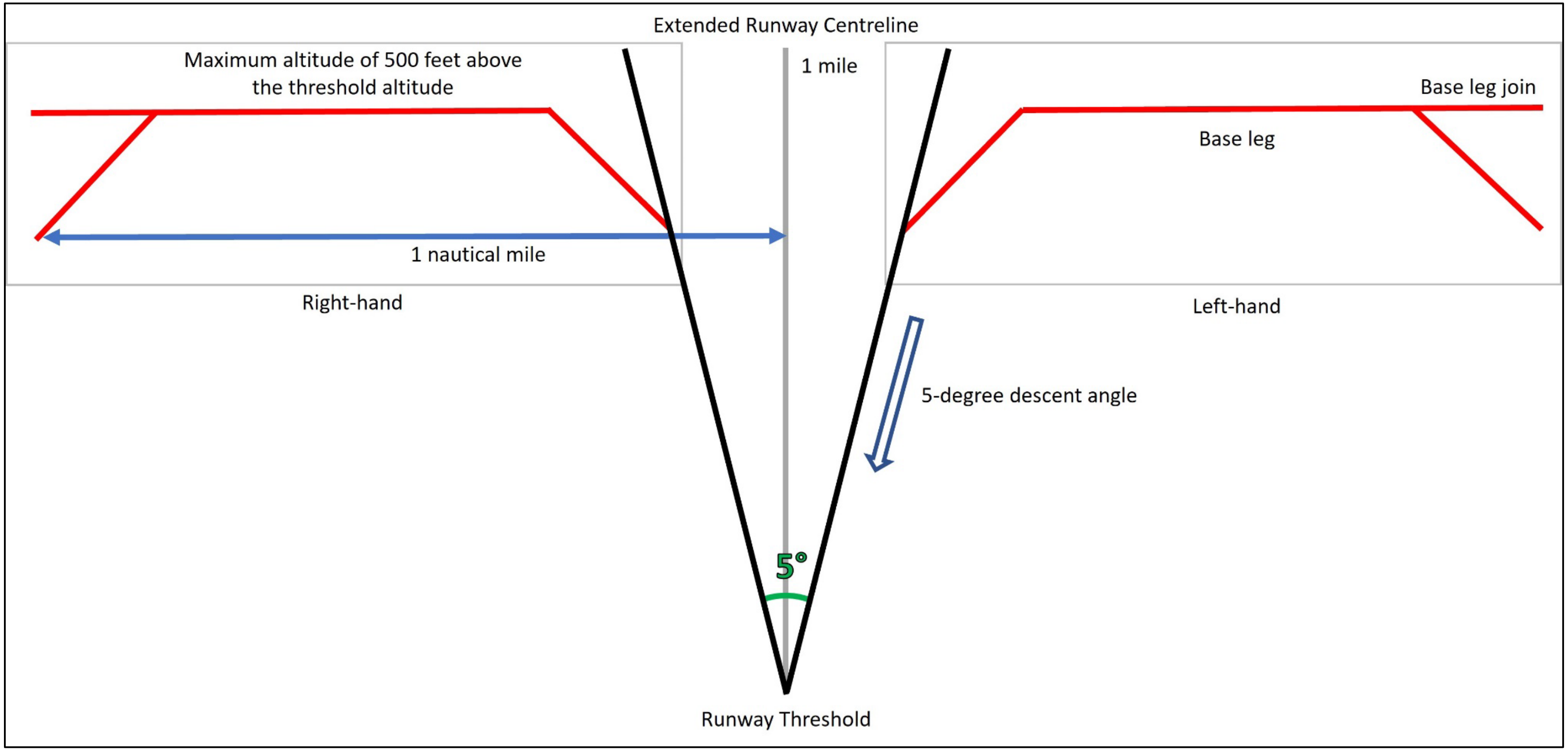

Figure 2 *Splayed approach and final sections of visual circuits*

Figure 3 on the following page shows the assessed aircraft receptor points of the splayed approach and final sections of the visual circuits at the assessed airfields. The receptor points pertaining to runway 05 at Pent Farm Airstrip are labelled.

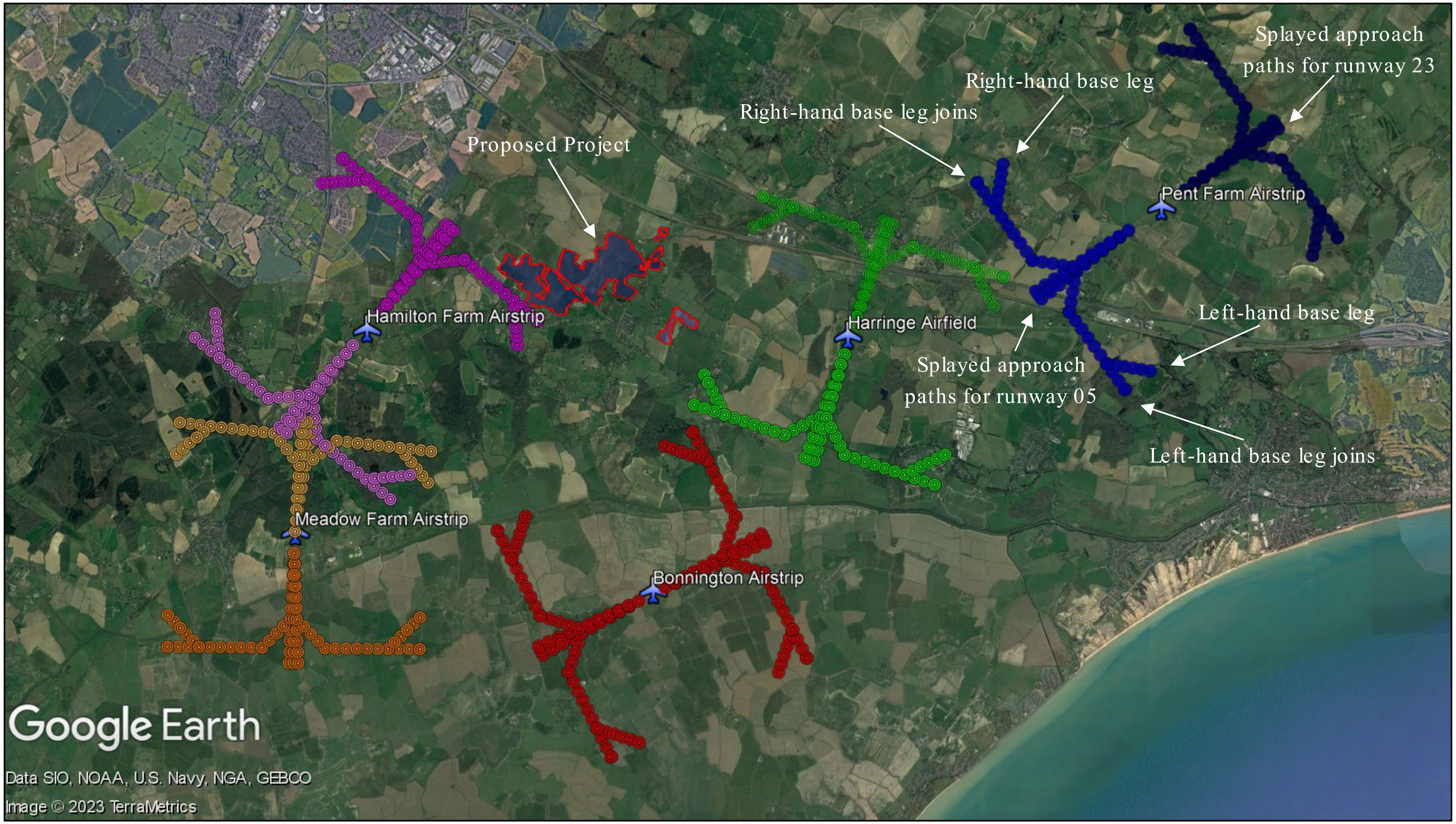

Figure 3 *General aviation splayed approach and visual circuit receptors*

5.2 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.

An study area is defined as a set distance around the solar panels and used to identify receptors for the assessment – the study area is not the same as the Project Site boundary. A 1km study area is considered appropriate for glint and glare effects on ground-based receptors. Receptors within this distance are identified based on mapping and aerial photography of the region. The study area is bounded by the orange outline in Figure 4 below. Receptors to the north of the Project 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.

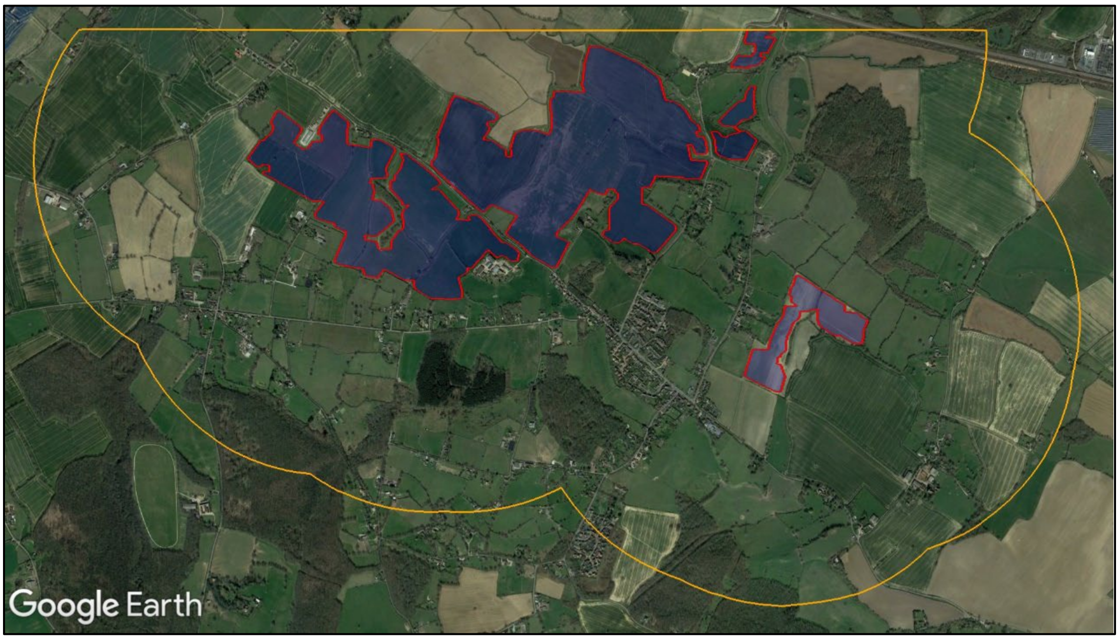

Figure 4 1km study *area*

[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

5.3 Road Receptors

5.3.1 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 most local roads, where traffic densities are likely to be relatively low. Solar reflections from a solar development that are experienced by a road user along a local road with low traffic densities are typically 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 or local roads that are important to the local road network that:

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

5.3.2 Identified Road Receptors

Table 2 below shows a summary of the roads identified within the 1km study area. Receptors 1 to 80 are placed circa 100m apart.

A height of 1.5 metres above ground level has been taken as the typical eye level of a road user[12]. Figures 5 to 7, on the following pages show the assessed road receptors.

Road	Receptors
Goldwell Lane[13]	1 – 21
New Hill Road / Forge Hill	22 – 29
Roman Road	30 – 49
Frith Road	50 – 73

[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.

[13] Taken forward for geometric modelling despite being deemed a local road due to its proximity to the Project.

Road	Receptors
Chequer Tree Lane	74 – 80

Table 2 *Summary of identified road receptors*

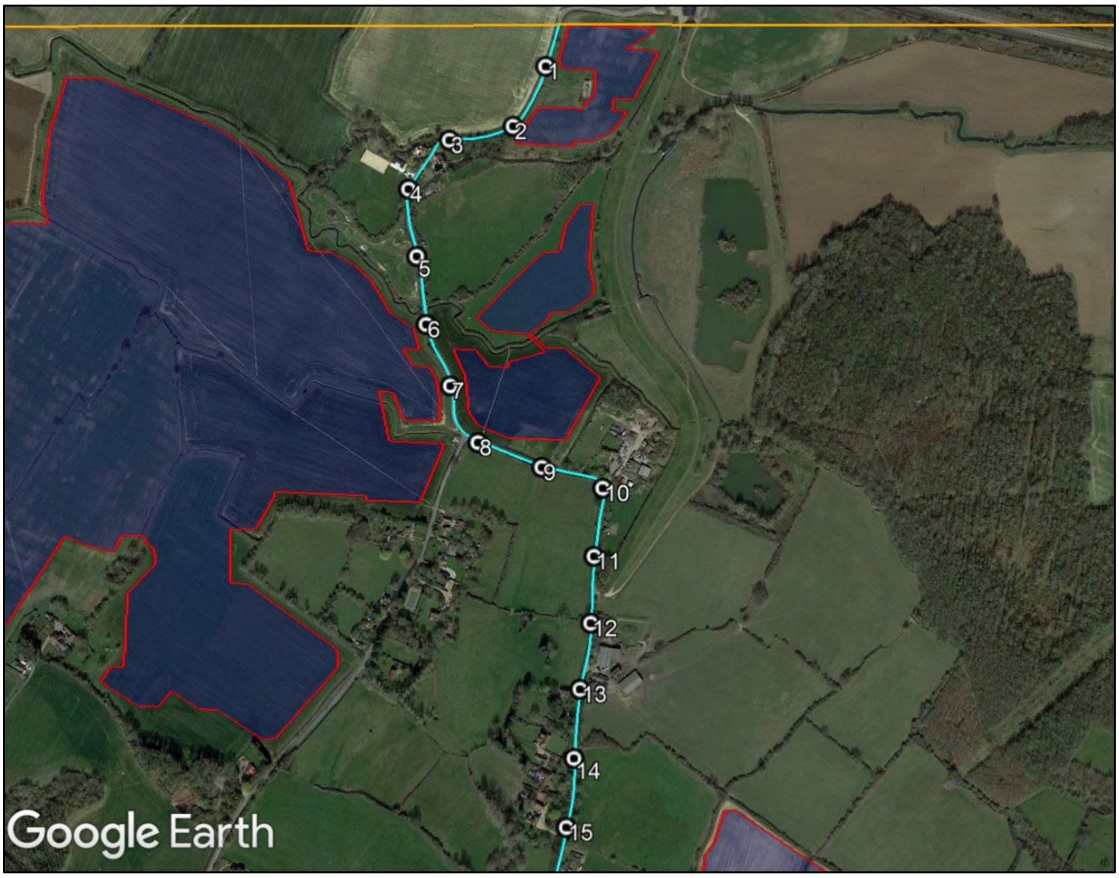

Figure 5 *Road receptors 1 to 15*

Figure 6 *Road receptors 16 to 55*

Figure 7 *Road receptors 56 to 80*

5.4 Dwelling Receptors

5.4.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

- Are within one-kilometre of the solar panels; 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 Project 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.

5.4.2 Identified Dwelling Receptors

The assessed dwelling receptors are shown in Figures 8 to 26, on the following pages. In total, 267 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[14].

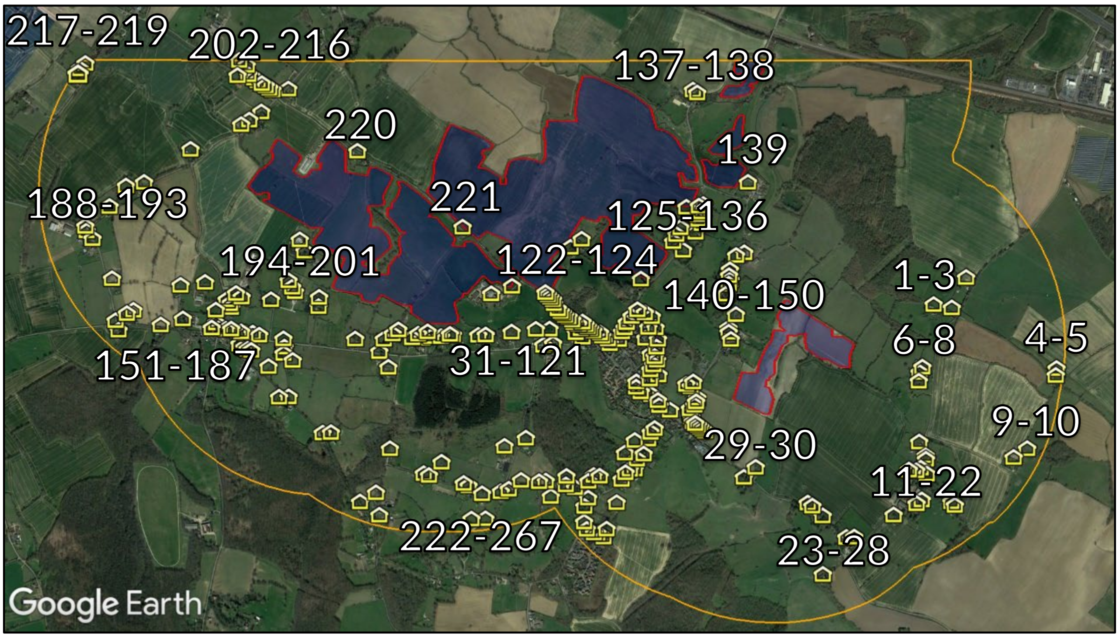

Figure 8 *Overview of all dwellings*

[14] 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.

Figure 9 *Dwellings 1 to 8*

Figure 10 *Dwellings 9 to 22*

Figure 11 *Dwellings 23 to 30*

Figure 12 *Dwellings 31 to 57*

Figure 13 *Dwellings 58 to 98 and 101 to 104*

Figure 14 *Dwellings 99 to 100 and 105 to 121*

Figure 15 *Dwellings 122 to 136 and 139 to 146*

Figure 16 *Dwellings 137 and 138*

Figure 17 *Dwellings 147 to 150*

Figure 18 *Dwellings 151 to 163*

Figure 19 *Dwellings 164 to 187*

Figure 20 *Dwellings 188 to 193 and 202*

Figure 21 *Dwellings 194 to 201*

Figure 22 *Dwellings 203 to 216*

Figure 23 *Dwellings 217 to 219*

Figure 24 *Dwellings 220 and 221*

Figure 25 *Dwellings 222 to 241*

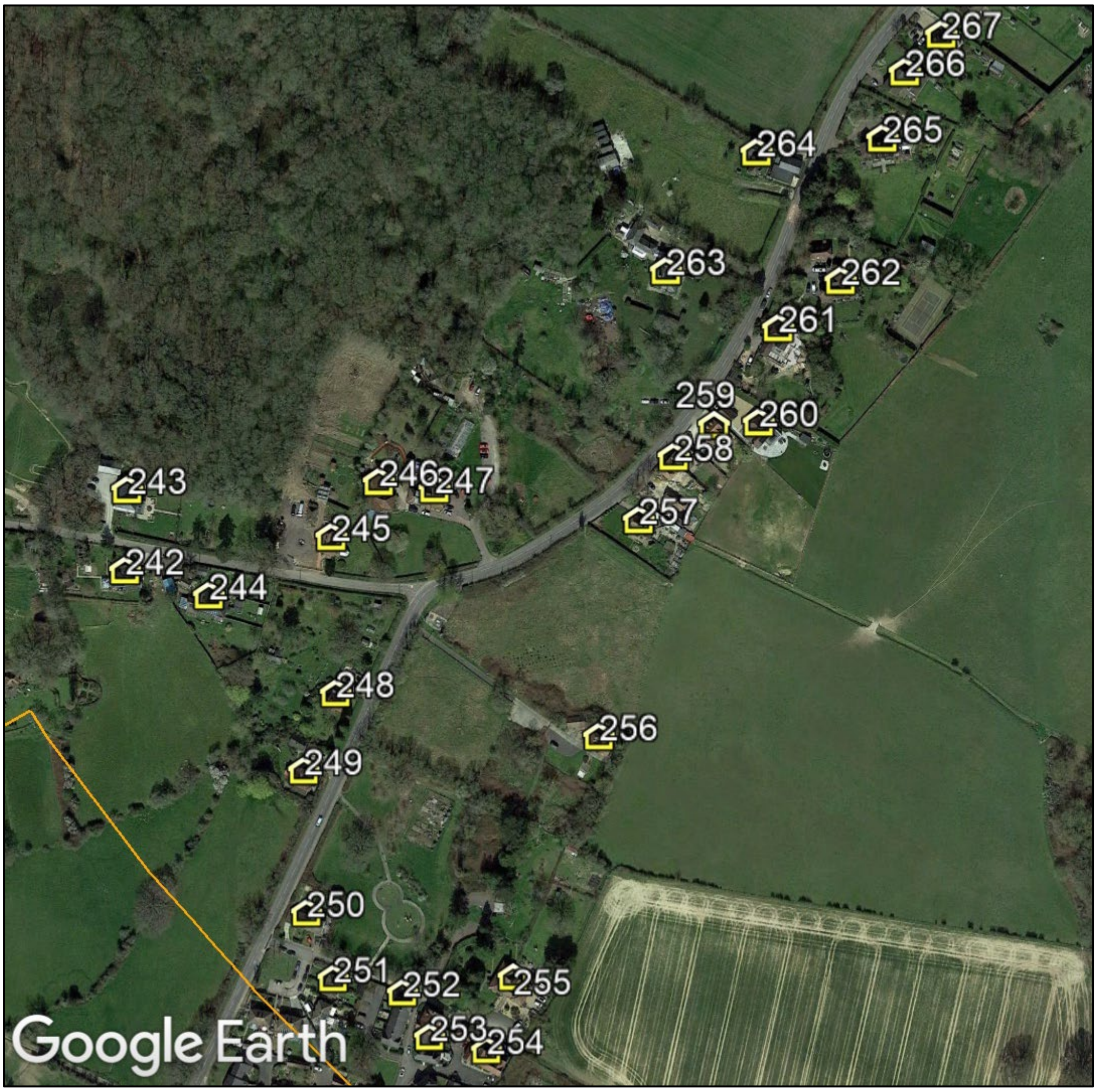

Figure 26 *Dwellings 242 to 267*

5.5 Railway Receptors

5.5.1 Railway Receptors Overview

The analysis has considered railway receptors, in the context of train drivers, that:

- Are within 500 metres of the solar panels; and
- Have a potential view of the panels.

Only a small section of the nearby HS1 Line between Ashford International and the Channel Tunnel touches the 500m study area. Therefore, railway impacts are not predicted.

The 500m study area is shown in Figure 27 below. The railway line can be seen in the top right corner of the figure.

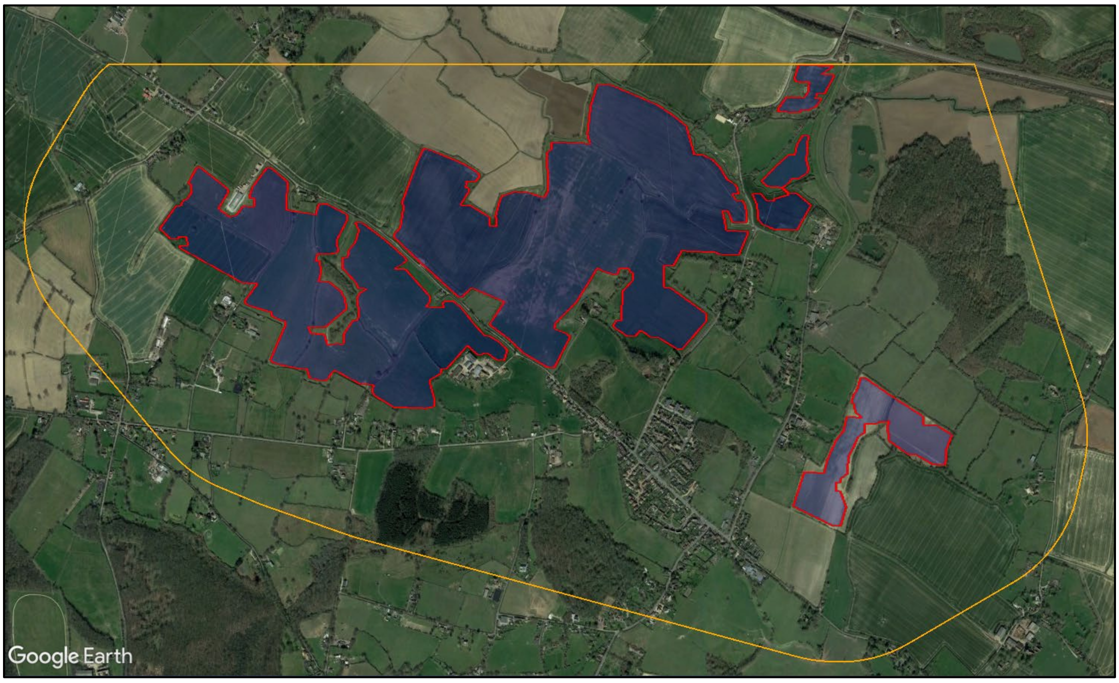

Figure 27 *500m study area*

Network Rail have been consulted on the Project and have not raised any specific concerns relating to glint and glare. Railway concerns have therefore not been assessed further in this report.

6 ASSESSED REFLECTOR AREAS

6.1 Reflector Areas

The bounding coordinates for the Project have been extrapolated from the **Works Plans (Doc Ref. 2.3)**. Mapping each reflector area included combining adjoined Fields (where appropriate) such that the assessment is conservative because it assesses panels were there will not be in practice. The data can be found in Appendix G. Figure 28 below shows the assessed reflector areas that have been used for modelling purposes.

The Pager Power model has used a resolution of 25m for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 25m 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 Project.

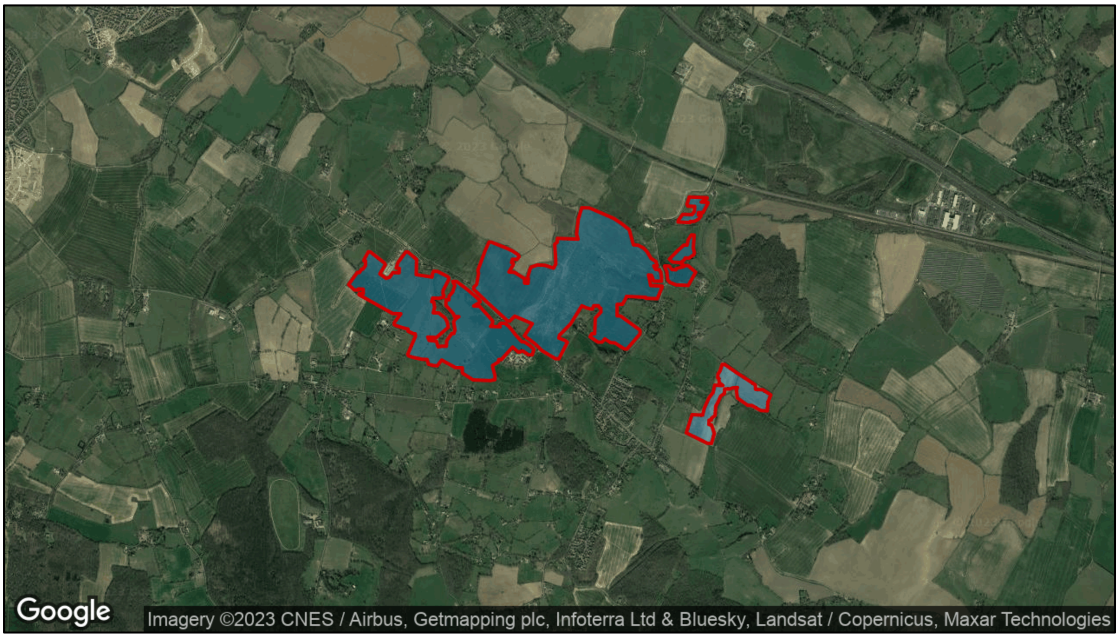

Figure 28 *Assessed reflector areas*

7 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

7.1 Overview

The following sub-section presents the results of the assessment and the significance of any predicted impact in the context of existing screening and the relevant criteria set out in each sub-section. The criteria are determined by the assessment process for each receptor, which are set out in Appendix D.

When determining the visibility of the reflecting panels for an observer, a conservative review of the available imagery has been undertaken, whereby it is assumed views of the panels are possible if it cannot be reliably determined that existing screening will remove effects.

7.2 Aviation Results

7.2.1 Glare Intensity Categorisation

The Pager Power and Forge model has been used to determine whether reflections are possible. 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 3 below along with the associated colour coding.

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

Table 3 *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 assessment of a variety of solar panel surface materials. In the first instance, a surface material of 'smooth glass without an anti-reflective coating' is assessed. This is the most reflective surface and allows for a 'worst case' assessment. Other surfaces that could be modelled include:

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

- Deeply textured glass.

If significant glare is predicted, modelling of less reflective surfaces could be undertaken.

7.2.2 Impact Significance Determination

The process for quantifying 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 approach bearing), the impact significance is low, and mitigation is not recommended.

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

- The likely traffic volumes and level of safeguarding at the aerodrome. Licensed aerodromes typically have higher traffic volumes and are formally safeguarded. Unlicensed aerodromes have greater capacity for operational acceptance.
- The time of day at which glare is predicted. Will the aerodrome be operational such that pilots can be on the approach at the time of day at which glare is predicted?

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

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

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

Following consideration of these 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 Project. Where the solar reflection is deemed significant, the impact significance is 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.

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.

7.2.3 Results Discussion – Hamilton Farm Airstrip

The results of the geometric calculation for aviation receptors at Hamilton Farm Airstrip are presented in Table 4 below.

<table>
<tr><th>Receptor/ Runway</th><th>Geometric Modelling Result</th><th>Glare Intensity</th><th>Comment</th><th>Impact Classification</th><th>Mitigation Recommended?</th></tr>
<tr><td>Runway 04
Splayed Approach</td><td>Solar reflections are geometrically possible between the threshold and 1-mile from the threshold</td><td></td><td>Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards this approach path</td><td>Low impact</td><td>No – airfield has been made aware of the effects so they can be accommodated</td></tr>
<tr><td>Runway 22
Splayed Approach</td><td>Solar reflections are geometrically possible between the threshold and 1-mile from the threshold</td><td></td><td>Any solar reflections would be outside of a pilot's primary field-of-view</td><td>Low impact</td><td>No</td></tr>
<tr><td>Runway 04
Visual Circuits</td><td>Solar reflections are geometrically possible along the left-hand base leg, right-hand base leg, and right-hand base leg joins</td><td></td><td>Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards sections of the visual circuits</td><td rowspan="2">Low impact</td><td rowspan="2">No – airfield has been made aware of the effects so they can be accommodated</td></tr>
<tr><td>Runway 22
Visual Circuits</td><td>Solar reflections are geometrically possible along sections of the left-hand base leg, right-hand base leg, and associated base leg joins</td><td></td><td>Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards sections of the visual circuits</td></tr>
</table>

Table 4 *Geometric analysis results – Hamilton Farm Airstrip*

Despite 'solar reflections with temporary after-image' being predicted towards pilots using Hamilton Farm Airstrip, the glare scenario has been considered in the following sub-sections to determine the overall impact and operational significance.

7.2.3.1 Effects in Context

The glint and glare study showed that aircraft approaching runway 04 could experience yellow glare from south-facing panels between 5:30am and 6:30am GMT and would occur from May to August. The instances of 'yellow' glare are predicted for a maximum of 1,066 minutes in total per year. This represents a very small proportion of time compared to average daylight hours in any one year (0.406%[17]). The maximum duration would be for less than 15 minutes on the days when the glare is possible. In practice, effects are likely to be noticeable for at most a few minutes as an aircraft is moving towards the runway threshold.

Solar reflections with yellow glare are predicted to occur within two hours of sunrise and therefore will occur when the sun is low in the sky beyond the reflecting panels. This means that a pilot will likely have a view of the sun within the same viewpoint of the reflecting solar panels. The sun is a far more significant source of light, therefore decreasing the impact significance of the reflecting panels. Furthermore, in practice the panels are flat and aligned with each other, meaning that only some of the sunlight is reflected.

The weather would have to be clear and sunny at the specific times when the glare was possible to be experienced.

7.2.3.2 Existing Mitigation for Direct Sunlight

There are a number of measures that pilots regularly employ to counter the effects of direct sunlight. These mitigation measures include:

- Using darkened cockpit sun visors to reduce the intensity of the Sun;
- Overflying the airfield and inspecting the runway prior to landing;
- Landing in the opposite direction if wind conditions allow;
- Planning the flight to land at a different time;
- Aborting their landing if uncertain that it is to be successful (known as a missed approach or a go-around).

The suitability of these options is influenced by many factors including the aerodrome type. Hamilton Farm Airstrip is a small unlicensed airfield with one grass runway and low air traffic volumes.

It is known that direct solar reflections from reflective surfaces, including solar panels, can be a distraction to pilots. The mitigation measures pilots use to mitigate the effects of direct sunlight can all be used to mitigate the effects of direct solar reflections from the solar panels.

[17] Based on 4,380 daylight hours (262,800 minutes) per year

7.2.3.3 Times which Effects are Predicted

For effects to be experienced, a pilot would have to be flying around the airfield at the specific times and dates when solar reflections are geometrically possible. Hamilton Farm Airstrip has confirmed that flights are typically scheduled after 8:00am and therefore any pilot using the airfield during the normal times would not experience any effects because they are only predicted between 5:30am and 6:30am GMT (6:30am and 7:30am BST).

In the highly unlikely scenario a pilot will be flying before 8:00am, the charts showing the locations and dates / times in which 'solar reflections with temporary after-image' are predicted have been provided in the 'Hamilton Farm Airstrip Glint and Glare' report. This is so that appropriate warning can be provided to pilots, and measures can be taken (e.g., existing measure to mitigate direct sunlight) to accommodate the effects if required.

7.2.4 Hamilton Farm Airstrip Conclusion

A low impact upon aviation activity associated with Hamilton Farm Airstrip is predicted following consideration of the glare scenario, primarily due to the effects occurring outside the typical scheduled flight times of the airfield and the ability of the pilots to accommodate the glare.

On the basis that the 'Hamilton Farm Airstrip Glint and Glare' report (see Appendix I) has been made available to the airfield, no further mitigation is recommended.

7.2.5 Results Discussion – Meadow Farm Airstrip

The results of the geometric calculation for aviation receptors at Meadow Farm Airstrip are presented in Table 5 below.

Receptor/Runway	Geometric Modelling Result	Glare Intensity	Comment	Impact Classification	Mitigation Recommended?
Runway 18 Splayed Approach	Solar reflections are geometrically possible between 0.2-miles from the threshold and 1-mile from the threshold		Any solar reflections would be outside of a pilot's primary field-of-view	Low impact	No
Runway 36 Splayed Approach	No solar reflections geometrically possible	N/A	N/A	No impact	No
Runway 18 Visual Circuits	Solar reflections are geometrically possible along the left-hand base leg, right-hand base leg, and associated base leg joins		Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards sections of the visual circuits	Low impact	No
Runway 36 Visual Circuits	No solar reflections geometrically possible	N/A	N/A	No impact	No

Table 5 *Geometric analysis results – Meadow Farm Airstrip*

7.2.6 Results Discussion – Harringe Airfield

The results of the geometric calculation for aviation receptors at Harringe Airfield are presented in Table 6 below.

Receptor/Runway	Geometric Modelling Result	Glare Intensity	Comment	Impact Classification	Mitigation Recommended?
Runway 02 Splayed Approach	Solar reflections are geometrically possible between the threshold and 0.7-miles from the threshold		Any solar reflections would be outside of a pilot's primary field-of-view	Low impact	No
Runway 20 Splayed Approach	Solar reflections are geometrically possible between the threshold and 1-mile from the threshold		Any solar reflections would be outside of a pilot's primary field-of-view	Low impact	No
Runway 02 Visual Circuits	Solar reflections are geometrically possible along the left-hand base leg and right-hand base leg		Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards sections of the visual circuits	Low impact	No
Runway 20 Visual Circuits	Solar reflections are geometrically possible along sections of the left-hand base leg, right-hand base leg, and associated base leg joins		Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards sections of the visual circuits	Low impact	No

Table 6 *Geometric analysis results – Harringe Airfield*

7.2.7 Results Discussion – Bonnington Airstrip

The results of the geometric calculation for aviation receptors at Bonnington Airstrip are presented in Table 7 below.

Receptor/Runway	Geometric Modelling Result	Glare Intensity	Comment	Impact Classification	Mitigation Recommended?
Runway 06 Splayed Approach	No solar reflections geometrically possible	N/A	N/A	No impact	No
Runway 24 Splayed Approach	No solar reflections geometrically possible	N/A	N/A	No impact	No
Runway 06 Visual Circuits	No solar reflections geometrically possible	N/A	N/A	No impact	No
Runway 24 Visual Circuits	No solar reflections geometrically possible	N/A	N/A	No impact	No

Table 7 *Geometric analysis results – Bonnington Airstrip*

7.2.8 Results Discussion – Pent Farm Airstrip

The results of the geometric calculation for aviation receptors at Pent Farm Airstrip are presented in Table 8 below.

Receptor/ Runway	Geometric Modelling Result	Glare Intensity	Comment	Impact Classification	Mitigation Recommended?
Runway 05 Splayed Approach	Solar reflections are geometrically possible between the threshold and 1-mile from the threshold		Any solar reflections would be outside of a pilot's primary field-of-view	Low impact	No
Runway 23 Splayed Approach	No solar reflections geometrically possible	N/A	N/A	No impact	No
Runway 05 Visual Circuits	Solar reflections are geometrically possible along the left-hand base leg, right-hand base leg, and the left-hand base leg join		Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards sections of the visual circuits	Low impact	No
Runway 23 Visual Circuits	Solar reflections are geometrically possible along sections of the right-hand base leg, and right-hand base leg joins		Any solar reflections would be outside of a pilot's primary field-of-view	Low impact	No

Table 8 *Geometric analysis results – Pent Farm Airstrip*

7.3 Road Results

7.3.1 Impact Significance Determination

The process for quantifying the impact significance concerning road safety is outlined in Appendix D. The key considerations for road users along major national, national, or regional roads are:

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

Where reflections are geometrically possible but expected to be screened, no impact is predicted, and mitigation is not required.

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

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

- Whether visibility is likely for elevated drivers (relevant to dual carriageways and motorways[18]);
- Whether the solar reflection originates from directly in front of a road user. Solar reflections that are directly in front of a road user are more hazardous;
- The separation distance to the reflecting 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.

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 further mitigating factors, the impact significance is high, and mitigation is required.

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

7.3.2 Results Discussion

The modelling has shown that solar reflections are geometrically possible towards 66 of the 80 assessed receptors. Table 9 below summarises the predicted impact at these receptors. Results where mitigation is recommended are shown in red.

<table>
<tr><th>Road Receptor</th><th>Geometric Modelling Results (screening not considered)</th><th>Identified Screening (desk-based review)</th><th>Relevant Factors</th><th>Impact Classification</th><th>Mitigation Recommended?</th></tr>
<tr><td>1</td><td>Solar reflections geometrically possible from <u>outside</u> a road user’s primary field-of-view</td><td>Existing vegetation to be reinforced and proposed hedgerows to be managed in accordance with the Outline LEMP (Doc Ref. 7.10).

Views of the reflecting solar panels are predicted to be significantly obstructed</td><td rowspan="2">N/A</td><td rowspan="2">No impact</td><td rowspan="2">No</td></tr>
<tr><td>2 – 3</td><td>Solar reflections geometrically possible from <u>inside</u> a road user’s primary field-of-view</td><td>Existing vegetation, existing vegetation to be reinforced and proposed hedgerows to be managed in accordance with the Outline LEMP (Doc Ref. 7.10).

Views of the reflecting solar panels are predicted to be significantly obstructed</td></tr>
</table>

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
4 – 7	Solar reflections geometrically possible from **outside** a road user's primary field-of-view	Existing vegetation, proposed woodland planting, and proposed hedgerow to be managed in accordance with the Outline LEMP (Doc Ref. 7.10). Views of the reflecting solar panels are predicted to be significantly obstructed			
8 – 9	Solar reflections geometrically possible from **inside** a road user's primary field-of-view	Existing vegetation, proposed hedgerow to be managed in accordance with the Outline LEMP (Doc Ref. 7.10), and proposed woodland planting. Partial views of the reflecting solar panels cannot be entirely ruled out	The road is deemed a local road. Effects coincide with direct sunlight	Low impact	No
10	Solar reflections geometrically possible from **inside** a road user's primary field-of-view	Existing vegetation, proposed hedgerow to be managed in accordance with the Outline LEMP (Doc Ref. 7.10), and proposed woodland planting. Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No

<table>
<tr><th>Road Receptor</th><th>Geometric Modelling Results (screening not considered)</th><th>Identified Screening (desk-based review)</th><th>Relevant Factors</th><th>Impact Classification</th><th>Mitigation Recommended?</th></tr>
<tr><td>11 – 15</td><td>Solar reflections geometrically possible from <u>outside</u> a road user’s primary field-of-view</td><td>Existing vegetation and proposed woodland planting
Views of the reflecting solar panels are predicted to be significantly obstructed</td><td></td><td></td><td></td></tr>
<tr><td>16 – 25</td><td>Solar reflections geometrically possible from <u>inside</u> a road user’s primary field-of-view</td><td>Existing vegetation, proposed hedgerow to be maintained in accordance with the Outline LEMP (Doc Ref. 7.10), and native small hedgerow Trees including Apple and Hawthorn
Views of the reflecting solar panels are predicted to be significantly obstructed</td><td rowspan="3">N/A</td><td rowspan="3">No impact</td><td rowspan="3">No</td></tr>
<tr><td>26 – 39</td><td>No solar reflections geometrically possible</td><td>N/A</td></tr>
<tr><td>40 – 73</td><td>Solar reflections geometrically possible from <u>inside</u> a road user’s primary field-of-view</td><td>Existing vegetation and the general rural environment</td></tr>
</table>

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
74 – 77	Solar reflections geometrically possible from **outside** a road user's primary field-of-view	Views of the reflecting solar panels are predicted to be significantly obstructed			
78 – 80	Solar reflections geometrically possible from **inside** a road user's primary field-of-view				

Table 9 *Impact classification – road receptors*

7.3.3 Desk-Based Review of Imagery

The figures in this sub-section provide a review of the imagery for receptors where the reflecting panels are predicted to be significantly obstructed from view. Imagery for the receptors where the reflecting panels are predicted to be visible are not presented in this sub-section.

The existing vegetation (green outlined areas), proposed landscaping (pink areas), and buildings (blue outlined areas) identified are shown in Figures 29 to 37 on the following pages[19]. The cumulative reflective panel areas are shown by the yellow icons.

[19] The street view imagery shown in Figure 33 were taken in 2009 where the hedgerow screening is much shorter than it is now.

Figure 29 *Reflective panel areas and screening for road receptors 1 to 3*

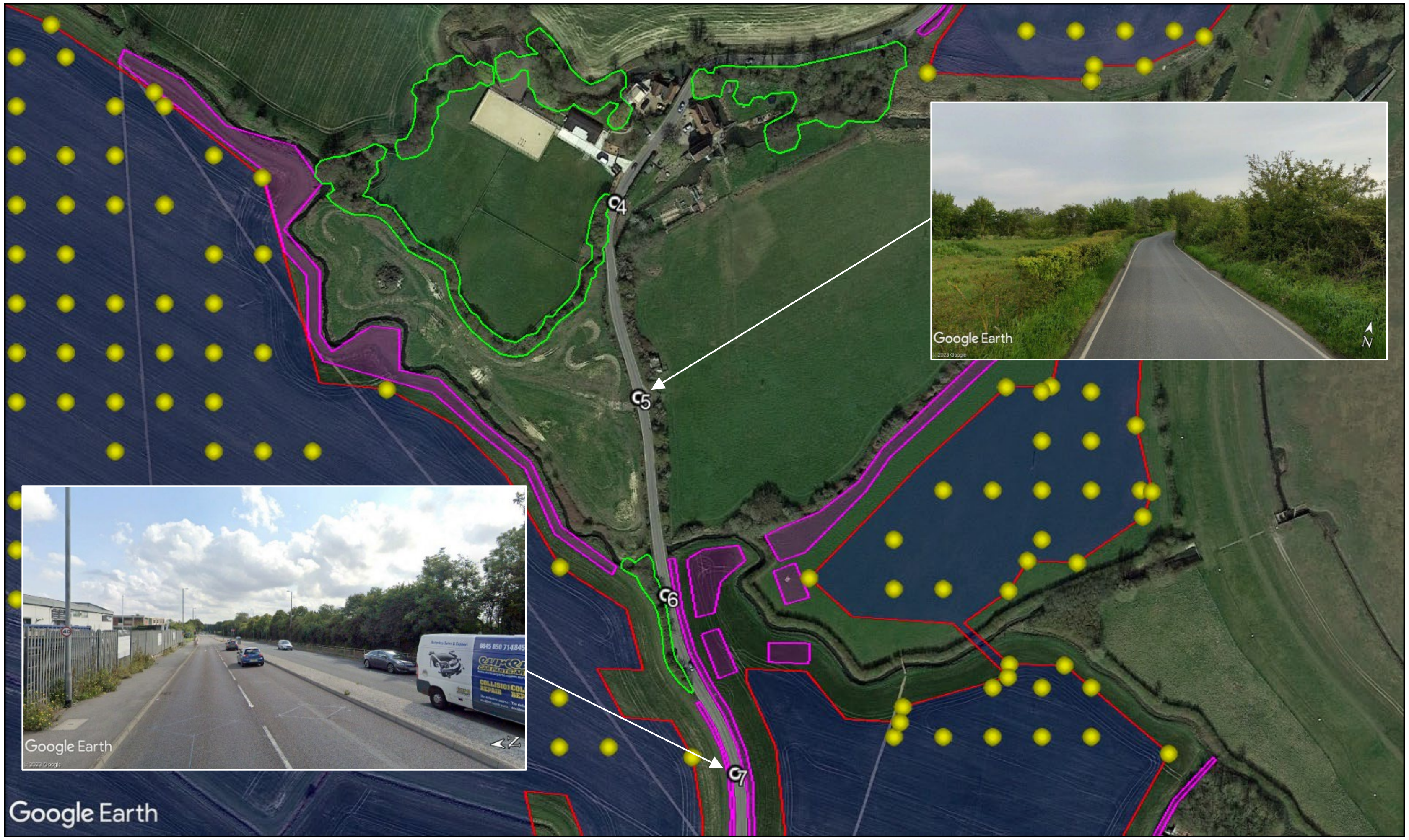

Figure 30 *Reflective panel areas and screening for road receptors 4 to 7*

Figure 31 *Reflective panel areas and screening for road receptors 10 to 15*

Figure 32 *Reflective panel areas and screening for road receptors 16 to 20*

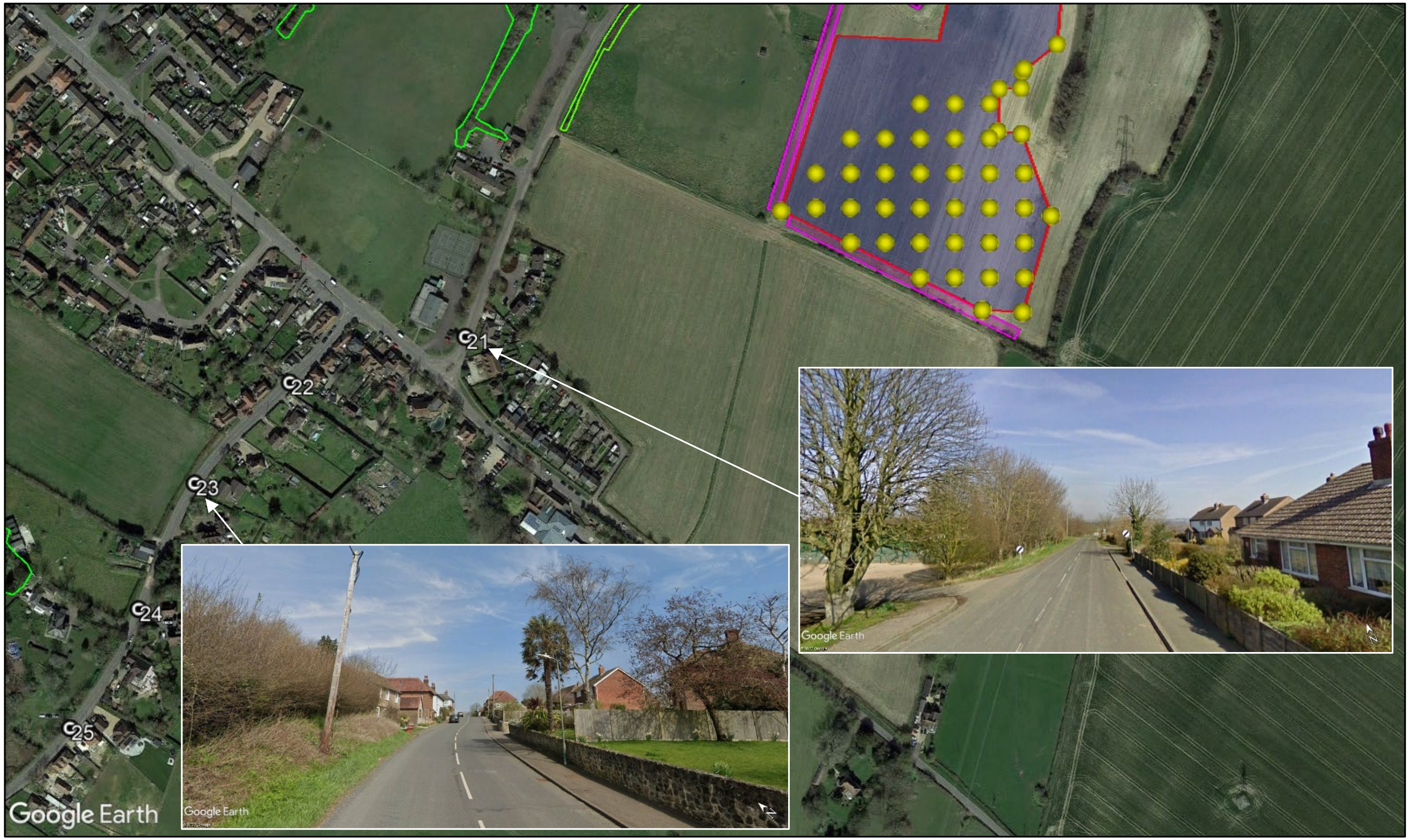

Figure 33 *Reflective panel areas and screening for road receptors 21 to 25*

Figure 34 *Reflective panel areas and screening for road receptors 40 to 49*

Figure 35 *Reflective panel areas and screening for road receptors 50 to 60*

Figure 36 *Reflective panel areas and screening for road receptors 61 to 70*

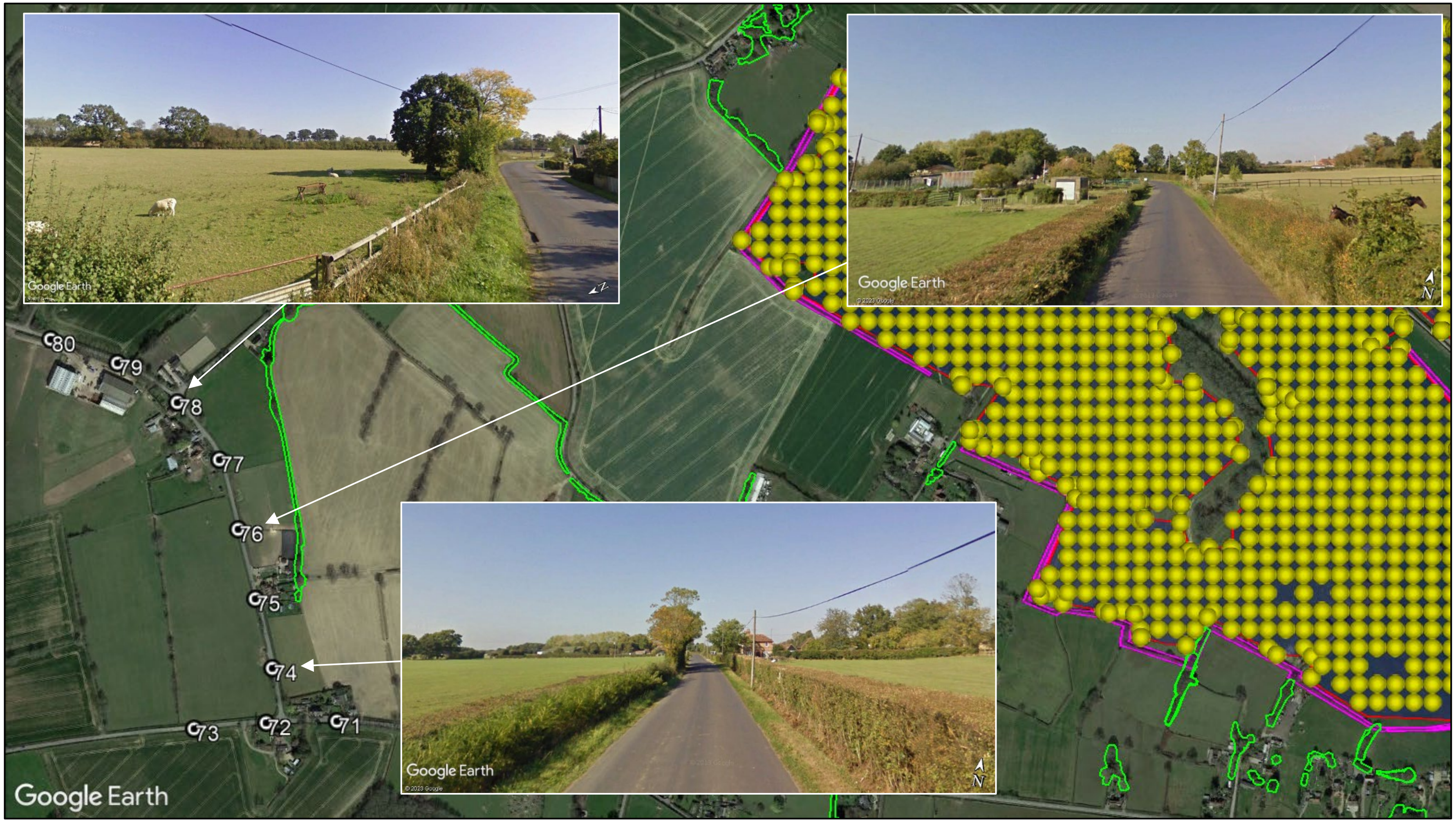

Figure 37 *Reflective panel areas and screening for road receptors 71 to 80*

7.4 Dwelling Results

7.4.1 Impact Significance Determination

The process for quantifying the impact significance concerning residential amenity is outlined in Appendix D. The key considerations for residential dwellings are:

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

Where reflections are geometrically possible but expected to be screened, no impact is predicted, and mitigation is not required.

Where effects occur for less than 3 months per year and less than 60 minutes on any given day, or the closest reflecting panel is over 1km from the dwelling, the impact significance is low, and mitigation is not recommended.

Where reflections are predicted to be experienced for more than 3 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 and mitigation requirement:

- The separation distance to the reflecting panel area[20]. 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 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;
- Whether the dwelling appears to have windows facing the reflecting areas. An observer may need to look at an acute 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.

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

[20] Which is often greater than the nearest panel boundary, because not all areas of the site cause specular reflections towards particular receptor locations.

7.4.2 Results Discussion

The modelling has shown that solar reflections are geometrically possible towards 246 of the 267 assessed dwellings. Table 10 below summarises the predicted impact at these receptors.

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
1 – 13	Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day	Existing vegetation and intervening terrain Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
14 – 22	Solar reflections geometrically possible for **less** than 3 months per year and **less** than 60 minutes on any given day				
23 – 30	No solar reflections geometrically possible	N/A	N/A		

<table>
<tr><th>Dwelling Receptor</th><th>Geometric Modelling Results (screening not considered)</th><th>Identified Screening (desk-based review)</th><th>Relevant Factors</th><th>Impact Classification</th><th>Mitigation Recommended?</th></tr>
<tr><td>31 – 33</td><td>Solar reflections geometrically possible for less than 3 months per year and less than 60 minutes on any given day</td><td rowspan="2">Proposed hedgerow managed to be managed in accordance with the Outline LEMP (Doc Ref. 7.10), and native small hedgerow trees including apple and hawthorn

Views of the reflecting solar panels to the east cannot be entirely ruled out from above the ground floor</td><td>N/A</td><td rowspan="2">Low impact</td><td rowspan="2">No</td></tr>
<tr><td>34 – 45</td><td rowspan="2">Solar reflections geometrically possible for more than 3 months per year but less than 60 minutes on any given day</td><td>Effects are not predicted to be experienced from the ground floor

Effects coincide with direct sunlight</td></tr>
<tr><td>46 – 64</td><td>Existing vegetation, surrounding dwellings, and native small hedgerow trees including apple and hawthorn

Views of the reflecting solar panels are predicted to be significantly obstructed</td><td>N/A</td><td>No impact</td><td>No</td></tr>
</table>

<table>
<tr><th>Dwelling Receptor</th><th>Geometric Modelling Results (screening not considered)</th><th>Identified Screening (desk-based review)</th><th>Relevant Factors</th><th>Impact Classification</th><th>Mitigation Recommended?</th></tr>
<tr><td>65 – 85</td><td rowspan="2">Solar reflections geometrically possible for <u>more</u> than 3 months per year but <u>less</u> than 60 minutes on any given day</td><td>Existing vegetation, intervening terrain and/or other dwellings
Views of the reflecting solar panels are predicted to be significantly obstructed</td><td>N/A</td><td>No impact</td><td>No</td></tr>
<tr><td>86 – 98</td><td>Existing vegetation, intervening terrain, other dwellings, and existing hedgerow to be reinforced
Views of the reflecting solar panels to the east cannot be entirely ruled out from above the ground floor</td><td>Effects are not predicted to be experienced from the ground floor
Effects coincide with direct sunlight</td><td>Low impact</td><td>No</td></tr>
<tr><td>99</td><td>Solar reflections geometrically possible for <u>more</u> than 3 months per year but <u>less</u> than 60 minutes on any given day</td><td>Existing vegetation, intervening terrain, other dwellings, and existing hedgerow to be reinforced
Views of the reflecting solar panels to the east cannot be entirely ruled out</td><td>Effects coincide with direct sunlight</td><td>Moderate impact</td><td>Yes</td></tr>
</table>

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
100 – 115	Solar reflections geometrically possible for <u>more</u> than 3 months per year but <u>less</u> than 60 minutes on any given day	Existing vegetation, intervening terrain, other dwellings, and proposed hedgerow to be maintained to a minimum height of 2.5-3m Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
116		Existing vegetation, intervening terrain, other dwellings, and proposed hedgerow to be maintained to a minimum height of 2.5-3m Views of the reflecting solar panels cannot be entirely ruled out from above the ground floor	Effects are not predicted to be experienced from the ground floor Effects coincide with direct sunlight	Low impact	No
117 – 121		Existing vegetation, intervening terrain, and other dwellings Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
122	Solar reflections geometrically possible for <u>more</u> than 3 months per year but <u>less</u> than 60 minutes on any given day	Existing vegetation, existing hedgerow to be reinforced to a minimum height of 2.5-3m, and proposed native woodland planting Views of the reflecting solar panels to the west cannot be entirely ruled out from above the ground floor	Effects are not predicted to be experienced from the ground floor Effects coincide with direct sunlight	Low impact	No
123 – 138		Existing vegetation and proposed native woodland planting Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
139		Existing hedgerow to be reinforced to a minimum height of 2.5-3m and proposed hedgerow to be managed in accordance with the Outline LEMP (Doc Ref. 7.10) Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
140 – 147	Solar reflections geometrically possible for more than 3 months per year but less than 60 minutes on any given day	Existing hedgerow to be reinforced to be maintained at a minimum height of 2.5-3m and proposed hedgerow to be maintained to a minimum height of 2.5-3m Views of the reflecting solar panels cannot be entirely ruled out from above the ground floor	Effects coincide with direct sunlight The closest visible reflecting solar panel is beyond 300m	Low impact	No
148 – 150		Proposed hedgerow to be maintained to a minimum height of 2.5-3m Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
151 – 194		Existing vegetation, intervening terrain, and/or other dwellings Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
195 – 199	Solar reflections geometrically possible for **more** than 3 months per year but **less** than 60 minutes on any given day	Existing vegetation and existing hedgerow to be reinforced Views of the reflecting solar panels to the east cannot be entirely ruled out from above the ground floor	Effects are not predicted to be experienced from the ground floor Effects coincide with direct sunlight	Low impact	No
200		Existing vegetation, existing hedgerow to be reinforced, and proposed hedgerow be managed in accordance with the Outline LEMP (Doc Ref. 7.10) Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
201		Existing vegetation, existing hedgerow to be reinforced, and proposed hedgerow be managed in accordance with the Outline LEMP (Doc Ref. 7.10) Views of the reflecting solar panels to the east cannot be entirely ruled out from above the ground floor	Effects are not predicted to be experienced from the ground floor Effects coincide with direct sunlight	Low impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
202	Solar reflections geometrically possible for less than 3 months per year and less than 60 minutes on any given day	Existing vegetation, intervening terrain, and proposed hedgerow managed to a minimum height of 2.5-3m. Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
203		Existing vegetation and intervening terrain Existing vegetation, intervening terrain, and proposed hedgerow managed to a minimum height of 2.5-3m. Views of the reflecting solar panels cannot be entirely ruled out from above the ground floor	N/A	Low impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
204 – 219	Solar reflections geometrically possible for less than 3 months per year and less than 60 minutes on any given day	Existing vegetation and intervening terrain Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
220 – 221	Solar reflections geometrically possible for more than 3 months per year but less than 60 minutes on any given day	Existing vegetation, existing hedgerow to be reinforced, and proposed hedgerow be managed in accordance with the Outline LEMP (Doc Ref. 7.10) Views of the reflecting solar panels cannot be entirely ruled out from above the ground floor	Effects are not predicted to be experienced from the ground floor Effects coincide with direct sunlight	Low impact	No
222 – 247	Solar reflections geometrically possible for less than 3 months per year and less than 60 minutes on any given day	Existing vegetation and intervening terrain Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
248 – 260	No solar reflections geometrically possible	N/A			

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening (desk-based review)	Relevant Factors	Impact Classification	Mitigation Recommended?
261 – 263	Solar reflections geometrically possible for less than 3 months per year and less than 60 minutes on any given day	Existing vegetation and intervening terrain Views of the reflecting solar panels are predicted to be significantly obstructed	N/A	No impact	No
264 – 267	Solar reflections geometrically possible for more than 3 months per year but less than 60 minutes on any given day				

Table 10 *Impact classification – dwelling receptors*

7.4.3 Desk-Based Review of Imagery

The figures in this sub-section provide a review of the imagery for receptors where the reflecting panels are predicted to be significantly obstructed from view. The receptors where the reflecting panels are predicted to be visible are not presented in this sub-section.

The existing vegetation (green outlined areas), proposed landscaping (pink areas), and terrain identified is shown in Figures 38 to 53 on the following pages. The cumulative reflecting panel areas are shown by the yellow icons. Where terrain screening is a significant mitigating factor, high-level zones of theoretical visibility (ZTV Viewshed) generated by Google Earth are used[21].

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

Figure 38 *Reflective panel areas and screening for dwellings 1 to 3*

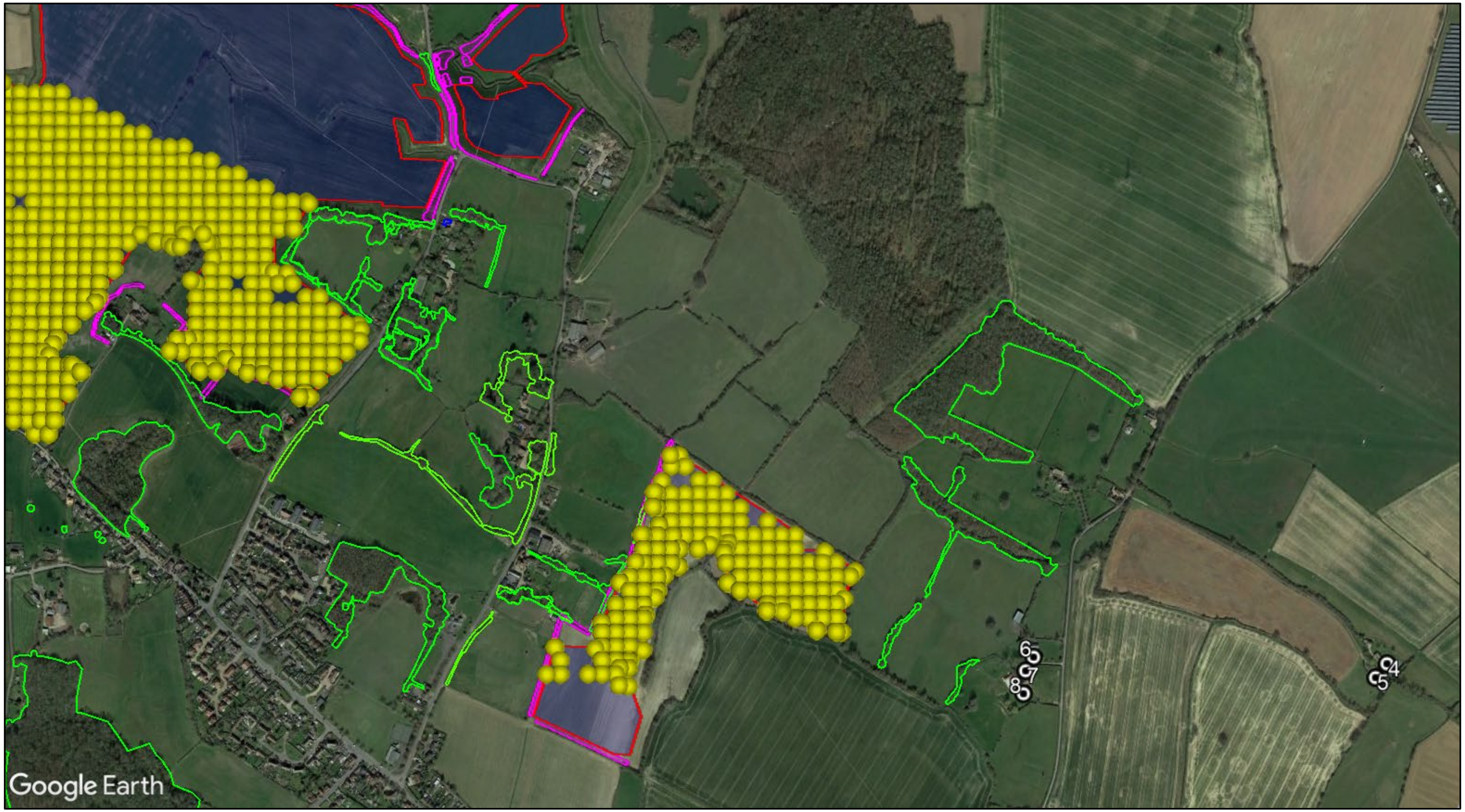

Figure 39 *Reflective panel areas and screening for dwellings 4 to 8*

Figure 40 *Reflective panel areas and screening for dwellings 9 to 22*

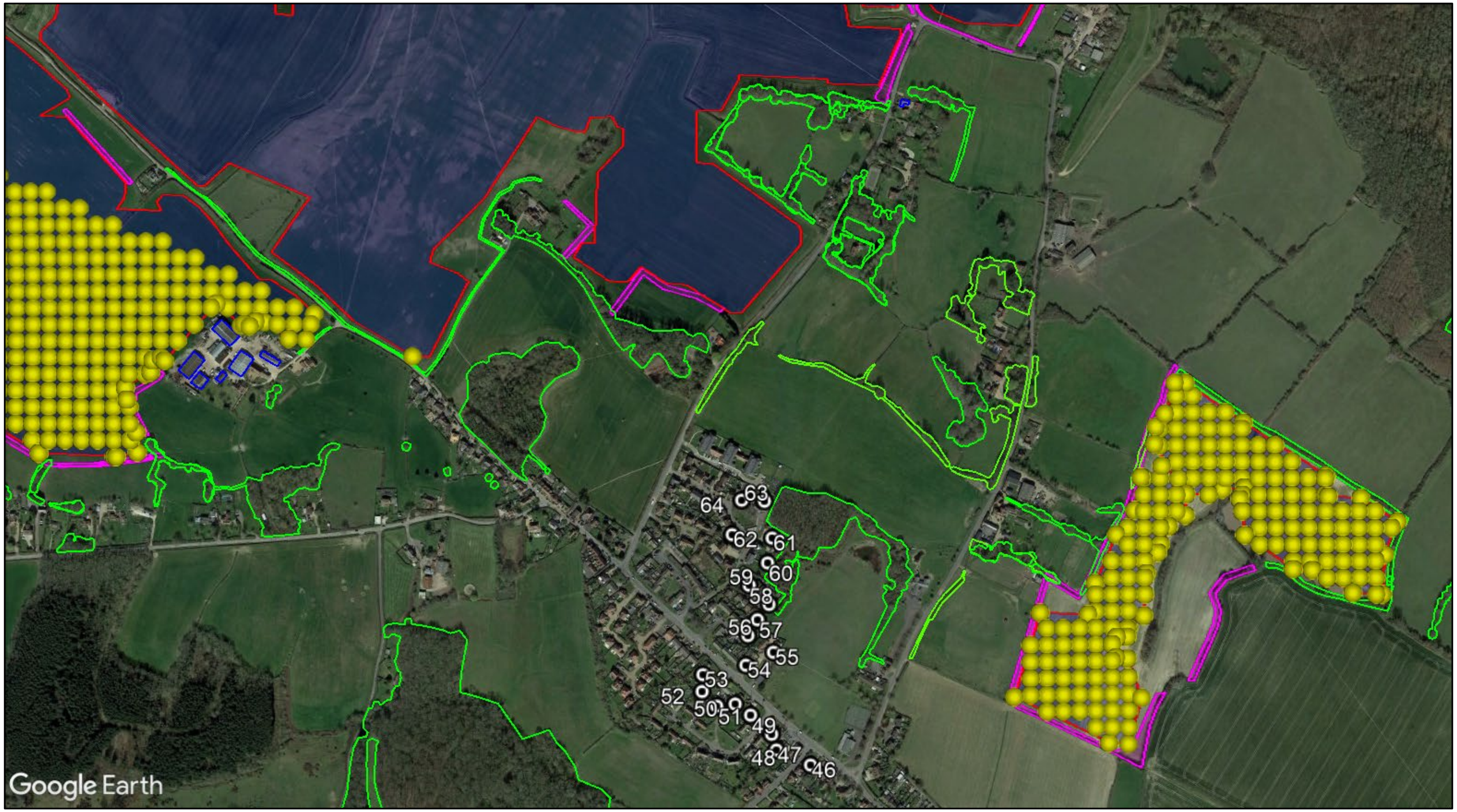

Figure 41 *Reflective panel areas and screening for dwellings 46 to 64*

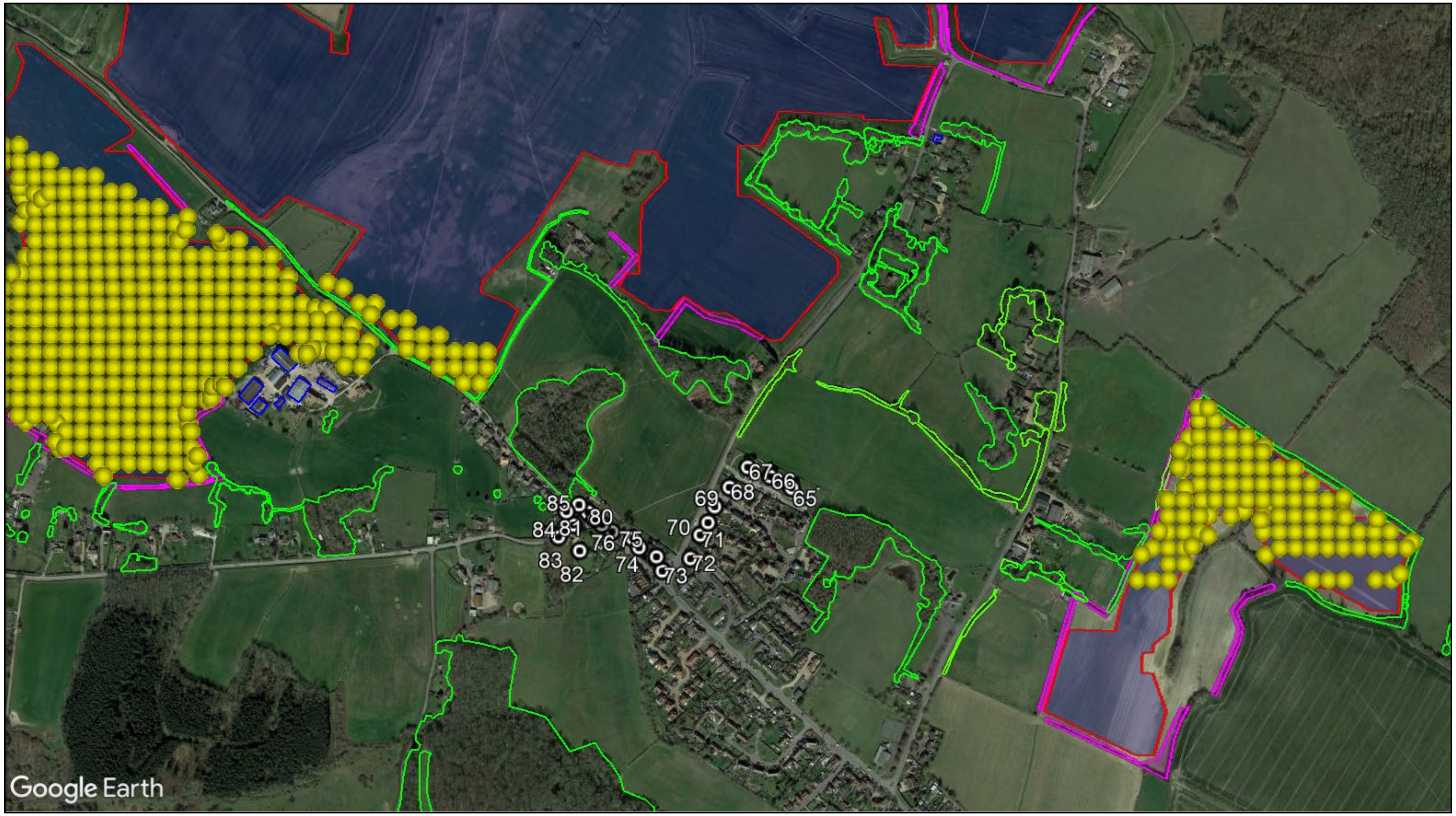

Figure 42 *Reflective panel areas and screening for dwellings 65 to 85*

Figure 43 *Reflective panel areas and screening for dwellings 100 to 115*

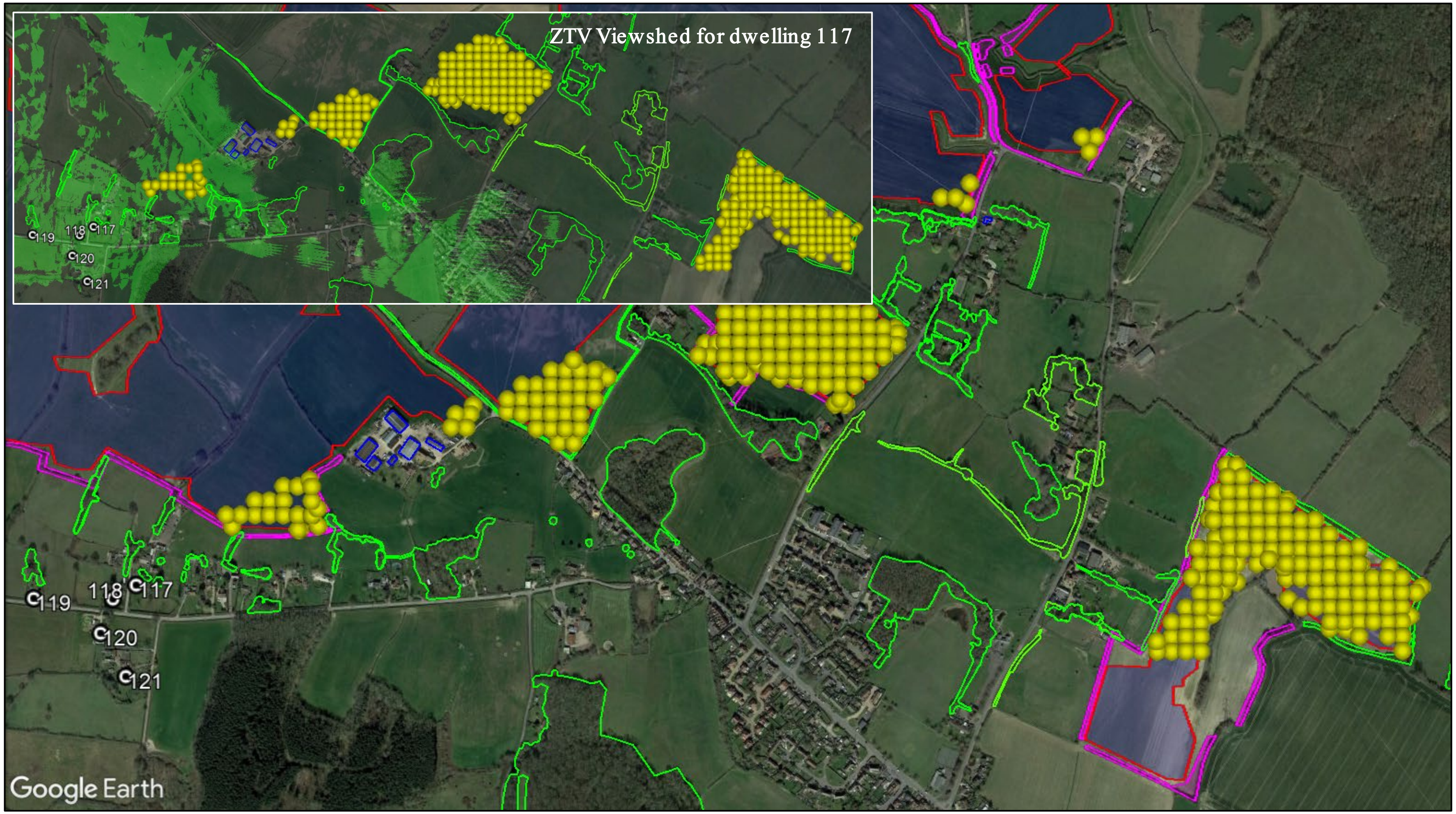

Figure 44 *Reflecting panel areas and screening for dwellings 117 to 121*

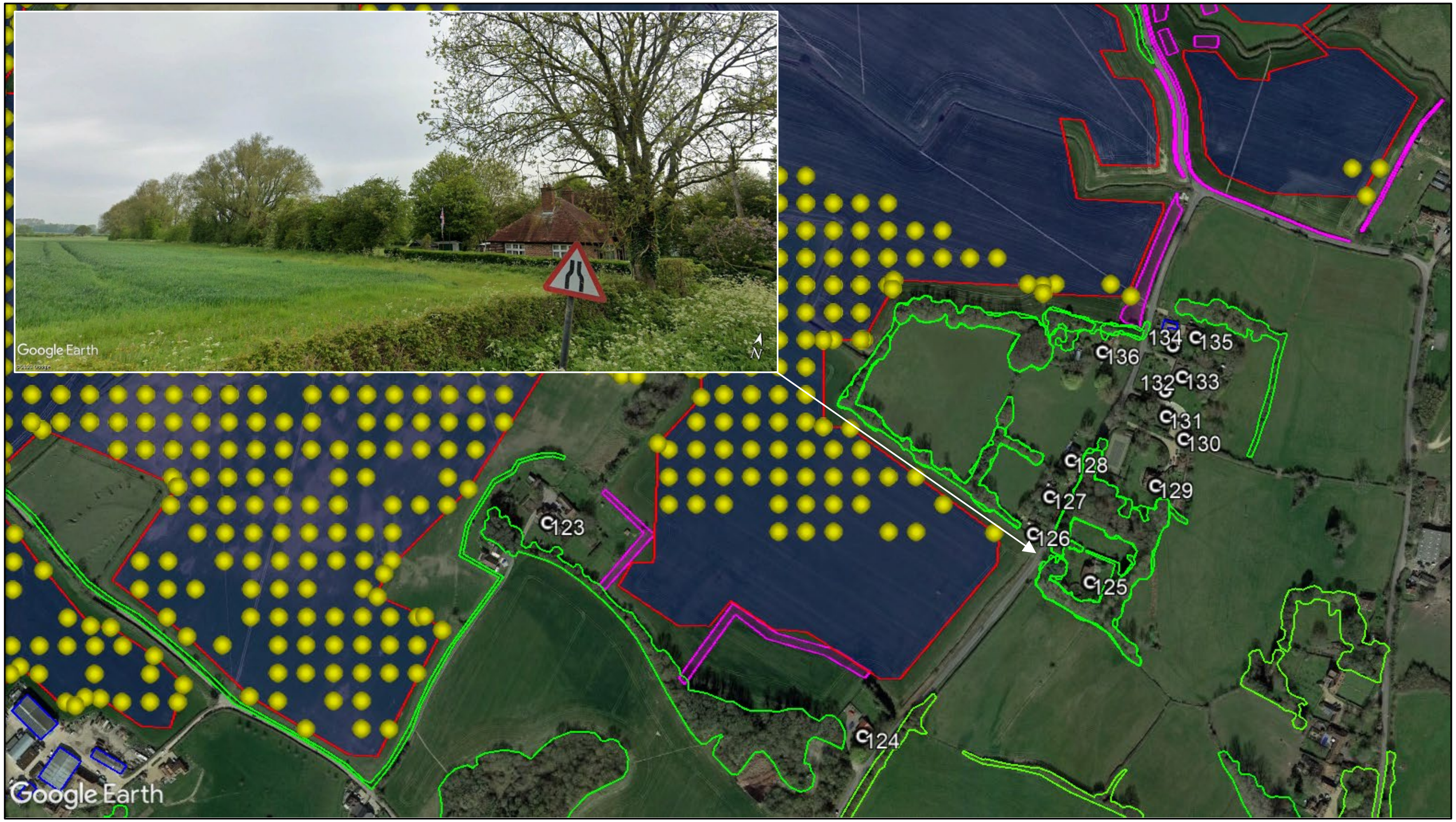

Figure 45 *Reflecting panel areas and screening for dwellings 123 to 136*

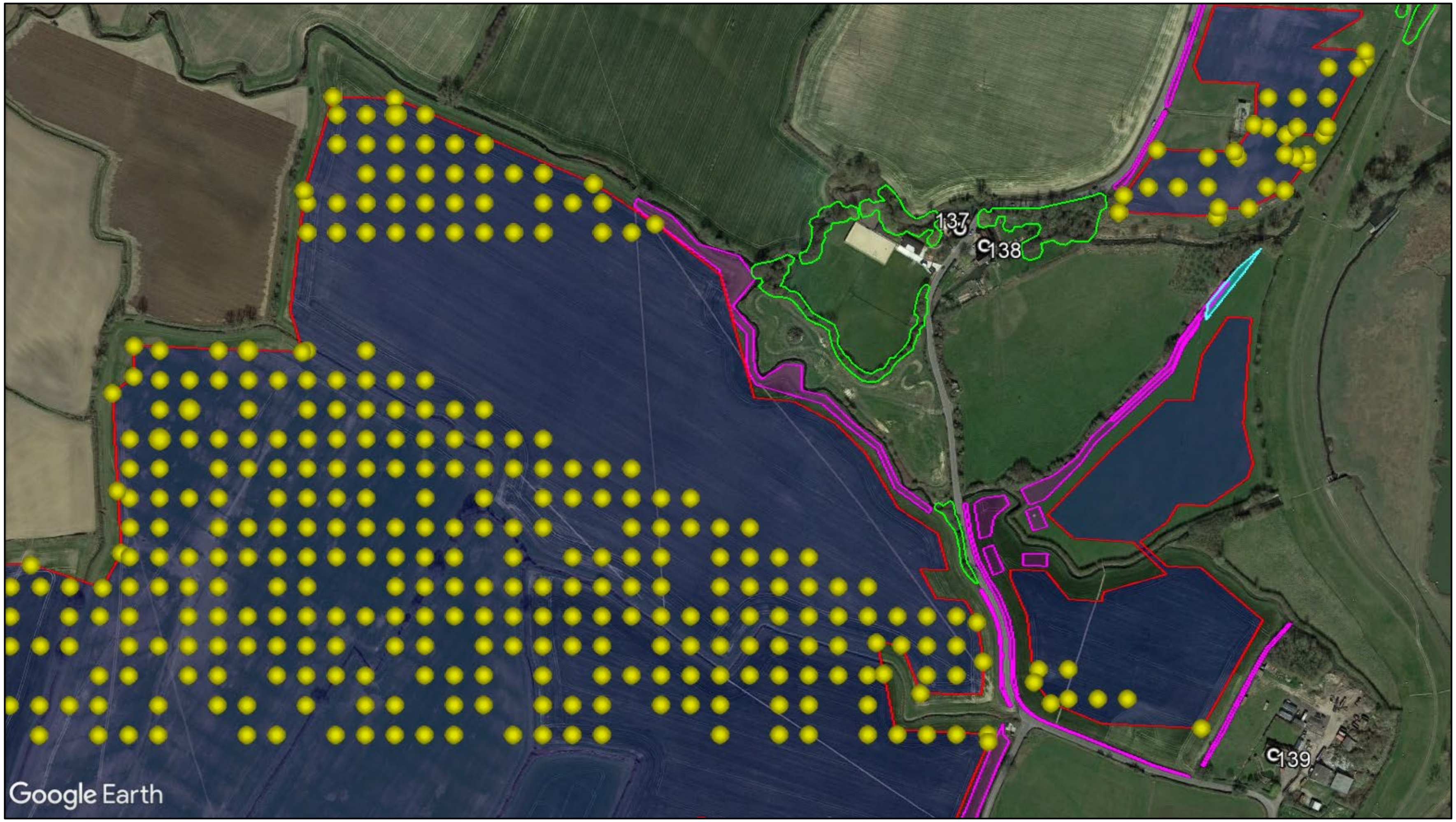

Figure 46 *Reflecting panel areas and screening for dwellings 137 to 139*

Figure 47 *Reflecting panel areas and screening for dwellings 148 to 150*

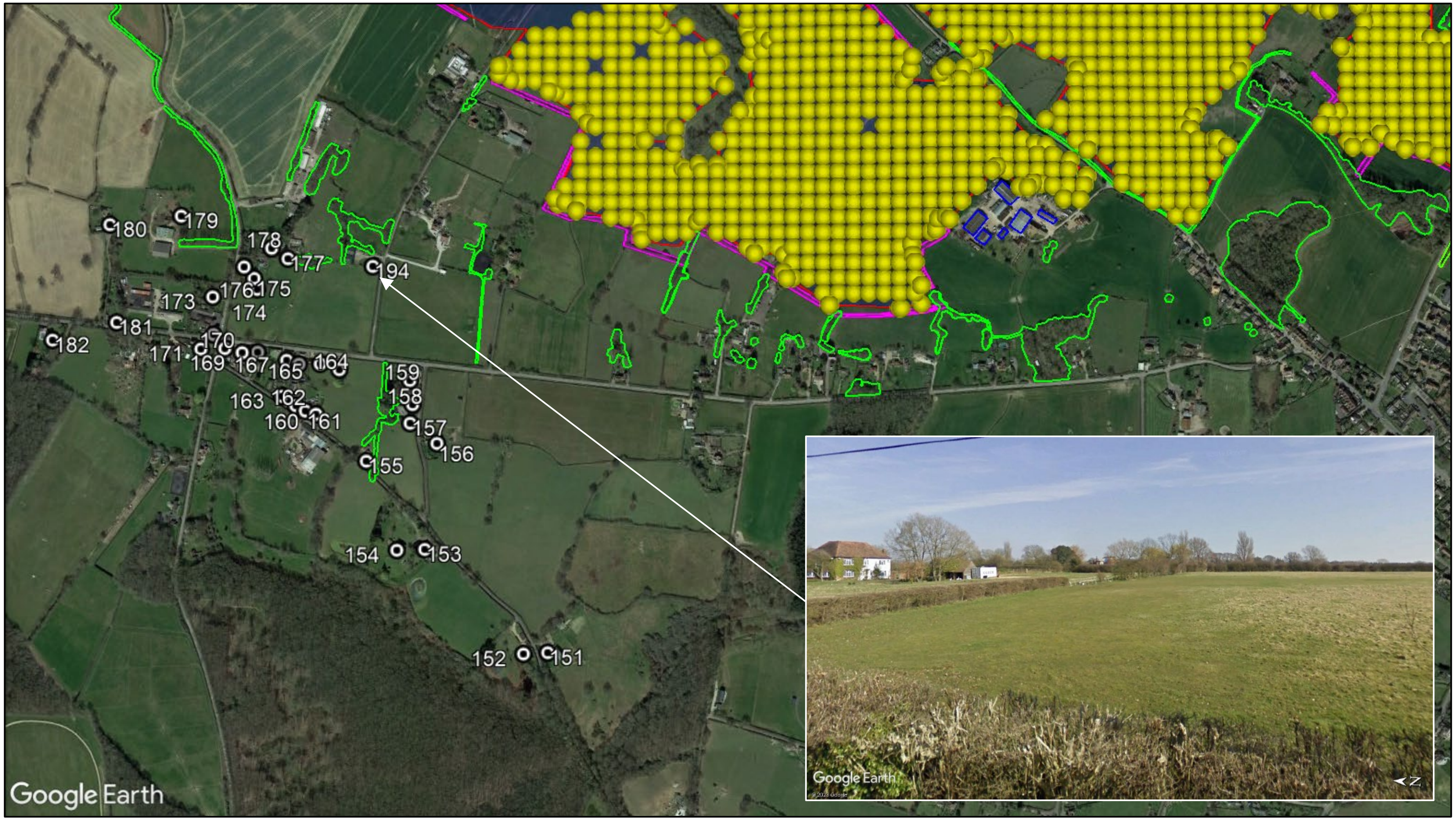

Figure 48 *Reflecting panel areas and screening for dwellings 151 to 182 and 194*

Figure 49 *Reflecting panel areas and screening for dwellings 183 to 193*

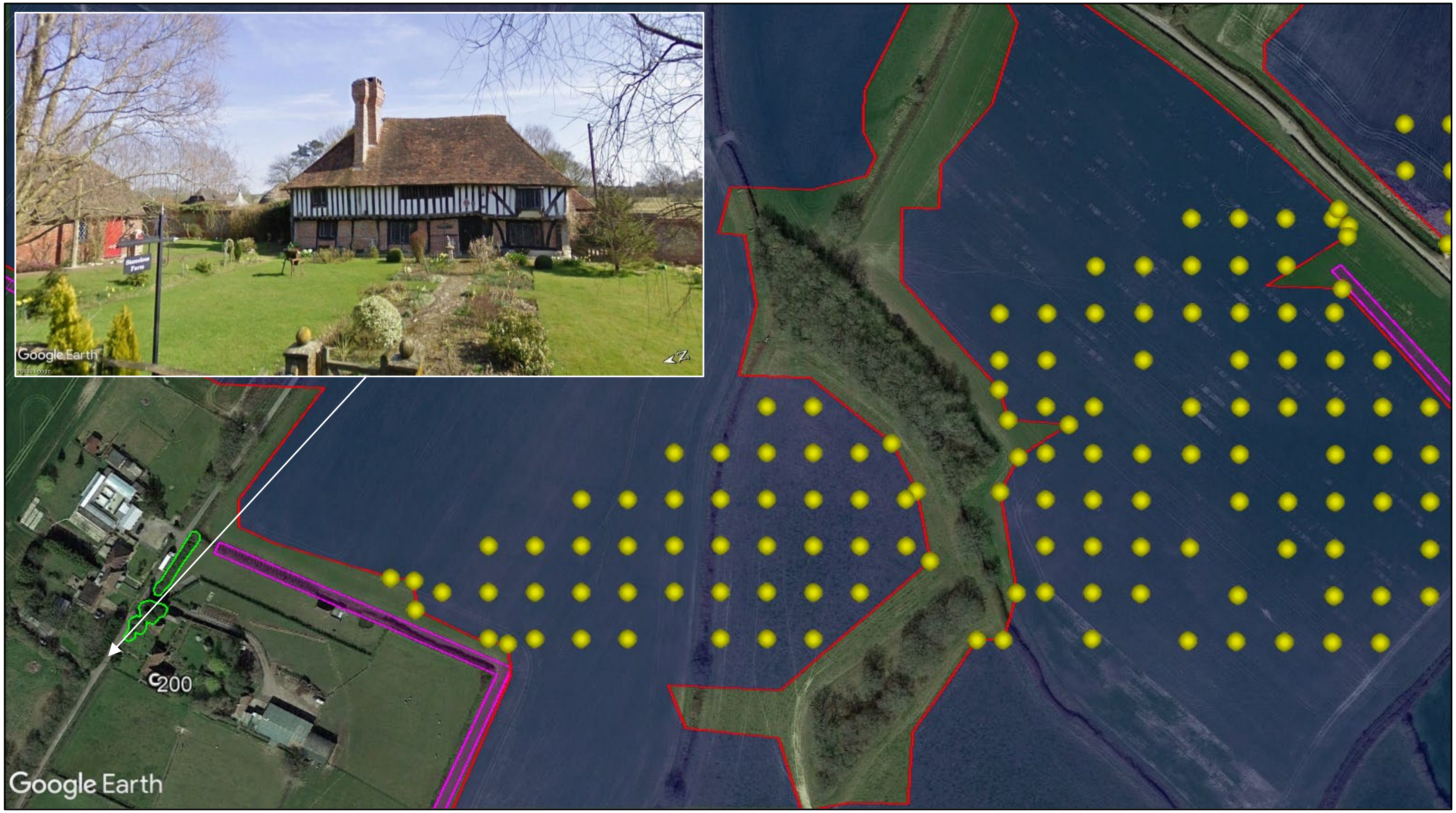

Figure 50 *Reflecting panel areas and screening for dwelling 200*

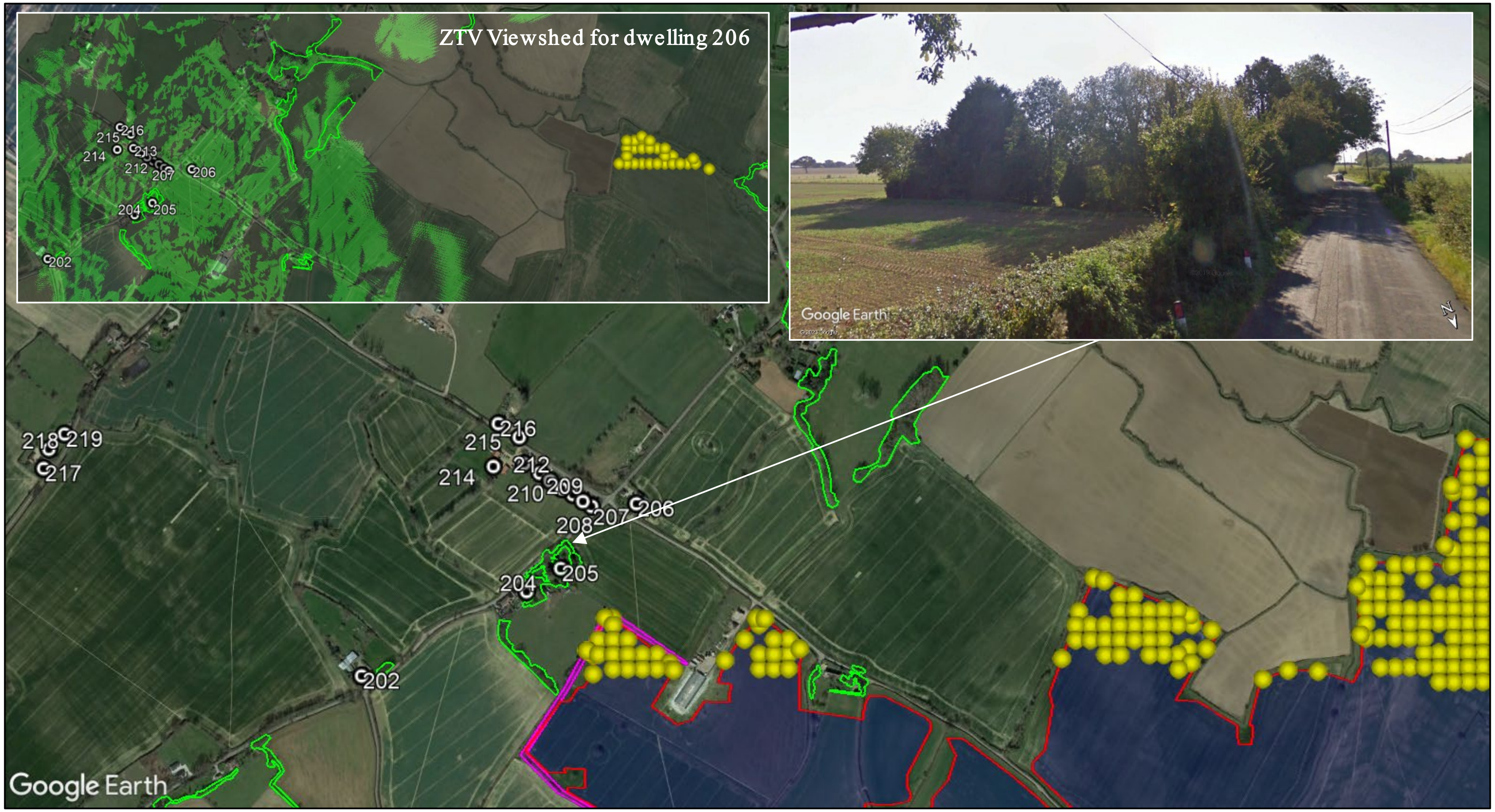

Figure 51 *Reflecting panel areas and screening for dwellings 202 and 204 to 219*

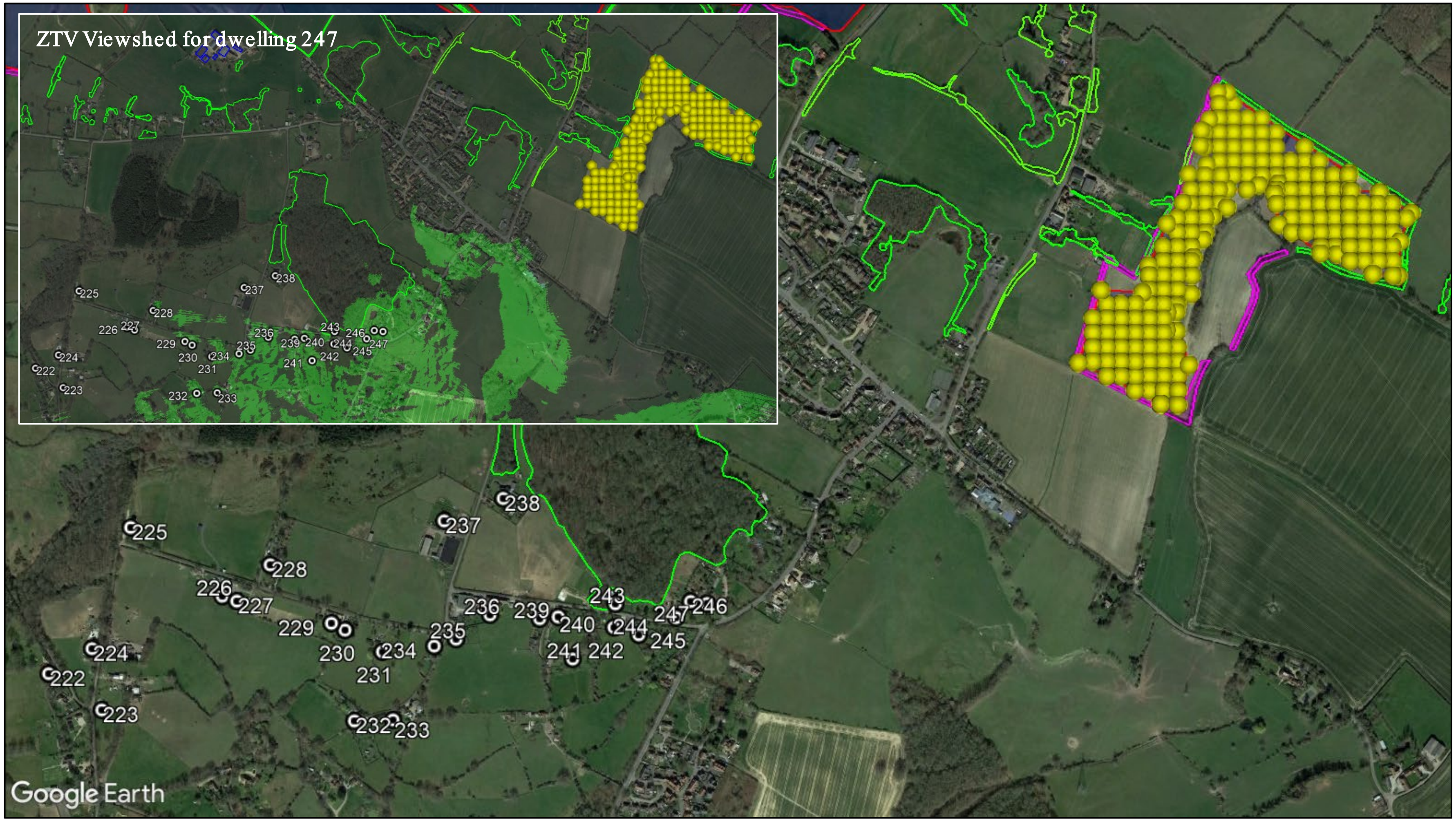

Figure 52 *Reflecting panel areas and screening for dwellings 222 to 247*

Figure 53 *Reflecting panel areas and screening for dwellings 261 to 267*

7.5 Mitigation Strategy

7.5.1 Dwelling Mitigation

A moderate impact has been predicted upon Broadbanks on Bank Road (dwelling 99), before mitigation is assumed. However, to ensure a worse-case assessment the following has not been accounted within the assessment, as shown on Figures 54 to 57 with the location of Site photographs shown on Figure 58), which restricts views from the Receptor into the Fields or would aid in screening the Receptor from the Fields:

- Existing vegetation as shown within Figure 54.
- An existing earthing structure, known as 'The Mount', see Figures 55 and 57; and
- Existing trees along Bank Road as shown within Figure 56.

Figure 54 *Photo from dwelling 99 which shows only a partial area of Field 12 would be visible*

Figure 55 *Photo from entrance of Bank Farm of The Mount situated in front of dwelling 99*

Figure 56 *Photo from Bank Road looking south east showing the hedgerow and trees situated between Field 12 and dwelling 99*

The detailed design is secured by Requirement in the **Draft DCO (Doc Ref. 3.1)**. The **Outline LEMP (Doc Ref. 7.10)** has been produced to specify the landscape and ecological establishment and management measures that the detailed landscape scheme would need to comply with. The **Outline LEMP (Doc Ref. 7.10)** includes a commitment that the detailed landscape scheme will be prepared having regard this Glint and Glare assessment and a specification for the area shown in blue on Figure 57. This would secure mitigation for dwelling receptor 99 that would be needed in the absence of the existing features. The following measures include (but not limited to):

- Proposed existing boundary hedgerows (blue line), shown in Figure 57, to be managed at a height of at least 4m; and
- Inclusion of opaque panelling (i.e., wooden fencing) attached to small sections of the security fencing.

The implementation of these measures along with the existing features would reduce impacts to negligible to low significance.

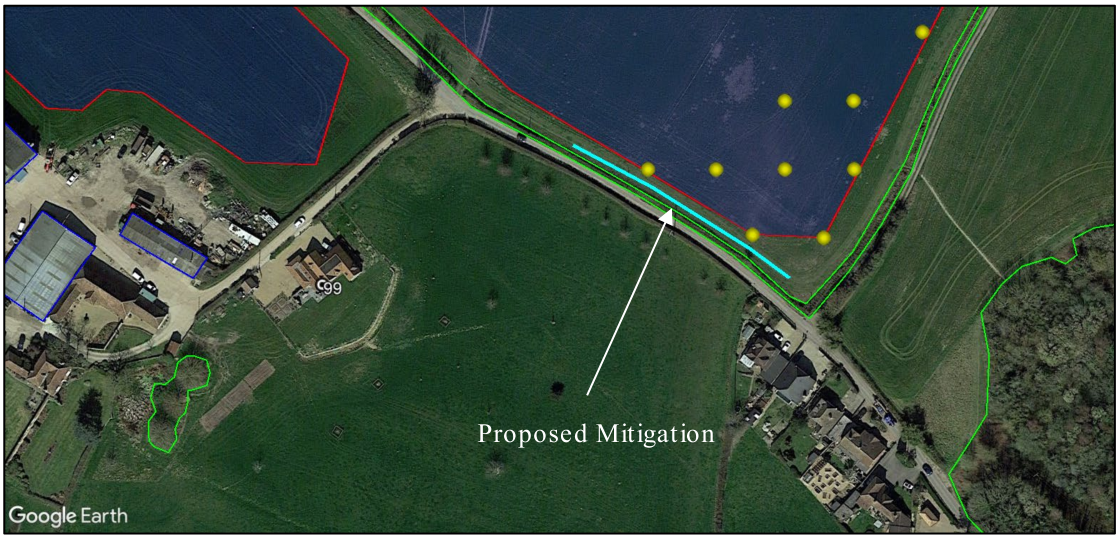

Figure 57 *Proposed mitigation for dwelling 99*

Figure 58 *Location plan of Site photographs as shown in Figures 55 to 57*

7.6 Conclusion

Solar reflections are possible at Dwelling 99 (of a total of 267) within the 1km study area. Before mitigation is assumed, a moderate impact has been predicted on this receptor.

Once mitigation has been taken into account, the residual impact is then considered to be negligible to low and not significant. Therefore, overall impacts on residential receptors are considered to be not significant and therefore acceptable.

8 HIGH-LEVEL ASSESSMENT OF PUBLIC RIGHTS OF WAY

8.1 Overview

Public Rights of Way (PRoW) run through and around the Project. Though it is likely that these will be screened, in the event that reflections are visible, the following section presents the impact significance.

8.2 Assessment

In Pager Power's experience, significant impacts to pedestrians/observers along PRoW are not possible due to glint and glare effects from solar developments. The reasoning is due to the sensitivity of the receptors (in terms of amenity and safety) being concluded to be of low significance because:

- Effects would typically coincide with direct sunlight. The Sun is a far more significant source of light;
- The reflection intensity is similar for solar panels and still water (and significantly less than reflections from glass and steel[22]) which is frequently a feature of the outdoor environment surrounding PRoW. Therefore, the reflections are likely to be comparable to those from common outdoor sources whilst navigating the natural and built environment on a regular basis;
- The typical density of pedestrians, cyclists and/or horse riders on a PRoW is low in a rural environment (such as the location of the Project);
- Any resultant effect is much less serious and has far lesser consequences than, for example, solar reflections experienced towards a road network whereby the resultant impacts of a solar reflection can be much more serious to safety;
- Glint and glare effects towards observers on a PRoW are transient, and time and location sensitive whereby the observer could move beyond the solar reflection zone with ease with little impact upon safety or amenity.

8.3 Conclusions

No significant impacts are predicted upon PRoW. No mitigation is recommended.

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

9 HIGH-LEVEL AVIATION CONSIDERATIONS

9.1 Overview

The following section presents an overview of the possible effects of glint and glare concerning aviation activity at Little Engeham Farm Airstrip at a high-level.

Little Engeham Farm Airstrip is located approximately 9.4km west of the Project. The location of the aerodrome relative to the Project and two-mile runway approach paths are shown in Figure 59 on the following page.

9.2 Aerodrome Details

Little Engeham Farm Airstrip is an unlicensed aerodrome and is not understood to have an Air Traffic Control (ATC) Tower. It has one operational runway, the details[23] of which are presented below:

- 03/21 measuring 530m by 40m (grass).

9.3 High-Level Assessment Conclusions

Considerations of the Project size, distance between the aerodrome and Project, and previous project experience are made during the assessment.

Reference to a pilot's primary field-of-view is made when determining the predicted impact significance, which is defined as 50 degrees either side of the 2-mile approach path, relative to the runway threshold.

For aviation activity associated with Little Engeham Farm Airstrip, the following can be concluded:

- Any solar reflections towards pilots approaching runway threshold 21 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 03 would have intensities no greater than 'low potential for temporary after-image'. Based upon site size, distance, and previous project experience, this level of glare is acceptable in accordance with the associated guidance and industry best practice.

As a result, no significant impacts are predicted upon aviation activity at Little Engeham Airstrip and detailed modelling is not recommended.

[23] As determined by available aerial imagery

Figure 59 *Location of Little Engeham Farm Airstrip relative to the proposed solar development*

10 OVERALL CONCLUSIONS

10.1 Assessment Conclusions – Aviation

10.1.1 Hamilton Farm Airstrip

Solar reflections are predicted towards the approach path and visual circuits for runways 04 and 22. Solar reflections towards the approach path for runway 22 will be outside of a pilot's primary field-of-view (50 degrees either side of the direction of travel). This is deemed acceptable in line with the associated guidance and industry standards; a low impact is predicted, and mitigation is not required.

Solar reflections towards the visual circuits for runways 04 and 22 are predicted to have 'potential for temporary after-image'. This is considered to be operationally accommodatable, given the size and expected usage of the airstrip; as such a low impact is predicted and no mitigation is recommended.

Solar reflections towards the approach path for runway 04 are predicted to have 'potential for temporary after-image', also known as 'yellow' glare. Considering the glare scenario, primarily the effects occurring outside the typical scheduled flight times of the airfield and the ability of the pilots to accommodate the glare, a low impact is predicted.

On the basis that the 'Hamilton Farm Airstrip Glint and Glare' report (see Appendix I) has been made available to the airfield, no further mitigation is recommended.

10.1.2 Meadow Farm Airstrip

Solar reflections are predicted towards the approach path and visual circuits for runway 18. Solar reflections towards the approach path will be outside of a pilot's primary field-of-view. This is deemed acceptable in line with the associated guidance and industry standards; a low impact is predicted, and mitigation is not required.

Solar reflections towards the visual circuits are predicted to be of an intensity no greater than 'potential for temporary after-image'. This is considered to be operationally accommodatable; as such a low impact is predicted and no mitigation is recommended.

No solar reflections are geometrically possible towards the approach path and visual circuits for runway 36. No impact is predicted, and no mitigation is required.

Overall, a low impact is predicted, and no mitigation is recommended.

10.1.3 Harringe Airfield

Solar reflections are predicted towards the approach path and visual circuits for runways 02 and 20. Solar reflections towards the approach paths for runways 02 and 20 will be outside of a pilot's primary field-of-view. This is deemed acceptable in line with the associated guidance and industry standards; a low impact is predicted, and mitigation is not required.

Solar reflections towards the visual circuits for runways 02 and 20 are predicted to be of an intensity no greater than 'potential for temporary after-image'. This is considered to be operationally accommodatable; as such a low impact is predicted and no mitigation is recommended.

Overall, a low impact is predicted, and no mitigation is recommended.

10.1.4 Bonnington Airstrip

No solar reflections are predicted towards the approach paths and visual circuits for runways 06 and 24.

No impact is predicted, and mitigation is not required.

10.1.5 Pent Farm Airstrip

Solar reflections are predicted towards the approach path and visual circuits for runway 05 and the visual circuits for runway 23. Solar reflections towards the splayed approach for runway 05 and visual circuit for runway 23 will be outside of a pilot's primary field-of-view. This is deemed acceptable in line with the associated guidance and industry standards; a low impact is predicted, and mitigation is not required.

Solar reflections towards the visual circuit for runway 05 are predicted to be of an intensity no greater than 'potential for temporary after-image'. This is considered to be operationally accommodatable; as such a low impact is predicted and no mitigation is recommended.

No solar reflections are geometrically possible towards the splayed approach path for runway 23. No impact is predicted, and no mitigation is required.

Overall, a low impact is predicted, and no mitigation is recommended.

10.2 Assessment Conclusions – Roads

Solar reflections are geometrically possible towards approximately 2.2km of Goldwell Lane, 1.8km of Roman Road, 900m of Forge Hill, 2.3km of Frith Road, and 700m of Chequer Tree Lane.

Existing screening, proposed landscaping, and intervening terrain is predicted to significantly obstruct views of reflecting panels along most of Goldwell Lane and all of Forge Hill, Roman Road, Frith Road and Chequer Tree Lane. No impact is predicted, and no further mitigation is required.

Partial views of the reflecting panels cannot be ruled out along a small section of Goldwell Lane, which is a local road with low traffic densities. A low impact is predicted and no further mitigation is recommended.

10.3 Assessment Conclusions – Dwellings

Solar reflections are geometrically possible towards 246 of the 267 assessed dwellings.

For 198 dwellings, screening in the form of existing and proposed landscaping and/or intervening terrain is predicted to significantly obstruct views of reflecting panels. No impact is predicted, and no further mitigation is required.

For 47 dwellings, effects are predicted to occur for less than three months per year and less than 60 minutes per day or the glare scenario sufficiently reduces the level of impact. A low impact is predicted, and no further mitigation is recommended.

For the remaining dwelling, a moderate impact is predicted. Provided that suitable mitigation is implemented, as outlined in Section 7.5.2, during detailed design, a negligible to low impact will remain.

10.4 Assessment Conclusions – Railway

Only a small section of the nearby HS1 Line between Ashford International and the Channel Tunnel touches the 500m study area, considering that solar reflections would not be geometrically possible north of the Project. Therefore, railway impacts are not predicted.

Network Rail have been consulted on the Project and have not raised any specific concerns relating to glint and glare.

10.5 High-Level Conclusions – Public Rights of Way

No significant impacts are predicted upon public rights of way. No mitigation is recommended.

10.6 High-Level Conclusions – Little Engeham Farm Airstrip

Any solar reflections towards Little Engeham Farm Airstrip are predicted to be acceptable in accordance with the associated guidance. Any possible solar reflections towards runway 03 would have an intensity no greater than 'low potential for temporary after-image', which is acceptable in line with the associated guidance and industry standards. Solar reflections would be outside a pilot's primary field-of-view (50 degrees either side of the approach bearing) for pilots on approach to runway 21.

Therefore, a low impact is predicted upon aviation activity at Little Engeham Farm Airstrip and detailed modelling is not recommended.

APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

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

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

UK Planning Policy

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[24] (specifically regarding the consideration of solar farms, paragraph 013) states:

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

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

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

…

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

…

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

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[24] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 14 August 2023, accessed on: 02 May 2024.

National Policy Statement for Renewable Energy Infrastructure

The National Policy Statement for Renewable Energy Infrastructure (EN-3)[25] 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.[26] However, solar panels may reflect the sun's rays at certain angles, causing glint and glare. Glint is defined as a momentary flash of light that may be produced as a direct reflection of the sun in the solar panel. Glare is a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from the face of the panel. The effect occurs when the solar panel is stationed between or at an angle of the sun and the receptor.

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

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

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

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

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

Sections 2.10.134-136 state:

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

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

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

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[25] National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Energy Security & Net Zero, date: January 2024, accessed on: 02 May 2024.

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

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

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

Sections 2.10.158-159 state:

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

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

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare is provided for assessing the impact of solar reflections upon surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the relevant 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[27] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

Assessment Process – Railways

Railway operations is not mentioned specifically within the Planning Policy Guidance however it is stated that a developer will need to consider *'the proposal's visual impact, the effect on landscape of glint and glare and on neighbouring uses…'.* Network Rail is a statutory consultee when a development is located in close proximity to its infrastructure.

No process for determining and contextualising the effects of glint and glare are, however, provided. Therefore, the Pager Power approach is to determine whether a reflection from a development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

[27] Pager Power Glint and Glare Guidance, Fourth Edition (4.0), August 2022.

Railway Assessment Guidelines

The following section provides an overview of the relevant railway guidance with respect to the siting of signals on railway lines. Network Rail is the stakeholder of the UK's railway infrastructure.

A railway operator's concerns would likely to relate to the following:

1. The development producing solar glare that affects train drivers; and
2. The development producing solar reflections that affect railway signals and create a risk of a phantom aspect signal.

Railway guidelines are presented below. These relate specifically to the sighting distance for railway signals.

Reflections and Glare

The extract below is taken from Section A5 – Reflections and glare (pages 64-65) of the 'Signal Sighting Assessment Requirements'[28] which details the requirement for assessing glare towards railway signals.

Reflections and glare

Rationale

Reflections can alter the appearance of a display so that it appears to be something else.

Guidance

A5 is present if direct glare or reflected light is directed into the eyes or into the lineside signalling asset that could make the asset appear to show a different aspect or indication to the one presented.

A5 is relevant to any lineside signalling asset that is capable of presenting a lit signal aspect or indication.

The extent to which excessive illumination could make an asset appear to show a different signal aspect or indication to the one being presented can be influenced by the product being used. Requirements for assessing the phantom display performance of signalling products are set out in GKRT0057 section 4.1.

Problems arising from reflection and glare occur when there is a very large range of luminance, that is, where there are some objects that are far brighter than others. The following types of glare are relevant:

a) *Disability glare, caused by scattering of light in the eye, can make it difficult to read a lit display.*
b) *Discomfort glare, which is often associated with disability glare. While being unpleasant, it does not affect the signal reading time directly, but may lead to distraction and fatigue.*

Examples of the adverse effect of disability glare include:

[28] Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 18.10.2016.

a) When a colour light signal presenting a lit yellow aspect is viewed at night but the driver is unable to determine whether the aspect is a single yellow or a double yellow.

b) Where a colour light signal is positioned beneath a platform roof painted white and the light reflecting off the roof can make the signal difficult to read.

Options for militating against A5 include:

a) Using a product that is specified to achieve high light source: phantom ratio values.

b) Alteration to the features causing the glare or reflection.

c) Provision of screening.

Glare is possible and should be assessed when the luminance is much brighter than other light sources. Glare may be unpleasant and therefore cause distraction and fatigue, or may make the signal difficult to read and increase the reading time.

Determining the Field of Focus

The extract below is taken from Appendix F - Guidance on Field of Vision (pages 98-101) of the 'Signal Sighting Assessment Requirements'[29] which details the visibility of signals, train drivers' field of vision and the implications with regard to signal positioning.

Asset visibility

The effectiveness of an observer's visual system in detecting the existence of a target asset will depend upon its:

a) Position in the observer's visual field.

b) Contrast with its background.

c) Luminance properties.

d) The observer's adaptation to the illumination level of the environment.

It is also influenced by the processes relating to colour vision, visual accommodation, and visual acuity. Each of these issues is described in the following sections.

[29] Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 28.08.2020.

Field of vision

The field of vision, or visual field, is the area of the visual environment that is registered by the eyes when both eyes and head are held still. The normal extent of the visual field is approximately 135o in the vertical plane and 200o in the horizontal plane.

The visual field is usually described in terms of central and peripheral regions: the central field being the area that provides detailed information. This extends from the central point (0^o) to approximately 30^o at each eye. The peripheral field extends from 30o out to the edge of the visual field.

F.6.3 Objects positioned towards the centre of the observer's field of vision are seen more quickly and identified more accurately because this is where our sensitivity to contrast is the highest. Peripheral vision is particularly sensitive to movement and light.

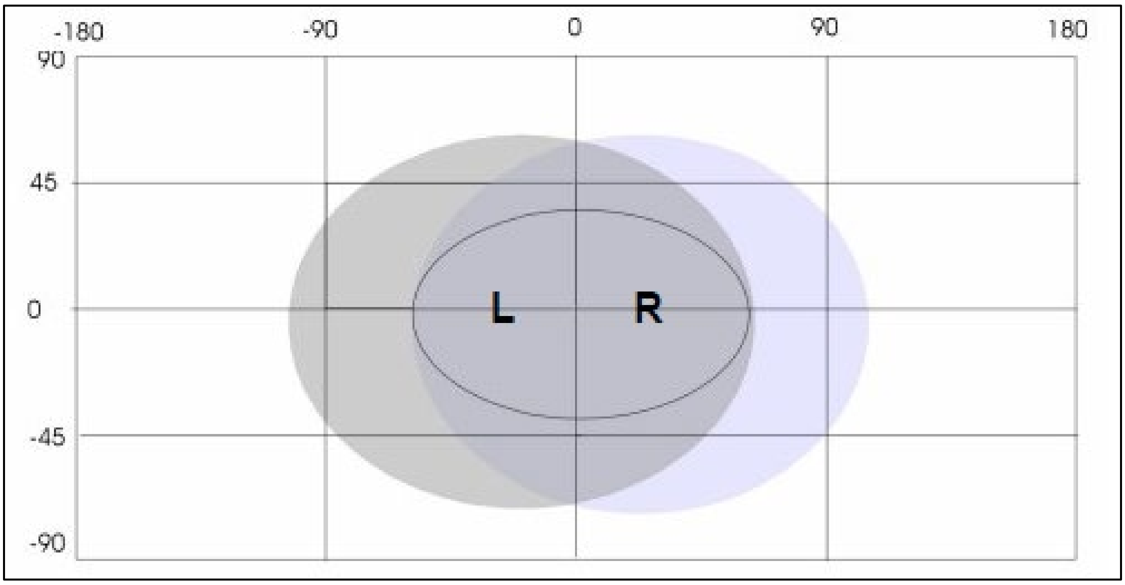

Figure G21 - Field-of-view

In Figure G21, the two shaded regions represent the view from the left eye (L) and the right eye (R) respectively. The darker shaded region represents the region of binocular overlap. The oval in the centre represents the central field of vision.

Research has shown that drivers search for signs or signals towards the centre of the field of vision. Signals, indicators and signs should be positioned at a height and distance from the running line that permits them to be viewed towards the centre of the field of vision. This is because:

- a) *As train speed increases, drivers become increasingly dependent on central vision for asset detection. At high speeds, drivers demonstrate a tunnel vision effect and focus only on objects in a field of + 8^o from the direction of travel.*
- b) *Sensitivity to movement in the peripheral field, even minor distractions can reduce the visibility of the asset if it is viewed towards the peripheral field of vision. The presence of clutter to the sides of the running line can be highly distracting (for example, fence posts, lamp-posts, traffic, or non-signal lights, such as house, compatibility factors or security lights).*

Figure G 22 and Table G 5 identify the radius of an 8o cone at a range of close-up viewing distances from the driver's eye. This shows that, depending on the lateral position of a stop signal, the optimal (normal) train stopping point could be as far as 25 m back from the signal to ensure that it is sufficiently prominent.

The dimensions quoted in Table G 5 assume that the driver is looking straight ahead. Where driver-only operation (DOO) applies, the drivers' line of sight at the time of starting the train is influenced by the location of DOO monitors and mirrors. In this case it may be appropriate to provide supplementary information alongside the monitors or mirrors using one of the following:

- *a) A co-acting signal.*
- *b) A miniature banner repeater indicator.*
- *c) A right away indicator.*
- *d) A sign to remind the driver to check the signal aspect.*

In order to prevent misreading by trains on adjacent lines, the co-acting signal or miniature banner repeater may be configured so that the aspect or indication is presented only when a train is at the platform to which it applies.

'Car stop' signs should be positioned so that the relevant platform starting signals and / or indicators can be seen in the driver's central field of vision.

If possible, clutter and non-signal lights in a driver's field-of-view should be screened off or removed so that they do not cause distraction.

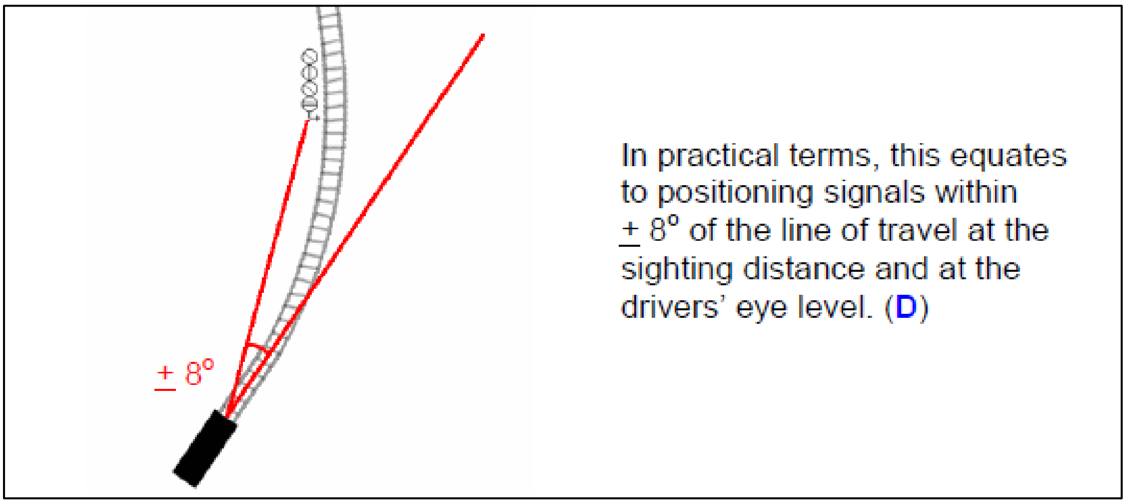

Figure G 22 - Signal positioning

'A' (m)	'B' (m)	Typical display positions
5	*0.70*	-
6	*0.84*	-

‘A’ (m)	‘B’ (m)	Typical display positions
7	*0.98*	-
8	*1.12*	-
9	*1.26*	-
10	*1.41*	-
11	*1.55*	-
12	*1.69*	-
13	*1.83*	-
14	*1.97*	-
15	*2.11*	*A stop aspect positioned 3.3 m above rail level and 2.1 m from the left hand rail is within the 8º cone at 15.44 m in front of the driver*
16	*2.25*	-
17	*2.39*	-
18	*2.53*	*A stop aspect positioned 5.1 m above rail level and 0.9 m from the left hand rail is within the 8º cone at 17.93 m in front of the driver*
19	*2.67*	-
20	*2.81*	-
21	*2.95*	-
22	*3.09*	-
23	*3.23*	-
24	*3.37*	-
25	*3.51*	*A stop aspect positioned 3.3 m above rail level and 2.1 m from the right hand rail is within the 8º cone at 25.46 m in front of the driver*

Table G 5 – 8º cone angle co-ordinates for close-up viewing

The distance at which the 8° cone along the track is initiated is dependent on the minimum reading time and distance which is associated to the speed of trains along the track. This is discussed below.

Determining the Assessed Minimum Reading Time

The extract below is taken from section B5 (pages 8-9) of the 'Guidance on Signal Positioning and Visibility' which details the required minimum reading time for a train driver when approaching a signal.

'B5.2.2 Determining the assessed minimum reading time

GE/RT8037

The assessed minimum reading time shall be no less than eight seconds travelling time before the signal.

The assessed minimum reading time shall be greater than eight seconds where there is an increased likelihood of misread or failure to observe. Circumstances where this applies include, but are not necessarily limited to, the following:

a) *the time taken to identify the signal is longer (for example, because the signal being viewed is one of a number of signals on a gantry, or because the signal is viewed against a complex background)*
b) *the time taken to interpret the information presented by the signal is longer (for example, because the signal is capable of presenting route information for a complex layout ahead)*
c) *there is a risk that the need to perform other duties could cause distraction from viewing the signal correctly (for example, the observance of lineside signs, a station stop between the caution and stop signals, or DOO (P) duties)*
d) *the control of the train speed is influenced by other factors (for example, anticipation of the signal aspect changing).*

The assessed minimum reading time shall be determined using a structured format approved by the infrastructure controller.'

The distance at which a signal should be clearly viewable is determined by the maximum speed of the trains along the track. If there are multiple signals present at a location then an additional 0.2 seconds reading time is added to the overall viewing time.

Signal Design and Lighting System

Many railway signals are now LED lights and not filament (incandescent) bulbs. The benefits of an LED signal over a filament bulb signal with respect to possible phantom aspect illuminations are as follows:

- An LED railway signal produces a more intense light making them more visible to approaching trains when compared to the traditional filament bulb technology[30];
- No reflective mirror is present within the LED signal itself unlike a filament bulb. The presence of the reflective surfaces greatly increases the likelihood of incoming light being reflecting out making the signal appear illuminated.

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[30] Source: Wayside LED Signals – Why it's Harder than it Looks, Bill Petit.

Many LED signal manufacturers[31,32,33] claim that LED signal lights significantly reduce or completely remove the likelihood of a phantom aspect illumination occurring.

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[34] however the advice is still applicable[35] 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[36], 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

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[31] Source: http://www.unipartdorman.co.uk/assets/unipart_dorman_rail_brochure.pdf. (Last accessed 21.02.18).

[32] Source: http://www.vmstech.co.uk/downloads/Rail.pdf. (Last accessed 21.02.18).

[33] Source: Siemens, Sigmaguard LED Tri-Colour L Signal – LED Signal Technology at Incandescent Prices. Datasheet 1A-23. (Last accessed 22.02.18).

[34] Archived at Pager Power

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

[36] Aerodrome Licence Holder.

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

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

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

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

FAA Guidance

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

The 2010 document is entitled 'Technical Guidance for Evaluating Selected Solar Technologies on Airports'[37], the 2013 update is entitled 'Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports'[38], and the 2021 final policy is entitled 'Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports'[39].

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

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[37] Archived at Pager Power

[38] 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.

[39] 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.

that it has analyzed the potential for glint and glare and determined there is no potential for ocular impact to the airport's ATCT cab. This process will enable FAA to evaluate the solar energy system project, with assurance that the system will not impact the ATCT cab.

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

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

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

In 2018, the FAA released the latest version (Version 1.1) of the 'Technical Guidance for Evaluating Selected Solar Technologies on Airports'[40]. 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[41].*
- *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[42], 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*

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

[41] 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.

[42] First figure in Appendix B.

polished, the more it shines. Rough or uneven surfaces reflect light in a diffused or scattered manner and, therefore, the light will not be received as bright.

- *Because the FAA has no specific standards for airport solar facilities and potential glare, the type of glare analysis may vary. Depending on site specifics (e.g., existing land uses, location and size of the project) an acceptable evaluation could involve one or more of the following levels of assessment:*
  - *A qualitative analysis of potential impact in consultation with the Control Tower, pilots and airport officials;*
  - *A demonstration field test with solar panels at the proposed site in coordination with FAA Tower personnel;*
  - *A geometric analysis to determine days and times when an impact is predicted.*
- *The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and system design.*
- ***1. Assessing Baseline Reflectivity Conditions** – Reflection in the form of glare is present in current aviation operations. The existing sources of glare come from glass windows, auto surface parking, rooftops, and water bodies. At airports, existing reflecting surfaces may include hangar roofs, surface parking, and glassy office buildings. To minimize unexpected glare, windows of air traffic control towers and airplane cockpits are coated with anti-reflective glazing. Operators also wear polarized eye wear. Potential glare from solar panels should be viewed in this context. Any airport considering a solar PV project should first 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[43] *but still requires further research to definitively answer.*

- ***Experiences of Existing Airport Solar Projects*** *– Solar installations are presently operating at a number of airports, including megawatt-sized solar facilities covering multiple acres. Air traffic control towers have expressed concern about glint and glare from a small number of solar installations. These were often instances when solar installations were sited between the tower and airfield, or for installations with inadequate or no reflectivity analysis. Adequate reflectivity analysis and alternative siting addressed initial issues at those installations.*

Air Navigation Order (ANO) 2016

In some instances, an aviation stakeholder can refer to the ANO 2016[44] 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.'

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[43] 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.
[44] The Air Navigation Order 2016. [online] Available at: <https://www.legislation.gov.uk/uksi/2016/765/contents/made> [Accessed 4 February 2022].

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

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

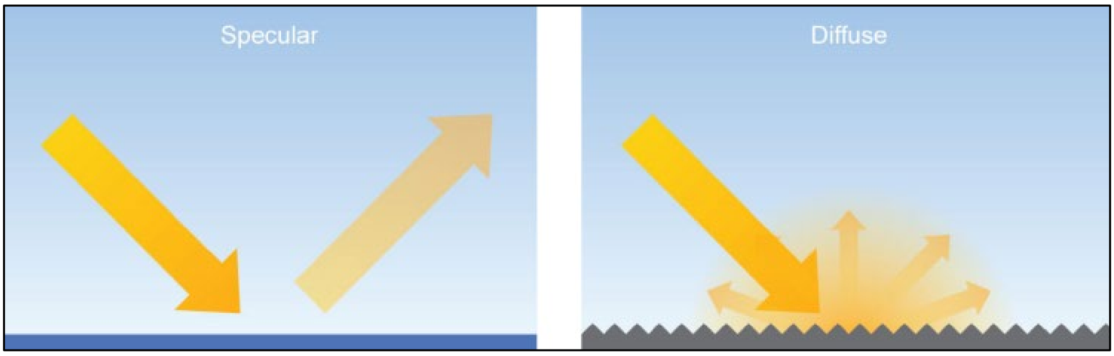
Overview

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[45], 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

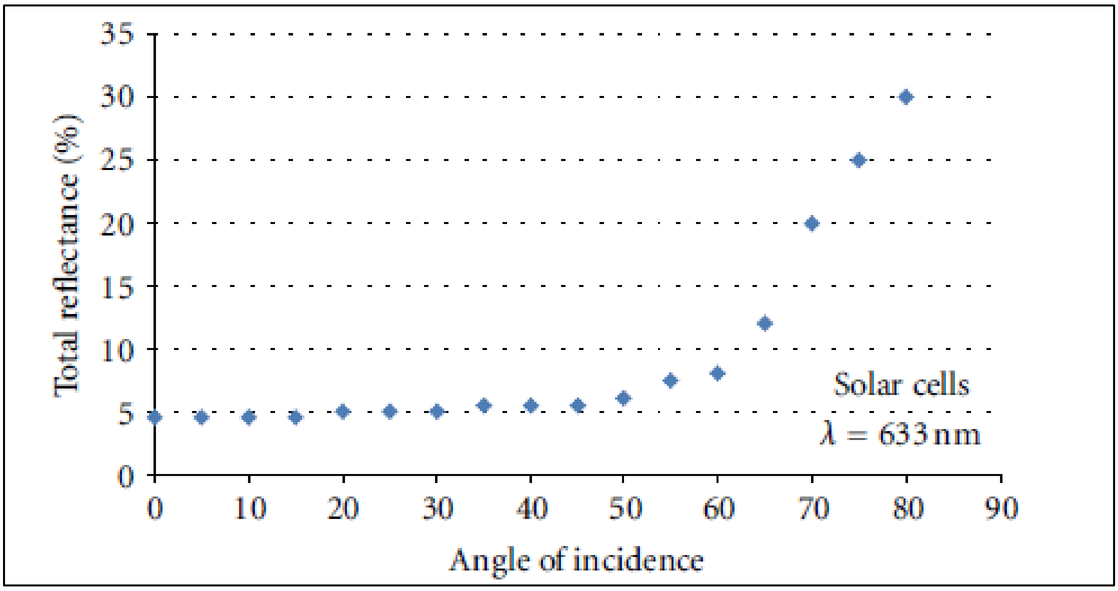
[45] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

Solar Reflection Studies

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

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

Evan Riley and Scott Olson published in 2011 their study titled: A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems[46]". 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.

[46] 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"[47]

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[48]
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.

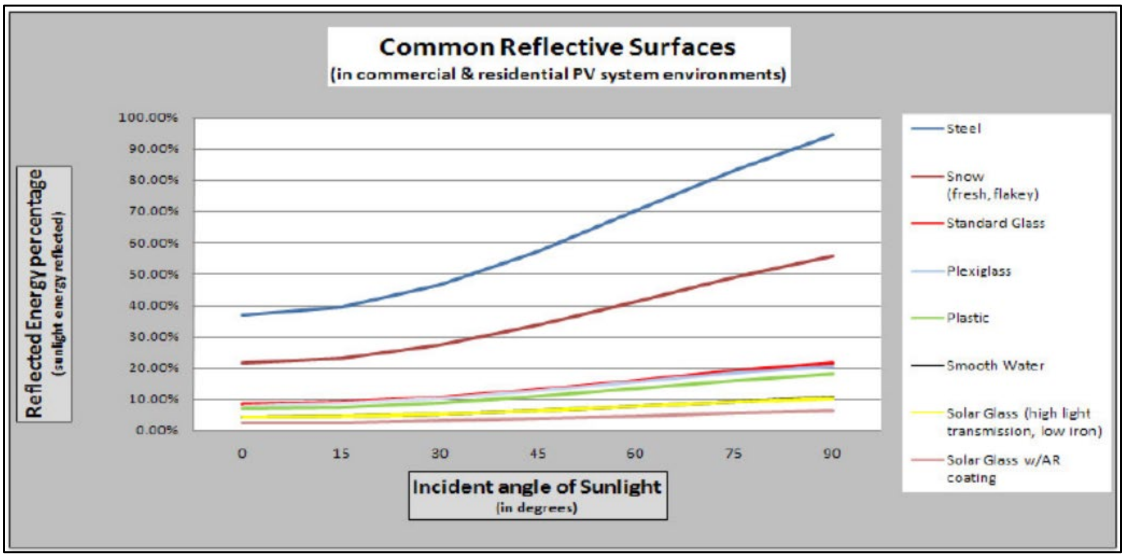
[47] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

[48] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

SunPower Technical Notification (2009)

SunPower published a technical notification[49] 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.

[49] 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).

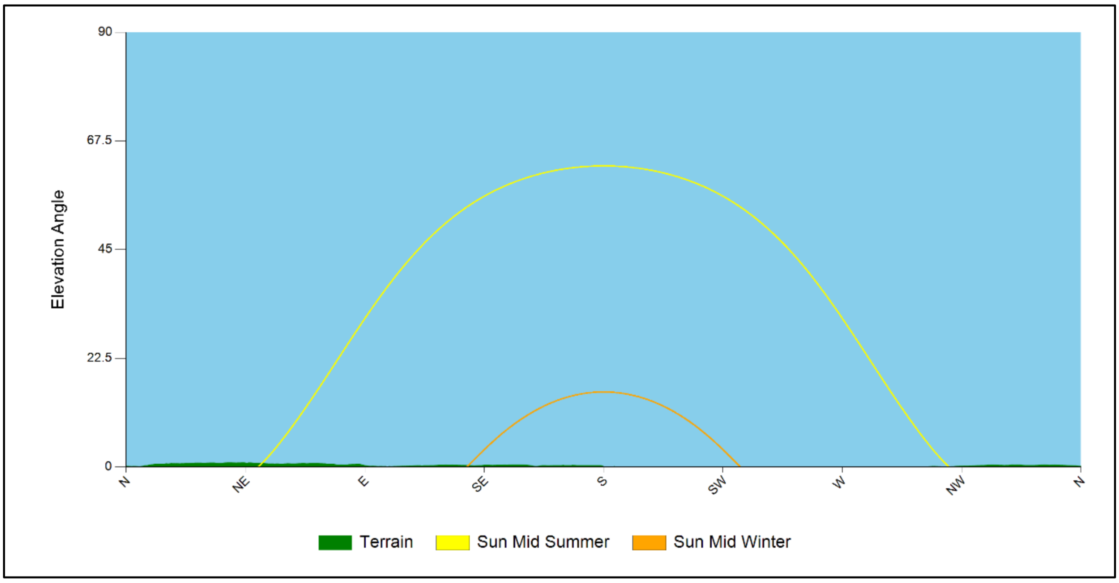
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- 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

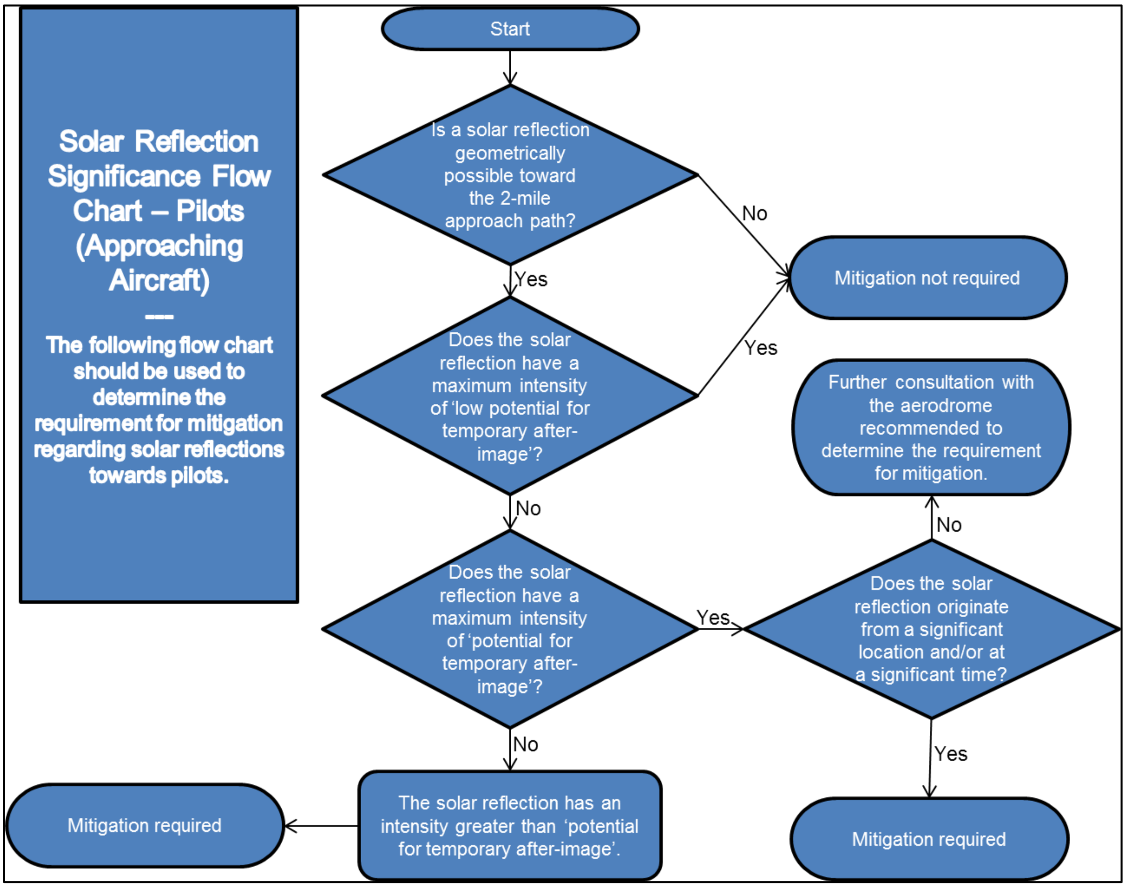
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

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 Approaching Aircraft

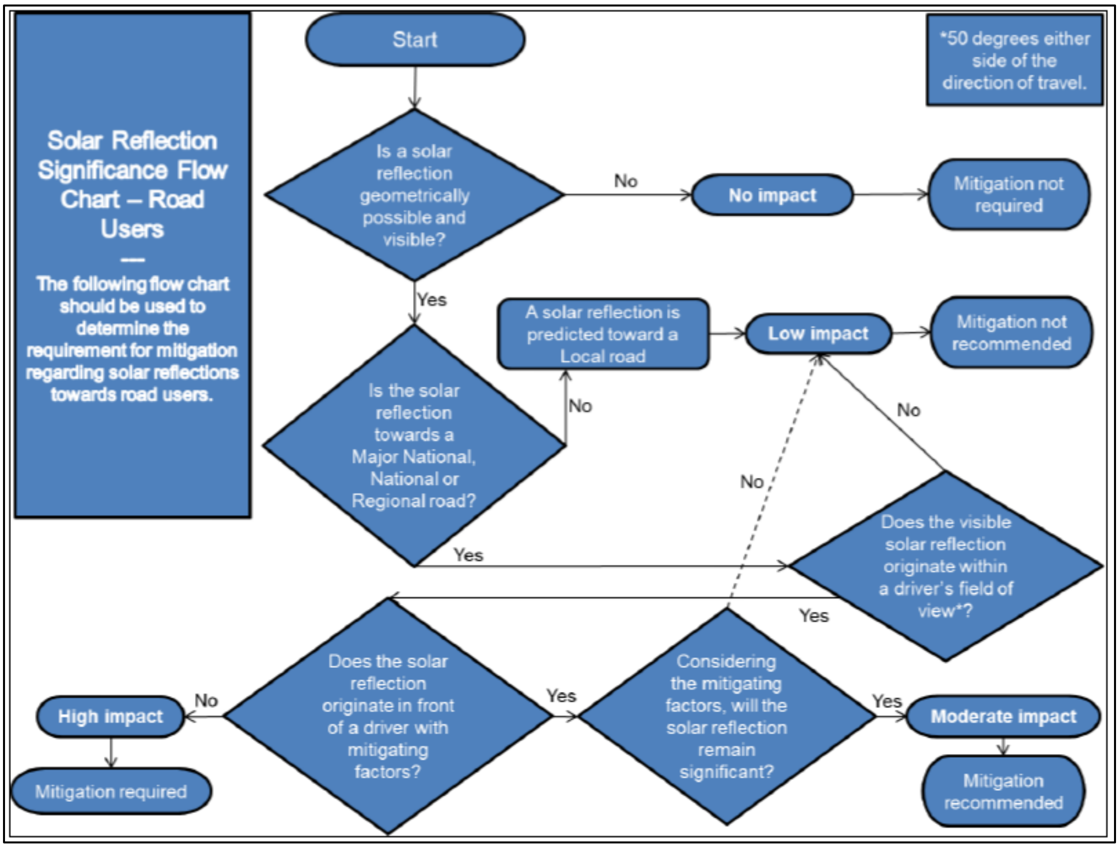
The flow chart presented below has been followed when determining the mitigation requirement for approaching aircraft.



Approaching aircraft receptor impact significance flow chart

Impact Significance Determination for Road Receptors

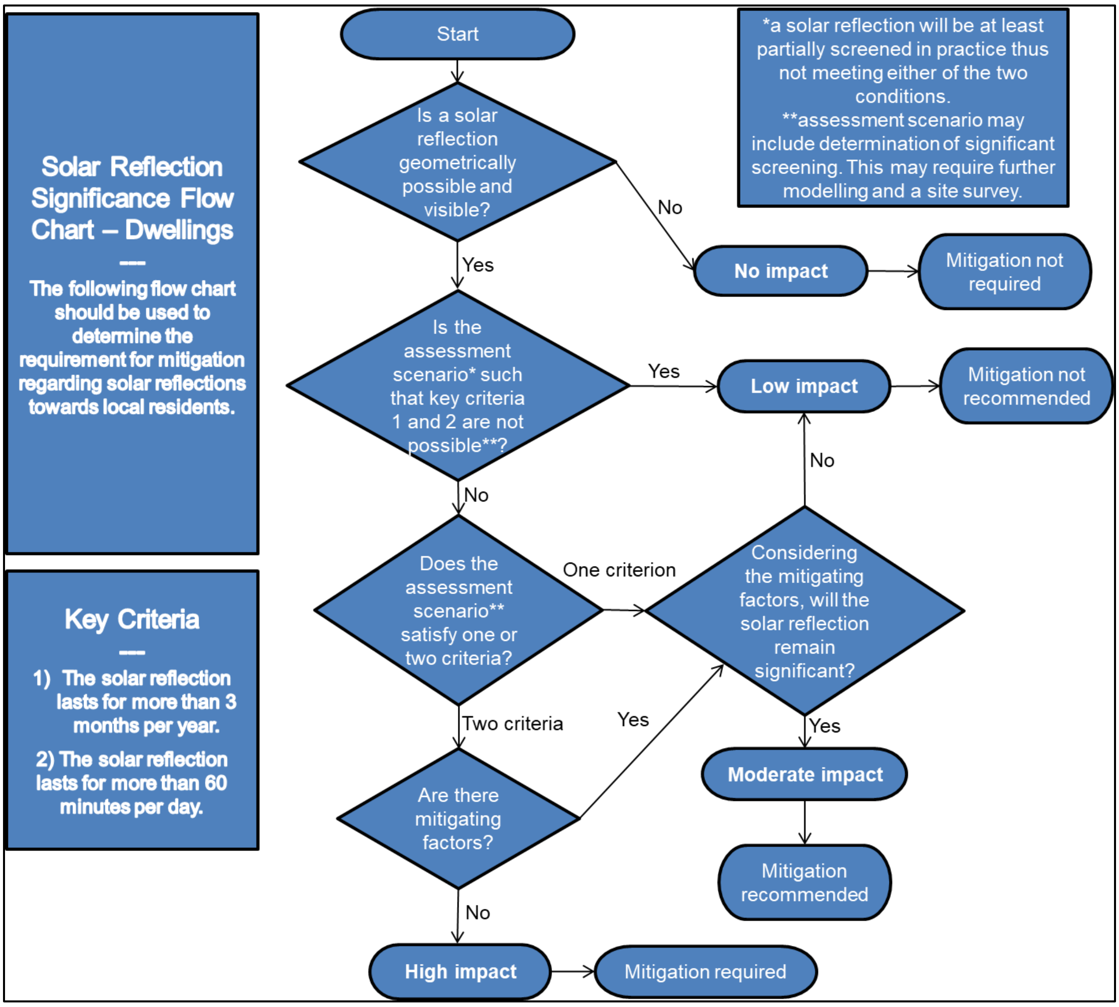
The flow chart presented below has been followed when determining the mitigation requirement for road receptors.



Road receptor impact significance flow chart

Impact Significance Determination for Dwelling Receptors

The flow chart presented below has been followed when determining the mitigation requirement for dwelling receptors.



Dwelling receptor impact significance flow chart

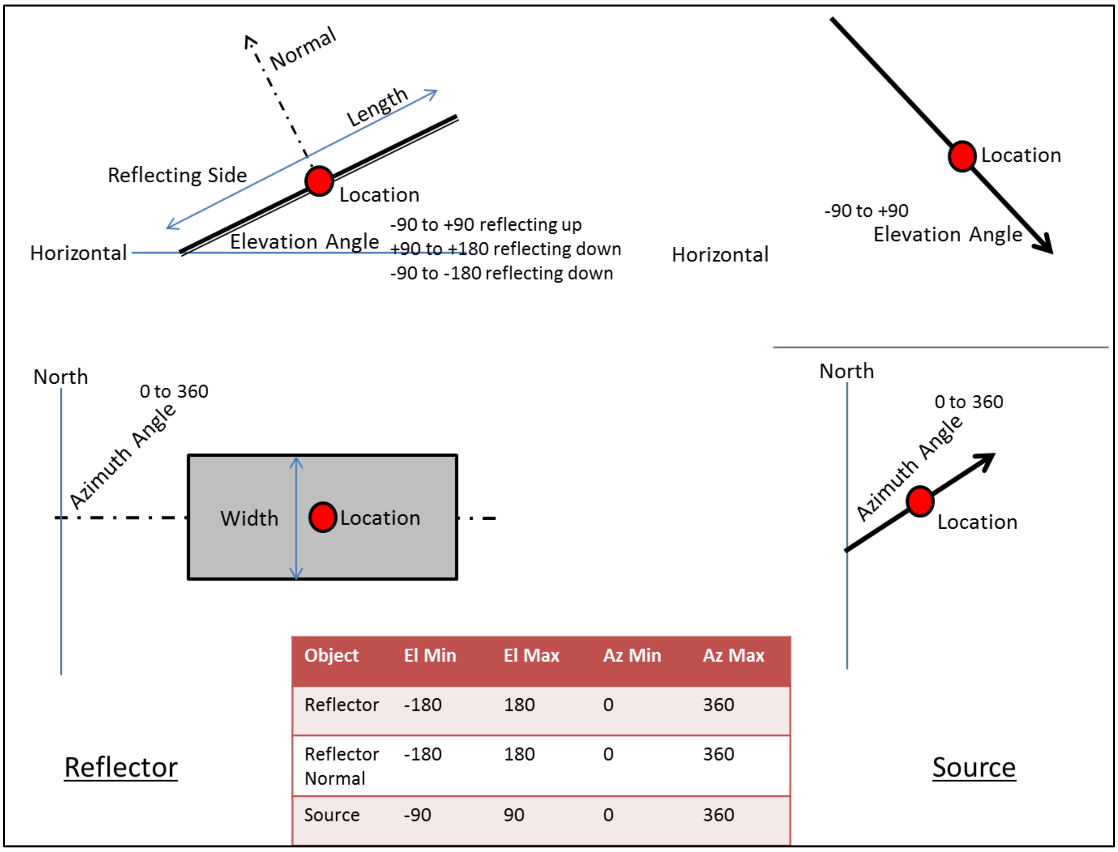
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power Methodology

The calculations are three dimensional and complex, accounting for:

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

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



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

Reflection calculation process

The following process is used to determine the 3D Azimuth and Elevation of a reflection:

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

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)[50].

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

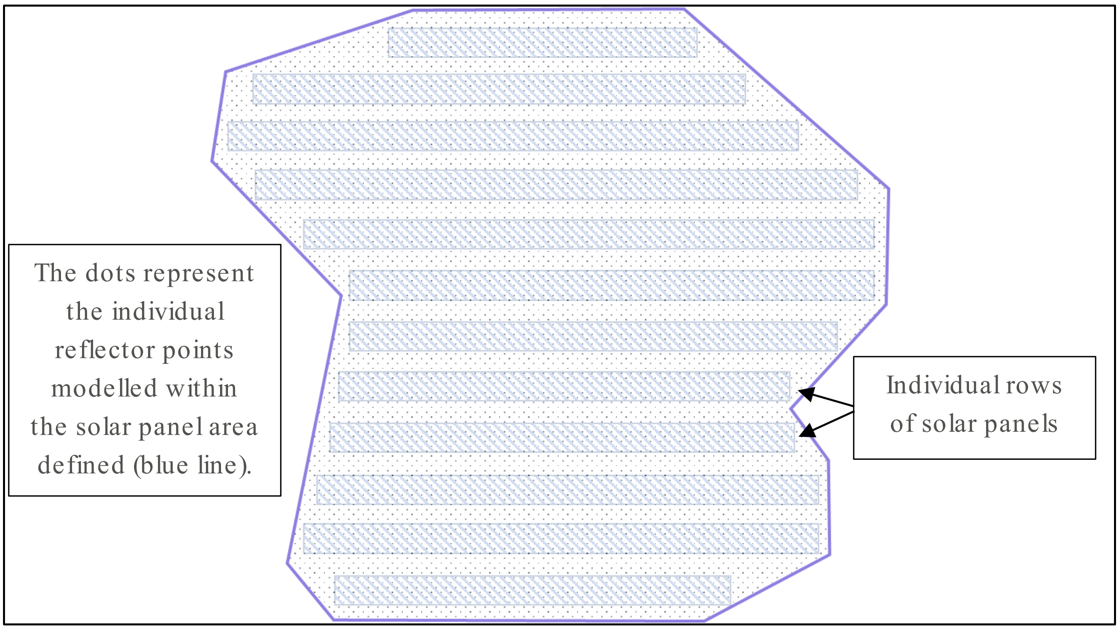
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

Only a reflection from the face of the panel has been considered. The frames and supports have not been considered because these surfaces represent a much smaller surface area than the solar panels and they are not flat surfaces where specular reflections are likely to occur. This means they will not significantly add to the identified effects.

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.

[50] 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[51] 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.

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

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Airfield Details

The table below presents the data for the assessed airfields, including runway details. The receptor locations are based on the methodology set out in Section 5.1.6.

Airfield	Threshold	Longitude (°)	Latitude (°)	Threshold Height (m) (amsl)
Hamilton Farm Airstrip	04	0.88536	51.09149	51
	22	0.89092	51.09572	39
Meadow Farm Airstrip	18	0.87318	51.06704	34
	36	0.87292	51.06417	16
Harringe Airfield	02	0.98802	51.09027	89
	20	0.98990	51.09382	83
Bonnington Airstrip	06	0.94502	51.05787	2
	24	0.95057	51.05963	2
Pent Farm Airstrip	05	1.04725	51.10644	79
	23	1.05903	51.11172	93

Assessed airfield information

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.

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
1	0.94889	51.10639	53.9	41	0.94752	51.09016	75.4
2	0.94819	51.10560	50.1	42	0.94637	51.09071	75.8
3	0.94685	51.10542	49.5	43	0.94534	51.09131	75.5

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
4	0.94599	51.10477	49.2	44	0.94426	51.09190	80.9
5	0.94616	51.10388	48.5	45	0.94320	51.09249	81.5
6	0.94636	51.10298	48.5	46	0.94215	51.09310	79.4
7	0.94686	51.10216	48.5	47	0.94110	51.09373	75.5
8	0.94744	51.10141	48.5	48	0.94009	51.09434	70.9
9	0.94879	51.10109	50.1	49	0.93897	51.09491	69.9
10	0.95008	51.10081	50.5	50	0.93745	51.09463	62.6
11	0.94990	51.09991	51.8	51	0.93600	51.09463	59.7
12	0.94984	51.09903	53.5	52	0.93461	51.09449	58.8
13	0.94962	51.09816	55.6	53	0.93320	51.09440	58.2
14	0.94950	51.09725	57.6	54	0.93179	51.09434	58.7
15	0.94934	51.09635	60.6	55	0.93034	51.09428	57.5
16	0.94898	51.09550	63.1	56	0.92893	51.09421	54.8
17	0.94836	51.09468	69.1	57	0.92749	51.09415	55.1
18	0.94767	51.09391	73.8	58	0.92607	51.09414	54.3
19	0.94692	51.09313	76.8	59	0.92463	51.09424	55.4
20	0.94633	51.09230	78.5	60	0.92323	51.09435	55.4
21	0.94583	51.09147	76.5	61	0.92179	51.09445	55.5
22	0.94402	51.09118	77.9	62	0.92038	51.09455	54.5
23	0.94304	51.09053	70.9	63	0.91898	51.09465	53.5
24	0.94246	51.08971	65.2	64	0.91754	51.09475	52.5

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
25	0.94175	51.08894	59.4	65	0.91610	51.09486	51.5
26	0.94068	51.08837	54.4	66	0.91469	51.09496	48.5
27	0.93957	51.08788	49.0	67	0.91326	51.09507	47.4
28	0.93895	51.08707	38.3	68	0.91185	51.09518	48.1
29	0.93833	51.08627	32.3	69	0.91045	51.09528	47.9
30	0.95824	51.08366	92.5	70	0.90901	51.09539	48.1
31	0.95743	51.08436	94.0	71	0.90760	51.09549	47.2
32	0.95681	51.08515	92.3	72	0.90619	51.09546	47.5
33	0.95623	51.08598	89.0	73	0.90474	51.09539	46.8
34	0.95572	51.08680	84.5	74	0.90631	51.09615	48.6
35	0.95478	51.08748	81.8	75	0.90598	51.09702	48.7
36	0.95347	51.08779	81.4	76	0.90564	51.09789	49.6
37	0.95208	51.08802	76.5	77	0.90527	51.09876	50.4
38	0.95091	51.08849	71.9	78	0.90444	51.09947	49.5
39	0.94980	51.08906	72.9	79	0.90324	51.09997	49.5
40	0.94865	51.08961	74.5	80	0.90190	51.10026	49.5

Road receptor data

Dwelling Receptor Data

The dwelling receptor data is presented in the table below. 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	0.96515	51.09711	58.9	135	0.94705	51.10028	50.1
2	0.96418	51.09580	54.8	136	0.94588	51.10016	49.8
3	0.96293	51.09594	53.8	137	0.94634	51.10524	49.8
4	0.97114	51.09318	57.8	138	0.94664	51.10511	49.8
5	0.97109	51.09289	58.4	139	0.95014	51.10124	49.9
6	0.96213	51.09323	59.0	140	0.94986	51.09818	55.5
7	0.96193	51.09301	59.6	141	0.94929	51.09806	56.0
8	0.96187	51.09263	60.4	142	0.94886	51.09744	57.5
9	0.96913	51.08975	61.4	143	0.94880	51.09719	58.0
10	0.96820	51.08937	64.2	144	0.94889	51.09701	58.6
11	0.96185	51.09001	69.1	145	0.94878	51.09682	59.1
12	0.96227	51.08942	71.1	146	0.94859	51.09640	60.8
13	0.96228	51.08927	71.6	147	0.94926	51.09551	63.8
14	0.96231	51.08865	79.9	148	0.94874	51.09492	67.2
15	0.96190	51.08890	77.7	149	0.94876	51.09475	67.9
16	0.96158	51.08879	79.2	150	0.94891	51.09444	68.8
17	0.96108	51.08882	82.1	151	0.92129	51.09040	34.0
18	0.96402	51.08745	78.3	152	0.92071	51.09037	33.4
19	0.96426	51.08729	75.8	153	0.91839	51.09195	45.3

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
20	0.96193	51.08754	84.7	154	0.91773	51.09194	43.8
21	0.96158	51.08738	85.0	155	0.91702	51.09327	49.6
22	0.95999	51.08690	87.8	156	0.91871	51.09353	53.4
23	0.95727	51.08596	90.5	157	0.91808	51.09383	53.3
24	0.95674	51.08595	90.3	158	0.91814	51.09411	53.5
25	0.95513	51.08436	84.1	159	0.91808	51.09447	53.3
26	0.95515	51.08685	81.0	160	0.91582	51.09397	49.3
27	0.95445	51.08727	80.6	161	0.91556	51.09401	48.6
28	0.95414	51.08740	80.9	162	0.91534	51.09409	48.9
29	0.94977	51.08850	74.2	163	0.91500	51.09423	46.4
30	0.95060	51.08893	72.0	164	0.91639	51.09463	51.8
31	0.94709	51.09050	76.1	165	0.91592	51.09471	51.1
32	0.94692	51.09059	76.8	166	0.91541	51.09471	50.2
33	0.94676	51.09067	76.8	167	0.91512	51.09477	48.7
34	0.94660	51.09075	76.8	168	0.91442	51.09489	46.8
35	0.94643	51.09082	76.4	169	0.91405	51.09488	46.6
36	0.94627	51.09090	76.3	170	0.91364	51.09494	47.5
37	0.94615	51.09110	76.8	171	0.91308	51.09494	47.3
38	0.94610	51.09126	76.8	172	0.91338	51.09515	48.0
39	0.94607	51.09146	76.9	173	0.91337	51.09571	49.3
40	0.94638	51.09161	77.6	174	0.91442	51.09582	49.7

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
41	0.94649	51.09176	77.9	175	0.91435	51.09599	50.0
42	0.94656	51.09192	78.0	176	0.91412	51.09616	50.5
43	0.94611	51.09241	78.8	177	0.91517	51.09628	50.7
44	0.94582	51.09251	79.3	178	0.91478	51.09643	51.0
45	0.94629	51.09261	78.8	179	0.91265	51.09691	51.8
46	0.94469	51.09140	77.5	180	0.91095	51.09678	50.8
47	0.94396	51.09160	80.9	181	0.91109	51.09533	48.9
48	0.94386	51.09181	81.5	182	0.90956	51.09507	47.7
49	0.94341	51.09207	81.5	183	0.90766	51.09570	47.8
50	0.94308	51.09222	81.8	184	0.90721	51.09556	46.8
51	0.94268	51.09219	81.2	185	0.90663	51.09484	46.7
52	0.94237	51.09239	81.6	186	0.90642	51.09525	47.8
53	0.94239	51.09262	81.8	187	0.90618	51.09707	49.6
54	0.94331	51.09274	81.8	188	0.90484	51.09881	50.3
55	0.94390	51.09291	81.7	189	0.90444	51.09914	49.8
56	0.94335	51.09314	81.3	190	0.90435	51.09934	49.8
57	0.94356	51.09335	80.8	191	0.90604	51.10020	50.8
58	0.94380	51.09355	80.3	192	0.90718	51.10108	51.8
59	0.94338	51.09381	79.8	193	0.90845	51.10124	55.4
60	0.94377	51.09411	79.2	194	0.91721	51.09616	51.8
61	0.94387	51.09445	77.9	195	0.91843	51.09698	54.5

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
62	0.94301	51.09449	77.5	196	0.91868	51.09670	53.9
63	0.94371	51.09495	76.4	197	0.91887	51.09651	54.3
64	0.94322	51.09496	76.2	198	0.92054	51.09626	55.8
65	0.94346	51.09543	75.2	199	0.92050	51.09586	55.8
66	0.94298	51.09559	74.9	200	0.91953	51.09826	54.8
67	0.94247	51.09572	73.9	201	0.91920	51.09875	54.2
68	0.94207	51.09544	74.2	202	0.91168	51.10266	57.0
69	0.94173	51.09517	74.9	203	0.91514	51.10374	52.0
70	0.94159	51.09494	75.4	204	0.91570	51.10394	51.7
71	0.94141	51.09477	75.7	205	0.91653	51.10429	50.5
72	0.94120	51.09444	75.0	206	0.91838	51.10528	49.7
73	0.94057	51.09427	72.8	207	0.91729	51.10524	49.6
74	0.94044	51.09446	73.1	208	0.91707	51.10532	49.7
75	0.94005	51.09459	71.4	209	0.91683	51.10543	49.5
76	0.93990	51.09472	71.7	210	0.91656	51.10552	49.6
77	0.93944	51.09481	70.3	211	0.91627	51.10564	49.8
78	0.93921	51.09491	70.1	212	0.91602	51.10576	49.8
79	0.93905	51.09499	70.5	213	0.91563	51.10590	49.8
80	0.93890	51.09509	71.2	214	0.91489	51.10586	50.8
81	0.9387	51.09519	71.8	215	0.91552	51.10631	49.8
82	0.938709	51.094536	67.9	216	0.91500	51.10652	50.1

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
83	0.938236	51.09473	68.9	217	0.90391	51.10584	56.9
84	0.938574	51.09490	70.3	218	0.90404	51.10614	57.8
85	0.93842	51.09509	71.7	219	0.90443	51.10637	58.3
86	0.938073	51.09516	70.7	220	0.92316	51.10259	50.8
87	0.93799	51.09528	71.0	221	0.93045	51.09928	64.8
88	0.937736	51.09541	71.8	222	0.92331	51.08739	35.1
89	0.937503	51.09548	69.8	223	0.92465	51.08681	37.1
90	0.937333	51.09558	69.3	224	0.92442	51.08779	37.2
91	0.937192	51.09565	68.1	225	0.92539	51.08970	35.8
92	0.943647	51.09370	80.1	226	0.92774	51.08863	47.9
93	0.936999	51.09576	68.8	227	0.92811	51.08855	49.3
94	0.936732	51.09599	68.0	228	0.92898	51.08913	52.8
95	0.936665	51.09616	68.0	229	0.93051	51.08822	54.7
96	0.936474	51.09627	66.8	230	0.93085	51.08811	55.1
97	0.936312	51.09636	67.3	231	0.93177	51.08776	53.2
98	0.936148	51.09646	66.9	232	0.93103	51.08666	43.8
99	0.933858	51.09673	72.1	233	0.93199	51.08667	43.6
100	0.932425	51.09641	73.8	234	0.93307	51.08786	54.1
101	0.93643	51.09489	61.0	235	0.93362	51.08797	53.9
102	0.935488	51.09488	60.6	236	0.93447	51.08835	56.1
103	0.936671	51.09426	59.4	237	0.93332	51.08982	56.2

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
104	0.935999	51.09419	58.0	238	0.93480	51.09017	55.9
105	0.933815	51.09476	59.9	239	0.93570	51.08829	53.2
106	0.932032	51.09463	60.4	240	0.93616	51.08831	53.2
107	0.931523	51.09462	60.3	241	0.93651	51.08764	47.7
108	0.929768	51.09464	56.9	242	0.93756	51.08815	50.4
109	0.929569	51.09466	57.1	243	0.93759	51.08852	52.4
110	0.928957	51.09456	56.5	244	0.93817	51.08803	51.3
111	0.928277	51.09456	56.5	245	0.93911	51.08830	53.6
112	0.928025	51.09477	57.3	246	0.93947	51.08856	55.8
113	0.927686	51.09449	56.4	247	0.93988	51.08853	55.8
114	0.927377	51.09467	56.7	248	0.93909	51.08757	44.1
115	0.926964	51.09451	56.5	249	0.93883	51.08720	40.4
116	0.92601	51.09486	56.2	250	0.93881	51.08651	34.4
117	0.925622	51.09468	55.8	251	0.93900	51.08619	31.5
118	0.925006	51.09445	55.8	252	0.93949	51.08602	30.7
119	0.92303	51.09446	55.8	253	0.93974	51.08601	30.8
120	0.924692	51.09391	55.0	254	0.94017	51.08584	29.9
121	0.925312	51.09324	52.5	255	0.94038	51.08619	31.7
122	0.937883	51.09842	64.0	256	0.94106	51.08736	43.1
123	0.938647	51.09877	61.2	257	0.94140	51.08838	53.9
124	0.942721	51.09704	66.3	258	0.94166	51.08868	56.9

No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)	No.	Longitude (°)	Latitude (°)	Assessed Height (m amsl)
125	0.945647	51.09830	54.5	259	0.94196	51.08883	58.5
126	0.944966	51.09867	53.1	260	0.94229	51.08884	59.7
127	0.945182	51.09897	52.2	261	0.94244	51.08927	62.7
128	0.945467	51.09927	51.5	262	0.94291	51.08949	64.5
129	0.946506	51.09904	50.9	263	0.94162	51.08954	63.6
130	0.946941	51.09945	51.0	264	0.94229	51.09008	68.0
131	0.946714	51.09963	50.7	265	0.94321	51.09014	69.5
132	0.946641	51.09984	50.2	266	0.94338	51.09044	70.8
133	0.946864	51.09996	50.1	267	0.94365	51.09060	72.9
134	0.946748	51.10021	49.8				

Dwelling receptor data

Modelled Reflector Areas

The modelled reflector areas are presented in the tables below and on the following pages.

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	0.91715	51.10301	70	0.92990	51.09923
2	0.91715	51.10295	71	0.92860	51.10014
3	0.91731	51.10294	72	0.92802	51.10015
4	0.91730	51.10265	73	0.92864	51.10039
5	0.91705	51.10244	74	0.92865	51.10044
6	0.91692	51.10244	75	0.92858	51.10052
7	0.91671	51.10223	76	0.92806	51.10082
8	0.91650	51.10223	77	0.92748	51.10113
9	0.91564	51.10148	78	0.92632	51.10167

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
10	0.91619	51.10115	79	0.92595	51.10168
11	0.91662	51.10114	80	0.92615	51.10142
12	0.91661	51.10121	81	0.92596	51.10103
13	0.91708	51.10119	82	0.92558	51.10074
14	0.91709	51.10091	83	0.92556	51.10053
15	0.91668	51.10092	84	0.92528	51.10054
16	0.91667	51.10085	85	0.92527	51.10019
17	0.92000	51.09968	86	0.92603	51.09966
18	0.92081	51.09966	87	0.92610	51.09951
19	0.92015	51.09912	88	0.92656	51.09949
20	0.92015	51.09899	89	0.92618	51.09933
21	0.92043	51.09891	90	0.92604	51.09916
22	0.92133	51.09874	91	0.92617	51.09867
23	0.92151	51.09873	92	0.92606	51.09844
24	0.92152	51.09859	93	0.92586	51.09845
25	0.92205	51.09843	94	0.92536	51.09800
26	0.92224	51.09843	95	0.92532	51.09766
27	0.92226	51.09827	96	0.92488	51.09766
28	0.92149	51.09715	97	0.92450	51.09761
29	0.92156	51.09706	98	0.92432	51.09797
30	0.92199	51.09697	99	0.92361	51.09802
31	0.92291	51.09685	100	0.92347	51.09822
32	0.92341	51.09683	101	0.92434	51.09820
33	0.92354	51.09655	102	0.92550	51.09883

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
34	0.92402	51.09646	103	0.92539	51.09917
35	0.92442	51.09645	104	0.92520	51.09940
36	0.92484	51.09680	105	0.92457	51.09971
37	0.92620	51.09634	106	0.92402	51.09973
38	0.92690	51.09632	107	0.92415	51.10007
39	0.92688	51.09605	108	0.92406	51.10041
40	0.92696	51.09597	109	0.92386	51.10042
41	0.92796	51.09557	110	0.92395	51.10064
42	0.92966	51.09553	111	0.92459	51.10063
43	0.93012	51.09559	112	0.92501	51.10070
44	0.93012	51.09586	113	0.92507	51.10078
45	0.92992	51.09630	114	0.92498	51.10092
46	0.92989	51.09646	115	0.92499	51.10111
47	0.93046	51.09668	116	0.92554	51.10178
48	0.93050	51.09684	117	0.92555	51.10190
49	0.93077	51.09683	118	0.92542	51.10198
50	0.93188	51.09761	119	0.92444	51.10229
51	0.93241	51.09730	120	0.92406	51.10231
52	0.93260	51.09730	121	0.92395	51.10217
53	0.93272	51.09736	122	0.92389	51.10194
54	0.93291	51.09735	123	0.92233	51.10209
55	0.93344	51.09713	124	0.92237	51.10303
56	0.93382	51.09712	125	0.92151	51.10349
57	0.93398	51.09746	126	0.92130	51.10350

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
58	0.93360	51.09770	127	0.92053	51.10285
59	0.93304	51.09792	128	0.92035	51.10251
60	0.93278	51.09794	129	0.92065	51.10248
61	0.93215	51.09838	130	0.92063	51.10221
62	0.93178	51.09868	131	0.92002	51.10222
63	0.93146	51.09891	132	0.91969	51.10193
64	0.93112	51.09907	133	0.91935	51.10186
65	0.93069	51.09908	134	0.91873	51.10214
66	0.93055	51.09899	135	0.91927	51.10271
67	0.93065	51.09886	136	0.91918	51.10281
68	0.92970	51.09889	137	0.91777	51.10351
69	0.92986	51.09904	138	0.91759	51.10351

Fields 1-9

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	0.92941	51.10035	56	0.94662	51.10193
2	0.93141	51.09921	57	0.94654	51.10223
3	0.93157	51.09921	58	0.94639	51.10240
4	0.93208	51.09952	59	0.94604	51.10242
5	0.93383	51.09905	60	0.94585	51.10264
6	0.93304	51.09830	61	0.94618	51.10263
7	0.93401	51.09785	62	0.94606	51.10291
8	0.93482	51.09737	63	0.94558	51.10310
9	0.93609	51.09689	64	0.94518	51.10352
10	0.93646	51.09688	65	0.94482	51.10375

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
11	0.93730	51.09790	66	0.94433	51.10391
12	0.93707	51.09801	67	0.94383	51.10394
13	0.93645	51.09817	68	0.94342	51.10488
14	0.93652	51.09835	69	0.94264	51.10527
15	0.93761	51.09904	70	0.94189	51.10558
16	0.93873	51.10017	71	0.93947	51.10623
17	0.93914	51.10005	72	0.93872	51.10624
18	0.93959	51.09996	73	0.93837	51.10552
19	0.93978	51.09996	74	0.93820	51.10461
20	0.93991	51.10017	75	0.93835	51.10429
21	0.94037	51.10017	76	0.93631	51.10434
22	0.94049	51.10003	77	0.93630	51.10411
23	0.94060	51.10001	78	0.93605	51.10398
24	0.94062	51.09978	79	0.93612	51.10324
25	0.94006	51.09940	80	0.93615	51.10276
26	0.94000	51.09843	81	0.93593	51.10250
27	0.93972	51.09843	82	0.93507	51.10267
28	0.93955	51.09824	83	0.93433	51.10269
29	0.94032	51.09791	84	0.93371	51.10256
30	0.94073	51.09791	85	0.93358	51.10241
31	0.94101	51.09811	86	0.93335	51.10186
32	0.94156	51.09788	87	0.93343	51.10185
33	0.94199	51.09786	88	0.93341	51.10155
34	0.94295	51.09748	89	0.93306	51.10157

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
35	0.94320	51.09748	90	0.93305	51.10185
36	0.94448	51.09841	91	0.93204	51.10224
37	0.94450	51.09859	92	0.93151	51.10226
38	0.94445	51.09867	93	0.93194	51.10271
39	0.94257	51.09953	94	0.93191	51.10283
40	0.94222	51.09954	95	0.93178	51.10284
41	0.94222	51.10025	96	0.93185	51.10305
42	0.94275	51.10025	97	0.93230	51.10304
43	0.94313	51.10068	98	0.93252	51.10320
44	0.94314	51.10075	99	0.93244	51.10332
45	0.94506	51.10069	100	0.93189	51.10355
46	0.94506	51.10063	101	0.93135	51.10371
47	0.94620	51.10061	102	0.92976	51.10411
48	0.94668	51.10132	103	0.92955	51.10412
49	0.94668	51.10138	104	0.92917	51.10361
50	0.94555	51.10142	105	0.92875	51.10290
51	0.94541	51.10184	106	0.92844	51.10237
52	0.94532	51.10208	107	0.92850	51.10217
53	0.94562	51.10206	108	0.92832	51.10150
54	0.94586	51.10169	109	0.92803	51.10131
55	0.94660	51.10168	110	0.92802	51.10119

Fields 10-19

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	0.95115	51.09164	23	0.95709	51.09365
2	0.95156	51.09163	24	0.95716	51.09419
3	0.95186	51.09225	25	0.95744	51.09464
4	0.95155	51.09278	26	0.95665	51.09496
5	0.95131	51.09280	27	0.95594	51.09498
6	0.95132	51.09307	28	0.95590	51.09526
7	0.95155	51.09308	29	0.95412	51.09599
8	0.95156	51.09318	30	0.95286	51.09653
9	0.95192	51.09336	31	0.95263	51.09653
10	0.95199	51.09394	32	0.95241	51.09611
11	0.95223	51.09422	33	0.95221	51.09593
12	0.95248	51.09457	34	0.95218	51.09569
13	0.95285	51.09472	35	0.95229	51.09567
14	0.95287	51.09501	36	0.95234	51.09540
15	0.95336	51.09500	37	0.95270	51.09522
16	0.95365	51.09507	38	0.95188	51.09524
17	0.95414	51.09510	39	0.95173	51.09479
18	0.95404	51.09494	40	0.95132	51.09446
19	0.95413	51.09445	41	0.95086	51.09381
20	0.95514	51.09400	42	0.95070	51.09338
21	0.95556	51.09398	43	0.94964	51.09341
22	0.95644	51.09367	44	0.94907	51.09228

Fields 20-22

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	0.94693	51.10258	17	0.94986	51.10455
2	0.94715	51.10228	18	0.94958	51.10456
3	0.94723	51.10178	19	0.94927	51.10427
4	0.94744	51.10162	20	0.94915	51.10393
5	0.94806	51.10146	21	0.94882	51.10392
6	0.94927	51.10143	22	0.94819	51.10357
7	0.95000	51.10225	23	0.94739	51.10305
8	0.94925	51.10265	24	0.94770	51.10287
9	0.94885	51.10266	25	0.94843	51.10284
10	0.94851	51.10285	26	0.94884	51.10260
11	0.94884	51.10299	27	0.94807	51.10246
12	0.94898	51.10313	28	0.94805	51.10239
13	0.94934	51.10312	29	0.94765	51.10241
14	0.94982	51.10333	30	0.94737	51.10263
15	0.94988	51.10344	31	0.94693	51.10264
16	0.94977	51.10375			

Fields 23-24

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	0.94944	51.10532	13	0.95113	51.10682
2	0.94946	51.10539	14	0.95114	51.10686
3	0.94983	51.10539	15	0.94937	51.10691
4	0.95026	51.10552	16	0.94914	51.10646
5	0.95053	51.10573	17	0.94922	51.10634
6	0.95053	51.10579	18	0.94991	51.10632

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
7	0.95026	51.10579	19	0.94988	51.10602
8	0.95028	51.10594	20	0.94965	51.10582
9	0.95072	51.10594	21	0.94871	51.10583
10	0.95121	51.10651	22	0.94831	51.10548
11	0.95121	51.10657	23	0.94825	51.10536
12	0.95055	51.10659			

Field 25

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.

For approach paths, two further charts are shown within the Forge modelling results:

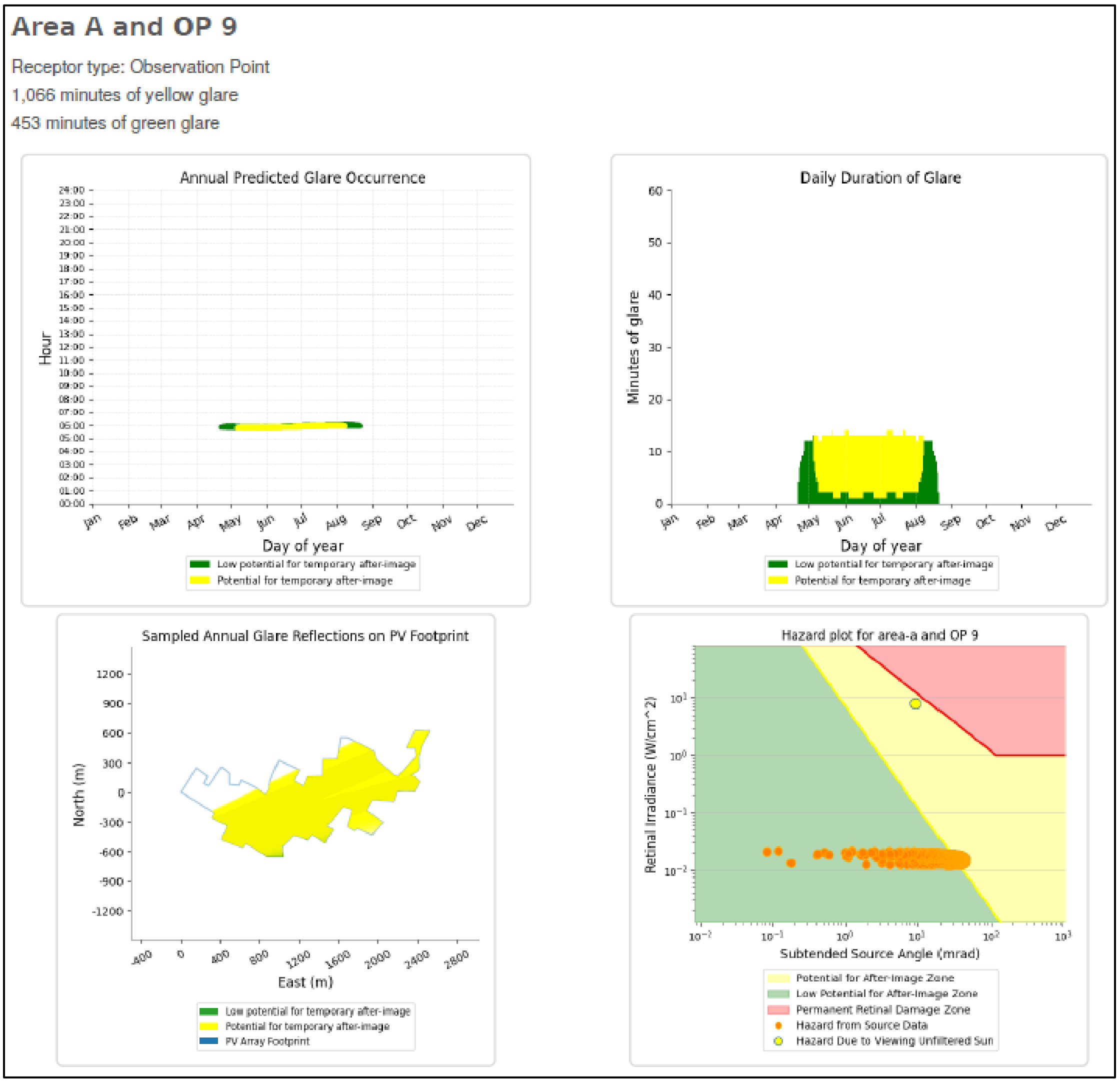
- Locations along the approach path receiving glare.
- The dates when glare would occur at each location along the approach.

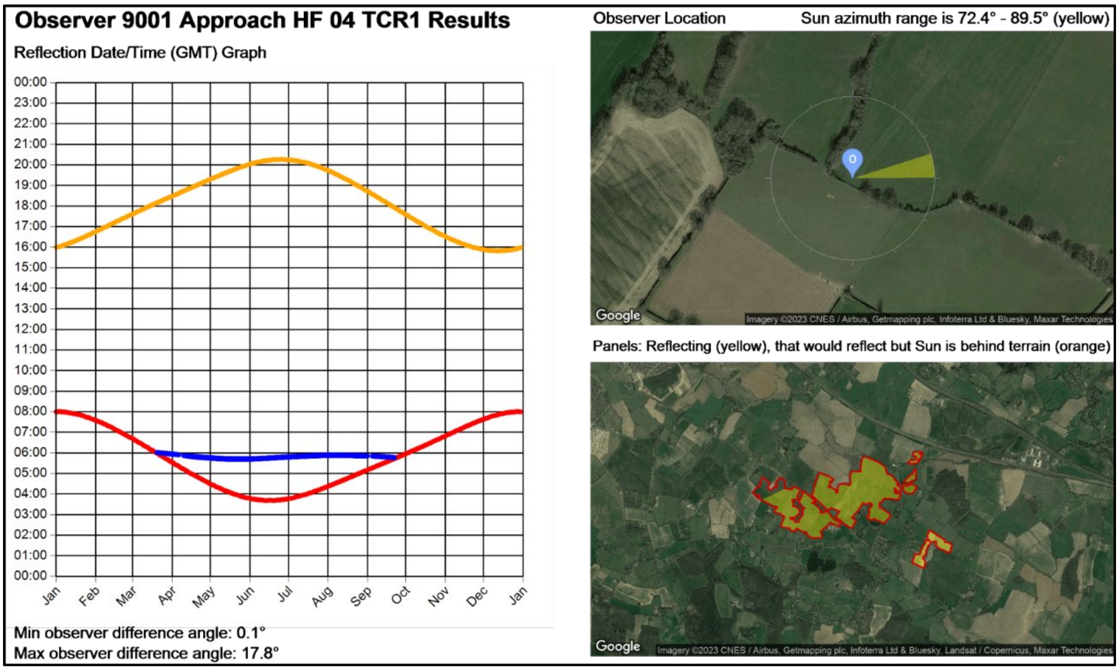
Full modelling results can be provided upon request.

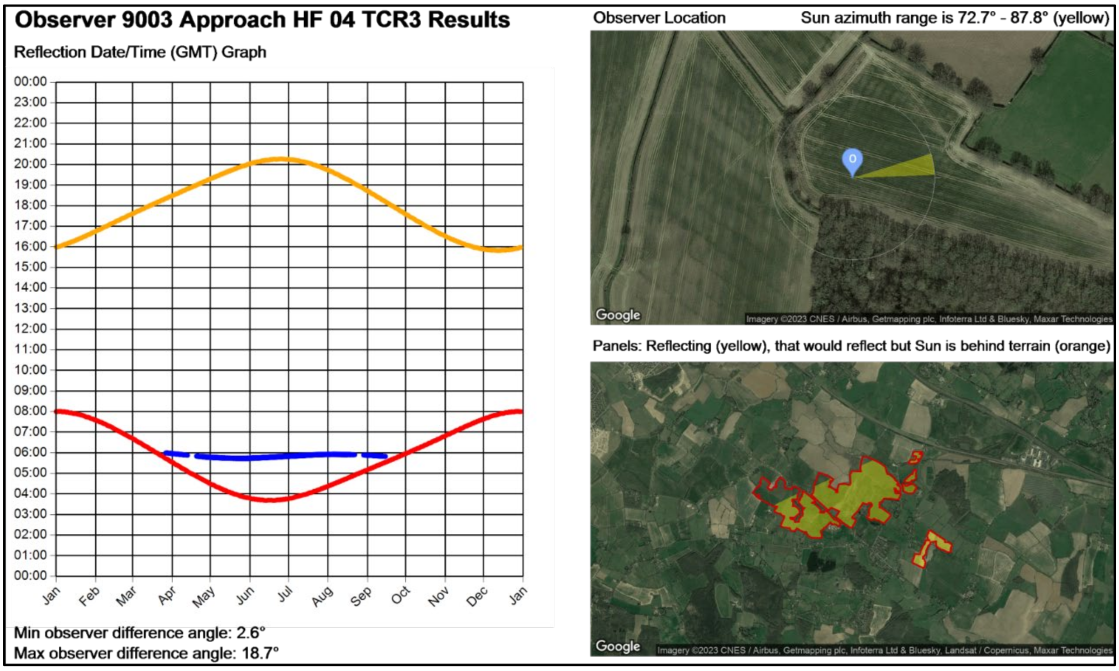
Aviation Receptors

Selected results have been included for the splayed approach for runway 04 at Hamilton Farm Airstrip to show a range of representative results.

Forge

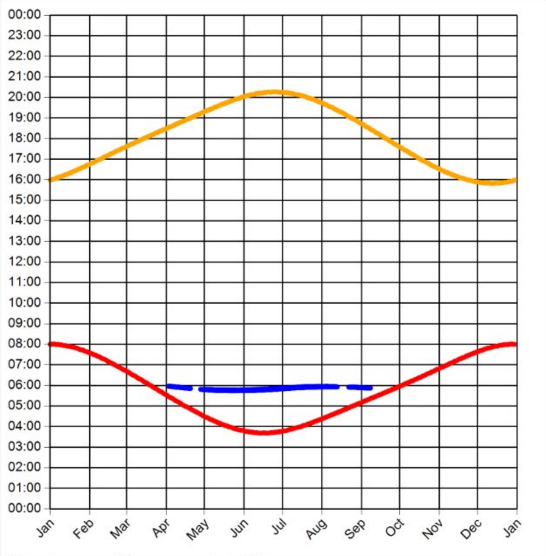



Observer 9001 Approach HF 04 TCR1 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0.1°
Max observer difference angle: 17.8°
Observer Location
Sun azimuth range is 72.4° - 89.5° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 9003 Approach HF 04 TCR3 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 2.6°
Max observer difference angle: 18.7°
Observer Location
Sun azimuth range is 72.7° - 87.8° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Observer 9005 Approach HF 04 TCR5 Results

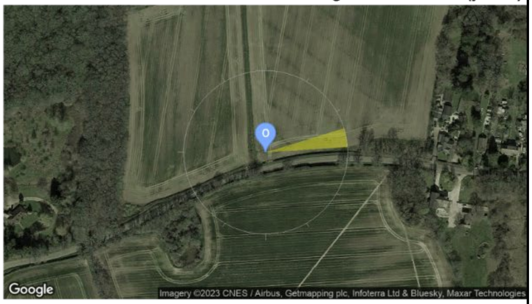
Reflection Date/Time (GMT) Graph



Min observer difference angle: 5.2°
Max observer difference angle: 19.4°

Observer Location

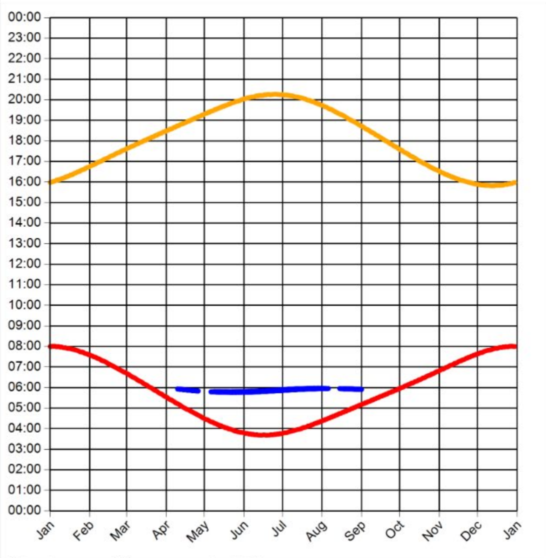
Sun azimuth range is 72.8° - 86.2° (yellow)



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

Observer 9007 Approach HF 04 TCR7 Results

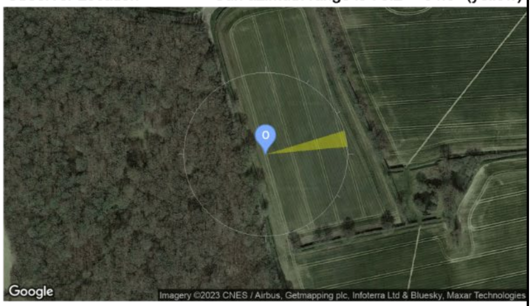
Reflection Date/Time (GMT) Graph



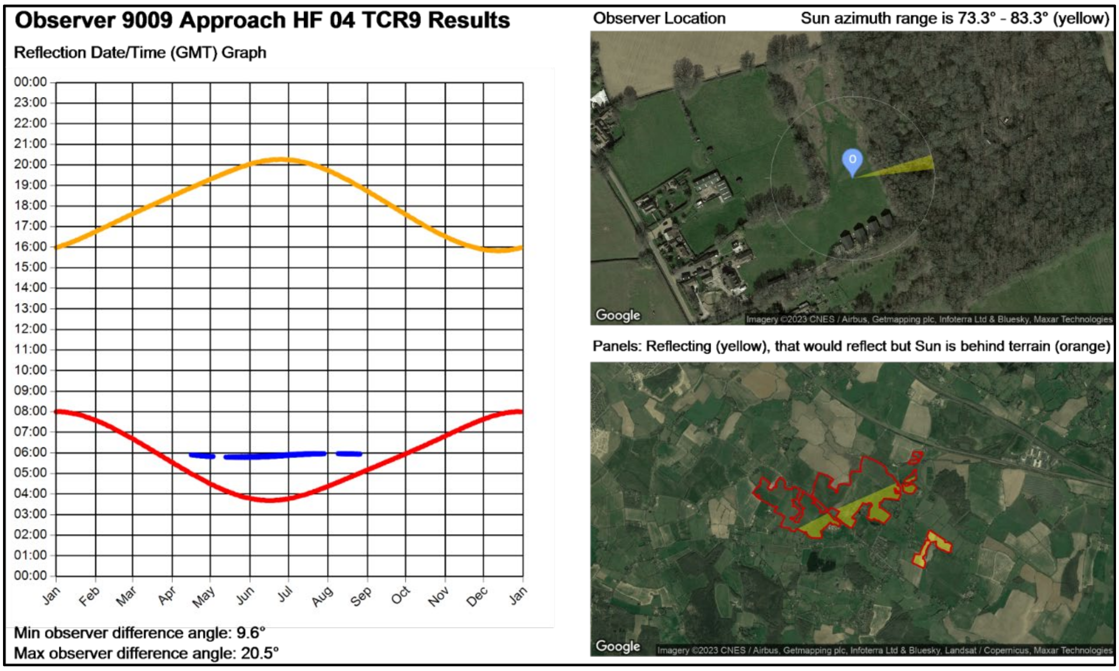
Min observer difference angle: 7.5°
Max observer difference angle: 20°

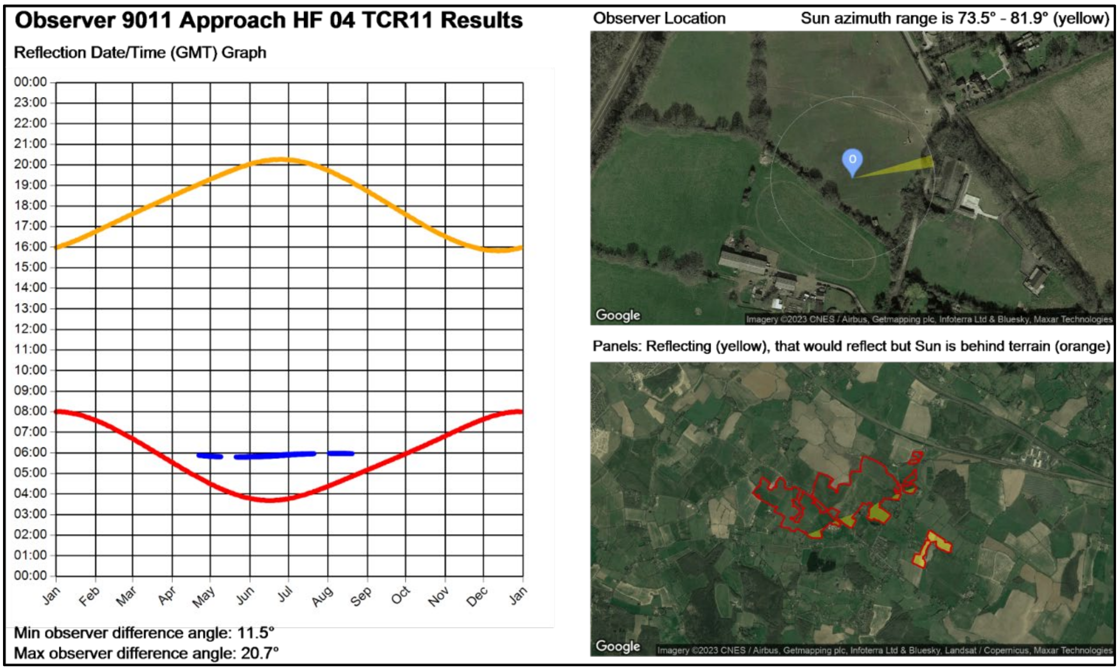
Observer Location

Sun azimuth range is 73.2° - 84.6° (yellow)



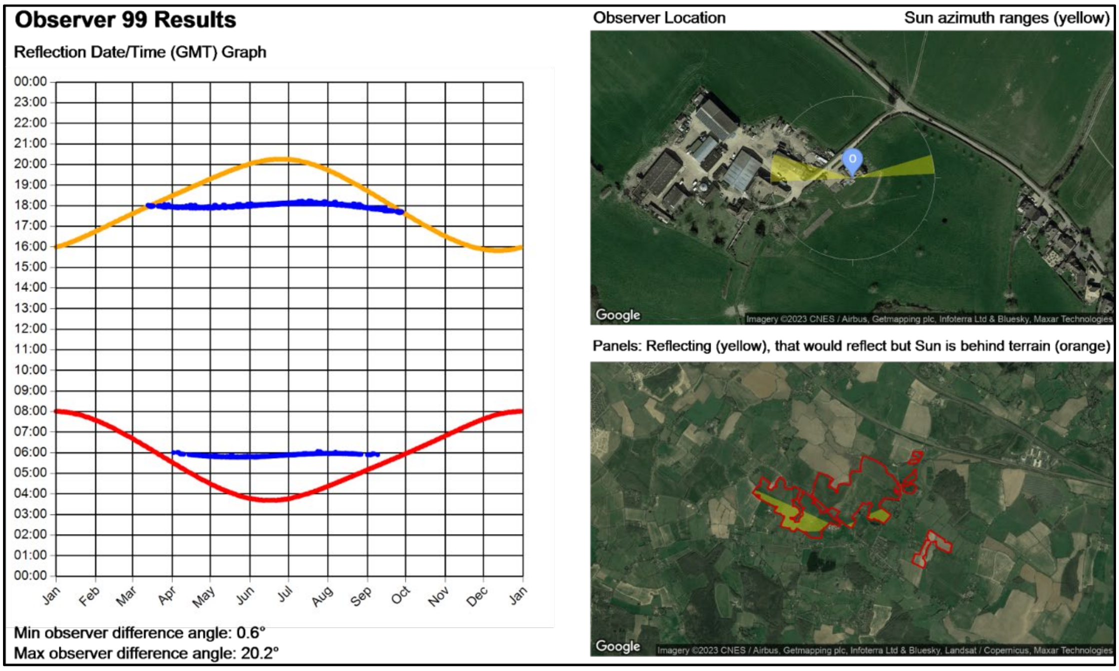
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)


Observer 9009 Approach HF 04 TCR9 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 9.6°
Max observer difference angle: 20.5°
Observer Location
Sun azimuth range is 73.3° - 83.3° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 9011 Approach HF 04 TCR11 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 11.5°
Max observer difference angle: 20.7°
Observer Location
Sun azimuth range is 73.5° - 81.9° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Dwelling Receptors

The charts for the receptor where a moderate impact has been predicted is provided below.



APPENDIX I - HAMILTON FARM AIRSTRIP GLINT AND GLARE

Purpose of this Report

Pager Power has been retained to assess the possible effects of glint and glare from a fixed ground-mounted solar photovoltaic development, located near Ashford, Kent, UK.

The purpose of this report is to evidence why effects towards Hamilton Farm Airstrip can be operationally accommodated and so it can be used to make the pilots at the airfield aware of the potential effects.

Geometric Modelling Results

The results of the geometric calculation for aviation receptors at Hamilton Farm Airstrip are presented in the table below.

Receptor/Runway	Geometric Modelling Result	Glare Intensity	Comment
Runway 04 Splayed Approach	Solar reflections are geometrically possible between the threshold and 1-mile from the threshold		Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards this approach path
Runway 22 Splayed Approach	Solar reflections are geometrically possible between the threshold and 1-mile from the threshold		Any solar reflections would be outside of a pilot's primary field-of-view
Runway 04 Visual Circuits	Solar reflections are geometrically possible along the left-hand base leg, right-hand base leg, and right-hand base leg joins		Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards sections of the visual circuits
Runway 22 Visual Circuits	Solar reflections are geometrically possible along sections of the left-hand base leg, right-hand base leg, and associated base leg joins		Solar reflections with a maximum intensity of 'potential for temporary after-image' are possible towards sections of the visual circuits

Geometric modelling results - Hamilton Farm Airstrip

Results Discussion

Effects in Context

The glint and glare study showed that aircraft approaching runway 04 could experience 'yellow' glare (potential for temporary after-image) between 5:30am and 6:30am GMT and would occur from May to August. The instances of 'yellow' glare are predicted for a maximum of 1,066 minutes in total per year. This represents a very small proportion of time compared to average daylight hours in any one year (0.406%[52]). The maximum duration would be for less than 15 minutes on the days when the glare is possible. In practice, effects are likely to be noticeable for at most a few minutes as an aircraft is moving towards the runway threshold.

Solar reflections with yellow glare are predicted to occur within two hours of sunrise and therefore will occur when the sun is low in the sky beyond the reflecting panels. This means that a pilot will likely have a view of the sun within the same viewpoint of the reflecting solar panels. The sun is a far more significant source of light, therefore decreasing the impact significance of the reflecting panels. Furthermore, in practice the panels are flat and aligned with each other, meaning that only some of the sunlight is reflected.

The weather would have to be clear and sunny at the specific times when the glare was possible to be experienced.

Existing Mitigation for Direct Sunlight

There are a number of measures that pilots regularly employ to counter the effects of direct sunlight. These mitigation measures include:

- Using darkened cockpit sun visors to reduce the intensity of the Sun;
- Overflying the airfield and inspecting the runway prior to landing;
- Landing in the opposite direction if wind conditions allow;
- Planning the flight to land at a different time;
- Aborting their landing if uncertain that it is to be successful (known as a missed approach or a go-around).

The suitability of these options is influenced by many factors including the aerodrome type. Hamilton Farm Airstrip is a small unlicensed airfield with one grass runway and low air traffic volumes.

It is known that direct solar reflections from reflective surfaces, including solar panels, can be a distraction to pilots. The mitigation measures pilots use to mitigate the effects of direct sunlight can all be used to mitigate the effects of direct solar reflections from the solar panels.

[52] Based on 4,380 daylight hours (262,800 minutes) per year

Times which Effects are Predicted

For effects to be experienced, a pilot would have to be flying around the airfield at the specific times and dates when solar reflections are geometrically possible. Hamilton Farm Airstrip has confirmed that flights are typically scheduled after 8:00am and therefore any pilot using the airfield during the normal times would not experience any effects.

In the highly unlikely scenario a pilot will be flying before 8:00am, the charts showing the locations and dates / times in which 'solar reflections with temporary after-image' are predicted have been presented in the following section. This is so that appropriate warning can be provided to pilots, and measures can be taken (e.g., existing measure to mitigate direct sunlight) to accommodate the effects if required.

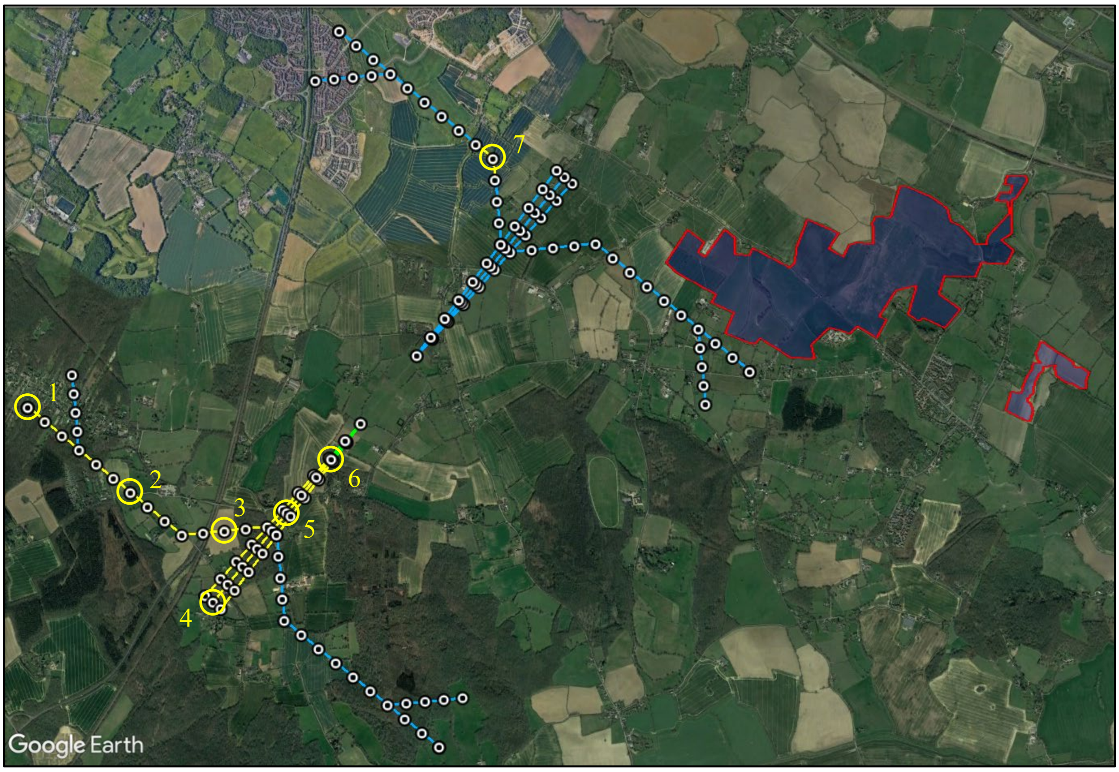
Glare Times/Dates

The times and dates which solar reflections are predicted towards pilots at Hamilton Farm Airstrip are presented in this section. This has been achieved by providing solar reflection charts of multiple receptors which are representative of all assessed receptors associated with Hamilton Farm Airstrip[53].

The seven receptors which have been used to represent all receptors where a pilot will experience effects within their primary field of view are circled in yellow in the figure on the following page. The line are coloured in accordance with the predicted glare intensity:

- Yellow lines – Solar reflections with 'potential for temporary after-image' (yellow glare) are predicted;
- Green lines – Solar reflections with 'low potential for temporary after-image' (green glare) are predicted;
- Blue lines – Solar reflections are not geometrically possible or occur outside a pilots primary horizontal field of view (50 degrees either side of the direction of travel).

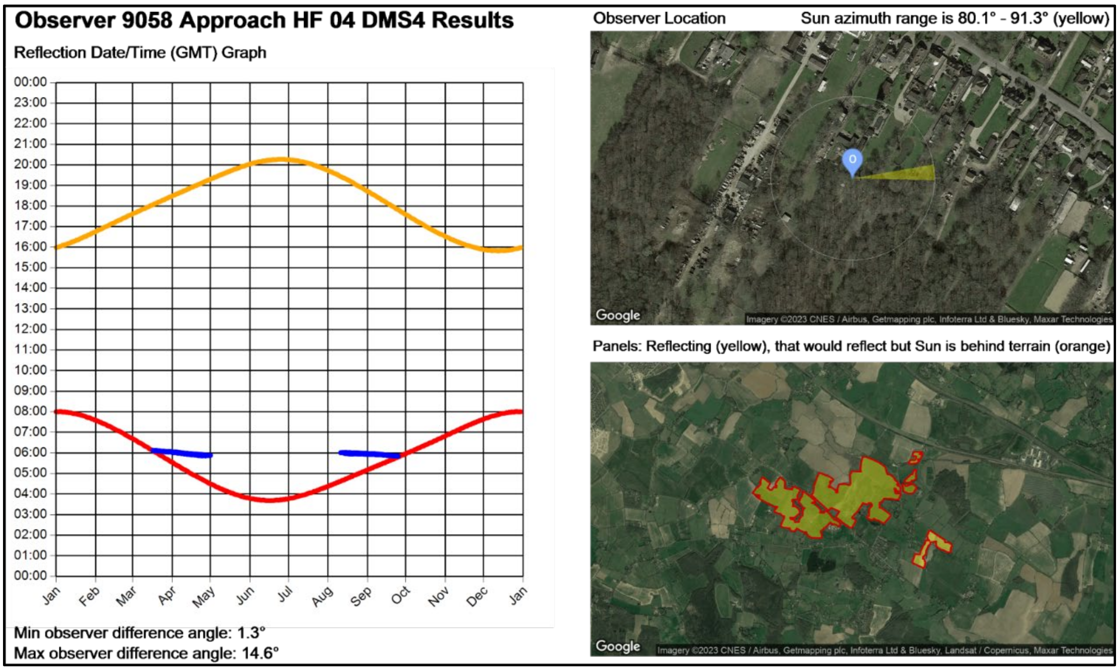
[53] The difference in time between one receptor and another is likely to be a few minutes on any given day or a few days.



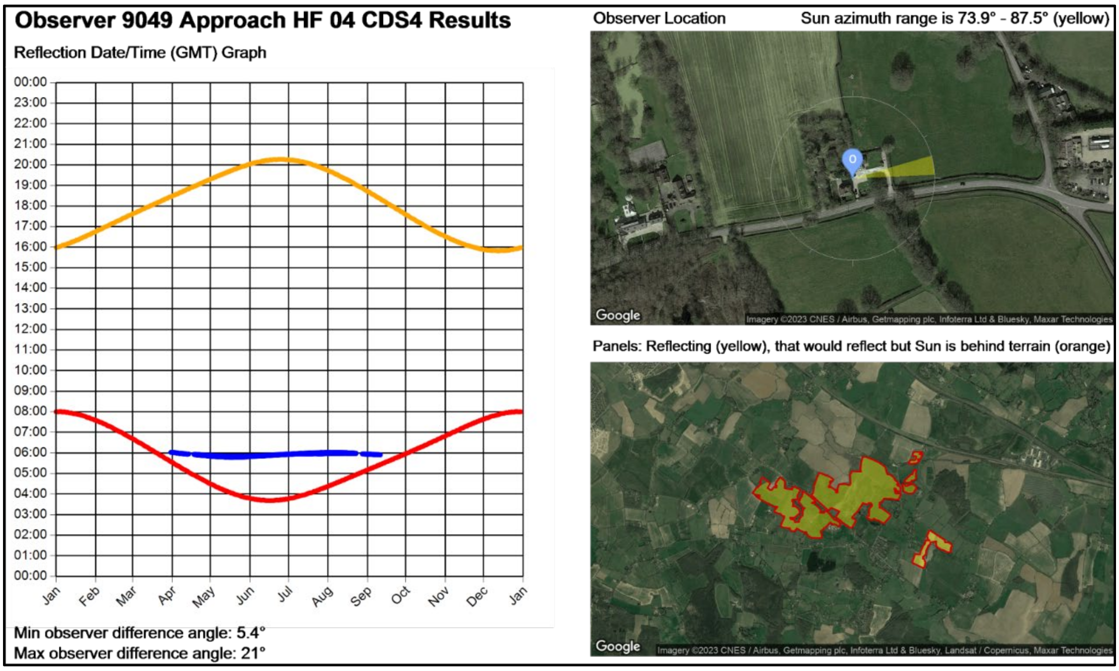
Hamilton Farm Airstrip receptors used to show effects

The specific solar reflection charts in accordance with the numbering in the figure above are then shown in the figures on the following pages. Each chart shows:

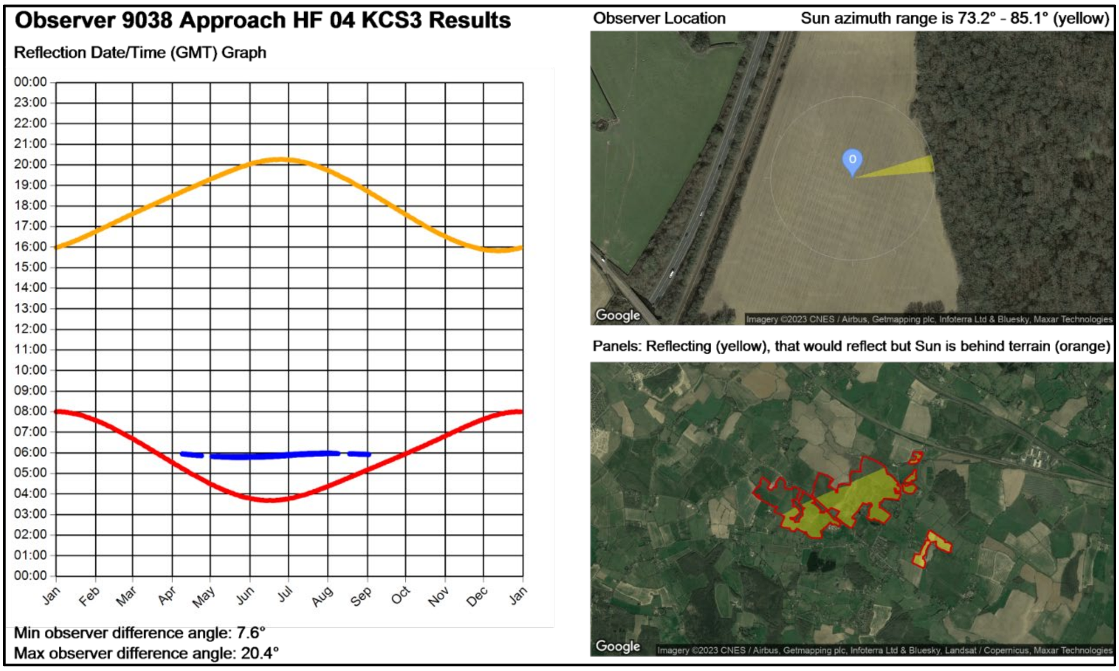
- The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible.;
- The reflecting panels – bottom right image. The reflecting area is shown in yellow.;
- The reflection date/time graph – left hand side of image. The blue 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).



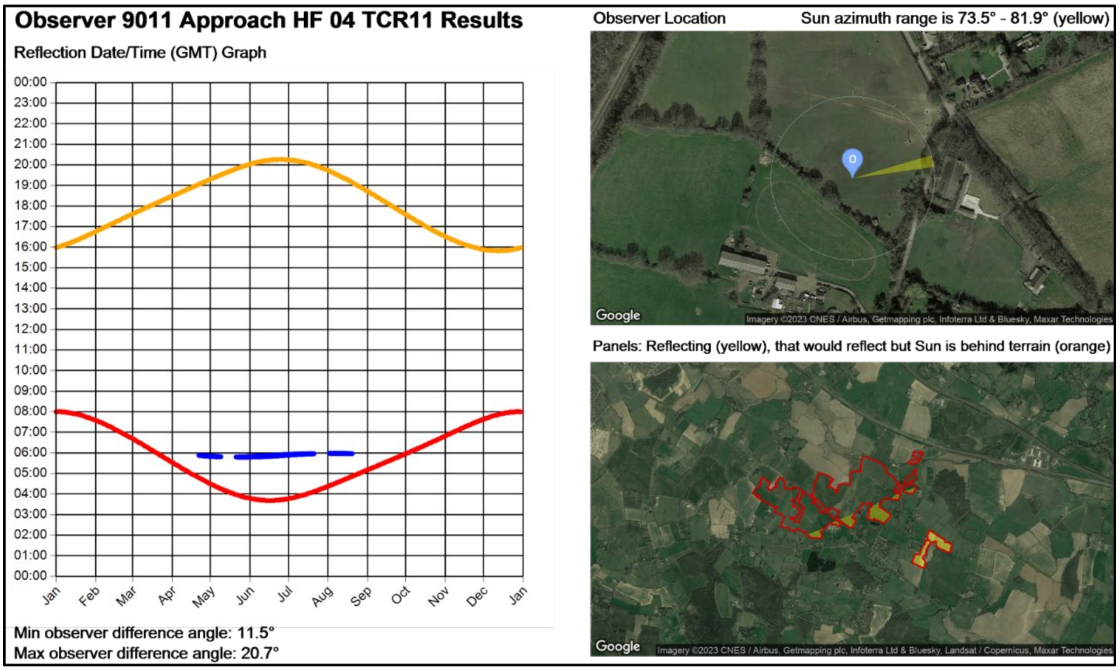
Solar reflection chart - receptor 1



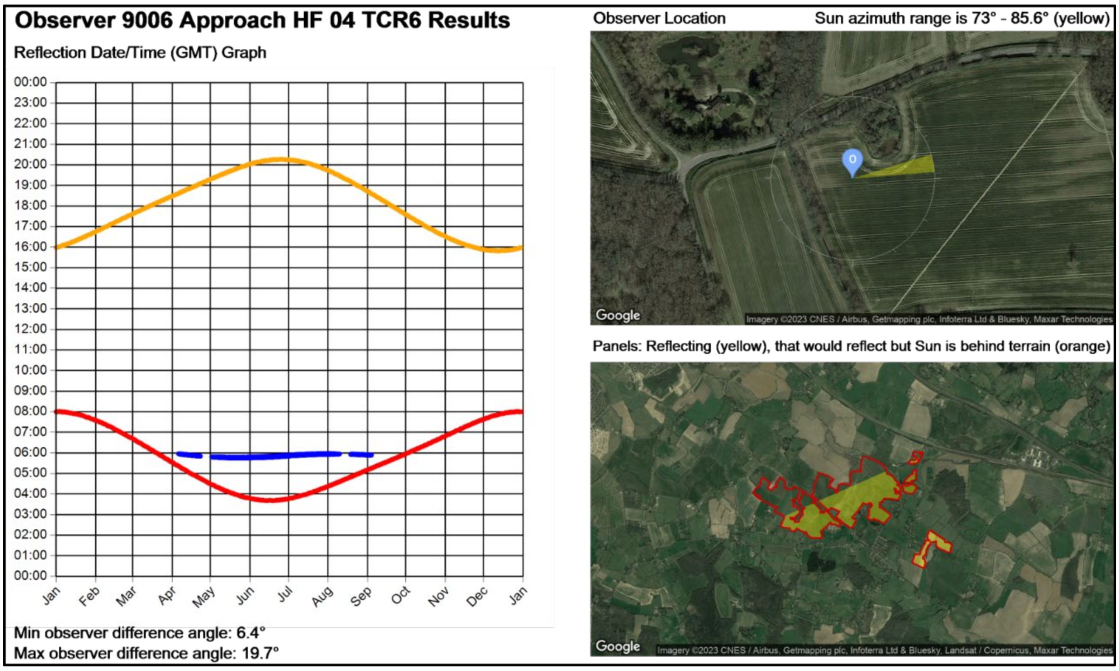
Solar reflection chart – receptor 2



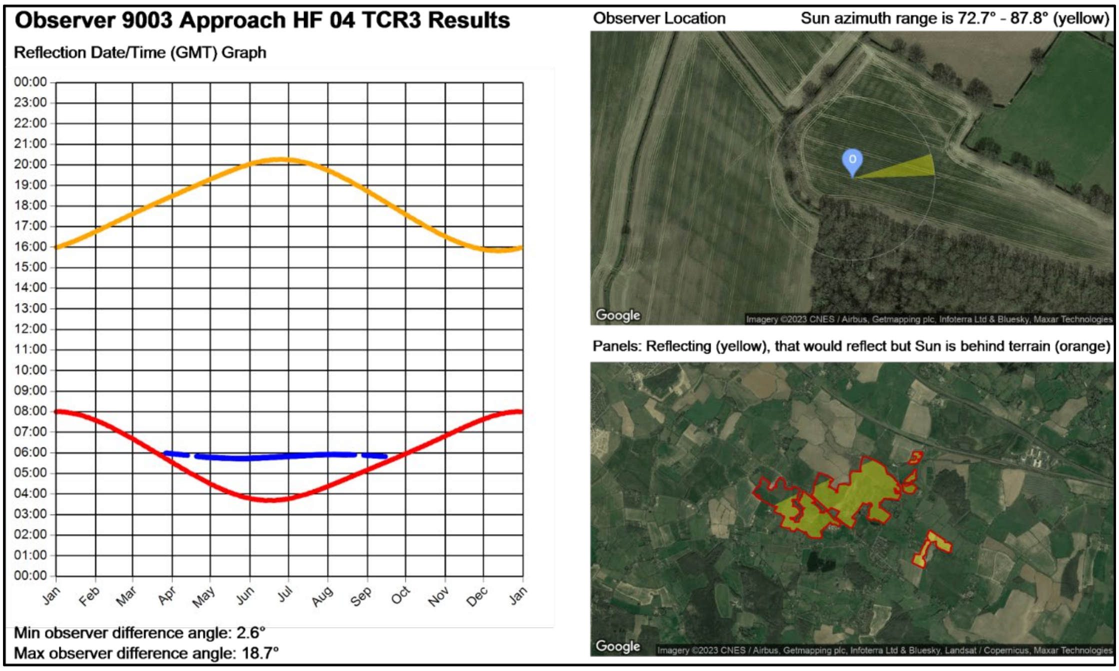
Solar reflection chart – receptor 3



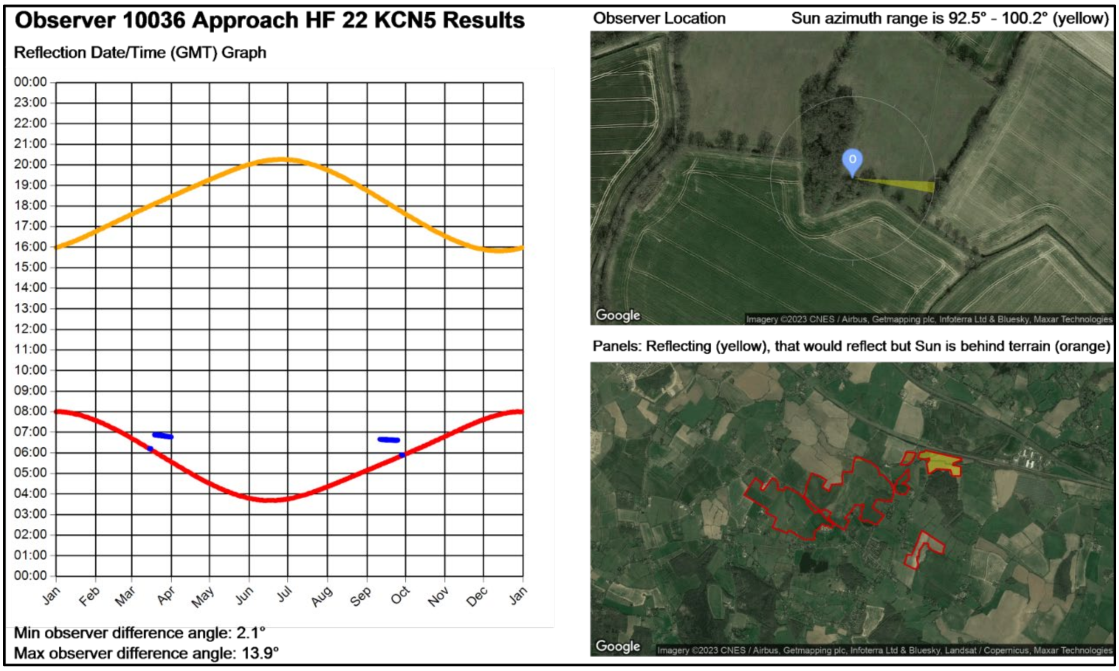
Solar reflection chart – receptor 4



Solar reflection chart – receptor 5



Solar reflection chart – receptor 6



Solar reflection chart – receptor 7

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