Solar Photovoltaic Glint and Glare Study

FUSE Renewables Limited

Brogan Solar Farm

April 2026

www.pagerpower.com

ADMINISTRATION PAGE

Job Reference:	15130A1
Author:	Adam Hardie
Email:	adam@pagerpower.com

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

Issue	Date	Detail of Changes
1	05 February 2026	Initial issue
2	06 March 2026	Administrative revisions
3	09 April 2026	Administrative revisions

Stour Valley Business Centre, Brundon Lane, Sudbury, CO10 7GB

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

EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the potential effects of glint and glare from a fixed ground-mounted solar photovoltaic development located east of Llanfyllin, Wales. This assessment pertains to the potential impacts upon road safety and residential amenity.

Overall Conclusions

A moderate impact is predicted upon road safety, and mitigation in the form of screening along the site boundary is recommended.

No significant impact is predicted upon residential amenity and mitigation is not recommended.

Guidance and Studies

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.

Pager Power's approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels. The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that the reflections produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel[2].

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

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

Assessment Conclusions – Residential Amenity

The table below summarises the predicted impact upon the assessed dwelling receptors.

	Number of Receptors
Number of dwelling receptors assessed	20
Number of dwelling receptors where a solar reflection is geometrically possible	11
Number of dwelling receptors predicted to experience no impact due to significant screening	5
Number of dwelling receptors predicted to experience a low impact due to marginal views and sufficient mitigating factors	6

Summary of assessment for dwelling receptors

Overall, a low impact is predicted upon residential amenity, and mitigation is not recommended.

Assessment Conclusions – Road Safety

The table below summarises the predicted impact upon the assessed road receptors.

	Number of Receptors
Number of road receptors assessed	24 (approximately 2,200m)
Number of road receptors where a solar reflection is geometrically possible	15
Number of road receptors predicted to experience no impact due to significant screening	11
Number of road receptors predicted to experience a moderate impact due to views originating within Field-of-View (FOV) and without sufficient mitigating factors	4

Summary of assessment for road receptors

For the four road receptors where a moderate impact has been predicted, mitigation is recommended (see Section 5.4).

LIST OF CONTENTS

Administration Page 1

Executive Summary 2

Report Purpose 2

Overall Conclusions 2

Guidance and Studies 2

Assessment Conclusions – Residential Amenity 3

Assessment Conclusions – Road Safety 3

List of Contents 4

List of Figures 6

List of Tables 7

About Pager Power 8

1 Introduction 9

1.1 Overview 9

1.2 Glint and Glare Definition 9

2 Solar Development Location and Details 10

2.1 Proposed Development Site Layout 10

2.2 Modelled Reflector Areas 11

2.3 Solar Panel Technical Information 13

3 Glint and Glare Assessment Methodology 14

3.1 Overview 14

3.2 Background 14

3.3 Methodology 14

3.4 Assessment Methodology and Limitations 15

4 Identification of Receptors 16

4.1 Overview 16

4.2 Ground Based Receptors Overview 16

4.3 Road Receptors 18

4.4 Dwelling Receptors 22
5 Geometric Assessment Results and Discussion 24
5.1 Overview 24
5.2 Assessment Results – Dwelling Receptors 24
5.3 Assessment results - Road Receptors 36
5.4 Road Mitigation Strategy 43
6 Conclusions 47
6.1 Assessment Conclusions – Residential Amenity 47
6.2 Assessment Conclusions – Road Safety 48
Appendix A – Overview of Glint and Glare Guidance 49
Overview 49
UK Planning Policy 49
Assessment Process – Ground-Based Receptors 51
Appendix B – Overview of Glint and Glare Studies 52
Overview 52
Reflection Type from Solar Panels 52
Solar Reflection Studies 53
Appendix C – Overview of Sun Movements and Relative Reflections 56
Appendix D – Glint and Glare Impact Significance 57
Overview 57
Impact Significance Definition 57
Impact Significance Determination for Road Receptors 58
Impact Significance Determination for Dwelling Receptors 59
Appendix E – Reflection Calculations Methodology 60
Pager Power Methodology 60
Appendix F – Assessment Limitations and Assumptions 62
Pager Power's Model 62
Appendix G – Receptor and Reflector Area Details 64
Overview 64

Dwelling Receptor Data 64
Road Receptor Data 65
Modelled Reflector Areas 66
Appendix H – Detailed Modelling Results 67
Overview 67
Dwelling Receptors 68
Road Receptors 69

LIST OF FIGURES

Figure 1 Proposed Development 10
Figure 2 Updated Proposed Development 11
Figure 3 Modelled reflector areas 12
Figure 4 1km assessment area 17
Figure 5 Identified road sections within the 1km area 19
Figure 6 Receptors placed along the B4393 20
Figure 7 Receptors placed along the A490 21
Figure 8 Overview of assessed dwelling receptors 23
Figure 9 Screening relevant to dwelling receptor 1, with ZTV viewshed showing terrain visibility 29
Figure 10 Screening relevant to dwelling receptors 2 and 3, with ZTV viewshed showing representative terrain visibility from dwelling 2 30
Figure 11 Screening relevant to dwelling receptors 4 to 7, with ZTV viewshed showing representative terrain visibility from dwelling 4 31
Figure 12 Screening relevant to dwelling receptor 14 32
Figure 13 Screening relevant to dwelling receptor 17, with ZTV viewshed showing terrain visibility 33
Figure 14 Screening relevant to dwelling receptors 18 and 19, with ZTV viewshed showing representative terrain visibility from dwelling 19 34
Figure 15 Screening relevant to dwelling receptor 20 35

Figure 16 Screening relevant to road receptors 2 to 5, with ZTV viewshed showing representative terrain visibility originating from road receptor 4 40

Figure 17 Screening relevant to road receptors 10 and 11 41

Figure 18 Screening relevant to road receptors 12 to 16 42

Figure 19 Screening relevant to road receptors 6 to 9 44

Figure 20 Reflecting panel areas and recommended mitigation for road receptors 6 to 9 . 45

Figure 21 Recommended mitigation measures according to layout amendments 46

LIST OF TABLES

Table 1 Assessed panel area technical information 13

Table 2 Geometric modelling results - dwelling receptors 28

Table 3 Geometric modelling results - road receptors 39

Table 4 Summary of assessment for dwelling receptors 47

Table 5 Summary of assessment for road receptors 48

ABOUT PAGER POWER

Pager Power is a specialist technical consultancy based in the United Kingdom and has been providing independent expertise on planning issues for solar, wind, and building developments for over 20 years.

Established in 1997, the company initially specialised in assessing the impact of wind turbines on radar systems. Pager Power has since expanded into a multidisciplinary technical planning consultancy that offers a comprehensive range of services and has supported renewable and building projects in more than 60 countries.

Pager Power's core competencies now include:

- Aviation and Radar;
- Daylight, Sunlight and Overshadowing;
- Glint and Glare;
- Shadow Flicker;
- Telecommunications.

Using proprietary modelling software, each study is tailored to the individual project, ensuring that results are relevant, defensible, and aligned with current national and international standards. The company also provides planning support and stakeholder consultation across all service areas, helping clients to understand constraints, explore potential mitigation options, and forge a path forward for their projects.

Pager Power's work helps our clients identify potential risks, inform project design, and support the decision-making process, and can provide support at any stage of a project, from initial feasibility through to completion. Pager Power's assessments – recognised for their objectivity, accuracy, and technical integrity – are designed to withstand legal scrutiny, and trusted by developers and stakeholders alike.

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the potential effects of glint and glare from a fixed ground-mounted solar photovoltaic development located north of Bwlch-y-cibau, Wales. This assessment pertains to the potential impacts upon road safety and residential amenity.

This report contains the following:

- Solar development details;
- Explanation of glint and glare;
- Overview of relevant guidance and studies;
- Assessment methodology;
- Identification of receptors;
- Glint and glare assessment for identified receptors;
- Desk-based review of the available imagery;
- Results discussion;
- Overall conclusions and recommendations.

1.2 Glint and Glare Definition

The definition[3] of glint and glare is as follows:

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

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

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

2 SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Layout

Figure 1 below shows the modelled solar panel layout[4] for the proposed development, with solar panels shown by the blue rectangles. Figure 2 on the following page shows the updated layout[5].

The updated layout has slightly amended panel areas, with the expansion of parcels 1 and 2, and the removal of parcel 3. No additional receptors would need to be assessed due to the expansion of parcels 1 and 2 and no additional impact is predicted on top of those already predicted in this report. Additionally, the removal of parcel 3 means that any impacts predicted in this report will be the same or worse than the expected impacts of the completed development.

Figure 1 *Superseded Layout*

[4] Source: BGS.LYT.DEV.01 Final.pdf (Cropped).
[5] Source: BGS.LYT.DEV.06.pdf (Cropped).

Figure 2 *Updated Proposed Development*

2.2 Modelled Reflector Areas

The bounding coordinates for the proposed development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 3 on the following page shows the assessed reflector areas that have been used for modelling purposes. The areas are shown in blue and outlined in red.

Figure 3 *Modelled reflector areas*

The Pager Power model has used a resolution of 5m for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 5m from within the defined area. This resolution is sufficiently high to maximise the accuracy of the results – increasing the resolution further would not significantly change the modelling output. If a reflection is experienced from an assessed panel location, then it is likely that a reflection will be viewable from similarly located panels within the proposed solar development.

2.3 Solar Panel Technical Information

The technical information used for the modelling and the latest proposed design specifications are presented in Table 1 below. The bounding coordinates for each area are provided in Appendix G. The modelling of this assessment has been carried out based on a previous solar panel design. The currently proposed layout has a slightly reduced elevation and no change in tilt or azimuth angle. The results of the modelling and therefore the conclusions of the assessment are not expected to be significantly impacted by these amendments.

Layout	Height (m) above ground level	Tilt Angle[6] (°)	Azimuth Angle[7] (°)
Modelled Technical Information	1.75[8]	25	180
Latest Proposed Solar Panel Design	1.64[9]	25	180

Table 1 *Assessed panel area technical information*

[6] Tilt above horizontal.
[7] Orientation the panels are facing relative to True North (0°).
[8] Relative to the minimum (0.8m) and maximum (2.7m) heights of panels above ground level.
[9] Relative to the minimum (0.8m) and maximum (2.47m) heights of panels above ground level.

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Overview

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

- Specular reflections of the Sun from solar panels and glass 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 still water and similar to those from glass. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces, which are common in an outdoor environment, including steel.

3.2 Background

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

3.3 Methodology

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

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

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

3.4 Assessment Methodology and Limitations

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

4 IDENTIFICATION OF RECEPTORS

4.1 Overview

The following sections present the relevant receptors assessed within this report. Terrain data has been interpolated based on Ordnance Survey (OS) 50 Digital Terrain Model (DTM) data. The receptor details for all receptors are presented in Appendix G.

4.2 Ground Based Receptors Overview

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

The above parameters and industry experience over a significant number of glint and glare assessments undertaken, shows that a 1km assessment area is considered appropriate for glint and glare effects on ground-based receptors – bounded by the yellow outlined area in Figure 4 on the following page. Receptors within this distance are identified based on mapping and aerial photography of the region. The initial judgement is made based on high-level consideration of aerial photography and mapping i.e. receptors are excluded if it is clear from the outset that no visibility would be possible. A more detailed assessment is made if the modelling reveals a reflection would be geometrically possible. Receptors to the north of the development are not included because solar reflections would not be geometrically possible towards the north when the azimuth angle is considered[10].

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

Figure 4 *1km assessment area*

4.3 Road Receptors

4.3.1 Road Receptors Overview

Road types can generally be categorised as:

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

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

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

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

4.3.2 Identified Road Receptors

A section of the B4393, totalling 800m and a section of the A490, totalling 1,400m, have been identified within the assessment area. The road sections for the B4393 and A490 are shown in purple and blue, respectively, in Figure 5 on the following page.

Receptors are placed, approximately 100-metres apart, along these sections of road and are shown on Figures 6 and 7 on pages 20 and 21, respectively. A height of 1.5 metres above ground level has been taken as the typical eye level of a road user[11].

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

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

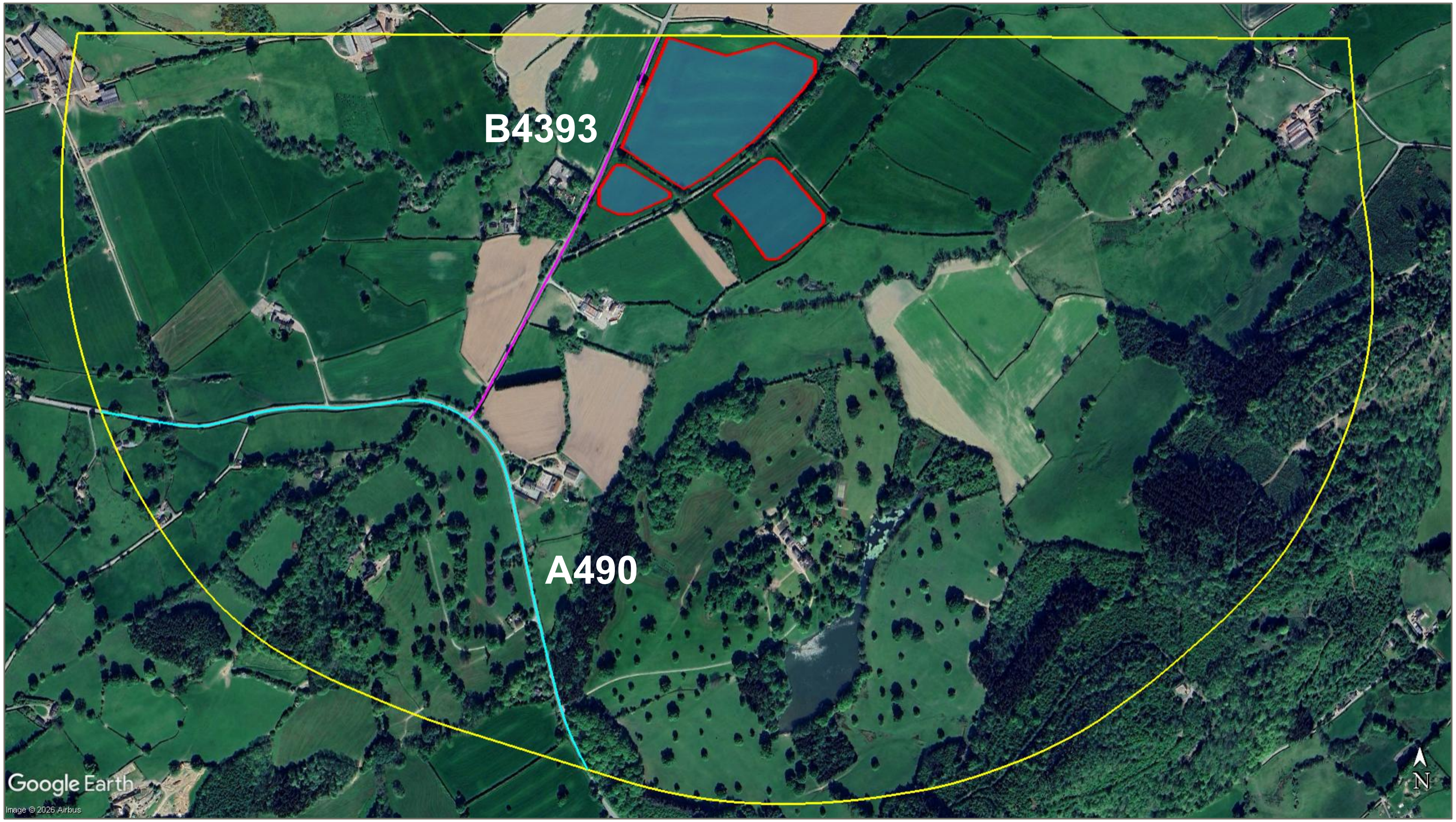


Figure 5 *Identified road sections within the 1km area*

Figure 6 *Receptors placed along the B4393*

Figure 7 *Receptors placed along the A490*

4.4 Dwelling Receptors

4.4.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

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

In some 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.

4.4.2 Identified Dwelling Receptors

20 dwelling receptors were identified to be taken forward for geometric modelling, which are shown in Figure 8 on the following page. An additional height of 1.8m above ground is used in the modelling to simulate the typical viewing height of an observer on the ground floor[12].

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

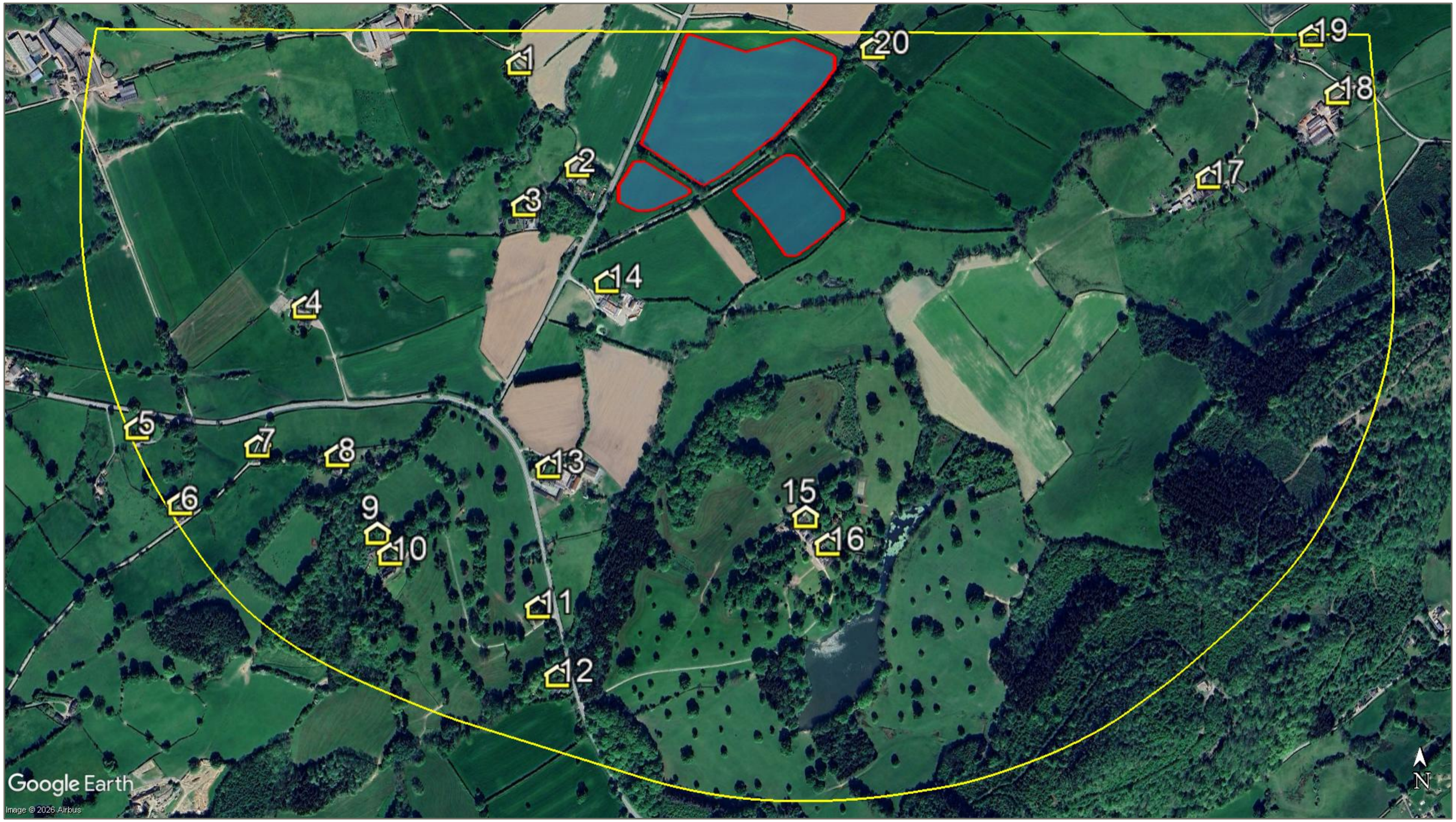


Figure 8 Overview of assessed dwelling receptors

5 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

5.1 Overview

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

5.2 Assessment Results – Dwelling Receptors

5.2.1 Key Considerations

The key considerations for residential dwellings are:

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

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

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

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

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

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

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

5.2.2 Geometric Modelling Results and Discussion

Table 2 on the following pages presents:

- Geometric modelling results (bare earth terrain i.e. without consideration of screening);
- Desk-based review of identified screening (presented in more detail in the following sub-section);
- Consideration of any relevant factors present, where appropriate;
- Predicted impact significance.

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[13]	Mitigating Factors	Predicted Impact Classification
1	Solar reflections **are** geometrically possible for: **Less** than 3 months **Less** than 60 minutes	Existing vegetation is predicted to partially obstruct views of reflecting panels	**Less** than 3 months **Less** than 60 minutes	N/A	Low impact
2, 4	Solar reflections **are** geometrically possible for: **More** than 3 months **Less** than 60 minutes	Existing vegetation and terrain are predicted to partially obstruct views of reflecting panels Residual views are considered possible	**Less** than 3 months **Less** than 60 minutes	N/A	Low impact

[13] Assessment scenario may include an initial conservative qualitative consideration of screening in determining the duration of predicated effects in practice. The reflecting area of the solar development may be partially screened such that it does not meet the two key criteria i.e. 1) The solar reflection occurs for more than 3 months per year. 2) and/or for more than 60 minutes on any given day.

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[13]	Mitigating Factors	Predicted Impact Classification
3, 17	Solar reflections **are** geometrically possible for: **More** than 3 months **Less** than 60 minutes	Existing vegetation and terrain are predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact
5, 14, 20	Solar reflections **are** geometrically possible for: **More** than 3 months **Less** than 60 minutes	Existing vegetation is predicted to partially obstruct views of reflecting panels Residual views are considered possible	**Less** than 3 months **Less** than 60 minutes	N/A	Low impact
6, 18	Solar reflections **are** geometrically possible for: **Less** than 3 months **Less** than 60 minutes	Existing vegetation and terrain are predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact

Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[13]	Mitigating Factors	Predicted Impact Classification
7	Solar reflections **<u>are</u>** geometrically possible for: **<u>Less</u>** than 3 months **<u>Less</u>** than 60 minutes	Existing vegetation is predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact
8 – 13, 15 – 16, 19	Solar reflections **<u>are not</u>** geometrically possible	N/A	N/A	N/A	No impact

Table 2 *Geometric modelling results - dwelling receptors*

5.2.3 Desk-Based Review of Available Imagery - Dwelling receptors

A desk-based review of the available imagery is presented in Figures 9 to 15 on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow icons. The identified screening in the form of existing vegetation is highlighted in white. High-level Zones of Theoretical Visibility (ZTV Viewshed)[14] generated by Google Earth have been used to show the intervening terrain in green. Streetview images are used to show a ground-based view of screening at specific locations, with a white arrow and purple cone to illustrate the location and direction.

[14] The green highlighted extents show the areas of terrain from the relevant receptor point that is visible to an observer. For dwellings receptors, viewing height is set to 5m agl for multistorey houses, and 2m for single story houses.

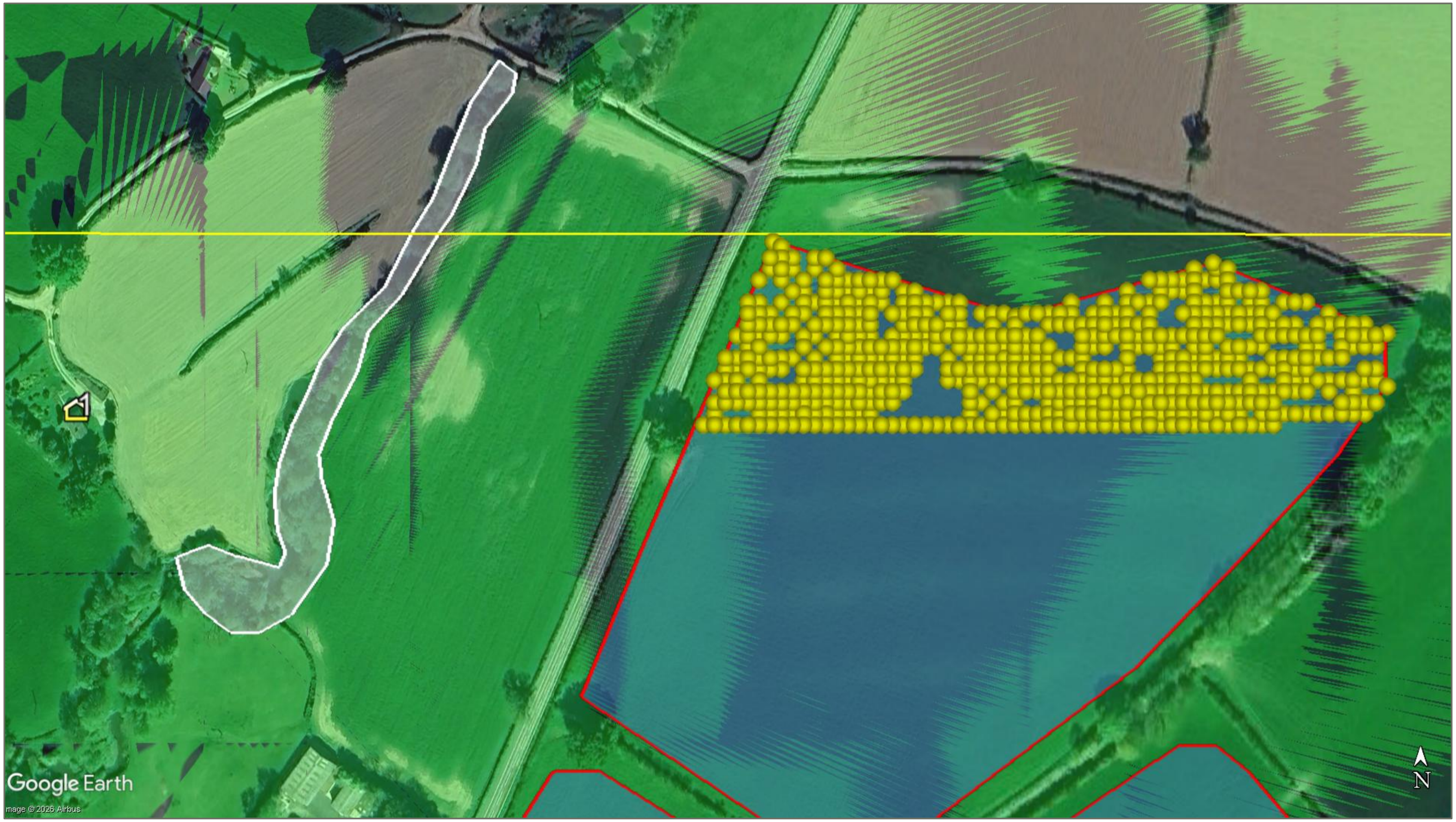


Figure 9 *Screening relevant to dwelling receptor 1, with ZTV viewshed showing terrain visibility*

Figure 10 *Screening relevant to dwelling receptors 2 and 3, with ZTV viewshed showing representative terrain visibility from dwelling 2*

Figure 11 *Screening relevant to dwelling receptors 4 to 7, with ZTV viewshed showing representative terrain visibility from dwelling 4*

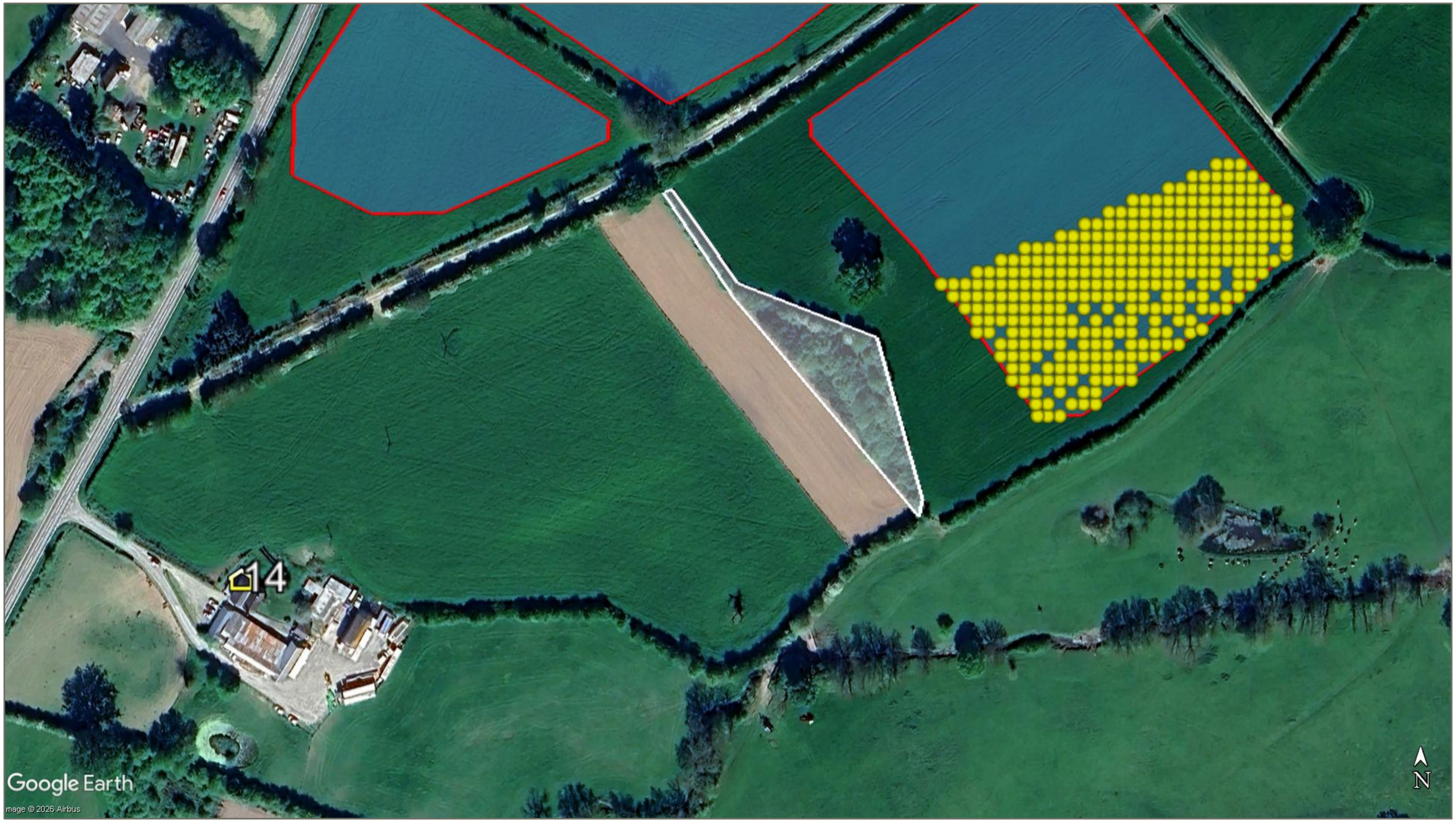


Figure 12 *Screening relevant to dwelling receptor 14*

Figure 13 *Screening relevant to dwelling receptor 17, with ZTV viewshed showing terrain visibility*

Figure 14 *Screening relevant to dwelling receptors 18 and 19, with ZTV viewshed showing representative terrain visibility from dwelling 19*

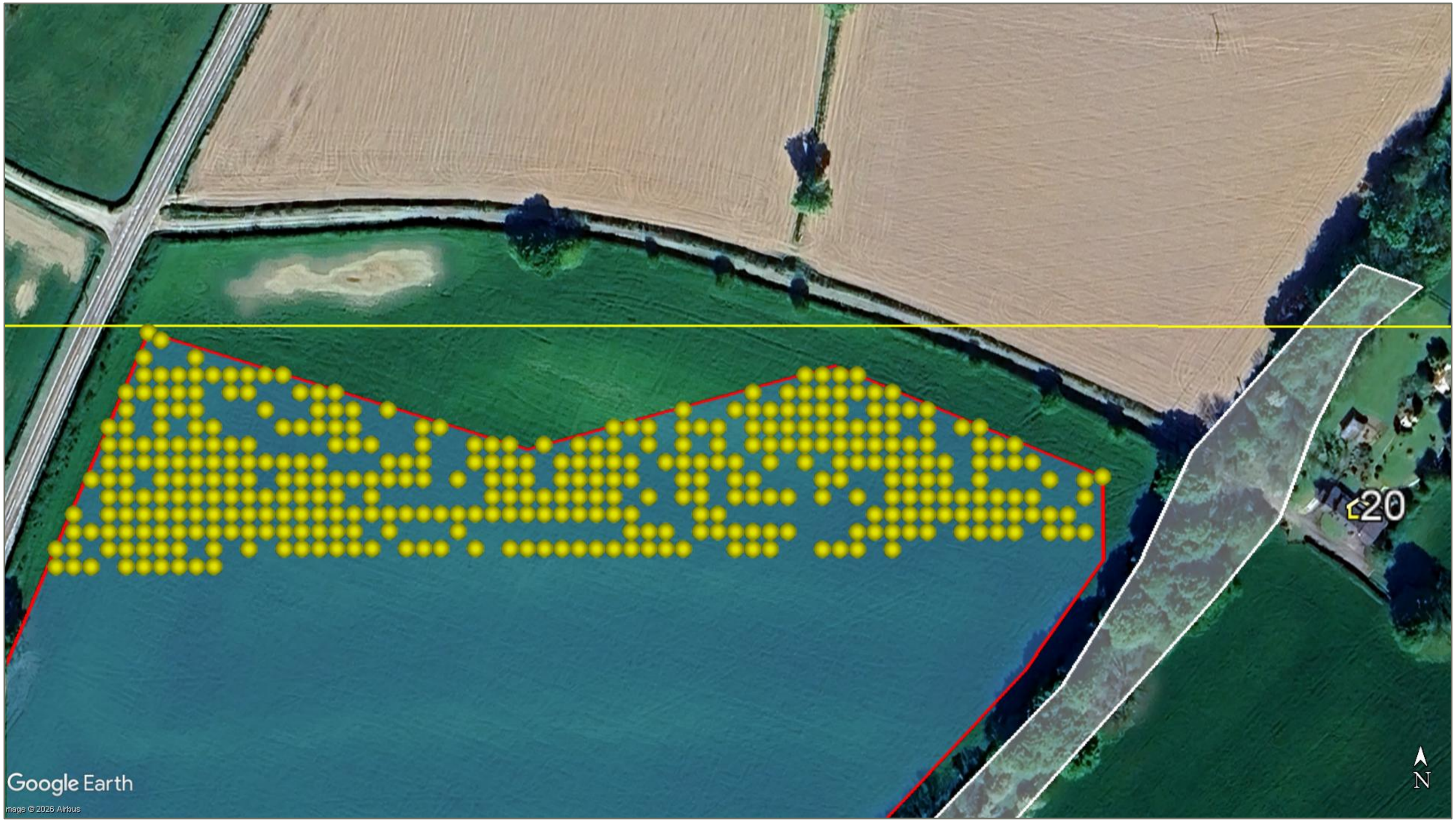


Figure 15 *Screening relevant to dwelling receptor 20*

5.3 Assessment results - Road Receptors

5.3.1 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 primary 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.

5.3.2 Geometric Modelling Results Overview

Table 3 on the following pages presents:

- 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 for which mitigation is recommended are highlighted in red for ease of reference.

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Considering screening[15], do reflections remain inside a road user's primary Field-of View (FOV)	Mitigating Factors	Predicted Impact Classification
1, 17 - 24	Solar reflections are **not geometrically possible**	N/A	N/A	N/A	No impact
2 – 5, 10 - 16	Solar reflections are **geometrically possible** and occur **inside** a road user's primary FOV	Existing vegetation and / or terrain are predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	N/A	N/A	No impact

[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.

Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Considering screening[15], do reflections remain inside a road user's primary Field-of View (FOV)	Mitigating Factors	Predicted Impact Classification
6 - 9	Solar reflections are **geometrically possible** and occur **inside** a road user's primary FOV	None identified	Solar reflections occur **inside** a road user's primary FOV, but not directly in front of a road user	Reflections do not occur directly in front of a road user Reflections coincide with direct sunlight	Moderate impact Mitigation recommended (see Section 5.4.2)

Table 3 *Geometric modelling results - road receptors*

5.3.3 Desk-Based Review of Available Imagery – Road receptors

A desk-based review of the available imagery is presented in Figures 16 to 18 on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow icons. The identified screening in the form of existing vegetation is highlighted in white. High-level Zones of Theoretical Visibility (ZTV Viewshed)[16] generated by Google Earth have been used to show the intervening terrain in green. Streetview images are used to show a ground-based view of screening at specific locations, with a white arrow and purple cone to illustrate the location and direction.

[16] The green highlighted extents show the areas of terrain from the relevant receptor point that is visible to an observer. For road receptors, viewing height is set to 2m agl, the closest available height to the modelled height of 1.5m agl.

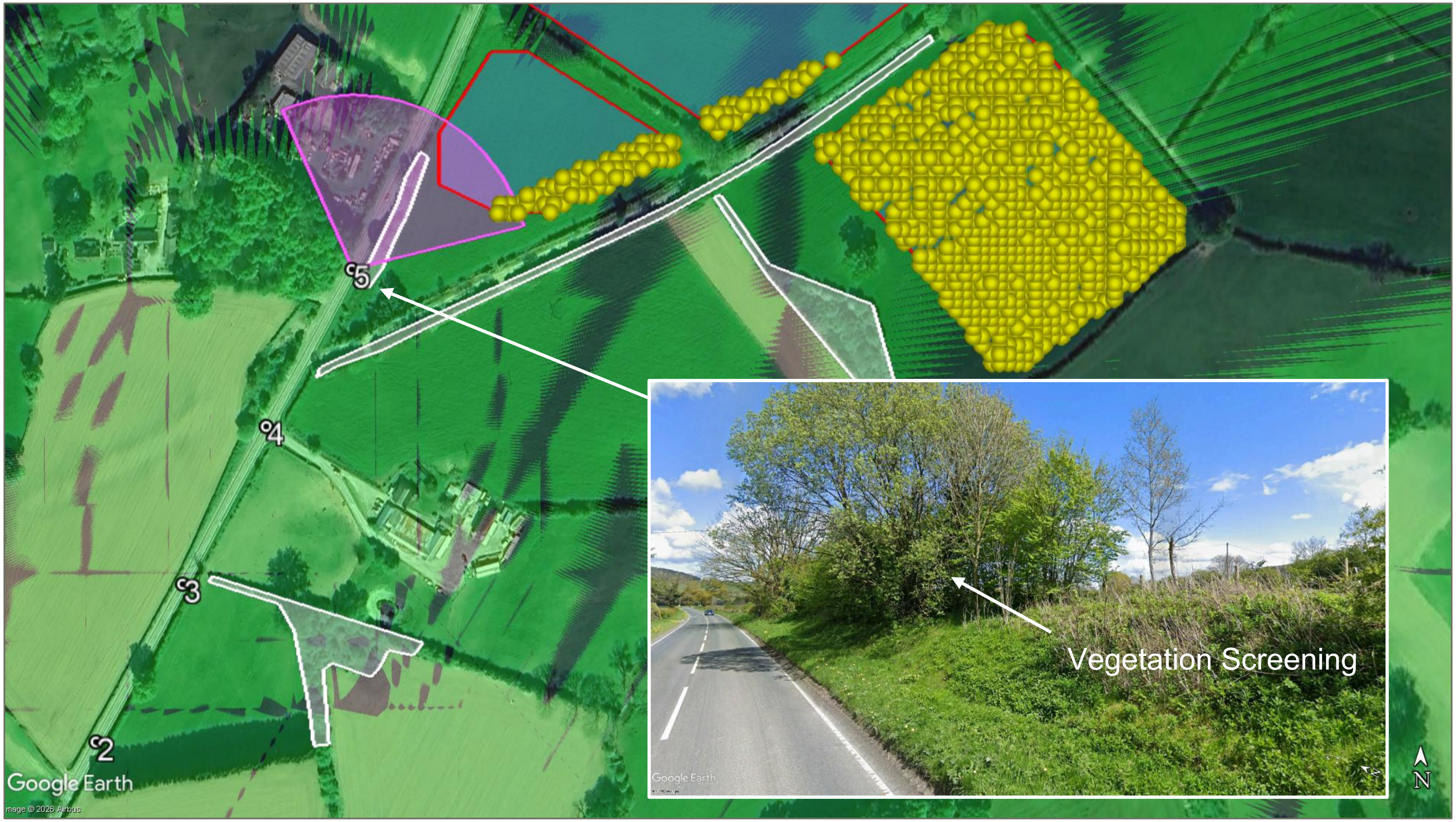


Figure 16 *Screening relevant to road receptors 2 to 5, with ZTV viewshed showing representative terrain visibility originating from road receptor 4*

Figure 17 *Screening relevant to road receptors 10 and 11*

Figure 18 *Screening relevant to road receptors 12 to 16*

5.4 Road Mitigation Strategy

A moderate impact has been identified upon a 300m section of the B393. Figure 19 on the following page shows the relevant screening and cumulative reflecting areas for the impacted road receptors. Figure 20 on page 45 shows the recommended locations for mitigation for road receptors 6 to 9 (blue line).

There are a number of forms of mitigation that can be explored:

- Screening in the form of vegetation or opaque fencing / wall can be implemented between the reflecting panels and the concerned road receptors;
  - If vegetation is used, it should be ensured that the screening significantly obstructs the reflecting panels during the periods when solar reflections are geometrically possible, late-March until mid-September;
- Panel configuration changes such that views do not occur within a road user's primary FOV.

Due to amendments in the panel extent, expanded mitigation measures are recommended in Figure 21 on page 46, to account for the expansion in parcels 1 and 2 of the proposed development.

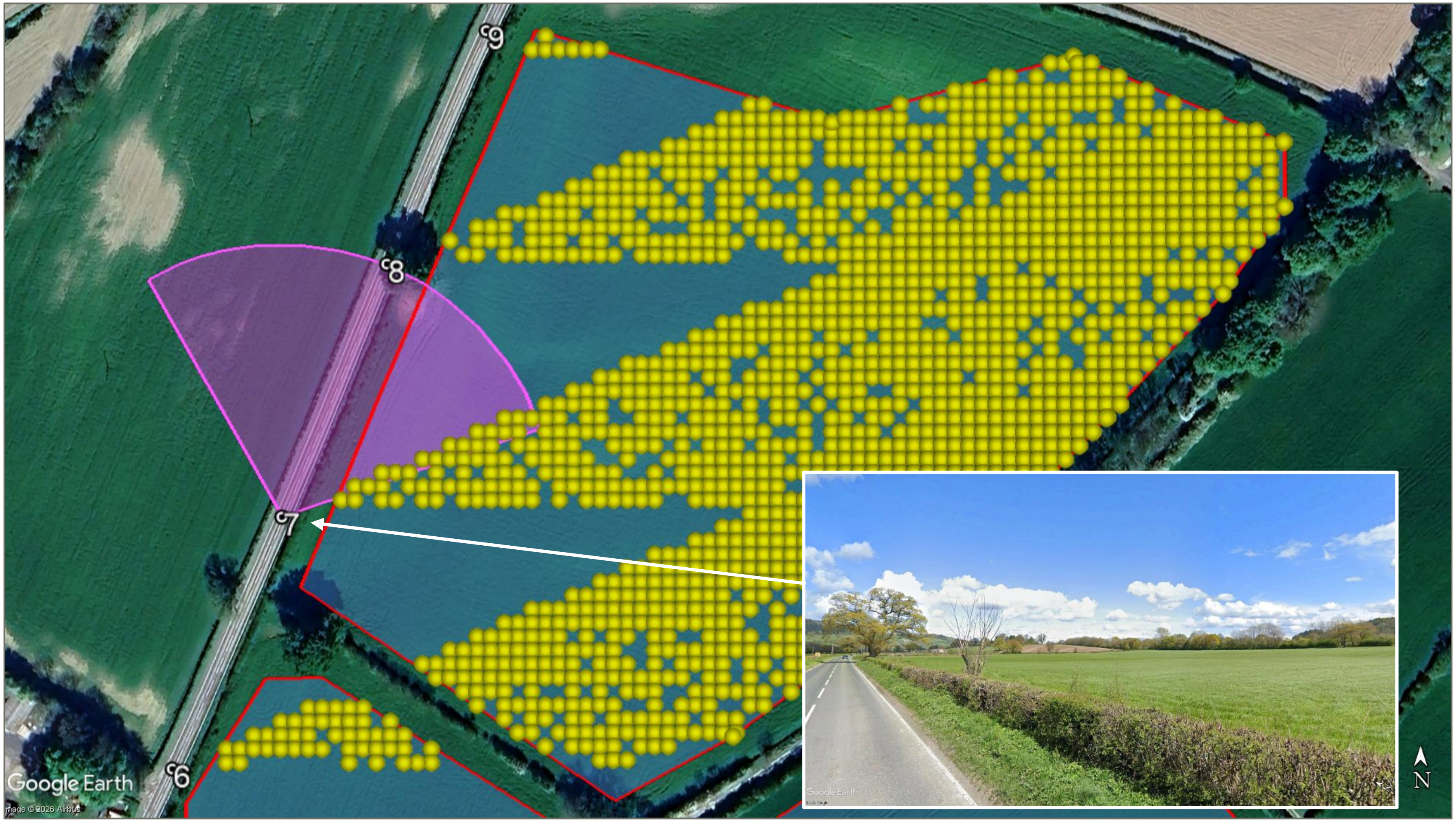


Figure 19 *Screening relevant to road receptors 6 to 9*

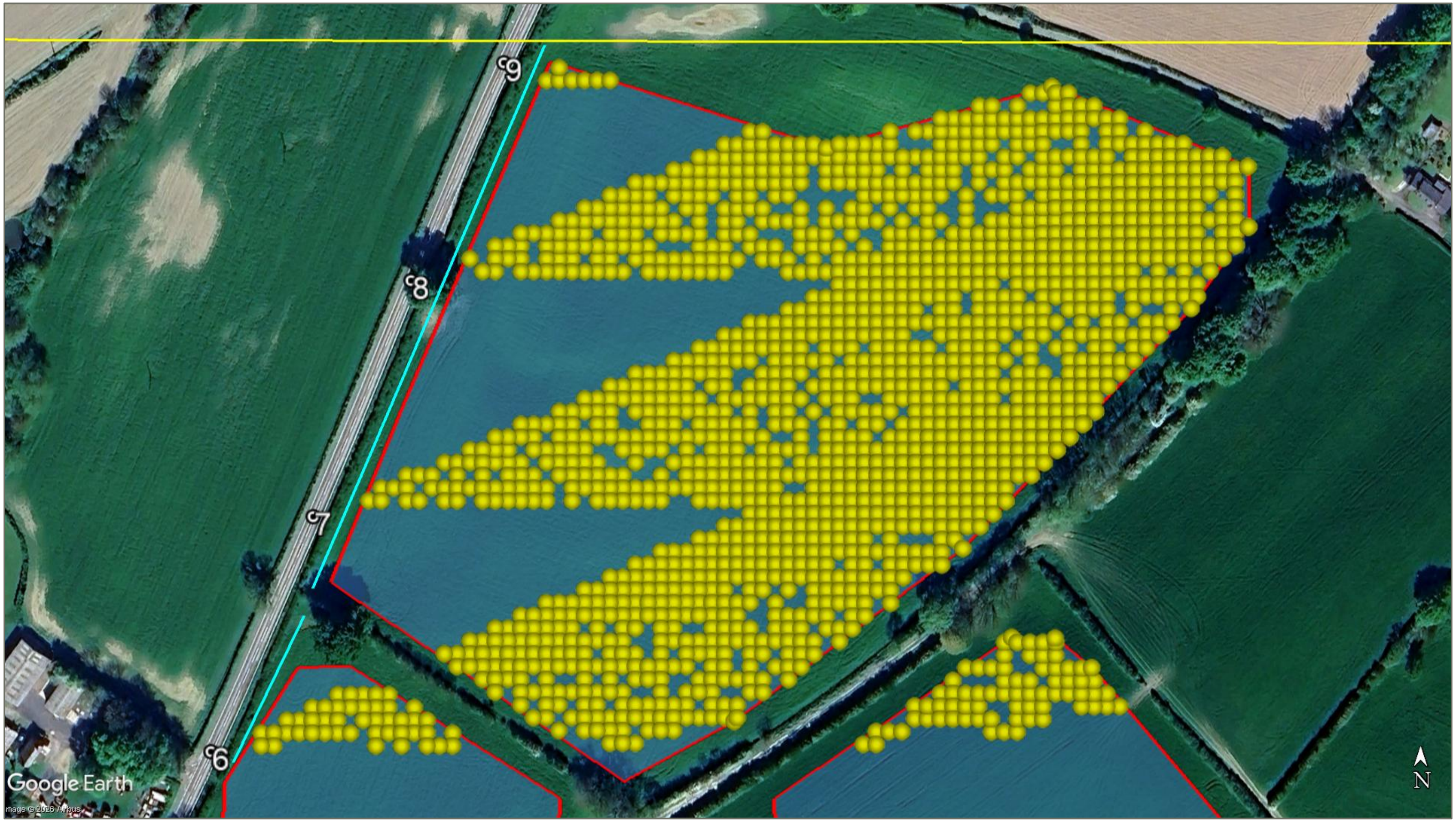


Figure 20 *Reflecting panel areas and recommended mitigation for road receptors 6 to 9*

Figure 21 *Recommended mitigation measures according to layout amendments*

6 CONCLUSIONS

6.1 Assessment Conclusions – Residential Amenity

The table below summarises the predicted impact upon the assessed dwelling receptors.

	Number of Receptors
Number of dwelling receptors assessed	20
Number of dwelling receptors where a solar reflection is geometrically possible	11
Number of dwelling receptors predicted to experience no impact due to significant screening	5
Number of dwelling receptors predicted to experience a low impact due to marginal views and sufficient mitigating factors	6

Table 4 *Summary of assessment for dwelling receptors*

Overall, a low impact is predicted upon residential amenity, and mitigation is not recommended.

6.2 Assessment Conclusions – Road Safety

The table below summarises the predicted impact upon the assessed road receptors.

	Number of Receptors
Number of road receptors assessed	24 (approximately 2,200m)
Number of road receptors where a solar reflection is geometrically possible	15
Number of road receptors predicted to experience no impact due to significant screening	11
Number of road receptors predicted to experience a moderate impact due to views originating within Field-of-View (FOV) and without sufficient mitigating factors	4

Table 5 *Summary of assessment for road receptors*

For the four road receptors where a moderate impact has been predicted, mitigation is recommended (see Section 5.4).

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 and is limited to the UK; however, it is relevant from a technical and planning perspective. The section is intended to give an overview of the important parameters and considerations that have informed this assessment.

UK Planning Policy

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[17] (specifically regarding the consideration of solar farms, paragraph 013) states:

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

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

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

…

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

…

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

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

National Policy Statement for Renewable Energy Infrastructure

The National Policy Statement for Renewable Energy Infrastructure (EN-3)[18] 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.[19] However, solar panels may reflect the sun's rays at certain angles, causing glint and glare. Glint is defined as a momentary flash of light that may be produced as a direct reflection of the sun in the solar panel. Glare is a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from the face of the panel. The effect occurs when the solar panel is stationed between or at an angle of the sun and the receptor.*
>
> *2.10.103 Applicants should map receptors to qualitatively identify potential glint and glare issues and determine if a glint and glare assessment is necessary as part of the application.*
>
> *2.10.104 When a quantitative glint and glare assessment is necessary, applicants are expected to consider the geometric possibility of glint and glare affecting nearby receptors and provide an assessment of potential impact and impairment based on the angle and duration of incidence and the intensity of the reflection.*
>
> *2.10.105 The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and design. This may need to account for 'tracking' panels if they are proposed as these may cause differential diurnal and/or seasonal impacts.*
>
> *2.10.106 When a glint and glare assessment is undertaken, the potential for solar PV panels, frames and supports to have a combined reflective quality may need to be assessed, although the glint and glare of the frames and supports is likely to be significantly less than the panels.'*

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

Sections 2.10.134-136 state:

> *'2.10.134 Applicants should consider using, and in some cases the Secretary of State may require, solar panels to comprise of (or be covered with) anti-glare/anti-reflective coating with a specified angle of maximum reflection attenuation for the lifetime of the permission.*
>
> *2.10.135 Applicants may consider using screening between potentially affected receptors and the reflecting panels to mitigate the effects.*

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

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

2.10.136 Applicants may consider adjusting the azimuth alignment of or changing the elevation tilt angle of a solar panel, within the economically viable range, to alter the angle of incidence. In practice this is unlikely to remove the potential impact altogether but in marginal cases may contribute to a mitigation strategy.'

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

Sections 2.10.158-159 state:

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

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

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

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

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare has been determined when assessing the impact of solar reflections upon surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant. The Pager Power approach has been informed by the policy presented above, current studies (presented in Appendix B) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document[20] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

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

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

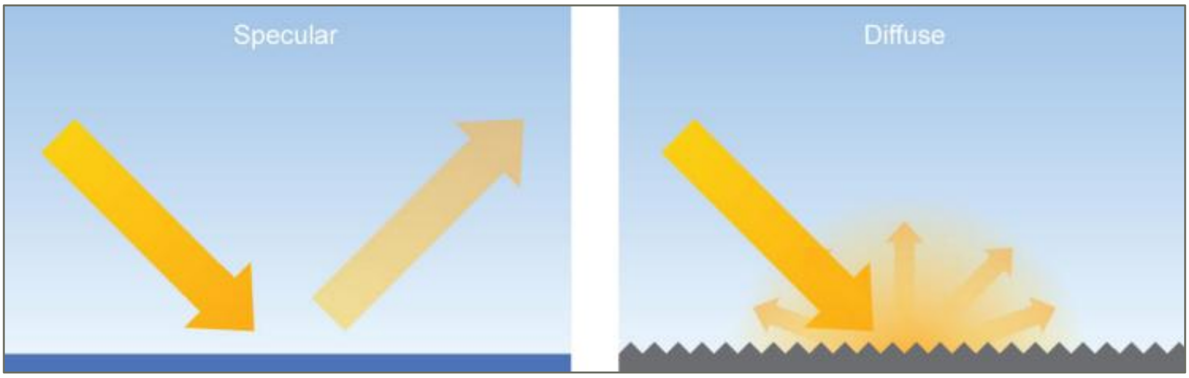
Overview

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

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

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance[21], 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

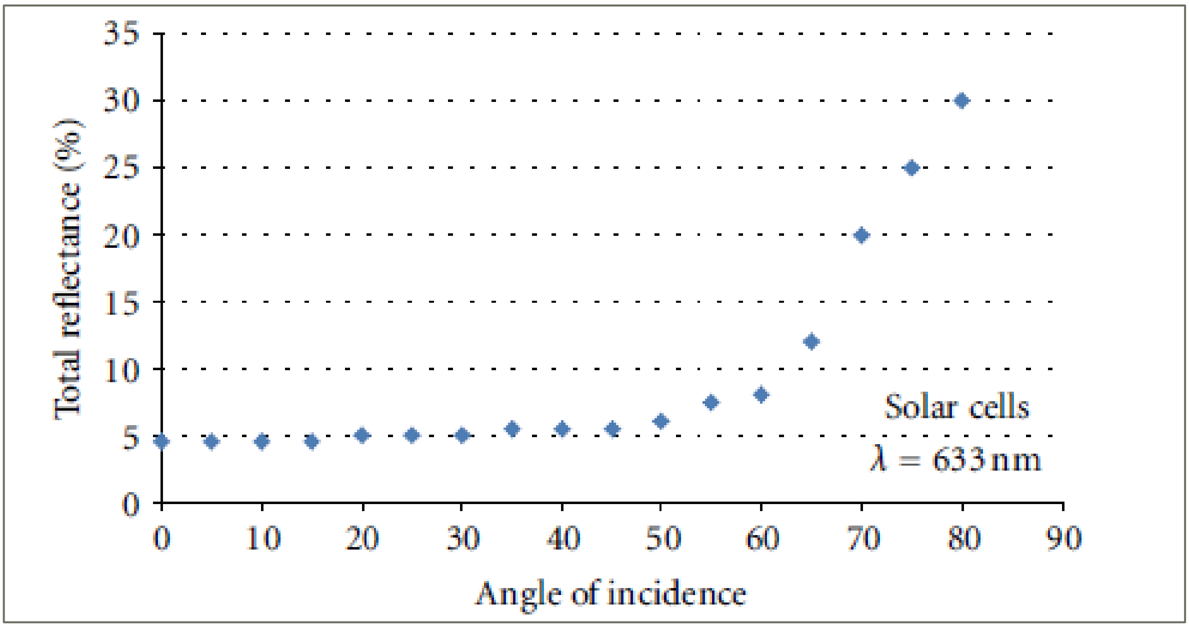
[21] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021

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*[22]". 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 reflections % 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.

[22] 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"[23]

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[24]
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 reflectively 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.

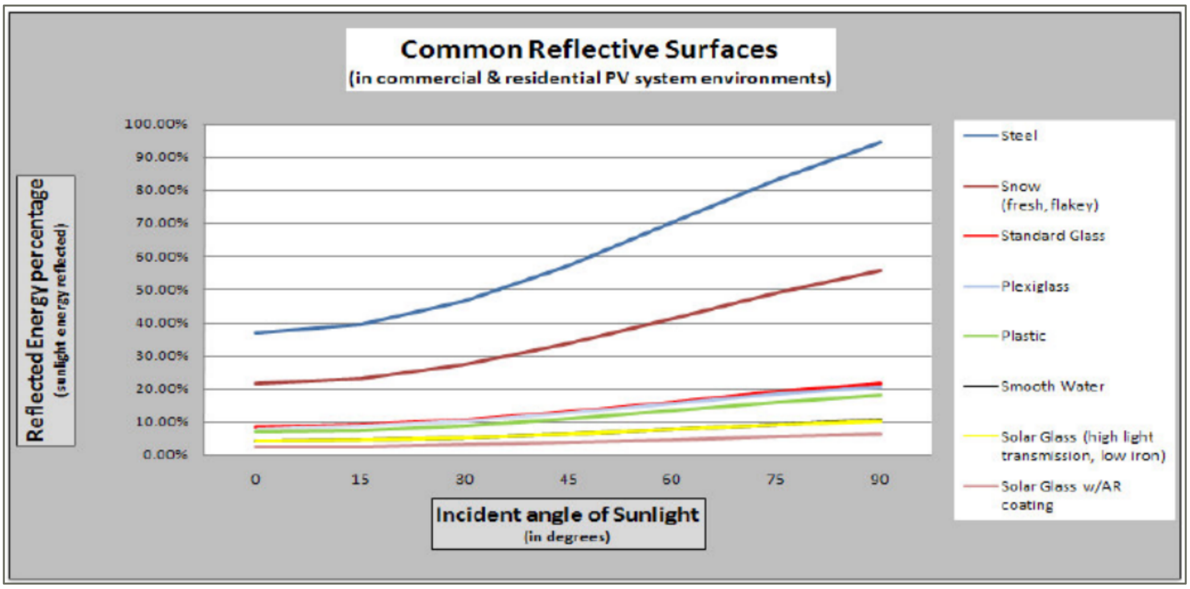
[23] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019

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

SunPower Technical Notification (2009)

SunPower published a technical notification[25] 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.

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

APPENDIX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

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

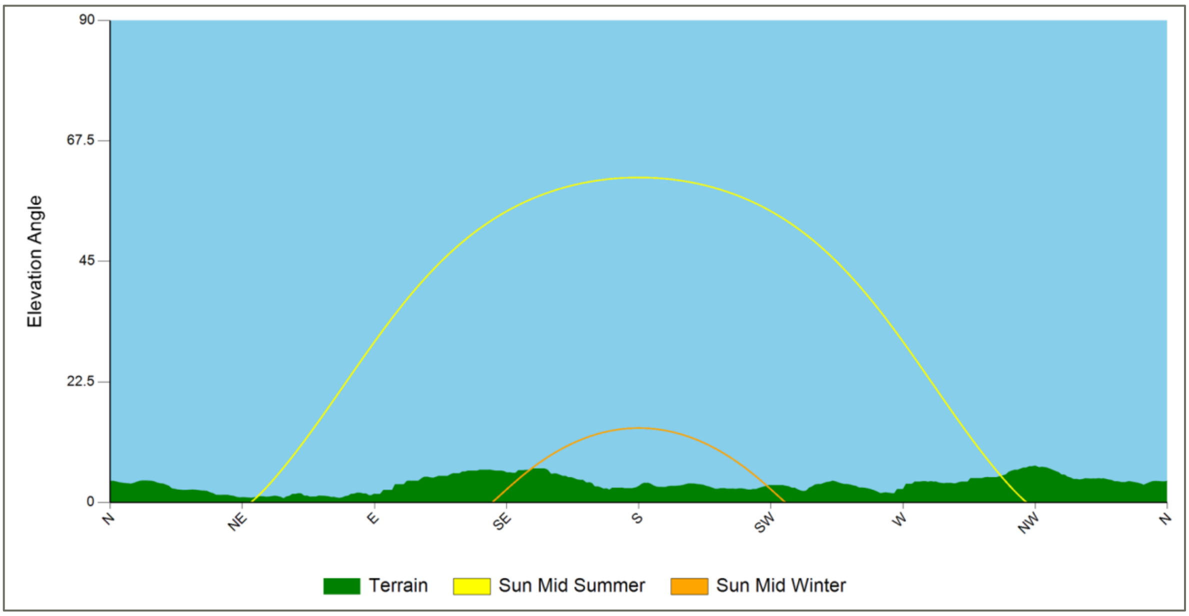
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

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

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

- The Sun is at its highest around midday and is to the south at this time;
- The Sun rises highest on 21 June (longest day);
- On 21 December, the maximum elevation reached by the Sun is at its lowest (shortest day).

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a reflector.



Terrain at the visible horizon and sun paths

APPENDIX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

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

Impact Significance Definition

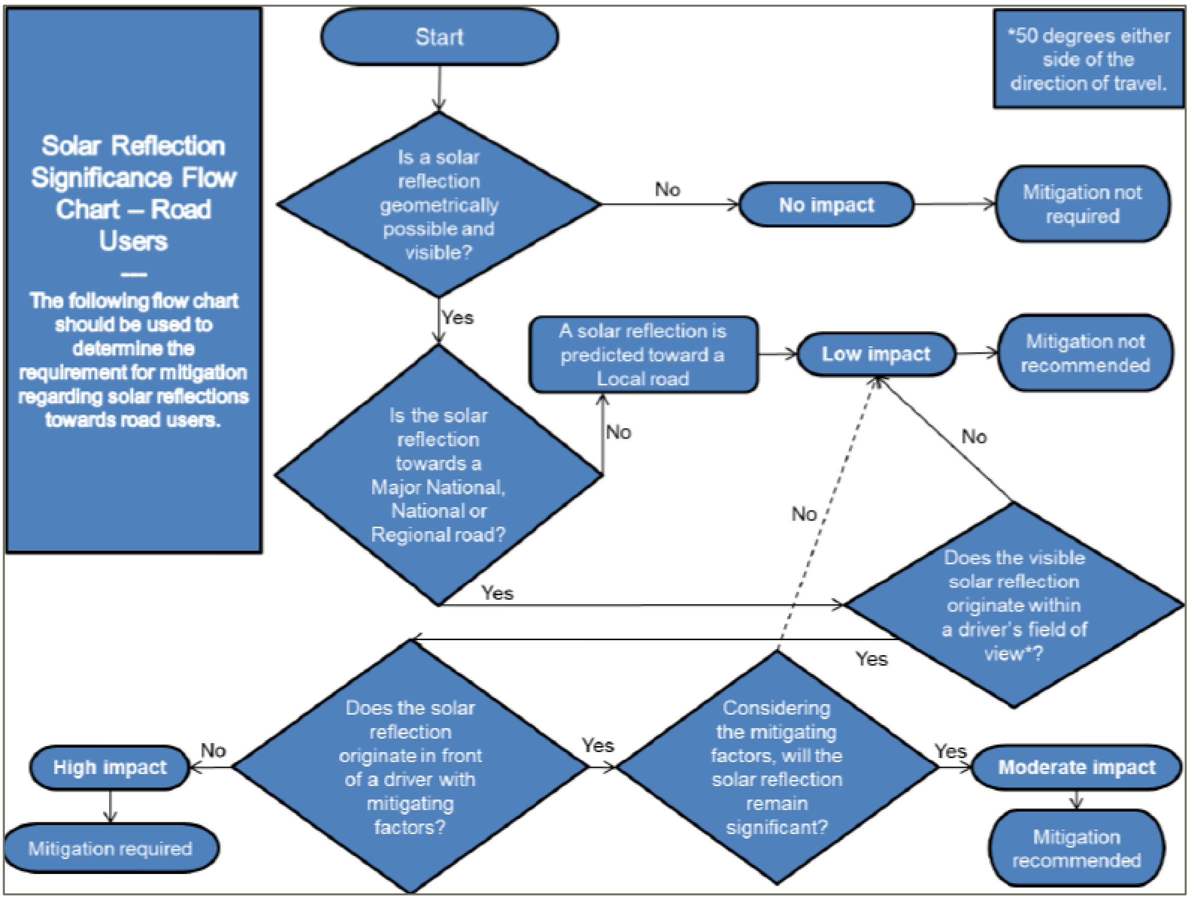
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels 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

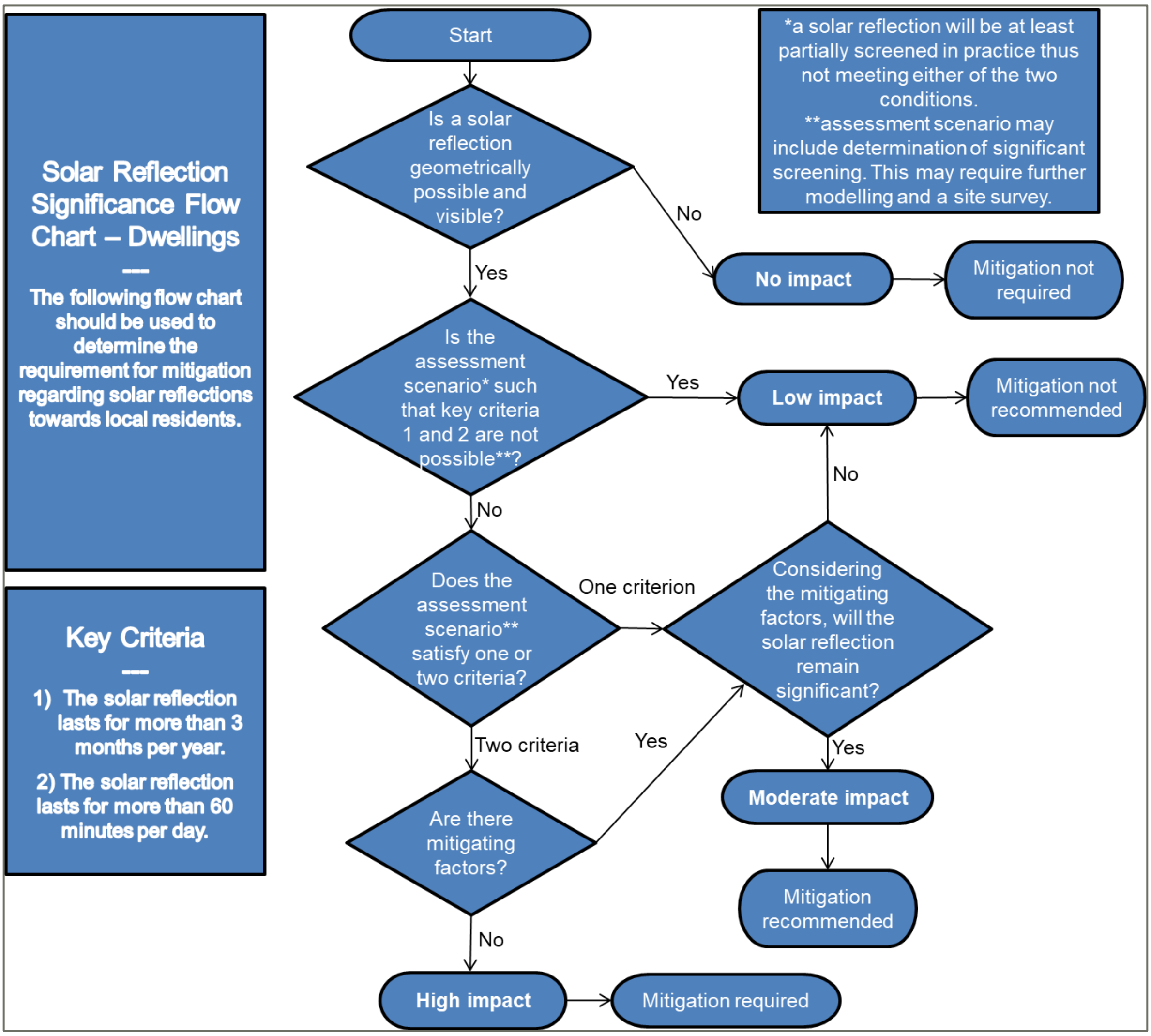
The flow chart presented below has been followed when determining the impact significance for road receptors.



Road receptor impact significance flow chart

Impact Significance Determination for Dwelling Receptors

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



Dwelling receptor impact significance flow chart

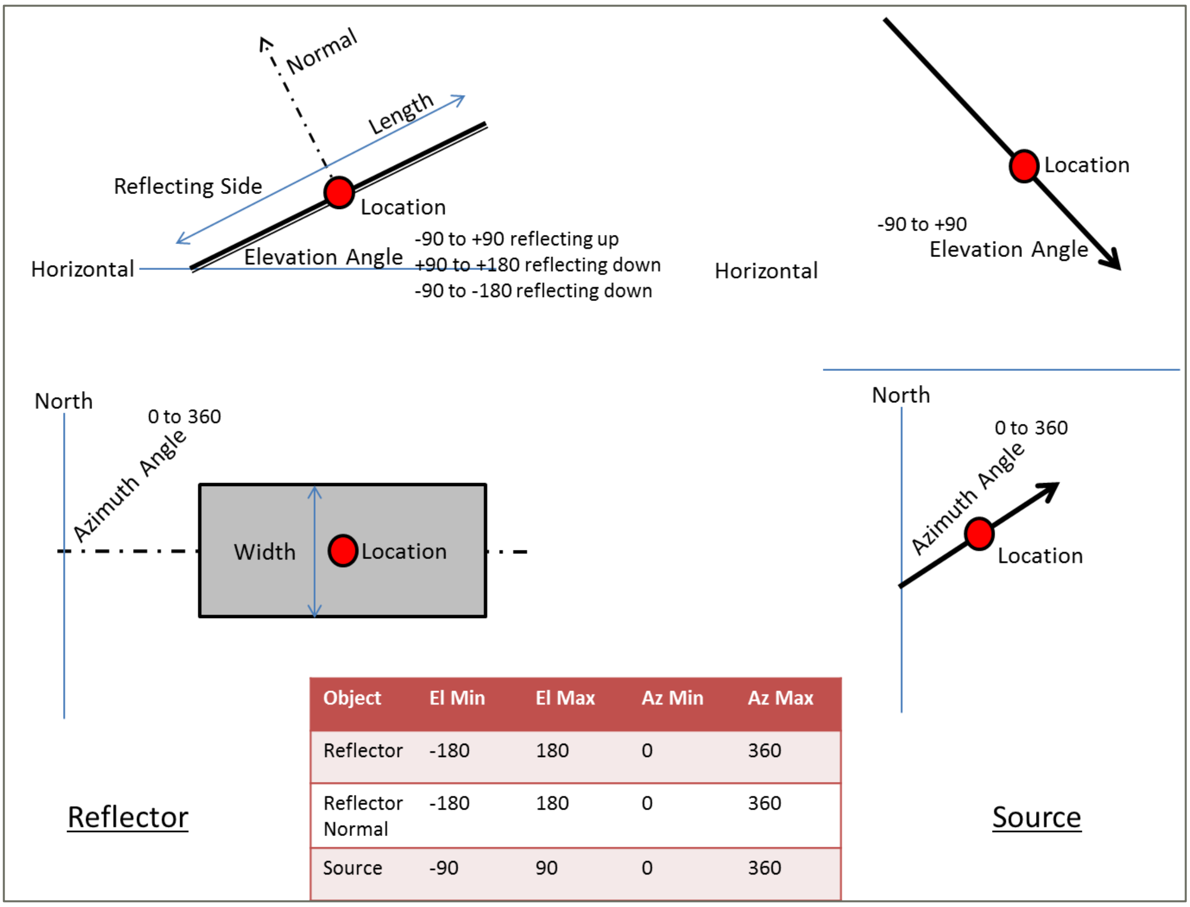
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power Methodology

The calculations are three dimensional and complex, accounting for:

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

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



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

Reflection calculation process

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

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

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)[26].

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

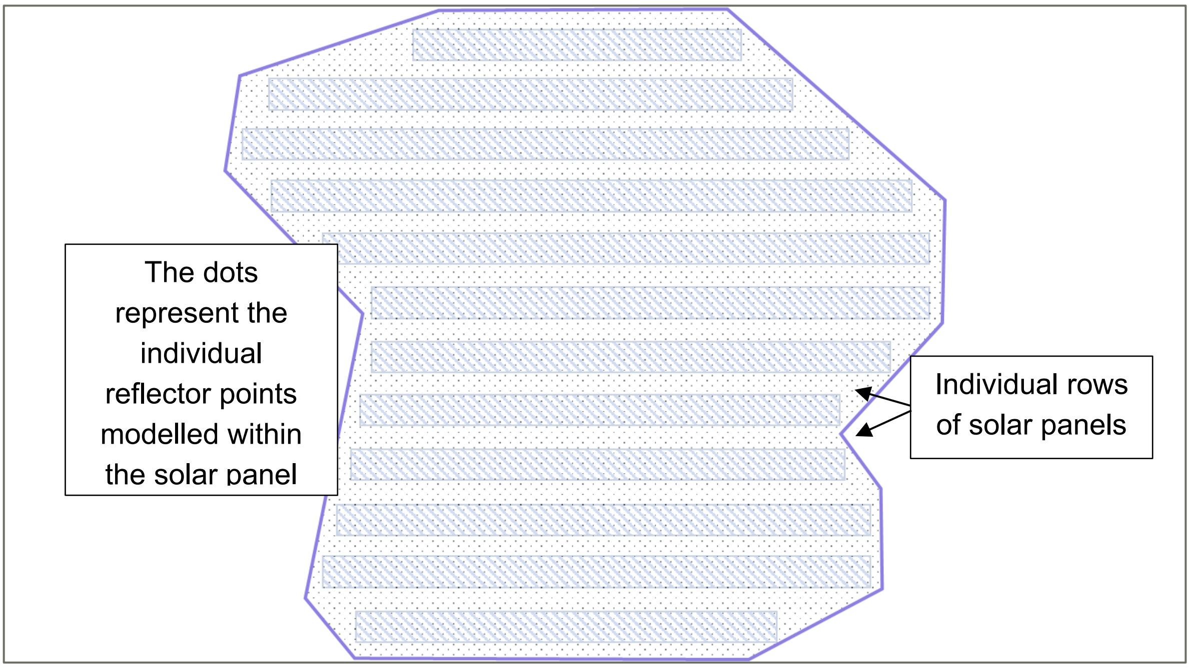
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

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.

[26] 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.

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Overview

Coordinate and terrain data has been ascertained based on Ordnance Survey (OS) 50 Digital Terrain Model (DTM) data.

Dwelling Receptor Data

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

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
1	52.76245	-3.22738	102.94	11	52.75339	-3.22684	106.47
2	52.76073	-3.22577	101.8	12	52.75225	-3.22631	107.7
3	52.76008	-3.22724	102.54	13	52.75572	-3.22656	106.55
4	52.75837	-3.23328	108.26	14	52.75881	-3.22496	102.8
5	52.75636	-3.2378	117.72	15	52.75491	-3.21951	130.17
6	52.75512	-3.23651	134.82	16	52.75446	-3.21891	133.28
7	52.75607	-3.23444	129.32	17	52.76054	-3.20834	97.92
8	52.75592	-3.23223	136.64	18	52.76196	-3.20474	96.8
9	52.75465	-3.23111	148.29	19	52.76293	-3.20547	95.8
10	52.75431	-3.23077	139.87	20	52.7627	-3.21762	108.18

Dwelling receptor data

Road Receptor Data

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

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
1-B4393	52.75679	-3.22822	112.8	13-A490	52.7569	-3.23402	117.29
2-B4393	52.75757	-3.22747	106.82	14-A490	52.757	-3.23254	114.01
3-B4393	52.75836	-3.22676	103.5	15-A490	52.75702	-3.23106	116.09
4-B4393	52.75915	-3.22606	102.5	16-A490	52.75711	-3.22958	113.83
5-B4393	52.75995	-3.22536	101.59	17-A490	52.75679	-3.22822	112.81
6-B4393	52.76076	-3.22471	102.19	18-A490	52.75609	-3.22731	109.22
7-B4393	52.76158	-3.22412	101.5	19-A490	52.75523	-3.22693	106.93
8-B4393	52.76241	-3.22354	101.5	20-A490	52.75434	-3.22662	106.5
9-B4393	52.76309	-3.22308	100.66	21-A490	52.75347	-3.2263	105.96
10-A490	52.75693	-3.2384	111.5	22-A490	52.75259	-3.22594	106.88
11-A490	52.75678	-3.23694	112.3	23-A490	52.75173	-3.22553	109.32
12-A490	52.75669	-3.23546	117.37	24-A490	52.75098	-3.22494	110.99

Road receptor data

Modelled Reflector Areas

The vertices of the modelled reflector areas are presented in the tables below.

Panel Area 1

No.	Latitude (°)	Longitude (°)	No	Latitude (°)	Longitude (°)
1	52.76064	-3.22231	7	52.76281	-3.21867
2	52.76085	-3.22166	8	52.76309	-3.21981
3	52.76146	-3.22033	9	52.76288	-3.22112
4	52.7619	-3.21963	10	52.76318	-3.22274
5	52.76231	-3.21901	11	52.76194	-3.22362
6	52.76259	-3.21867	12	52.76134	-3.22403

Panel Area 1

Panel Area 2

No.	Latitude (°)	Longitude (°)	No	Latitude (°)	Longitude (°)
1	52.76063	-3.22464	5	52.7605	-3.22269
2	52.76037	-3.22465	6	52.76058	-3.22268
3	52.76023	-3.22415	7	52.76104	-3.22391
4	52.76023	-3.22371	8	52.76104	-3.22421

Panel Area 2

Panel Area 3

No.	Latitude (°)	Longitude (°)	No	Latitude (°)	Longitude (°)
1	52.76058	-3.22143	7	52.76008	-3.21846
2	52.76052	-3.22143	8	52.76024	-3.21846
3	52.76008	-3.22075	9	52.76105	-3.21959
4	52.75947	-3.22001	10	52.76115	-3.2198
5	52.75947	-3.21973	11	52.76115	-3.22005
6	52.7598	-3.21898			

Panel Area 3

APPENDIX H – DETAILED MODELLING RESULTS

Overview

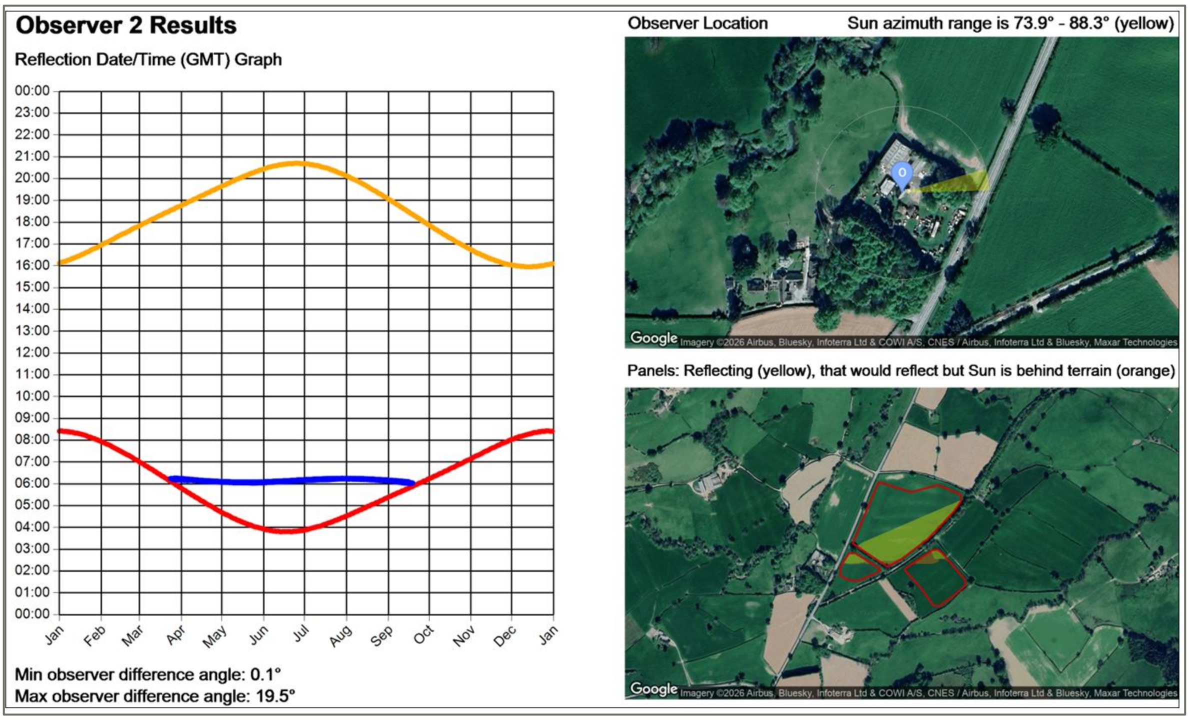
The Pager Power charts for a selection of representative receptors are shown on the following pages. Each chart shows:

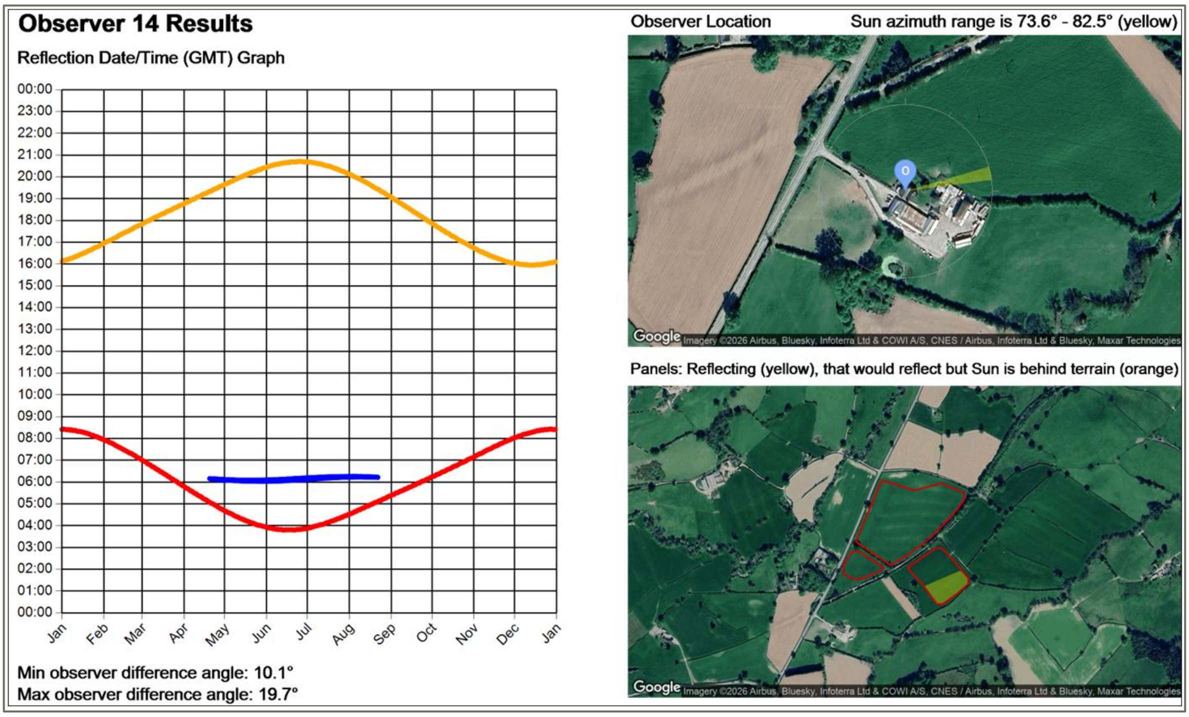
- The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible. If sunlight is experienced from the same direction as the reflecting panels, the overall impact of the reflection is reduced as discussed within the body of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

Modelling results for all receptors can be provided upon request.

Dwelling Receptors

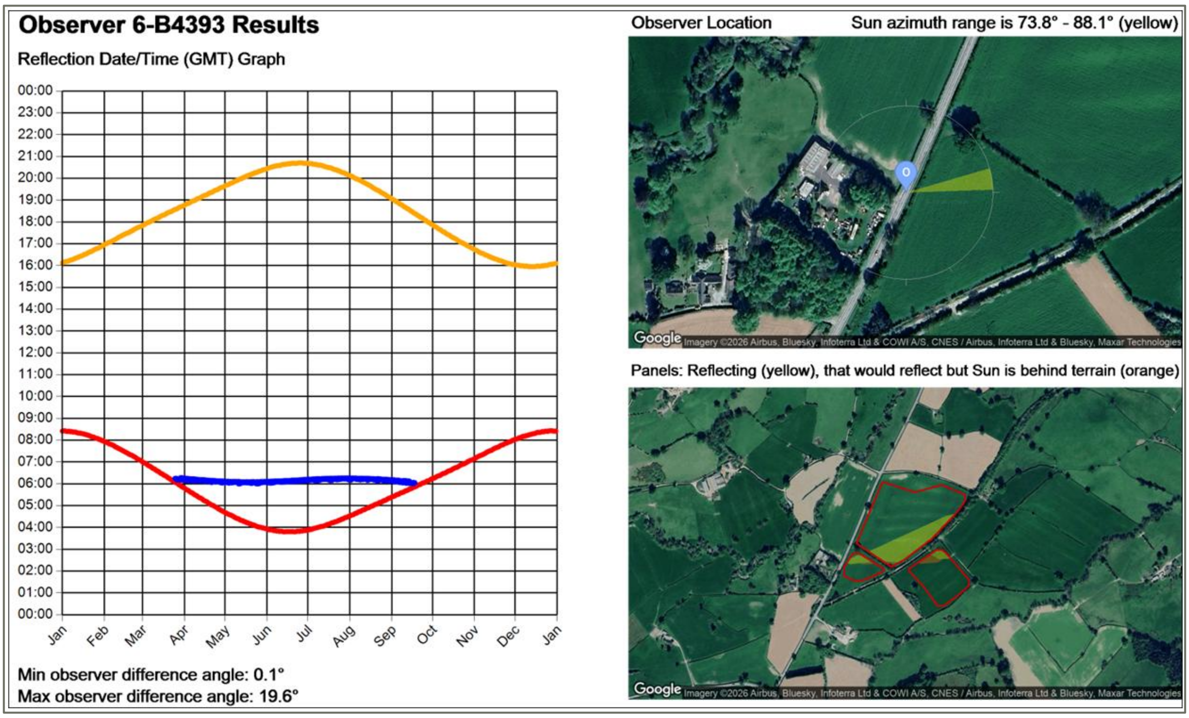
Results have been included for a selection of representative receptors

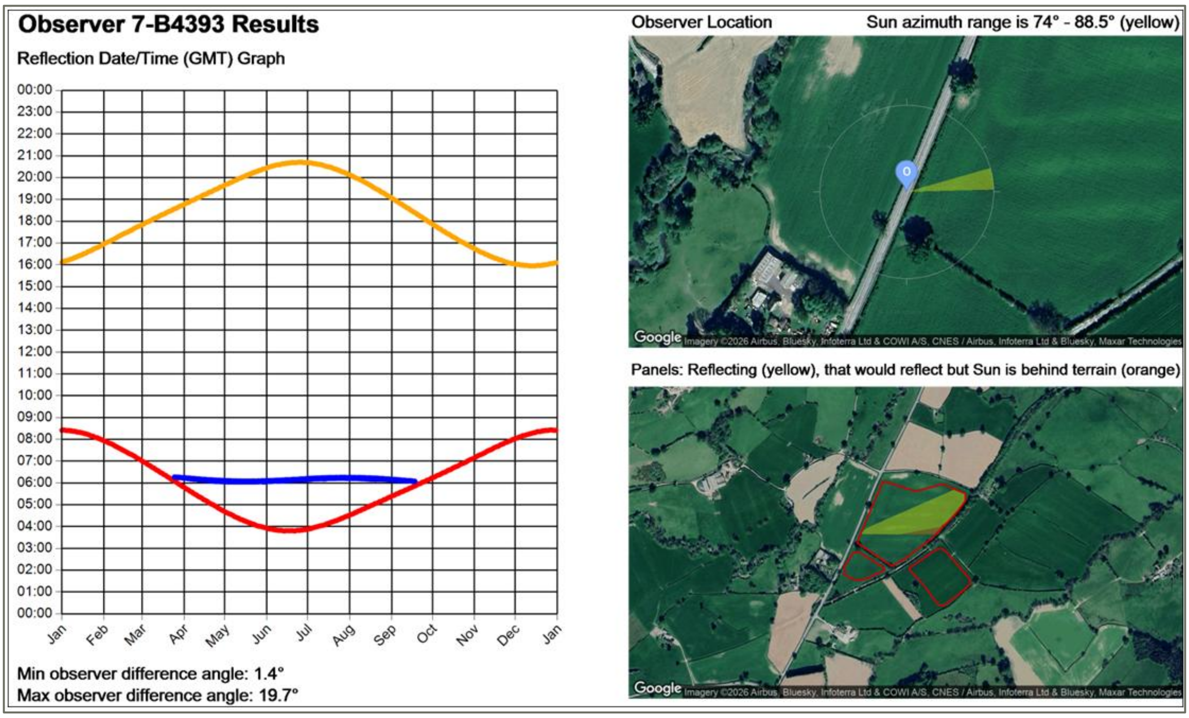


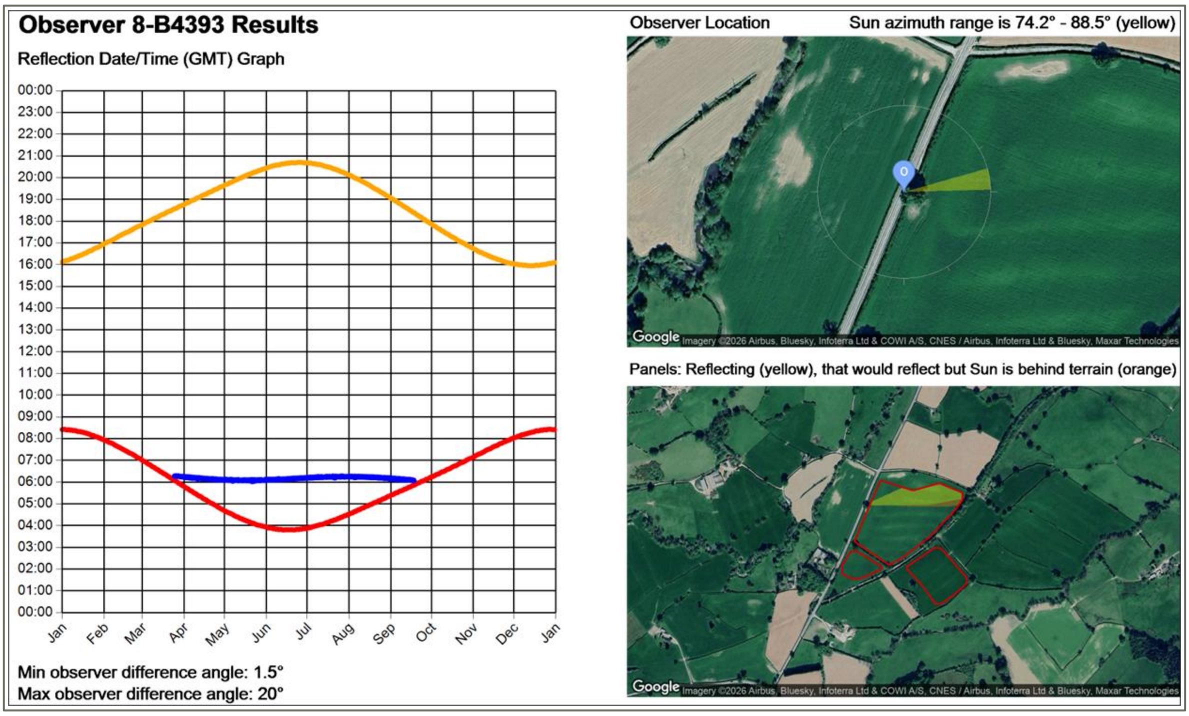


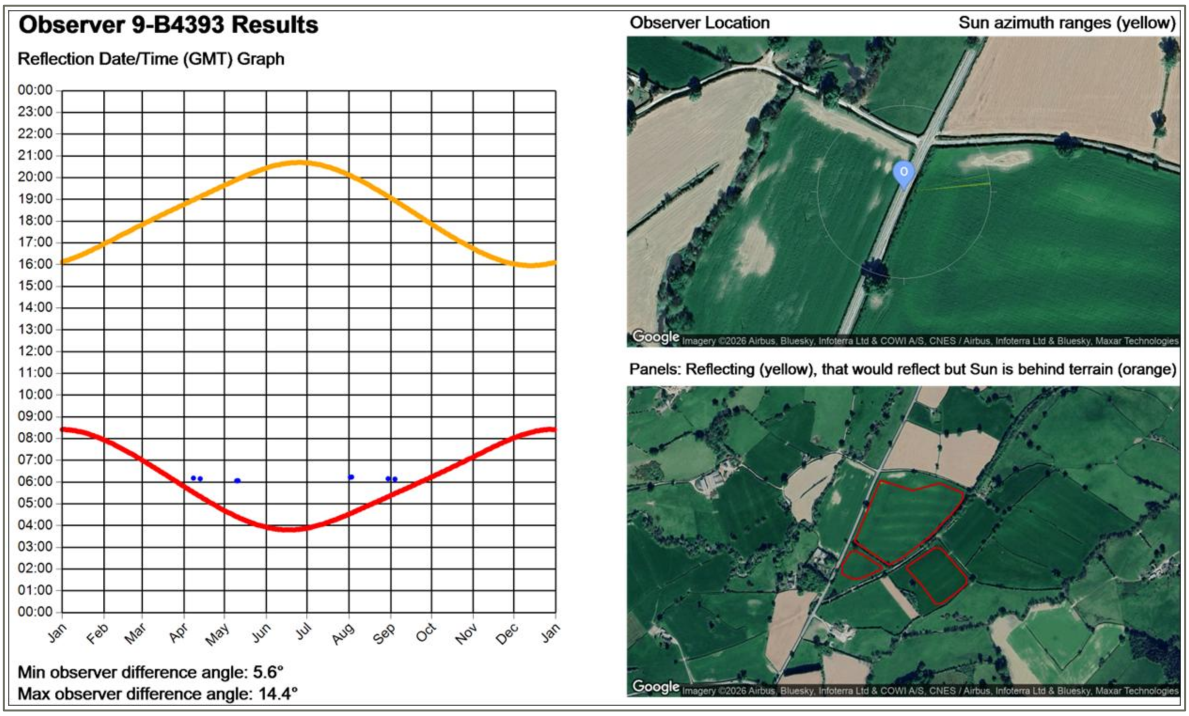
Road Receptors

Results have been included for a selection of representative receptors.






Observer 8-B4393 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 1.5°
Max observer difference angle: 20°
Observer Location
Sun azimuth range is 74.2° - 88.5° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 9-B4393 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 5.6°
Max observer difference angle: 14.4°
Observer Location
Sun azimuth ranges (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

Pager Power Limited
Stour Valley Business Centre
Sudbury | Suffolk | CO10 7GB
T +44 (0)1787 319001 | **E** info@pagerpower.com
www.pagerpower.com