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GLINT AND GLARE ASSESSMENT

Shelburne Energy Farm
County Wexford

Prepared by Macro Works Ltd

April 2026



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EXECUTIVE SUMMARY

This Glint and Glare Assessment was carried out by Macro Works Ltd to determine the potential for solar reflectance effects upon dwelling and transport route receptors within 1km of the proposed Shelburne Energy Farm.

The R735 and R734 were identified at an early stage of the process as a key receptor within the study area. Analysis of the final proposed solar farm layout identified that there was no potential for reflectance along these route once mitigation screen planting has fully established. It should be noted that there are no motorway or national route corridors within the glint and glare study area.

The assessment of reflectance at all residential dwellings within the 1km study area was also assessed. It concluded that there will be no notable reflectance effects generated from glint and glare towards surrounding dwellings as a result of the proposed solar farm.

The potential for hazardous effects upon aviation activities in the wider area was also considered but no relevant aviation receptors were identified and thus, aviation receptors were scoped out for further consideration.

On the basis of the analysis undertaken, it is not considered that there will be any notable reflectance effects or hazard effects generated from glint and glare upon any receptor identified in the study area as a result of the proposed solar farm.

1. GLINT AND GLARE ASSESSMENT

1.1 INTRODUCTION

This Glint and Glare Assessment was carried out by Macro Works Ltd to determine the potential for solar reflectance effects upon dwelling and transport route receptors of Shelburne Energy Farm in County Wexford.

1.1.1 Statement of Authority

Macro Works' relevant experience includes twenty years of analysing the visual effects of a wide range of infrastructural and commercial development types. This experience includes numerous domestic and international wind and solar energy developments. The Glint and Glare analysis model used in this study for non-aviation receptors was developed by Macro Works in conjunction with the National University of Ireland, (NUI) Maynooth. It has successfully replicated results from the Federal Aviation Administration (FAA) approved Solar Glare Hazard Analysis Tool (SGHAT) software and has been utilised to assess the effects of glint and glare for many solar development sites throughout Ireland to date.

1.1.2 Guidance and Best Practice

There is currently no specific guidance or standards for the assessment of photovoltaic glint and glare effects on residential and/or route (road and rail) receptors in Ireland. Guidance has been prepared, however, by the Federal Aviation Administration to address the potential hazards that solar developments may pose to aviation activities, and this has been adopted for use by the Irish Aviation Authority. This guidance, concerned with hazard assessment, has relevance to the other receptor types mentioned, and coupled with numerous assessments already carried out across the UK, combine to establish a suitable best practice for solar development.

By virtue of their efficiency, the intensity of reflected light from modern PV solar panels is deliberately low and currently equates with that of the reflection from still water. Recent studies generally agree, however, that there still exists the potential for hazard or nuisance upon surrounding receptors. Macro Works' glint and glare analysis methods and determination of effects are based on a combination of available studies and established best practice. This methodology has been successfully implemented on numerous previous solar farm projects that met with the approval of both Planning Authorities and An Bord Pleanála.

1.1.3 Definitions

The study is concerned with the potential nuisance and hazard effects of glint and glare in relation to receptors that include the occupants of surrounding dwellings as well as road and rail users. In its "Technical Guidance for Evaluating Selected Solar Technologies on Airports"¹ the FAA have defined the terms 'Glint' and 'Glare' as meaning;

Glint – "A momentary flash of bright light"

Glare – "A continuous source of bright light"

¹ Harris, Miller, Miller & Hanson Inc.. (November 2010). Technical Guidance for Evaluating Selected Solar Technologies on Airports; 3.1.2 Reflectivity. Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at: https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide.pdf

Glint and glare are essentially the reflection of sunlight from reflective surfaces. This study uses a multi-step process of elimination to determine which receptors have the potential to experience the effects of glint and glare. It then examines, using a computer-generated geometric model, the times of the year and the times of the day such effects could occur. This is based on the relative angles between the sun, the panels and the receptor throughout the year.

1.1.4 **General Nature of Reflectance From Photovoltaic Panels**

In terms of reflectance, photovoltaic solar panels are by no means a highly reflective surface. They are designed to absorb sunlight and not to reflect it. Nonetheless, photovoltaic panels have a flat, polished surface, which emits 'specular' reflectance rather than a 'diffuse' reflectance, which would occur from a rough surface (Figure 1.1 refers). Several studies have shown that photovoltaic panels (as opposed to Concentrated Solar Power) have similar reflectance characteristics to water, which is much lower than the likes of glass, steel, snow and white concrete by comparison (Figure 1.2 refers). Similar levels of reflectance can be found in common situations in rural environments from surfaces such as shed roofs, lines of plastic ground covering used in cropping and wet roads to name but a few (Figure 1.3 - Figure 1.5 refer).

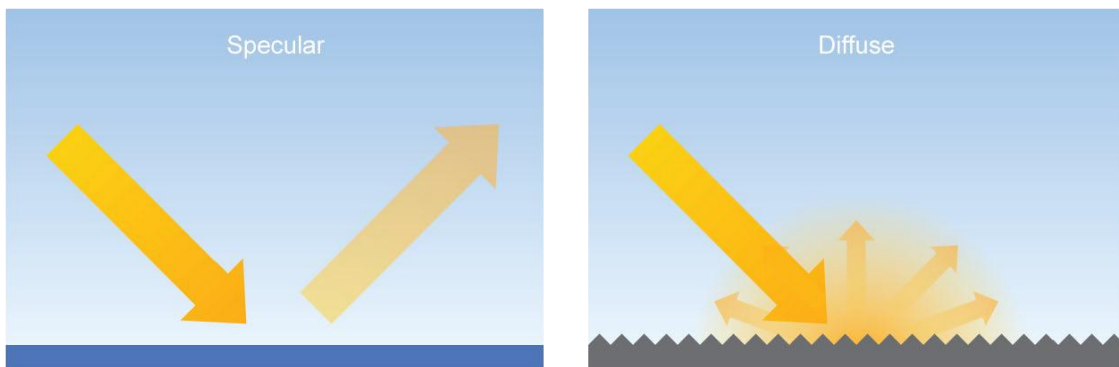


Figure 1.1: Specular vs Diffuse reflection of light from polished and rough surfaces.

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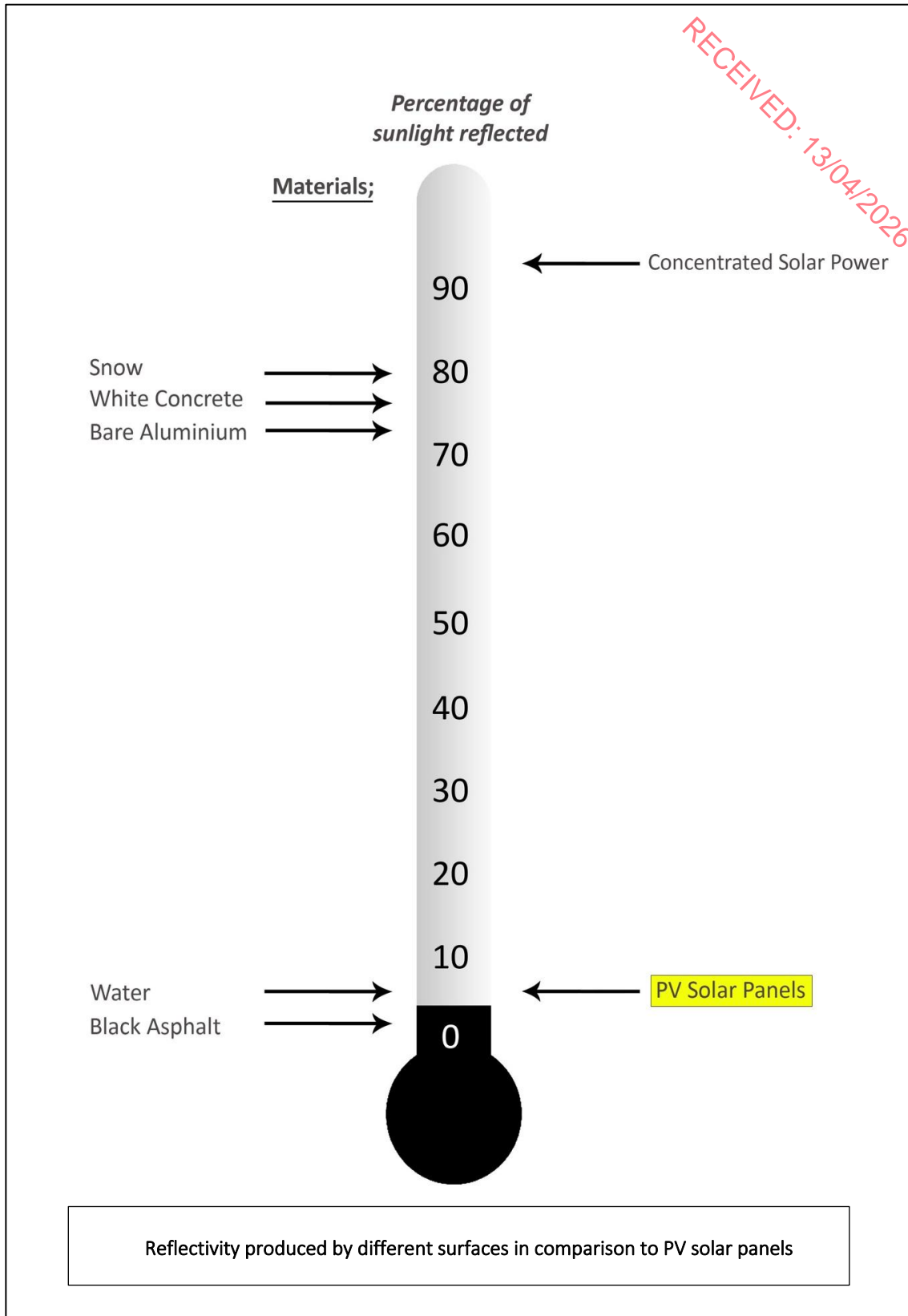


Figure 1.2: Demonstrates that the amount of sunlight (measured in watts per meter $-W/m^2$) reflected from the surface of a solar panel is very similar to that of still water and is far less than that of many surfaces commonly found in the environment, urban or rural.



Figure 1.3: Similar level of reflectance (to photovoltaic panels) emanating from plastic ground covering in an Irish rural scenario.



Figure 1.4: Similar levels of reflectance (to photovoltaic panels) emanating from wet road surfaces.



Figure 1.5: Higher levels of reflectance (to photovoltaic panels) emanating from powder coated corrugated metal roof surfaces in an Irish rural scenario.

1.2 ASSESSMENT OF GROUND-BASED RECEPTORS

1.2.1 Assessment Methodology For Ground-Base Receptors

Macro Works' glint and glare assessment methodology follows a rational sequence of steps to identify receptors that might potentially be affected by glint and glare. These are then further filtered to yield those receptors to those that are likely to actually experience such effects. These steps are set out below:

1. Identify study area within which to assess the potential for glint and glare effects. The potential for substantial nuisance or hazardous impacts are greatest in close proximity to the source of reflectance and the potential for adverse impacts reduces with increased distances therefore to balance these factors a buffer extent of 1km from the site boundary is used by default on all solar farms.
2. Pre-analyse the study area for potential glare effects by populating the study area with a regular grid of receptor points (100m spacing). This analysis (1st analysis) allows us to determine those areas theoretically exposed to glint and glare effects that might warrant further investigation. We call this the "Area of Consideration for Further Analysis". This pre-analysis is based on a 3D model of the development superimposed onto a Digital Terrain Model (DTM) of the study area. Note: This DTM accurately replicates the profile of the terrain but does not account for screening by the vegetation or buildings that are present – in this sense the results are somewhat theoretical but they do offer a representation of a bare-earth, worst-case scenario.
3. Identify relevant receptors (dwellings and transport routes) that fall within the theoretically affected zones of the study area (or the "Area of Consideration for Further Analysis"). Dwelling identification utilises a combination of up to date aerial photography and the Eircode Finder tool which locates and identifies buildings classed as residential. Transport route receptors are defined by regularly spaced points along roads and rail lines (50m spacing). The height of the road Receptor Points are set to 1.7m above ground level. This is broadly equivalent to the eye level a person walking or a driver of a 4x4 / SUV type vehicle. The height of rail Receptor Points are set to 2.8m above ground level to represent the eye level of a train driver.
4. Execute the glint and glare analysis on the DTM-based 3-D model (2nd analysis), in respect of each of the theoretically affected receptors. This identifies the times of the day and months of the year that glint and glare could potentially affect receptors in the absence of screening.

Note: When the sun is situated within 10 degrees of a reflecting PV panel as viewed from a particular receptor, the sun will be a much greater source of glare than what emanates from the surface of the PV panel therefore any potential glare during these periods is excluded when assessing potential impacts.

5. Perform the same calculations (3rd analysis) using a high-resolution digital surface model (DSM) that accounts for the existing screening inherent on and surrounding the site at the time of capture. This offers a truer reflection of the actual glare that is likely to occur and highlights where landscape mitigation may be required.

Note: A limitation of DSM data in the context of this assessment type is that it is a snapshot of the screening situation at the time of the data capture. This situation is broadly indicative as hedgerows are a semi-permanent feature of the Irish countryside, however, seasonal variation through growth and/or cutting may result in minor changes to their screening potential. A further limitation is due to the aerial overhead nature of data capture. This can result in the under-reporting of potential visibility beneath the tree or woodland canopy and can understate the visibly porous nature of some thin hedgerows. This can result in minor underestimating of glare periods. However, where the data is deemed to be significantly unreliable for the reasons stated, analysis is supplemented, where possible, with a thorough assessment of aerial photography, Google Street View imagery and on-site verification.

6. Where instances of glint and glare remain, determine whether they are likely to cause a hazard / nuisance. For dwellings, this is achieved by comparing the periods of glare potential with our 'Magnitude of Glint and Glare Effects' table, while transport routes are examined in further detail for potential for hazardous impacts.
7. If hazard / substantial nuisance is likely to occur, mitigation measures are proposed where possible. This might relate to the re-siting of particular panels and / or the provision of additional screening.
8. If necessary, re-run the glint and glare calculations (4th analysis) to verify the effectiveness of the proposed mitigation measures and determine if there are any residual glare impacts.

1.2.2 Magnitude of Impacts for Dwelling Receptors

Although there is currently no regulation or guidance as to acceptable levels of glint and glare effects at receptors in Ireland, it is considered necessary to provide a gauge for determining relative levels of impact across a range of development types. Macro Works has established the following indicative textual categories of effect, which are used herein to determine the relative impact levels (Table 1.1 refers). The percentage figures provided are intended as a relative guide only. The final category of assessment is determined on the basis of professional judgement, and accounts for mitigating factors where relevant and the careful consideration of a range of circumstantial variables that may act to intensify or reduce the effect upon a particular receptor.

Note: The magnitude of glint and glare effects in Table 1.1 relates only to static receptors such as residential dwelling. As road receptors are moving objects and will only ever have the potential to experience momentary reflectance periods, the following impact magnitudes are not considered relevant for road receptors. Instead, road receptors will be assessed on whether periods of reflectance have the potential to generate significant nuisance or hazard effects.

Table 1.1 Magnitude of Glint and Glare Effects

Magnitude of Impact	Description
Very High	Hazard / nuisance effects emanating from highly reflective surfaces (>50% sunlight reflection) for most of the year (>70% / 255 days) and for significant periods of each day (>45 mins).
High	Hazard / nuisance effects emanating from moderately reflective surfaces (>30% sunlight reflection) for the majority of days in a year (>50% / 182 days) and for substantial periods of each day (>30 mins).
Medium	Nuisance effects emanating from moderately/low reflective surfaces (>10% sunlight reflection) for a substantial number of days in a year (>30% / 109 days) and for substantial periods of each day (>20 mins).
Low	Nuisance effects emanating from low reflective surfaces (>5% sunlight reflection) for a modest number of days in a year (>10% / 36 days) and for notable periods of each day (>15 mins).
Very Low	Nuisance effects emanating from low reflective surfaces (>5% sunlight reflection) for a small number of days in a year (\leq 10% / 36 days) and for short periods of each day (<15 mins).
Negligible	Effects either not geometrically possible or barely measurable.

Important Note

It must be emphasised at this point that all results, whether from FAA endorsed SGIAT software or our own bespoke software, are theoretical by default in that they assume that the sun is always shining and at full intensity. The results do not account for climate and inherent weather patterns that occur across the island of Ireland.

Records from the meteorological station of Dublin Airport for the years 2010 - 2017 indicate a mean daily duration of sunshine of 4.1 hours, or approximately 33% of daylight hours². If we consider only those months where glare is likely to occur (March-September) this figure increases to 5.3 hours, or approximately 45% of daylight hours.

While we cannot correlate the historic random periods of sunshine with our predicted periods of glare, we can state with a high level of confidence that the weather, more precisely cloud cover, will account for a substantial reduction in all figures quoted in this report i.e. frequency and duration of glare periods.

In addition, atmospheric conditions such as haze, mist, fog and precipitation will all have the effect of both reducing the visibility of the site overall and reducing the intensity of any glare emanating from the proposed solar farm.

1.2.3 Relevant Parameters of the Proposed Development

The photovoltaic panels are to be oriented in a south-facing direction to maximise solar gain and will remain in a fixed position throughout the day and year (i.e. they will not rotate to track the movement of the sun). The panels will maintain a maximum height of up to 3.86 m above the terrain and will be tilted at a pitch of up to 20 degrees from horizontal towards the south. It is not geometrically possible for glare to occur in the terrain to the north of these south-facing PV panels; hence the 1 km study area does not extend to the north of the proposed PV panels.

A Zone of Theoretical Visibility (ZTV) analysis was undertaken as part of the Landscape and Visual Impact Assessment (LVIA), but it should be noted that areas shown on the ZTV map to have the potential for visibility of the PV array do not necessarily have the potential to be impacted by glint and glare (e.g. there is no geometric potential for glare anywhere to the north of the site but there may be the theoretical potential to see the back of PV panels).

The study area comprises low rolling terrain interspersed with small streams, with more notable elevations in the wider landscape to the west. The Owenduff River is the nearest notable watercourse to the Proposed Project, with other smaller streams situated along the boundary of the proposed solar array or in its immediate vicinity. In terms of land use, the study area is predominantly influenced by typical rolling pastoral lands divided by networks of well-established, mature, tree-lined hedgerows. Blocks of conifer forest plantation are also a notable land use, with a linear arrangement of forestry bounding the Proposed Project to the west.

² <https://www2.metweb.ie/climate/available-data/historical-data>

With regard to settlement, there are no notable centres of population within the 1 km glint and glare study area. The only settlement of note is the small rural village of Gusserane, located to the south of the Proposed Project. Otherwise, the study area comprises dispersed rural dwellings, small linear clusters of houses, and minor crossroads settlements. The principal transport routes comprise the R734 and R735 regional roads, situated to the west and south of the Proposed Project respectively. The R735 is the nearer of the two, located approximately 250 m to the south of the site at its closest point. Otherwise, the study area consists of a network of intersecting local roads, several of which run immediately adjacent to the Proposed Project.

Further, south facing panels in a landscape such as this result in a typical pattern of glare with potential glare impacts upon surrounding receptors occurring during the months February – October. This broadly represents the season where some or all foliage is present on vegetation. The assessment of the screening capacity of the surrounding vegetation in its winter state is therefore not necessary.



Figure 1.6: Aerial view (Google Earth Pro) of proposed solar development site (red outline), and the study area (blue outline).

1.2.4 Mitigation by Design

It is proposed that all existing hedgerows within and around the perimeter of the site be allowed to ‘grow-out’ prior to construction.

The location of the proposed mitigation planting is indicated on the Landscape Mitigation Plans - Overall, Section A, B and C (Drawing numbers 25WX01_DR-0100 to 103). This comprises proposed screen planting in the surrounds of the nearest residential receptors adjacent to Array Area A, protection and enhancement of hedgerows with replanting of degraded hedgerow, retained hedgerow reinforced with new planting, woodland retention, and proposed native woodland planting. The removal of hedgerows to accommodate sightlines will result in a net loss of 75m of hedgerows (accounting for a loss of only 0.5% of existing hedgerow length).

Once the relevant construction and associated works are complete, the hedgerows will be brought under regular agricultural management and trimmed to a height of approximately 4m (generally greater than the maximum height of the proposed panels). Other existing hedgerows and vegetation will also be maintained to maximise screening of the proposed development to provide consistent screening of the solar farm from nearby dwellings and transport routes. These proposed mitigation measures were added to the Digital Surface Model (DSM) analysis in order to produce the 'post-mitigation' results.

1.2.5 **Assessment of Residential Receptors**

1.2.5.1 *Identification of Relevant Residential Receptors*

Figure 1.7 and 1.8 are output maps of the study area showing the results (areas of potential solar irradiance) of 1st phase reflectance analysis carried out on the proposed solar farm. These account for the path of the sun throughout the entire year; the panel positions and parameters; the 3D terrain parameters. This is the starting point for determining which residential receptors have the geometric potential to be affected by glint and glare – in the absence of screening.

Note: the yellow buffer line around the reflectance pattern indicating 'Area of consideration for further analysis' on the output maps represents a precautionary approach of including dwellings at the fringe of potentially affected areas. It accounts for the fact that this 'first-filter' map is based on a sampling grid point density of 100m.

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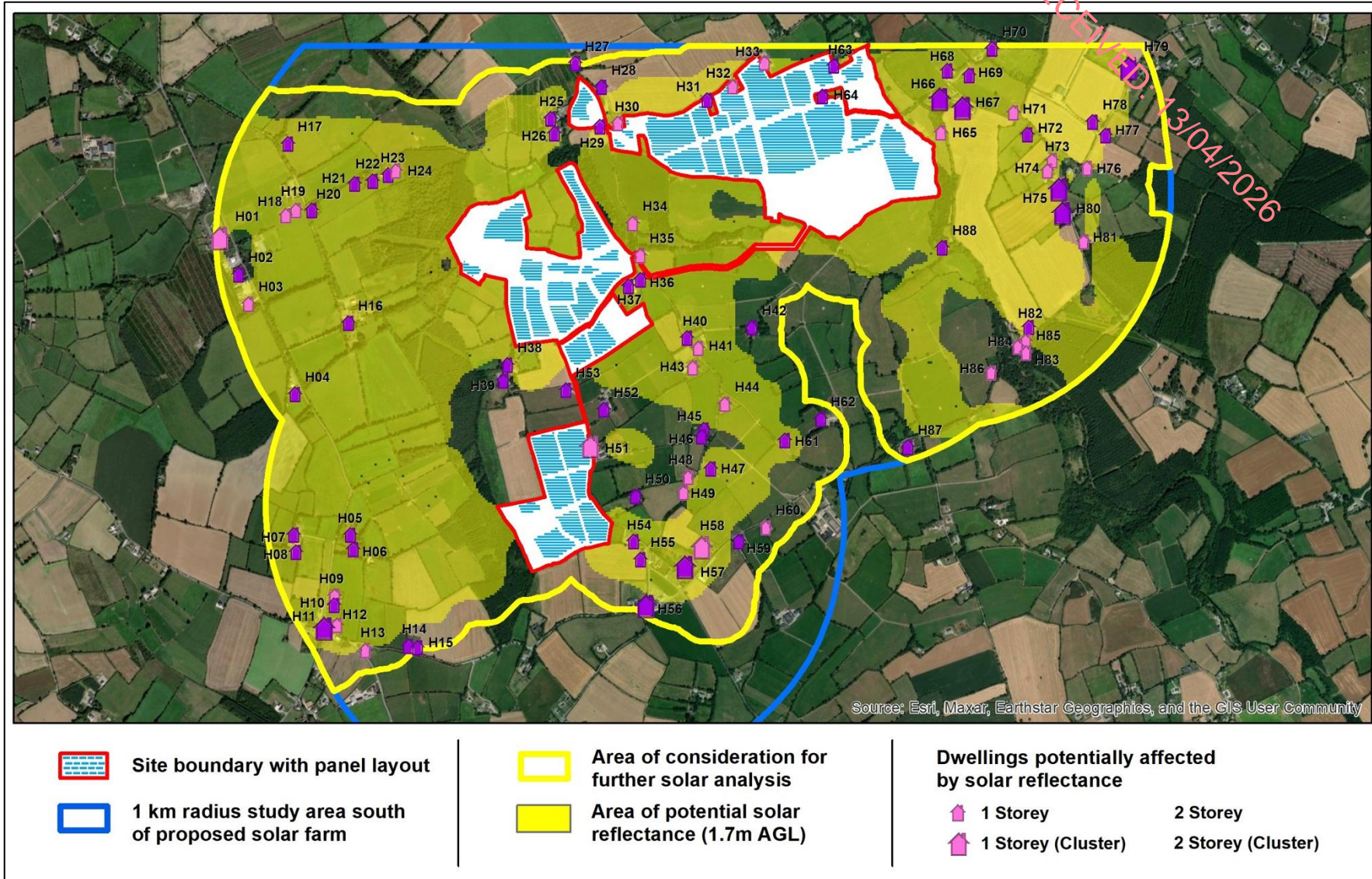
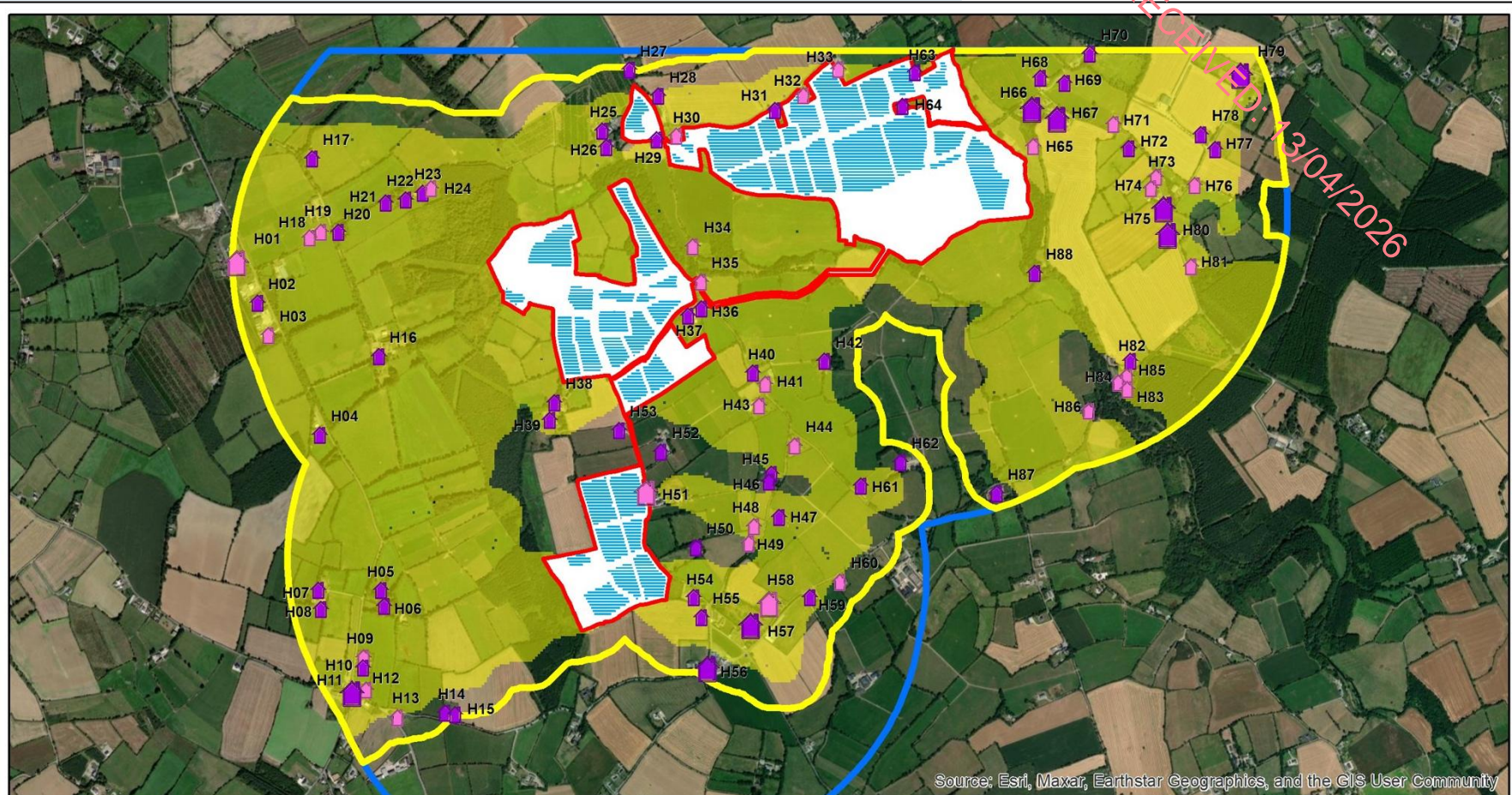


Figure 1.7 Parts of the study area where houses are potentially affected by glint and glare. The results are based on 3D terrain data that does not account for screening by vegetation or man-made structures and are based on a viewers' eye-level when standing on the ground floor = 1.7m above ground level.

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Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community







 Site boundary with panel layout  1 km radius study area south of proposed solar farm	 Area of consideration for further solar analysis  Area of potential solar reflectance (4.3m AGL)	Dwellings potentially affected by solar reflectance  1 Storey 2 Storey  1 Storey (Cluster) 2 Storey (Cluster)
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Figure 1.8 Parts of the study area where houses are potentially affected by glint and glare. The results are based on 3D terrain data that does not account for screening by vegetation or man-made structures and are based on a viewers' eye-level when standing on the ground floor = 4.3m above ground level.

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1.2.6 Results of Analysis of Residential Receptors

The results of the analysis for the dwellings which occur within the ‘Area of Consideration for Further Analysis’ are contained in Appendix A and C. These set out the times of day and days of the year that glint and glare effects could theoretically be experienced at residential receptors within the study area. Appendix C includes the entire potential glare periods, however in accordance with the stated methodology, Appendix A excludes periods where the sun is within 10 degrees of the angle of reflectance and it is these figures that form the basis of this assessment.

A summary of the results in Appendix A is included in Table 1.2 below. An assessment of the results will be undertaken in Section 1.2.6.1. This assessment also outlines the potential magnitude of impact that may occur at residential receptors.

Note: The results in the left hand columns of Appendix A are theoretical in that they are derived from a “bare-ground” data model that does not account for screening that might exist in the intervening landscape in the form of buildings and/or vegetation. This helps to establish a worst-case scenario baseline, from which we identify a subset of receptors for more thorough investigation. It is important to note that these figures do not necessarily represent an accurate portrayal of real impacts.

Table 1.2 Summary of Results in Appendix A - Dwellings

Receptor ID	Reflectance theoretically possible based on DTM topographic mapping (for control purposes)	Potential for impact after existing screening is taken into account (DSM)	Potential for impact after the proposed mitigation screening is taken into account (DSM)
H01	Yes Potentially	None	None
H02	Yes Potentially	None	None
H03	Yes Potentially	None	None
H04	Yes Potentially	None	None
H05	Yes Potentially	None	None
H06	Yes Potentially	None	None
H07	Yes Potentially	None	None
H08	Yes Potentially	None	None
H09	Yes Potentially	None	None
H10	Yes Potentially	Yes Potentially	Yes Potentially
H11	Yes Potentially	None	None
H12	Yes Potentially	None	None
H13	None	None	None
H14	None	None	None
H15	None	None	None
H16	Yes Potentially	None	None
H17	Yes Potentially	Yes Potentially	None

H18	Yes Potentially	None	None
H19	Yes Potentially	None	None
H20	Yes Potentially	None	None
H21	Yes Potentially	None	None
H22	Yes Potentially	None	None
H23	Yes Potentially	None	None
H24	Yes Potentially	None	None
H25	Yes Potentially	None	None
H26	Yes Potentially	None	None
H27	None	None	None
H28	Yes Potentially	None	None
H29	Yes Potentially	None	None
H30	Yes Potentially	None	None
H32	Yes Potentially	None	None
H33	None	None	None
H34	Yes Potentially	None	None
H35	Yes Potentially	None	None
H36	Yes Potentially	None	None
H37	Yes Potentially	Yes Potentially	None
H38	Yes Potentially	None	None
H39	Yes Potentially	None	None
H40	Yes Potentially	None	None
H41	Yes Potentially	None	None
H42	None	None	None
H43	Yes Potentially	None	None
H44	Yes Potentially	None	None
H45	None	None	None
H46	None	None	None
H47	Yes Potentially	None	None
H48	None	None	None
H49	Yes Potentially	None	None
H50	Yes Potentially	None	None
H51	Yes Potentially	None	None
H52	None	None	None
H53	None	None	None
H54	Yes Potentially	None	None
H55	Yes Potentially	None	None

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H56	Yes Potentially	None	None
H57	Yes Potentially	None	None
H58	Yes Potentially	None	None
H59	Yes Potentially	None	None
H60	None	None	None
H61	Yes Potentially	None	None
H62	None	None	None
H63	Yes Potentially	Yes Potentially	Yes Potentially
H64	Yes Potentially	None	None
H65	Yes Potentially	None	None
H66	Yes Potentially	None	None
H67	Yes Potentially	Yes Potentially	Yes Potentially
H68	Yes Potentially	Yes Potentially	Yes Potentially
H69	Yes Potentially	Yes Potentially	Yes Potentially
H70	Yes Potentially	None	None
H71	Yes Potentially	Yes Potentially	Yes Potentially
H72	Yes Potentially	None	None
H73	Yes Potentially	None	None
H74	Yes Potentially	None	None
H75	Yes Potentially	None	None
H76	None	None	None
H77	Yes Potentially	None	None
H78	Yes Potentially	None	None
H79	Yes Potentially	None	None
H80	Yes Potentially	None	None
H81	None	None	None
H82	Yes Potentially	None	None
H83	Yes Potentially	None	None
H84	None	None	None
H85	None	None	None
H86	None	None	None
H87	None	None	None
H88	Yes Potentially	None	None

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1.2.6.1 *Effects on Residential Receptors*

A total of 88 dwellings were examined. Computer analysis using terrain-only data (DTM) identified that glint and glare is geometrically possible at 68 of these. Further analysis, taking account of the existing screening inherent across the study area (using a digital surface model - DSM) and on-site verification of the analysis results, indicates that 8 no. dwellings are actually likely to have the potential to be materially affected by glint and glare prior to mitigation. This is on the basis of the considerable screening afforded by buildings and hedgerows that occur between the vast majority of receptors and potentially reflecting panels. Post mitigation establishment only 6 no. of these dwellings have the potential to incur glint and glare effects. Details of the assessment for these dwellings are outlined below.

H10

House 10 is a two storey dwelling located at Rose Hall along the alignment of the R734 regional road some c. 850 m southwest of the site. The analysis indicates the theoretical potential for reflectance emanating from the proposed PV panels at only the first floor of this dwelling for a maximum of 22 minutes per day and a total of 103 days of the year. Once the proposed mitigation screen planting has fully establish, the potential reflectance periods will marginal reduce from a maximum of 1070 minutes per year to a maximum of 1042 minutes per year. It should also be noted that the potentially reflecting panels are located some c. 1km from this dwelling. As a result, the magnitude of effect is deemed **Low**.

H63

House H63 is a two storey dwelling located along the northern boundary of parcel A, with panels contained to the east and west of this dwelling. The analysis indicates the theoretical potential for reflectance emanating from the proposed PV panels at only the first floor of this dwelling for a maximum of 2 minutes per day and a total of 36 minutes over an entire year period. The proposed mitigation screen planting will have no effect on these reflectance periods, however, due to the limited periods of potential reflectance, the magnitude of effect is deemed **Negligible**.

H67

House H67 represents a small linear cluster of dwellings located along a local road laneway to the east of parcel A. The analysis indicates the theoretical potential for reflectance emanating from the proposed PV panels at only the first floor of this dwelling for a maximum of 8 minutes per day and a total of 44 minutes over an entire year period. The proposed mitigation screen planting will have no effect on these reflectance periods, however, due to the limited periods of potential reflectance, the magnitude of effect is deemed **Negligible**.

H68

House H68 represents a two-storey dwelling located along a local road some c. 300 m east of parcel A. The analysis indicates the theoretical potential for reflectance emanating from the proposed PV panels at the ground floor of this dwelling for a maximum of 4 minutes per day over 15 days of the year and a maximum of 38 minutes over an entire year period. Reflectance has the potential to occur at the first floor of this dwelling for a maximum of 2 minutes per day over 17 days of the year and for a total of 34 minutes over an entire year. The proposed mitigation screen planting will have no effect on these reflectance periods, however, due to the limited periods of potential reflectance, the magnitude of effect is deemed **Negligible**.

H69

House H69 represents a two-storey residential dwelling located some c. 370 m to the east of the proposed parcel A. The analysis indicates the theoretical potential for reflectance emanating from the proposed PV panels at only the first floor of this dwelling for a maximum of 2 minutes per day over 2 days of the year and a total of 4 minutes over an entire year period. The proposed mitigation screen planting will have no effect on these reflectance periods, however, due to the limited periods of potential reflectance, the magnitude of effect is deemed **Negligible**.

H71

House H71 represents a single-storey residential dwelling located some c. 390 m to the east of the proposed parcel A. The analysis indicates the theoretical potential for reflectance emanating from the proposed PV panels at this dwelling for a maximum of 12 minutes per day over 20 days of the year and a total of 116 minutes over an entire year period. Once fully established, the proposed mitigation will further reduce these periods to a maximum of 6 minutes of reflectance per day over 20 days of the year and for a total of 74 minutes over an entire year period. Thus, the magnitude of effect is deemed **Very Low**.

Note: It is important to note that the reflectance periods identified above are theoretical and represent the worst-case scenario in terms of potential reflectance and assume that the sun is always shining and at full intensity. The results do not account for climate and inherent weather patterns that occur across the island of Ireland (refer to Met Eireann data³). In addition, atmospheric conditions such as haze, mist, fog and precipitation will all have the effect of both reducing the visibility of the site overall and reducing the intensity of any glare emanating from the proposed solar farm. Overall, it is not considered that the reflectance periods outlined above will materially impact on the enjoyment of any properties considered in this assessment. As landscape professionals with a combined 20+ years of LVIA experience, Macro Works do not consider that the reflectance periods outlined above will materially impact on the enjoyment of this property.

1.2.6.2 *Ameliorating Factors*

A key consideration for reflectance effects is the incidence (incoming) angle of the sun's rays when they strike the reflecting surface (solar panels in this instance). The most intense reflective rays occur when the receptor is at 90 degrees to the incidence rays. At decreasing angles the reflectance becomes increasingly diffused across a wider portion of the reflecting surface, thereby diminishing the intensity of the reflected rays. The nature of the reflecting surface also plays a major part in the degree of diffusion / absorption of the incidence rays and modern PV solar panels have become very efficient at absorbing rather than reflecting light.

³ <https://www2.metweb.ie/climate/available-data/historical-data>

A technical note on solar module glare and reflectance prepared by SunPower Corporation⁴ outlines the degree of material reflectivity for a range of sun incident angles. As per the table below (Table 1.3 below) the degree of reflectivity of solar panels below 30 degrees is < 5.03% and is likely to have no material consequence on surrounding receptors. It is also important to reiterate that in terms of reflectance, photovoltaic solar panels are by no means a highly reflective surface. They are designed to absorb sunlight and not to reflect it. Furthermore, as technology has improved, the addition of an antireflective coating on panels has become an option. A June 2023 study by Loughborough University states “currently around 90% of commercial PV modules are supplied with an AR coating applied to the cover glass”⁵.

Several studies have shown that even standard photovoltaic panels, without anti-reflective coatings have similar reflectance characteristics to water, which is much lower than the likes of glass, steel and snow by comparison (see Table 1.3). Similar levels of reflectance can be found in common situations in rural environments from surfaces such as shed roofs, lines of plastic ground covering used in cropping and wet roads to name but a few. In the case of modern PV solar panels which include an anti-reflective coating, reflectance levels are even less than that emitted from standard window glass and still water.

Table 1.3 Material Reflectivity at various sun incident angles (derived from Sunpower Corporation (September 2009), T09014 Solar Module Glare and Reflectance Technical Memo)

Common Reflective Surfaces (In surrounding environments for PV systems)		Sun Incident angle in degrees						
		0	15	30	45	60	75	90
Material Reflectivity (percent of incident light reflected)	Steel	36.73%	39.22%	46.34%	57.11%	70.02%	83.15%	94.40%
	Snow	21.63%	23.09%	27.29%	33.63%	41.23%	48.96%	55.59%
	Standard Glass	8.44%	9.01%	10.65%	13.12%	16.09%	19.10%	21.69%
	Plexiglass	8.00%	8.54%	10.09%	12.44%	15.25%	18.11%	20.56%
	Plastic	6.99%	7.46%	8.82%	10.87%	13.33%	15.83%	17.97%
	Smooth Water	4.07%	4.35%	5.14%	6.33%	7.76%	9.22%	10.47%
	Solar Glass (high light transmission)	3.99%	4.26%	5.03%	6.20%	7.61%	9.03%	10.26%
	Solar Glass w/AR coating	2.47%	2.64%	3.12%	3.84%	4.71%	5.59%	6.35%

Note: Index of refraction values may vary slightly depending on suppliers and reference documentation.

1.2.7 Conclusion - Residential Receptors

Each dwelling within 1km of the proposed development has been fully assessed based on location, height and orientation in relation to the proposed solar farm. For the reasons outlined above, it has been determined that glint and glare impacts are at the lower end of the spectrum (i.e. ranging between Low and Negligible) as the proposed panels are not considered to be highly reflective surfaces, and the frequency/durations involved are not considered excessive to the degree that they will have a material impact on the enjoyment of any property.

It must also be re-emphasised that the reflectance periods provided are theoretical by default and represent a worst-case scenario in that they assume that the sun is always shining and at full intensity. In the Irish context, the reflectance frequency/duration figures provided are likely to be at least double the reality, according to Met Eireann data.

⁴ Sunpower Corporation (September 2009), T09014 Solar Module Glare and Reflectance Technical Memo

⁵ “The performance and durability of Anti-reflection coatings for solar module cover glass – a review” Available at: <https://www.sciencedirect.com/science/article/pii/S0038092X23004061>

Thus, it is considered that there will be no notable reflectance effects generated from glint and glare towards surrounding dwellings as a result of the proposed solar farm.

1.2.8 **Assessment of Transport Route Receptors**

1.2.8.1 *Identification of Relevant Transport Route Receptors*

Figure 1.9 is an output map of the study area showing the results (areas of potential solar irradiance) of 1st phase reflectance analysis carried out on the proposed solar farm. These account for the path of the sun throughout the entire year; the panel positions and parameters; the 3D terrain parameters. This is the starting point for determining which transport route receptors have the geometric potential to be affected by glint and glare – in the absence of screening.

Note: the yellow buffer line around the reflectance pattern indicating 'Area of consideration for further analysis' on the output map represents a precautionary approach of including transport route sections at the fringe of potentially affected areas. It accounts for the fact that this 'first-filter' map is based on a sampling grid point density of 100m.

Receptor Points have been positioned along all the potentially affected roads (R) and railways (T) within the 'Area of Consideration for Further Analysis'. Transport route Receptor Points are placed automatically in an un-biased fashion at 50m intervals along route lines using Geographic Information Systems (GIS) software. There will be instances where points may be screened by single trees in otherwise open sections of route, or, conversely they may be exposed through a gateway in an otherwise long section of screening hedgerow. Their frequency is designed, however, to reflect the overall screening characteristics of the route sections.

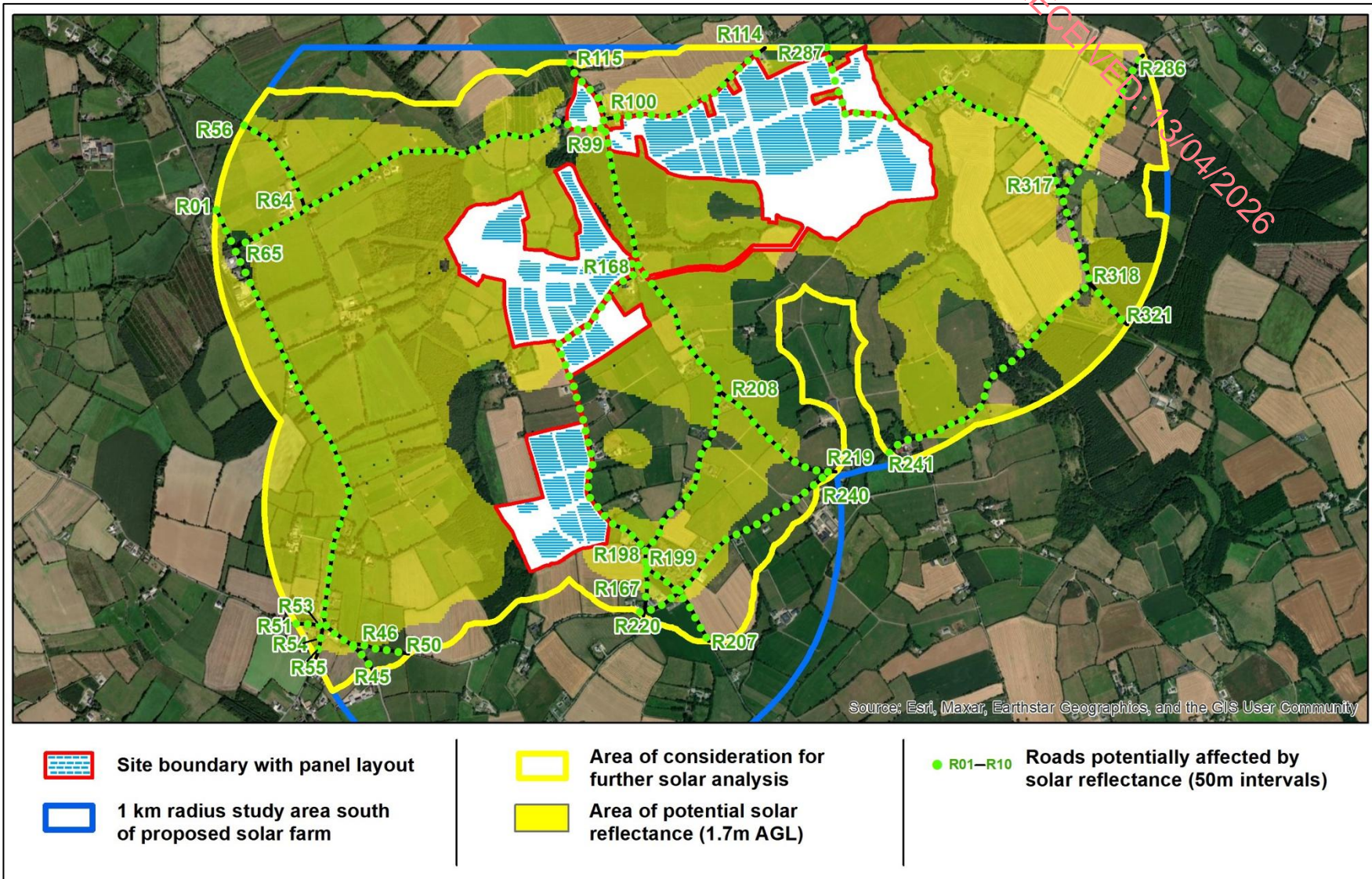


Figure 1.9 Parts of the study area where roads are potentially affected by glint and glare. The results are based on 3D terrain data that does not account for screening by vegetation or man-made structures and are based on viewer's eye level at 1.7m above ground level for roads

1.2.9 Results of Analysis of Transport Route Receptors

The results of the analysis for the transport routes which occur within the 'Area of Consideration for Further Analysis' is contained in Appendix B and D. These set out the times of day and days of the year that glint and glare effects could theoretically be experienced at transport route receptors within the study area. Appendix D includes the entire potential glare periods, however in accordance with the stated methodology, Appendix B excludes periods where the sun is within 10 degrees of the angle of reflectance, and it is these figures that form the basis of this assessment.

A summary of the results in Appendix B is included in Table 1.4 below. An assessment of the results will be undertaken in Section 1.2.9.1

Note: The results in the left hand columns of Appendix B are theoretical in that they are derived from a "bare-ground" data model that does not account for screening that might exist in the intervening landscape in the form of buildings and/or vegetation. This helps to establish a worst-case scenario baseline, from which we identify a subset of receptors for more thorough investigation. It is important to note that these figures do not necessarily represent an accurate portrayal of real impacts.

It is important to note that the figures for the maximum minutes per day in Appendix B relate to the time window that a section of route can potentially experience reflectance and are therefore of less consequence than they would be for a static dwelling receptor. Such effects can only be experienced for the period of time it takes to travel along the affected road section, and therefore will be fleeting and in any event significantly less than the maximum periods outlined.

Table 1.4 Summary of Results contained in Appendix B - Transport Receptors: Roads

Receptor ID	Reflectance theoretically possible based on DTM topographic mapping (for control purposes)	Potential for impact after existing screening is taken into account (DSM)	Potential for impact after the proposed mitigation screening is taken into account (DSM)
R01	Yes Potentially	None	None
R02	Yes Potentially	None	None
R03	Yes Potentially	None	None
R04	None	None	None
R05	None	None	None
R06	None	None	None
R07	None	None	None
R08	Yes Potentially	None	None
R09	Yes Potentially	None	None
R10	Yes Potentially	None	None
R11	Yes Potentially	None	None
R12	Yes Potentially	None	None
R13	Yes Potentially	None	None
R14	Yes Potentially	None	None
R15	Yes Potentially	None	None

R16	Yes Potentially	None	None
R17	Yes Potentially	None	None
R18	Yes Potentially	None	None
R19	Yes Potentially	None	None
R20	Yes Potentially	None	None
R21	Yes Potentially	None	None
R22	Yes Potentially	None	None
R23	Yes Potentially	None	None
R24	Yes Potentially	None	None
R25	Yes Potentially	None	None
R26	Yes Potentially	None	None
R27	Yes Potentially	None	None
R28	Yes Potentially	None	None
R29	Yes Potentially	None	None
R30	Yes Potentially	None	None
R31	Yes Potentially	None	None
R32	Yes Potentially	None	None
R33	Yes Potentially	None	None
R34	Yes Potentially	None	None
R35	Yes Potentially	None	None
R36	Yes Potentially	None	None
R37	Yes Potentially	None	None
R38	Yes Potentially	None	None
R39	Yes Potentially	None	None
R40	Yes Potentially	None	None
R41	Yes Potentially	None	None
R42	Yes Potentially	None	None
R43	Yes Potentially	None	None
R44	None	None	None
R45	None	None	None
R46	Yes Potentially	None	None
R47	None	None	None
R48	None	None	None
R49	None	None	None
R50	None	None	None
R51	Yes Potentially	None	None
R52	Yes Potentially	None	None

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R53	Yes Potentially	None	None
R54	Yes Potentially	None	None
R55	None	None	None
R56	Yes Potentially	None	None
R57	Yes Potentially	None	None
R58	Yes Potentially	None	None
R59	None	None	None
R60	Yes Potentially	None	None
R61	Yes Potentially	None	None
R62	Yes Potentially	None	None
R63	Yes Potentially	None	None
R64	Yes Potentially	None	None
R65	None	None	None
R66	Yes Potentially	None	None
R67	Yes Potentially	None	None
R68	Yes Potentially	None	None
R69	Yes Potentially	None	None
R70	Yes Potentially	None	None
R71	Yes Potentially	None	None
R72	Yes Potentially	None	None
R73	Yes Potentially	None	None
R74	Yes Potentially	None	None
R75	Yes Potentially	None	None
R76	Yes Potentially	None	None
R77	Yes Potentially	None	None
R78	Yes Potentially	None	None
R79	Yes Potentially	None	None
R80	Yes Potentially	None	None
R81	Yes Potentially	None	None
R82	Yes Potentially	None	None
R83	Yes Potentially	None	None
R84	Yes Potentially	None	None
R85	Yes Potentially	None	None
R86	Yes Potentially	None	None
R87	None	None	None
R88	None	None	None
R89	Yes Potentially	None	None

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R90	Yes Potentially	None	None
R91	Yes Potentially	None	None
R92	Yes Potentially	None	None
R93	Yes Potentially	None	None
R94	Yes Potentially	None	None
R95	Yes Potentially	None	None
R96	None	None	None
R97	None	None	None
R98	Yes Potentially	None	None
R99	Yes Potentially	None	None
R100	Yes Potentially	None	None
R101	Yes Potentially	None	None
R102	Yes Potentially	None	None
R103	Yes Potentially	None	None
R104	Yes Potentially	None	None
R105	Yes Potentially	Yes Potentially	None
R106	Yes Potentially	Yes Potentially	None
R107	Yes Potentially	None	None
R108	Yes Potentially	Yes Potentially	None
R109	Yes Potentially	None	None
R110	Yes Potentially	None	None
R111	Yes Potentially	Yes Potentially	Yes Potentially
R112	Yes Potentially	Yes Potentially	None
R113	None	None	None
R114	None	None	None
R115	None	None	None
R116	None	None	None
R117	None	None	None
R118	Yes Potentially	None	None
R119	Yes Potentially	None	None
R120	Yes Potentially	None	None
R121	Yes Potentially	None	None
R122	Yes Potentially	None	None
R123	None	None	None
R124	Yes Potentially	None	None
R125	Yes Potentially	None	None
R126	Yes Potentially	None	None

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R127	Yes Potentially	None	None
R128	Yes Potentially	None	None
R129	Yes Potentially	None	None
R130	Yes Potentially	None	None
R131	Yes Potentially	None	None
R132	Yes Potentially	None	None
R133	Yes Potentially	None	None
R134	Yes Potentially	None	None
R135	Yes Potentially	None	None
R136	Yes Potentially	None	None
R137	Yes Potentially	None	None
R138	Yes Potentially	None	None
R139	Yes Potentially	None	None
R140	Yes Potentially	None	None
R141	Yes Potentially	None	None
R142	Yes Potentially	None	None
R143	Yes Potentially	None	None
R144	Yes Potentially	None	None
R145	Yes Potentially	None	None
R146	Yes Potentially	None	None
R147	Yes Potentially	None	None
R148	Yes Potentially	None	None
R149	Yes Potentially	None	None
R150	Yes Potentially	None	None
R151	None	None	None
R152	None	None	None
R153	None	None	None
R154	Yes Potentially	None	None
R155	Yes Potentially	None	None
R156	Yes Potentially	None	None
R157	Yes Potentially	None	None
R158	Yes Potentially	None	None
R159	Yes Potentially	None	None
R160	Yes Potentially	None	None
R161	Yes Potentially	None	None
R162	Yes Potentially	None	None
R163	Yes Potentially	None	None

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R164	Yes Potentially	None	None
R165	Yes Potentially	None	None
R166	Yes Potentially	None	None
R167	Yes Potentially	None	None
R168	Yes Potentially	None	None
R169	Yes Potentially	None	None
R170	Yes Potentially	None	None
R171	None	None	None
R172	Yes Potentially	None	None
R173	Yes Potentially	None	None
R174	Yes Potentially	None	None
R175	Yes Potentially	None	None
R176	Yes Potentially	None	None
R177	Yes Potentially	None	None
R178	Yes Potentially	None	None
R179	Yes Potentially	None	None
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R181	None	None	None
R182	None	None	None
R183	None	None	None
R184	None	None	None
R185	None	None	None
R186	Yes Potentially	None	None
R187	Yes Potentially	None	None
R188	Yes Potentially	None	None
R189	Yes Potentially	None	None
R190	Yes Potentially	None	None
R191	None	None	None
R192	Yes Potentially	None	None
R193	Yes Potentially	None	None
R194	None	None	None
R195	Yes Potentially	None	None
R196	Yes Potentially	None	None
R197	Yes Potentially	Yes Potentially	None
R198	Yes Potentially	None	None
R199	Yes Potentially	None	None
R200	Yes Potentially	None	None

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R201	Yes Potentially	None	None
R202	Yes Potentially	None	None
R203	None	None	None
R204	None	None	None
R205	None	None	None
R206	None	None	None
R207	None	None	None
R208	Yes Potentially	None	None
R209	Yes Potentially	None	None
R210	Yes Potentially	None	None
R211	Yes Potentially	None	None
R212	Yes Potentially	None	None
R213	Yes Potentially	None	None
R214	Yes Potentially	None	None
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R222	Yes Potentially	None	None
R223	Yes Potentially	None	None
R224	Yes Potentially	None	None
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R231	Yes Potentially	None	None
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R234	None	None	None
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R237	None	None	None

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R238	None	None	None
R239	None	None	None
R240	None	None	None
R241	None	None	None
R242	None	None	None
R243	None	None	None
R244	None	None	None
R245	Yes Potentially	None	None
R246	Yes Potentially	None	None
R247	Yes Potentially	None	None
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R249	None	None	None
R250	None	None	None
R251	None	None	None
R252	None	None	None
R253	None	None	None
R254	None	None	None
R255	None	None	None
R256	None	None	None
R257	Yes Potentially	None	None
R258	Yes Potentially	None	None
R259	Yes Potentially	None	None
R260	Yes Potentially	None	None
R261	Yes Potentially	None	None
R262	Yes Potentially	None	None
R263	Yes Potentially	None	None
R264	Yes Potentially	None	None
R265	Yes Potentially	None	None
R266	Yes Potentially	None	None
R267	Yes Potentially	None	None
R268	None	None	None
R269	None	None	None
R270	None	None	None
R271	None	None	None
R272	None	None	None
R273	None	None	None
R274	None	None	None

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R275	None	None	None
R276	None	None	None
R277	Yes Potentially	None	None
R278	Yes Potentially	None	None
R279	Yes Potentially	None	None
R280	None	None	None
R281	Yes Potentially	None	None
R282	None	None	None
R283	None	None	None
R284	None	None	None
R285	None	None	None
R286	None	None	None
R287	None	None	None
R288	None	None	None
R289	Yes Potentially	None	None
R290	Yes Potentially	Yes Potentially	None
R291	Yes Potentially	None	None
R292	Yes Potentially	None	None
R293	Yes Potentially	None	None
R294	Yes Potentially	None	None
R295	Yes Potentially	None	None
R296	Yes Potentially	None	None
R297	Yes Potentially	None	None
R298	Yes Potentially	None	None
R299	Yes Potentially	None	None
R300	Yes Potentially	None	None
R301	Yes Potentially	None	None
R302	Yes Potentially	None	None
R303	Yes Potentially	None	None
R304	Yes Potentially	None	None
R305	Yes Potentially	None	None
R306	Yes Potentially	None	None
R307	Yes Potentially	None	None
R308	Yes Potentially	Yes Potentially	None
R309	Yes Potentially	None	None
R310	Yes Potentially	None	None
R311	Yes Potentially	None	None

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R312	Yes Potentially	None	None
R313	Yes Potentially	None	None
R314	Yes Potentially	None	None
R315	Yes Potentially	None	None
R316	Yes Potentially	None	None
R317	None	None	None
R318	Yes Potentially	None	None
R319	Yes Potentially	None	None
R320	Yes Potentially	None	None
R321	Yes Potentially	None	None

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1.2.9.1 *Effects on Road Receptors*

Appendix B examined a total of 321 road Receptor Points. Analysis of terrain-level screening (using a digital terrain model - DTM) identified that glint and glare is theoretically possible at 237 of these road Receptor Points. Further analysis, taking account of the existing screening inherent across the study area (using a digital surface model - DSM) and on-site verification of the analysis results, determined that 8 of the road receptor points will actually have the potential to be materially affected by glint and glare prior to mitigation. These road receptor points are situated on local and regional roads in the vicinity of the proposed development. The results indicate that the existing screening afforded by buildings and vegetation that occurs between receptors and potentially reflecting panels has a significant bearing on reducing the overall glint and glare likely to be experienced within the study area. The final analysis (DSM with mitigation added) indicates 1 Road Receptor Point has the potential to experience residual glare.

The 1 road Receptor Point with the potential to incur glint and glare residual effects in the DSM analysis will be assessed in further detail (pre and post-mitigation) in the sections below.

R111

This receptor point is located along the L40232 local road immediately to the north of parcel A. The DSM analysis results show that reflectance has the potential to occur from the proposed panels for a maximum window of up to 4 minutes per day over 33 days of the year and for a maximum window of 68 minutes over an entire year period. Post mitigation establishment, the potential glare periods will remain the same.

It is important to note that there must be clear sunshine for any glare to occur. It is also important to note that reflectance only has the potential to occur for a brief section of this local road carriageway (< 50m section) and only has the potential to affect receptors travelling east along this road carriageway as the potential reflectance will be emanating from behind the line of travel (refer to Figure 1.10). For these reasons, it is not considered that there will be any significant nuisance or hazard effects generated from glint and glare.

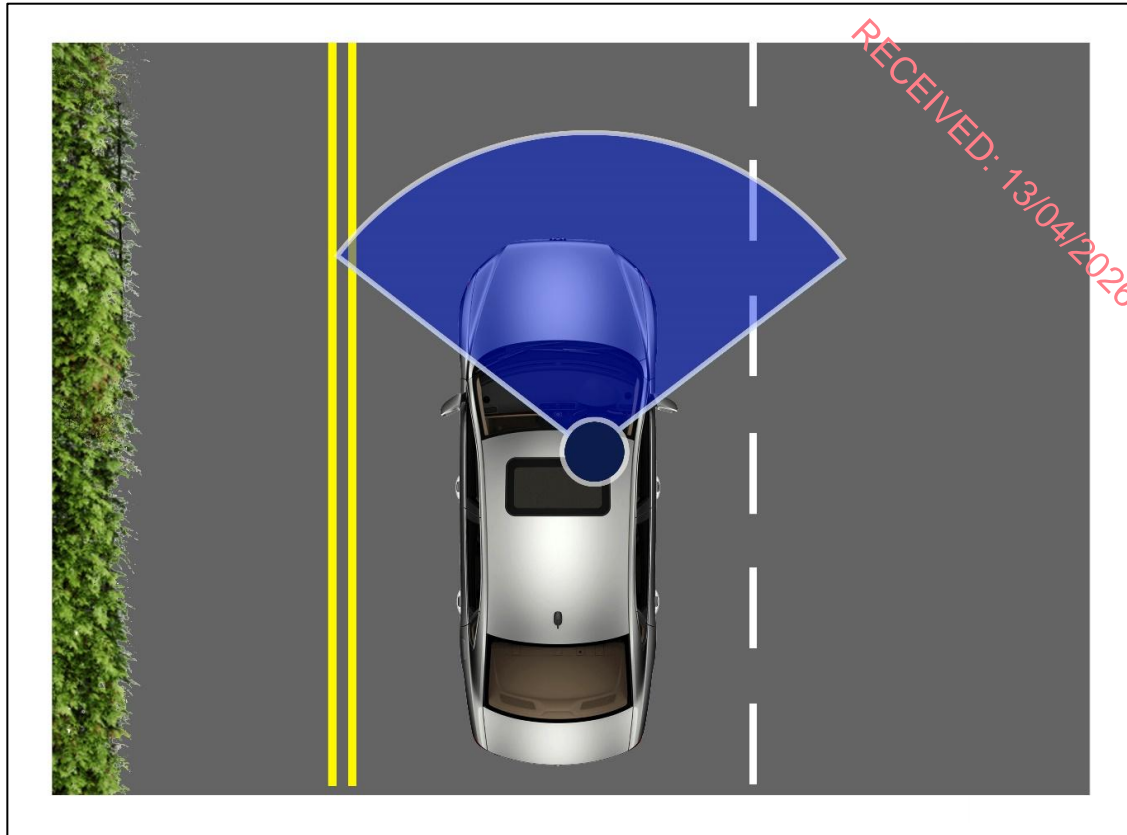


Figure 1.10 Illustration of a 100 degree field of view for driver (blue hatched area) extending 50 degrees to the left and 50 degrees to the right from the direction of travel.

1.2.10 Conclusion - Road Receptors

For the reasons outlined above, it is not considered that the glint and glare emanating from the proposed solar PV panels will generate significant nuisance or hazard effects for road users within the study area.

1.3 ASSESSMENT OF AVIATION RECEPTORS

1.3.1 Identification of Relevant Aviation Receptors

In accordance with current IAA and DAA protocol 10 km and 15 km radius study areas were established for the identification of IAA registered aerodromes and main airports respectively, that might require testing for glint and glare impacts. However, there are no IAA registered aerodromes within the 10 km aviation study area and neither of DAA's Dublin or Cork airports occur within 15 km of the proposed solar farm. For these reasons, no further aviation analysis was undertaken.

Furthermore, the Planning and Development (Solar Safeguarding Zone) Regulations 2022 set out 43 Solar Safeguarding Zones (SSZs). A SSZ is an area around an airport, aerodrome or helipad in which there is a potential for glint or glare from solar panels to impact aviation safety. The proposed development is not located within any of the defined SSZs, and therefore, an aviation-based glint and glare analysis was scoped out for further assessment.

1.4 OVERALL CONCLUSION

From the analysis and discussions contained herein, it is considered that there will not be any notable reflectance effects from glint and glare at dwellings within the study area. It is also considered that there will not be any hazardous glint and glare effects upon road receptors resulting from the proposed Shelburne Energy Farm.

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