Appendix I.6

Glint and Glare Assessment

PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

Bodelwyddan Solar & Energy Storage Limited

Bodelwyddan

September 2025

PLANNING SOLUTIONS FOR:

- Solar
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1	June 2025	Initial issue
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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the potential effects of glint and glare from a ground mounted solar photovoltaic development, located northwest of Bodelwyddan, Wales, UK. This assessment pertains to the potential impact upon road safety, residential amenity, and aviation activity associated with Ysbyty Glan Clywd Hospital Heliport, Rhedyn Coch Farm Airfield, and Bryngwyn Bach Airfield.

Overall Conclusions

A low impact is predicted upon aviation activity associated with Ysbyty Glan Clywd Hospital Heliport. Mitigation is not recommended.

No significant impact is predicted towards road safety, residential amenity and aviation activity associated with Rhedyn Coch Farm Airfield and Bryngwyn Bach Airfield. Mitigation is not required.

Guidance and Studies

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

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

The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that the reflections

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

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

produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel[3].

Conclusions – Ysbyty Glan Clywd Hospital Heliport

Solar reflections with an intensity of 'low potential for temporary after-image' are geometrically possible towards sections of the 2-mile helicopter approach paths. This category of glare intensity is acceptable in accordance with the associated guidance (Appendix D) and industry best practice. A low impact is predicted upon pilots on these approaches, and mitigation is not recommended.

Solar reflections with an intensity of 'potential for temporary after-image' ('yellow' glare) are geometrically possible towards sections of the helicopter approach paths. The existing Kinmel Bay Solar Farm produces yellow glare towards some of the helicopter approach paths. These instances of 'yellow' glare could be accommodated subject to consultation with the Heliport. A low impact is predicted and mitigation is not recommended.

The analysis of this yellow glare scenario has been made available to the operator of Ysbyty Glan Clywd Hospital Heliport for further discussion. Initial consultation with the Heliport has not indicated any concerns in relation to the assessment, however further feedback is awaited which will be reviewed and addressed (if necessary) ahead of final submission of the DNS application.

Conclusions – Roads

The results of road assessment is shown in the table below.

Road	Section of which solar reflections are possible	Sections of which are screened (no impact)	Sections of which are low impact	Sections of which are moderate impact
A55	3.9km	3.7km screened by vegetation	200m with partial screening. Views are outside of field of view (50 degrees either side of the direction of travel)	N/A
St Asaphs	2.1km	2.1km screened by vegetation and/or buildings	N/A	N/A

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

Road	Section of which solar reflections are possible	Sections of which are screened (no impact)	Sections of which are low impact	Sections of which are moderate impact
A547	3.1km	2.3km screened by vegetation	800m with partial screening. Proposed vegetation is predicted to partially obstruct views of the reflecting panels for typical road users. Views may be possible for elevated road users	N/A
St Georges	1.3km	800m screened by vegetation	500m with partial screening. Proposed vegetation is predicted to partially obstruct views of the reflecting panel. Reflections coincide with direct sunlight	N/A
Gors	1.3km	1.3km screened by vegetation and buildings	N/A	N/A
Ronalds way	1.6km	1.6km screened by vegetation and/or buildings	N/A	N/A

The existing Kinmel Bay Solar Farm produces reflections towards the A55, St Asaphs Road, St Georges Road, and Ronaldsway. Solar reflections produced by Kinmel Bay Solar Farm are significantly screened by existing vegetation and/or buildings.

Conclusions – Dwellings

Solar reflections are predicted to be geometrically possible towards 110 of the 192 assessed dwellings.

For 75 dwellings, existing vegetation and/or buildings have been identified which significantly obstruct views of the reflecting panels. No impact is predicted and mitigation is not required.

For 27 dwellings, solar reflections are predicted to occur for less than three months a year and less than 60 minutes on any given day. Existing vegetation and/or buildings have been identified which partially obstruct views of the reflecting panels, at ground floor level, however, views are still considered possible from above the ground floor. A low impact is predicted and mitigation is not recommended.

For five dwellings, solar reflections are predicted to occur for more than three months a year and less than 60 minutes on any given day. Existing vegetation has been identified which significantly obstruct views of the reflecting panels, at ground floor level, however, views are still considered possible from above the ground floor. A low impact is predicted and mitigation is not recommended.

For the remaining three dwellings, solar reflections are predicted to occur for more than three months a year but less than 60 minutes on any given day. Proposed vegetation is predicted to partially obstruct views of the reflecting panels. Views are still considered possible above the ground floor. Reflections coincide with direct sunlight. A low impact is predicted and mitigation is not recommended.

The existing Kinmel Bay Solar Farm produces reflections towards 32 of the 192 dwellings. Solar reflections produced by Kinmel Bay Solar Farm are significantly screened by existing vegetation for 30 of the 32 dwellings.

Conclusions – High-Level Aviation

Rhedyn Coch Farm Airfield and Bryngwyn Bach Airfield

The development size, distance between the aerodrome and the development, the existing Kinmel Bay Solar Farm, and industry experience have been considered to determine the impact during the assessment.

Solar reflections towards the splayed approaches and final sections of visual circuits at Rhedyn Coch Farm Airfield and Bryngwyn Bach Airfield are predicted to occur outside a pilot's field-of-view (50 degrees on either side relative to the direction of travel) or have intensities no greater than 'low potential for temporary after-image'. No significant impact is predicted and mitigation is not required.

Overall, no significant impact upon aviation activity associated with Rhedyn Coch Farm Airfield and Bryngwyn Bach Airfield are predicted. Mitigation is not required.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 62 countries within Europe, Africa, America, Asia and Oceania.

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

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

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

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

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

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the potential effects of glint and glare from a ground mounted solar photovoltaic development, located northwest of Bodelwyddan, Wales, UK. This assessment pertains to the potential impact upon road safety, residential amenity, and aviation activity associated with Ysbyty Glan Clywd Hospital Heliport, Rhedyn Coch Farm Airfield, and Bryngwyn Bach Airfield.

This report contains the following:

- Solar development details;
- Cumulative Assessment;
- Explanation of glint and glare;
- Overview of relevant guidance and relevant studies;
- Assessment methodology;
- Identification of receptors;
- Glint and glare assessment for identified receptors;
- Results discussion.

1.2 Pager Power's Experience

Pager Power has undertaken over 1,600 Glint and Glare assessments in the UK and internationally. The studies have included assessment of civil and military aerodromes, railway infrastructure and other ground-based receptors including roads and dwellings.

1.3 Glint and Glare Definition

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

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

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

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

2 PROPOSED DEVELOPMENT LOCATION AND DETAILS

2.1 Overview

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

2.2 Proposed Development Site Layout

Figure 1 below shows the proposed development site layout[5] plan. The blue striped area denotes the solar panel locations.

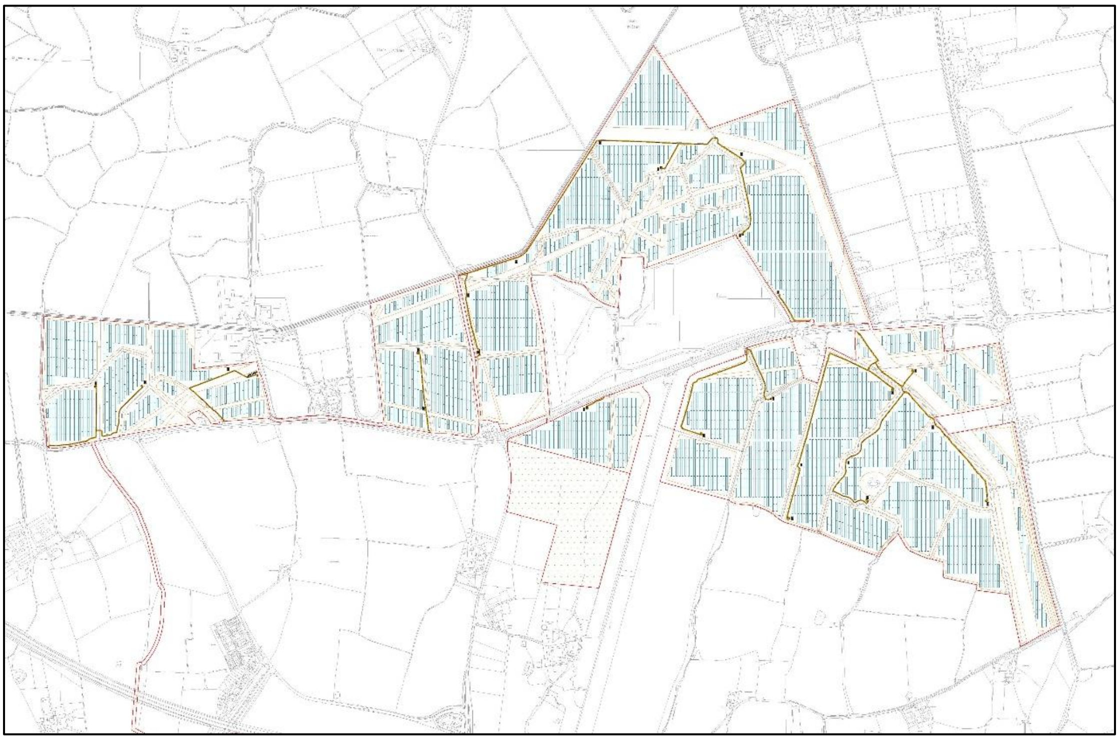

Figure 1 *Proposed development panel layout*

2.3 Cumulative Assessment

Kinmel Bay Solar Farm is an existing solar farm, located in the middle of the proposed development. Kinmel Bay Solar Farm shares the same receptors as the proposed development, therefore, Kinmel Bay Solar Farm has been modelled as part of this assessment. Figure 2 on the following page shows Kinmel Bay Solar Farm modelled cumulatively with the proposed development. The solar panel details used at Kinmel Bay Solar Farm are not known, therefore the Kinmel Bay Solar Farm panels have been modelled to the same specifications as the proposed development.

[5] Source: Ref02_Solar – Site Layout.pdf (cropped).

2.4 Reflector Areas

The bounding coordinates for the development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 2 below shows the assessed reflector areas that have been used for modelling purposes.

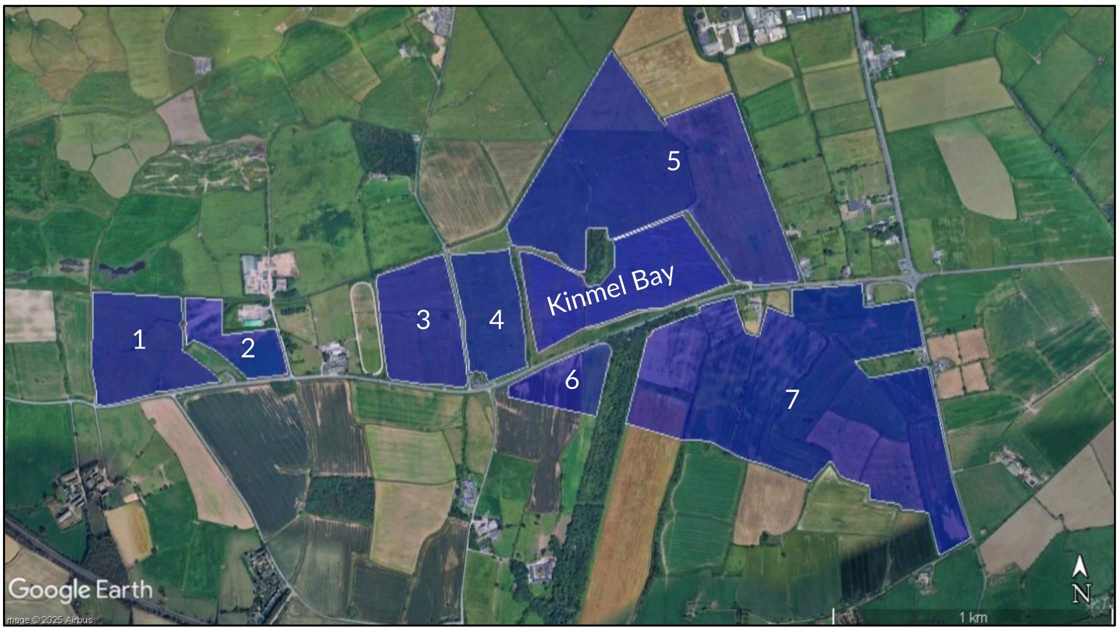

Figure 2 *Assessed reflector areas*

2.5 Solar Panel Technical Information

The technical information used for the single-axis solar panels in this assessment are presented in Table 1 below.

Single-axis Tracker Panel Technical Information	
Assessed centre-height	2.17m agl (above ground level)
Tracking	Horizontal Single Axis tracks Sun East to West
Tilt of tracking axis	0°
Orientation of tracking axis	180°
Offset angle of module	0°
Tracker Range of Motion	±60°[6]

[6] The actual panels installed will have a range of motion of ±55°. There should be no significant increase in impacts towards receptors due to this change in the range of motion.

Single-axis Tracker Panel Technical Information	
Resting angle	0°
Backtracking Method	Instant (for modelling purposes)
Surface material	Smooth glass with an ARC (anti-reflective coating)

Table 1 *Single-axis solar panel technical information*

2.5.1 Solar Panel Backtracking

Shading considerations dictate the panel tilt. This is affected by:

- The elevation angle of the Sun;
- The vertical tilt of the panels;
- The spacing between the panel rows.

This means that early in the morning and late in the evening, the panels will not be directed exactly towards the Sun, as the loss from shading of the panels (caused by facing the sun directly when the Sun is low in the horizon), would be greater than the loss from lowering the panels to a less direct angle in order to avoid the shading Figure 3 below illustrates this.

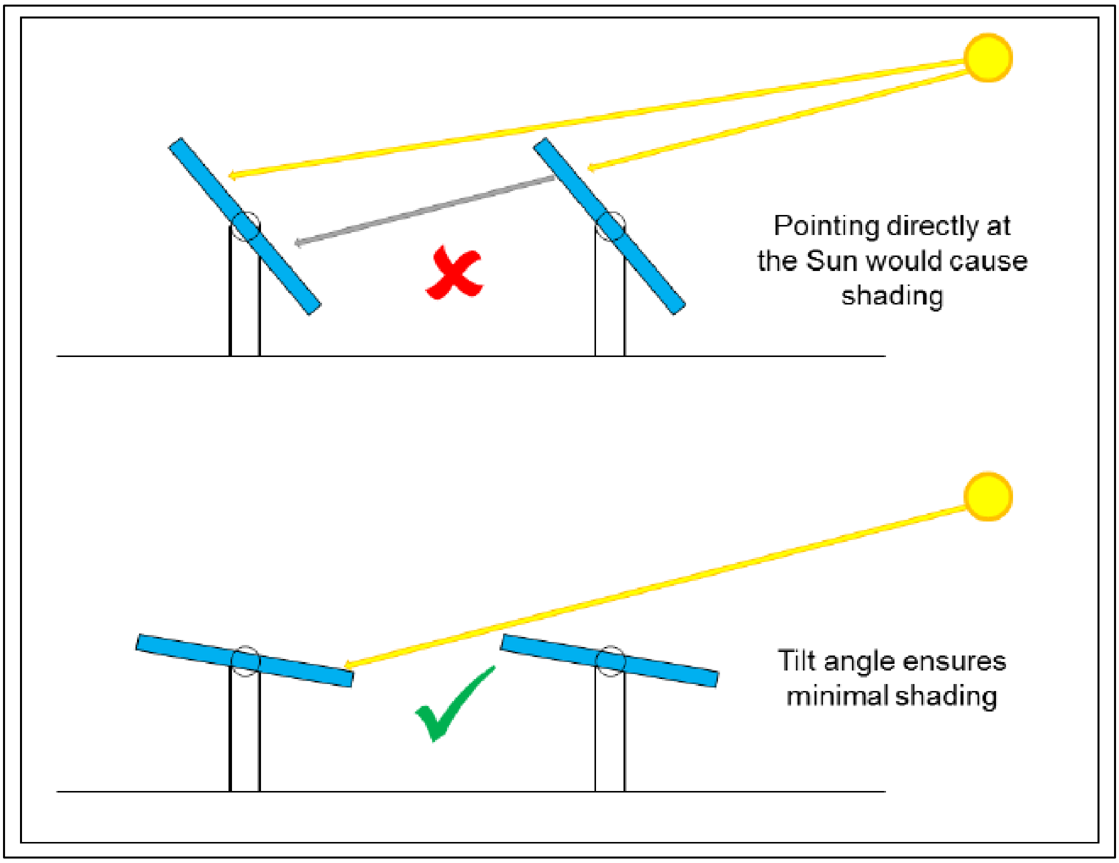

Figure 3 *Shading considerations*

Later in the day, the panels can be directed towards the Sun without any shading issues. This is illustrated in Figure 4 on the following page.

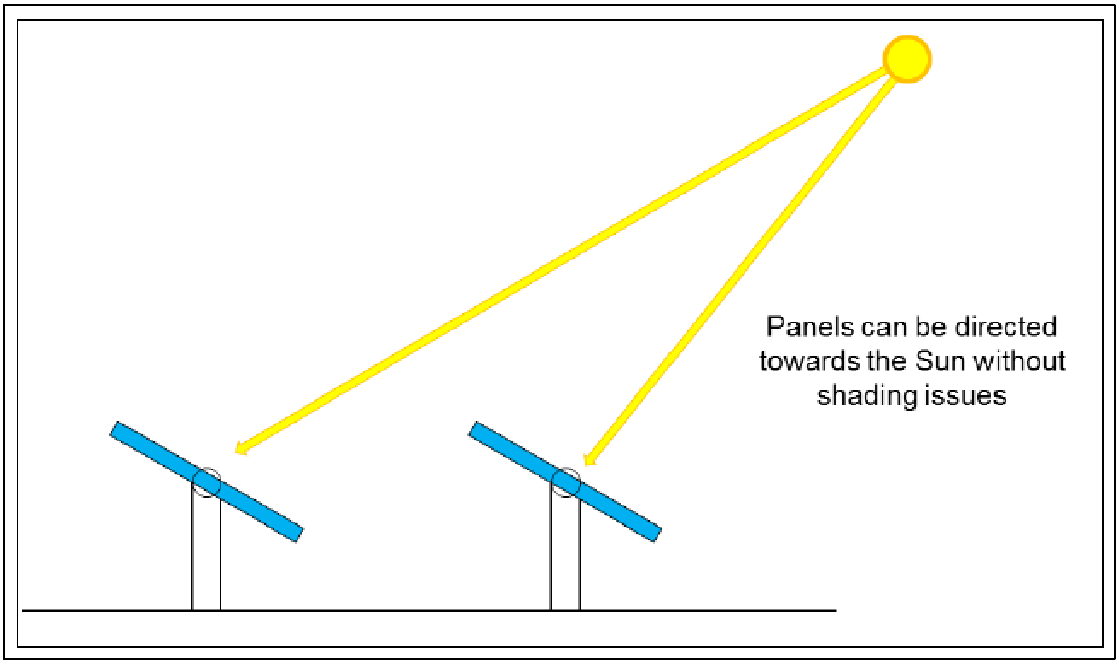

Figure 4 *Panel alignment at high solar angles*

Note that in reality, the lines from the Sun to each panel would be effectively parallel due to the large separation distance. The two previous figures are for illustrative purposes only.

The solar panels backtrack (where the panel angle gradually declines to prevent shading) by reverting to 0 degrees (flat) once the maximum elevation angle of the panels (60 degrees) becomes ineffective due to the low height of the Sun above the horizon and to avoid shading.

2.5.2 Back Tracking Solar Panel Model

Back tracking systems are sensitive to panel length, row spacing, topography and the level of shading which varies throughout the year. The Forge Solar model used in this assessment is a widely accepted model within this area. The model approximates a backtracking system by assuming the panels instantaneously revert to its resting angle of 0 degrees whenever the sun is outside the rotation range (60 degrees in this instance). Panels with a maximum tracking angle of 60 degrees and resting angle of 0 degrees would therefore lie horizontally from sunrise until the Sun enters the rotation range, and immediately after the sun leaves the rotation range until sunset daily. This definition is taken from Forge (see Appendix E) and by rotation range it is assumed the panels remain at 0 degrees until the Sun reaches 35 degrees above the horizon – when the Sun is at right angles to the panels at 60 degrees. It is understood that this option was created specifically to account for backtracking to the extent possible.

Whilst this model simplifies the backtracking process to be used by the solar panels within the solar development, panels that revert back to their resting angle immediately in many cases present a worst-case scenario for reflectors. This is because flatter panels can produce solar reflections in a much greater range of azimuth angles at ground level. The results would in most cases be more conservative than modelling a detailed back tracking system.

2.6 Landscape Strategy Plan

The landscape strategy plan confirms[7] the location of proposed vegetation that will be grown to facilitate existing screening. The proposed vegetation consists of trees and hedgerows. The hedgerows will be maintained at a height of 3m once fully matured[8]. The landscape strategy plan is shown in Figure 5 on the following page.

[7] Edp8841_d044a Illustrative Landscape and Ecology Strategy.pdf.
[8] Source: Email confirmation with EDP on August 19th 2025.

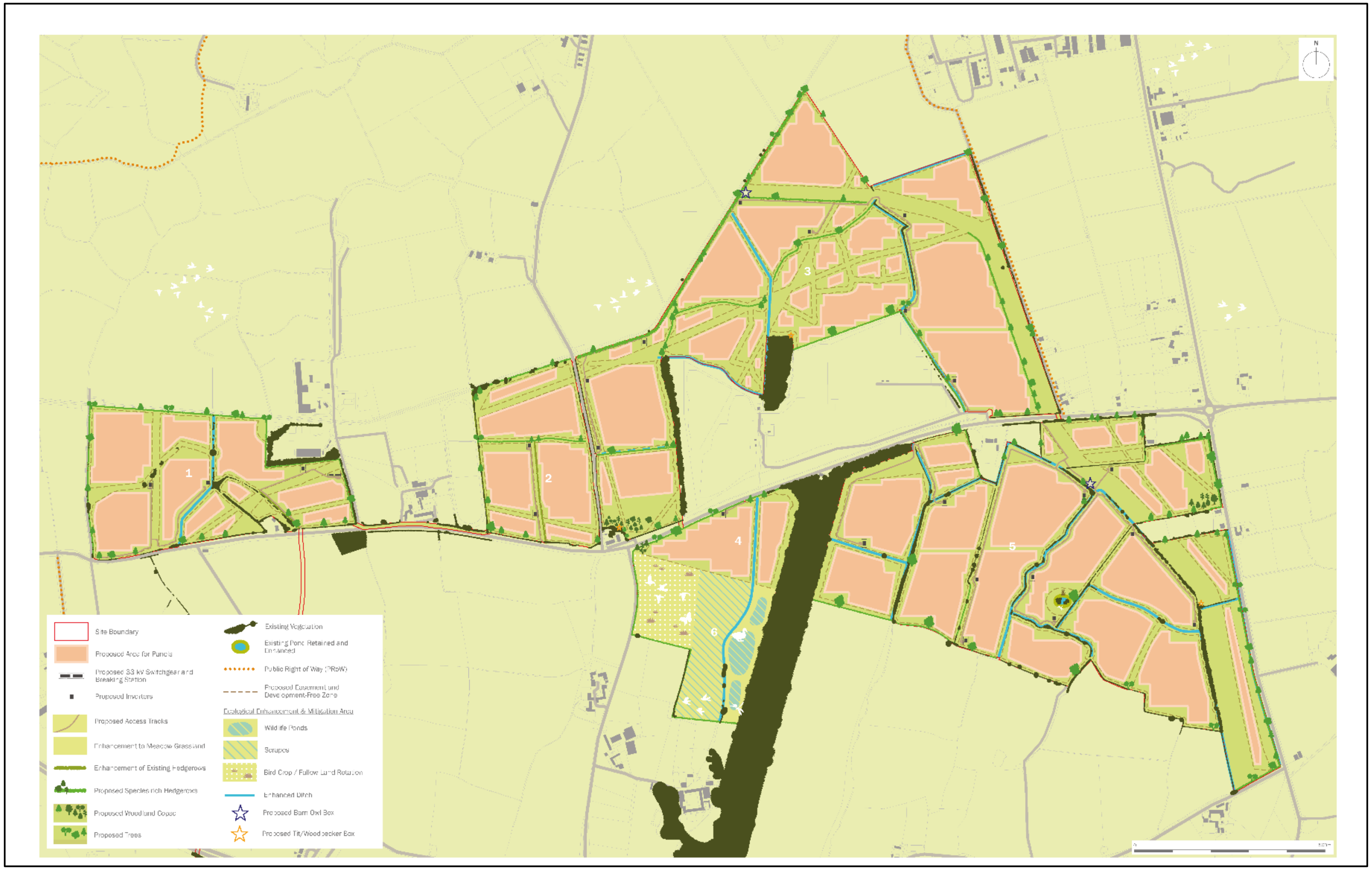

Figure 5 Landscape Strategy Plan

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Guidance and Studies

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

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

3.2 Background

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

3.3 Methodology

3.3.1 Pager Power's Methodology

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

- Identify receptors in the area surrounding the solar development;
- 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.

3.3.2 Sandia National Laboratories' Methodology

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

3.4 Assessment Methodology and Limitations

The model considers 100% sunlight during daylight hours which is highly conservative. Further technical details regarding the methodology of the geometric calculations and limitations are presented in Appendices E and F.

4 IDENTIFICATION OF RECEPTORS

4.1 Overview

The following section presents the relevant receptors assessed within this report.

4.2 Aviation Receptors

The following subsections present the relevant data and receptors associated with Ysbyty Glan Clywd Hospital Heliport.

4.2.1 Ysbyty Glan Clywd Hospital Heliport Information

Ysbyty Glan Clywd Hospital Heliport is a hospital heliport operating emergency service flights, located approximately 760m southeast of the proposed development.

The development's relative location to Ysbyty Glan Clywd Hospital Heliport is shown in Figure 6 on the following page.

Figure 7 on page 24 shows the helicopter paths. The helicopter approach paths have been placed every 45 degrees within a 360 degree azimuth, using a 10 degree descent gradient. Locations have been selected every 0.1-miles along the helicopter approach paths out to a distance of 2 miles.

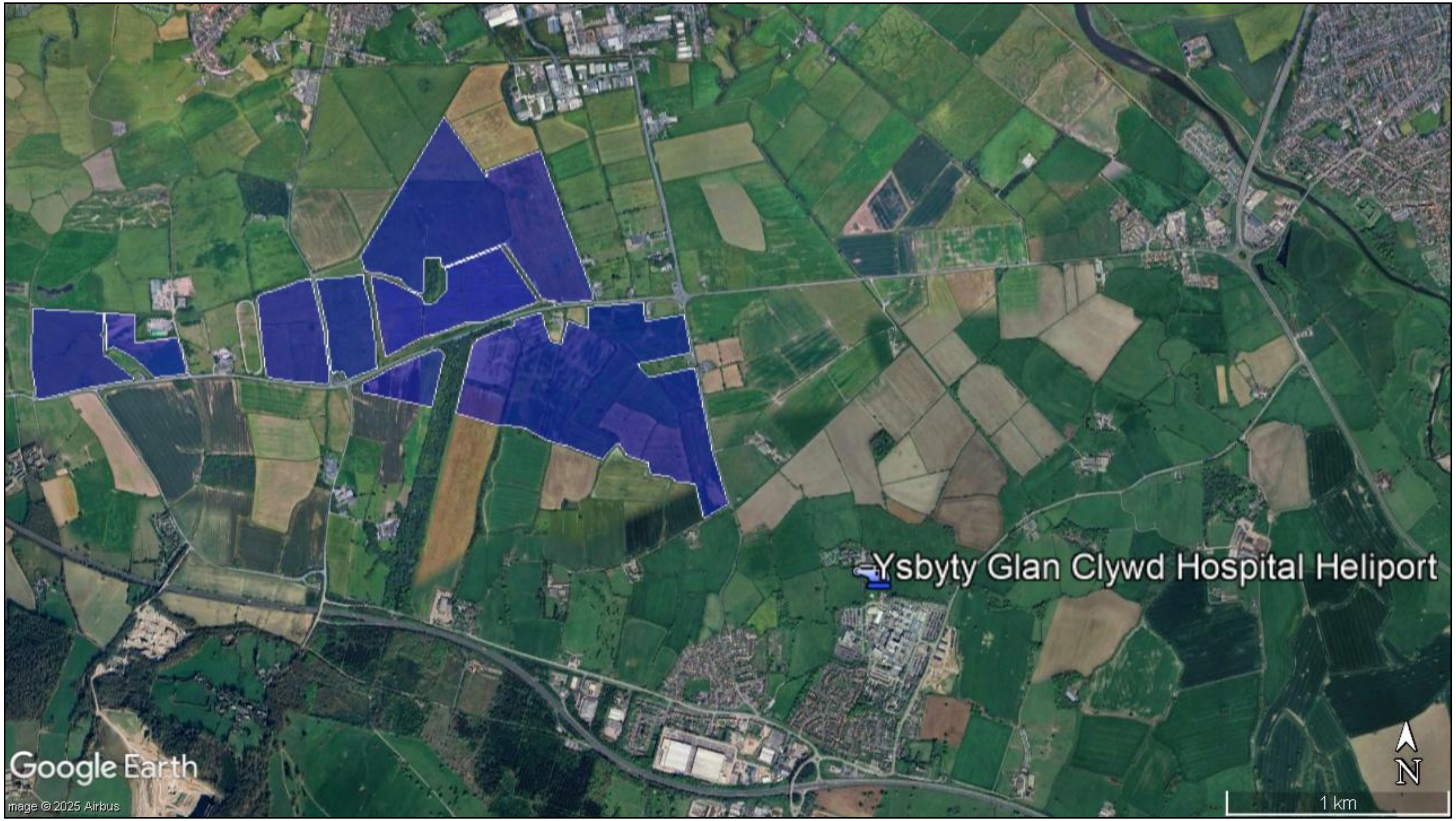

Figure 6 *Ysbyty Glan Clywd Hospital Heliport relative to the proposed development*

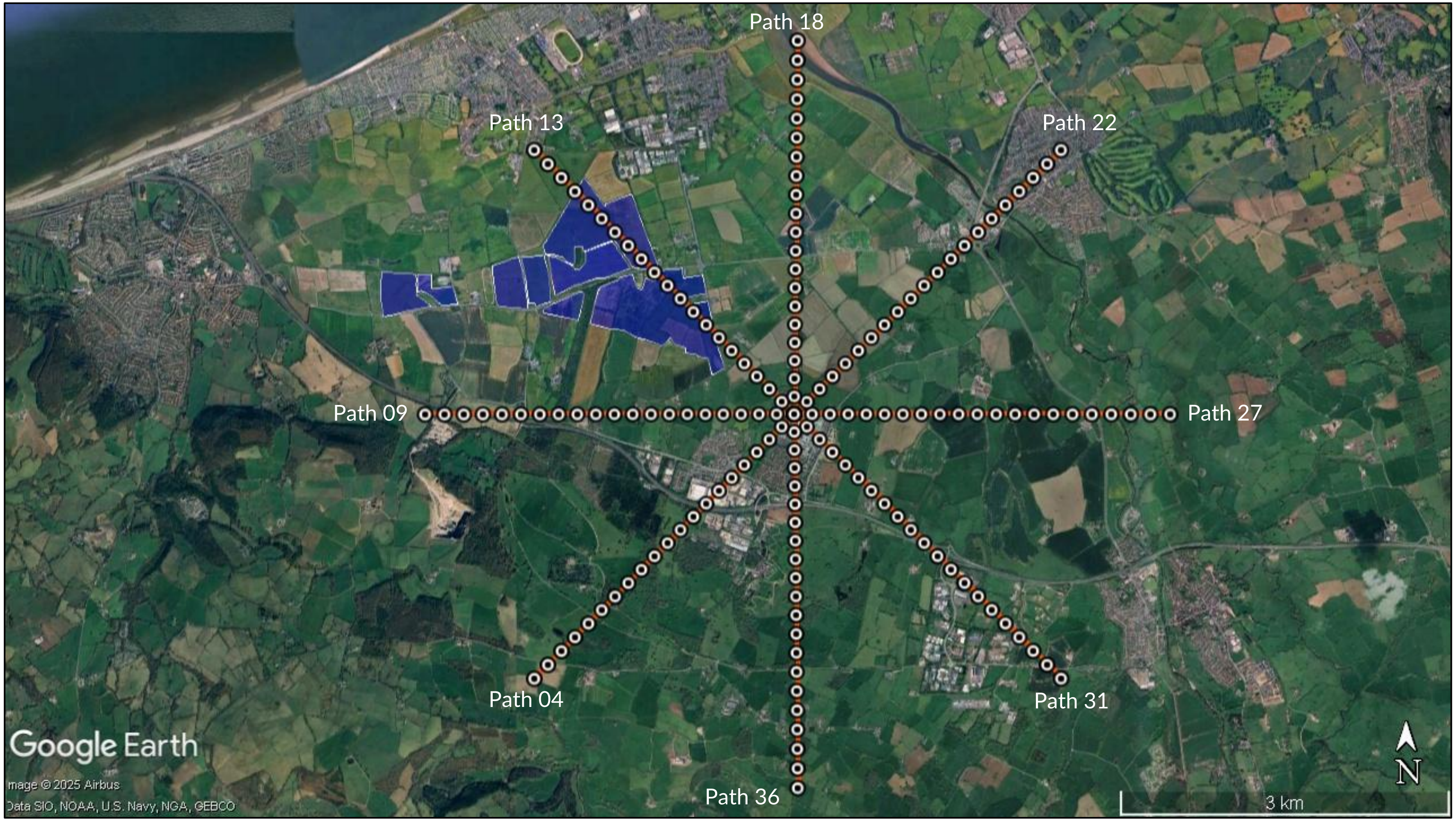

Figure 7 *Ysbyty Glan Clywd Hospital Heliport approach paths – aerial image*

4.3 Ground-Based Receptors Overview

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

A 1km assessment 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 assessment area is bounded by the white outline in Figure 8 below.

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

Figure 8 *1km assessment area*

4.4 Road Receptors

4.4.1 Road Receptors Overview

Road types can generally be categorised as:

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

Technical modelling is not recommended for local roads, where traffic densities are likely to be relatively low. Any solar reflections from the proposed development that are experienced by a road user along a local road would be considered low impact in the worst case in accordance with the guidance presented in Appendix D. The analysis has therefore considered major national, national, and regional roads that:

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

4.4.2 Identified Road Receptors

A section of the A55 totalling 4km, St Asaph Road totalling 2.1km, A547 totalling 5km, St George Road totalling 1.3km, Gors Road totalling 2.1km, and Ronaldsway totalling 3.6km have been identified in the 1km assessment area, shown in Figures 9 to 15 on the following pages.

A height of 1.5 metres above ground level has been taken as the typical eye level[9] for a typical road user. Receptors are placed approximately 100m apart along the identified road.

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

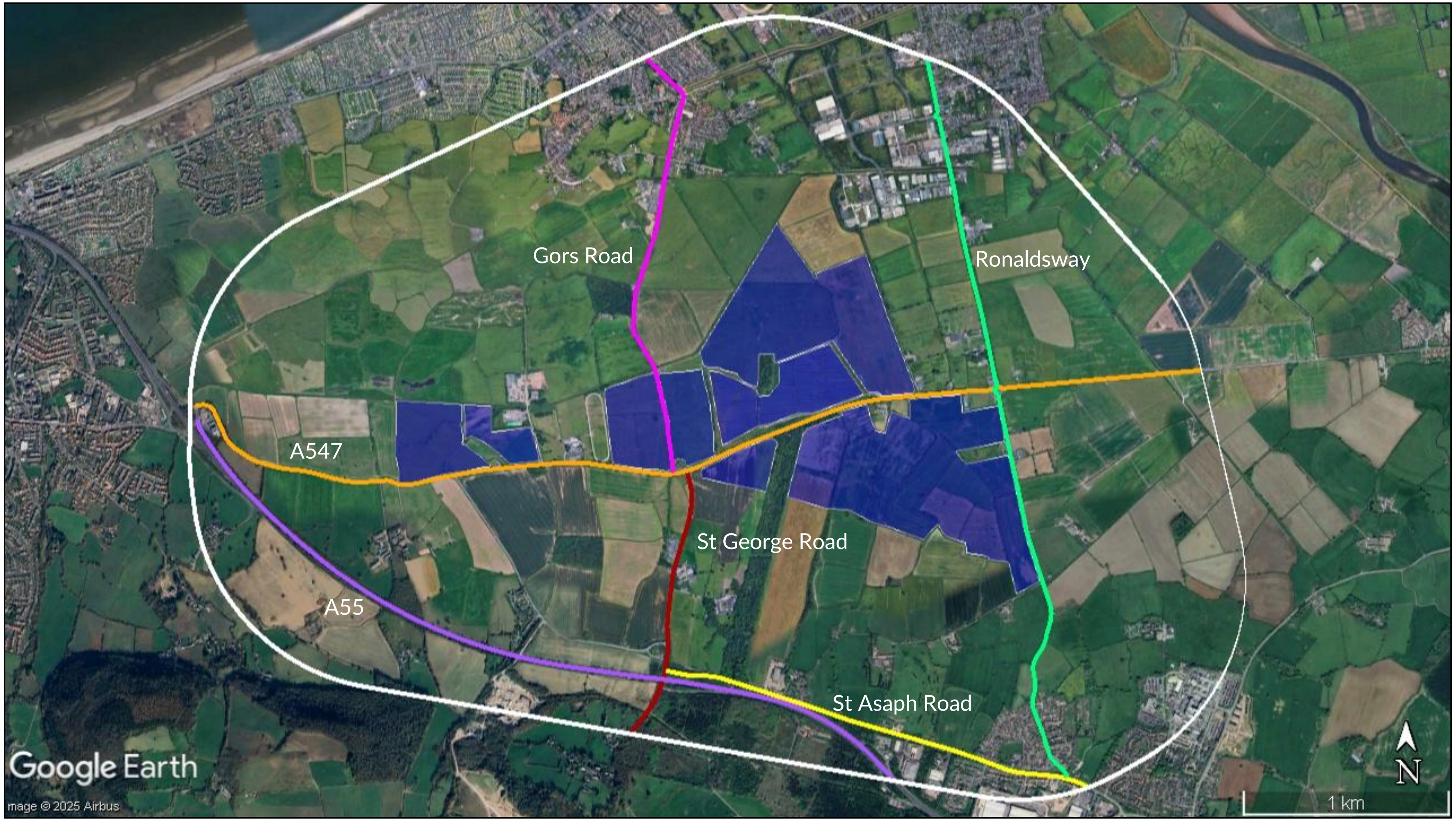

Figure 9 *Assessed road receptors*

Figure 10 *Assessed road receptors - A55*

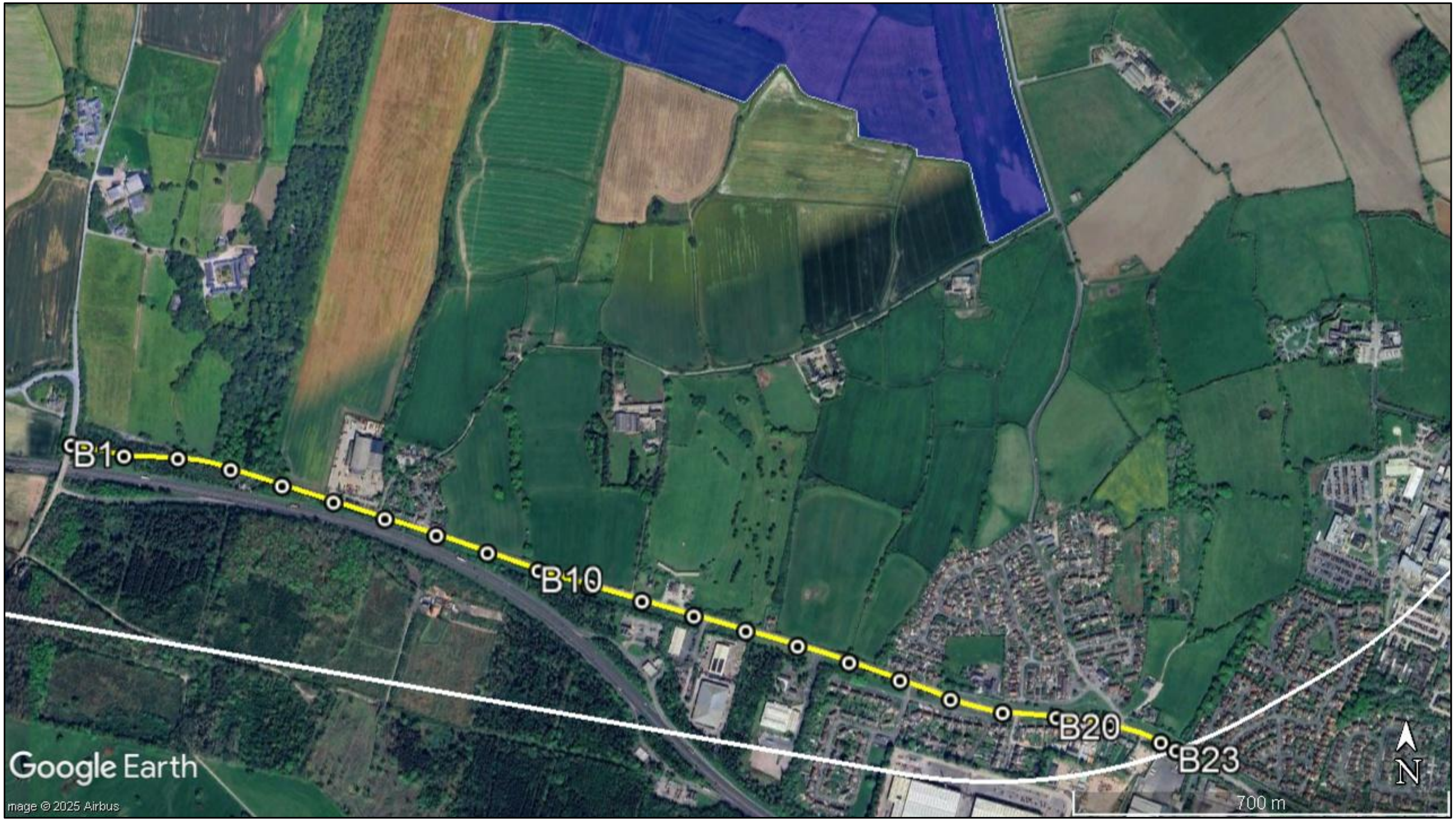

Figure 11 *Assessed road receptors - St Asaph Road*

Figure 12 *Assessed road receptors - A547*

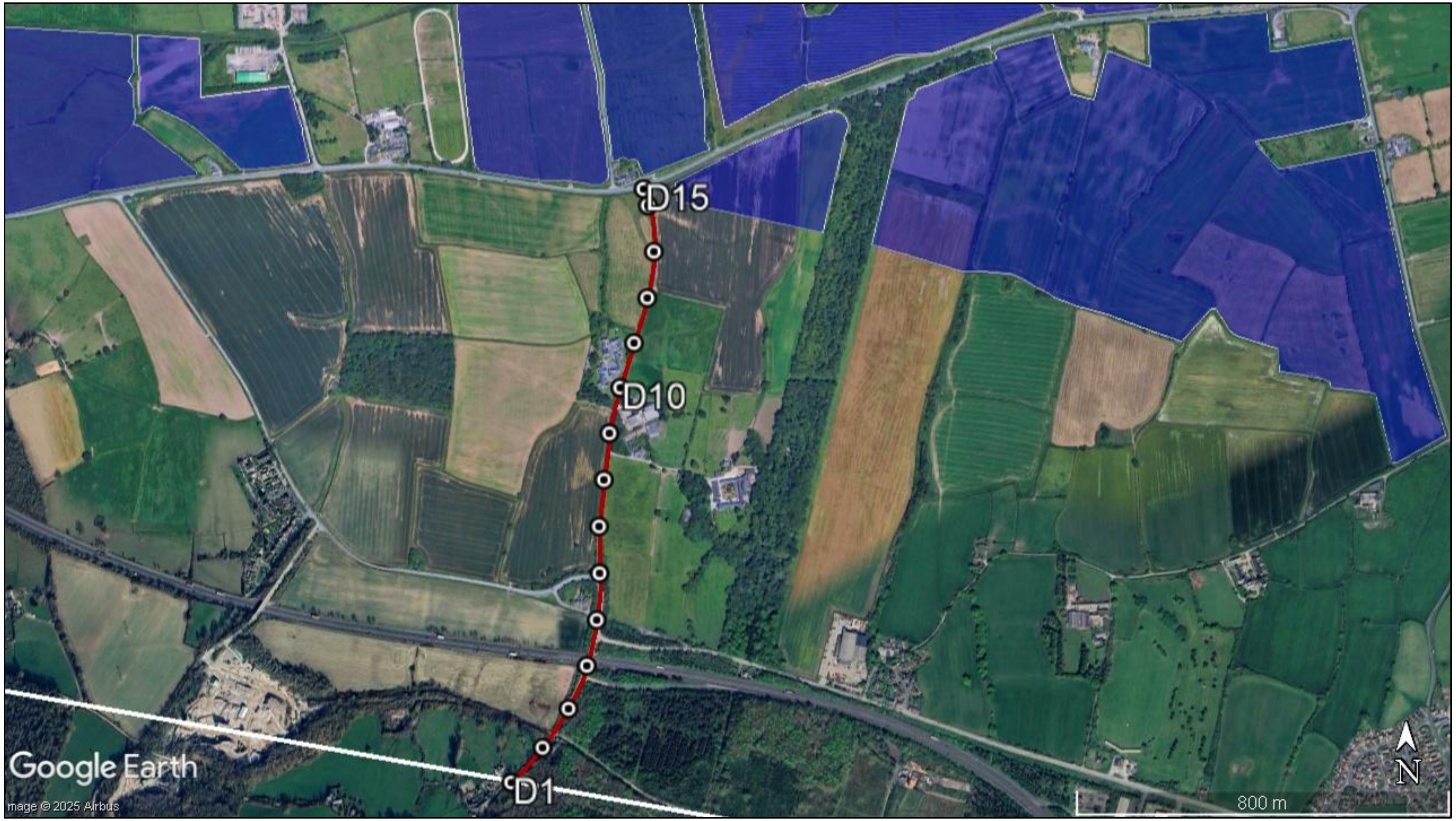

Figure 13 Assessed road receptors - St George Road

Figure 14 *Assessed road receptors - Gors Road*

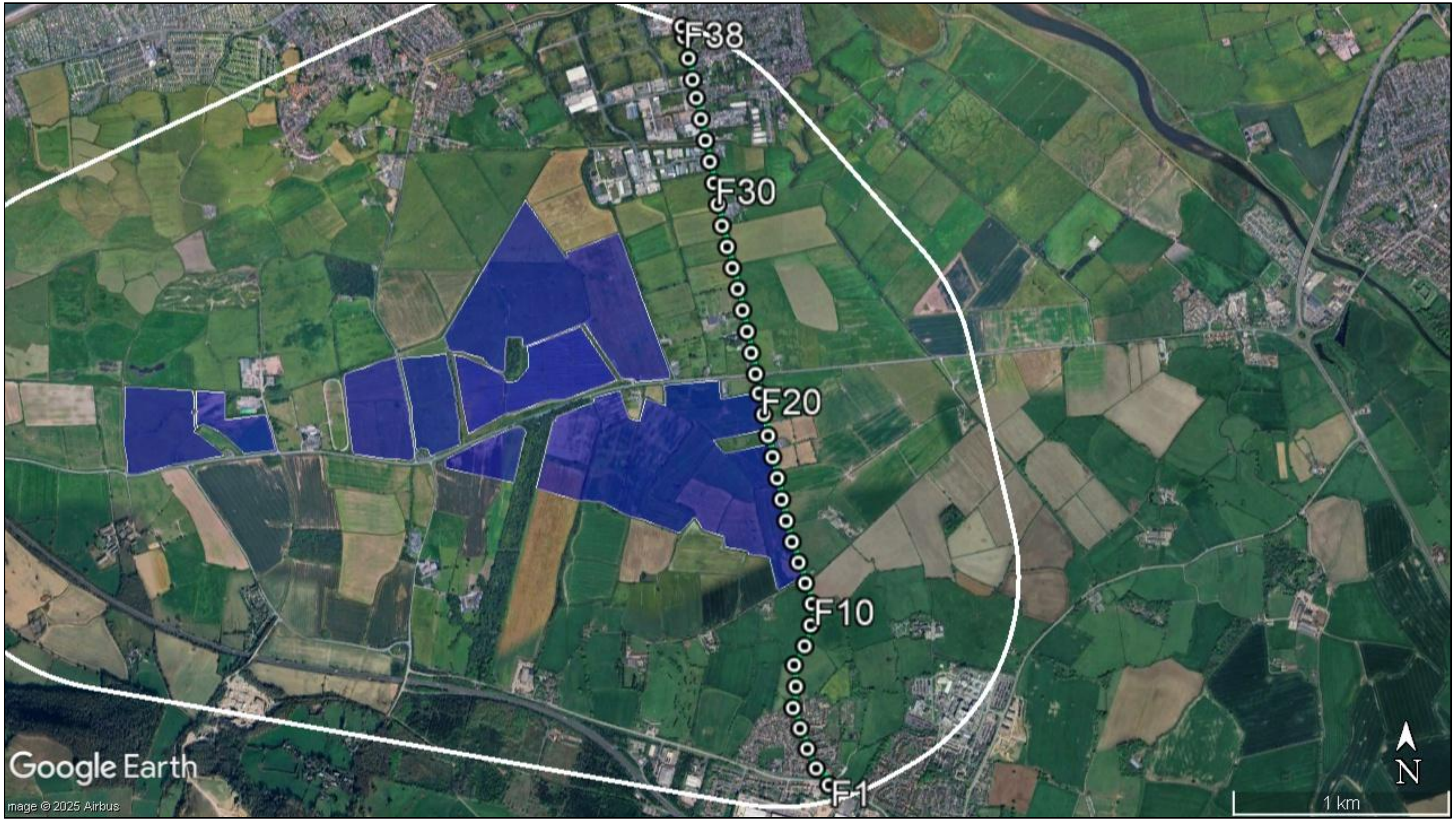

Figure 15 *Assessed road receptors - Ronaldsway*

4.5 Dwelling Receptors

4.5.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

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

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

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

4.5.2 Identified Dwelling Receptors

The assessed dwelling receptors are shown in Figures 16 to 20 on the following pages. In total, 192 dwellings have been assessed (in some cases a receptor is representative of multiple addresses e.g. attached/terraced houses). 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[10].

[10] 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.

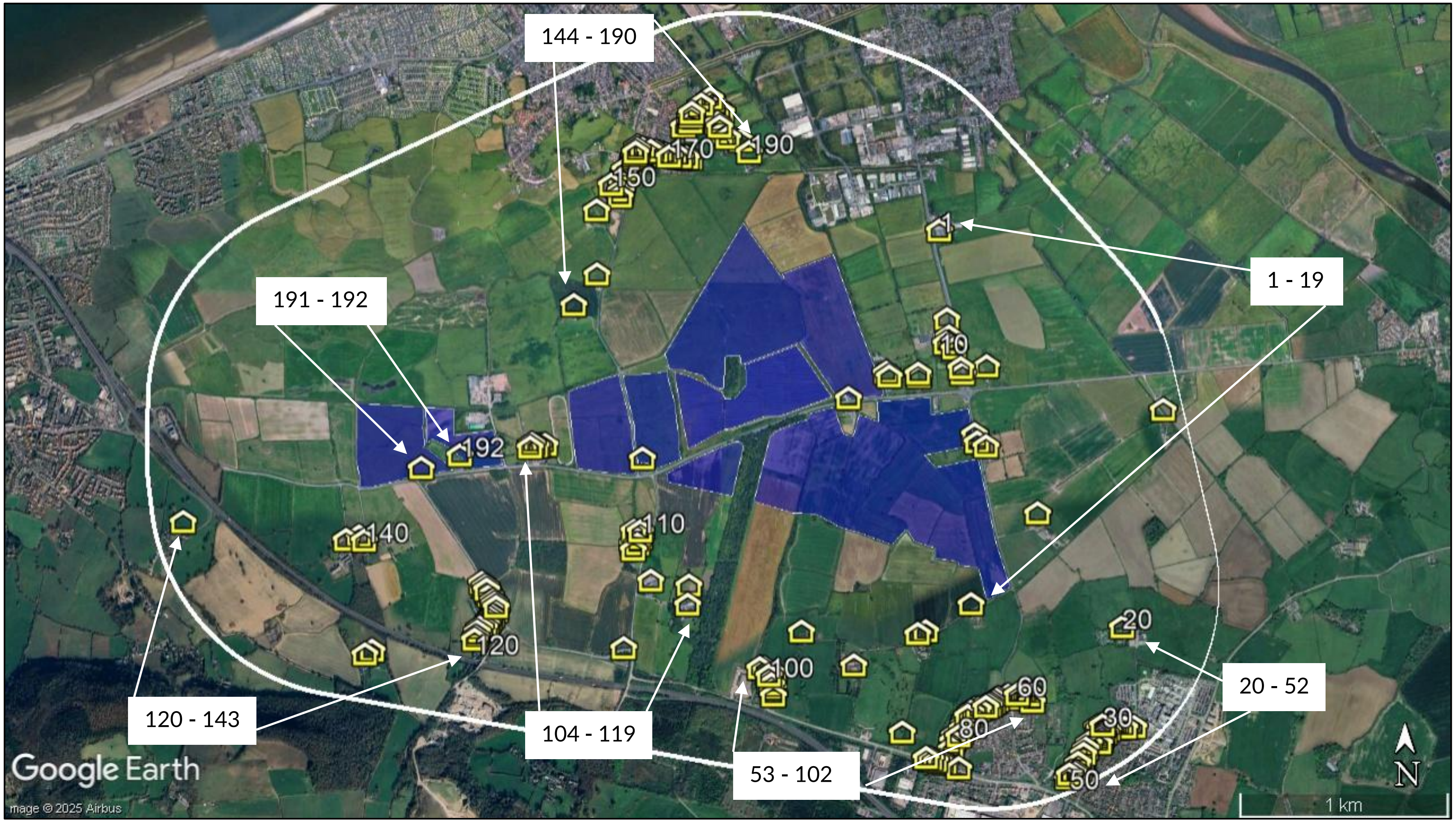

Figure 16 *Dwelling receptors within a 1km area*

Figure 17 *Dwelling receptors 1 to 18*

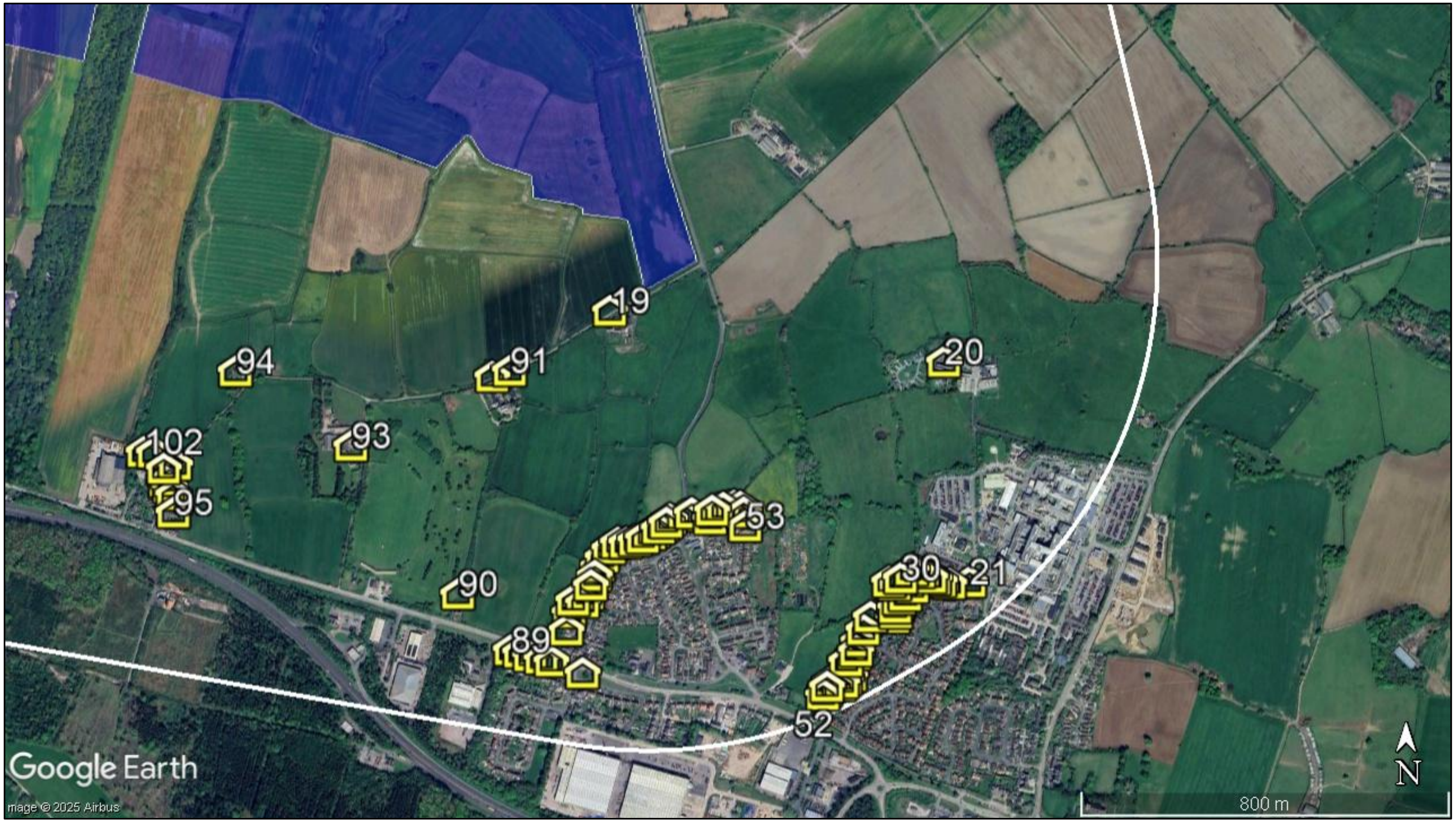

Figure 18 *Dwelling receptors 19 to 102*

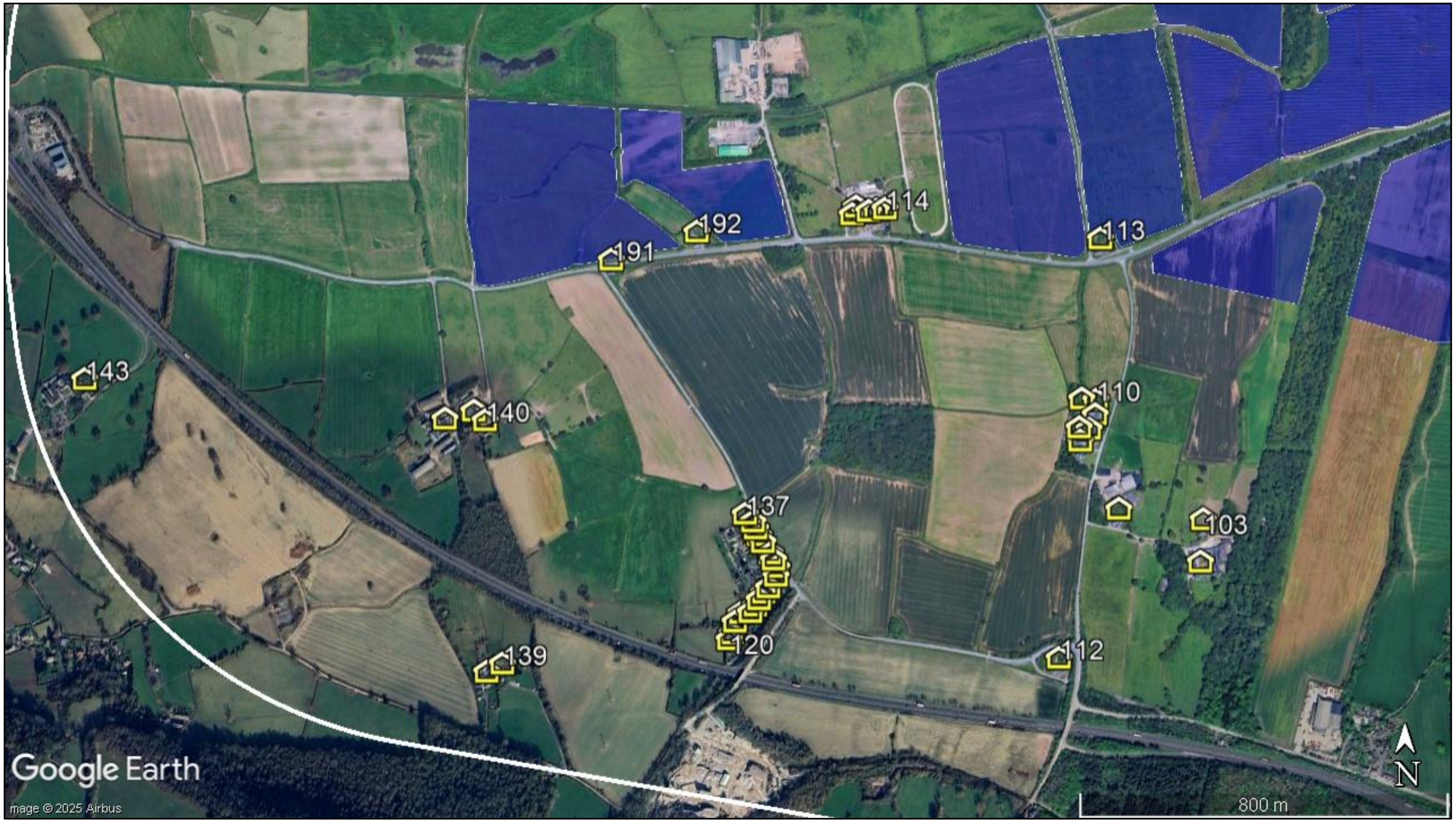

Figure 19 *Dwelling receptors 103 to 143, 191, and 192*

Figure 20 *Dwelling receptors 144 to 190*

5 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

5.1 Overview

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

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

5.2 Aviation Receptors

5.2.1 Glare Intensity Categorisation

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

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

Table 2 *Glare intensity designation*

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

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

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

5.2.2 Key Considerations – Runway Approach Paths

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

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

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

Where solar reflections are of an intensity no greater than 'low potential for temporary after-image' (green glare) or occur outside of a pilot's primary field-of-view (50 degrees either side of the runway approach relative to the runway threshold), the impact significance is low, and mitigation is not required.

Pager Power recommends a pragmatic approach whereby instances of 'yellow' glare are evaluated in a technical and operational context. Where solar reflections are of an intensity of potential for temporary after-image' expert assessment of the following relevant factors is required to determine the impact significance[11]:

- The likely traffic volumes and level of safeguarding at the aerodrome – licensed aerodromes typically have higher traffic volumes and are formally safeguarded;

[11] 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 time of day at which glare is predicted and whether the aerodrome will be operational such that pilots can be on the approach at these times;
- The duration of any predicted glare – glare that occurs for low durations throughout the year is less likely to be experienced than glare that occurs for longer durations throughout the year;
- The location and size of the reflecting panel area relative to a pilot's primary field-of-view;
- The location of the source of glare relative to the position of the Sun at the times and dates in which solar reflections are geometrically possible – effects that coincide with direct sunlight appear less prominent than those that do not;
- The level of predicted effect relative to existing sources of glare – a solar reflection is less noticeable by pilots when there are existing reflective surfaces in the surrounding environment.

Following consideration of these mitigating factors, where the solar reflection is not deemed to be 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 development.

Where the solar reflections are deemed to be 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.

5.3 Assessment Results – Aviation Receptors

5.3.1 Geometric Modelling Results and Discussion

Table 3 on the following pages presents the following for Ysbyty Glan Clywd Hospital Heliport:

- Geometric modelling results;
- Glare intensity;
- Predicted impact significance.

The existing Kinmel Bay Solar Farm produces solar reflections with the same glare categorisation as the proposed development, in isolation. Therefore, the cumulative glare intensity is not considered to be significantly worse than which pilots may already experience.

Receptor/Runway	Geometric Modelling Result	Maximum Coding	Comment	Impact Classification
Helicopter Approach path 04	Solar reflections are geometrically possible for 1 mile of the approach path	'Green'	Solar reflections occur inside a pilot's primary field-of-view for a 0.6 mile section with glare intensities no greater than having a 'low potential for temporary after-image' ('green' glare), which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice	Low impact
Helicopter Approach path 09	Solar reflections are geometrically possible for the entire 2-mile approach path	'Green'	Solar reflections occur inside a pilot's primary field-of-view for a 1.4 mile section with glare intensities no greater than having a 'low potential for temporary after-image' ('green' glare), which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice	Low impact
Helicopter Approach path 13	Solar reflections are geometrically possible for the entire 2-mile approach path	'Yellow'	Solar reflections occur inside a pilot's primary field-of-view for a 1.3 mile section with glare intensities no greater than having a 'low potential for temporary after-image' ('green' glare), which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice Solar reflections occur inside a pilot's primary field-of-view for a 0.2 mile section with glare intensities with 'potential for a temporary after-image' ('yellow' glare). See Section 5.3.2	Low impact (see Section 5.3.2)

Receptor/Runway	Geometric Modelling Result	Maximum Coding	Comment	Impact Classification
Helicopter Approach path 18	Solar reflections are geometrically possible for the entire 2-mile approach path	'Yellow'	Solar reflections occur inside a pilot's primary field-of-view for a 1.4 mile section with glare intensities with 'potential for a temporary after-image' ('yellow' glare). See Section 5.3.2	Low impact (see Section 5.3.2)
Helicopter Approach path 22	Solar reflections are geometrically possible for the entire 2-mile approach path	'Yellow'	Solar reflections occur inside a pilot's primary field-of-view for a 1.8 mile section with glare intensities with 'potential for a temporary after-image' ('yellow' glare). See Section 5.3.2	Low impact (see Section 5.3.2)
Helicopter Approach path 27	Solar reflections are geometrically possible for the entire 2-mile approach path	'Yellow'	Solar reflections occur inside a pilot's primary field-of-view for a 1.8 mile section with glare intensities with 'potential for a temporary after-image' ('yellow' glare). See Section 5.3.2 Solar reflections occur inside a pilot's primary field-of-view for a 0.2 mile section with glare intensities no greater than having a 'low potential for temporary after-image' ('green' glare), which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice	Low impact (see Section 5.3.2)

Receptor/Runway	Geometric Modelling Result	Maximum Coding	Comment	Impact Classification
Helicopter Approach path 31	Solar reflections are geometrically possible for the entire 2-mile approach path	'Yellow'	Solar reflections occur inside a pilot's primary field-of-view for a 0.6 mile section with glare intensities with 'potential for a temporary after-image' ('yellow' glare). See Section 5.3.2 Solar reflections occur inside a pilot's primary field-of-view for a 1.4 mile section with glare intensities no greater than having a 'low potential for temporary after-image' ('green' glare), which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice	Low impact (see Section 5.3.2)
Helicopter Approach path 36	Solar reflections are geometrically possible for 1.3 miles of the approach path	'Yellow'	Solar reflections occur inside a pilot's primary field-of-view for a 1.2 mile section with glare intensities no greater than having a 'low potential for temporary after-image' ('green' glare), which is acceptable in accordance with the associated guidance (Appendix D) and industry best practice Solar reflections occur inside a pilot's primary field-of-view for a 0.1 mile section with glare intensities with 'potential for a temporary after-image' ('yellow' glare). See Section 5.3.2	Low impact (see Section 5.3.2)

Table 3 *Geometric modelling results – Ysbyty Glan Clywd Heliport receptors*

5.3.2 Helicopter Approach Paths Impact Significance

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[12] for on-airfield solar toward approach paths. 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. In the case of the proposed development:

Instances of 'yellow' glare (shown in Figure 21 on the following page) are laid out in the table below:

Helicopter Path	Location of 'Yellow' Glare	Maximum Annual Duration (mins)	Percentage of Daylight Hours (%)[13]
13	0.6 miles from threshold	55	0.02
18	0.7 miles from threshold to 2 miles from threshold	20,973	7.98
22	0.3 miles from threshold to 1.9 miles from threshold	14,042	5.34
27	From threshold to 1.7 miles from threshold	12,665	4.82
31	From threshold to 0.6 miles from threshold	2,851	1.08
36	0.1 miles from threshold	337	0.12

Table 4 *Yellow glare occurrence*

[12] This FAA guidance from 2013 has since been superseded by the FAA guidance in 2021 whereby airports are tasked with determining safety requirements themselves.
[13] Based on 12 hours of sunlight per day (262,800 minutes a year).

- The instances of ‘yellow’ glare would occur between:
    - 13, 18, 22, 27, 31, and 36 approach paths: early-March to early-October;
    - The maximum duration of yellow glare would be less than 60 minutes on the days when the glare is possible[14].
- The ‘yellow’ glare marginally passes the ‘yellow’/’green’ threshold on the intensity chart. Green glare (or glare with ‘low potential for temporary after-image’) is acceptable for approaching aircraft;
- Solar reflections with the same glare categorisation originate from the existing Kinmel Bay Solar Farm in isolation. Therefore, the cumulative glare intensity is not considered to be significantly worse than which pilots may already experience;
- The weather would have to be clear and sunny at the specific times when the glare was possible to be experienced. The modelling considers 100% sunlight during daylight hours which is highly conservative.

The instances of ‘yellow’ glare could be accommodated subject to consultation with the Heliport. A low impact is predicted and mitigation is not recommended.

It is recommended that the analysis of this yellow glare scenario be made available to the operator of Ysbyty Glan Clywd Hospital Heliport for further discussion.

[14] A conservative estimate based on the annual predicted glare occurrence chart.

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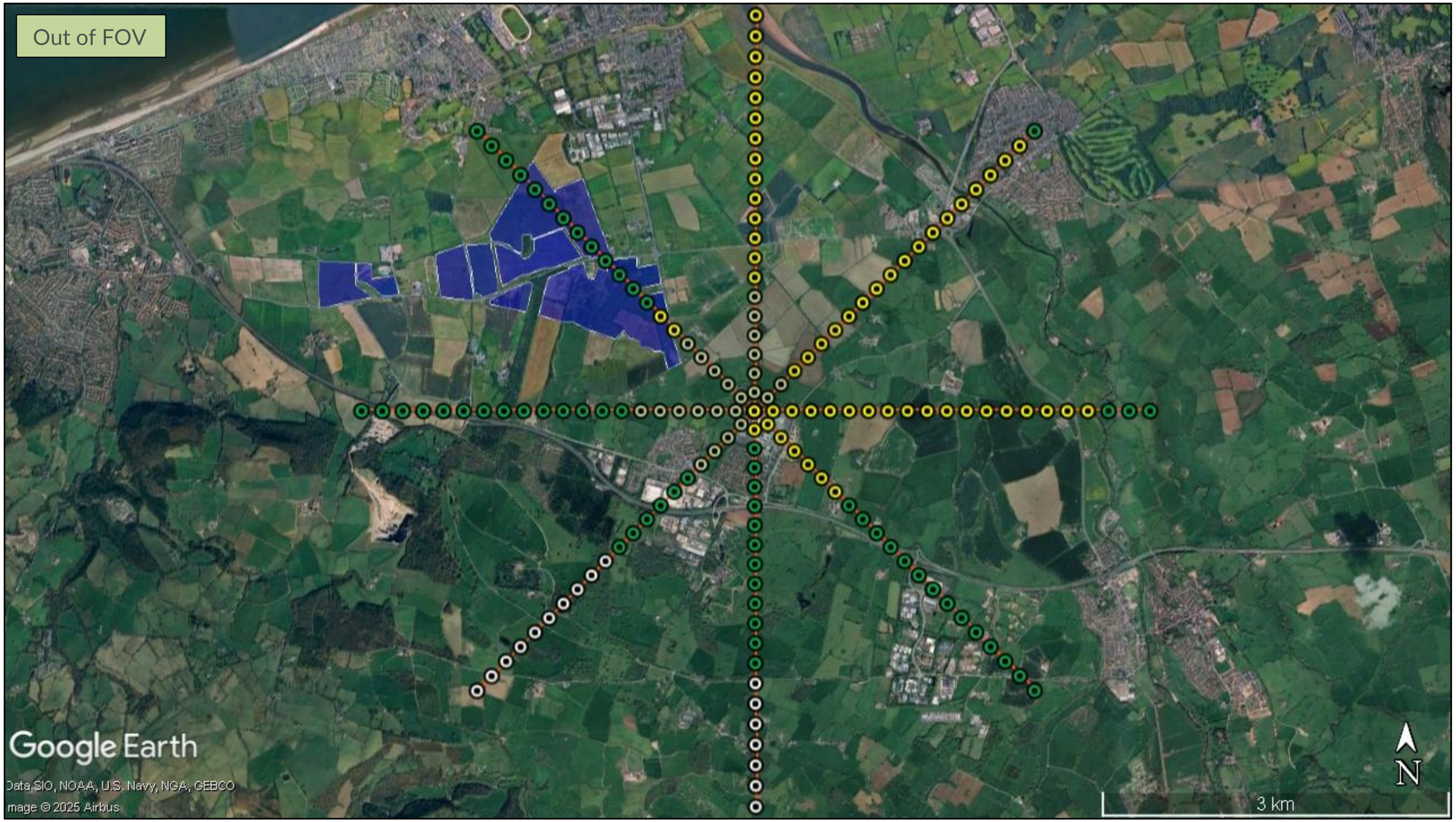

Figure 21 *Yellow glare towards Southweald Private Airfield receptors*

5.4 Assessment Results - Road Results

5.4.1 Key Considerations

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

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

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

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

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

- Whether visibility is likely for elevated drivers (applicable to dual carriageways and motorways only) – there is typically a higher density of elevated drivers (such as HGVs) along dual carriageways and motorways compared to other types of road;
- Whether a solar reflection is fleeting in nature. Small gap/s in screening (e.g., an access point to the site) may not result in a sustained reflection for a road user;
- The separation distance to the panel area – larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not;
- Whether the solar reflection originates from directly in front of a road user – a solar reflection that is directly in front of a road user is more hazardous than a solar reflection to one side.

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

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

5.4.2 Geometric Modelling Results Overview

Table 4 on the following pages presents the following:

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

Receptors where mitigation has been recommended have been highlighted in red for ease of reference.

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
A1	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No
A2	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary field of view[16] (FOV)	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	N/A	N/A	No impact	No
A3 – A5	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	No

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
A6 – A10	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	N/A	N/A	N/A	N/A
A11 – A23	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A

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

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
A24 – A26	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation and intervening terrain Predicted to partially obstruct views of the reflecting panels such that views are possible in practice	Solar reflections occur **outside** a road user's primary FOV	Closest reflecting panel is 1km away	Low impact	No
A27 – A41	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
B1 – B23	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation and buildings Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
C1 – C6	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
C7 – C12	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation predicted to partially obstruct views of the reflecting panels Proposed vegetation predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
C13 – C15	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation predicted to partially obstruct views of the reflecting panels Proposed vegetation predicted to partially obstruct views of the reflecting panels Views considered possible for elevated road users (e.g. HGVs)	Solar reflections occur **outside** a road user's primary FOV	N/A	Low impact	N/A
C16 – C19	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
C20 – C21	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
C22 – C24	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
C25 – C30	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation predicted to partially obstruct views of the reflecting panels Proposed vegetation predicted to partially obstruct views of the reflecting panels Views considered possible for elevated road users (e.g. HGVs)	Solar reflections occur **outside** a road user's primary FOV	N/A	Low impact	N/A
C31 – C33	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
C34	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
C35 – C40	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No
C41	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
C42 – C53	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
D1 – D3	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
D4	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
D5 – D9	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
D10 – D15	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation predicted to partially obstruct views of the reflecting panels Proposed vegetation is predicted to partially obstruct views of the reflecting panels	Solar reflections occur **inside** a road user's primary FOV	Reflections to coincide with direct sunlight	Low impact	N/A
E1	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation predicted to partially obstruct views of the reflecting panels Proposed vegetation is predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
E2 – E10	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
E11 – E16	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No
E17 – E18	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation and buildings Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
E19	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
E20 – E23	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing buildings Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
F1 – F3	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No
F4	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation and buildings Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
F5 – F21	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact	No

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
F22 – F25	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
F26 – F30	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A
F31	Solar reflections are **geometrically possible** Solar reflections occur **inside** a road user's primary FOV	Existing vegetation and buildings Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Whether reflections occur inside a road user's primary FOV (with consideration of screening)[15]	Mitigating Factors	Predicted Impact Classification	Mitigation recommended?
F32 – F38	Solar reflections are **geometrically possible** Solar reflections occur **outside** a road user's primary FOV	Existing vegetation and buildings Predicted to significantly obstruct views of the reflecting panels	None	N/A	No impact	N/A

Table 5 *Geometric modelling results – road receptors*

5.4.3 Desk-Based Review of Imagery

A desk-based review of the available images is presented in Figures 22 to 27 on the following pages. The cumulative reflective panel areas are shaded in yellow. Screening in the form of existing vegetation and buildings are outlined in pink and blue, respectively. Proposed vegetation is shown in white.

Figure 22 *Screening for road receptors A1 to A41, with Streetview from receptor A10*

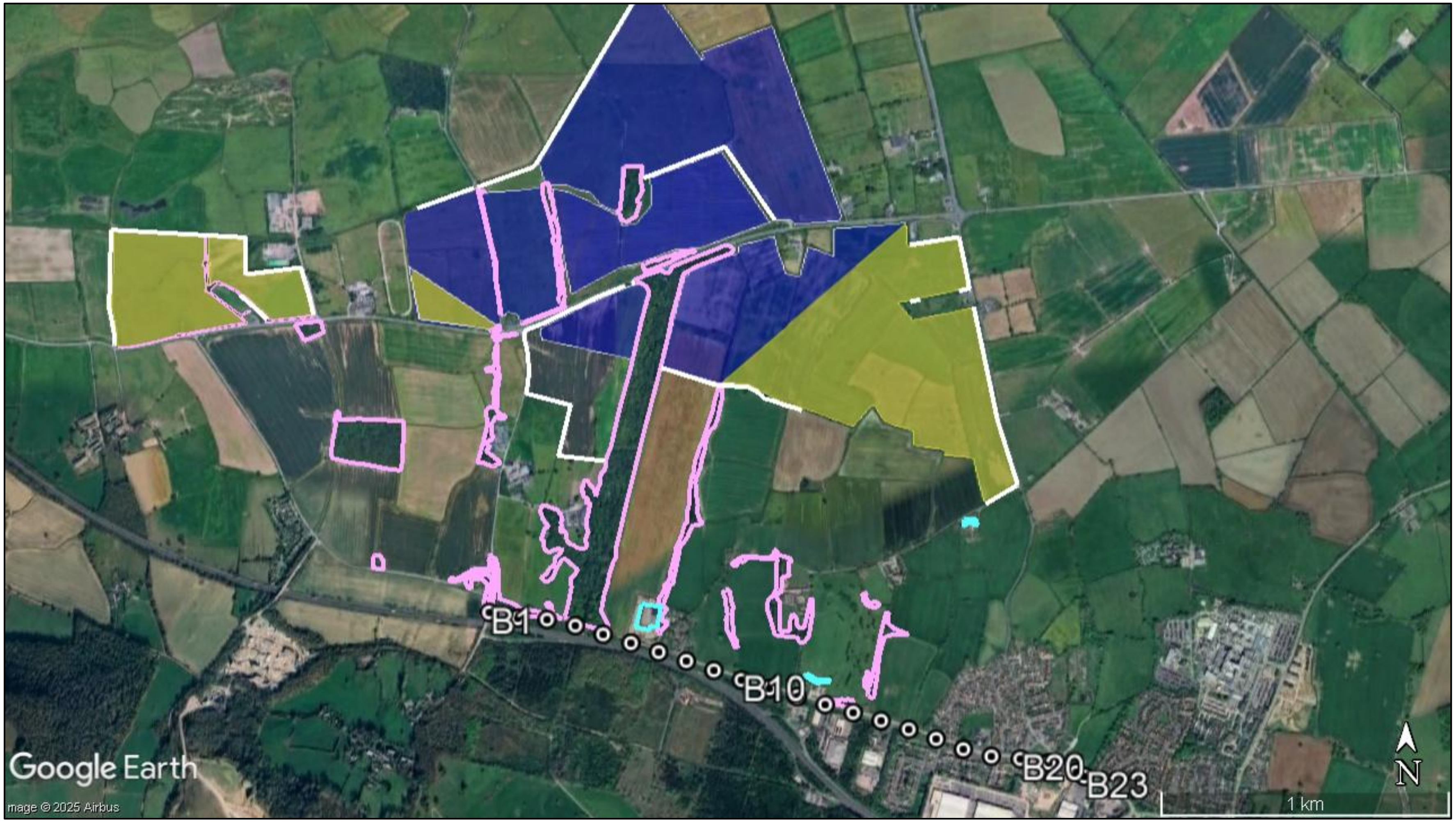

Figure 23 Screening for road receptors B1 to B23

Figure 24 *Screening for road receptors C1 to C6, C16 to C24, and C31 to C53, with Streetview from receptor C33*

Figure 25 *Screening for road receptors D1 to D9, with Streetview from receptor D9*

Figure 26 *Screening for road receptors E2 to E23, with Streetview from receptor E3*

Figure 27 *Screening for road receptors F1 to F38, with Streetview from receptor F28*

5.5 Dwelling Results

5.5.1 Key Considerations

The key considerations for quantifying the impact significance for dwelling receptors are:

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

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

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

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

- Whether solar reflections will be experienced from all storeys. The ground floor is typically considered the main living space and therefore has a greater significance with respect to residential amenity;
- The separation distance to the panel area. Larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun. Effects that coincide with direct sunlight appear less prominent than those that do not. The Sun is a far more significant source of light;
- Whether the dwelling appears to have windows facing the reflecting areas. An observer may need to look from a wide angle to observe the reflecting areas.

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

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

5.5.2 Geometric Modelling Results Overview

Solar reflections are geometrically possible towards a total of 110 of the 190 assessed dwelling receptors.

Table 5 on the following pages presents the following:

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

Receptors where mitigation has been recommended have been highlighted in red for ease of reference.

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
1	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
2	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
3 – 4	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
5	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
6 – 9	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
10 – 12	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
13	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
14 – 20	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
21	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
22 – 41	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
42 – 43	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
44	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
45 – 46	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
47 – 61	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
62 – 64	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
65	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
66	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
67 – 75	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
76 – 79	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
80	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
81 – 90	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
91 – 92	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to partially obstruct views of reflecting panels such that views **are predicted** in practice	Views are possible above the ground floor	Low impact	No
93 – 108	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
109 – 110	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation predicted to partially obstruct views of reflecting panels Proposed vegetation is predicted to partially obstruct views of the reflecting panels	Closest reflecting panel is 400 away Reflections coincide with direct sunlight Views still considered possible above the ground floor	Low impact	No
111 – 112	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
113	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation predicted to partially obstruct views of reflecting panels Proposed vegetation is predicted to partially obstruct views of the reflecting panels	Reflections coincide with direct sunlight Views still considered possible above the ground floor	Low impact	No
114 – 119	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
120 – 132	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
133 – 137	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation Predicted to partially obstruct views of reflecting panels such that views **are predicted** in practice	**Less** than three months **Less** than 60 minutes Views possible above ground floor	Low impact	No
138 – 143	Solar reflections **are geometrically possible** for: **More** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
144 – 145	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
146 - 155	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
156 – 180	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to partially obstruct views of reflecting panels such that views **are possible** in practice	Views are possible from above the ground floor	Low impact	No
181 – 184	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
185 – 188	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Mitigating Factors	Predicted Impact Classification (with consideration of screening)	Further Mitigation Recommended / Required?
189	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No
190	Solar reflections **are geometrically possible** for: **Less** than three months **Less** than 60 minutes	Existing vegetation Predicted to significantly obstruct views of reflecting panels such that views are **not predicted** in practice	N/A	No impact	No
191 - 192	Solar reflections are **not geometrically possible**	N/A	N/A	No impact	No

Table 6 *Geometric modelling results - dwelling receptors*

5.5.3 Desk-Based Review of Imagery

The screening identified is shown in Figures 28 to 31 on the following pages. The cumulative reflective panel areas are shaded in yellow. Screening in the form of existing vegetation and buildings are outlined in pink and blue, respectively. Proposed vegetation is shown in white.

Figure 28 *Reflective panel area and screening for dwellings 1, 3, 4, 6 to 9, and 13, with Streetview from dwelling 1*

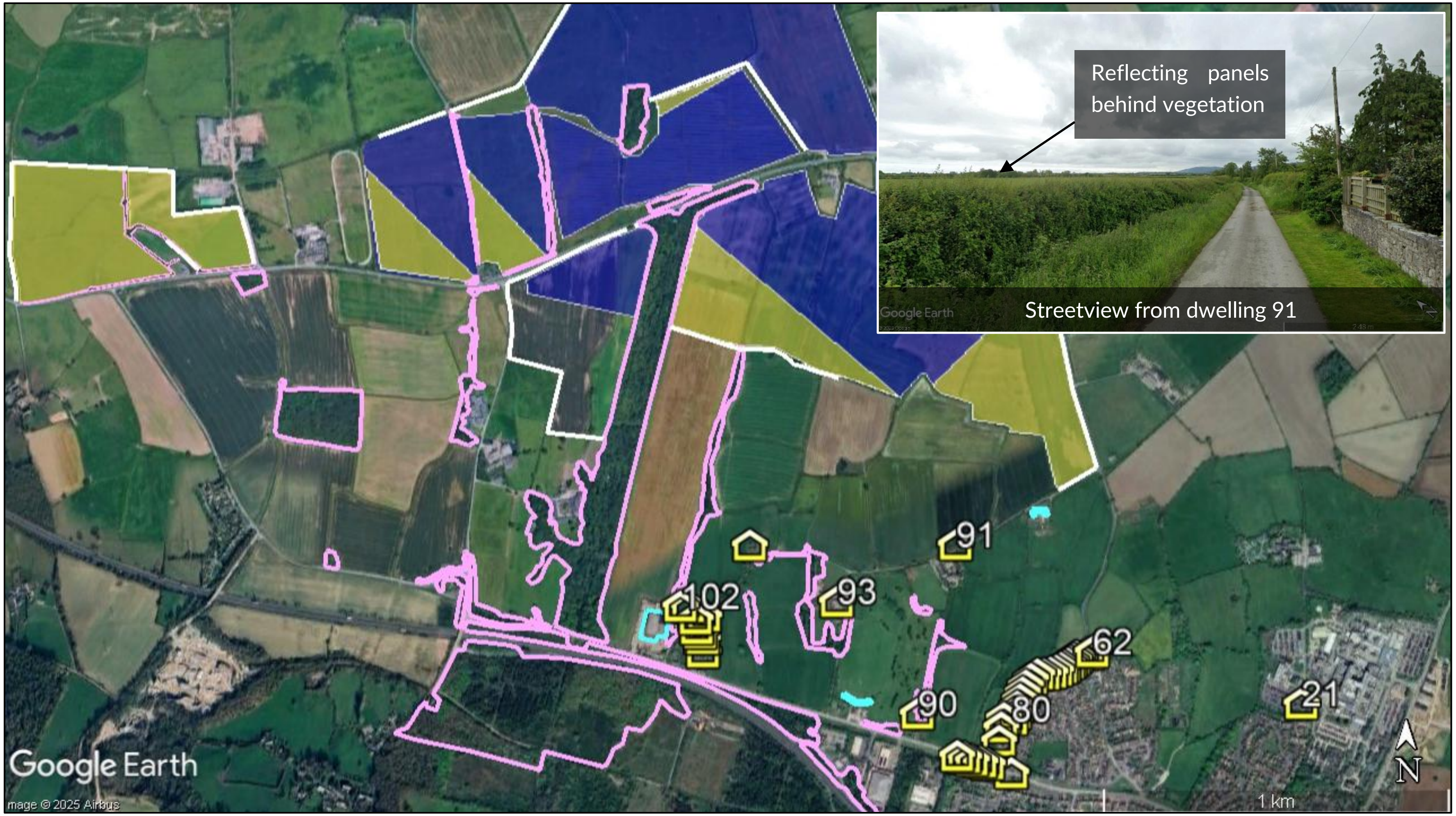

Figure 29 *Reflective panel area and screening for dwellings 21, 62 to 91 and 93 to 102, with Streetview from dwelling 91*

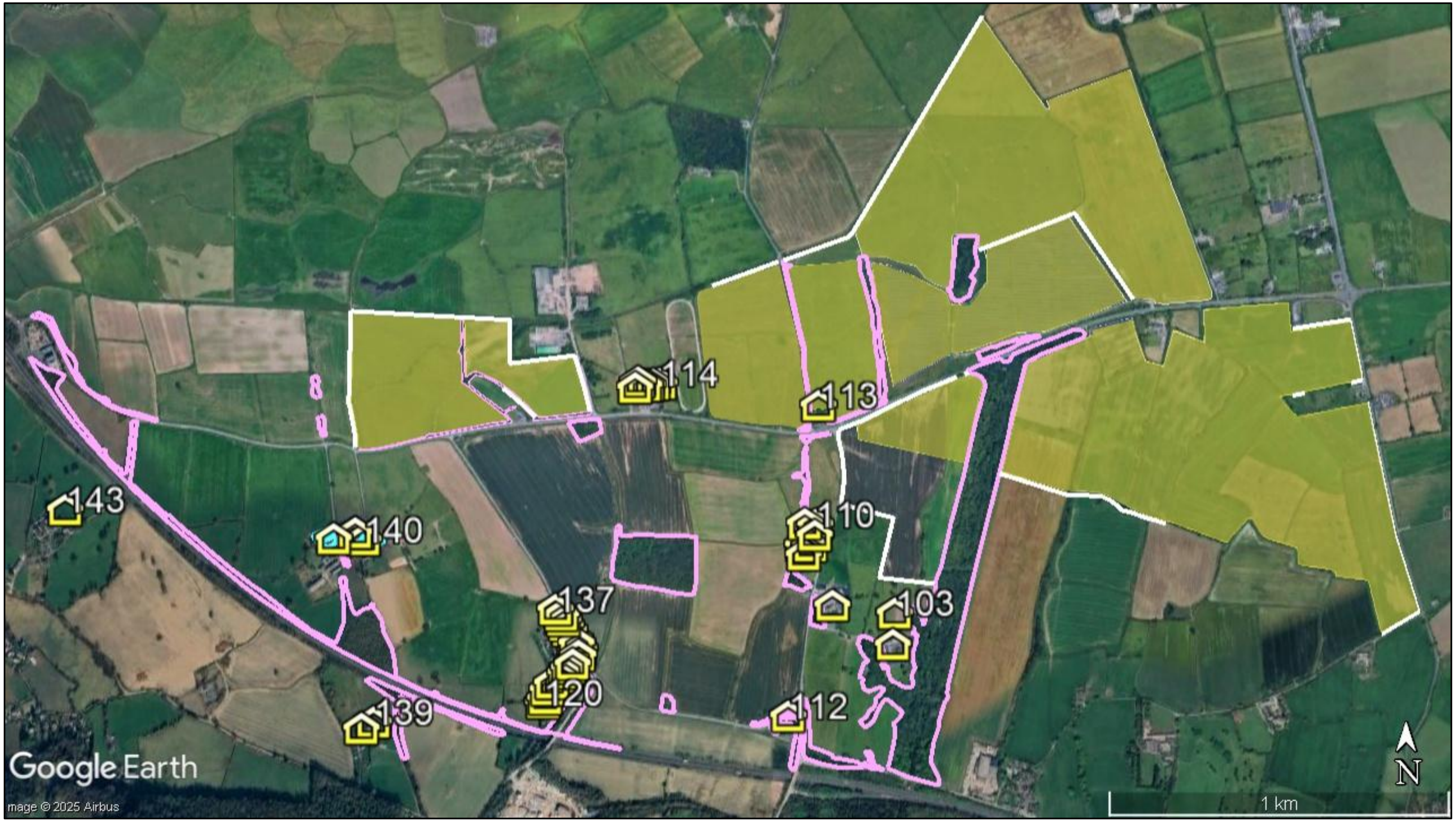

Figure 30 *Reflective panel area and screening for dwellings 103 to 108, 111, 112, 120 to 138, and 143*

Figure 31 *Reflective panel area and screening for dwellings 144, 145, 156 to 180, 185 to 188, and 190, with Streetview from dwelling 145*

6 HIGH-LEVEL AVIATION ASSESSMENTS

6.1 Overview

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

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

6.2 High-Level Assessment of Rhedyn Coch Farm Airfield

Rhedyn Coch Farm Airfield is an unlicensed GA airfield approximately 9.4km east of the development with one operational runway and is understood not to have an ATC Tower. The runway details[17] are presented below:

- 16/34 measuring 405 metres x 9 metres (grass).

The location of Rhedyn Coch Farm Airfield and 1-mile splayed approach paths for each runway threshold relative to the development is shown in Figure 32 below.

Figure 32 *Rhedyn Coch Farm Airfield relative to the proposed development*

[17] As determined from aerial imagery.

6.2.1 Assessment

The development size, distance between the aerodrome and the development, and industry experience have been considered to determine the impact during the assessment.

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

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway thresholds 16/34 will be outside a pilot's primary field-of-view (50 degrees horizontally either side of the direction of travel), and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths;
- Solar reflections towards the visual circuits for runway thresholds 16/34 are expected to have glare intensities no greater than 'low potential for temporary after-image' (green glare, see Table 2). Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths at licensed aerodromes, which states this level of glare is acceptable, it can be reliably concluded that this level of glare is also acceptable for these visual circuits.

6.2.2 Conclusions

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

6.3 High-Level Assessment of Bryngwyn Bach Airfield

Bryngwyn Bach Airfield is an unlicensed GA airfield approximately 9.7km southeast of the development with one operational runway and is understood not to have an ATC Tower. The runway details[18] are presented below:

- 07/25 measuring 895 metres x 26 metres (grass).

The location of Bryngwyn Bach Airfield and 1-mile splayed approach paths for each runway threshold relative to the development is shown in Figure 33 on the following page.

[18] As determined from aerial imagery.

Figure 33 *Bryngwyn Bach Airfield relative to the proposed development*

6.3.1 Assessment

The following can be concluded for Bryngwyn Bach Airfield with regards to the development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 07 will be outside a pilot's primary field-of-view (50 degrees horizontally either side of the direction of travel), and would therefore not be considered significant considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths;
- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 25 are expected to have glare intensities no greater than 'low potential for temporary after-image' (green glare, see Table 2). Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths at licensed aerodromes, which states this level of glare is acceptable, it can be reliably concluded that this level of glare is also acceptable;
- Solar reflections towards the visual circuits for runway thresholds 07/25 are expected to have glare intensities no greater than 'low potential for temporary after-image' (green glare, see Table 2). Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths at licenced aerodromes, which states this level of glare is acceptable, it can be reliably concluded that this level of glare is also acceptable for these visual circuits.

6.3.2 Conclusions

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

7 OVERALL CONCLUSIONS

7.1 Assessment Conclusions – Ysbyty Glan Clywd Hospital Heliport

Solar reflections with an intensity of 'low potential for temporary after-image' are geometrically possible towards sections of the 2-mile helicopter approach paths. This category of glare intensity is acceptable in accordance with the associated guidance (Appendix D) and industry best practice. A low impact is predicted upon pilots on these approaches, and mitigation is not recommended.

Solar reflections with an intensity of 'potential for temporary after-image' ('yellow' glare) are geometrically possible towards sections of the helicopter approach paths. The existing Kinmel Bay Solar Farm produces yellow glare towards some of the helicopter approach paths. These instances of 'yellow' glare could be accommodated subject to consultation with the Heliport. A low impact is predicted and mitigation is not recommended.

The analysis of this yellow glare scenario has been made available to the operator of Ysbyty Glan Clywd Hospital Heliport for further discussion. Initial consultation with the Heliport has not indicated any concerns in relation to the assessment, however further feedback is awaited which will be reviewed and addressed (if necessary) ahead of final submission of the DNS application.

7.2 Assessment Conclusions – Roads

The results of road assessment is shown in the table below.

Road	Section of which solar reflections are possible	Sections of which are screened (no impact)	Sections of which are low impact	Sections of which are moderate impact
A55	3.9km	3.7km screened by vegetation	200m with partial screening. Views are outside of field of view (50 degrees either side of the direction of travel)	N/A
St Asaphs	2.1km	2.1km screened by vegetation and/or buildings	N/A	N/A

Road	Section of which solar reflections are possible	Sections of which are screened (no impact)	Sections of which are low impact	Sections of which are moderate impact
A547	3.1km	2.3km screened by vegetation	800m with partial screening. Proposed vegetation is predicted to partially obstruct views of the reflecting panels for typical road users. Views may be possible for elevated road users	N/A
St Georges	1.3km	800m screened by vegetation	500m with partial screening. Proposed vegetation is predicted to partially obstruct views of the reflecting panel. Reflections coincide with direct sunlight	N/A
Gors	1.3km	1.3km screened by vegetation and buildings	N/A	N/A
Ronalds way	1.6km	1.6km screened by vegetation and/or buildings	N/A	N/A

The existing Kinmel Bay Solar Farm produces reflections towards the A55, St Asaphs Road, St Georges Road, and Ronaldsway. Solar reflections produced by Kinmel Bay Solar Farm are significantly screened by existing vegetation and/or buildings.

7.3 Assessment Conclusions – Dwellings

Solar reflections are predicted to be geometrically possible towards 110 of the 192 assessed dwellings.

For 75 dwellings, existing vegetation and/or buildings have been identified which significantly obstruct views of the reflecting panels. No impact is predicted and mitigation is not required.

For 27 dwellings, solar reflections are predicted to occur for less than three months a year and less than 60 minutes on any given day. Existing vegetation and/or buildings have been identified which partially obstruct views of the reflecting panels, at ground floor level, however, views are still considered possible from above the ground floor. A low impact is predicted and mitigation is not recommended.

For five dwellings, solar reflections are predicted to occur for more than three months a year and less than 60 minutes on any given day. Existing vegetation has been identified which significantly obstruct views of the reflecting panels, at ground floor level, however, views are still considered possible from above the ground floor. A low impact is predicted and mitigation is not recommended.

For the remaining three dwellings, solar reflections are predicted to occur for more than three months a year but less than 60 minutes on any given day. Proposed vegetation is predicted to partially obstruct views of the reflecting panels. Views are still considered possible above the ground floor. Reflections coincide with direct sunlight. A low impact is predicted and mitigation is not recommended.

The existing Kinmel Bay Solar Farm produces reflections towards 32 of the 192 dwellings. Solar reflections produced by Kinmel Bay Solar Farm are significantly screened by existing vegetation for 30 of the 32 dwellings.

7.4 Assessment Conclusions – High-Level Aviation

Rhedyn Coch Farm Airfield and Bryngwyn Bach Airfield

The development size, distance between the aerodrome and the development, the existing Kinmel Bay Solar Farm, and industry experience have been considered to determine the impact during the assessment.

Solar reflections towards the splayed approaches and final sections of visual circuits at Rhedyn Coch Farm Airfield and Bryngwyn Bach Airfield are predicted to occur outside a pilot's field-of-view (50 degrees on either side relative to the direction of travel) or have intensities no greater than 'low potential for temporary after-image'. No significant impact is predicted and mitigation is not required.

Overall, no significant impact upon aviation activity associated with Rhedyn Coch Farm Airfield and Bryngwyn Bach Airfield are predicted. Mitigation is not required.

7.5 Overall Conclusions

A low impact is predicted upon aviation activity associated with Ysbyty Glan Clywd Hospital Heliport. Mitigation is not recommended.

No significant impact is predicted towards road safety, residential amenity and aviation activity associated with Rhedyn Coch Farm Airfield and Bryngwyn Bach Airfield. Mitigation is not required.

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.

Welsh Planning Policy

Future Wales

Future Wales Policies 17 and 18[19] are relevant in the context of potential glint and glare effects.

Policies 17 and 18 state:

'*All proposals should demonstrate that they will not have an unacceptable adverse impact on the environment*'

…

'*There are no unacceptable adverse impact by way of shadow flicker, noise, reflected light, air quality or electromagnetic disturbance*'.

Planning Policy Wales

Planning Policy Wales – Edition 12[20] is relevant in the context of potential glint and glare effects:

'Prevent glare and respect the amenity of neighbouring land uses'.

UK Planning Policy

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[21] (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.

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[19] Future Wales: The National Plan 2040, Welsh Government, date: 21 February 2021, accessed on: 08/10/2024.
[20] Planning Policy Wales – Edition 12, Welsh Government, date: February 2024, accessed on: 07/08/2025.
[21] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 01/11/2021.

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.'

National Policy Statement for Renewable Energy Infrastructure

The National Policy Statement for Renewable Energy Infrastructure (EN-3)[22] 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.[23] 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.'

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

[23] *'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.'*

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

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

Sections 2.10.158-159 state:

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

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

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

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

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare has been determined when assessing the impact of solar reflections upon surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

The Pager Power approach has been informed by the policy presented above, current studies (presented in Appendix B) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document[24] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

Aviation Assessment Guidance

The UK Civil Aviation Authority (CAA) issued interim guidance relating to Solar Photovoltaic Systems (SPV) on 17 December 2010 and was subject to a CAA information alert 2010/53. The formal policy was cancelled on September 7th, 2012[25] however the advice is still applicable[26] 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[27], as part of a condition of a CAA Aerodrome Licence, the ALH is required to obtain prior consent from CAA Aerodrome Standards Department before any work is begun or approval to the developer or LPA is granted, in accordance with the procedures set out in CAP 791 Procedures for Changes to Aerodrome Infrastructure.

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

[25] Archived at Pager Power.

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

[27] Aerodrome Licence Holder.

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'[28], the 2013 update is entitled 'Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports'[29], and the 2021 final policy is entitled 'Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports'[30].

Key excerpts from the final policy are presented below:

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

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

[28] Archived at Pager Power.

[29] 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.

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

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

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

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

In 2018, the FAA released the latest version (Version 1.1) of the 'Technical Guidance for Evaluating Selected Solar Technologies on Airports'[31]. 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[32].
- 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[33], flat, smooth surfaces reflect a more concentrated amount of sunlight back to the receiver, which is referred to as specular reflection. The more a surface is polished, the more it shines. Rough or uneven surfaces reflect light in a diffused or scattered manner and, therefore, the light will not be received as bright.
- Because the FAA has no specific standards for airport solar facilities and potential glare, the type of glare analysis may vary. Depending on site specifics (e.g., existing

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

[32] 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.

[33] First figure in Appendix B.

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[34] 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[35] 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

34 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.

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

225. A person must not in the United Kingdom direct or shine any light at any aircraft in flight so as to dazzle or distract the pilot of the aircraft.'

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

Endangering safety of an aircraft

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

Endangering safety of any person or property

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

Civil Aviation Authority consolidation of UK Regulation 139/2014

The Civil Aviation Authority (CAA) published a consolidating document[36] of UK regulations, (Implementing Rules, Acceptable Means of Compliance and Guidance Material), in 2023. A summary of material relevant to aerodrome safeguarding is presented below:

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

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

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

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

1. obstacles and the possibility of induced turbulence;
2. the use of hazardous, confusing, and misleading lights;
3. <u>the dazzling caused by large and highly reflective surfaces;</u>
4. sources of non-visible radiation, or the presence of moving, or fixed objects which may interfere with, or adversely affect, the performance of aeronautical communications, navigation and surveillance systems;

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

5. and non-aeronautical ground light near an aerodrome which may endanger the safety of aircraft and which should be extinguished, screened, or otherwise modified so as to eliminate the source of danger.

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

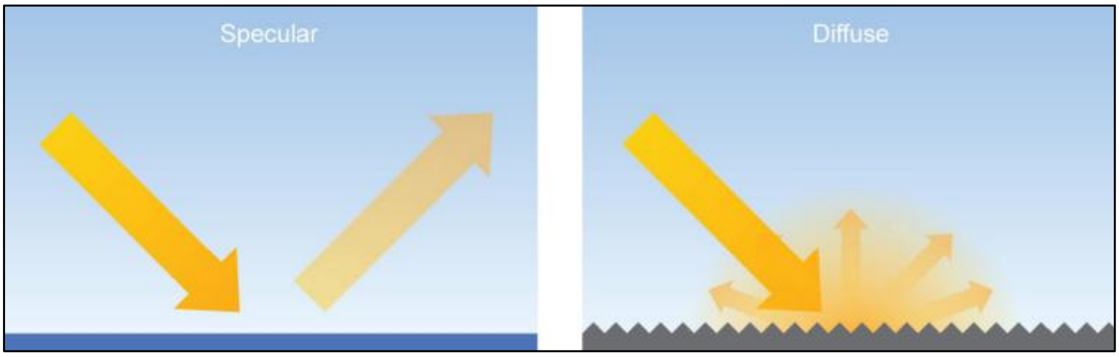
Overview

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[37], 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

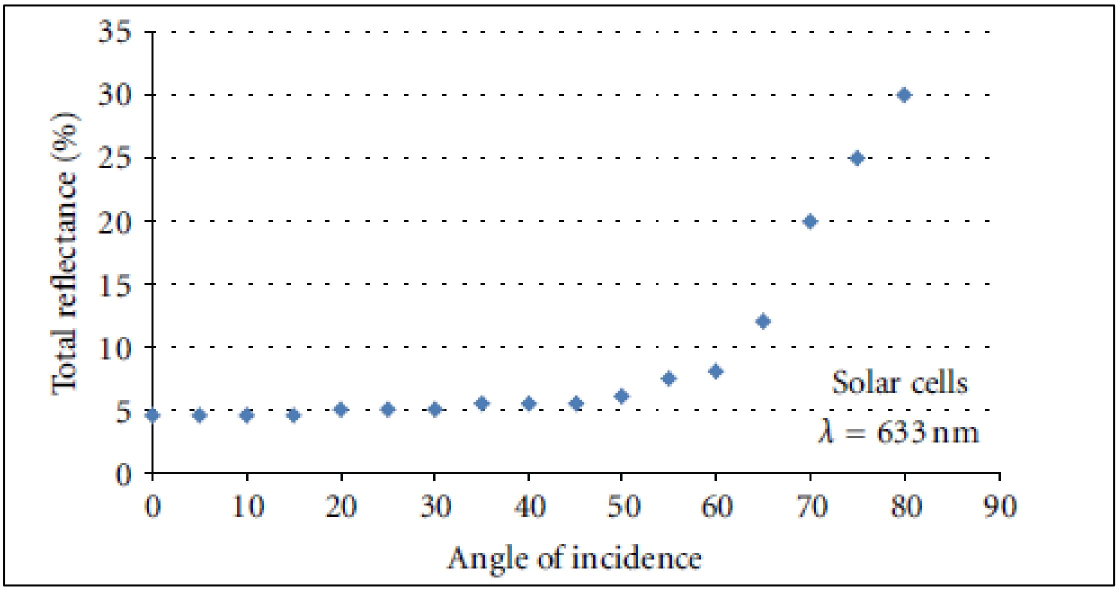
[37] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

Solar Reflection Studies

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

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

Evan Riley and Scott Olson published in 2011 their study titled: A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems[38]". 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.

[38] 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"[39]

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[40]
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).

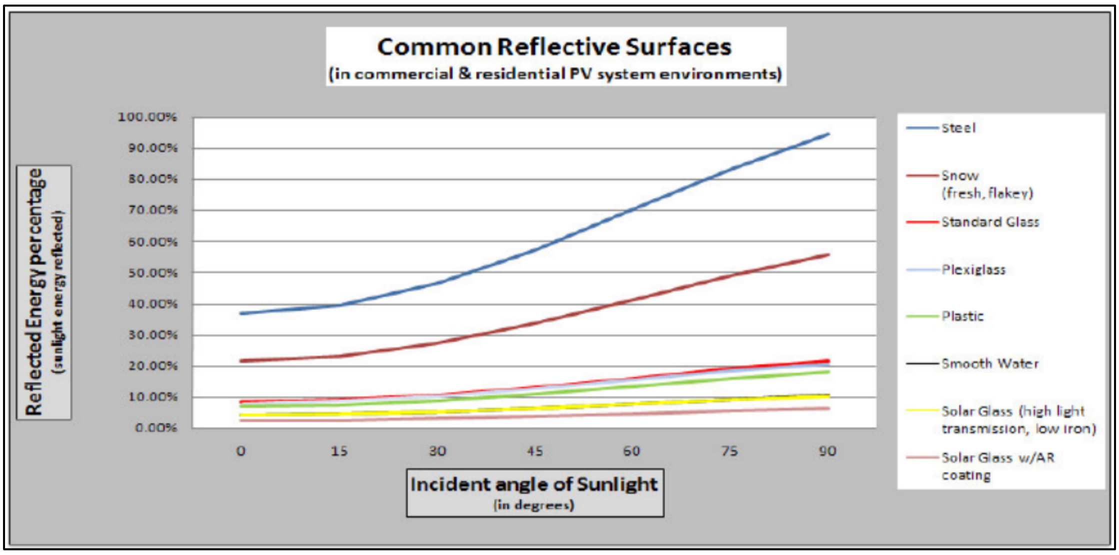
An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

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

SunPower Technical Notification (2009)

SunPower published a technical notification[41] 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.

[41] 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 north at this time;
- The Sun rises highest on 21 December (longest day);
- On 21 June, 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.

APPENDIX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

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

Impact Significance Definition

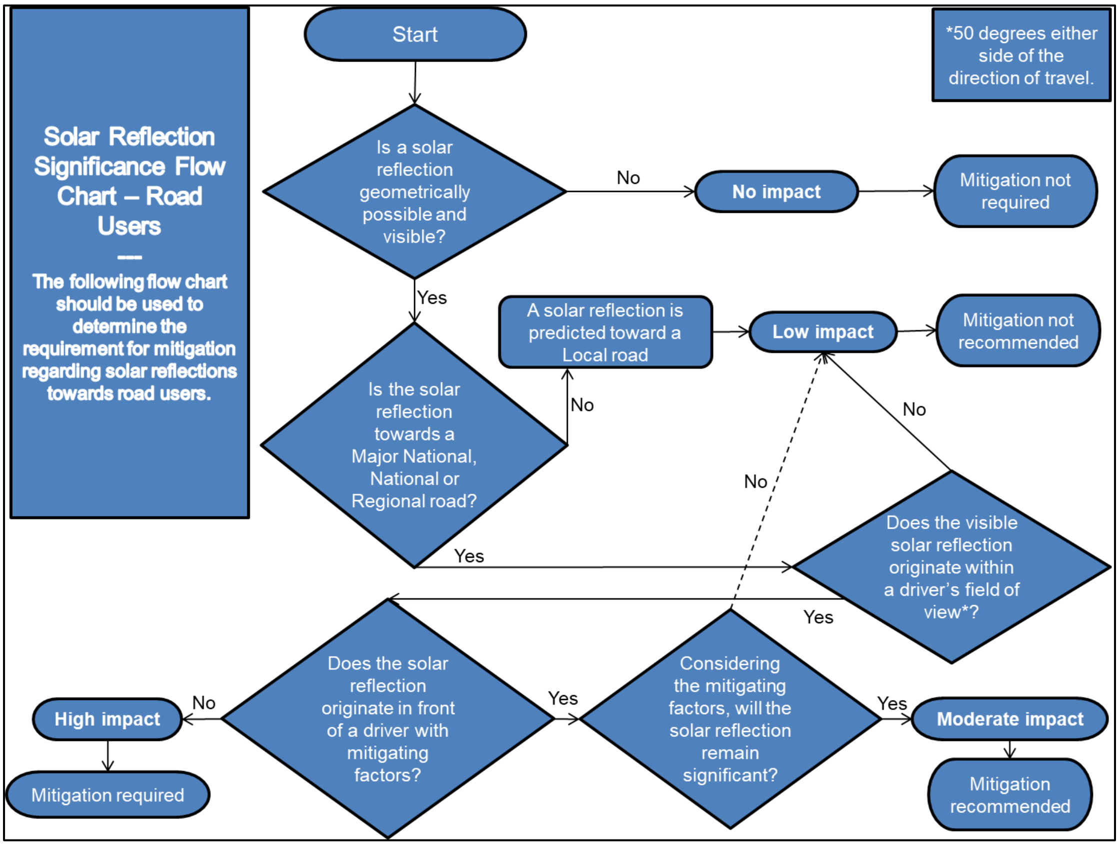
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels significantly.	No mitigation recommended.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case given individual receptor criteria.	Mitigation recommended.
High	A solar reflection is geometrically possible and visible under worst-case conditions that will produce a significant impact given individual receptor criteria	Mitigation will be required if the proposed development is to proceed.

Impact significance definition

Impact Significance Determination for Road Receptors

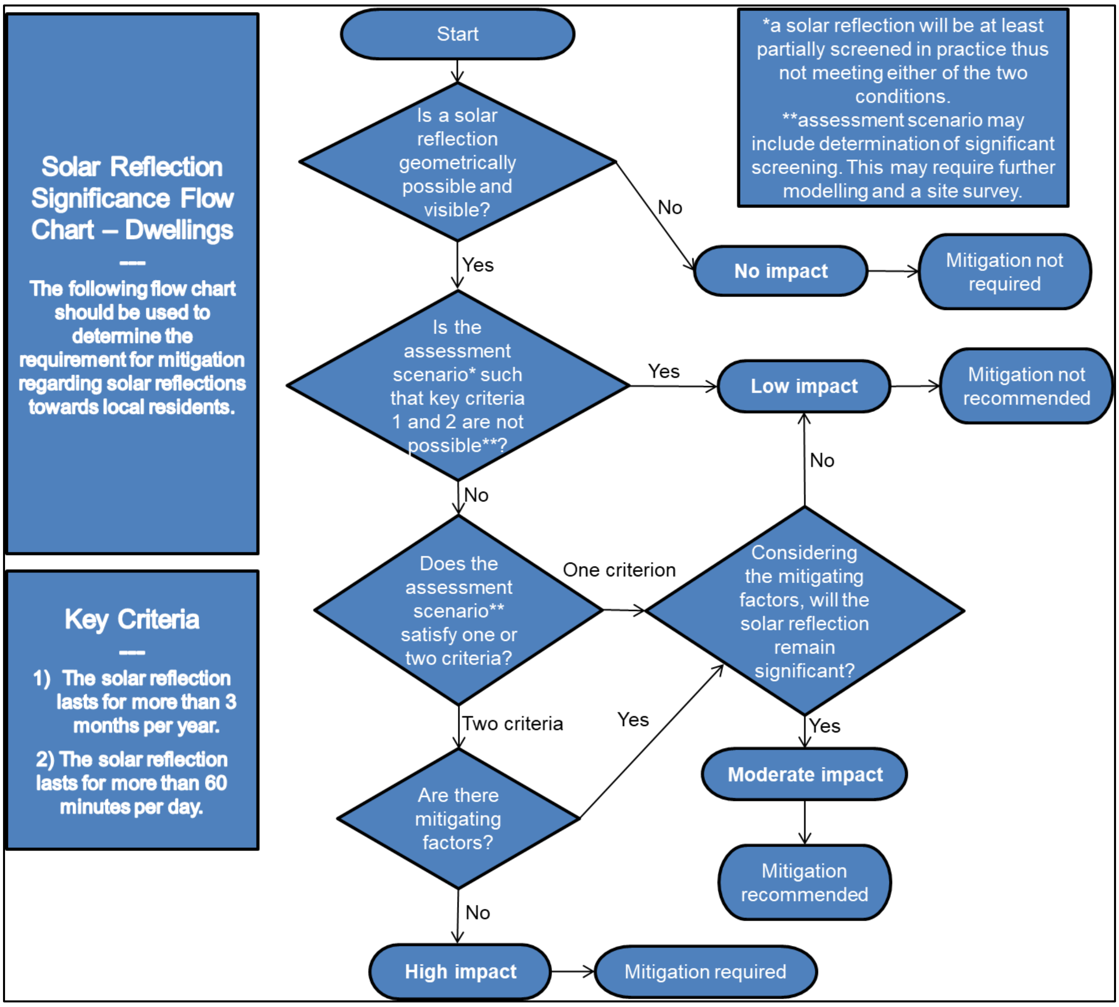
The flow chart presented below has been followed when determining the impact significance for road receptors.



Road user impact significance flow chart

Impact Significance Determination for Dwelling Receptors

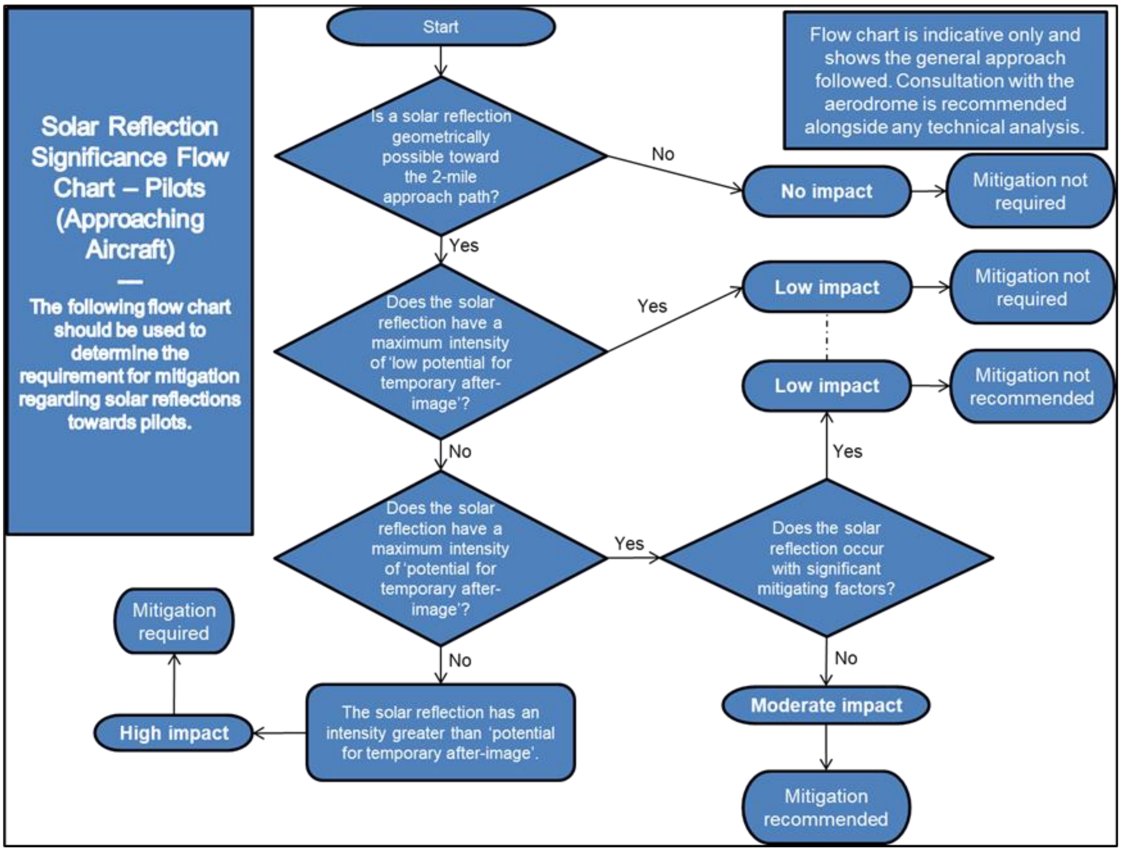
The flow chart presented below has been followed when determining the impact significance for dwelling receptors.



Dwelling impact significance flow chart

Impact Significance Determination for Approaching Aircraft

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



Approaching aircraft receptor impact significance flow chart

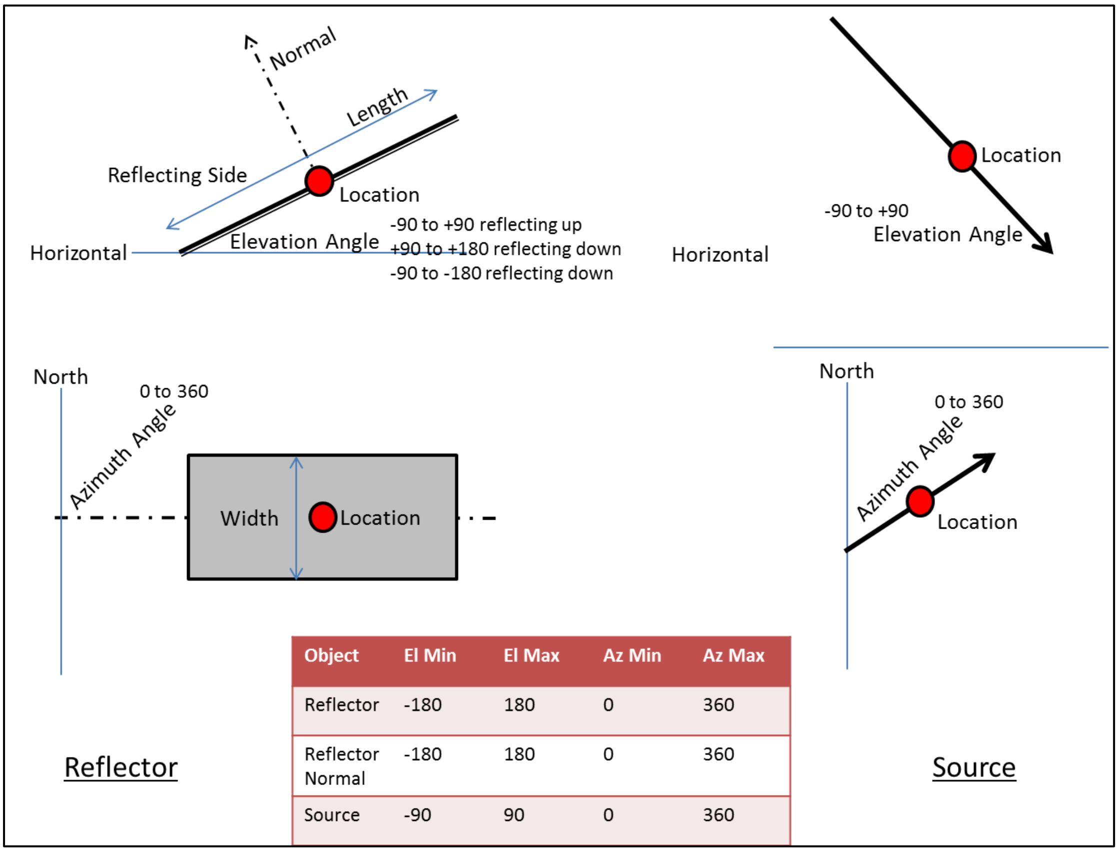
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power Methodology

The calculations are three dimensional and complex, accounting for:

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

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



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

Reflection calculation process

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

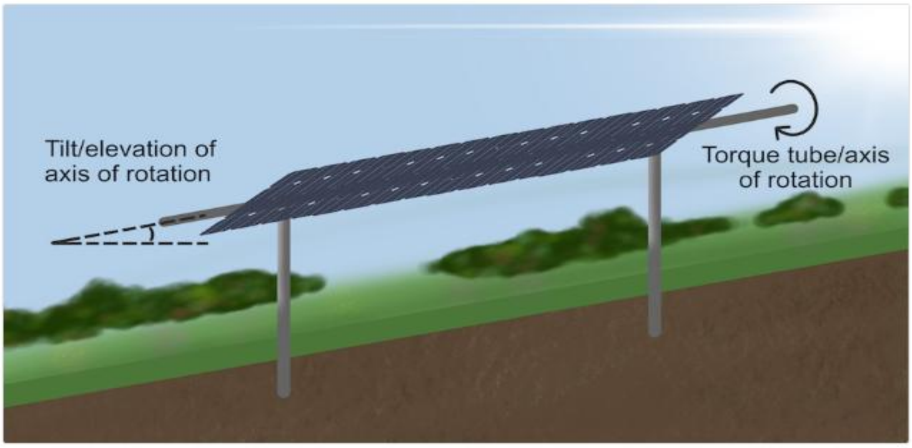
- Use the Latitude and Longitude of reflector as the reference for calculation purposes;
- Calculate the Azimuth and Elevation of the normal to the reflector;
- Calculate the 3D angle between the source and the normal;
- If this angle is less than 90 degrees a reflection will occur. If it is greater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

Forge Reflection Calculations Methodology

Extracts taken from the Forge Solar Model.

Tracking System Parameters

Single-axis module tracking systems are described by a unique set of parameters. These angular inputs model the tracking axis, rotation range and backtracking behavior. Dual-axis module tracking systems are assumed to track the sun at all times.



Single-axis tracking system with torque tube tilted due to geography

Tilt of tracking axis (°)
Tilt above flat ground of axis over which panels rotate (e.g. torque tube). System on flat, level ground would have axis tilt of 0°.

Orientation of tracking axis (°)
Azimuthal angle of axis over which panels rotate. Angle represents the facing of the axis and system. For example. typical tracking system in northern hemisphere has tracking axis oriented north-south with an orientation of 180°, allowing panels to rotate east-west with potential south-facing tilt. Typical tracking system in southern hemisphere runs south-north with axis orientation of 0°, yielding east-west rotation with potential north-facing tilt.

Offset angle of module (°)
Additional tilt angle of PV module elevated above tracking axis/torque tube. Offset angle is measured from the torque tube.

Maximum tracking angle (°)
Maximum angle of rotation of tracking system in one direction. For example, a typical system with a 120° range of rotation has a *max tracking angle* of 60° (east/west).

Resting angle (°)
Angle of rotation of panels when sun is outside tracking range. Used to model backtracking. Panels will revert to the position described by this rotation angle at all times when the sun is outside the rotation range. Setting this equal to the *maximum tracking angle* implies the panels do not backtrack.

ForgeSolar utilizes a simplified model of backtracking which assumes panels instantaneously revert to the *resting angle* whenever the sun is outside the rotation range. For example, panels with *max tracking angle* of 60° and *resting angle* of 0° would lie flat from sunrise until the sun enters the rotation range, and immediately after the sun leaves the rotation range until sunset daily.

Tracking System Parameters

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Pager Power's Model

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

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

The model considers terrain between the reflecting solar panels and the visible horizon (where the sun may be obstructed from view of the panels)[42].

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

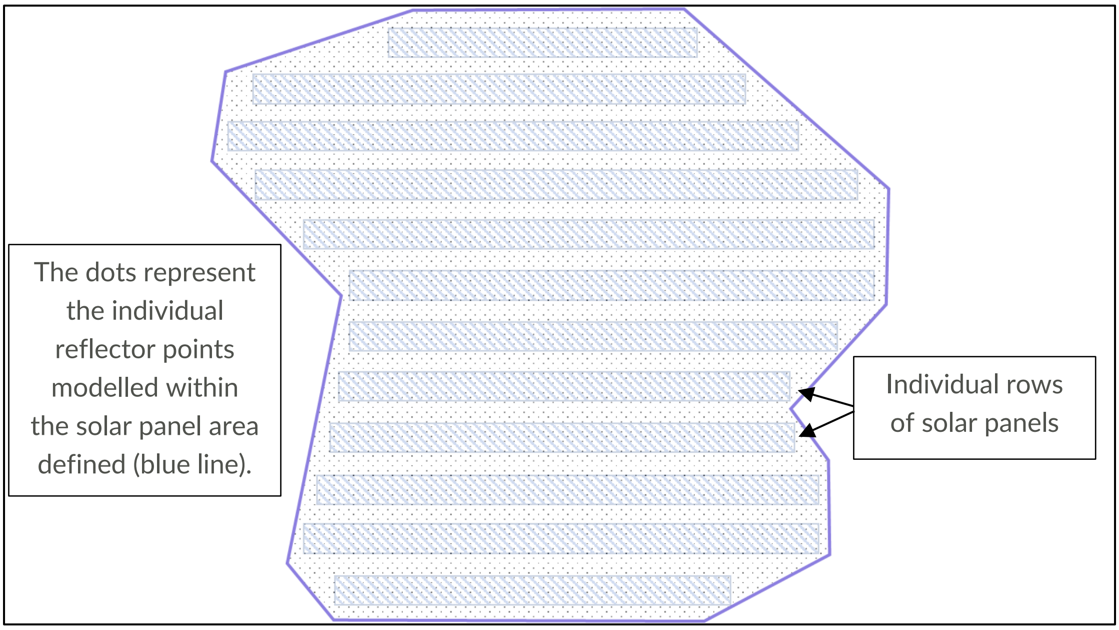
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

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

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

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

[42] 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[43] 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.

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

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Aviation Receptor Data

The table below presents the helicopter approach path details for Ysbyty Glan Clywd Hospital Heliport. Full receptor details can be provided upon request.

Runway	Longitude (°)	Latitude (°)	Threshold Elevation (ft) (amsl)
00	-3.49812	53.27374	25.24
04			
09			
13			
18			
22			
27			
31			

Helicopter approach path details for Ysbyty Glan Clywd Hospital Heliport

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 (°)	No.	Longitude (°)	Latitude (°)
A1	-3.56926	53.28449	C34	-3.52319	53.28478
A2	-3.56869	53.28368	C35	-3.52177	53.28508
A3	-3.56786	53.28293	C36	-3.52030	53.28528
A4	-3.56695	53.28221	C37	-3.51881	53.28541
A5	-3.56599	53.28152	C38	-3.51732	53.28549
A6	-3.56495	53.28087	C39	-3.51582	53.28557

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
A7	-3.56387	53.28024	C40	-3.51432	53.28565
A8	-3.56277	53.27963	C41	-3.51282	53.28573
A9	-3.56163	53.27904	C42	-3.51132	53.28577
A10	-3.56047	53.27847	C43	-3.50989	53.28588
A11	-3.55929	53.27791	C44	-3.50839	53.28596
A12	-3.55806	53.27740	C45	-3.50690	53.28604
A13	-3.55679	53.27691	C46	-3.50540	53.28612
A14	-3.55550	53.27644	C47	-3.50390	53.28620
A15	-3.55418	53.27601	C48	-3.50240	53.28628
A16	-3.55284	53.27561	C49	-3.50090	53.28637
A17	-3.55146	53.27525	C50	-3.49940	53.28645
A18	-3.55006	53.27492	C51	-3.49790	53.28653
A19	-3.54864	53.27462	C52	-3.49640	53.28661
A20	-3.54720	53.27436	C53	-3.49599	53.28663
A21	-3.54575	53.27413	D1	-3.53778	53.27078
A22	-3.54428	53.27393	D2	-3.53677	53.27145
A23	-3.54280	53.27376	D3	-3.53594	53.27220
A24	-3.54131	53.27362	D4	-3.53535	53.27302
A25	-3.53982	53.27350	D5	-3.53503	53.27390
A26	-3.53833	53.27338	D6	-3.53494	53.27480
A27	-3.53684	53.27326	D7	-3.53496	53.27570
A28	-3.53535	53.27315	D8	-3.53480	53.27659

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
A29	-3.53386	53.27303	D9	-3.53463	53.27749
A30	-3.53237	53.27288	D10	-3.53428	53.27836
A31	-3.53089	53.27272	D11	-3.53383	53.27922
A32	-3.52941	53.27255	D12	-3.53341	53.28009
A33	-3.52795	53.27235	D13	-3.53320	53.28097
A34	-3.52649	53.27213	D14	-3.53339	53.28186
A35	-3.52508	53.27182	D15	-3.53353	53.28218
A36	-3.52372	53.27143	E1	-3.53453	53.28217
A37	-3.52243	53.27097	E2	-3.53471	53.28306
A38	-3.52123	53.27043	E3	-3.53492	53.28395
A39	-3.52011	53.26983	E4	-3.53516	53.28483
A40	-3.51908	53.26917	E5	-3.53550	53.28571
A41	-3.51836	53.26871	E6	-3.53584	53.28659
B1	-3.53505	53.27352	E7	-3.53653	53.28738
B2	-3.53358	53.27334	E8	-3.53730	53.28816
B3	-3.53207	53.27330	E9	-3.53742	53.28904
B4	-3.53061	53.27311	E10	-3.53732	53.28993
B5	-3.52917	53.27284	E11	-3.53685	53.29079
B6	-3.52774	53.27257	E12	-3.53638	53.29164
B7	-3.52630	53.27229	E13	-3.53592	53.29250
B8	-3.52487	53.27202	E14	-3.53561	53.29338
B9	-3.52345	53.27173	E15	-3.53538	53.29427

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
B10	-3.52203	53.27143	E16	-3.53512	53.29515
B11	-3.52059	53.27117	E17	-3.53483	53.29604
B12	-3.51914	53.27092	E18	-3.53451	53.29692
B13	-3.51769	53.27067	E19	-3.53411	53.29778
B14	-3.51625	53.27043	E20	-3.53383	53.29866
B15	-3.51480	53.27017	E21	-3.53488	53.29930
B16	-3.51337	53.26990	E22	-3.53598	53.29992
B17	-3.51195	53.26960	E23	-3.53661	53.30028
B18	-3.51054	53.26928	F1	-3.50585	53.26887
B19	-3.50909	53.26906	F2	-3.50673	53.26955
B20	-3.50759	53.26898	F3	-3.50735	53.27036
B21	-3.50611	53.26885	F4	-3.50784	53.27121
B22	-3.50468	53.26857	F5	-3.50834	53.27206
B23	-3.50426	53.26843	F6	-3.50814	53.27294
C1	-3.56947	53.28506	F7	-3.50826	53.27383
C2	-3.56811	53.28489	F8	-3.50753	53.27462
C3	-3.56750	53.28407	F9	-3.50712	53.27548
C4	-3.56672	53.28331	F10	-3.50703	53.27637
C5	-3.56549	53.28280	F11	-3.50749	53.27722
C6	-3.56408	53.28249	F12	-3.50796	53.27808
C7	-3.56261	53.28231	F13	-3.50841	53.27894
C8	-3.56112	53.28219	F14	-3.50882	53.27980

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
C9	-3.55966	53.28196	F15	-3.50913	53.28068
C10	-3.55819	53.28177	F16	-3.50943	53.28156
C11	-3.55669	53.28177	F17	-3.50976	53.28244
C12	-3.55520	53.28179	F18	-3.51007	53.28332
C13	-3.55374	53.28165	F19	-3.51037	53.28420
C14	-3.55227	53.28184	F20	-3.51069	53.28508
C15	-3.55080	53.28202	F21	-3.51093	53.28588
C16	-3.54931	53.28218	F22	-3.51123	53.28676
C17	-3.54782	53.28230	F23	-3.51152	53.28764
C18	-3.54633	53.28240	F24	-3.51184	53.28852
C19	-3.54483	53.28248	F25	-3.51217	53.28940
C20	-3.54333	53.28256	F26	-3.51254	53.29027
C21	-3.54183	53.28260	F27	-3.51290	53.29114
C22	-3.54033	53.28253	F28	-3.51325	53.29202
C23	-3.53884	53.28240	F29	-3.51355	53.29290
C24	-3.53735	53.28226	F30	-3.51383	53.29378
C25	-3.53586	53.28214	F31	-3.51410	53.29467
C26	-3.53436	53.28213	F32	-3.51441	53.29555
C27	-3.53291	53.28237	F33	-3.51472	53.29643
C28	-3.53155	53.28275	F34	-3.51504	53.29731
C29	-3.53019	53.28314	F35	-3.51530	53.29806
C30	-3.52881	53.28349	F36	-3.51558	53.29895

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
C31	-3.52741	53.28382	F37	-3.51589	53.29983
C32	-3.52600	53.28414	F38	-3.51605	53.30026
C33	-3.52460	53.28447			

Road receptor data

Dwelling Receptor Data

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

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.51288	53.29211	97	-3.52495	53.27266
2	-3.51670	53.28601	98	-3.52509	53.27277
3	-3.51649	53.28585	99	-3.52477	53.27309
4	-3.51436	53.28584	100	-3.52514	53.27302
5	-3.51441	53.28597	101	-3.52546	53.27333
6	-3.51234	53.28831	102	-3.52580	53.27334
7	-3.51220	53.28756	103	-3.53089	53.27689
8	-3.51241	53.28727	104	-3.53098	53.27607
9	-3.51182	53.28705	105	-3.53364	53.27709
10	-3.51134	53.28621	106	-3.53489	53.27841
11	-3.51122	53.28597	107	-3.53493	53.27867
12	-3.50949	53.28629	108	-3.53460	53.27864
13	-3.51942	53.28492	109	-3.53440	53.27893
14	-3.51036	53.28337	110	-3.53439	53.27921

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
15	-3.51017	53.28303	111	-3.53484	53.27923
16	-3.50954	53.28285	112	-3.53558	53.27420
17	-3.49679	53.28441	113	-3.53423	53.28234
18	-3.50583	53.27998	114	-3.54124	53.28292
19	-3.51061	53.27609	115	-3.54152	53.28290
20	-3.49974	53.27510	116	-3.54177	53.28287
21	-3.49891	53.27081	117	-3.54190	53.28286
22	-3.49957	53.27078	118	-3.54218	53.28295
23	-3.49988	53.27082	119	-3.54231	53.28280
24	-3.50006	53.27086	120	-3.54631	53.27456
25	-3.50019	53.27090	121	-3.54622	53.27467
26	-3.50043	53.27095	122	-3.54611	53.27490
27	-3.50056	53.27100	123	-3.54592	53.27507
28	-3.50080	53.27105	124	-3.54561	53.27509
29	-3.50076	53.27071	125	-3.54545	53.27521
30	-3.50115	53.27089	126	-3.54533	53.27534
31	-3.50135	53.27076	127	-3.54519	53.27546
32	-3.50153	53.27082	128	-3.54503	53.27557
33	-3.50100	53.27055	129	-3.54478	53.27579
34	-3.50119	53.27048	130	-3.54476	53.27597
35	-3.50126	53.27040	131	-3.54486	53.27611
36	-3.50132	53.27031	132	-3.54497	53.27622

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
37	-3.50130	53.27021	133	-3.54521	53.27645
38	-3.50139	53.27012	134	-3.54535	53.27658
39	-3.50212	53.27013	135	-3.54545	53.27671
40	-3.50236	53.26989	136	-3.54553	53.27685
41	-3.50252	53.26966	137	-3.54578	53.27700
42	-3.50260	53.26947	138	-3.55418	53.27393
43	-3.50266	53.26941	139	-3.55367	53.27409
44	-3.50292	53.26928	140	-3.55424	53.27881
45	-3.50280	53.26899	141	-3.55461	53.27899
46	-3.50295	53.26892	142	-3.55554	53.27884
47	-3.50305	53.26886	143	-3.56724	53.27961
48	-3.50314	53.26880	144	-3.53917	53.28892
49	-3.50344	53.26887	145	-3.53751	53.29023
50	-3.50355	53.26878	146	-3.53754	53.29297
51	-3.50360	53.26870	147	-3.53584	53.29356
52	-3.50368	53.26862	148	-3.53584	53.29368
53	-3.50621	53.27190	149	-3.53578	53.29381
54	-3.50626	53.27217	150	-3.53648	53.29407
55	-3.50637	53.27228	151	-3.53570	53.29410
56	-3.50657	53.27230	152	-3.53567	53.29424
57	-3.50674	53.27228	153	-3.53562	53.29436
58	-3.50693	53.27226	154	-3.53559	53.29448

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
59	-3.50711	53.27223	155	-3.53555	53.29461
60	-3.50729	53.27220	156	-3.53549	53.29473
61	-3.50734	53.27204	157	-3.53482	53.29517
62	-3.50795	53.27216	158	-3.53481	53.29526
63	-3.50818	53.27210	159	-3.53477	53.29536
64	-3.50866	53.27204	160	-3.53473	53.29546
65	-3.50878	53.27197	161	-3.53462	53.29558
66	-3.50891	53.27191	162	-3.53460	53.29569
67	-3.50903	53.27186	163	-3.53424	53.29561
68	-3.50920	53.27179	164	-3.53390	53.29556
69	-3.50933	53.27174	165	-3.53365	53.29552
70	-3.50954	53.27168	166	-3.53329	53.29548
71	-3.50979	53.27162	167	-3.53299	53.29543
72	-3.51008	53.27158	168	-3.53274	53.29538
73	-3.51036	53.27158	169	-3.53256	53.29534
74	-3.51063	53.27146	170	-3.53232	53.29528
75	-3.51086	53.27130	171	-3.53195	53.29532
76	-3.51099	53.27112	172	-3.53154	53.29525
77	-3.51111	53.27094	173	-3.53128	53.29524
78	-3.51123	53.27075	174	-3.53106	53.29522
79	-3.51135	53.27058	175	-3.53080	53.29520
80	-3.51150	53.27042	176	-3.53127	53.29657

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
81	-3.51181	53.27046	177	-3.53078	53.29675
82	-3.51193	53.27022	178	-3.53073	53.29700
83	-3.51203	53.26988	179	-3.53069	53.29715
84	-3.51151	53.26905	180	-3.53000	53.29751
85	-3.51252	53.26927	181	-3.52937	53.29778
86	-3.51284	53.26932	182	-3.52922	53.29766
87	-3.51321	53.26937	183	-3.52886	53.29737
88	-3.51354	53.26944	184	-3.52855	53.29719
89	-3.51384	53.26949	185	-3.52883	53.29671
90	-3.51556	53.27058	186	-3.52868	53.29656
91	-3.51387	53.27492	187	-3.52840	53.29630
92	-3.51444	53.27481	188	-3.52811	53.29609
93	-3.51904	53.27346	189	-3.52715	53.29597
94	-3.52280	53.27491	190	-3.52656	53.29547
95	-3.52482	53.27217	191	-3.55014	53.28193
96	-3.52484	53.27251	192	-3.54736	53.28247

Dwelling receptor data

Modelled Reflector Area

The modelled reflector areas are presented in the tables below.

Panel Area 1

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.55480	53.28531	19	-3.54792	53.28246
2	-3.55487	53.28291	20	-3.54797	53.28249
3	-3.55461	53.28209	21	-3.54804	53.28254
4	-3.55463	53.28174	22	-3.54860	53.28283
5	-3.55452	53.28168	23	-3.54923	53.28310
6	-3.55420	53.28165	24	-3.54942	53.28320
7	-3.55383	53.28168	25	-3.54962	53.28330
8	-3.55258	53.28188	26	-3.54985	53.28339
9	-3.55156	53.28203	27	-3.54997	53.28340
10	-3.55143	53.28209	28	-3.55002	53.28346
11	-3.55133	53.28210	29	-3.54994	53.28349
12	-3.55109	53.28210	30	-3.55002	53.28413
13	-3.55070	53.28214	31	-3.55017	53.28424
14	-3.54969	53.28224	32	-3.55011	53.28431
15	-3.54900	53.28232	33	-3.55000	53.28441
16	-3.54887	53.28235	34	-3.55005	53.28512
17	-3.54863	53.28237	35	-3.55022	53.28514
18	-3.54795	53.28243			

Panel Area 1

Panel Area 2

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.54988	53.28512	18	-3.54656	53.28253
2	-3.54983	53.28436	19	-3.54637	53.28254
3	-3.54976	53.28430	20	-3.54581	53.28256
4	-3.54978	53.28424	21	-3.54534	53.28259
5	-3.54984	53.28422	22	-3.54465	53.28264
6	-3.54979	53.28362	23	-3.54459	53.28265
7	-3.54974	53.28361	24	-3.54442	53.28267
8	-3.54951	53.28371	25	-3.54433	53.28268
9	-3.54939	53.28374	26	-3.54451	53.28314
10	-3.54929	53.28373	27	-3.54457	53.28324
11	-3.54917	53.28370	28	-3.54457	53.28334
12	-3.54834	53.28346	29	-3.54498	53.28414
13	-3.54787	53.28326	30	-3.54781	53.28393
14	-3.54740	53.28301	31	-3.54785	53.28393
15	-3.54704	53.28283	32	-3.54785	53.28464
16	-3.54681	53.28270	33	-3.54788	53.28505
17	-3.54661	53.28258			

Panel Area 2

Panel Area 3

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.53953	53.28583	16	-3.53474	53.28233
2	-3.53960	53.28564	17	-3.53471	53.28238
3	-3.53945	53.28475	18	-3.53474	53.28276
4	-3.53927	53.28379	19	-3.53478	53.28290

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
5	-3.53901	53.28267	20	-3.53480	53.28305
6	-3.53895	53.28259	21	-3.53497	53.28361
7	-3.53881	53.28250	22	-3.53507	53.28429
8	-3.53702	53.28234	23	-3.53511	53.28442
9	-3.53669	53.28232	24	-3.53523	53.28473
10	-3.53600	53.28232	25	-3.53597	53.28653
11	-3.53577	53.28230	26	-3.53654	53.28643
12	-3.53536	53.28226	27	-3.53699	53.28638
13	-3.53508	53.28223	28	-3.53751	53.28623
14	-3.53500	53.28223	29	-3.53819	53.28608
15	-3.53483	53.28229	30	-3.53877	53.28599

Panel Area 3

Panel Area 4

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.53435	53.28271	26	-3.53173	53.28420
2	-3.53432	53.28275	27	-3.53173	53.28430
3	-3.53425	53.28277	28	-3.53180	53.28459
4	-3.53416	53.28277	29	-3.53176	53.28469
5	-3.53411	53.28274	30	-3.53179	53.28477
6	-3.53403	53.28272	31	-3.53185	53.28486
7	-3.53397	53.28274	32	-3.53189	53.28500
8	-3.53388	53.28274	33	-3.53187	53.28513
9	-3.53379	53.28272	34	-3.53200	53.28548
10	-3.53374	53.28268	35	-3.53206	53.28555
11	-3.53372	53.28263	36	-3.53206	53.28564

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
12	-3.53368	53.28258	37	-3.53237	53.28626
13	-3.53362	53.28248	38	-3.53246	53.28669
14	-3.53356	53.28244	39	-3.53325	53.28660
15	-3.53349	53.28244	40	-3.53389	53.28657
16	-3.53279	53.28261	41	-3.53529	53.28651
17	-3.53147	53.28292	42	-3.53567	53.28648
18	-3.53148	53.28296	43	-3.53514	53.28511
19	-3.53152	53.28303	44	-3.53490	53.28448
20	-3.53159	53.28308	45	-3.53484	53.28438
21	-3.53157	53.28319	46	-3.53483	53.28379
22	-3.53160	53.28333	47	-3.53478	53.28362
23	-3.53158	53.28344	48	-3.53464	53.28307
24	-3.53160	53.28386	49	-3.53458	53.28270
25	-3.53167	53.28413			

Panel Area 4

Panel Area 5

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.53207	53.28675	28	-3.52015	53.28565
2	-3.53163	53.28674	29	-3.51985	53.28564
3	-3.53126	53.28673	30	-3.51955	53.28563
4	-3.53080	53.28662	31	-3.51942	53.28559
5	-3.53010	53.28653	32	-3.51934	53.28551
6	-3.52994	53.28650	33	-3.51717	53.28561
7	-3.52982	53.28640	34	-3.51705	53.28563
8	-3.52964	53.28627	35	-3.51696	53.28567

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
9	-3.52950	53.28617	36	-3.51691	53.28575
10	-3.52914	53.28604	37	-3.51691	53.28581
11	-3.52877	53.28595	38	-3.51697	53.28594
12	-3.52853	53.28593	39	-3.51776	53.28722
13	-3.52845	53.28593	40	-3.51896	53.28907
14	-3.52838	53.28598	41	-3.51935	53.28978
15	-3.52836	53.28632	42	-3.51984	53.29058
16	-3.52834	53.28728	43	-3.52048	53.29167
17	-3.52820	53.28734	44	-3.52054	53.29167
18	-3.52754	53.28735	45	-3.52417	53.29086
19	-3.52722	53.28733	46	-3.52404	53.29066
20	-3.52722	53.28727	47	-3.52415	53.29064
21	-3.52714	53.28700	48	-3.52700	53.29305
22	-3.52704	53.28698	49	-3.52952	53.29054
23	-3.52669	53.28704	50	-3.53021	53.28984
24	-3.52322	53.28786	51	-3.53185	53.28821
25	-3.52291	53.28793	52	-3.53264	53.28742
26	-3.52107	53.28632	53	-3.53230	53.28677
27	-3.52032	53.28566	54	-3.53212	53.28677

Panel Area 5

Panel Area 6

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.52769	53.28158	7	-3.52774	53.28362
2	-3.52708	53.28317	8	-3.53025	53.28299
3	-3.52695	53.28339	9	-3.53253	53.28229

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
4	-3.52703	53.28350	10	-3.53251	53.28193
5	-3.52719	53.28363	11	-3.52780	53.28131
6	-3.52741	53.28366			

Panel Area 6

Panel Area 7

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.52623	53.28109	31	-3.51284	53.28258
2	-3.52335	53.28058	32	-3.51316	53.28255
3	-3.52280	53.28058	33	-3.51384	53.28300
4	-3.52248	53.28056	34	-3.51390	53.28309
5	-3.52173	53.28052	35	-3.51309	53.28317
6	-3.52137	53.28043	36	-3.51042	53.28351
7	-3.52085	53.28025	37	-3.51033	53.28360
8	-3.52068	53.28021	38	-3.51037	53.28376
9	-3.52034	53.28008	39	-3.51079	53.28507
10	-3.51966	53.27992	40	-3.51324	53.28481
11	-3.51867	53.27976	41	-3.51342	53.28481
12	-3.51629	53.27923	42	-3.51354	53.28557
13	-3.51532	53.27986	43	-3.51732	53.28537
14	-3.51516	53.27986	44	-3.51726	53.28451
15	-3.51516	53.27985	45	-3.51863	53.28482
16	-3.51471	53.27943	46	-3.51907	53.28388
17	-3.51449	53.27934	47	-3.51978	53.28398
18	-3.51316	53.27909	48	-3.52019	53.28466
19	-3.51313	53.27866	49	-3.52038	53.28514

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
20	-3.51172	53.27852	50	-3.52213	53.28487
21	-3.51148	53.27844	51	-3.52226	53.28480
22	-3.51151	53.27834	52	-3.52222	53.28466
23	-3.51024	53.27826	53	-3.52238	53.28460
24	-3.51003	53.27821	54	-3.52281	53.28453
25	-3.50949	53.27690	55	-3.52351	53.28438
26	-3.50936	53.27688	56	-3.52423	53.28420
27	-3.50778	53.27742	57	-3.52478	53.28407
28	-3.50880	53.27935	58	-3.52487	53.28392
29	-3.50949	53.28132	59	-3.52506	53.28385
30	-3.51006	53.28292			

Panel Area 7

Cumulative Panel Area (Kinmel Bay Solar Farm)

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.53195	53.28662	10	-3.52316	53.28778
2	-3.53135	53.28448	11	-3.52691	53.28694
3	-3.53095	53.28334	12	-3.52681	53.28668
4	-3.52845	53.28415	13	-3.52681	53.28609
5	-3.52739	53.28431	14	-3.52758	53.28553
6	-3.52549	53.28474	15	-3.52830	53.28548
7	-3.52427	53.28477	16	-3.52849	53.28578
8	-3.52062	53.28559	17	-3.52999	53.28623
9	-3.52135	53.28623	18	-3.53112	53.28653

Cumulative panel area

APPENDIX H – DETAILED MODELLING RESULTS

Overview

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.
- 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

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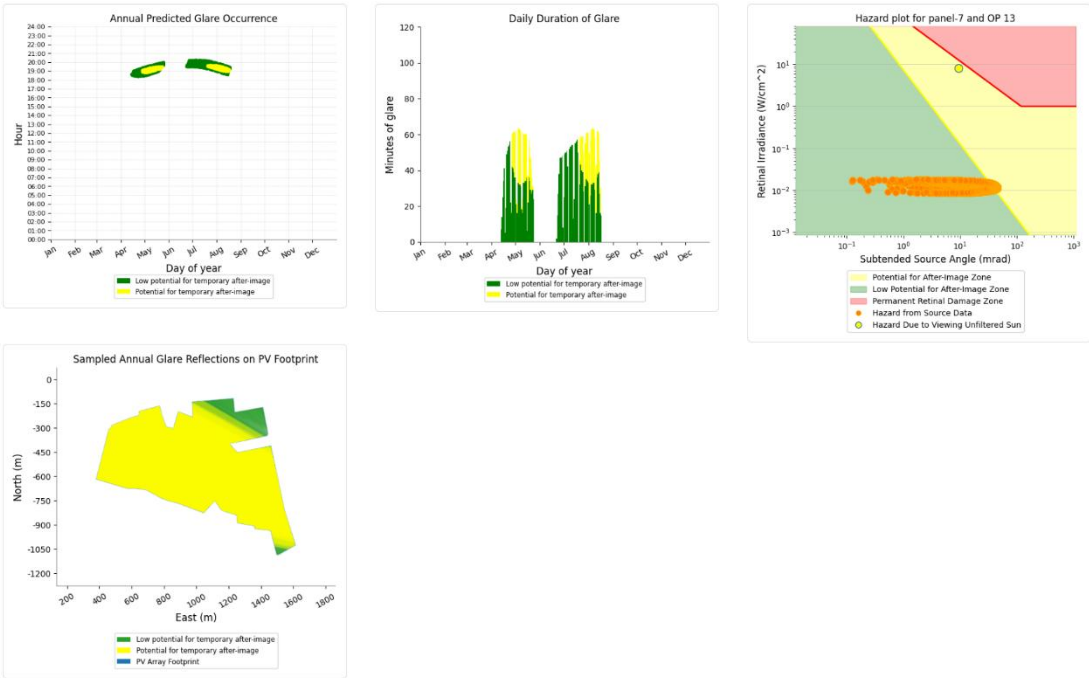
Panel 7: OP 13

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

- 3,182 minutes of "green" glare with low potential to cause temporary after-image.
- 1,104 minutes of "yellow" glare with potential to cause temporary after-image.

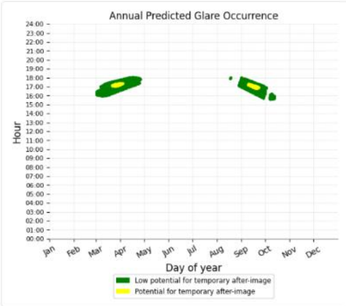


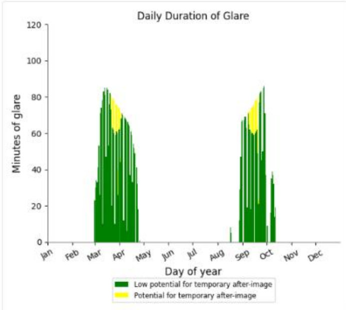
18

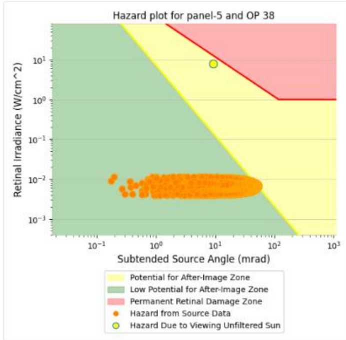
Panel 5: OP 38

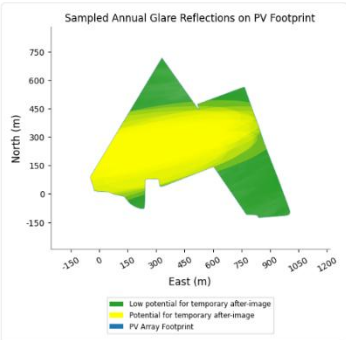
PV array is expected to produce the following glare for this receptor:

- 4,922 minutes of "green" glare with low potential to cause temporary after-image.
- 296 minutes of "yellow" glare with potential to cause temporary after-image.







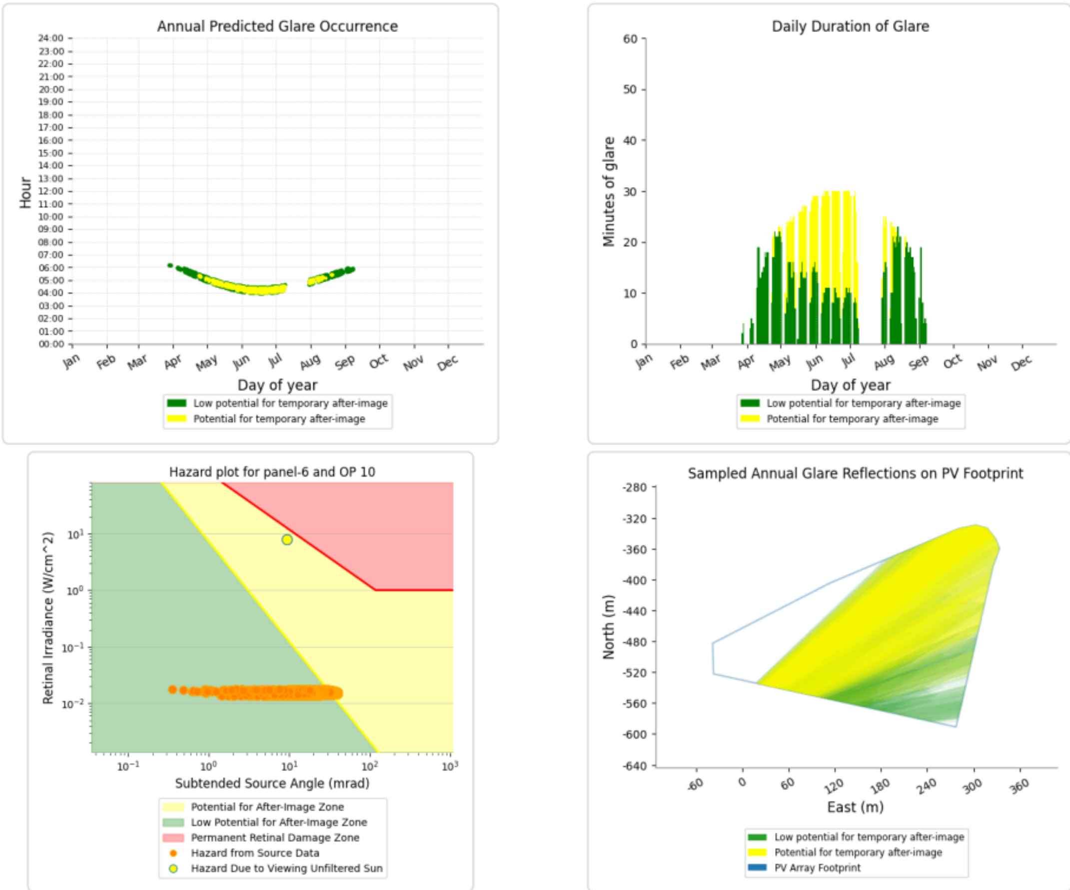


Road Receptors

Results have been included for all selective road receptors where a moderate impact is predicted.

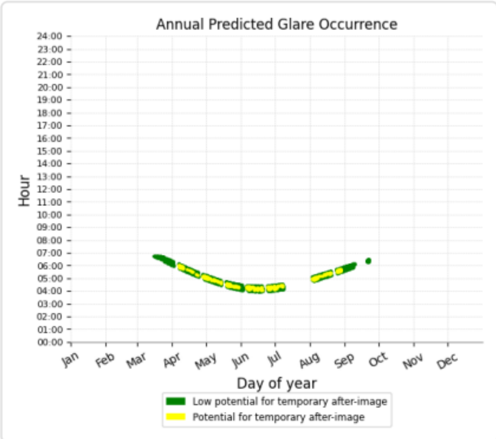
Panel 6 and OP 10

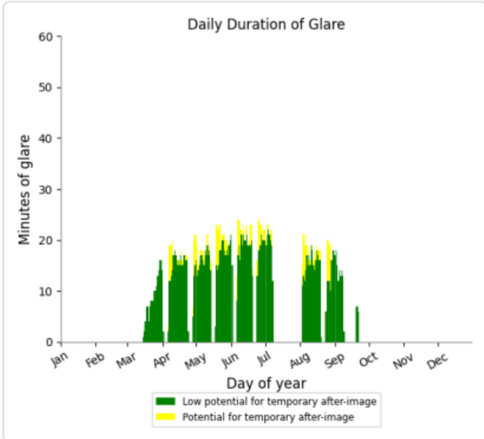
Yellow glare: 967 min.
Green glare: 1,464 min.

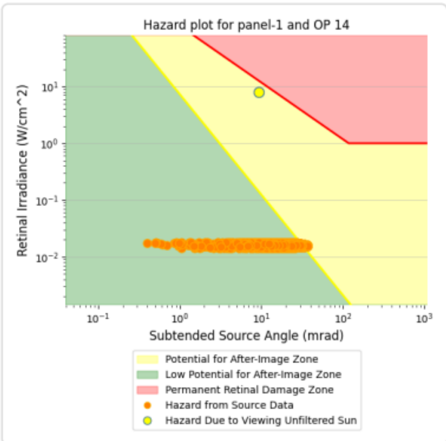


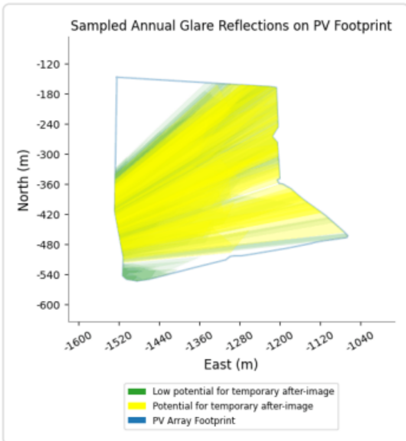
Panel 1 and OP 14

Yellow glare: 268 min.
Green glare: 2,016 min.







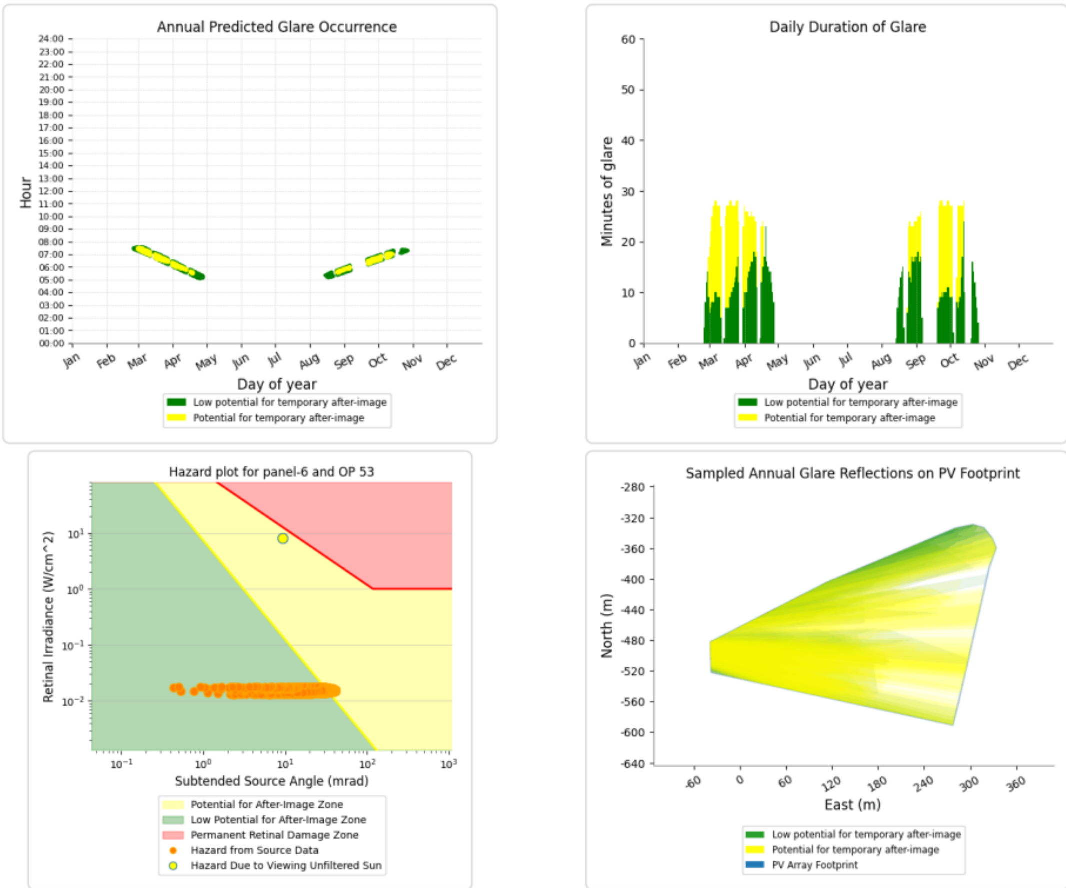


Dwelling Receptors

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

Panel 6 and OP 53

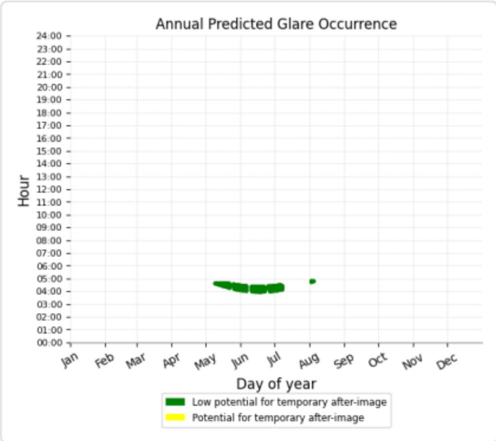
Yellow glare: 1,008 min.
Green glare: 1,187 min.

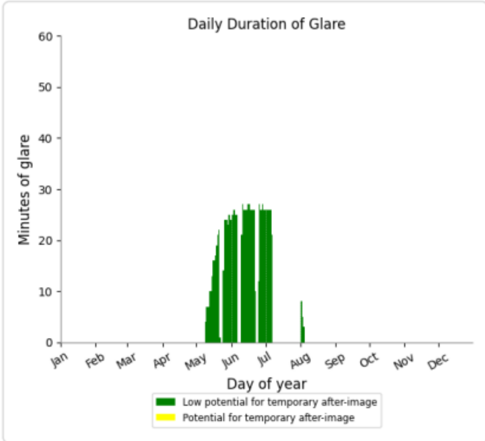


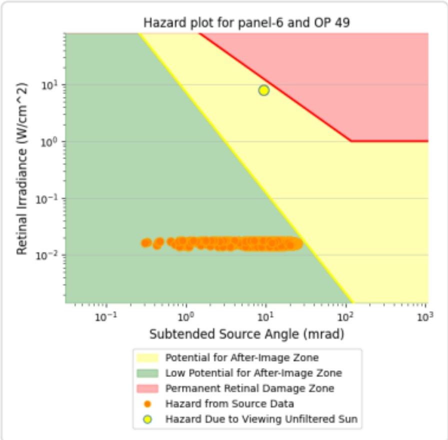
Panel 6 and OP 49

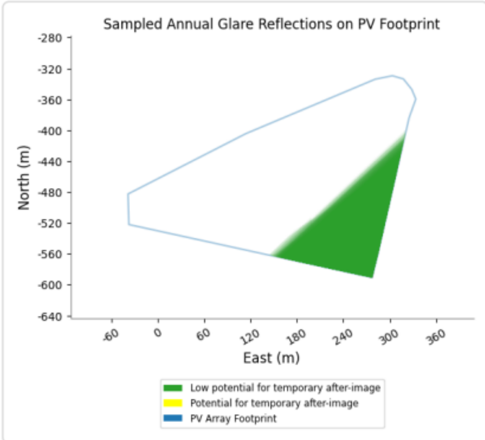
Yellow glare: none

Green glare: 1,136 min.









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