Appendix 11.5

Glint and Glare Assessment

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PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

Herbata Data Centre

RPS Group Plc

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ADMINISTRATION PAGE

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1	13th July 2023	Initial issue
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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a rooftop solar photovoltaic (PV) development located west of Naas in Ireland. The assessment pertains to the possible impact upon surrounding residential amenity, road safety, and aviation activity associated with Allenwood Airfield, Millicent Airfield, and Gowran Grange Airfield.

Conclusions

No significant impacts are predicted upon aviation operations associated with the nearby airfields (Allenwood Airfield, Millicent Airfield, and Gowran Grange Airfield). No impacts are predicted towards road users travelling along the nearby roads and the residential amenity for nearby dwellings due to the buildings' parapet blocking the views of the panels[1]. Therefore, no mitigation is recommended.

Guidance and Studies

Pager Power is not aware of any glint and glare guidance for projects in Ireland. Therefore, the UK and USA guidelines were used for this report.

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[2] 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 a solar reflection is predicted, solar intensity calculations are undertaken where appropriate in line with the Sandia National Laboratories' FAA methodology[3]. 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

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[1] Changes to the panel's configurations are not predicted to change the conclusions of this report since the screening will still be effective at blocking views of the panel area.

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

[3] 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.

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[4].

Assessment Results – Road Users

R409

The results of the modelling indicate that solar reflections are geometrically possible towards 13 of the 25 assessed road receptors equivalent to 1.2km section of R409. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

L2030 Newhall

The results of the modelling indicate that solar reflections are geometrically possible towards four of the 14 assessed road receptors equivalent to 0.3km section of L2030 Newhall. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

L2030 Newhall

The results of the modelling indicate that solar reflections are not geometrically possible towards any of the 23 assessed road receptors equivalent associated with L2030 Newhall. Therefore, no impact is predicted, and no mitigation is required.

M7

The results of the modelling indicate that solar reflections are geometrically possible towards nine of the 24 assessed road receptors equivalent to 0.8km section of M7. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

R445 Millenium Park

The results of the modelling indicate that solar reflections are geometrically possible towards 12 of the 18 assessed road receptors equivalent to 1.1km section of R445 Millenium Park. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

R445

The results of the modelling indicate that solar reflections are not geometrically possible towards any of the 13 assessed road receptors equivalent associated with R445. Therefore, no impact is predicted and no mitigation is required.

Assessment Results – Dwelling

The results of the modelling indicate that solar reflections are geometrically possible towards 17 of the 42 assessed dwellings. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

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

High-Level Assessment Results – Airfields

No significant impacts upon aviation activity associated with Allenwood Airfield, Millicent Airfield, and Gowran Grange Airfield are predicted, and detailed modelling for these airfields is not recommended (see Section 8.3 at page 48).

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 58 countries within Europe, Africa, America, Asia and Australasia.

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

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

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

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

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

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the possible effects of glint and glare from a rooftop solar photovoltaic (PV) development located west of Naas in Ireland. The assessment pertains to the possible impact upon surrounding residential amenity, road safety, and aviation activity associated with Allenwood Airfield, Millicent Airfield, and Gowran Grange Airfield.

This report contains the following:

- Solar development details.
- Explanation of glint and glare.
- Overview of relevant guidance and studies.
- Overview of Sun movement.
- Assessment methodology.
- Identification of receptors.
- Glint and glare assessment for identified receptors.
- Considerations of aviation activity.
- Results discussion.
- Assessment conclusions.

1.2 Pager Power's Experience

Pager Power has undertaken over 1,000 glint and glare assessments in the UK, Europe and internationally. The company's own glint and glare guidance is based on industry experience and extensive consultation with industry stakeholders including airports and aviation regulators.

1.3 Glint and Glare Definition

The definition of glint and glare is as follows[5]:

- 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.

[5] These definitions are aligned with those presented within the Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) – published by the Department for Energy Security and Net Zero in March 2023 and the Federal Aviation Administration in the USA.

2 PROPOSED DEVELOPMENT LOCATION AND CHARACTERISTICS

2.1 Proposed Development Site Layout

Figure 1[6] below and Figure 2[7] on the following page shows the proposed rooftop development layout.

Figure 1 – Proposed development site layout

[6] Source: Site Plan PV Layout, Ballyrashane Solar Farm, RKD, date: 01/06/23, drawing no.: 10360452-HDR-XX-XX-DR-E-PV.

[7] The redline boundary is from an old plan and it is only used for overlaying purposes.

Figure 2 – Proposed development aerial view

2.2 Panel Information

The information for the modelled solar panels in this assessment is shown in Table 1 below.

Panel Information	
Azimuth angle	148° (DC4 – 150°)
Tilt angle	15°
Assessed height above ground level (agl)[8]	16.5m

Table 1 – Panel information

[8] This is the average mid-height of the roof. The min-height of the roof is 15m and the max-height 18m (see Figure 3 on the following page). Small changes of this height are not predicted to affect the results of the modelling and the conclusion of the report.

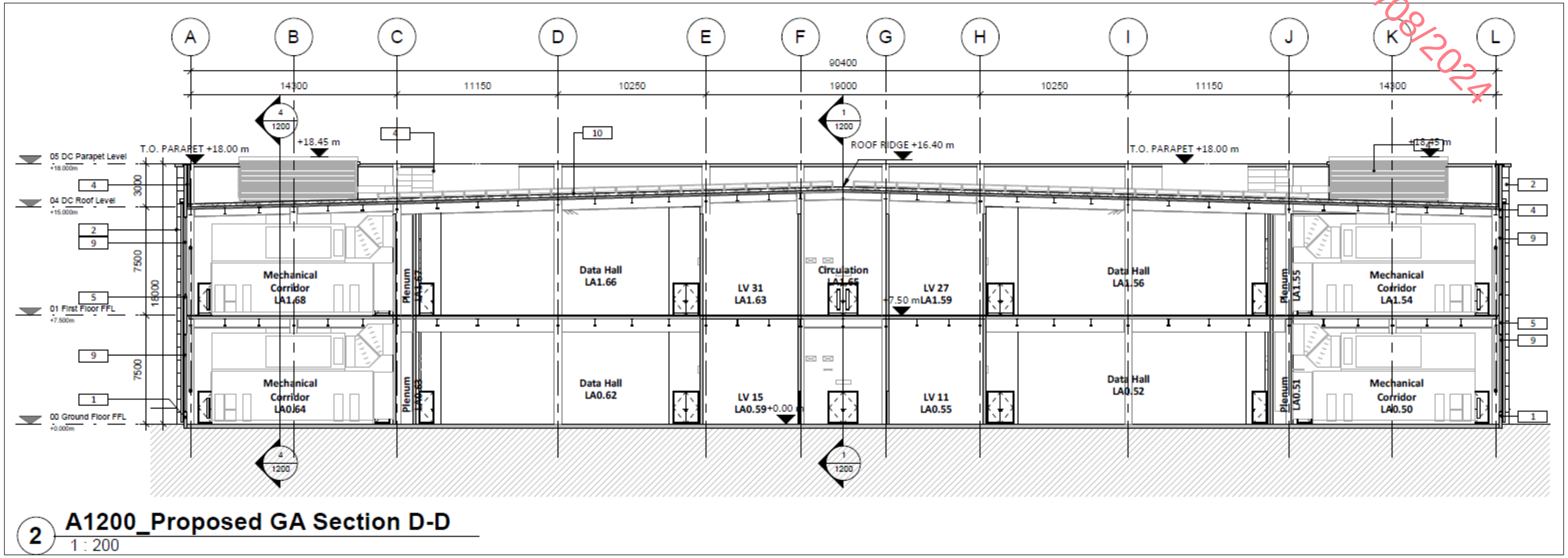

Figure 3 – Proposed GA Section D-D

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

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 assessments 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.

3.4 Assessment Methodology and Limitations

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

4 IDENTIFICATION OF RECEPTORS

4.1 Overview

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

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. 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[9].

Potential receptors within the associated assessment areas 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.

Terrain elevation heights have been interpolated based on OSGB terrain data. Receptor details can be found in Appendix G.

4.3 Road Receptors

4.3.1 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 120kmph. 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 80kmph or 120kmph. 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 80kmph. 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

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

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 a potential view of the panels.

4.3.2 Identified Road Receptors

Six roads have been identified nearby proposed development and taken forward for the modelling:

- R409 (circa 3.0km) – yellow line receptor 1 to 25;
- L2030 Newhall (circa 1.7km) – light green line receptor 26 to 43;
- L2006 Osberstown (circa 2.3km) – blue line receptors 44 to 66;
- M7 (circa 2.5km) – red line receptors 67 to 91;
- R445 Millenium Park (circa 1.7km) – violet line receptors 92 to 109;
- R445 (circa 1.2km) – white line receptors 110 to 122.

Figure 4 on the following page shows the road receptors modelled. The receptors are placed approximately 100m apart along these roads. A height of 1.5 metres above ground level has been taken as the typical eye-level of a road user[10].

[10] This height is used for modelling purposes. Small changes to this height are not significant, and views for elevated drivers are also considered where appropriate

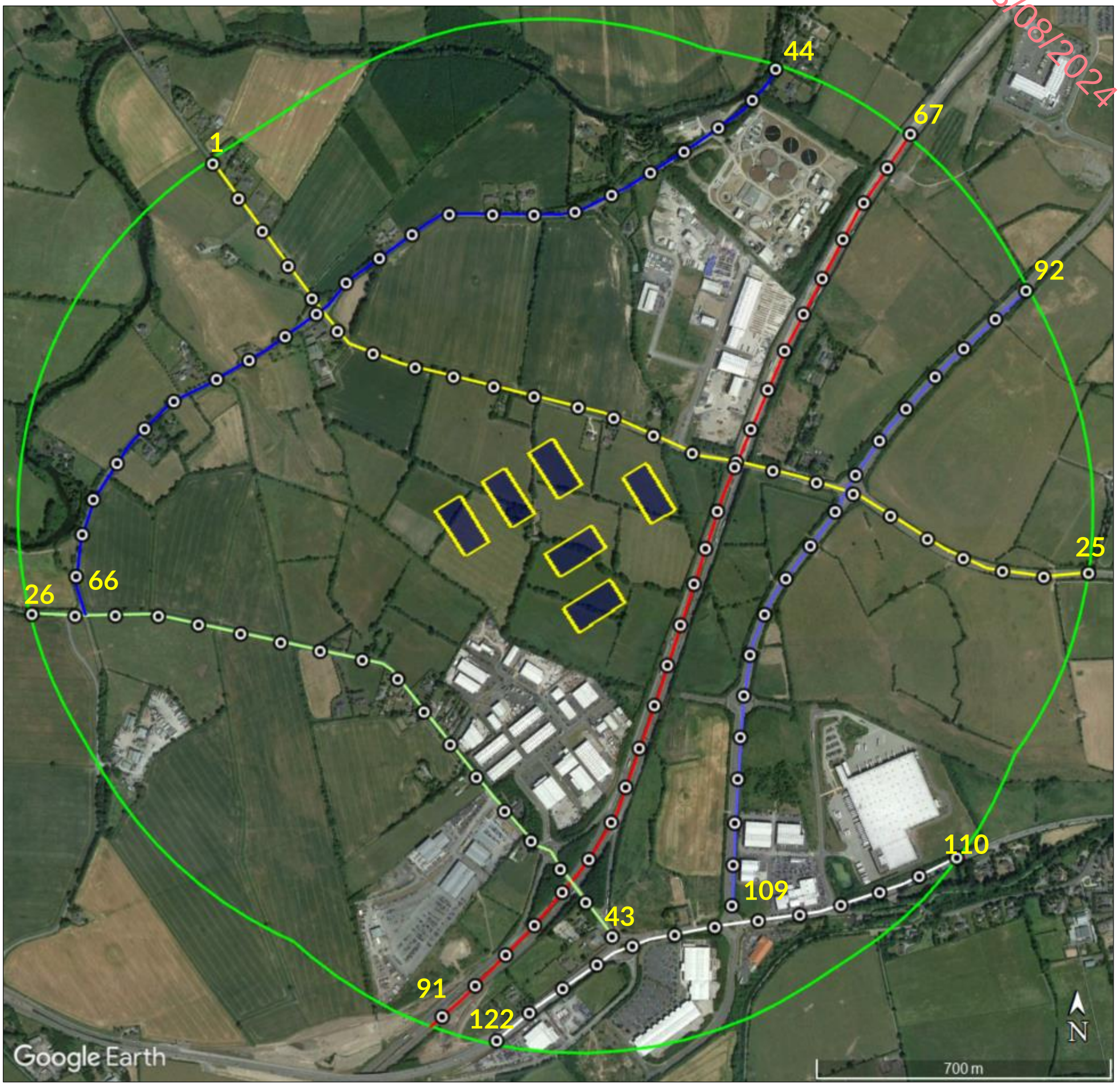

Figure 4 – Assessed road receptors

4.4 Dwelling Receptors

4.4.1 Overview

The analysis has considered dwellings that:

- Are within the one-kilometre assessment area;
- 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.

4.4.2 Identified Dwelling Receptors

The assessed dwelling receptors are shown in Figure 5 below. In total, 42 dwelling receptors have been assessed. A 1.8m height above ground level is used in the modelling to simulate the typical viewing height of an observer on the ground floor[11]. Three dwellings are located in the proximity of dwelling 1. These dwellings are located within the proposed development boundary and will be demolished. Therefore, these are not taken forward for the modelling.

Figure 5 – Assessed dwelling receptors 1 to 42

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

5 ASSESSED REFLECTOR AREAS AND SOLAR PANEL DETAILS

5.1 Reflector Area

A resolution of 5m has been chosen for this assessment. This means that a geometric calculation is undertaken for each identified receptor from a point every 5m from within the defined areas. This resolution is sufficiently high to maximise the accuracy of the results, increasing the resolution further would not significantly change the modelling output. The number of modelled reflector points is determined by the size of the reflector area and the assessment resolution. The bounding co-ordinates for the proposed solar development have been extrapolated from the site plans. The data can be found in Appendix G.

The assessed reflector areas are shown in Figure 6 below.

Figure 6 – Assessed reflector areas

6 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

6.1 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 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.

6.1 Geometric Calculation Results Overview – Roads

6.1.1 R409

The results of the geometric calculations for road users travelling along the assessed stretch of R409 are presented in Table 2 below. Discussed in Section 6.3.2 on page 40.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
1 – 12	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.
13	None.	Between 17:07 and 17:09 during early February. Between 16:36 and 16:39 during the beginning of November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
14	None.	Between 17:06 and 17:50 from early February to early April. Between 16:36 and 17:43 from early September to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
15	None.	Between 17:13 and 17:58 from mid- February to late April. Between 16:43 and 18:04 from mid- August to late October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
16	None.	Between 17:13 and 17:14 during mid- February. Between 17:20 and 17:56 from the beginning of March to the beginning of May. Between 16:54 and 18:05 from mid- August to mid- October. Between 16:42 and 16:44 during the end of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
17	None.	Between 17:10 and 17:57 from mid- February to early May. Between 16:39 and 18:06 from early August to the beginning of November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
18	None.	Between 17:05 and 17:11 during early February. Between 17:20 and 17:56 from the end of February to early May. Between 16:34 and 18:07 from the beginning of August to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
19	None.	Between 17:09 and 17:59 from mid- February to mid- May. Between 16:38 and 18:08 from the end of July to the beginning of November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
20	None.	Between 17:17 and 18:05 from late February to late May. Between 16:50 and 18:15 from mid- July to mid- October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
21	None.	Between 17:24 and 18:11 from mid- March to early June. Between 17:04 and 18:19 from early July to the beginning of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
22	None.	Between 17:13 and 18:18 from late March to late September.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
23	None.	Between 17:19 and 18:17 from late March to mid-September.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
24	None.	Between 17:23 and 18:16 from the end of March to mid-September.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
25	None.	Between 17:31 and 18:06 from the end of March to the beginning of June. Between 17:23 and 18:14 from early July to mid- September.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
26 – 31	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Table 2 – Geometric analysis results for R409

6.1.2 L2030 Newhall

The results of the geometric calculations for road users travelling along the assessed stretch of L2030 Newhall are presented in Table 3 on the following page. Discussed in Section 6.3.3 on page 40.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
26 – 31	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
32	Between 04:19 and 04:26 from early June to early July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
33	Between 04:19 and 04:26 from early June to early July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
34	Between 04:19 and 04:22 from mid- June to the end of June.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
35	Between 04:19 and 04:38 from late May to mid- July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
36 – 43	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Table 3 – Geometric analysis results for L2030 Newhall

6.1.3 L2006 Osberstown

The results of the geometric calculations for road users travelling along the assessed stretch of L2006 Osberstown are presented in Table 4 below. Discussed in Section 6.3.4 on page 41.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
44 – 66	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Table 4 – Geometric analysis results for L2006 Osberstown

6.1.4 M7

The results of the geometric calculations for road users travelling along the assessed stretch of M7 are presented in Table 5 below. Discussed in Section 6.3.5 on page 41.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
67 – 71	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
72	None.	Between 17:03 and 17:11 during early February. Between 16:33 and 16:41 during early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
73	None.	Between 17:03 and 17:20 from the beginning of February to late February. Between 16:33 and 16:53 from mid-October to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
74	None.	Between 17:04 and 17:30 from the beginning of February to mid- March. Between 16:34 and 17:12 from the end of September to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
75	None.	Between 17:13 and 17:42 from mid- February to early April. Between 16:42 and 17:37 from early September to late October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
76	None.	Between 17:13 and 17:59 from mid- February to early May. Between 16:42 and 18:09 from early August to the end of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
77	None.	Between 16:48 and 18:43 from mid- February to late October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
78	None.	Between 17:15 and 17:29 from mid- February to the beginning of March. Between 17:16 and 18:19 from late March to late September. Between 16:45 and 17:03 from mid- October to the end of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
79	None.	Between 16:53 and 18:26 from late February to late October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
80	None.	Between 17:43 and 18:34 from early April to early September.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
81 – 91	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Table 5 – Geometric analysis results for M7

6.1.5 R445 Millenium Park

The results of the geometric calculations for road users travelling along the assessed stretch of R445 Millenium Park are presented in Table 6 below. Discussed in Section 6.3.6 on page 41.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
92	None.	Between 17:01 and 17:22 from the beginning of February to early March. Between 16:31 and 16:58 from early October to mid- November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
93	None.	Between 17:01 and 17:25 from the beginning of February to mid- March. Between 16:32 and 17:04 from the beginning of October to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
94	None.	Between 17:02 and 17:28 from the beginning of February to mid- March. Between 16:32 and 17:11 from late September to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
95	None.	Between 17:05 and 17:31 from early February to late March. Between 16:35 and 17:19 from mid- September to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
96	None.	Between 17:09 and 17:37 from mid- February to the beginning of April. Between 16:39 and 17:28 from mid-September to the end of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
97	None.	Between 17:03 and 17:43 from the beginning of February to mid- April. Between 16:33 and 17:44 from late August to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
98	None.	Between 17:04 and 17:52 from early February to the beginning of May. Between 16:34 and 18:01 from mid-August to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
99	None.	Between 17:10 and 18:11 from mid- February to the beginning of June. Between 16:40 and 18:20 from mid-July to the end of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
100	None.	Between 16:50 and 18:25 from late February to mid-October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
101	None.	Between 17:05 and 18:18 from mid- March to the beginning of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
102	None.	Between 17:29 and 18:19 from the end of March to mid-September.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
103	None.	Between 17:58 and 18:22 from early May to mid-August.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
104 – 109	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Table 6 – Geometric analysis results for R445 Millenium Park

6.1.6 R445

The results of the geometric calculations for road users travelling along the assessed stretch of R445 are presented in Table 7 below. Discussed in Section 6.3.7 on page 42.

Receptor	Predicted reflection times towards road users (GMT)		Comment
	am	pm	
110 – 122	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Table 7 – Geometric analysis results for R445

6.2 Geometric Calculation Results Overview – Dwellings

The results of the geometric calculations for observers located within the identified dwelling are presented in Table 8 below. Discussed in Section 6.4 on page 42.

Receptor	Predicted reflection times towards dwelling receptors (GMT)		Comment
	am	pm	
1	None.	Between 17:05 and 17:36 from early February to mid- March. Between 16:35 and 17:13 from the beginning of October to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
2	None.	Between 17:12 and 17:54 from mid-February to the beginning of May. Between 16:41 and 18:02 from mid-August to the end of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
3	None.	Between 17:13 and 17:50 from mid-February to late April. Between 16:41 and 17:56 from mid- August to the end of October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards dwelling receptors (GMT)		Comment
	am	pm	
4	None.	Between 17:13 and 17:49 from mid- February to late April. Between 16:44 and 17:55 from mid- August to late October.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
5	None.	Between 17:07 and 17:39 from early February to early April. Between 16:36 and 17:33 from early September to early November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
6	None.	Between 17:07 and 17:29 from mid- February to mid- March. Between 16:36 and 17:12 from the end of September to the beginning of November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
7	None.	Between 17:06 and 17:28 from early February to mid- March. Between 16:36 and 17:07 from the beginning of October to the beginning of November.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards dwelling receptors (GMT)		Comment
	am	pm	
8	None.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
9	Between 04:19 and 04:24 from mid- June to the beginning of July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
10	Between 04:21 and 04:37 from the end of May to mid-July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
11	Between 04:20 and 04:30 from the beginning of June to mid- July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
12	None.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards dwelling receptors (GMT)		Comment
	am	pm	
13	None.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
14	Between 04:27 and 04:40 from late May to late July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
15	Between 04:20 and 04:38 from late May to late July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
16	Between 04:19 and 04:38 from late May to late July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
17	Between 04:20 and 04:39 from late May to late July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.

Receptor	Predicted reflection times towards dwelling receptors (GMT)		Comment
	am	pm	
18	Between 04:27 and 04:34 from early June to early July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
19	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.
20	At circa 04:21 during early June. At circa 04:27 during early July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
21	Between 04:21 and 04:31 from the end of May to mid-July.	None.	Solar reflections are geometrically possible. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted, and no mitigation is required.
22 – 42	None.	None.	Solar reflections are not geometrically possible. Therefore, no impact is predicted, and no mitigation is required.

Table 8 – Geometric analysis results for dwellings receptors

6.3 Geometric Assessment Results – Road Receptors

6.3.1 Overview

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

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

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

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

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

- Whether the solar reflection originates from directly in front of a road user – a solar reflection that is directly in front of a road user is more hazardous than a solar reflection to one side;
- Whether visibility is likely for elevated drivers (relevant to dual carriageways and motorways[12]);
- The separation distance to the panel area – larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- Whether a solar reflection is fleeting in nature – a momentary reflection is less significant than a sustained source of glare;
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not, as the Sun is a far more significant source of light.

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

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

6.3.2 Geometric Results and Discussion – R409

The results of the modelling indicate that solar reflections are geometrically possible towards 13 of the 25 assessed road receptors equivalent to 1.2km section of R409. The section of road where solar reflections are geometrically possible is shown by the orange lines in Figure 7 below. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

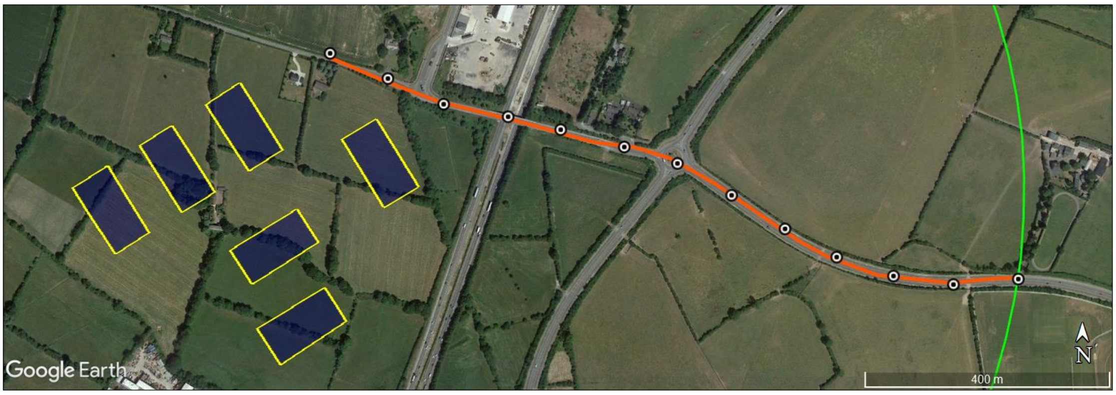

Figure 7 – Section of R409 where solar reflections are geometrically possible and relevant screening

6.3.3 Geometric Results and Discussion – L2030 Newhall

The results of the modelling indicate that solar reflections are geometrically possible towards four of the 14 assessed road receptors equivalent to 0.3km section of L2030 Newhall. The section of road where solar reflections are geometrically possible is shown by the orange lines in Figure 8 below. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

Figure 8 – Section of L2030 Newhall where solar reflections are geometrically possible and relevant screening

6.3.4 Geometric Results and Discussion – L2030 Newhall

The results of the modelling indicate that solar reflections are not geometrically possible towards any of the 23 assessed road receptors equivalent associated with L2030 Newhall. Therefore, no impact is predicted and no mitigation is required.

6.3.5 Geometric Results and Discussion – M7

The results of the modelling indicate that solar reflections are geometrically possible towards nine of the 24 assessed road receptors equivalent to 0.8km section of M7. The section of road where solar reflections are geometrically possible is shown by the orange lines in Figure 9 below. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

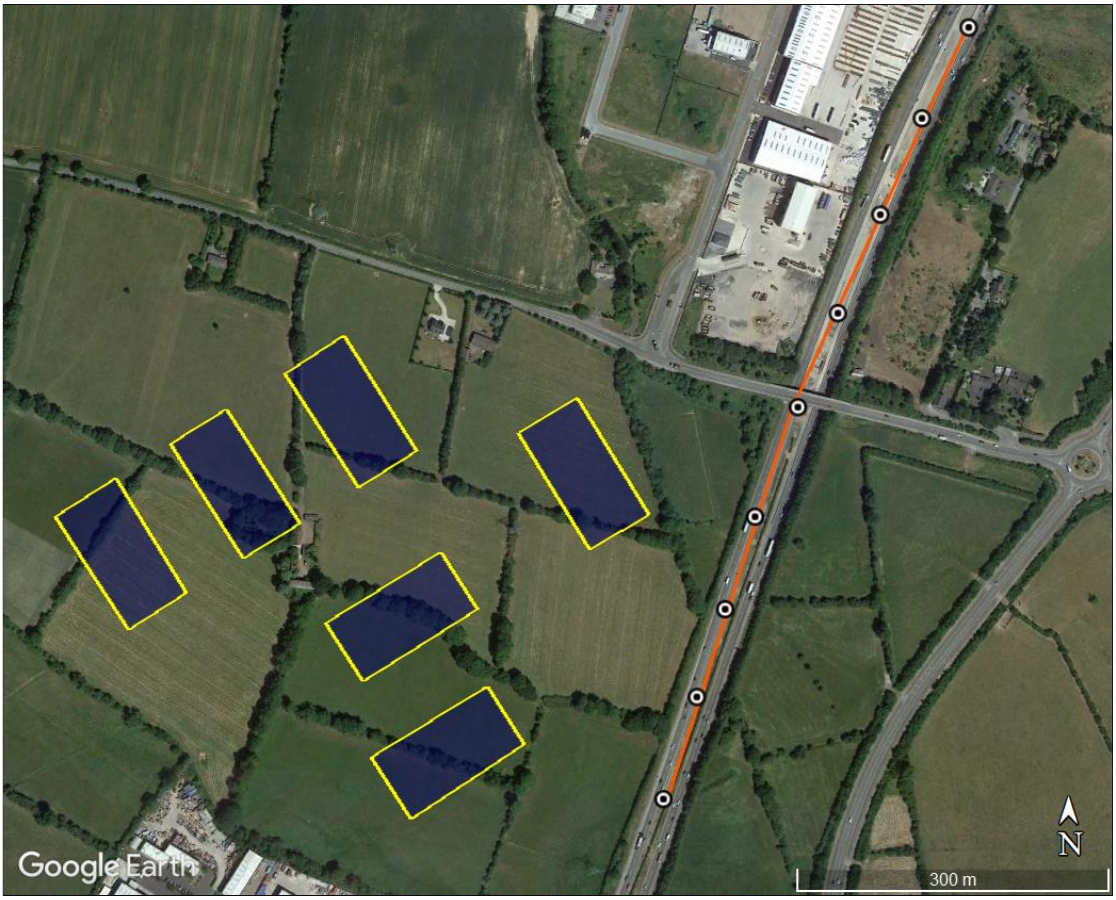

Figure 9 – Section of M7 where solar reflections are geometrically possible and relevant screening

6.3.6 Geometric Results and Discussion – R445 Millenium Park

The results of the modelling indicate that solar reflections are geometrically possible towards 12 of the 18 assessed road receptors equivalent to 1.1km section of R445 Millenium Park. The section of road where solar reflections are geometrically possible is shown by the orange lines in Figure 10 on the following page. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

Figure 10 – Section of R445 Millenium Park where solar reflections are geometrically possible and relevant screening

6.3.7 Geometric Results and Discussion – R445

The results of the modelling indicate that solar reflections are not geometrically possible towards any of the 13 assessed road receptors equivalent associated with R445. Therefore, no impact is predicted and no mitigation is required.

6.4 Geometric Assessment Results – Dwelling Receptors

6.4.1 Overview

The key considerations for residential dwellings are:

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

Where 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 relevant 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 relevant 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.

6.4.2 Geometric Results and Discussion

The results of the modelling indicate that solar reflections are geometrically possible towards 17 of the 42 assessed dwellings (see Figure 11 below). However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

Figure 11 – Dwellings where solar reflections are predicted to be geometrically possible

7 HIGH-LEVEL AVIATION ASSESSMENTS

7.1 Overview

Glint and glare assessment for aviation receptors are typically undertaken for licensed aerodromes within 10km of a proposed solar development. Geometric modelling for general aviation unlicensed aerodromes is typically required within 5km of a proposed development. At ranges of 10-20km, the requirement for assessment is much less common for licensed aerodromes, with typically assessment only being undertaken for licensed aerodromes at these ranges. Assessment of any aviation effects for developments over 20km is not a usual requirement. The following sections present high-level assessments and conclusions of aviation concerns for Allenwood Airfield, Millicent Airfield, and Gowran Grange Airfield.

7.2 High-Level Assessment

Allenwood Airfield is an unlicensed airfield approximately 10.4km northwest of the proposed development with one runway (06/24), and not understood to have an ATC Tower. Millicent Airfield is an unlicensed airfield approximately 6.2km north-east of the proposed development with two runways (06/24 and 15/33), and not understood to have an ATC Tower. Gowran Grange Airfield is an unlicensed airfield approximately 6.2km south-east of the proposed development with one runway (01/19), and not understood to have an ATC Tower. The location of the airfields and their 1-mile splayed approach paths for each runway threshold relative to the proposed development is shown in Figure 12 below.

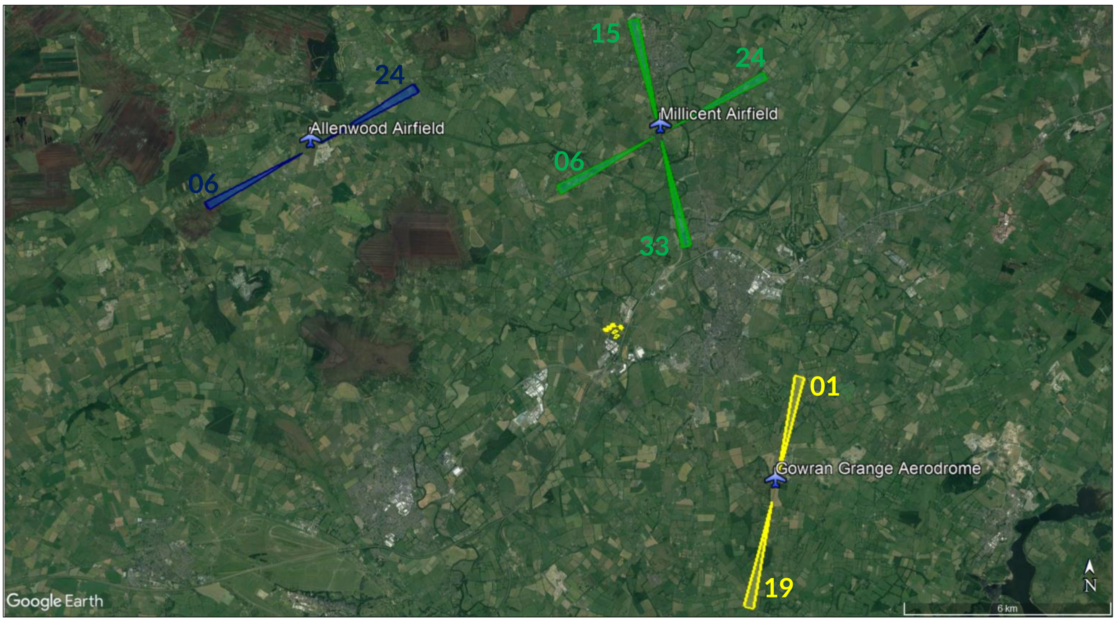

Figure 12 – Identified airfields and their position relative to proposed development

The following can be concluded with regards to the proposed development:

- Allenwood Airfield: solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 06 and 24 are unlikely to be geometrically possible due to the location of the airfield relative to the proposed development (north). If solar reflections will be geometrically possible:
  - They will be outside a pilot's primary field-of-view (50-degrees either side relative to the runway bearing) for pilots using the 1-mile splayed approach path for runway threshold 24; and
  - Will have glare intensities no greater than 'low potential for temporary after-image' for pilots using the 1-mile splayed approach path for runway threshold 06 due to the large separation distance from the airfield.

  Therefore, even in the event of solar reflections being geometrically possible, the potential impact and glare intensities are considered to be acceptable considering the associated guidance (Appendix D) and industry best practices;
- Millicent Airfield: solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 06/24 and 15/33 are unlikely to be geometrically possible due to the location of the airfield relative to the proposed development (north). If solar reflections will be geometrically possible:
  - They will be outside a pilot's field-of-view for pilots using the 1-mile splayed approach path for runway threshold 06 and 33; and
  - Will have glare intensities no greater than 'low potential for temporary after-image' for pilots using the 1-mile splayed approach path for runway threshold 15 and 24 due to the large separation distance from the airfield.

  Therefore, even in the event of solar reflections being geometrically possible, the potential impact and glare intensities are considered to be acceptable considering the associated guidance (Appendix D) and industry best practices.
- Gowran Grange Airfield: solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 01/19 are likely to be geometrically possible. However:
  - They will be outside a pilot's field-of-view for pilots using the 1-mile splayed approach path for runway threshold 19; and
  - Will have glare intensities no greater than 'low potential for temporary after-image' for pilots using the 1-mile splayed approach path for runway threshold 01 due to the large separation distance from the airfield.

  Therefore, even in the event of solar reflections being geometrically possible, the potential impact and glare intensities are considered to be acceptable considering the associated guidance (Appendix D) and industry best practices.

7.2.1 Conclusions

Therefore, even in the event of solar reflections being geometrically possible, considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, the glare intensity is considered acceptable, and detailed modelling is not recommended Therefore, no significant impacts upon aviation activity associated with Allenwood Airfield, Millicent Airfield, and Gowran Grange Airfield are predicted, and detailed modelling for these airfields is not recommended.

8 OVERALL CONCLUSIONS

8.1 Assessment Results – Road Users

8.1.1 R409

The results of the modelling indicate that solar reflections are geometrically possible towards 13 of the 25 assessed road receptors equivalent to 1.2km section of R409. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

8.1.2 L2030 Newhall

The results of the modelling indicate that solar reflections are geometrically possible towards four of the 14 assessed road receptors equivalent to 0.3km section of L2030 Newhall. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

8.1.3 L2030 Newhall

The results of the modelling indicate that solar reflections are not geometrically possible towards any of the 23 assessed road receptors equivalent associated with L2030 Newhall. Therefore, no impact is predicted and no mitigation is required.

8.1.4 M7

The results of the modelling indicate that solar reflections are geometrically possible towards nine of the 24 assessed road receptors equivalent to 0.8km section of M7. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

8.1.5 R445 Millenium Park

The results of the modelling indicate that solar reflections are geometrically possible towards 12 of the 18 assessed road receptors equivalent to 1.1km section of R445 Millenium Park. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

8.1.6 R445

The results of the modelling indicate that solar reflections are not geometrically possible towards any of the 13 assessed road receptors equivalent associated with R445. Therefore, no impact is predicted and no mitigation is required.

8.2 Assessment Results – Dwelling

The results of the modelling indicate that solar reflections are geometrically possible towards 17 of the 42 assessed dwellings. However, the roof parapet is predicted to screen the visibility of the panel area. Therefore, no impact is predicted and no mitigation is required.

8.3 High-Level Assessment Results – Airfields

No significant impacts upon aviation activity associated with Allenwood Airfield, Millicent Airfield, and Gowran Grange Airfield are predicted, and detailed modelling for these airfields is not recommended.

APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

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

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

Pager Power is not aware of any glint and glare guidance for projects in Ireland. Therefore, the UK and USA guidelines (see below) were used for this report.

UK Planning Policy

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[13] (specifically regarding the consideration of solar farms, paragraph 013) states:

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

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

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

…

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

…

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

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

Draft National Policy Statement for Renewable Energy Infrastructure

The Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)[14] sets out the primary policy for decisions by the Secretary of State for nationally significant renewable energy infrastructure. Sections 3.10.93-97 state:

'3.10.93 Solar panels are specifically designed to absorb, not reflect, irradiation.[15] 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.

3.10.94 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.

3.10.95 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.

3.10.96 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.

3.10.97 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 3.10.125-127 state:

3.10.125 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.

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

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

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[14] Draft National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Energy Security & Net Zero, date: March 2023, accessed on: 05/04/2023.

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

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

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

Sections 3.10.149-150 state:

3.10.149 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).

3.10.150 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 latest version of the draft EN-3 goes some way in referencing that the issue is more complex than presented in the previous issue; 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 impact upon aviation safety. It is possible that the final issue of the policy will change in light of further consultation responses from aviation stakeholders.

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

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

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

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[16] however the advice is still applicable[17] 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[18], as part of a condition of a CAA Aerodrome Licence, the ALH is required to obtain prior consent from CAA Aerodrome Standards Department before any work is begun or approval to the developer or LPA is granted, in accordance with the procedures set out in CAP 791 Procedures for Changes to Aerodrome Infrastructure.

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

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[16] Archived at Pager Power

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

[18] Aerodrome Licence Holder.

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

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

FAA Guidance

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

The 2010 document is entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports'*[19], the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports'*[20], and the 2021 final policy is entitled '*Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports'*[21].

Key excerpts from the final policy are presented below:

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

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

FAA encourages airport sponsors of federally-obligated towered airports to conduct a sufficient analysis to support their assertion that a proposed solar energy system will not result in ocular impacts. There are several tools available on the open market to airport sponsors that can analyze potential

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[19] Archived at Pager Power

[20] 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.

[21] 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.

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*'[22]. 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*[23].
- *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*[24]*, flat, smooth surfaces reflect a more concentrated amount of sunlight back to the receiver, which is referred to as specular reflection. The more a surface is polished, the more it shines. Rough or uneven surfaces reflect light in a diffused or scattered manner and, therefore, the light will not be received as bright.*
- *Because the FAA has no specific standards for airport solar facilities and potential glare, the type of glare analysis may vary. Depending on site specifics (e.g., existing land uses, location and size of the project) an acceptable evaluation could involve one or more of the following levels of assessment:*

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

[23] 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.

[24] First figure in Appendix B.

- *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[25] but still requires further research to definitively answer.*

[25] 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.

- ***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[26] with regard to safeguarding. Key points from the document are presented below.

Lights liable to endanger

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

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

(b) by reason of its liability to be mistaken for an aeronautical ground light is liable to endanger aircraft.

(2) If any light which appears to the CAA to be a light described in paragraph (1) is exhibited, the CAA may direct the person who is the occupier of the place where the light is exhibited or who has charge of the light, to take such steps within a reasonable time as are specified in the direction—

(a) to extinguish or screen the light; and

(b) to prevent in the future the exhibition of any other light which may similarly endanger aircraft.

(3) The direction may be served either personally or by post, or by affixing it in some conspicuous place near to the light to which it relates.

(4) In the case of a light which is or may be visible from any waters within the area of a general lighthouse authority, the power of the CAA under this article must not be exercised except with the consent of that authority.

Lights which dazzle or distract

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

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

Endangering safety of an aircraft

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

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

Endangering safety of any person or property

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

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

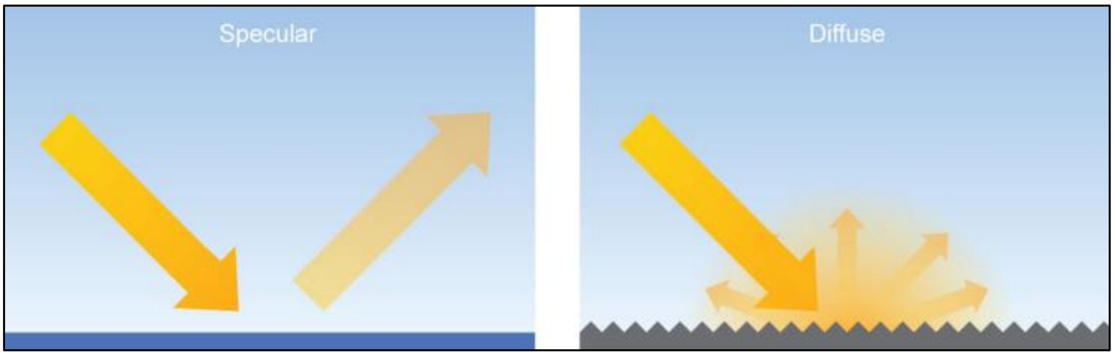
Overview

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

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

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance[27], 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

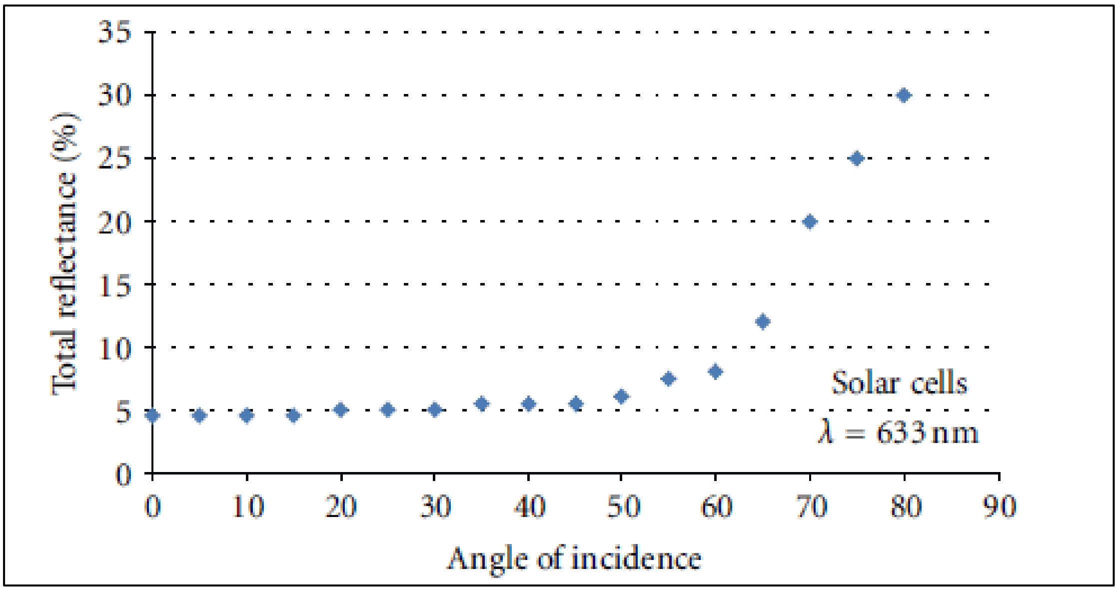
[27]Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

Solar Reflection Studies

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

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

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[28]". 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.

[28] 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"[29]

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[30]
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).

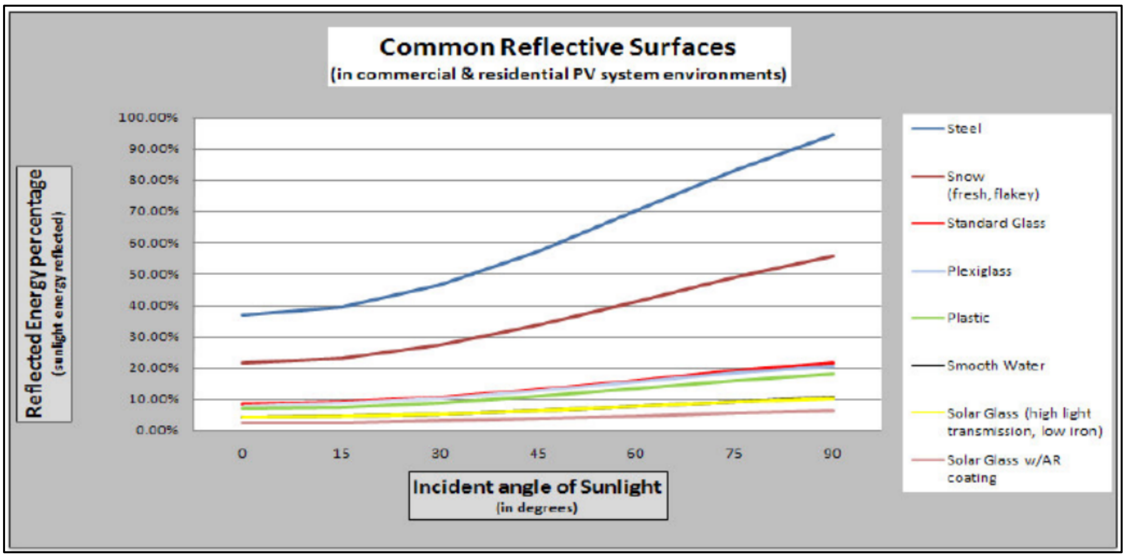
An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

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

SunPower Technical Notification (2009)

SunPower published a technical notification[31] 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.

[31] 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 22 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.

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

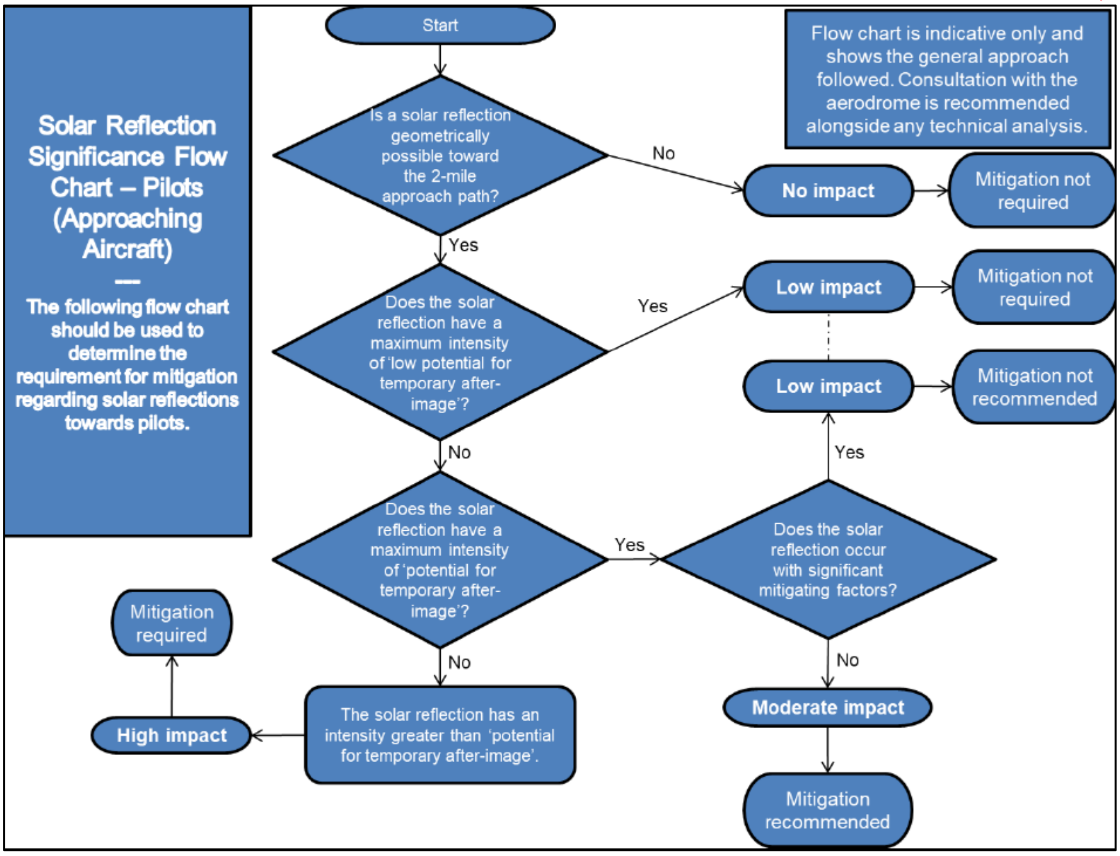
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

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.
Major	A solar reflection is geometrically possible and visible under worst-case conditions that will produce a significant impact given individual receptor criteria	

Impact significance definition

Impact Significance Determination for Approaching Aircraft

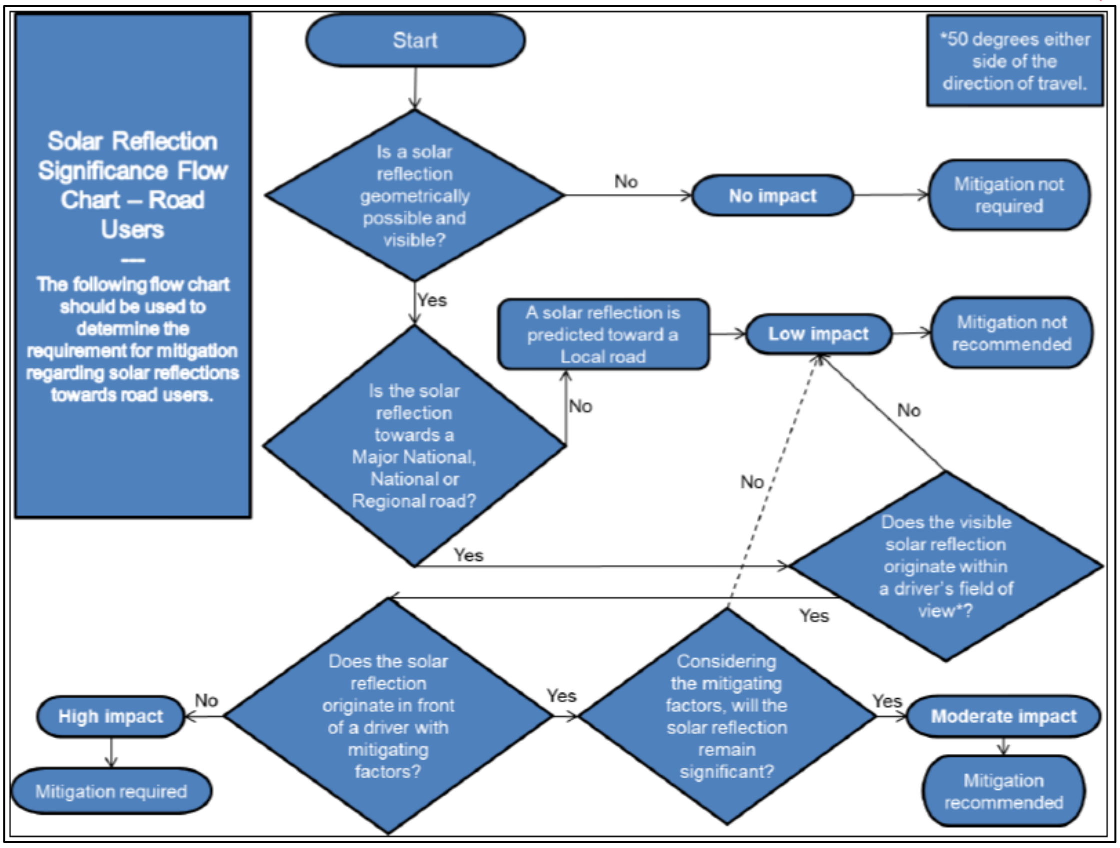
The flow chart presented below has been followed when determining the impact significance for approaching aircraft.



Approach path receptor impact significance flow chart

Impact Significance Determination for Road Receptors

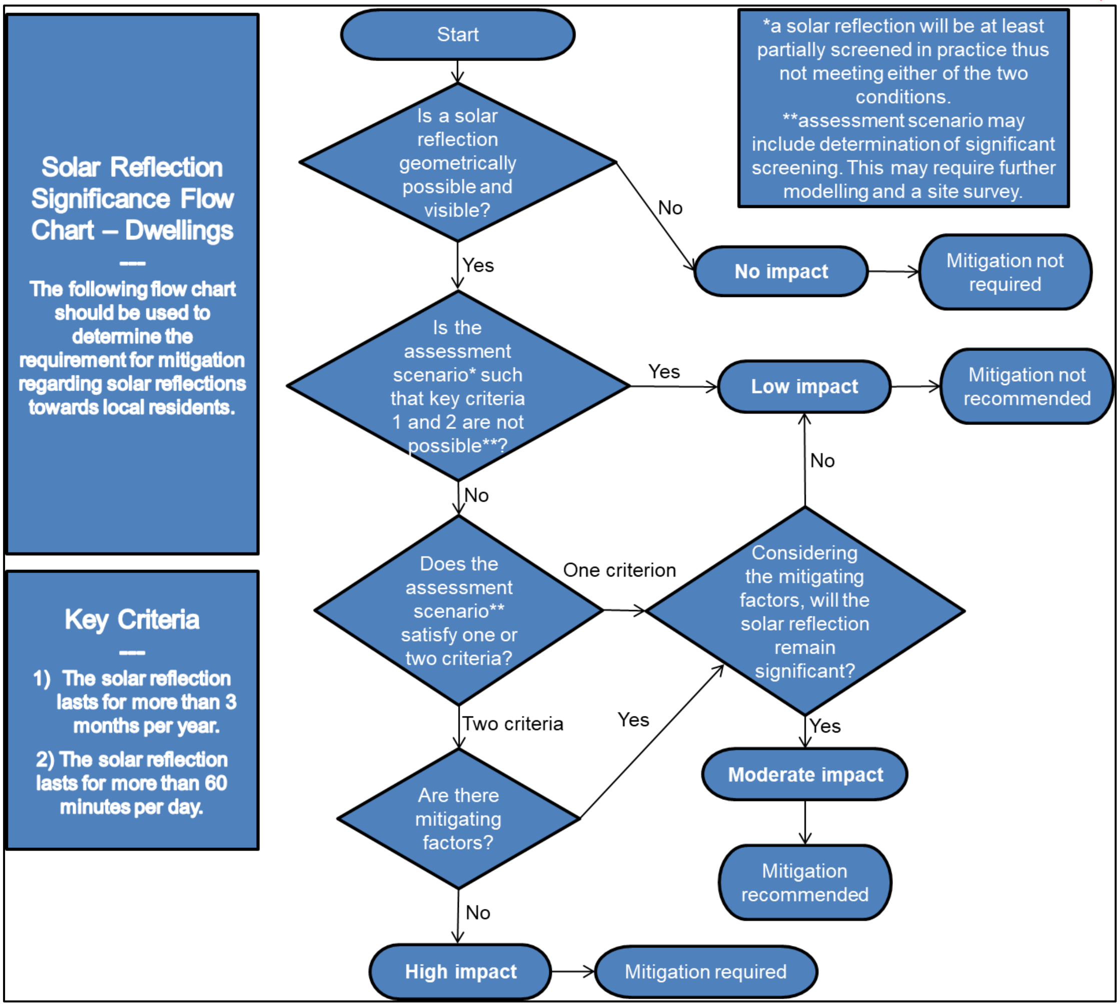
The flow chart presented below has been followed when determining the mitigation requirement for road receptors.



Road receptor mitigation requirement flow chart

Impact Significance Determination for Dwelling Receptors

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



Dwelling receptor mitigation requirement flow chart

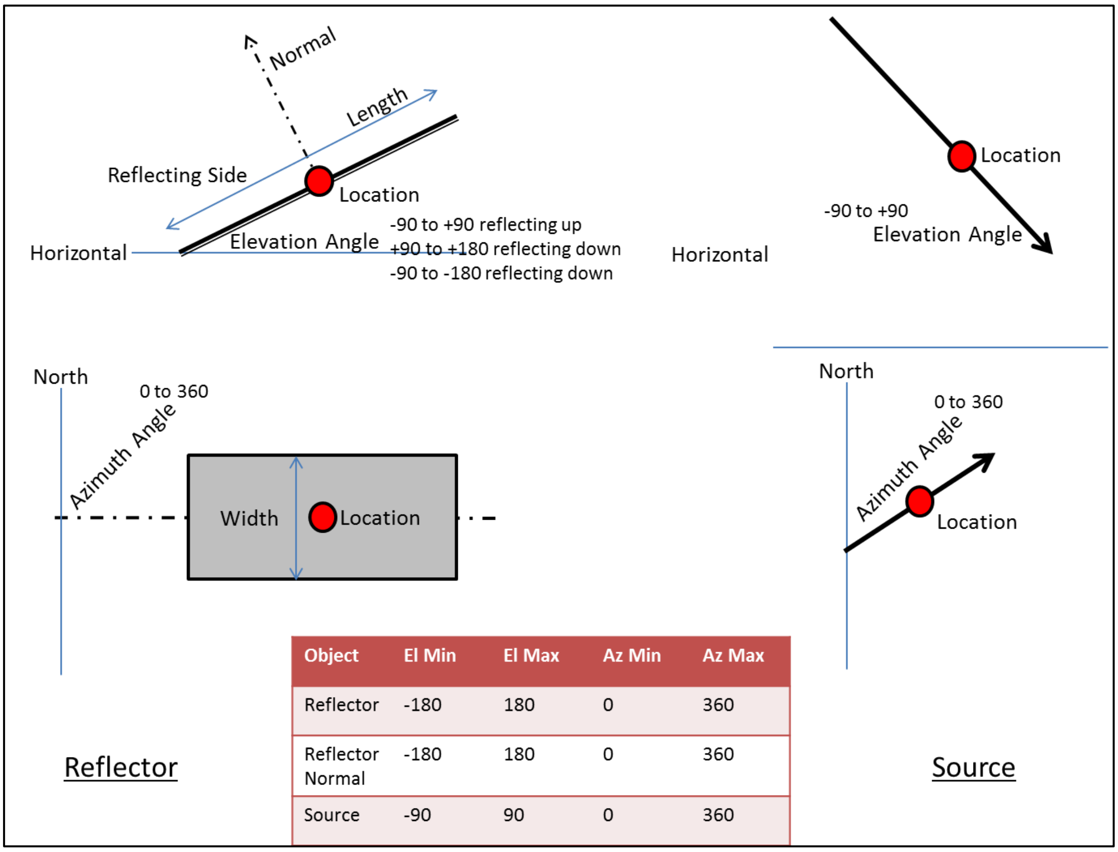
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

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)[32].

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

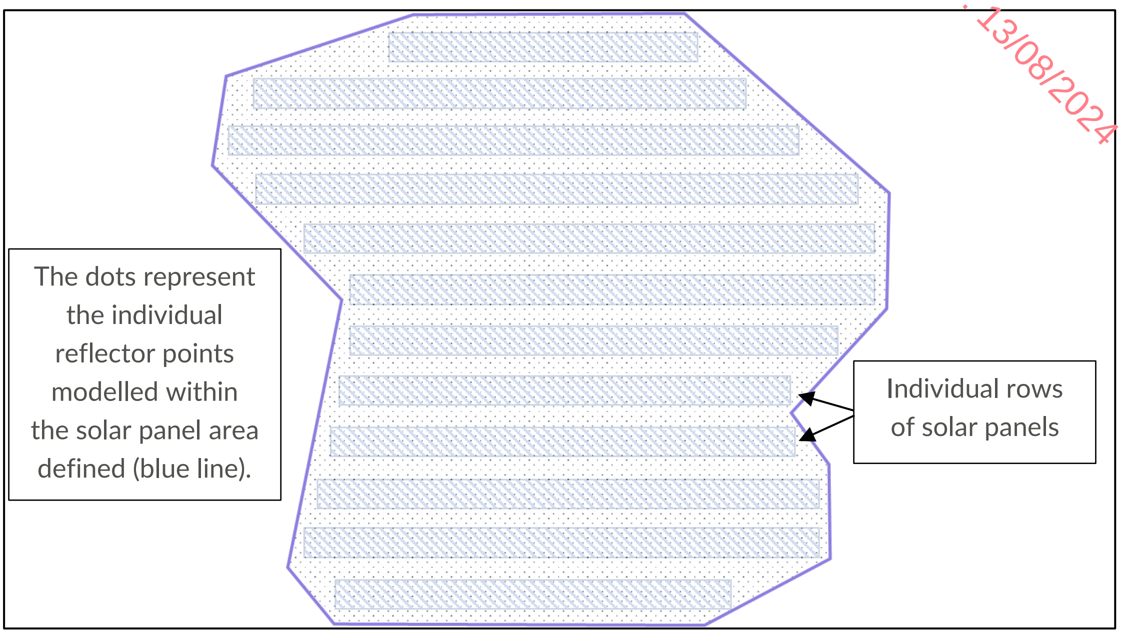
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

Only a reflection from the face of the panel has been considered. The frame or the reverse of the 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.

[32] 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

Terrain Data

Terrain elevation heights have been interpolated based on OSGB terrain data.

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 (°)
1	-6.71845	53.22800	62	-6.72089	53.22232
2	-6.71753	53.22725	63	-6.72187	53.22158
3	-6.71668	53.22656	64	-6.72272	53.22081
4	-6.71576	53.22581	65	-6.72312	53.22006
5	-6.71490	53.22511	66	-6.72334	53.21916
6	-6.71399	53.22441	67	-6.69350	53.22864
7	-6.71272	53.22393	68	-6.69433	53.22791
8	-6.71122	53.22363	69	-6.69519	53.22716
9	-6.70985	53.22343	70	-6.69593	53.22638
10	-6.70842	53.22322	71	-6.69667	53.22554
11	-6.70698	53.22301	72	-6.69734	53.22478
12	-6.70541	53.22278	73	-6.69802	53.22399
13	-6.70413	53.22255	74	-6.69861	53.22316
14	-6.70271	53.22218	75	-6.69923	53.22231
15	-6.70133	53.22180	76	-6.69981	53.22150
16	-6.69975	53.22161	77	-6.70042	53.22056

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
17	-6.69845	53.22142	78	-6.70085	53.21976
18	-6.69689	53.22117	79	-6.70127	53.21900
19	-6.69558	53.22092	80	-6.70174	53.21812
20	-6.69425	53.22045	81	-6.70221	53.21726
21	-6.69293	53.21996	82	-6.70268	53.21640
22	-6.69167	53.21955	83	-6.70321	53.21549
23	-6.69028	53.21927	84	-6.70370	53.21465
24	-6.68881	53.21915	85	-6.70422	53.21390
25	-6.68723	53.21923	86	-6.70501	53.21311
26	-6.72491	53.21835	87	-6.70597	53.21241
27	-6.72337	53.21831	88	-6.70696	53.21170
28	-6.72193	53.21832	89	-6.70799	53.21107
29	-6.72039	53.21831	90	-6.70907	53.21041
30	-6.71896	53.21813	91	-6.71026	53.20975
31	-6.71745	53.21793	92	-6.68940	53.22528
32	-6.71602	53.21775	93	-6.69049	53.22467
33	-6.71461	53.21756	94	-6.69162	53.22404
34	-6.71310	53.21737	95	-6.69265	53.22343
35	-6.71184	53.21697	96	-6.69369	53.22275
36	-6.71090	53.21627	97	-6.69464	53.22206
37	-6.70997	53.21557	98	-6.69550	53.22133
38	-6.70904	53.21487	99	-6.69622	53.22055

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
39	-6.70803	53.21415	100	-6.69711	53.21982
40	-6.70710	53.21351	101	-6.69799	53.21911
41	-6.70605	53.21291	102	-6.69875	53.21835
42	-6.70514	53.21220	103	-6.69926	53.21748
43	-6.70420	53.21146	104	-6.69947	53.21661
44	-6.69833	53.23002	105	-6.69960	53.21572
45	-6.69915	53.22936	106	-6.69971	53.21483
46	-6.70035	53.22878	107	-6.69982	53.21389
47	-6.70159	53.22826	108	-6.69988	53.21299
48	-6.70279	53.22781	109	-6.69993	53.21213
49	-6.70419	53.22733	110	-6.69192	53.21315
50	-6.70550	53.22697	111	-6.69326	53.21276
51	-6.70697	53.22690	112	-6.69467	53.21242
52	-6.70845	53.22691	113	-6.69606	53.21214
53	-6.70999	53.22692	114	-6.69752	53.21193
54	-6.71132	53.22648	115	-6.69899	53.21181
55	-6.71249	53.22598	116	-6.70054	53.21167
56	-6.71368	53.22545	117	-6.70197	53.21150
57	-6.71474	53.22478	118	-6.70348	53.21126
58	-6.71586	53.22430	119	-6.70474	53.21086
59	-6.71715	53.22379	120	-6.70596	53.21035
60	-6.71831	53.22339	121	-6.70715	53.20983

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
61	-6.71984	53.22291	122	-6.70831	53.20923

Road receptor data

Dwelling Receptor Data

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

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-6.70262	53.22263	22	-6.71109	53.21496
2	-6.69782	53.22149	23	-6.72339	53.21999
3	-6.69723	53.22166	24	-6.72073	53.22177
4	-6.69677	53.22165	25	-6.72038	53.22206
5	-6.69703	53.22248	26	-6.71990	53.22237
6	-6.69707	53.22335	27	-6.71959	53.22343
7	-6.69637	53.22359	28	-6.72098	53.22447
8	-6.71451	53.22426	29	-6.71946	53.22404
9	-6.71382	53.21772	30	-6.71726	53.22392
10	-6.71081	53.21677	31	-6.71888	53.22618
11	-6.71012	53.21636	32	-6.71792	53.22597
12	-6.70760	53.21417	33	-6.71647	53.22695
13	-6.70741	53.21318	34	-6.71246	53.22630
14	-6.71399	53.21635	35	-6.71204	53.22649
15	-6.71325	53.21641	36	-6.70862	53.22721
16	-6.71255	53.21659	37	-6.70790	53.22723
17	-6.71191	53.21650	38	-6.70715	53.22729

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
18	-6.71151	53.21632	39	-6.70362	53.22655
19	-6.71142	53.21609	40	-6.70538	53.21176
20	-6.71072	53.21625	41	-6.70576	53.21098
21	-6.71014	53.21592	42	-6.70183	53.21176

Dwelling receptor data

Modelled Reflector Data

DC1

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	-6.70946	53.21957	3	-6.70964	53.22088
2	-6.70862	53.21989	4	-6.71052	53.22054

Modelled Reflector Data – DC1

DC2

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	-6.70699	53.22049	3	-6.70886	53.22117
2	-6.70805	53.22148	4	-6.70781	53.22019

Modelled Reflector Data – DC2

DC3

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	-6.70531	53.22112	3	-6.70721	53.22178
2	-6.70636	53.22211	4	-6.70615	53.22080

Modelled Reflector Data – DC3

DC4

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	-6.70283	53.22026	3	-6.70301	53.22157
2	-6.70197	53.22057	4	-6.70386	53.22127

Modelled Reflector Data – DC4

DC5

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	-6.70608	53.21912	3	-6.70496	53.22025
2	-6.70444	53.21975	4	-6.70662	53.21963

Modelled Reflector Data – DC5

DC6

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	-6.70539	53.21793	3	-6.70429	53.21909
2	-6.70376	53.21858	4	-6.70597	53.21847

Modelled Reflector Data – DC6

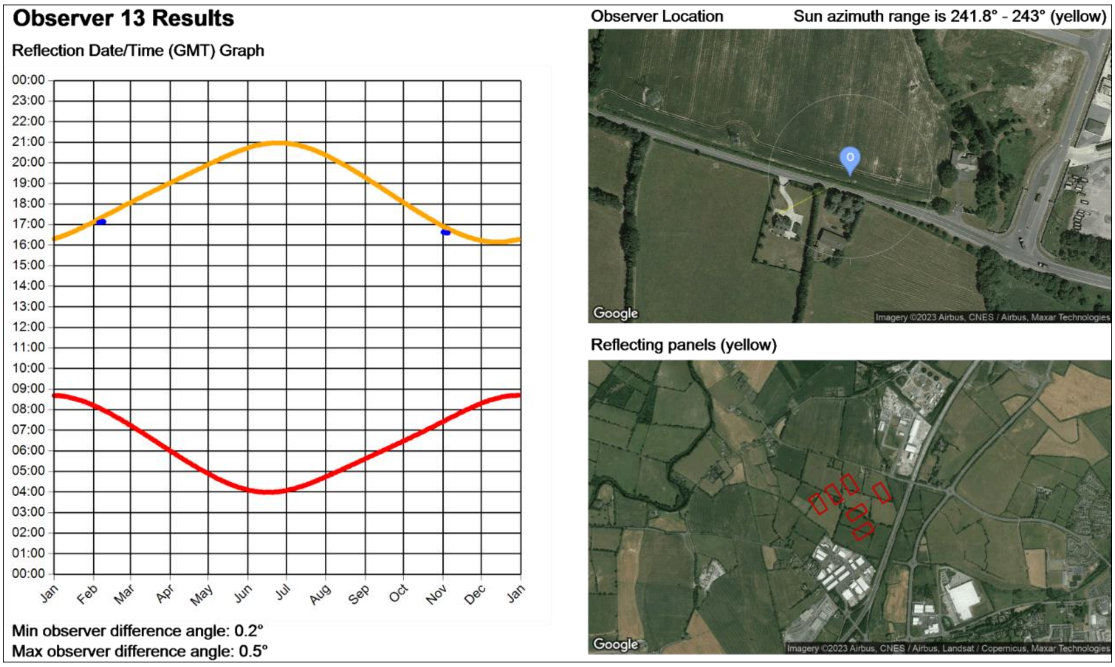
APPENDIX H – DETAILLED MODELLING RESULTS

Overview

The modelling results are shown in the figures on the following pages. The charts show:

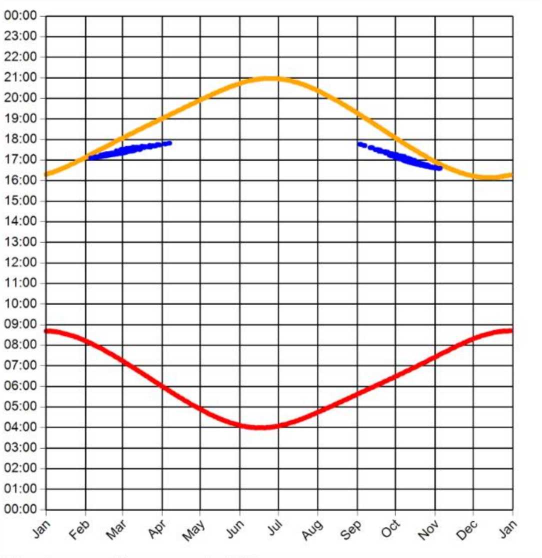
- The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible. If sunlight is experienced from the same direction as the reflecting panels, the overall impact of the reflection is reduced as discussed within the body of 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).

Road Receptors



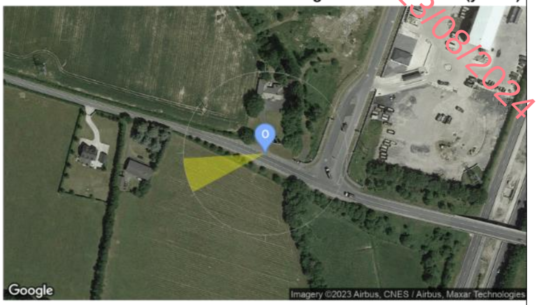
Observer 14 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.3°
Max observer difference angle: 8.4°

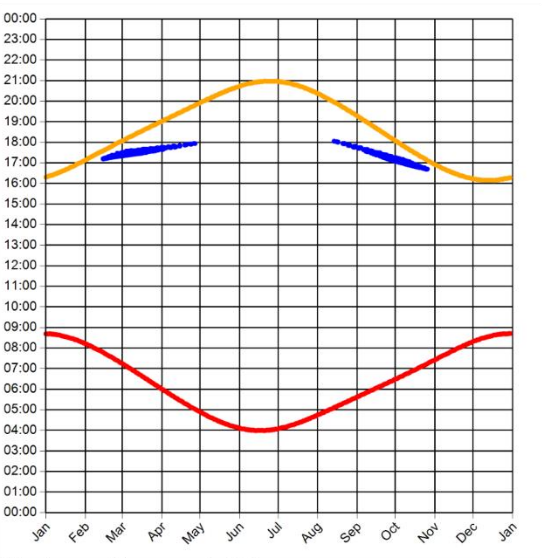
Observer Location Sun azimuth range is 241.8° - 266.5° (yellow)



Reflecting panels (yellow)

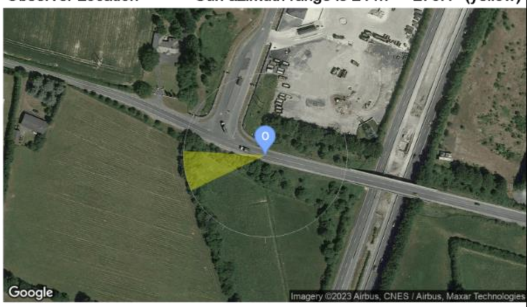
Observer 15 Results

Reflection Date/Time (GMT) Graph

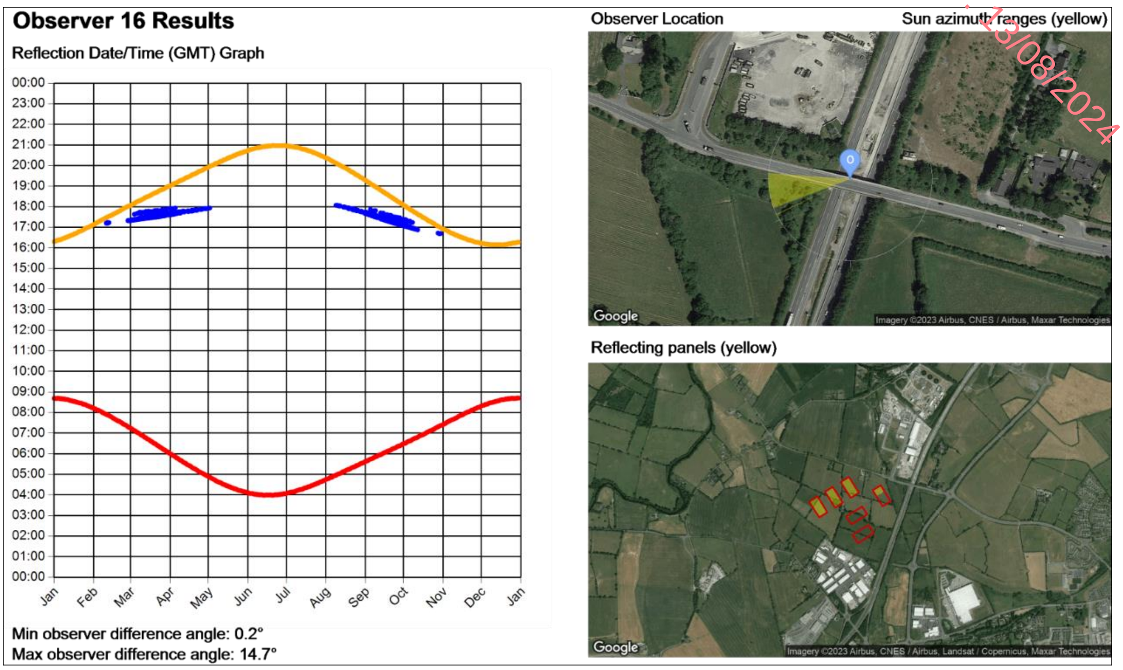


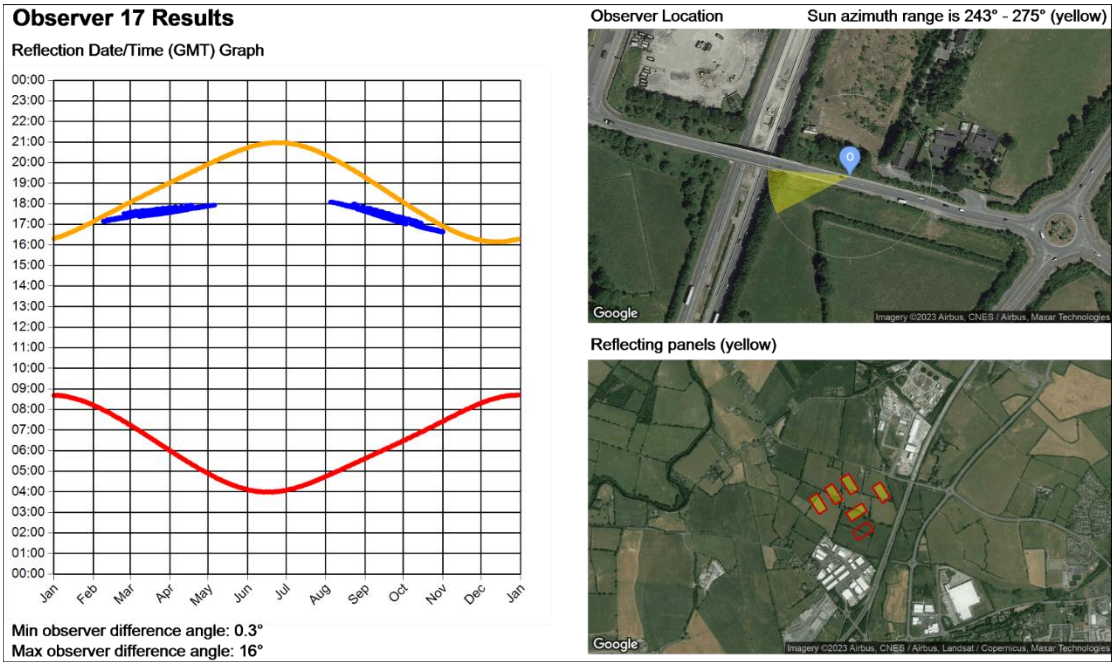
Min observer difference angle: 0.9°
Max observer difference angle: 12.9°

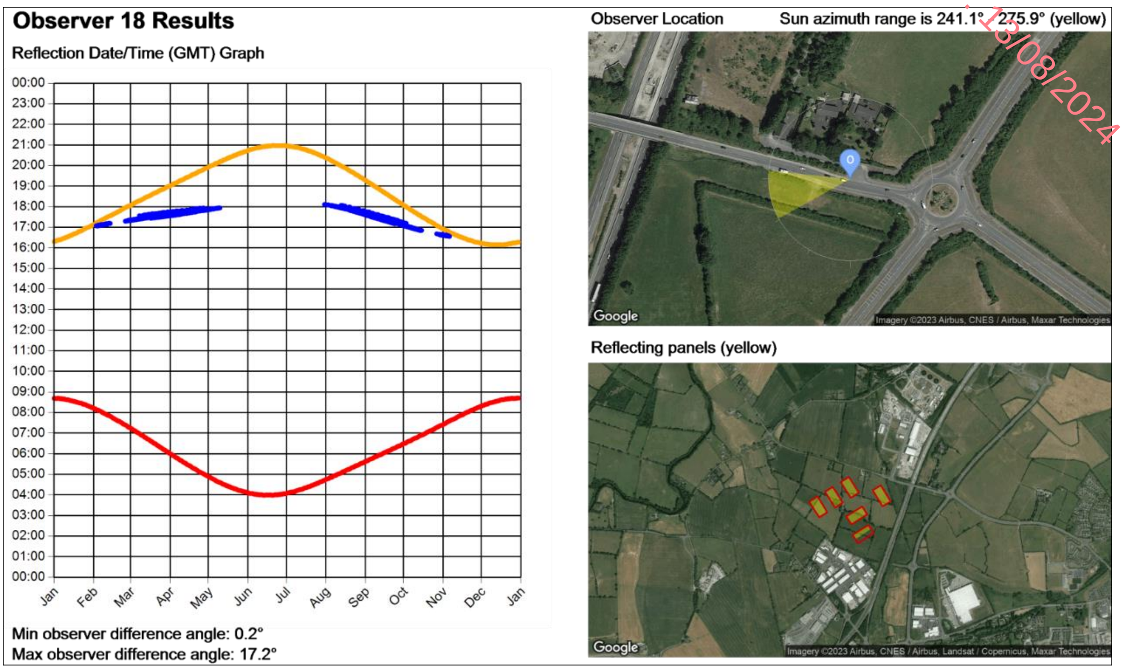
Observer Location Sun azimuth range is 244.7° - 273.1° (yellow)

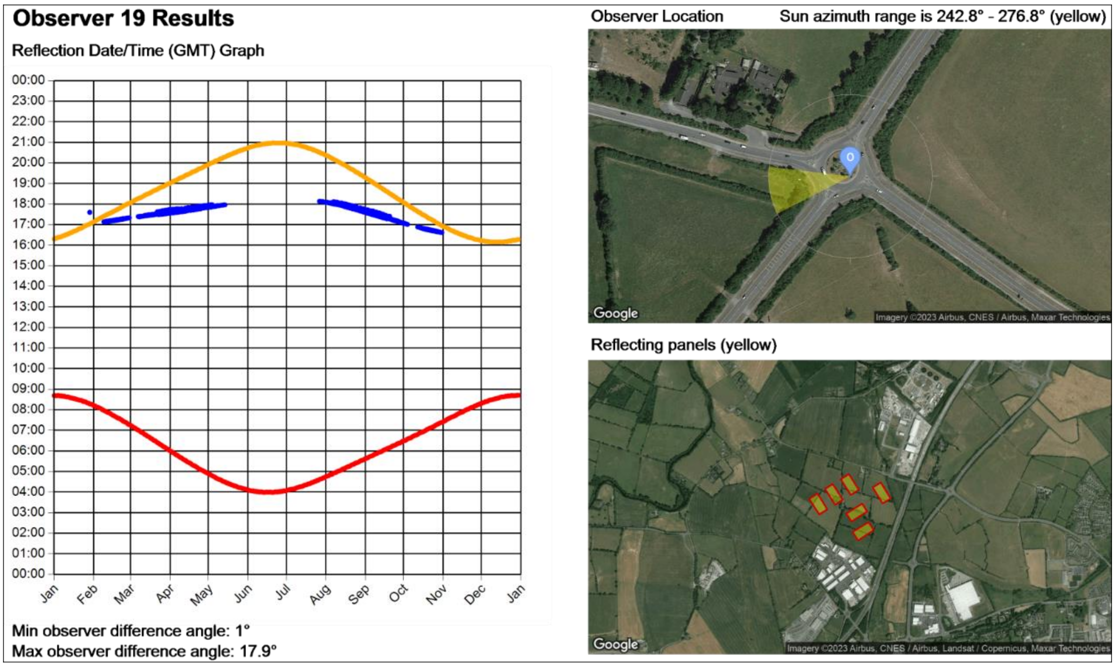


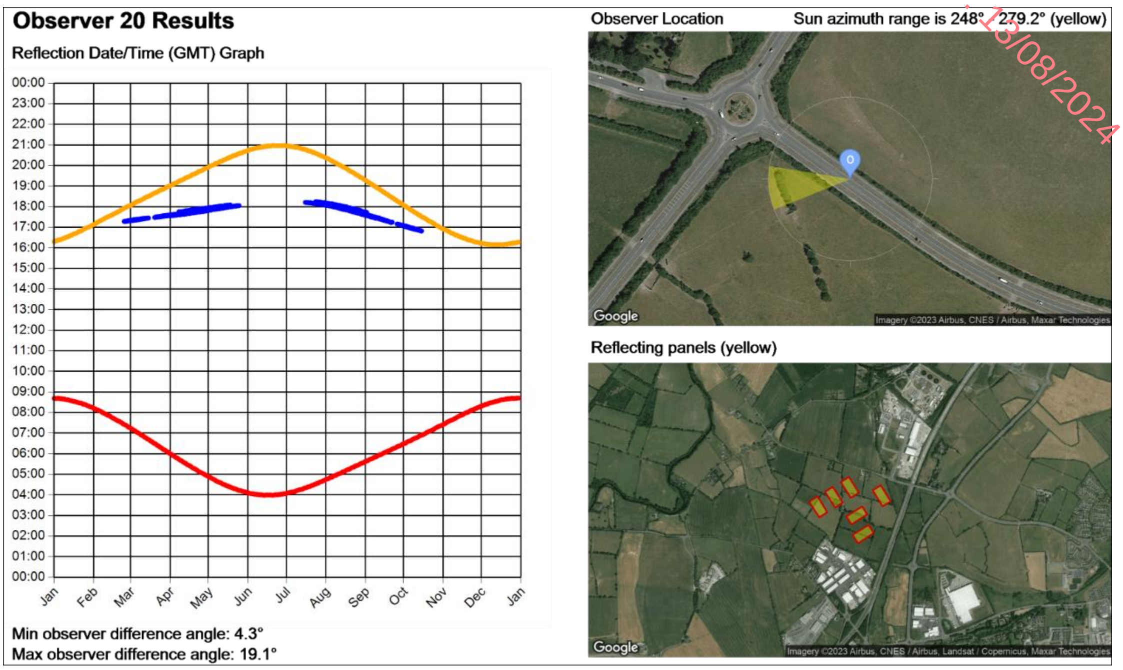
Reflecting panels (yellow)

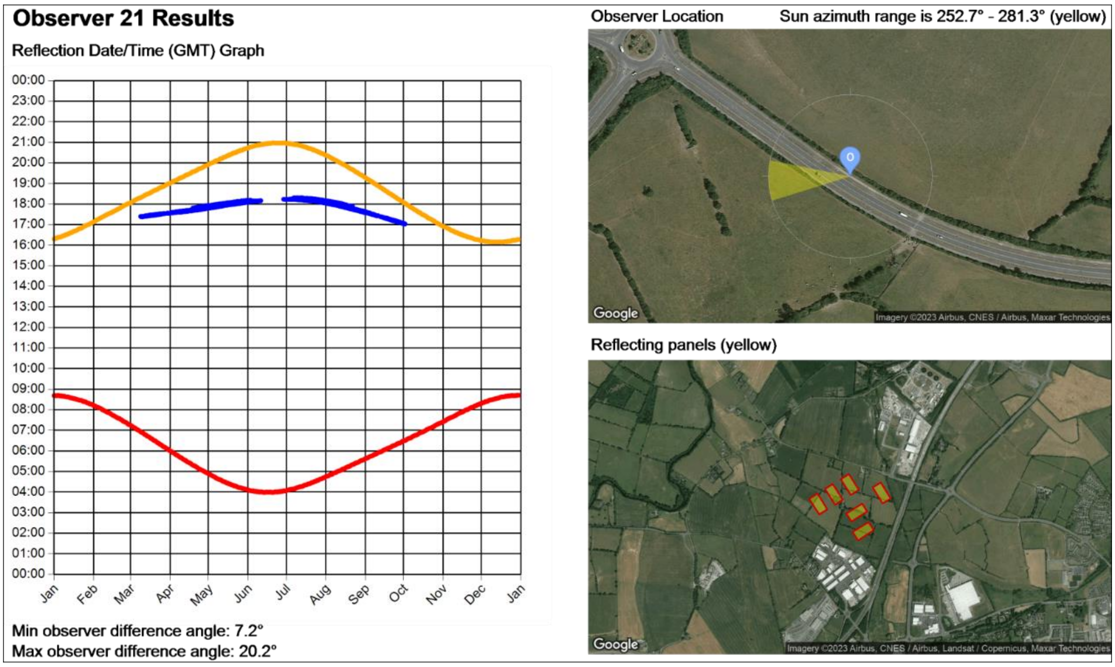

Observer 16 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 14.7°
Observer Location
Sun azimuth ranges (yellow)
Reflecting panels (yellow)


Observer 17 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.3°
Max observer difference angle: 16°
Observer Location
Sun azimuth range is 243° - 275° (yellow)
Reflecting panels (yellow)


Observer 18 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 17.2°
Observer Location
Sun azimuth range is 241.1° - 275.9° (yellow)
Reflecting panels (yellow)
Google

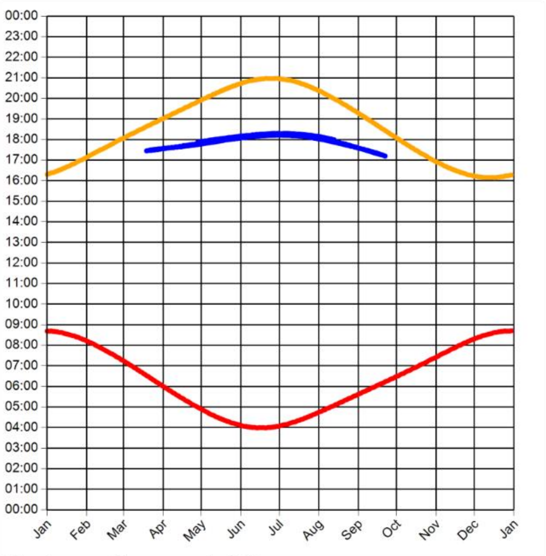

Observer 19 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 1°
Max observer difference angle: 17.9°
Observer Location
Sun azimuth range is 242.8° - 276.8° (yellow)
Reflecting panels (yellow)
Google


Observer 20 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: 4.3°
Max observer difference angle: 19.1°
Observer Location
Sun azimuth range is 248° - 279.2° (yellow)
Google
Reflecting panels (yellow)
Google


Observer 21 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: 7.2°
Max observer difference angle: 20.2°
Observer Location
Sun azimuth range is 252.7° - 281.3° (yellow)
Google
Reflecting panels (yellow)
Google

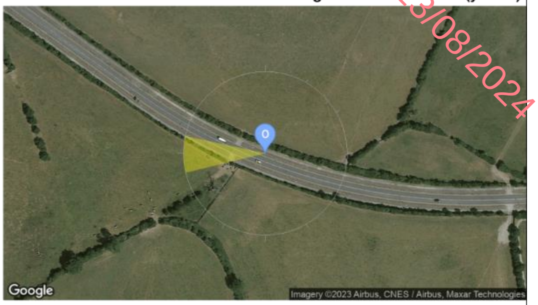
Observer 22 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 9.7°
Max observer difference angle: 20.7°

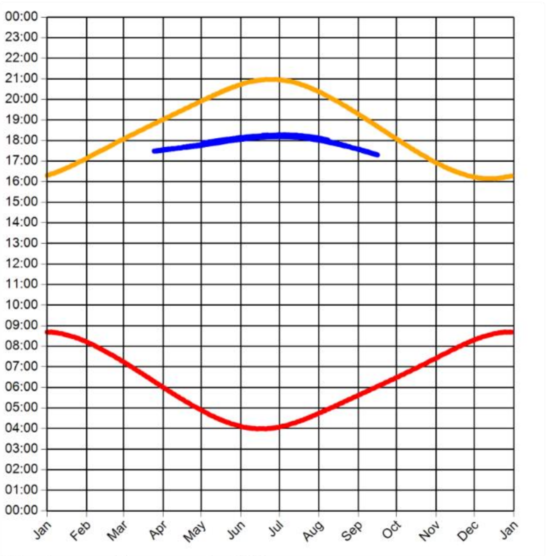
Observer Location — Sun azimuth range is 256.3° - 282.3° (yellow)



Reflecting panels (yellow)

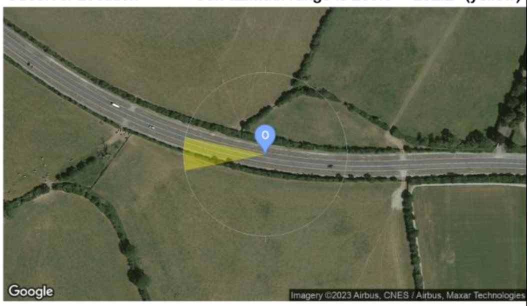
Observer 23 Results

Reflection Date/Time (GMT) Graph

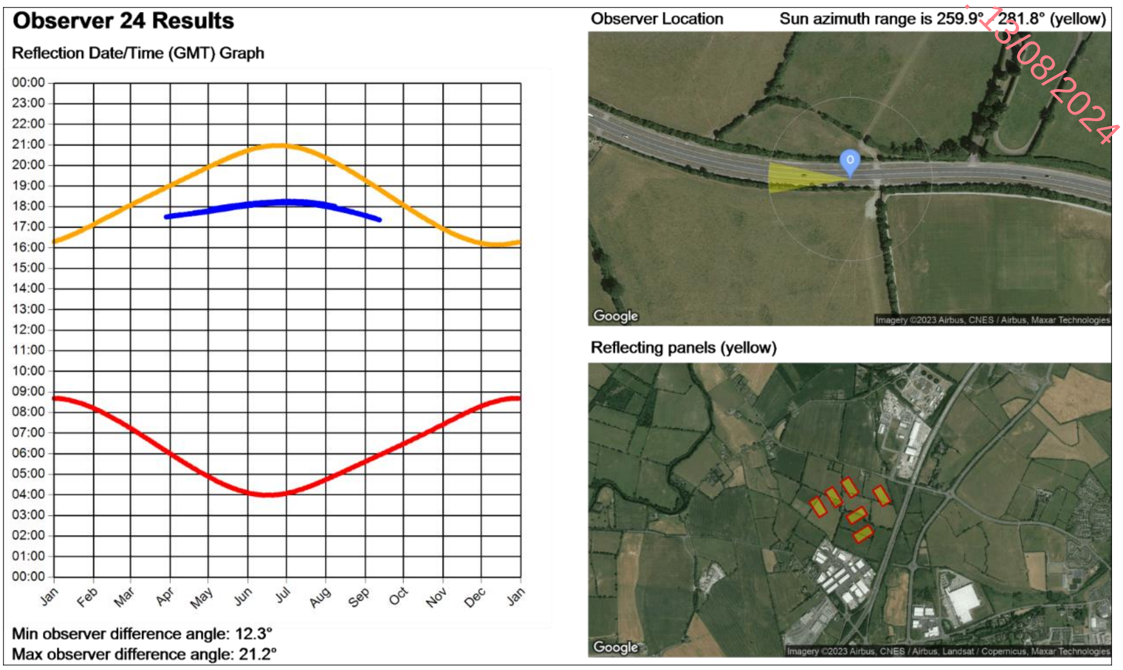


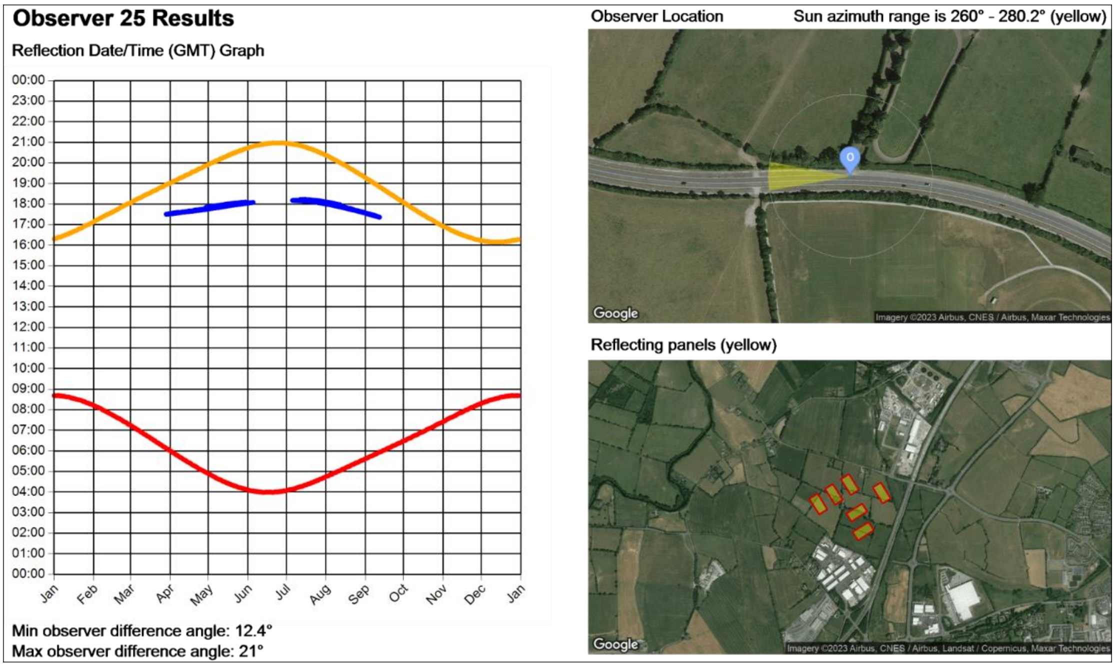
Min observer difference angle: 11.3°
Max observer difference angle: 21°

Observer Location — Sun azimuth range is 258.6° - 282.2° (yellow)



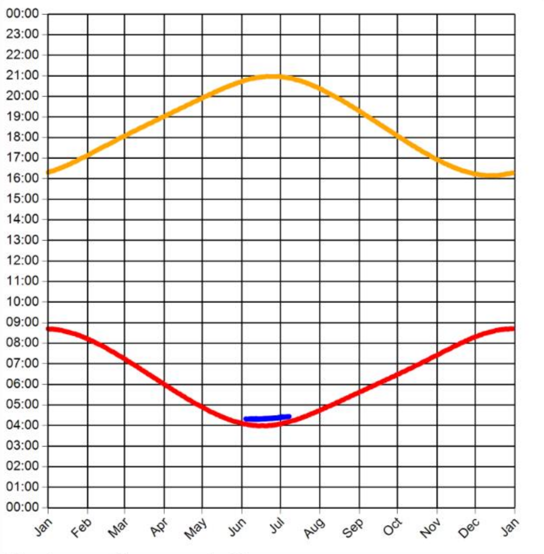
Reflecting panels (yellow)


Observer 24 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 12.3°
Max observer difference angle: 21.2°
Observer Location
Sun azimuth range is 259.9° - 281.8° (yellow)
Reflecting panels (yellow)


Observer 25 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 12.4°
Max observer difference angle: 21°
Observer Location
Sun azimuth range is 260° - 280.2° (yellow)
Reflecting panels (yellow)

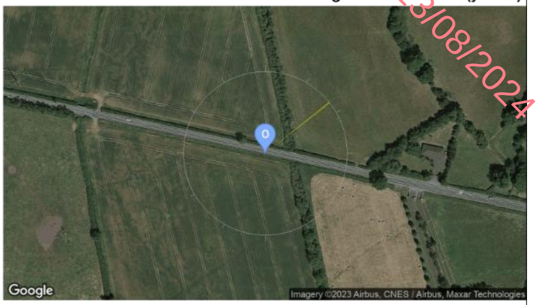
Observer 32 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 0.4°

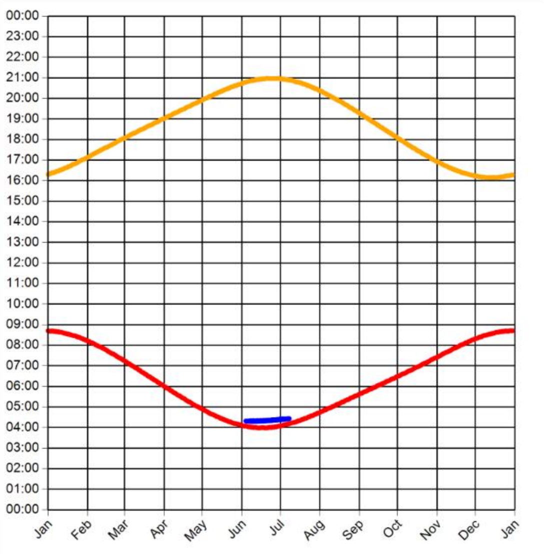
Observer Location — Sun azimuth range is 50.9° - 52.2° (yellow)



Reflecting panels (yellow)

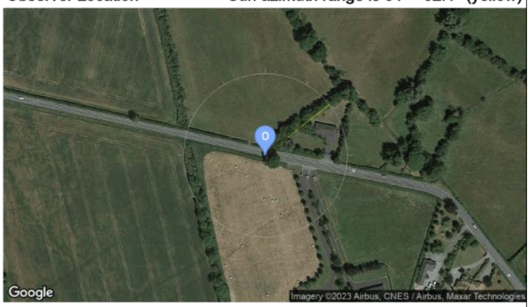
Observer 33 Results

Reflection Date/Time (GMT) Graph

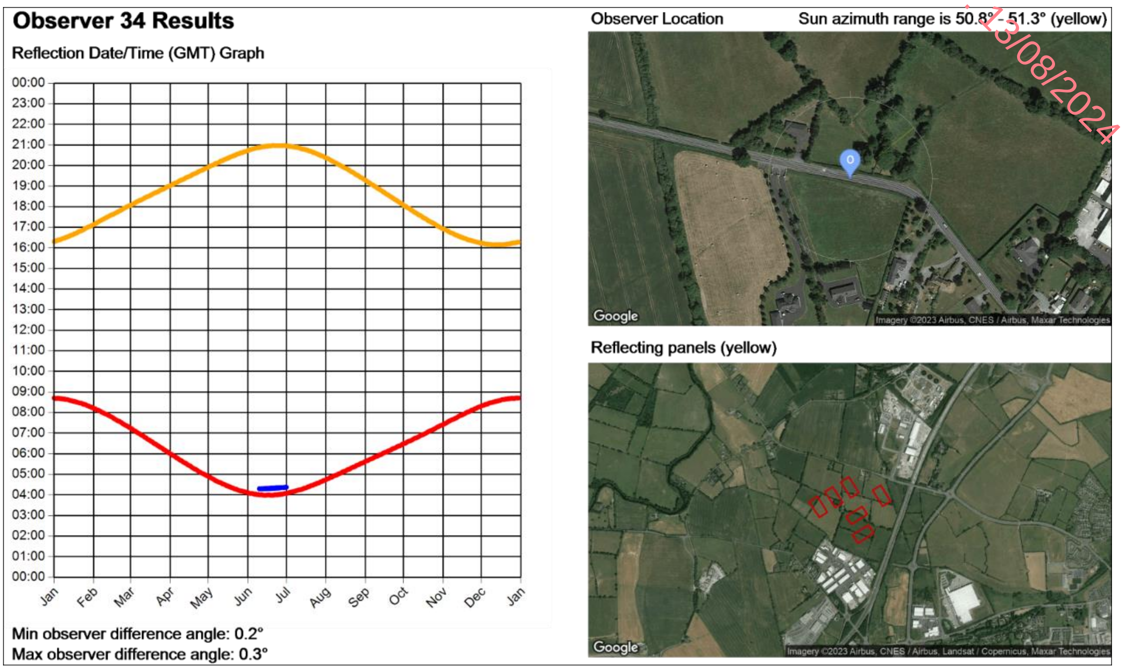


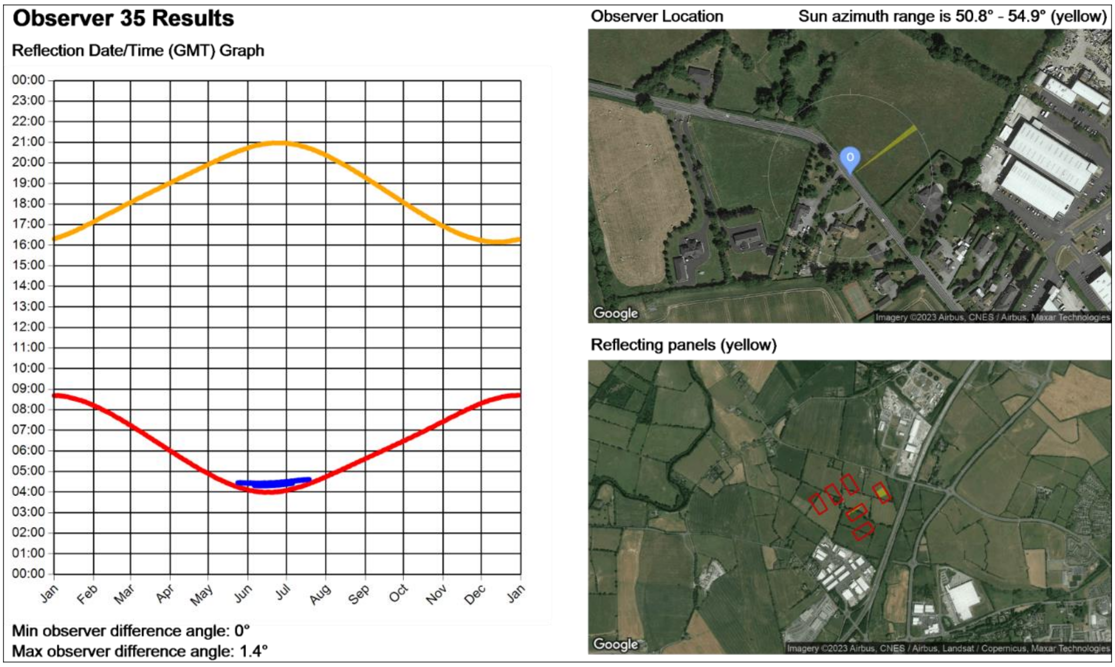
Min observer difference angle: 0°
Max observer difference angle: 0.4°

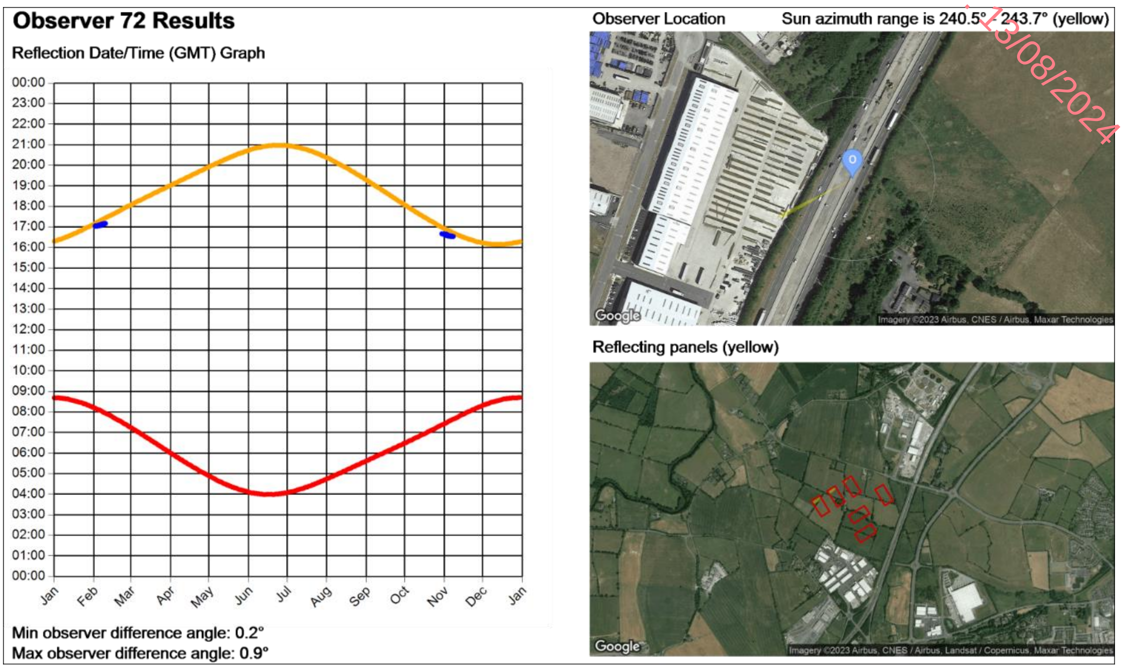
Observer Location — Sun azimuth range is 51° - 52.1° (yellow)

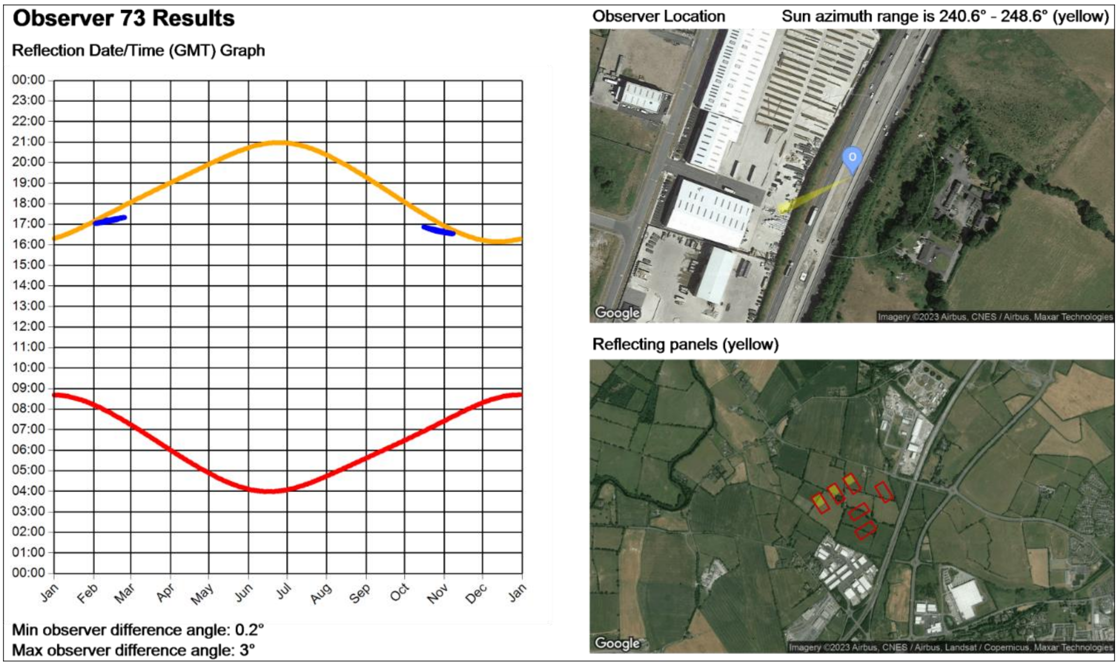


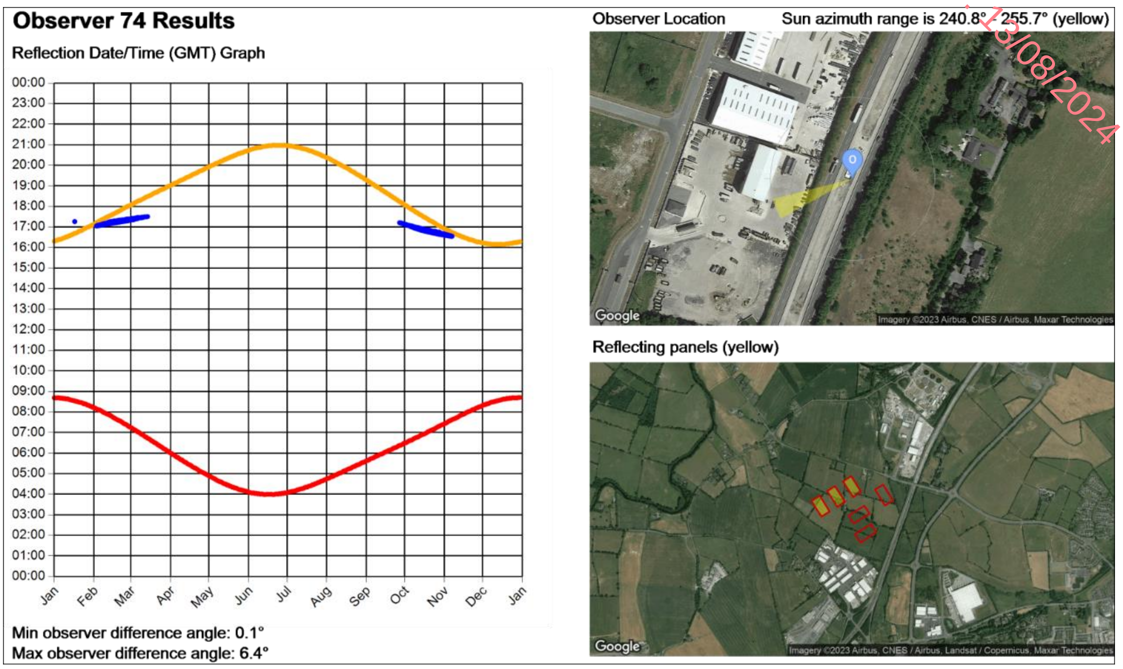
Reflecting panels (yellow)

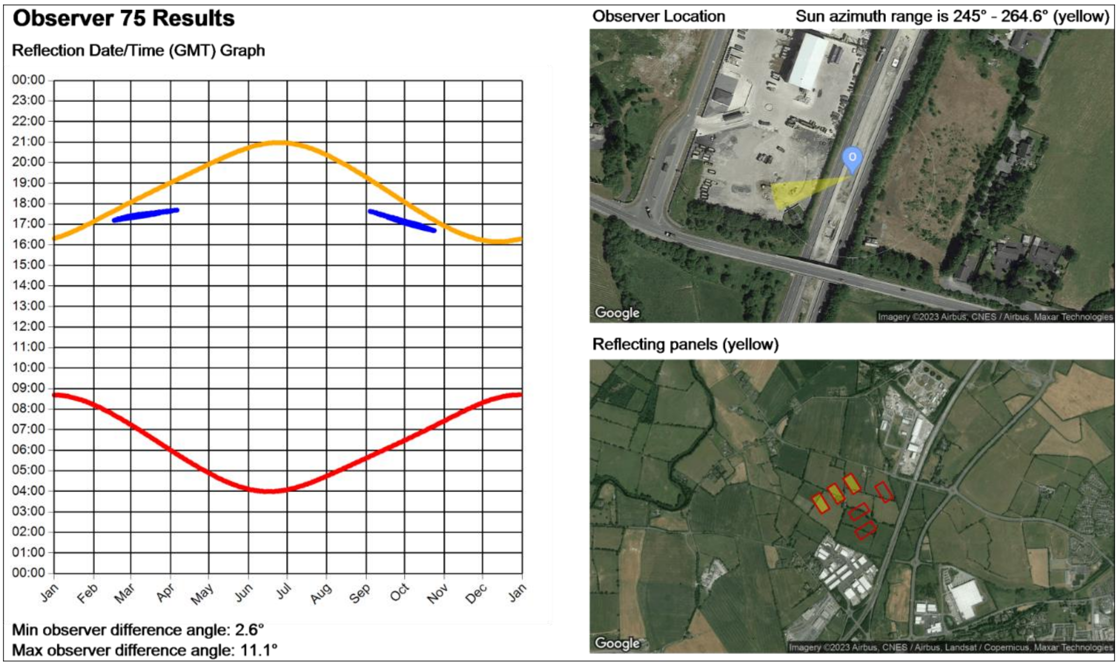

Observer 34 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0.2°
Max observer difference angle: 0.3°
Observer Location
Sun azimuth range is 50.8° - 51.3° (yellow)
Google
Reflecting panels (yellow)
Google

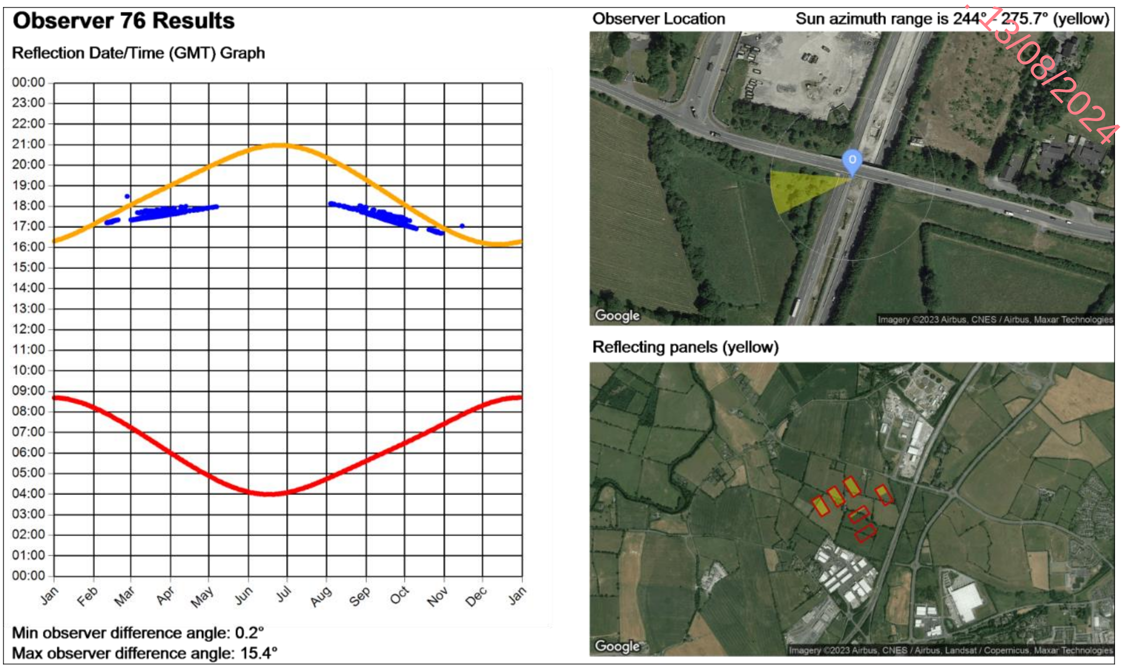

Observer 35 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0°
Max observer difference angle: 1.4°
Observer Location
Sun azimuth range is 50.8° - 54.9° (yellow)
Google
Reflecting panels (yellow)
Google

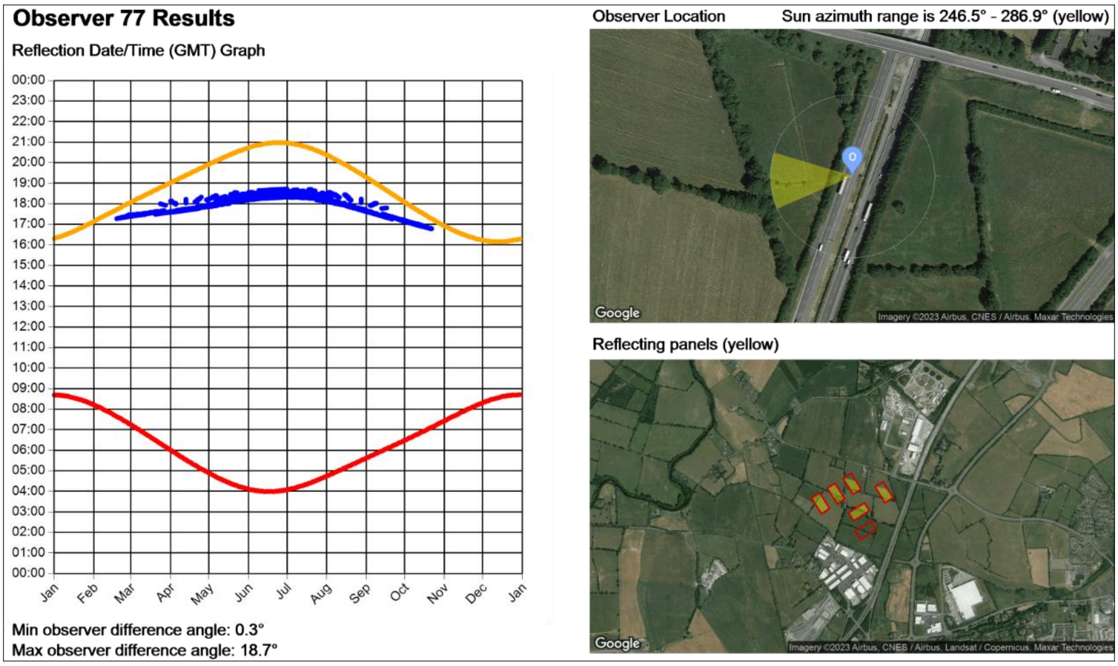

Observer 72 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 0.2°
Max observer difference angle: 0.9°
Observer Location
Sun azimuth range is 240.5° - 243.7° (yellow)
Google
Imagery ©2023 Airbus, CNES / Airbus, Maxar Technologies
Reflecting panels (yellow)
Google
Imagery ©2023 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies

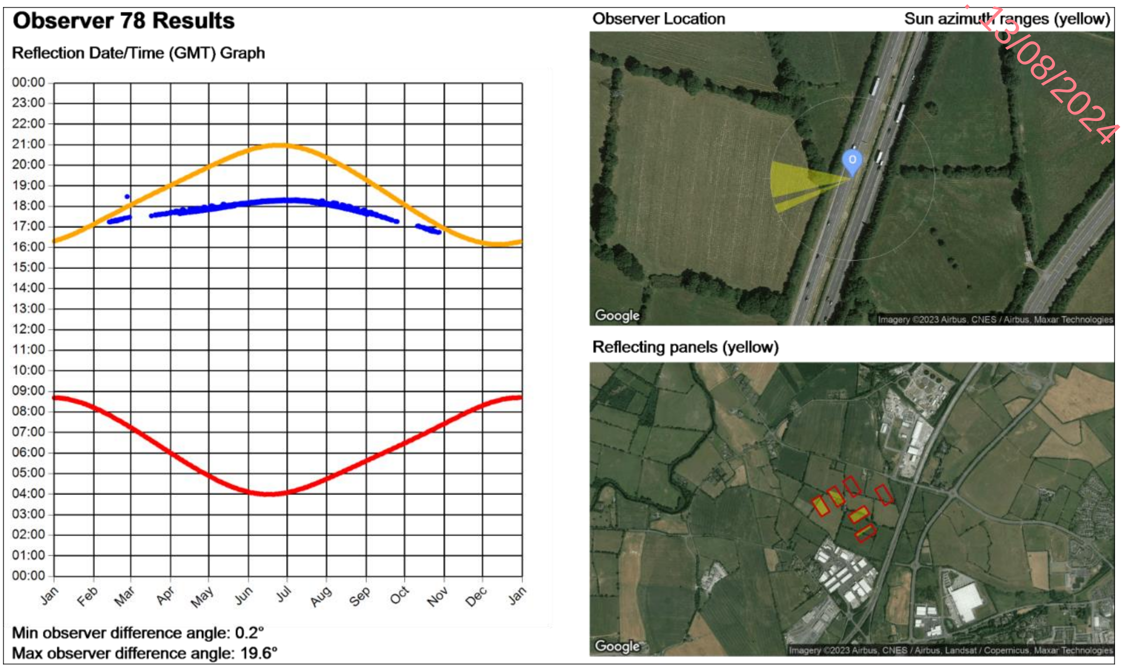

Observer 73 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Min observer difference angle: 0.2°
Max observer difference angle: 3°
Observer Location
Sun azimuth range is 240.6° - 248.6° (yellow)
Google
Imagery ©2023 Airbus, CNES / Airbus, Maxar Technologies
Reflecting panels (yellow)
Google
Imagery ©2023 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies

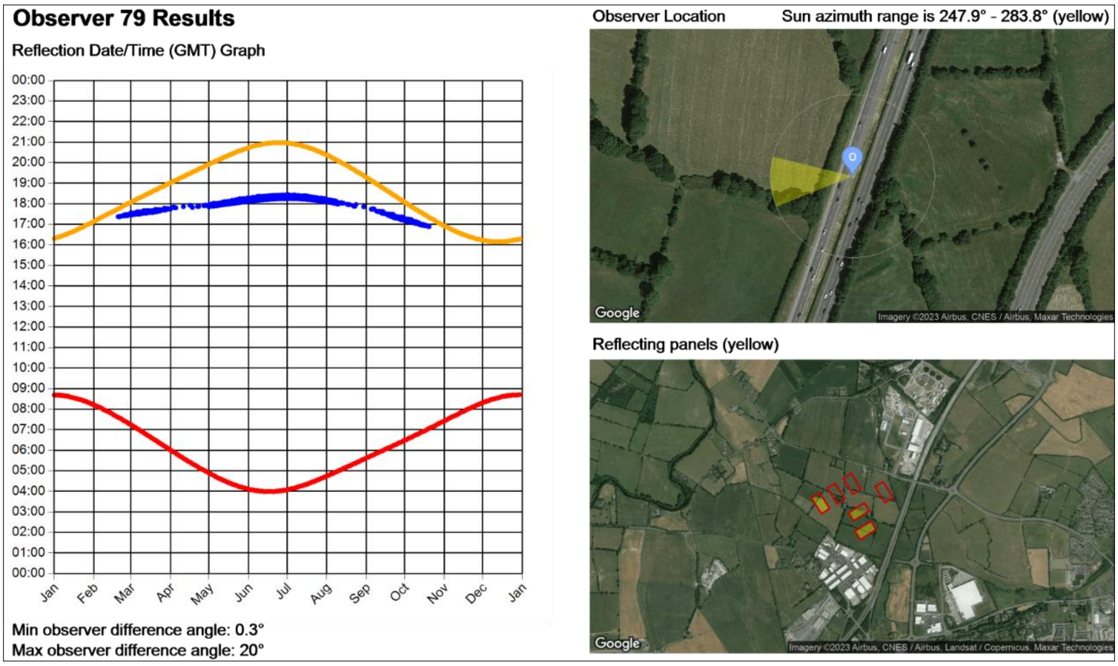

Observer 74 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0.1°
Max observer difference angle: 6.4°
Observer Location
Sun azimuth range is 240.8° - 255.7° (yellow)
Google
Reflecting panels (yellow)
Google

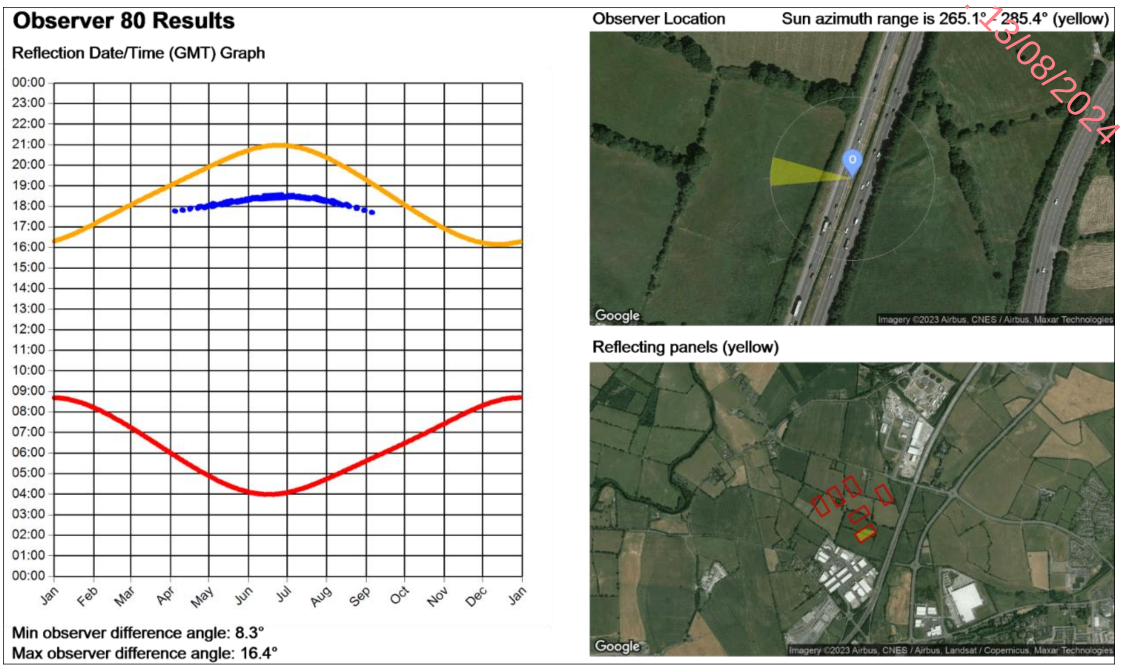

Observer 75 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 2.6°
Max observer difference angle: 11.1°
Observer Location
Sun azimuth range is 245° - 264.6° (yellow)
Google
Reflecting panels (yellow)
Google

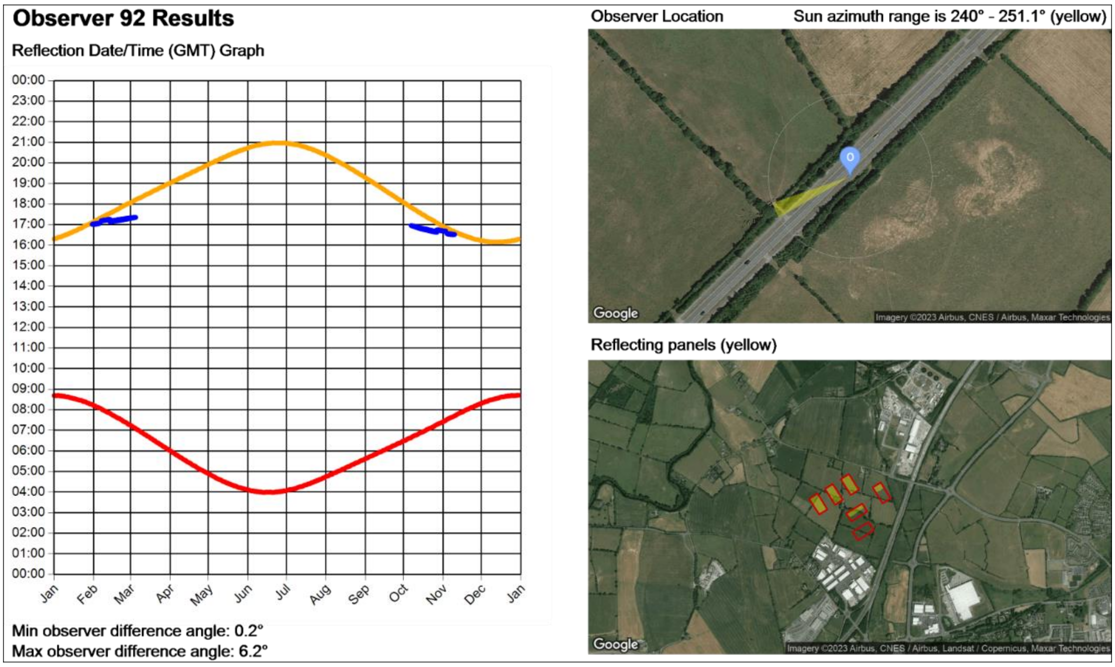

Observer 76 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 15.4°
Observer Location
Sun azimuth range is 244° - 275.7° (yellow)
Reflecting panels (yellow)
Google

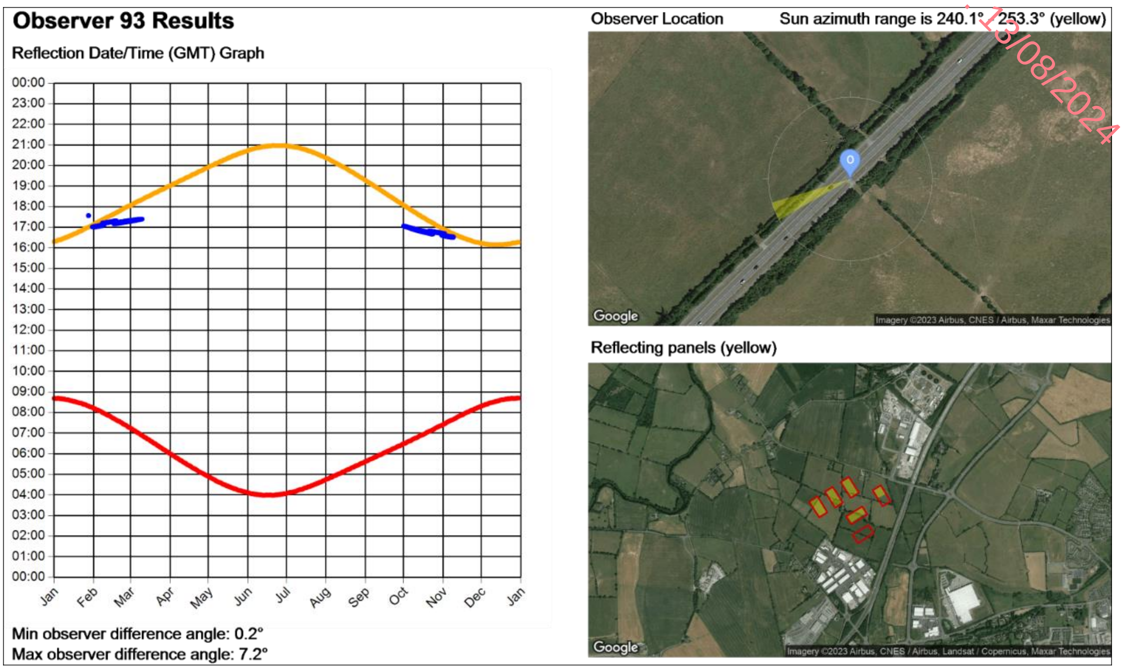

Observer 77 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.3°
Max observer difference angle: 18.7°
Observer Location
Sun azimuth range is 246.5° - 286.9° (yellow)
Reflecting panels (yellow)
Google

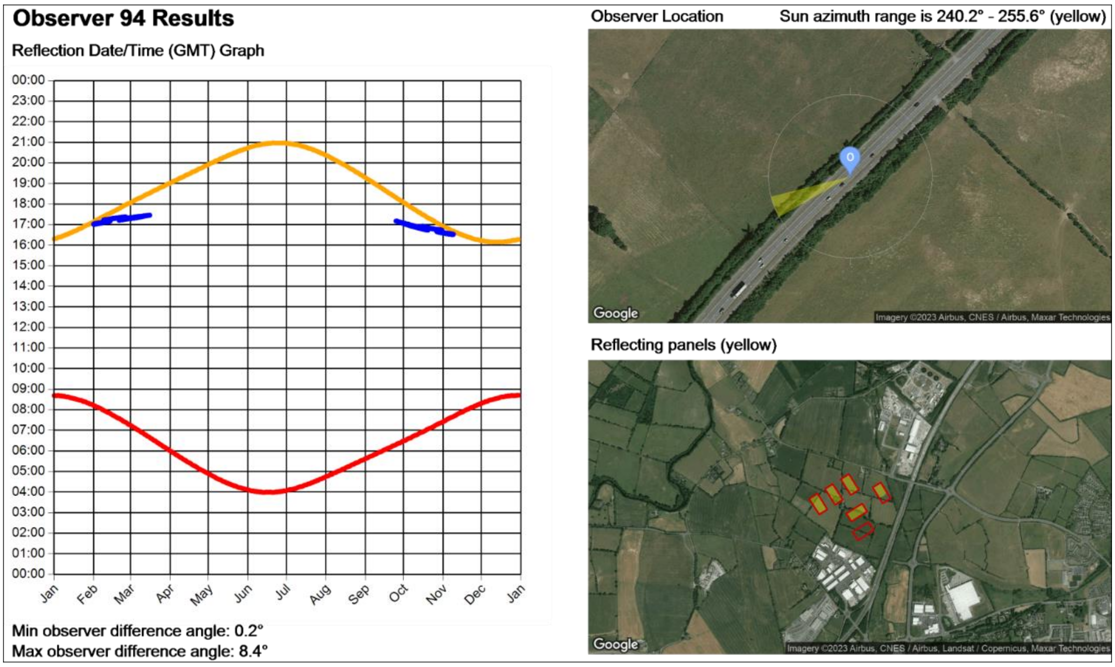

Observer 78 Results
Reflection Date/Time (GMT) Graph
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0.2°
Max observer difference angle: 19.6°
Observer Location
Sun azimuth ranges (yellow)
Reflecting panels (yellow)
Google


Observer 79 Results
Reflection Date/Time (GMT) Graph
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0.3°
Max observer difference angle: 20°
Observer Location
Sun azimuth range is 247.9° - 283.8° (yellow)
Reflecting panels (yellow)
Google


Observer 80 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: 8.3°
Max observer difference angle: 16.4°
Observer Location
Sun azimuth range is 265.1° - 285.4° (yellow)
Google
Imagery ©2023 Airbus, CNES / Airbus, Maxar Technologies
Reflecting panels (yellow)
Google
Imagery ©2023 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies

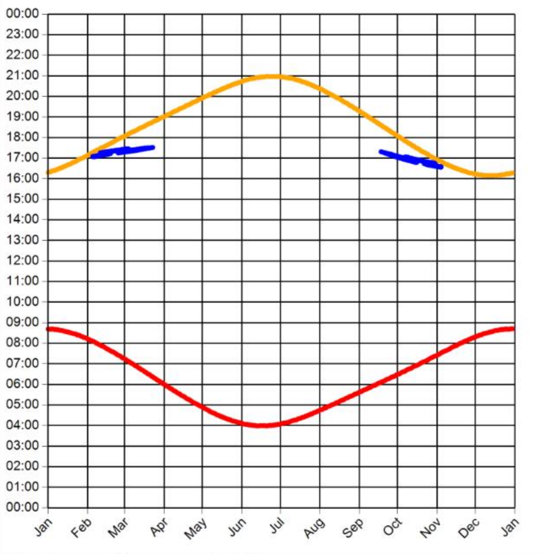

Observer 92 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0.2°
Max observer difference angle: 6.2°
Observer Location
Sun azimuth range is 240° - 251.1° (yellow)
Google
Imagery ©2023 Airbus, CNES / Airbus, Maxar Technologies
Reflecting panels (yellow)
Google
Imagery ©2023 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies


Observer 93 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 7.2°
Observer Location
Sun azimuth range is 240.1° - 253.3° (yellow)
Reflecting panels (yellow)


Observer 94 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 8.4°
Observer Location
Sun azimuth range is 240.2° - 255.6° (yellow)
Reflecting panels (yellow)

Observer 95 Results

Reflection Date/Time (GMT) Graph



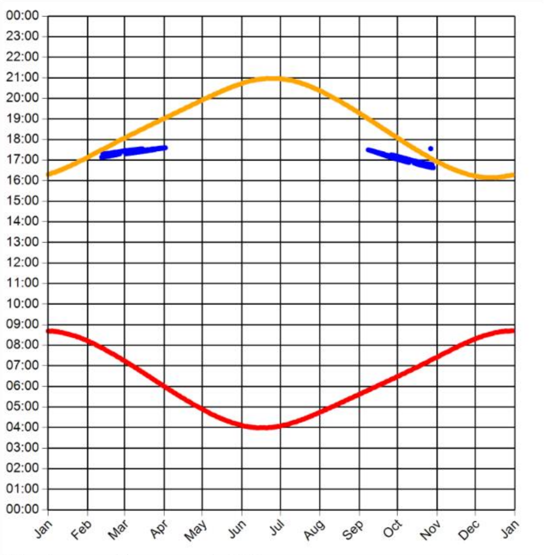
Min observer difference angle: 0.3°
Max observer difference angle: 9.8°

Observer Location — Sun azimuth range is 241.5° - 258.4° (yellow)

Reflecting panels (yellow)

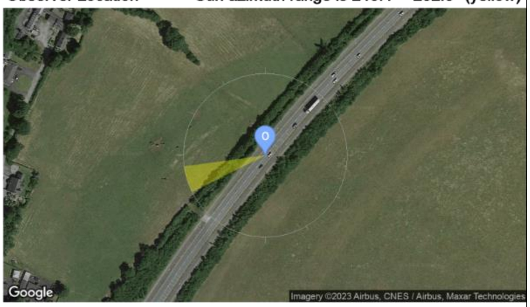
Observer 96 Results

Reflection Date/Time (GMT) Graph

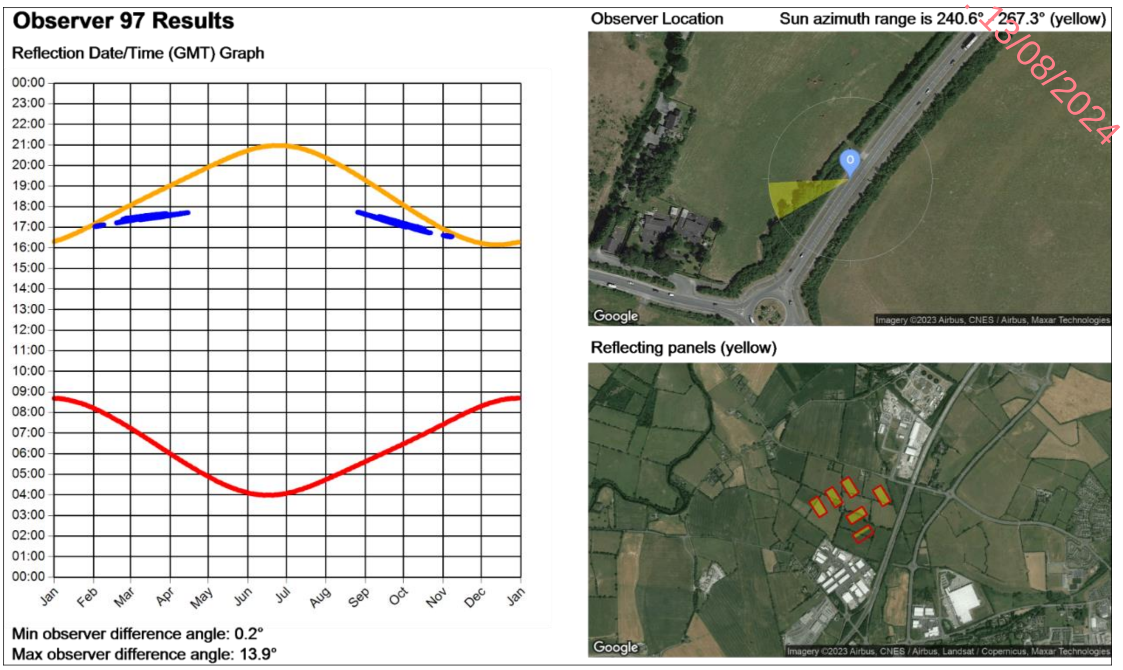


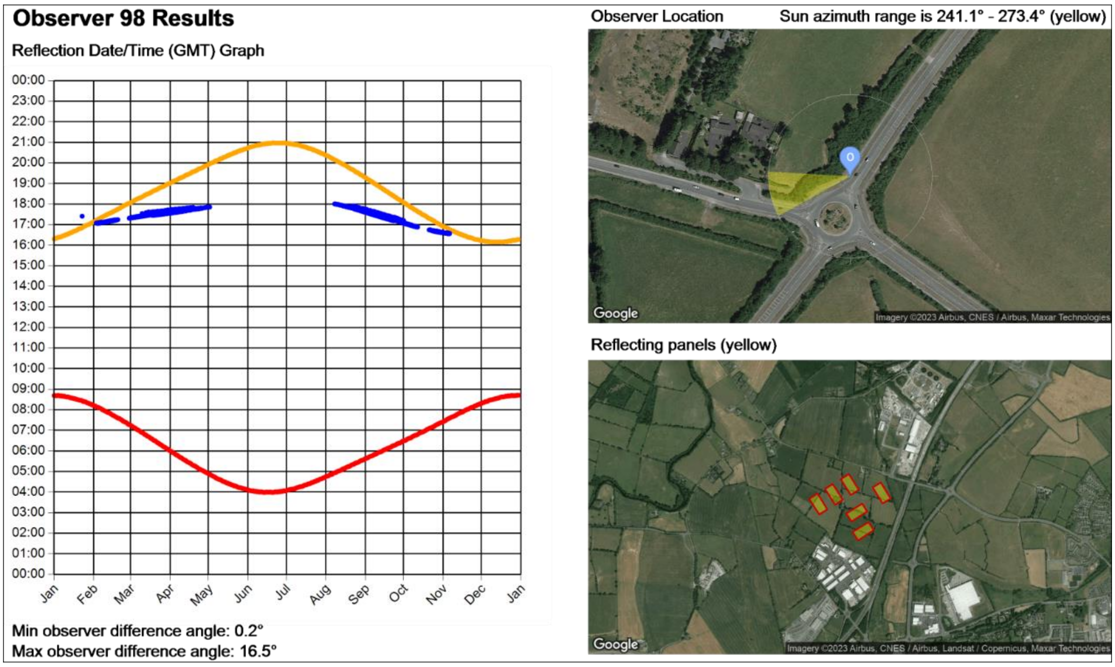
Min observer difference angle: 0.4°
Max observer difference angle: 11.6°

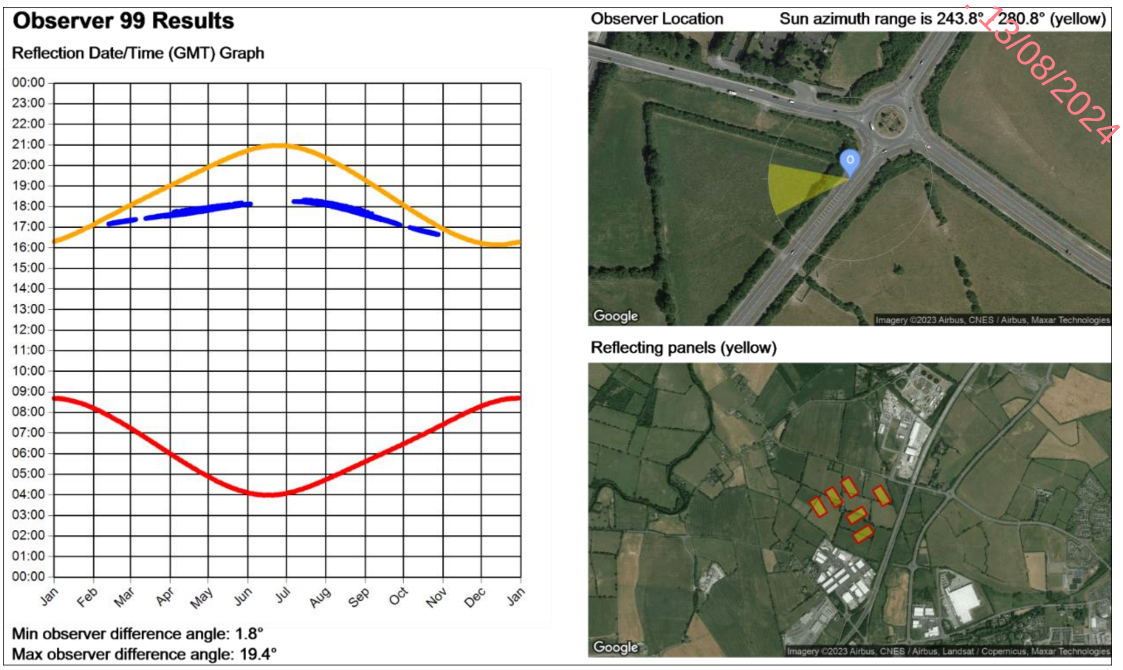
Observer Location — Sun azimuth range is 243.4° - 262.3° (yellow)

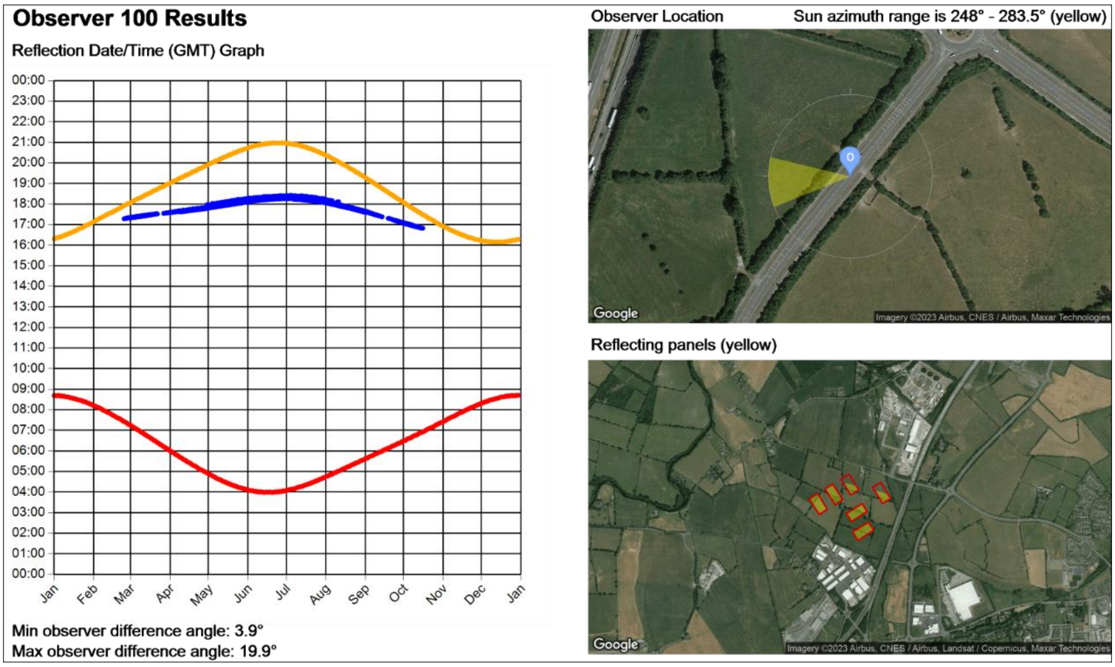


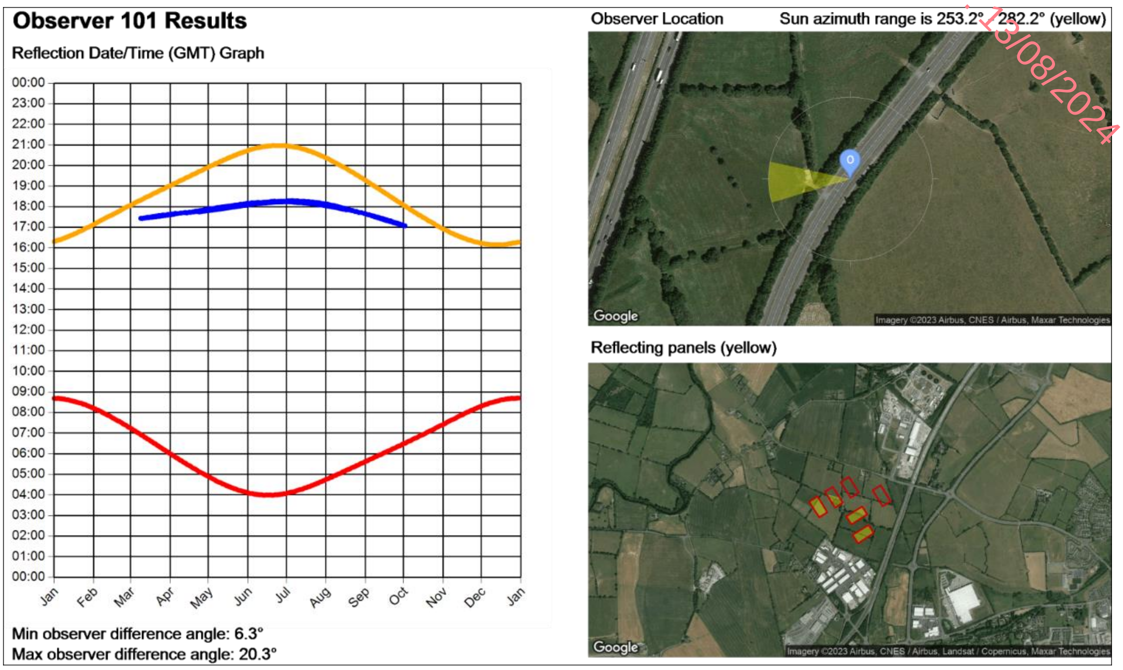
Reflecting panels (yellow)

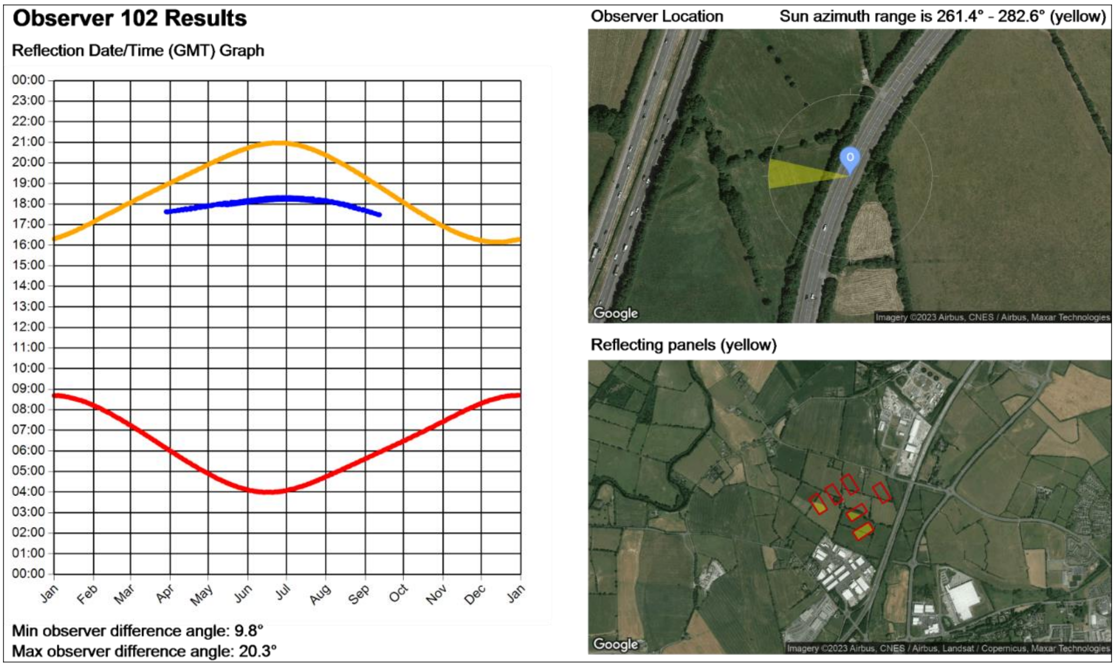

Observer 97 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 13.9°
Observer Location
Sun azimuth range is 240.6° - 267.3° (yellow)
Reflecting panels (yellow)

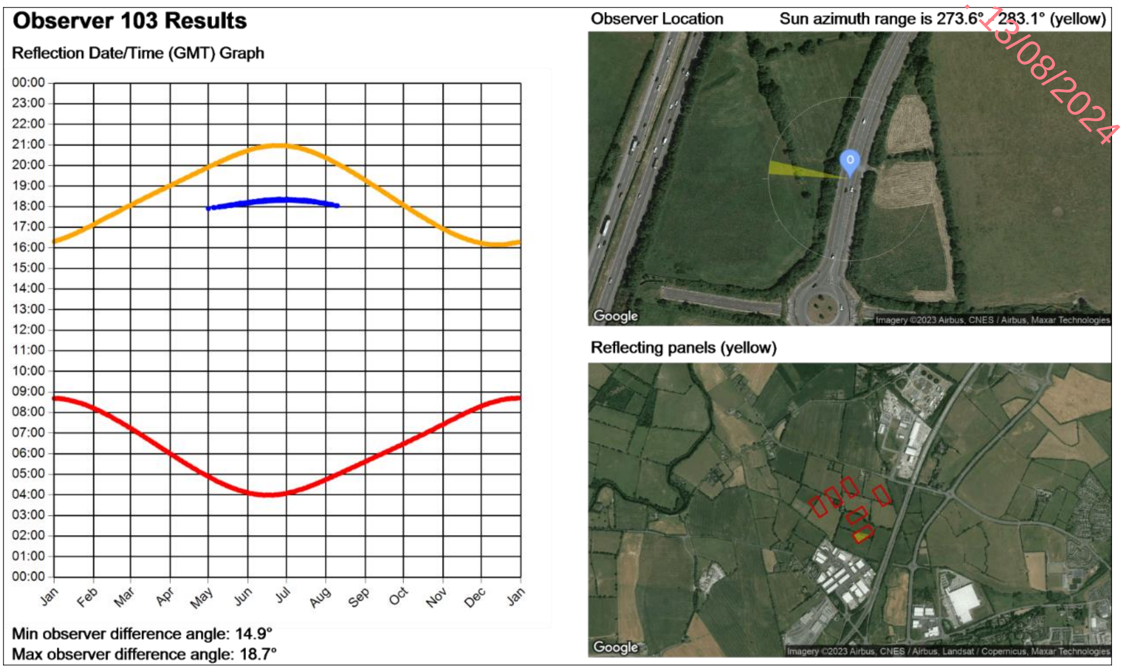

Observer 98 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 16.5°
Observer Location
Sun azimuth range is 241.1° - 273.4° (yellow)
Reflecting panels (yellow)


Observer 99 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 1.8°
Max observer difference angle: 19.4°
Observer Location
Sun azimuth range is 243.8° - 280.8° (yellow)
Reflecting panels (yellow)
Google

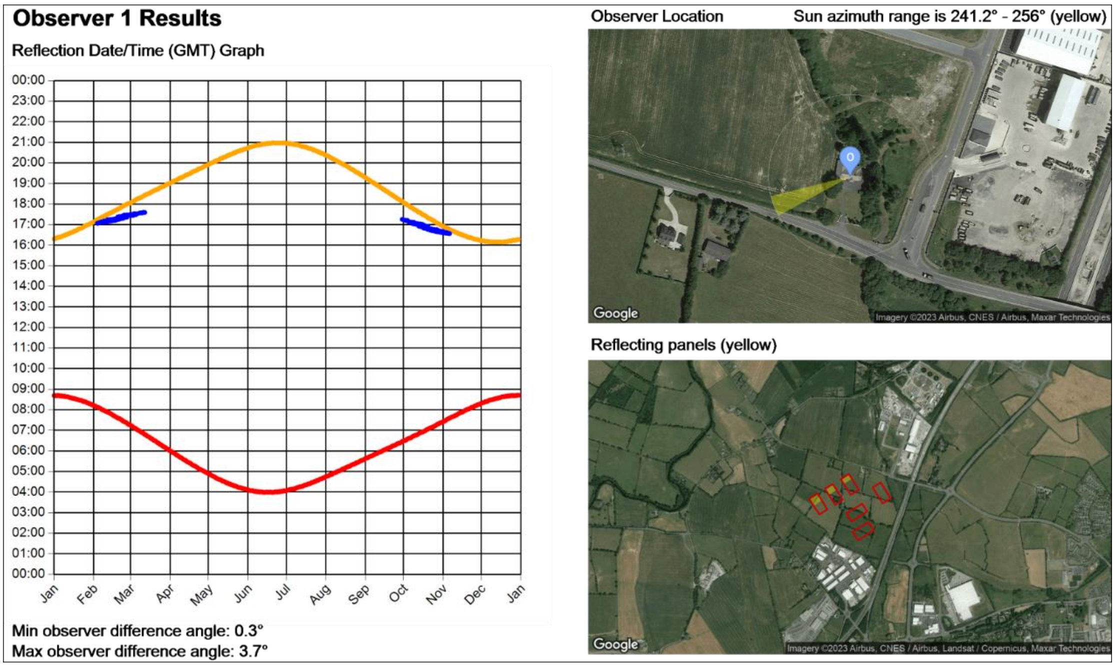

Observer 100 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 3.9°
Max observer difference angle: 19.9°
Observer Location
Sun azimuth range is 248° - 283.5° (yellow)
Reflecting panels (yellow)
Google

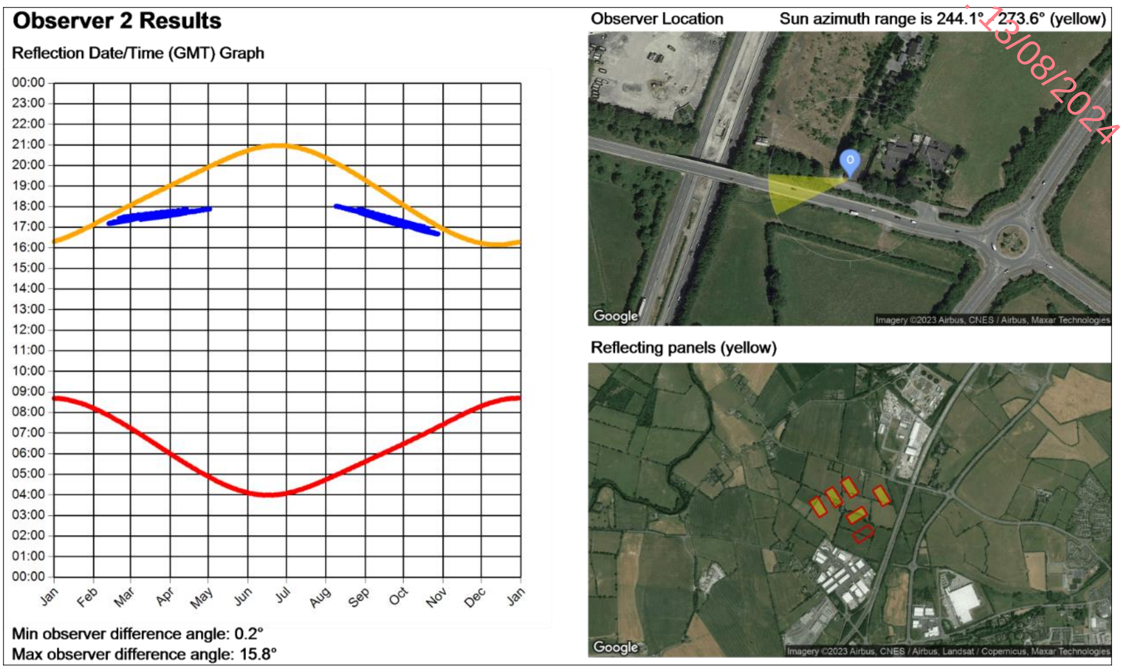

Observer 101 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 6.3°
Max observer difference angle: 20.3°
Observer Location
Sun azimuth range is 253.2° - 282.2° (yellow)
Reflecting panels (yellow)
Google

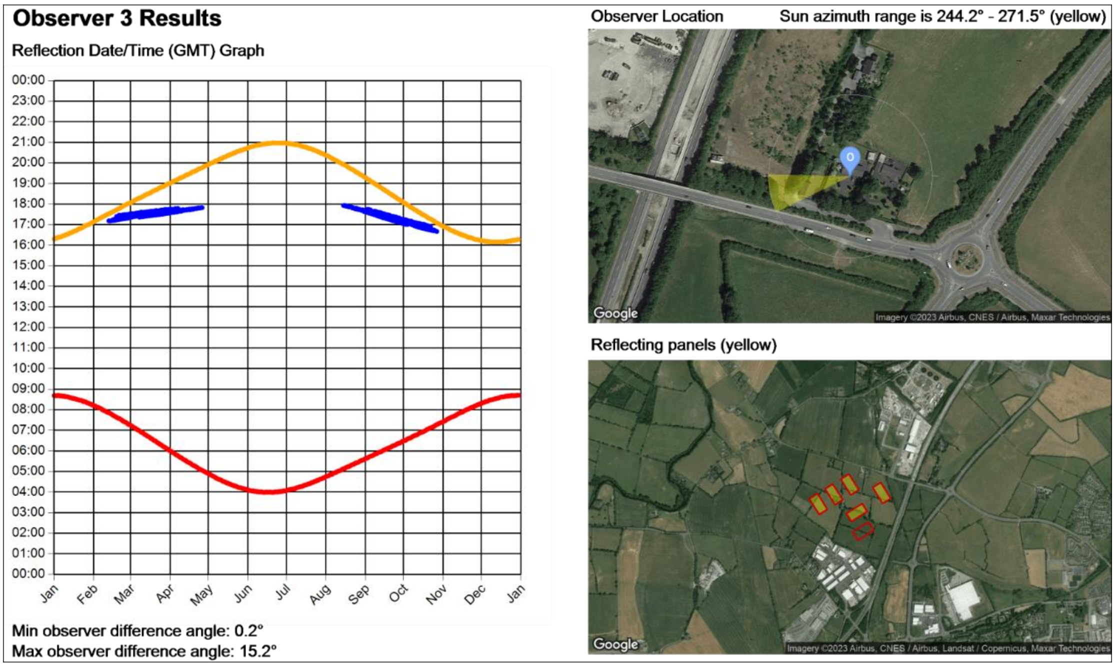

Observer 102 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 9.8°
Max observer difference angle: 20.3°
Observer Location
Sun azimuth range is 261.4° - 282.6° (yellow)
Reflecting panels (yellow)
Google



Dwelling Receptors

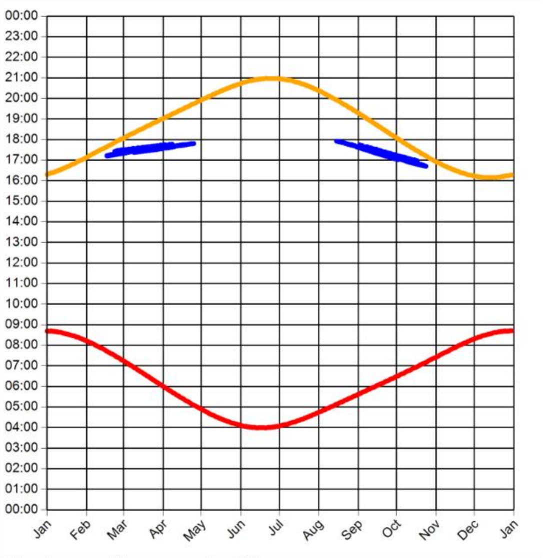



Observer 2 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 15.8°
Observer Location
Sun azimuth range is 244.1° - 273.6° (yellow)
Reflecting panels (yellow)


Observer 3 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.2°
Max observer difference angle: 15.2°
Observer Location
Sun azimuth range is 244.2° - 271.5° (yellow)
Reflecting panels (yellow)

Observer 4 Results

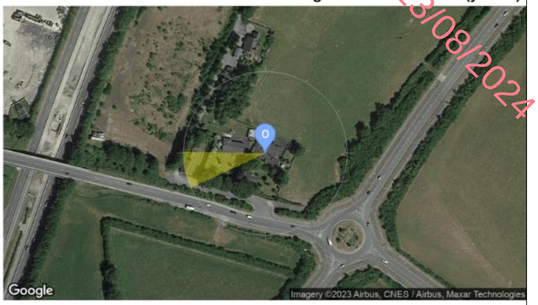
Reflection Date/Time (GMT) Graph



Min observer difference angle: 1.2°
Max observer difference angle: 15.3°

Observer Location

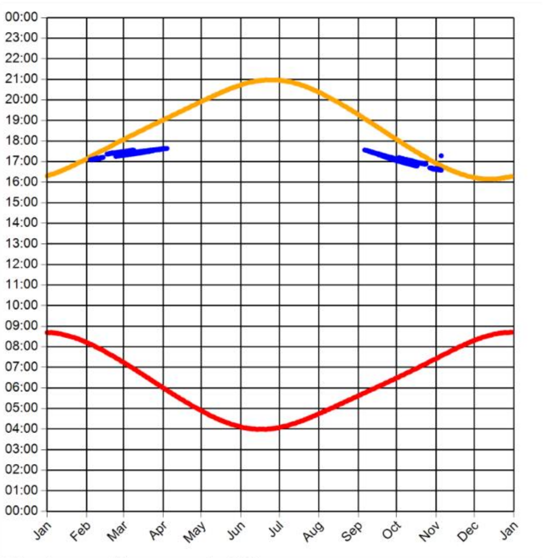
Sun azimuth range is 245.1° - 271.3° (yellow)



Reflecting panels (yellow)

Observer 5 Results

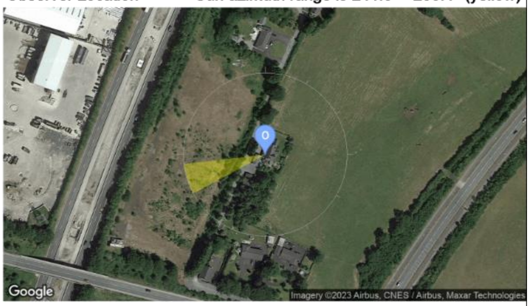
Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.2°
Max observer difference angle: 11.4°

Observer Location

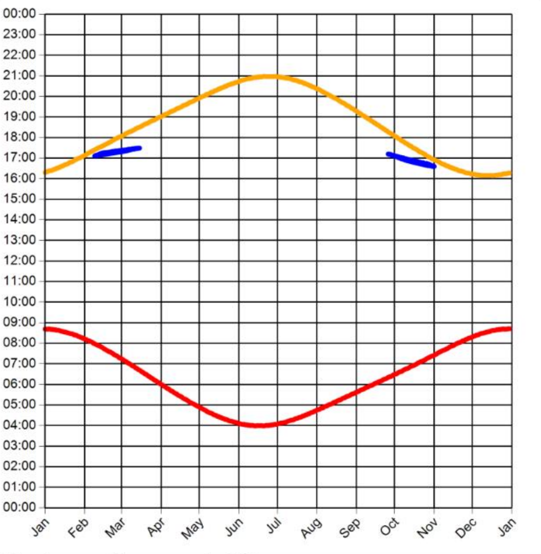
Sun azimuth range is 241.5° - 263.4° (yellow)



Reflecting panels (yellow)

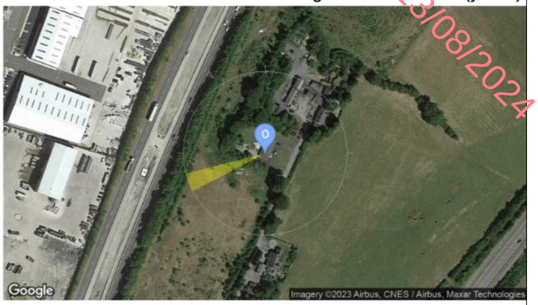
Observer 6 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.8°
Max observer difference angle: 7.3°

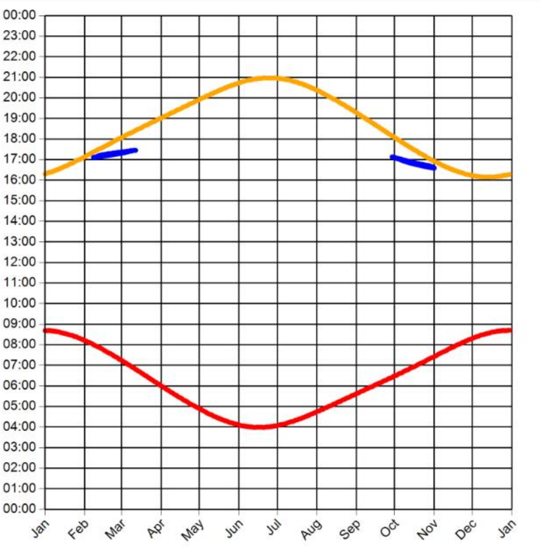
Observer Location   Sun azimuth range is 242.4° - 255.7° (yellow)



Reflecting panels (yellow)

Observer 7 Results

Reflection Date/Time (GMT) Graph



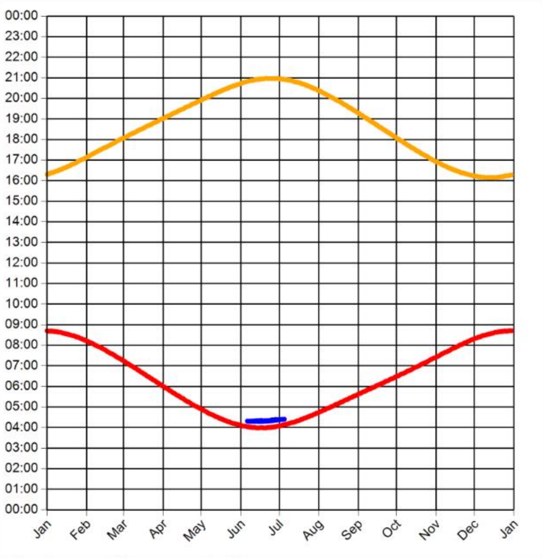
Min observer difference angle: 0.8°
Max observer difference angle: 6.8°

Observer Location   Sun azimuth range is 242.3° - 254.5° (yellow)

Reflecting panels (yellow)

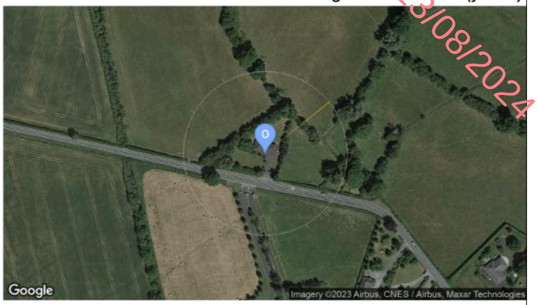
Observer 9 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 0.3°

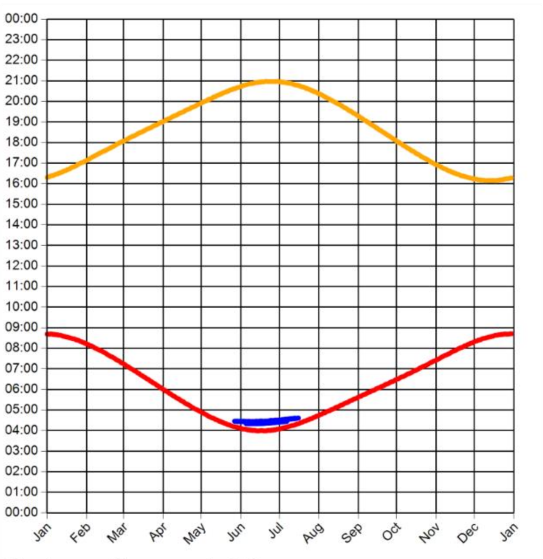
Observer Location — Sun azimuth range is 50.8° - 51.8° (yellow)



Reflecting panels (yellow)

Observer 10 Results

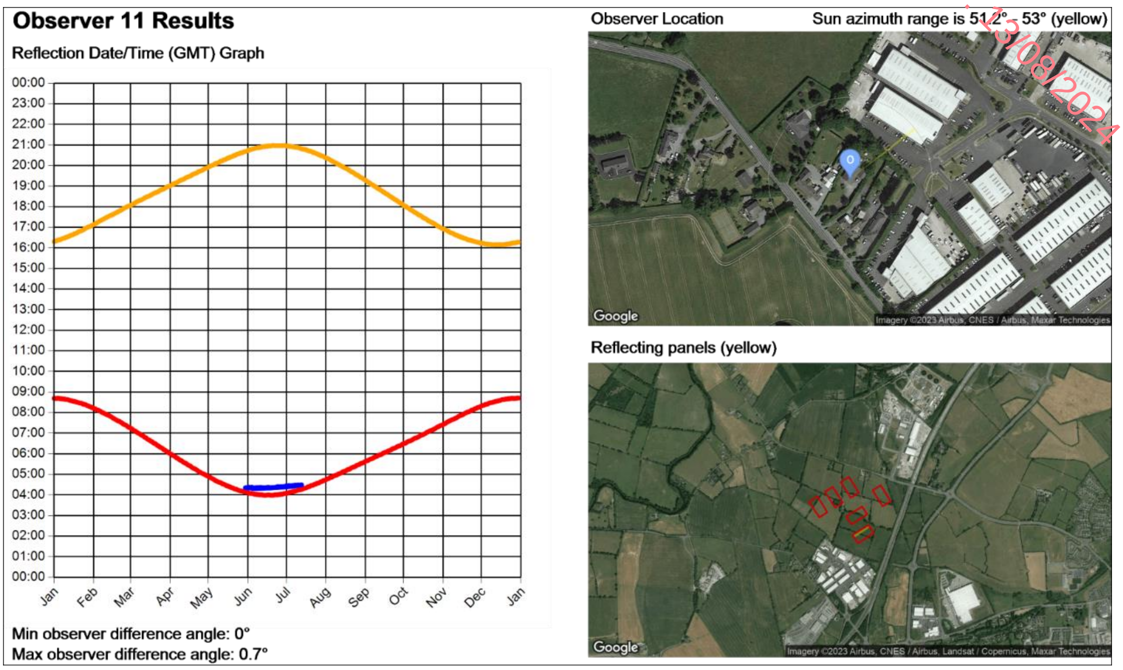
Reflection Date/Time (GMT) Graph

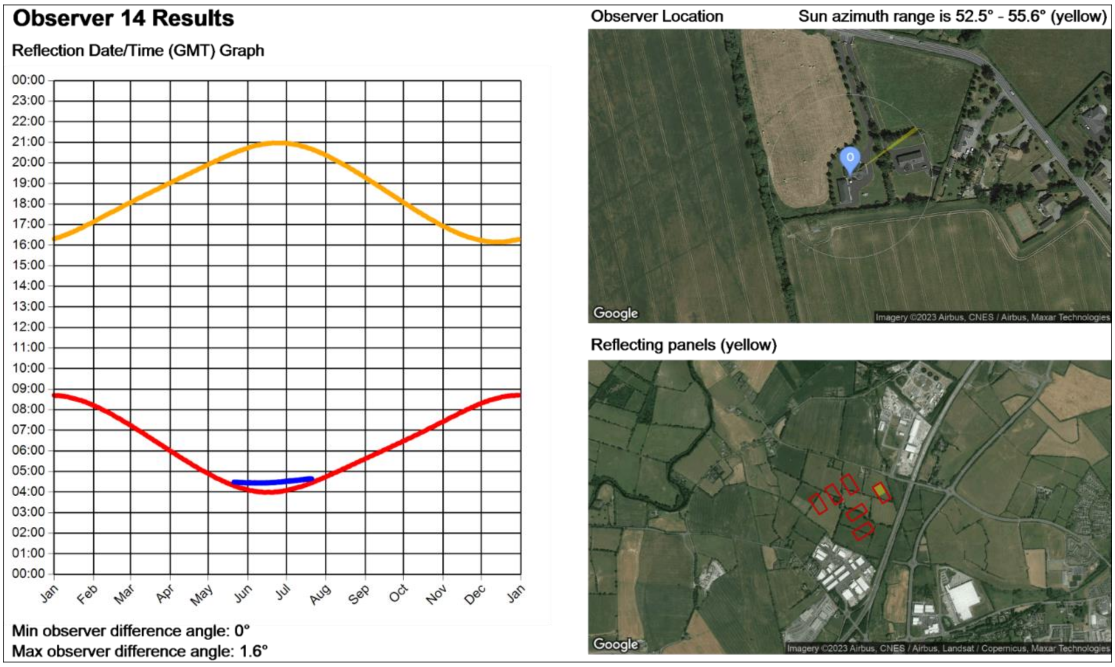


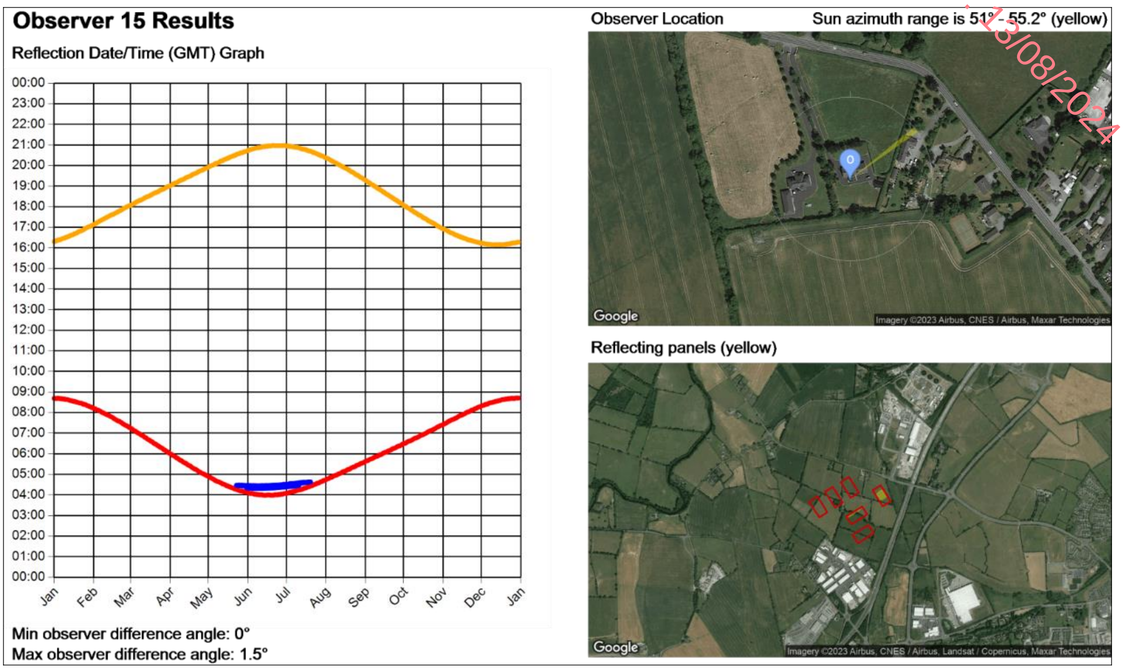
Min observer difference angle: 0.1°
Max observer difference angle: 1.6°

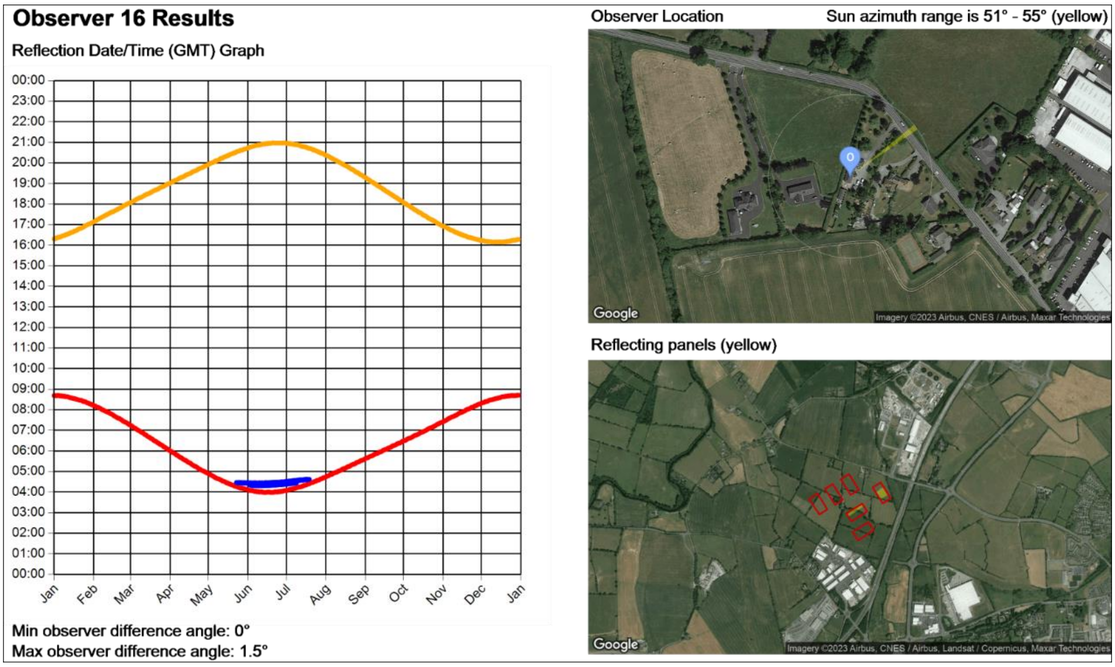
Observer Location — Sun azimuth range is 51.2° - 54.6° (yellow)

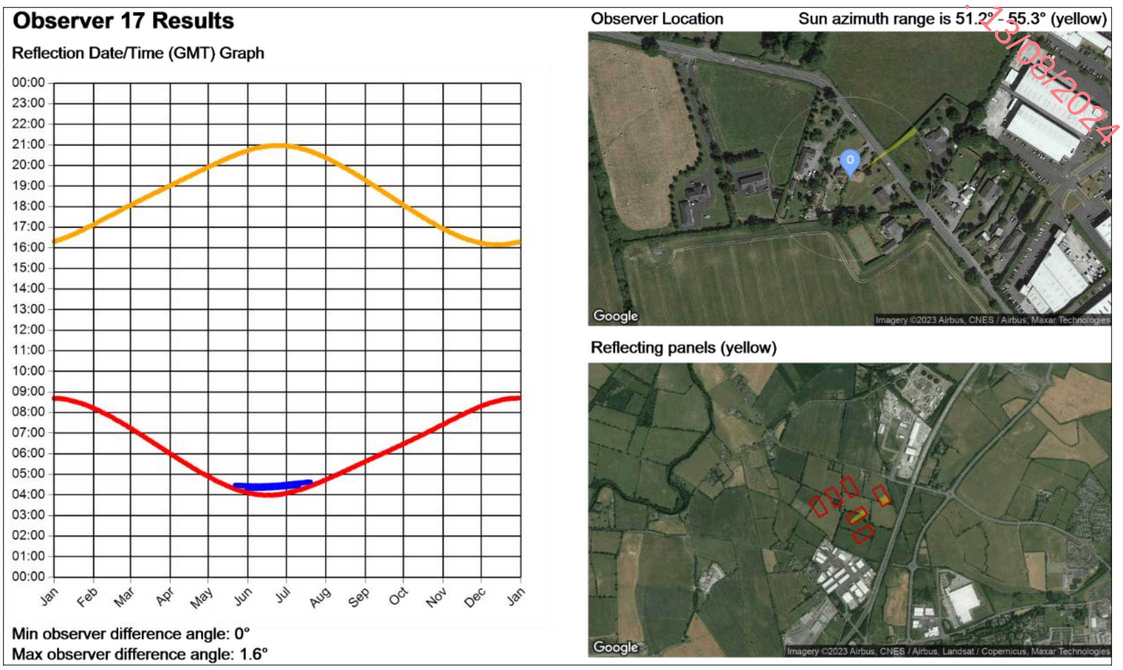
Reflecting panels (yellow)

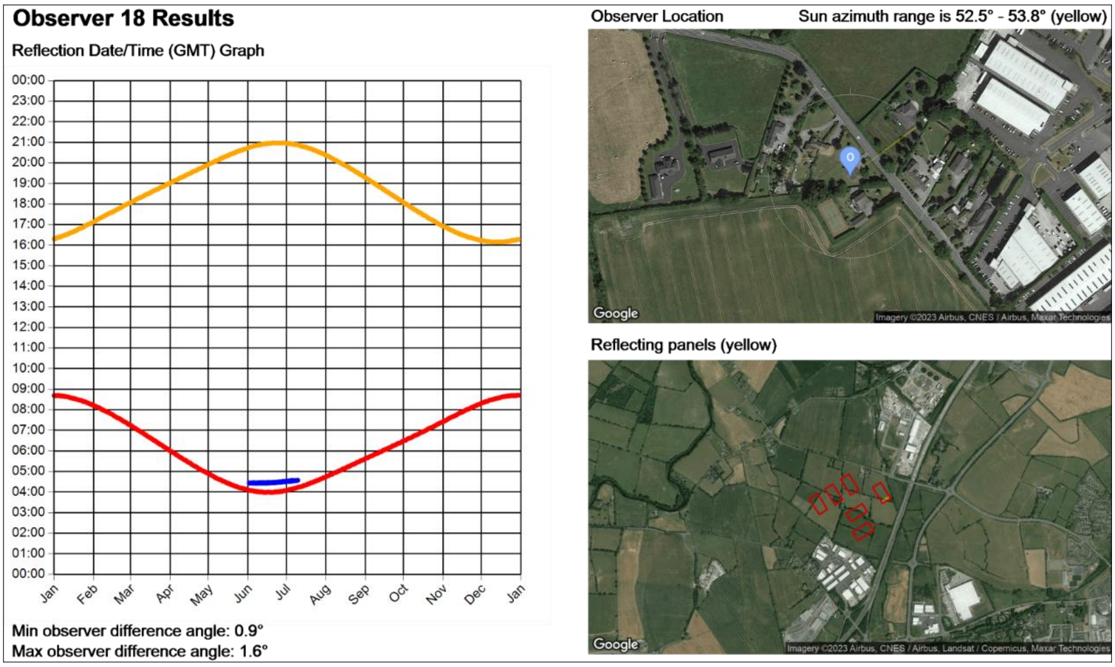

Observer 11 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0°
Max observer difference angle: 0.7°
Observer Location
Sun azimuth range is 51.2° - 53° (yellow)
Google
Reflecting panels (yellow)
Google

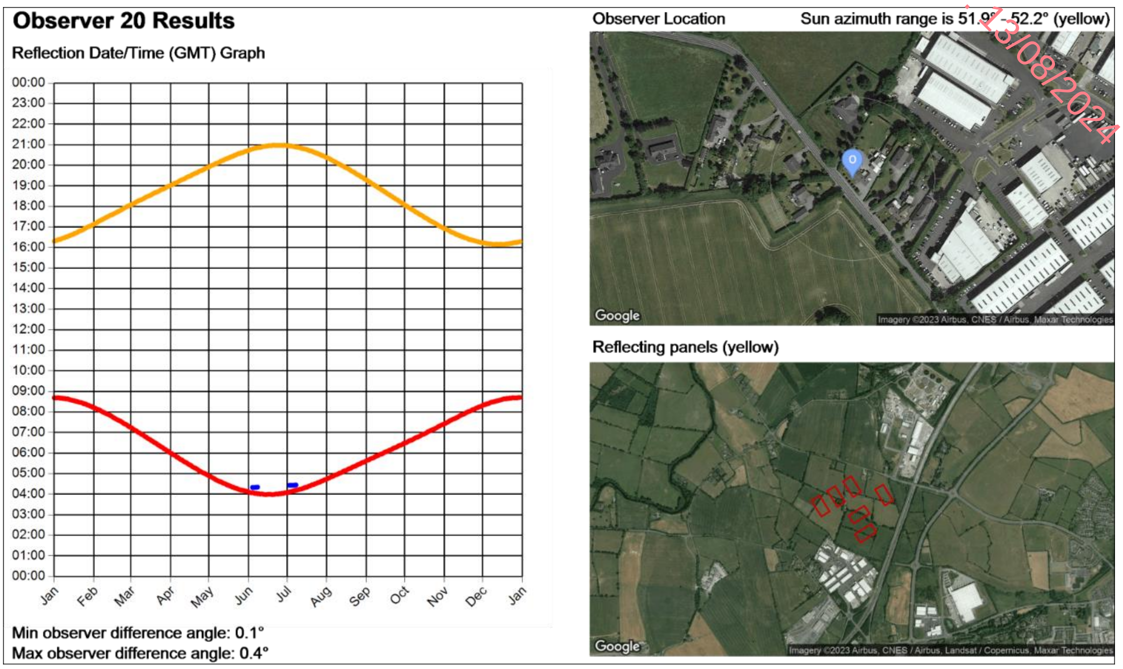

Observer 14 Results
Reflection Date/Time (GMT) Graph
00:00 23:00 22:00 21:00 20:00 19:00 18:00 17:00 16:00 15:00 14:00 13:00 12:00 11:00 10:00 09:00 08:00 07:00 06:00 05:00 04:00 03:00 02:00 01:00 00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0°
Max observer difference angle: 1.6°
Observer Location
Sun azimuth range is 52.5° - 55.6° (yellow)
Google
Reflecting panels (yellow)
Google

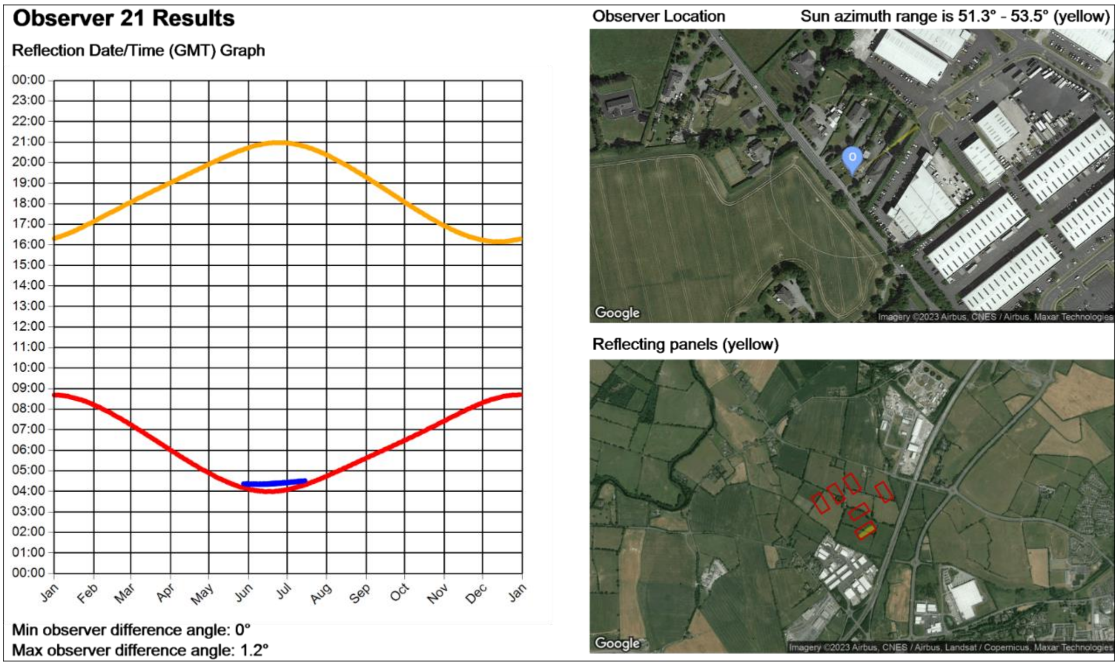

Observer 15 Results
Reflection Date/Time (GMT) Graph
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0°
Max observer difference angle: 1.5°
Observer Location
Sun azimuth range is 51° - 55.2° (yellow)
Reflecting panels (yellow)
Google


Observer 16 Results
Reflection Date/Time (GMT) Graph
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 0°
Max observer difference angle: 1.5°
Observer Location
Sun azimuth range is 51° - 55° (yellow)
Reflecting panels (yellow)
Google


Observer 17 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 51.2° - 55.3° (yellow)
Reflecting panels (yellow)
Min observer difference angle: 0°
Max observer difference angle: 1.6°


Observer 18 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 52.5° - 53.8° (yellow)
Reflecting panels (yellow)
Min observer difference angle: 0.9°
Max observer difference angle: 1.6°


Observer 20 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 51.9° - 52.2° (yellow)
Reflecting panels (yellow)
Min observer difference angle: 0.1°
Max observer difference angle: 0.4°


Observer 21 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 51.3° - 53.5° (yellow)
Reflecting panels (yellow)
Min observer difference angle: 0°
Max observer difference angle: 1.2°

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