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Project No: 311397

Varley Solar Farm Glint & Glare Assessment

Prepared for:

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Contents Amendment Record

This report has been issued and amended as follows:

Revision	Description	Date	Signed
1.0	First Issue	31 October 2022	Myria Monoyiou
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Acknowledgement

This report has been prepared for the sole and exclusive use of Pegasus Planning Group Ltd (Pegasus) in accordance with the scope of work presented in Mabbett & Associates Ltd (Mabbett) Letter Agreement (311397/LA/MM&RS), dated 03 May 2022. This report is based on information and data collected by Mabbett. Should any of the information be incorrect, incomplete or subject to change, Mabbett may wish to revise the report accordingly.

This report has been prepared by the following Mabbett personnel:

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Section 1.0: Introduction

1.1 Introduction

Pegasus are undertaking a planning application for a 25MWe Export Solar Farm. The proposed solar farm is located at Varley Farm, Cromhall, Gloucestershire, GL12 8AJ. To support the planning application, Pegasus require a Glint & Glare Assessment to be completed.

The report presents the Glint & Glare Assessment undertaken for the proposed solar development.

1.2 Glint & Glare

Reflectivity refers to light that is reflected off surfaces (e.g. glazed surfaces or areas of metal cladding). The potential effects of reflectivity are glint and glare. The Federal Aviation Administration's (FAA) *'Technical Guidance for Evaluating Selected Solar Technologies on Airports'* provides the following glint and glare definitions:

- Glint – *"a momentary flash of bright light"*
- Glare – *"a continuous source of bright light"*

These present an ocular hazard to light sensitive receptors such as road users, train drivers, occupants of nearby dwellings, pilots, and air-traffic control personnel, as they can cause a brief, temporary or permanent eye damage (ocular impact categories and significance further discussed in Section 4.4).

In general, solar PV systems are constructed of dark, light-absorbing material designed to maximise light adsorption and minimise reflection. However, the glass surfaces of solar PV systems also reflect sunlight to varying degrees throughout the day and year, based on the incidence angle of the sun relative to ground-based receptors. Lower incidence angles amount to increased reflection.

As such, the amount of light reflected off a solar PV panel surface or an array of solar panels depends on:

- The amount of sunlight hitting the surface;
- Its surface reflectivity;
- Its geographic location;
- Time of the year;
- Cloud coverage; and
- Panel orientation.

1.3 Scope of Work

Based on definitions and factors described in Section 1.2 and in combination with available guidance and best practice recommendations, a desk-based evaluation was undertaken to identify potential receptors and determine which have the potential to experience the effects of glint and glare. A solar glare analysis tool was utilised to model the solar PV array(s) and examine the times of the year and days such effects may occur, as well as the magnitude of their impact. The results of this study are subsequently interpreted, and appropriate recommendations made.

Section 4.0 provides further details on Methodology followed to complete this study.

Section 2.0: Development Characteristics

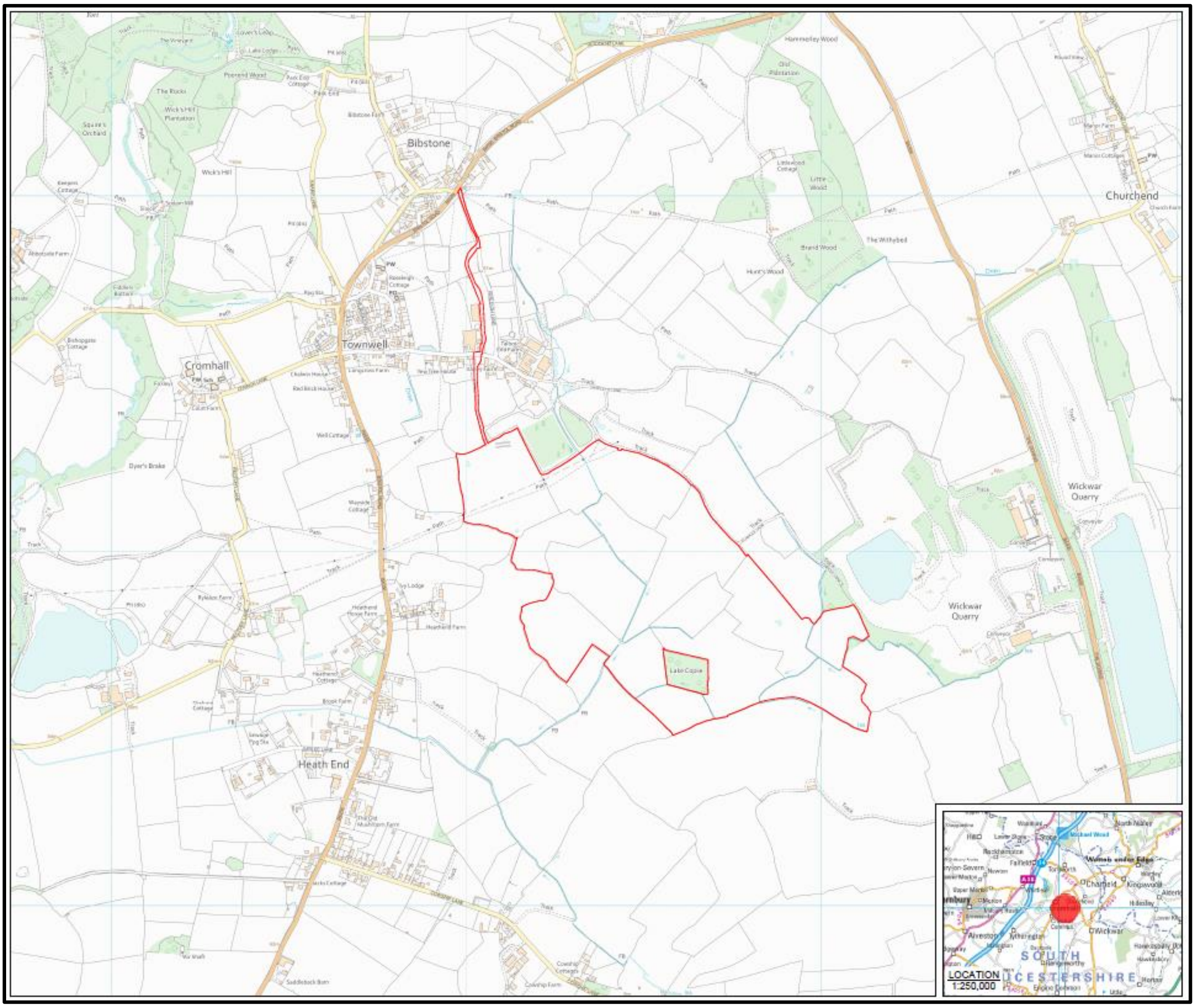
2.1 Site Description

Varley Farm (centred at National Grid Reference, NGR, 370535, 189882) is located at Cromhall, Gloucestershire, GL12 8AJ.

The site is surrounded by arable land, a quarry to the east and Cromhall and Heath End to the north and west, respectively.

The site location is shown in Figure 2.1 below in **red**.

Figure 2.1: Site Location (extract from RES drawing 04886-RES-LAY-DR-PT-002 Rev 1)



2.2 Proposed Development

The proposed solar development has a generating capacity of up to 25 MW and comprises the installation of solar PV panels and associated infrastructure.

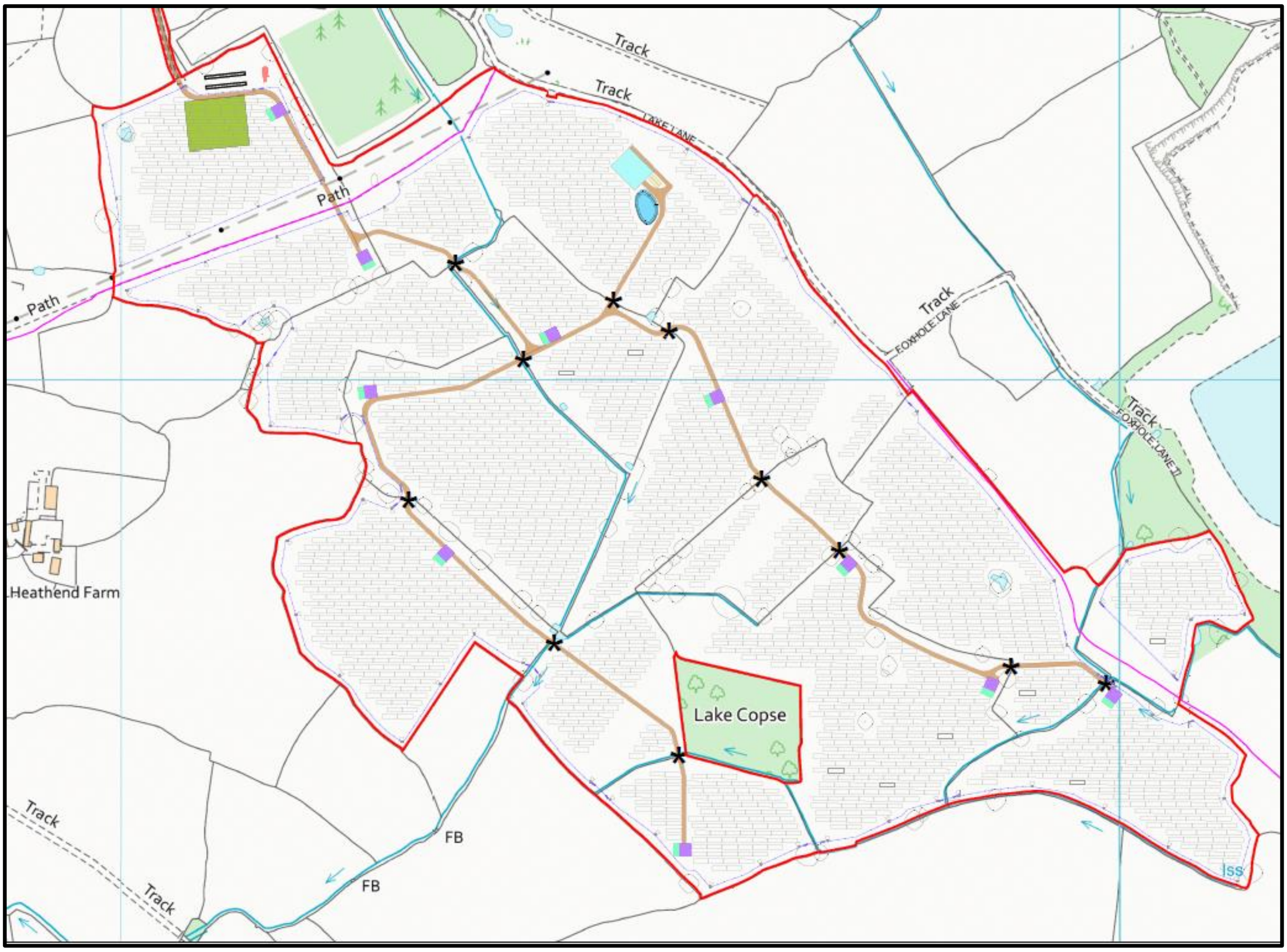
The proposed solar development is shown in Figure 2.2.

The proposed development PV array orientation and inclination are summarised in the table below:

Orientation	Tilt	Min Height Above Ground (m)	Max Height Above Ground (m)	Average Height Above Ground (m)
180°	18°	0.5	3.5	2

'Smooth glass with ARC' modules and the average panel height will be used to model the arrays.

Figure 2.2: Proposed Development Layout (extract from RES drawing 04886-RES-LAY-DR-PT-003 Rev 2)



Section 3.0: Legislation & Guidance

3.1 Planning Guidance

3.1.1 Planning Guidance: National Planning Policy Framework

The National Planning Policy Framework Guidance for *'Renewable and Low Carbon Energy'* dictates the following with respect to solar PV developments and glint and glare:

> *"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;*
> - *great care should be taken to ensure heritage assets are conserved in a manner appropriate to their significance, including the impact of proposals on views important to their setting. As the significance of a heritage asset derives not only from its physical presence, but also from its setting, careful consideration should be given to the impact of large-scale solar farms on such assets. Depending on their scale, design and prominence, a large-scale solar farm within the setting of a heritage asset may cause substantial harm to the significance of the asset;*
> - *the potential to mitigate landscape and visual impacts through, for example, screening with native hedges;*
> - *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."*

3.2 UK Highway Code

The UK Highway Code states that a road user should be aware of particular hazards such as glare from the sun and should adjust their driving style appropriately. Solar PV panels reflect sunlight producing solar glare under specific conditions, which may likely pose hazard towards road users.

3.3 Network Rail Guidance

Rail Industry Standard (RIS) RIS-0737-CCS on 'Signal Sighting Assessment Requirements' highlights that:

> *"a planned change external to the railway could affect signal sighting, for example changes that affect the built environment (for example, a new structure causing obscuration, a solar farm causing reflection)."*

In addition to the above, additional guidelines are provided which detail reflections and glare, visibility of signals, and train drivers' field of vision. As no nearby rail receptors have been identified in relation to the proposed development, the relevant guidance is excluded from the report for simplicity.

It should be noted that Network Rail guidance does not provide a specific glare assessment methodology for rail receptors, beyond the above information.

3.4 Aviation Guidance

3.4.1 Interim Civil Aviation Authority Guidance – Solar PV Systems

The UK Civil Aviation Authority (CAA) issued interim guidance relating to solar PV systems on 17 December 2010 but this was withdrawn on 7 September 2012. The guidance is provided in Appendix A. At the time of writing it remains the most recent and comprehensive CAA guidance produced to date.

In general, the interim guidance recommends that solar PV developments in the vicinity of or within an aerodrome's boundaries should provide safety assurance documentation (e.g. glint and glare assessment) regarding the full potential impact of the proposed installation on aviation interests, as part of the relevant planning application. It is further suggested that this information should be consulted with the CAA, particularly if the proposed development is within aerodrome boundaries, and during the installation process the developer should liaise with the affected aerodrome. Beyond these recommendations, no specific methodology or frame of reference are defined for assessing the impact of glint and glare on aviation infrastructure.

3.4.2 US Federal Aviation Agency Guidance

In general, aviation stakeholders in the UK, as well as internationally, make use of the US Federal Aviation Agency (FAA) relevant guidance on solar energy systems as it provides the most detailed methodology for assessing glint and glare internationally.

The most comprehensive guidelines available for the assessment of solar PV developments near aerodromes were initially produced in November 2010 (entitled *'Technical Guidance for Evaluating Selected Solar Technologies on Airports'*) by the FAA and updated in 2013 (entitled *'Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports').* The 2013 edition was updated in 2018 as version 1.1 and is entitled *'Technical Guidance for Evaluating Selected Solar Technologies on Airports'*. The key changes are as follows:

> *Version 1.1 (April 2018):*
>
> - *Updated Section 3.1.2, Reflectivity, to incorporate the latest information about evaluating solar glint and glare.*
> - *Updated corresponding references to glare throughout the document.*
> - *Clarified the relationship between solar energy and the FAA's Voluntary Airport Low Emissions (VALE) program in Section 5.3.2.*
> - *Added information about the FAA's Airport Energy Efficiency Program to Section 5.3.3.*
> - *Updated FAA Contact information on Appendix B (where appropriate).*

Key points from the latest FAA guidance produced in 2018 are presented in Appendix B. The full document can be accessed here.

Overall, the 2018 update offers three assessment options:

- Assessing Baseline Reflectivity Conditions
- Tests in the Field
- Geometric Analysis

However, where a proposed solar development is located where a risk to aviation safety is possible, geometric analysis, as per the 2013 guidance, will likely be the only option available to alleviate concerns. In addition to this, most aerodromes still apply the 2013 guidance[1].

Key points from the 2013 guidance are replicated below:

> *"…the FAA has determined that glint and glare from solar energy systems could result in an ocular impact to pilots and/or air traffic control (ATC) facilities and compromise the safety of the air transportation system. While the FAA supports solar energy systems on airports, the FAA seeks to ensure safety by eliminating the potential for ocular impact to pilots and/or air traffic control facilities due to glare from such projects."*

[1] PagerPower, 'Solar Photovoltaic and Building Development – Glint and Glare Guidance'

- ***Standard for Measuring Ocular Impact***

  "FAA adopts the Solar Glare Hazard Analysis Plot[2] *as the standard for measuring the ocular impact of any proposed solar energy system on a federally-obligated airport. To obtain FAA approval to revise an airport layout plan to depict a solar installation and/or a "no objection" to a Notice of Proposed Construction Form 7460-1, the airport sponsor will be required to demonstrate that the proposed solar energy system meets the following standards:*

  1. No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATCT) cab, and

  2. No potential for glare or "low potential for after-image" (shown in green in hazard plot) along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath.

  Ocular impact must be analysed over the entire calendar year in one (1) minute intervals from when the sun rises above the horizon until the sun sets below the horizon."

- ***Tool to Assess Ocular Impact***

  "In cooperation with the Department of Energy (DOE), the FAA is making available free-of-charge the Solar Glare Hazard Analysis Tool (SGHAT). The SGHAT was designed to determine whether a proposed solar energy project would result in the potential for ocular impact as depicted on the Solar Glare Hazard Analysis Plot shown above."

- ***Required Use of SGHAT***

  "As of the date of publication of this interim policy, the FAA requires the use of the SGHAT to demonstrate compliance with the standards for measuring ocular impact stated above for any proposed solar energy system located on a federally-obligated airport. The SGHAT is a validated tool specifically designed to measure glare according to the Solar Glare Hazard Analysis Plot. All sponsors of federally obligated airports who propose to install or to permit others to install solar energy systems on the airport must attach the SGHAT report, outlining solar panel glare and ocular impact, for each point of measurement to the Notice of Proposed Construction Form 7460-1. The FAA will consider the use of alternative tools or methods on a case-by-case basis. However, the FAA must approve the use of an alternative tool or method prior to an airport sponsor seeking approval for any proposed on-airport solar energy system. The alternative tool or method must evaluate ocular impact in accordance with the Solar Glare Hazard Analysis Plot."

It should be noted that due to cybersecurity restrictions, SGHAT public use is restricted. This has been succeeded by ForgeSolar which also meets FAA glare analysis requirements.

[2] Plot provided in Section 4.4.1.

Section 4.0: Methodology

A desk-based assessment is undertaken to assess glint and glare that may be experienced by light-sensitive receptors within the vicinity of the proposed solar PV development.

4.1 Solar Reflection Model

A computational modelling tool will be used, where appropriate/required, to model and assess solar reflectivity of the proposed development in relation to specified receptors, in line with FAA guidance.

The above tool employs an interactive Google map where the site location, proposed solar energy system and receptor paths/locations can be specified. Latitude, longitude, and elevation are automatically recorded through the Google interface, providing necessary information for sun position and vector calculations.

PV systems are represented by a contiguous planar polygon footprint and a set of customisable parameters. Each footprint comprises three or more vertices, defined by a latitude, longitude, elevation, and height. Each distinct PV installation or array is modelled with its own PV array footprint. For example, the PV panel tilt, orientation, and height are considered to be the same across the entire array. This is considered acceptable due to the distance of the sun from the proposed development and the miniscule differences in location of the Sun over the proposed development.

The solar reflectance of the PV modules is specified based on the module surface material. The modelling tool has 5 general module material reflectance profiles which were developed by analysing different PV module samples. The following options are available:

- Smooth glass without Anti-Reflective Coating (ARC)
- Smooth glass with ARC
- Light textured glass without ARC
- Light textured glass with ARC
- Deeply textured glass

During analysis, sunlight is reflected over each PV array on a minute-by-minute basis according to the specified module tilt and orientation or axis tracking parameters, if the system is not fixed-mount. The system then checks whether the resulting solar reflections intersect (impact) the specified receptors, thus determining glint and glare occurrence.

4.2 Receptor Identification

In general, light-sensitive receptors with view of a solar PV development have potential to experience solar reflection. While no technical distance limits exist within which solar reflections are possible for such receptors, the potential or significance of a reflection decreases with distance due to an observer’s decreasing field of vision capability with increasing distance, as well as possible obstructions such as shielding caused by terrain and vegetation.

For the purpose of this assessment, the following best practice considerations will be applied, incorporating relevant guidance as laid out in Section 3.0, where applicable:

Dwellings	▪ Residential dwellings to around 1 km from the solar PV development boundary with a visual line of sight to the panels will be considered. ▪ An additional height of 1.8 m above ground level will be considered to account for observer's eye level on ground floor which is typically occupied during daylight hours, unless otherwise stated. Where blocks of residential apartments are assessed, each storey height will be taken as 3 m plus 1.8 m to represent observer's eye level.
Road Users	▪ An additional height of 1.5 m above ground level will be considered to represent the typical road user viewing height, unless otherwise stated. ▪ A diver field-of-view (FOV) of 100° will be applied (50° view angle to left and right). According to the FAA, glare that appears beyond this FOV range is mitigated.
Railways	▪ Railways in the immediate surrounding area to around 100 m from the solar PV development boundary with a visual line of sight to the panels will be considered. ▪ Length of railway line will be assessed via individual static receptor locations no more than 200 m apart up to 500 m from the proposed development boundaries. ▪ An additional height of 2.75 m above ground level will be considered to represent typical train driver viewing height. ▪ Where signals are located immediately adjacent to or above a railway line, their lens is in line of sight of the proposed development, and are used to direct trains on the lines, these will also be assessed as individual static receptors.
Aviation	**Assessment Threshold** Aviation infrastructure located: ○ Within less than 5 km of proposed development, will be assessed for glint and glare. ○ Within 5-30 km away from the proposed development will be identified but not assessed unless requested by relevant aerodrome safeguarding authority during planning consultation. ○ Further than 30 km radius from the proposed development are not considered. **Aerodromes** ▪ Additional height above ground level will be considered to represent the viewing height of an air controller within the ATCT (ATCT height). ▪ 2-mile approach path thresholds towards runway(s) will be assessed, with starting points taken at 15.2 m above runway threshold at a 3-degree descent path (unless otherwise stated). ▪ Reference aircraft location receptor points will be taken at no more than ¼ miles intervals, with a minimum of 9 points, over the 2-mile approach paths identified. ▪ A pilot azimuthal field-of-view (FOV) of 100° will be applied (50° view angle to left and right). According to the FAA, glare that appears beyond this FOV range is mitigated. ▪ A pilot vertical FOV of 30° will be applied. Anything appearing beyond this FOV is not visible to the pilot and is acceptable to FAA.

As the tool does not consider obstructions (e.g. vegetation, other buildings, topography), to account for this, where appropriate the identified receptors will be further screened via a street-view desk-based assessment using Google Maps and/or a viewshed analysis. Where applicable, the aim will be to:

- Screen out receptors whose view of the proposed development is obstructed.
- Screen out road/rail receptor route sections whose view of the proposed development is obstructed (e.g. so that only affected sections of considered route receptors are assessed).
- Establish proposed development footprint to be modelled per receptor or receptor type.

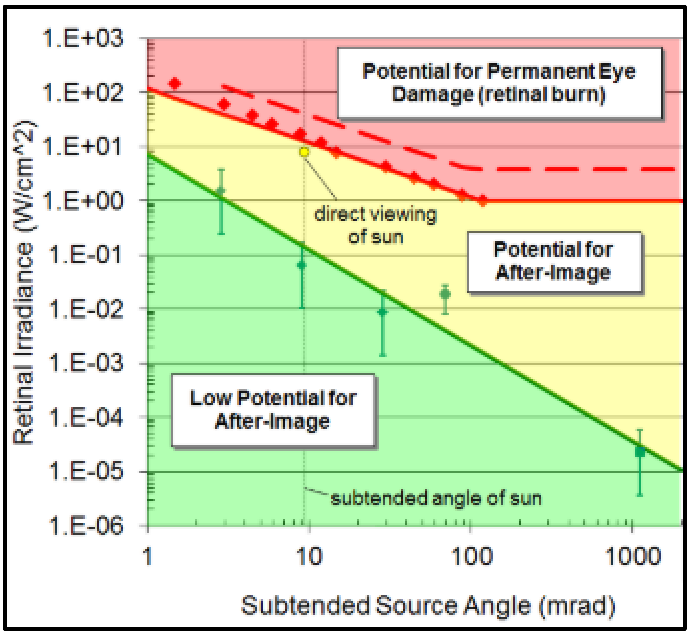
4.3 Magnitude of Impact

4.3.1 Ocular Impact

Ocular impact significance depends on the line of sight between the reflector (solar PV panels) and the receptor, the location of the receptor relative to the reflector and thus the solar reflection, the time of the day, they path between the Sun and the reflective surface, and the reflection exposure period (e.g. momentary exposure is less significant that prolonged exposure).

As such, ocular impact can be classified into three levels based on the retinal irradiance and subtended source angle: low potential for after-image (**green**), potential for after-image (**yellow**), and potential for permanent eye damage (**red**). These categories are illustrated in the Ocular Hazard plot[3] shown in Figure 4.1 (NOTE: this is a universal Ocular Hazard plot and does not represent potential glare conditions that may be experienced at the proposed development.).

Figure 4.1: Ocular Hazard Plot



The subtended source angle represents the size of glare observed by receptor, while the retinal irradiance is the quantity of energy impacting the retina of the observer. As it can be seen from Figure 1, wide subtended source angles can cause retinal irritation/damage even at low retinal irradiance.

4.3.2 Glint & Glare Impact Significance

4.3.2.1 Dwellings

While there is no specific guidance on glint and glare impact significance evaluation, the following classifications may be used:

No Impact	Solar reflection is not geometrically possible or will not be visible from the assessed receptor.
Low	Glare of any intensity (green or yellow) occurs for less than 60 minutes per day and for less than three months per year. Mitigation is not required.
Moderate	Glare of any intensity (green or yellow) occurs for longer than 60 minutes or for more than 3 months per year. Mitigation may be required at planner's discretion.
High	Glare of any intensity (green or yellow) occurs for longer than 60 minutes per day and for more than 3 months of the year. Mitigation will be required if the proposed development is to proceed.

4.3.2.2 Road, Rail and Aviation

<table>
<tr><td rowspan="1">Air Traffic Control Towers (ATCT)</td><td>Based on FAA guidance:
<table><tr><td>Acceptable</td><td>'No potential for glint and glare' towards ATCT should be produced by a proposed solar PV development.</td></tr><tr><td>Unacceptable</td><td>Any glare of any duration/frequency predicted towards ATCT from proposed solar PV development.</td></tr></table>
It is recommended that any predicted solar reflection is assessed pragmatically. Therefore, the following will also be considered when determining whether a solar reflection is significant:
1. The predicted intensity of the solar reflection;
2. Location of origin of the solar reflection relative to the ATCT;
3. Solar reflection duration per day;
4. Number of days a solar reflection is geometrically possible per year; and
5. The time of day when a solar reflection is geometrically possible.</td></tr>
<tr><td>Approaching Aircrafts</td><td>Based on FAA guidance:
<table><tr><td>Acceptable</td><td>'No potential for glare' or 'low potential for after-image' along the final approach path for any existing or future landing thresholds (as defined in Section 3.1).</td></tr><tr><td>Unacceptable</td><td>Yellow glare with potential for temporary after-image predicted towards the final approach path.</td></tr></table></td></tr>
<tr><td>Road Users</td><td>While there is no specific guidance on glint and glare impact significance evaluation or limits, the following approach will be adapted in line with best available practice guidance/recommendations:
<table><tr><td>No or Insignificant Impact</td><td>Solar reflection is not geometrically possible or will not be visible from the assessed receptor.</td></tr><tr><td>Low</td><td>▪ Glare of any intensity (yellow or green) predicted towards a local road; or
▪ Glare of any intensity (e.g. yellow or green) predicted towards a major national, national or regional road <u>and</u> originates outside of 50° relative to the direction of travel.

Mitigation is not considered necessary.</td></tr><tr><td>Moderate</td><td>Glare of any intensity (e.g. yellow or green) predicted towards a major national, national or regional road <u>and</u> it originates within 50° relative to the direction of travel under mitigating circumstances (e.g. duration of glare, vehicle speed, length of road affected, etc).

Mitigation may be required at regulator's discretion.</td></tr><tr><td>High</td><td>Glare of any intensity (e.g. yellow or green) predicted towards a major national, national or regional road <u>and</u> it originates within 50° relative to the direction of travel <u>without</u> mitigating circumstances.

Mitigation recommended if the proposed development is to proceed.</td></tr></table></td></tr>
<tr><td>Railways</td><td>While there is no specific guidance on glint and glare impact significance evaluation or limits, the following approach will be adapted in line with best available practice guidance/recommendations:
Railway
<table><tr><td>No or Insignificant Impact</td><td>Solar reflection is not geometrically possible or will not be visible from the assessed receptor.</td></tr></table></td></tr>
</table>

	Low	Glare which does not originate in front of the train driver predicted. Mitigation is not considered necessary.
	Moderate	Glare originates in front of the train driver and towards a section of track where no signal or crossing is sited. Mitigation may be required at regulator's discretion.
	High	Glare originates in front of the train driver and towards a section of track where a signal or crossing is sited. Mitigation recommended if the proposed development is to proceed.
	Signals If the assessed reflectors (e.g. solar development) are not in line of sight to the signal lens, then no phantom aspect illusion is possible.	

4.4 Time Zone / Datum

The UK uses British Summer Time (BST, UTC +01:00) in the summer and Greenwich Mean Time (GMT, UTC +0) in the winter. For the purpose of this report all time references are in GMT.

All locations are given in Eastings and Northings using the UK National Grid Reference system, unless otherwise specified.

4.5 Assumptions, Limitations & Fixed Model Variables

Provided in Appendix C is a list of assumptions, limitations and fixed variables of the model and assessment methodology.

Section 5.0: Receptor Screening & Other Considerations

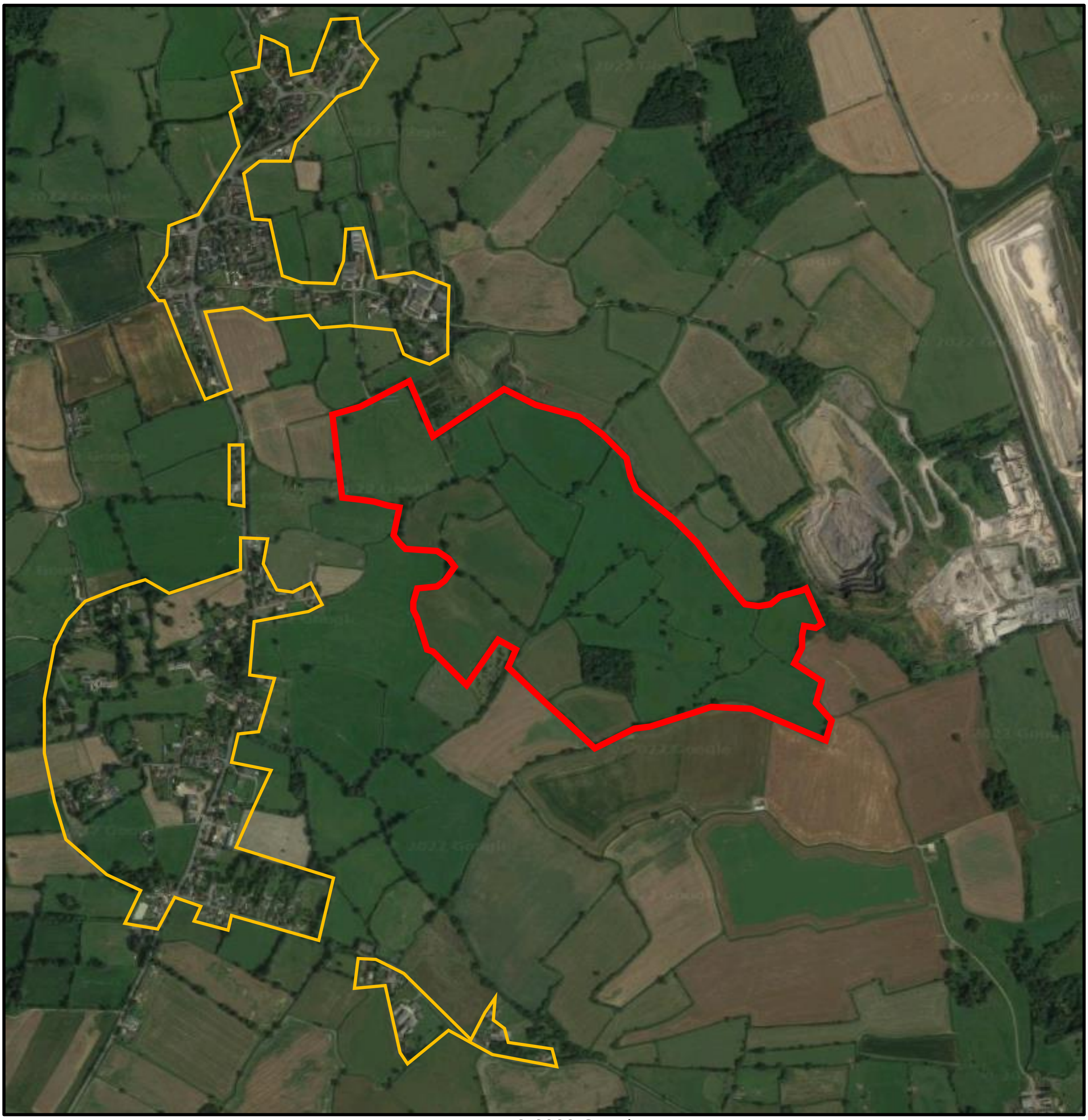
5.1 Receptors

In line with Section 4.2 considerations, the receptors discussed in following sections have been identified and further screened prior to modelling.

5.1.1 Nearby Dwellings

A number of residential dwellings/areas exist within 1 km of proposed solar farm boundaries. These residential areas are shown in Figure 5.1 in **yellow**, with the solar panel area in **red**.

Figure 5.1: Residential Areas



Imagery © 2022 Google

Only the receptor points closest to the proposed development found along border lines of each residential area will be modelled as other dwellings are expected to be screened by these receptors, as well as vegetation and/or buildings found in between them. Furthermore, various points across the border lines were taken as residential receptors to be modelled, as shown in Figures 5.2 – 5.4. These receptor points do not cover every house but are considered to be representative locations.

Figure 5.2: Modelled Residential Dwellings (north of solar panels)

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Figure 5.3: Modelled Residential Dwellings (west of solar panels)

Imagery © 2022 Google

Figure 5.4: Modelled Residential Dwellings (south of solar panels)

5.1.2 Road Infrastructure

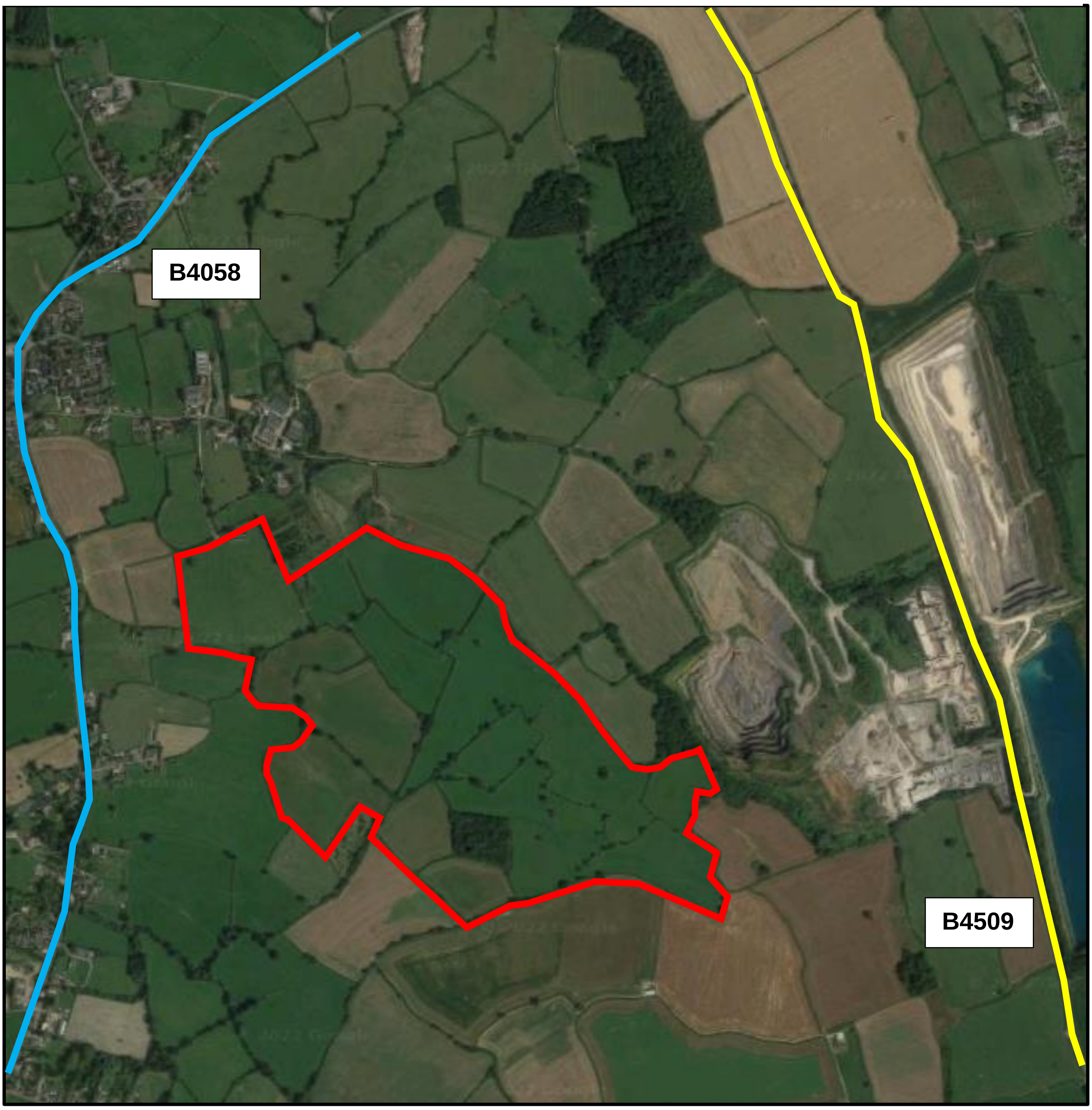
A number of roads exist within 1 km of the proposed development boundaries, including B4058/Bristol Road and B4509/The Downs among other local single-track roads (such as The Green, Talbots End, Cowship Lane, etc).

The assessment typically only focuses on higher traffic motorways and major roads, such as the M and A roads, in proximity to the proposed development boundaries. In this case there are no such high traffic or major roads. The identified nearby roads are classed as minor roads, and therefore, in the unlikely situation that glare does affect them its impact would be of low risk (in line with Section 4.3.2.2).

As such, the nearby road infrastructure will not be further considered in the assessment.

The B roads are shown in Figure 5.5 for illustrative purposes only.

Figure 5.5: Nearby B Roads



Imagery © 2022 Google

5.1.3 Aviation Infrastructure

Aviation infrastructure situated within 30 km of the development has been identified below:

- Oldbury-upon-Severn Airfield within 9 km
- Southmead Hospital Helipad within 17 km
- Bristol Royal Infirmary Helipad within 20 km
- Oaksey Park Airfield within 28 km
- Norton Malreward Airfield within 26 km
- Wadswick Farm Airstrip within 25 km

Based on Section 4.2 considerations (i.e. no infrastructure is within 5 km of the development), no aviation infrastructure requires modelling. As such, none of the above-mentioned aerodromes will be further considered/assessed, unless aerodrome safeguarding consultees to the planning committee deem it necessary.

It should be noted that previous experience of assessing aerodromes within 5-10 km of proposed solar developments (e.g. solar farms), shows that predicted glare towards runway approach paths is typically acceptable and has a 'low potential for temporary after image' towards approaching pilots.

Furthermore, the FAA 2013 glare policy, described in Section 3.4.2 of the report, was recently updated to focus on ATCTs only as:

> *"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"*

As such, the proposed development does not pose an ocular risk towards air traffic and approaching pilots.

Lastly, it is unlikely that ATCTs of any of the above aerodromes will have a view of the proposed solar development due to distance from site location (decreasing visibility with increasing distance), topography, vegetation, and/or other buildings blocking direct line of sight between the points of interest.

5.1.4 Rail Infrastructure

No rail infrastructure identified within 100 m of the proposed development boundaries.

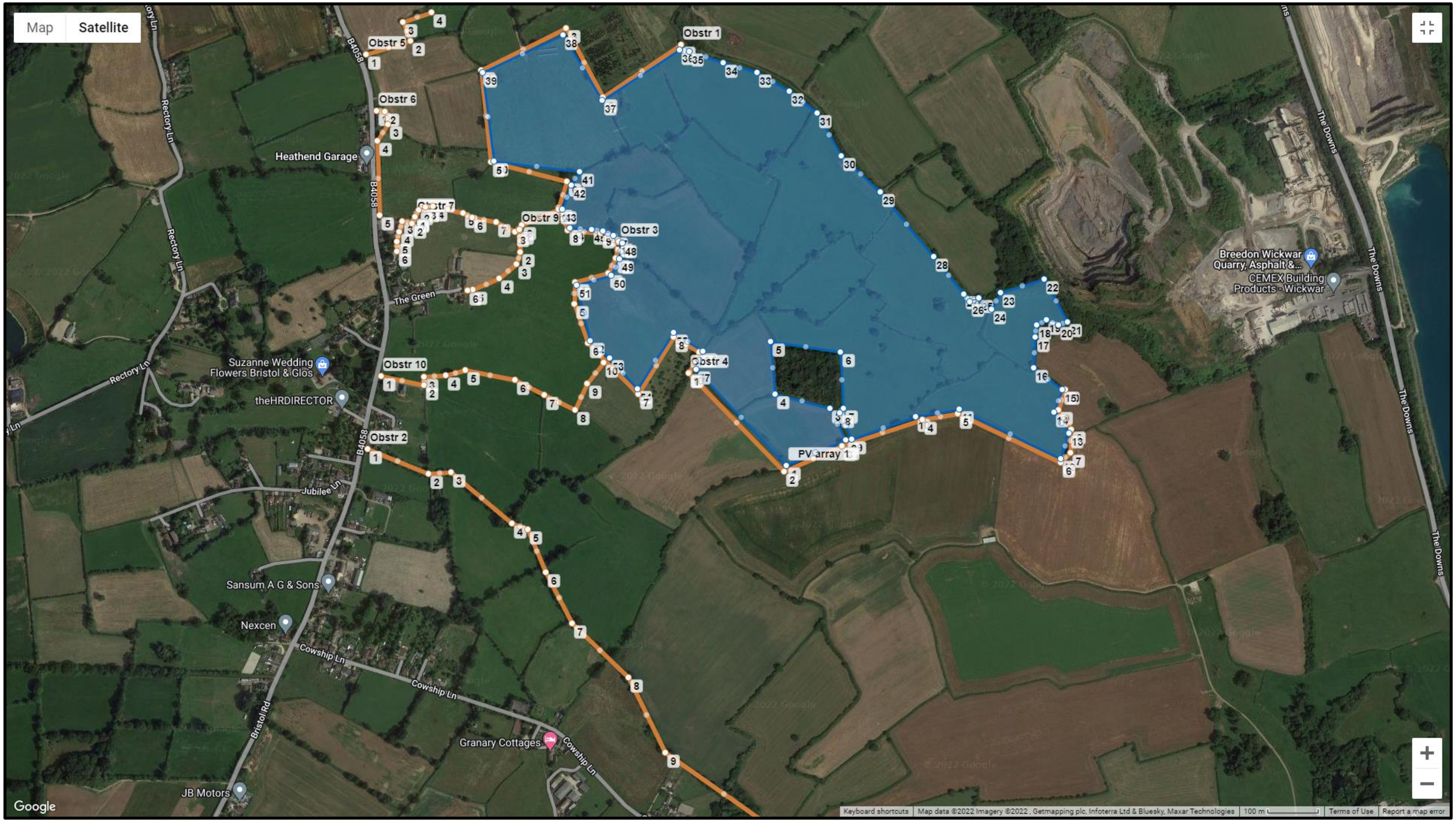
5.1.5 Modelling Considerations

The proposed development site is surrounded by trees and hedgerows alike. The current hedges are average 3m in height it is proposed that the hedges are managed up to 3.5m following planning consent. A review of off-site vegetation was also undertaken to establish if there were any trees and hedgerows which could block the line of sight between the solar panels and nearby receptors.

Figure 5.6 illustrates the vegetation/obstructions modelled with their description and height summarised in the table below:

Receptor	Description	Height (m)
Obstr 1	Hedgerow / trees aligning site boundary	3m
Obstr 2	Hedgerow / trees through fields from Bristol Road to Cowship Lane	3m
Obstr 3	Hedgerow / trees aligning site boundary	3m
Obstr 4	Hedgerow / trees aligning site boundary	3m
Obstr 5	Hedgerow / trees opposite OPs20 and OP21	3m
Obstr 6	Hedgerow / trees opposite OPs 22-24	3m
Obstr 7	Hedgerow / trees opposite at rear of 67A Bristol Road	3m
Obstr 8	Field hedgerow from rear of 67A Bristol Road to site boundary	2m
Obstr 9	Field hedgerow to The Green	2m
Obstr 10	Hedgerow north of OP33 from Bristol Road to site boundary	2m

Figure 5.6: Modelled Obstructions



Imagery © 2022 Google

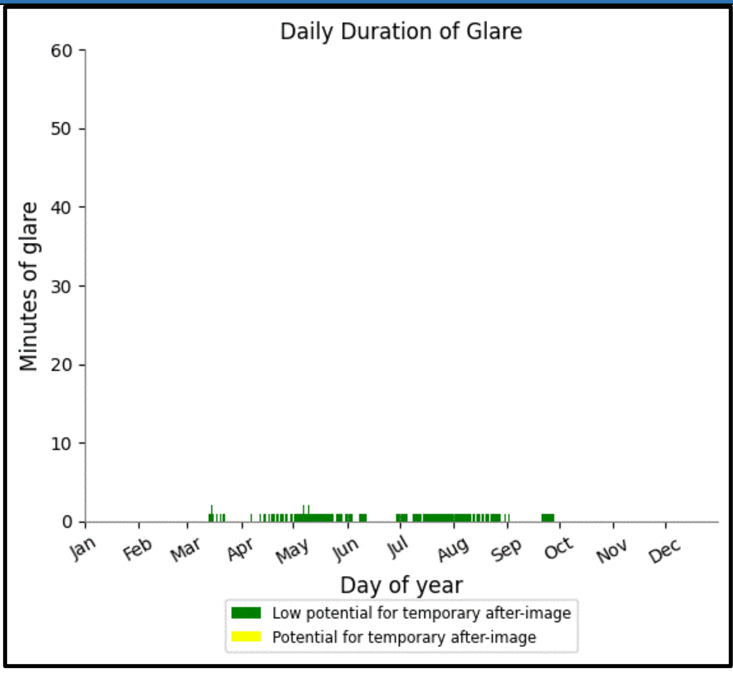
Section 6.0: Modelling Results

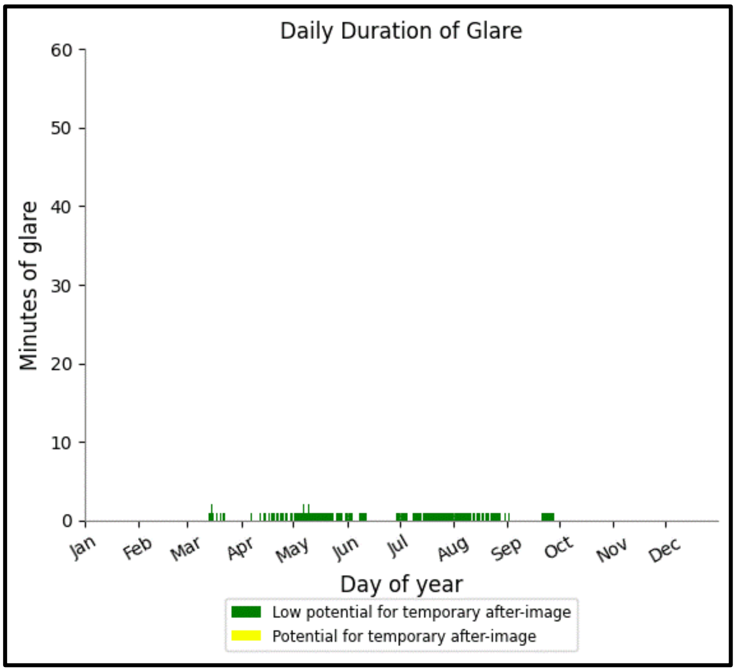
6.1 Dwellings

<table>
<tr><th>Receptor</th><th>Impact</th><th>Significance</th></tr>
<tr><td>OP1</td><td rowspan="24">No glare predicted.</td><td rowspan="24">No Impact</td></tr>
<tr><td>OP2</td></tr>
<tr><td>OP3</td></tr>
<tr><td>OP4</td></tr>
<tr><td>OP5</td></tr>
<tr><td>OP6</td></tr>
<tr><td>OP7</td></tr>
<tr><td>OP8</td></tr>
<tr><td>OP9</td></tr>
<tr><td>OP10</td></tr>
<tr><td>OP11</td></tr>
<tr><td>OP12</td></tr>
<tr><td>OP13</td></tr>
<tr><td>OP14</td></tr>
<tr><td>OP15</td></tr>
<tr><td>OP16</td></tr>
<tr><td>OP17</td></tr>
<tr><td>OP18</td></tr>
<tr><td>OP19</td></tr>
<tr><td>OP20</td></tr>
<tr><td>OP21</td></tr>
<tr><td>OP22</td></tr>
<tr><td>OP23</td></tr>
<tr><td>OP24</td></tr>
<tr><td>OP25</td><td rowspan="2">Green glare predicted towards receptor around 06:00 in the morning from mid-March to October for up to a max of 5 min/day.

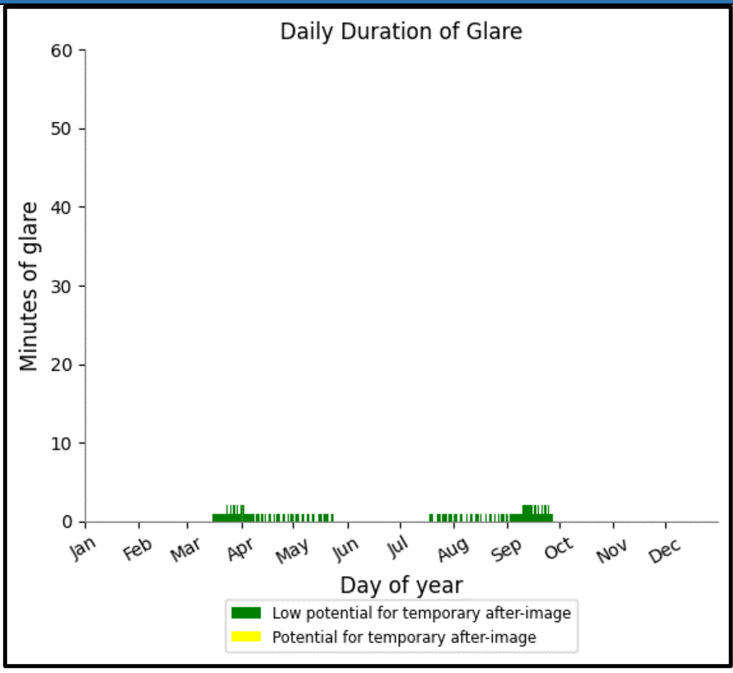
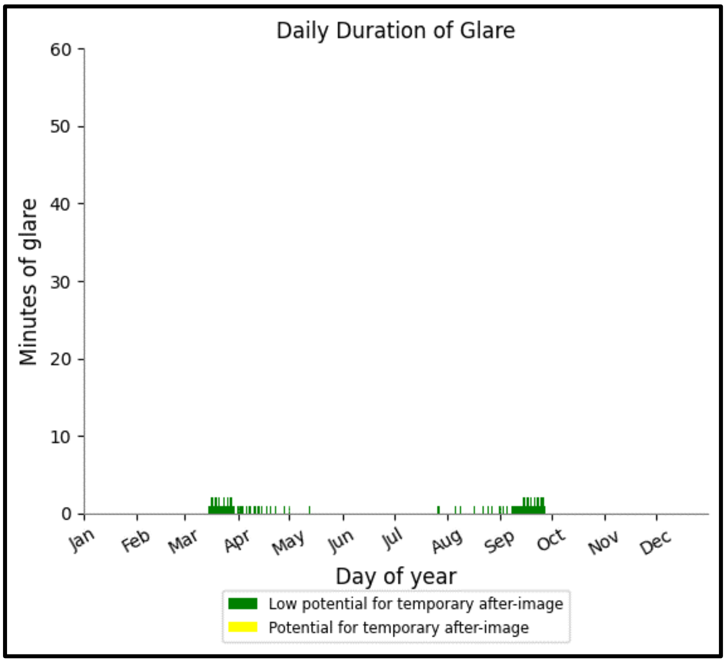
Moreover, average cloud cover data for the area reveal that it is overcast up to 50% mostly cloudy between 30-60% of the time during which glare is predicted. Therefore, the overall annual predicted glare occurrence, as well as daily duration, will likely be less than anticipated.

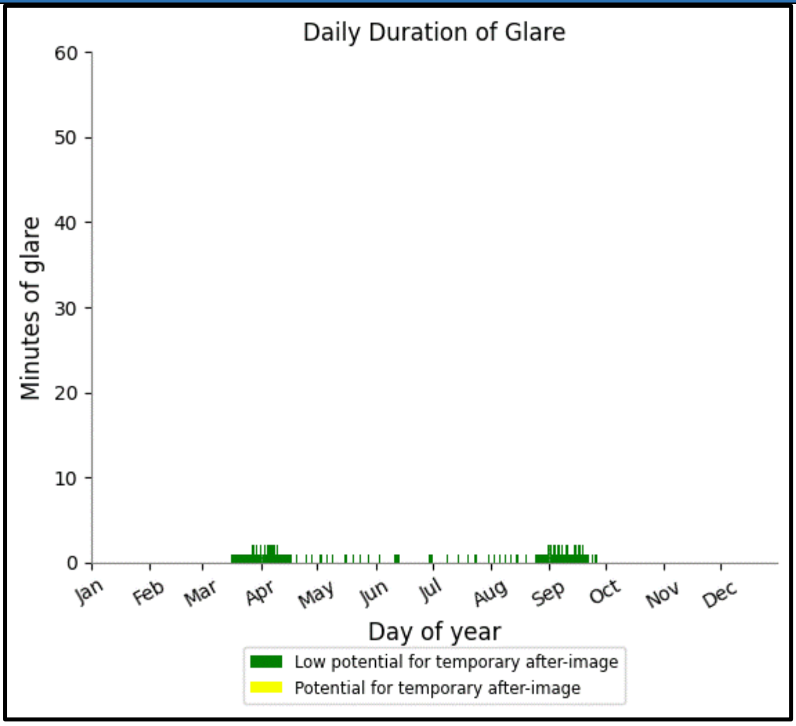
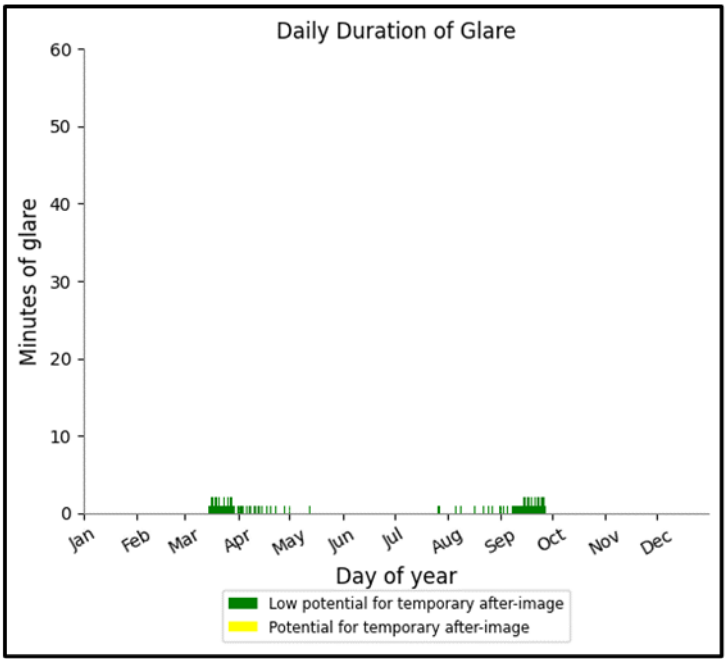
As such, due to the average cloud cover and the very short daily glare duration anticipated throughout the year, the predicted glare is classed as being of low risk.</td><td rowspan="2">Low</td></tr>
<tr><td>OP26</td></tr>
<tr><td>OP27</td><td>Green glare predicted towards receptor around 06:00 in the morning from mid-March to October. The predicted glare does not occur continuously during this range of time, but rather sporadically for only a couple of minutes at a time (as shown in below figure).</td><td>Low</td></tr>
</table>

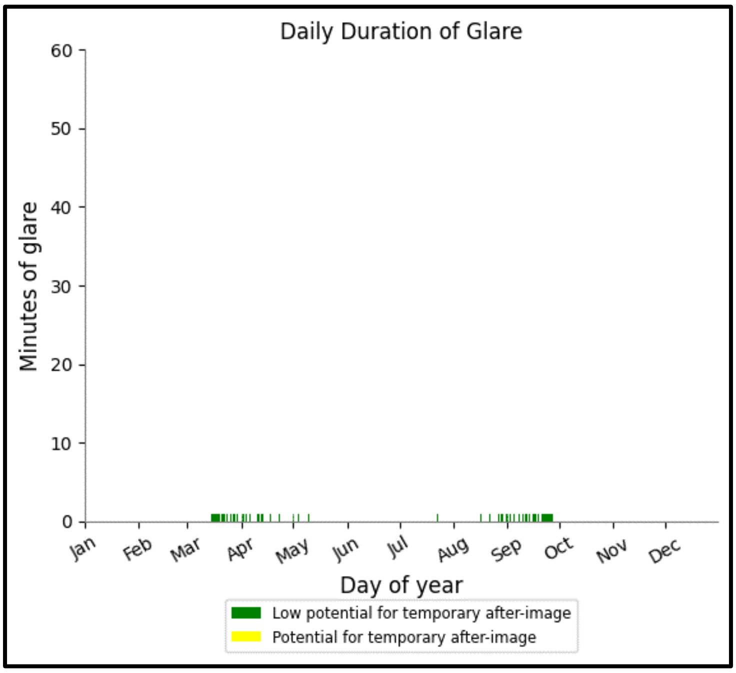
<table>
<tr><th>Receptor</th><th>Impact</th><th>Significance</th></tr>
<tr><td></td><td>

As such, the predicted glare is classed as being of low risk.</td><td></td></tr>
<tr><td>OP28</td><td>Green glare predicted towards receptor around 06:00 in the morning from mid-March to October. The predicted glare does not occur continuously during this range of time, but rather sporadically for only a couple of minutes at a time (as shown in below figure).


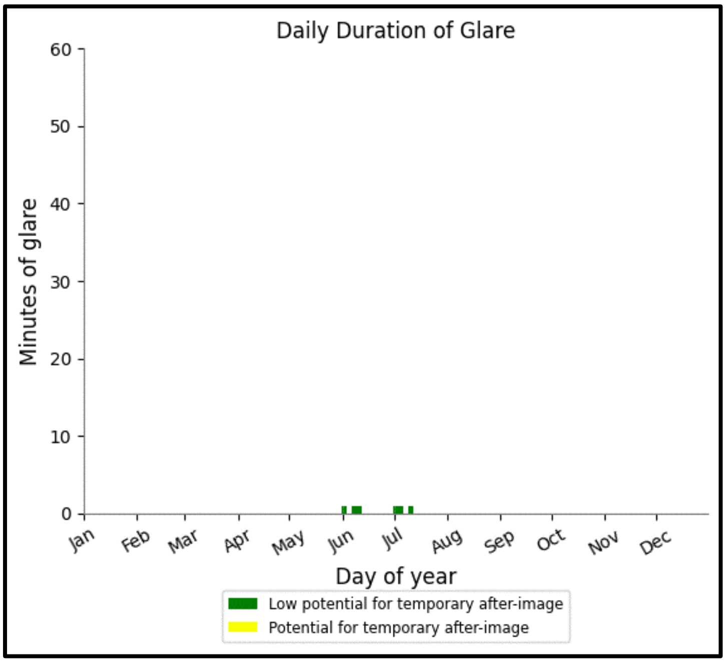
As such, the predicted glare is classed as being of low risk.</td><td>Low</td></tr>
<tr><td>OP29</td><td>Green glare predicted towards receptor around 06:00 in the morning from mid-March to mid-May and mid-July to mid-September. The predicted glare does not occur continuously during this range of time, but rather sporadically for only a couple of minutes at a time (as shown in below figure).</td><td>Low</td></tr>
</table>

Receptor	Impact	Significance
	 As such, the predicted glare is classed as being of low risk.	
OP30	Green glare predicted towards receptor around 06:00 in the morning from mid-March to mid-May and mid-July to mid-September. The predicted glare does not occur continuously during this range of time, but rather sporadically for only a couple of minutes at a time (as shown in below figure).  As such, the predicted glare is classed as being of low risk.	**Low**
OP31	Green glare predicted towards receptor around 06:00 in the morning from mid-March to mid-September. The predicted glare does not occur continuously during this range of time, but rather sporadically for only a couple of minutes at a time (as shown in below figure).	**Low**

Receptor	Impact	Significance
	 As such, the predicted glare is classed as being of low risk to negligible.	
OP32	Green glare predicted towards receptor around 06:00 in the morning from mid-March to mid-September. The predicted glare does not occur continuously during this range of time, but rather sporadically for only a couple of minutes at a time (as shown in below figure).  Due to the very short daily glare duration anticipated throughout the year, the predicted glare is classed as being of low risk.	**Low**
OP33	Green glare predicted towards receptor around 06:00 in the morning from mid-March to mid-May and mid-August to October. The predicted glare does not occur continuously during this range of time, but rather sporadically for only a couple of minutes at a time (as shown in below figure).	**Low**

Receptor	Impact	Significance
	 Due to the very short daily glare duration anticipated throughout the year, the predicted glare is classed as being of low risk.	
OP34	***No glare predicted.***	**No Impact**
OP35	Green glare predicted towards receptor around 06:00 in the morning from mid-April to September for up to a max of 5 min/day. Moreover, average cloud cover data for the area reveal that it is overcast up to 50% mostly cloudy between 30-60% of the time during which glare is predicted. Therefore, the overall annual predicted glare occurrence, as well as daily duration, will likely be less than anticipated. As such, due to the average cloud cover and the very short daily glare duration anticipated throughout the year, the predicted glare is classed as being of low risk.	**Low**
OP36	***No glare predicted.***	**No Impact**
OP37	***No glare predicted.***	**No Impact**
OP38	***No glare predicted.***	**No Impact**

<table>
<tr><th>Receptor</th><th>Impact</th><th>Significance</th></tr>
<tr><td>OP39</td><td>Green glare predicted towards receptor around 06:00 in the morning from early June and July. The predicted glare does not occur continuously during this range of time, but rather sporadically for only a couple of minutes at a time (as shown in below figure).



As such, the predicted glare is classed as being of low risk.</td><td>Low</td></tr>
<tr><td>OP40</td><td>Green glare predicted towards receptor around 06:00 in the morning from May to mid-August for up to a max of 5 min/day.

Moreover, average cloud cover data for the area reveal that it is overcast up to 50% mostly cloudy between 30-60% of the time during which glare is predicted. Therefore, the overall annual predicted glare occurrence, as well as daily duration, will likely be less than anticipated.

As such, due to the average cloud cover and the very short daily glare duration anticipated throughout the year, the predicted glare is classed as being of low risk.</td><td>Low</td></tr>
</table>

Section 7.0: Conclusions & Recommendations

7.1 Assessment Findings Summary

The glare assessment findings are summarised in table below:

Receptor	Impact	Significance
Nearby Dwellings	Low risk glare predicted towards OP25-OP33, OP35 and OP39-40. No glare predicted towards other assessed OPs.	**Low**
Road Infrastructure	Local roads exist within 1 km of the proposed development. However, the assessment typically only focuses on higher traffic motorways and major roads, such as the M and A roads, in proximity to the proposed development boundaries. In this case there are no such high traffic or major roads. The identified nearby roads are classed as minor roads, and therefore, in the unlikely situation that glare does affect them its impact would be of low risk. As such, the proposed development is considered to have no impact towards road receptors.	**No Impact**
Aviation Infrastructure	No aviation infrastructure exists within 5 km of the proposed development. Previous experience of assessing aerodromes within 5-10 km of proposed solar developments (e.g. solar farms), shows that predicted glare towards runway approach paths is typically acceptable and has a 'low potential for temporary after image' towards approaching pilots. Furthermore, the FAA 2013 glare policy, described in Section 3.4.2 of the report, was recently updated to focus on ATCTs only as: *"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"* As such, the proposed development does not pose an ocular risk towards air traffic and approaching pilots. Lastly, it is unlikely that ATCTs of any of the above aerodromes will have a view of the proposed solar development due to distance from site location (decreasing visibility with increasing distance), topography, vegetation, and/or other buildings blocking direct line of sight between the points of interest.	**No Impact**
Rail Infrastructure	No rail infrastructure within 100 m of proposed development boundaries.	**N/A**

As it can be seen from the summary table above, the proposed development does not pose any risks towards any of the assessed/considered light sensitive receptors.

Appendix A: Interim CAA Guidance on Solar Photovoltaic Systems

Civil Aviation Authority

Interim CAA Guidance - Solar Photovoltaic Systems

BACKGROUND

1 Airport interest in solar energy is growing rapidly as a way to reduce operating costs and to demonstrate a commitment to renewable energy and sustainable development. In response, the CAA is seeking to develop its policy on the installation of Solar Photovoltaic (SPV) Systems and their impact on aviation. In doing so, it is reviewing the results of research having been carried out in the United States by the Federal Aviation Administration (FAA) culminating in the publication of Technical Guidance for Evaluating Solar Technologies on Airports and also reviewing guidance issued by other National Aviation Safety Administrations and Authorities on this subject.

2 On completion of the review, the CAA, together with the assistance of other aviation stakeholders, will develop a policy and provide formal guidance material on the installation of SPV, principally on or in the vicinity[1] of licensed aerodromes but will also include guidance on installations away from aerodromes (or 'en-route'[2]). This document therefore constitutes interim CAA guidance until a formal policy has been developed.

DISCUSSION

3 At present the key safety issue is perceived to be the potential for reflection from SPV to cause glare, dazzling pilots or leading them to confuse reflections with aeronautical lights. Whilst permission is not required from the CAA for any individual or group to shine or reflect a light or lights into the sky, SPV developers should be aware of the requirements to comply with the Air Navigation Order (ANO) 2009. In particular, developers and Local Planning Authorities (LPA) should be cognisant of the following articles of the ANO with respect to any SPV development regardless of location:

- Article 137 – Endangering safety of an aircraft.
- Article 221 – Lights liable to endanger.
- Article 222 – Lights which dazzle or distract.

4 The potential for SPV installations to cause electromagnetic or other interference with aeronautical Communications Navigational and Surveillance equipment (CNS) must be considered by the SPV developer, in coordination with the CAA, the aerodrome Air Traffic Service provider (ATS), the Air Navigation Service Provider (ANSP) and/or NATS and the MoD, as required.

[1] In this context, the term "in the vicinity" refers to officially safeguarded aerodromes noted in the Planning Circulars (see Paragraph 10) and a distance of up to 15km from the 'Aerodrome Reference Point' or the centre of the longest runway.
[2] SPV installations proposed further than 15km from an aerodrome are considered "en-route" developments, and may still require consultation with the CAA for an assessment on the impact, if any, to CNS equipment.

1 of 3

5 Where SPV systems are installed on structures that, for example, extend above the roofline of tall buildings (either on, or 'off-aerodrome'), or where they are installed in the vertical plane (on plinths or towers), then there may be the potential for creating an obstacle hazard to aircraft and - in addition to the potential for creating turbulence hazard to aircraft - any infringement of the aerodrome Obstacle Limitation Surfaces (OLS) shall also need to be considered by the Aerodrome Licence Holder (ALH).

6 For all planned SPV installations it is best practice for the developer to consult with the operators of nearby aerodromes **before** any construction is initiated.

7 An ALH, in agreement with their LPA, may wish to initiate procedures so that it is only consulted on SPV planning applications at shorter distances from the aerodrome (for example within a 5 km radius), or at distances that would limit SPV development from within the aircraft operating visual circuit; however, this is at the discretion of the ALH and no CAA approval or endorsement of this decision is necessary.

RECOMMENDATIONS

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[3] 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, 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.

[3] The CAA is aware of changes to planning legislation that may provide for 'Permitted Development Rights' for certain micro-generation equipment on both domestic and non-domestic property, under the General Permitted Development Order (1995).

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.

17 December 2010

Appendix B: Technical Guidance for Evaluating Selected Solar Technologies on Airports (2018)

16. Abstract

"Airport interest in solar energy is growing rapidly as a way to reduce airport operating costs and to demonstrate a commitment to sustainable development. In response, the Federal Aviation Administration (FAA) has prepared Technical Guidance for Evaluating Selected Solar Technologies on Airports to meet the regulatory and informational needs of the FAA Airports organization and airport sponsors.

For airports with favourable solar access and economics, this report provides a checklist of FAA procedures to ensure that proposed photovoltaic or solar thermal hot water systems are safe and pose no risk to pilots, air traffic controllers, or airport operations. Case studies of operating airport solar facilities are provided, including Denver International, Fresno Yosemite International, and Albuquerque International Sunport."

Preface

"Over 15 airports around the country are operating solar facilities and airport interest in solar energy is growing rapidly. In response, the Federal Aviation Administration (FAA) has prepared this report, Technical Guidance for Evaluating Selected Solar Technologies on Airports, to meet the regulatory and information needs of FAA personnel and airport sponsors in evaluating airport solar projects.

The guidance is intended to provide a readily usable reference for FAA technical staff who review proposed airport solar projects and for airport sponsors that may be considering a solar installation. It addresses a wide range of topics including solar technology, electric grid infrastructure, FAA safety regulations, financing alternatives, and incentives.

Airport sponsors are interested in solar energy for many reasons. Solar technology has matured and is now a reliable way to reduce airport operating costs. Environmentally, solar energy shows a commitment to environmental stewardship, especially when the panels are visible to the traveling public. Among the environmental benefits are cleaner air and fewer greenhouse gases that contribute to climate change. Solar use also facilitates small business development and U.S. energy independence.

While offering benefits, solar energy introduces some new and unforeseen issues, like possible reflectivity and communication systems interference. The guidance discusses these issues and offers new information that can facilitate FAA project reviews, including a flow chart of FAA procedures to ensure that proposed systems are safe and pose no risks to pilots, air traffic controllers, or airport operations."

AIRPORTS AND SOLAR ENERGY: CHARTING A COURSE

"Though solar energy has been evolving since the early 1990's as a mainstream form of renewable energy generation, the expansion in the industry over the past 10 years and corresponding decrease in prices has only recently made it a practical consideration for airports. Solar energy presents itself as an opportunity for FAA and airports to produce on-site electricity and to reduce long-term electricity use and energy costs. While solar energy has many benefits, it does introduce some new and unforeseen issues, like possible glare (also referred to as reflectivity) and communication systems interference, which have complicated FAA review and approval of this technology. This guide discusses such issues and how FAA reviews for solar projects can be streamlined and standardized to a greater extent."

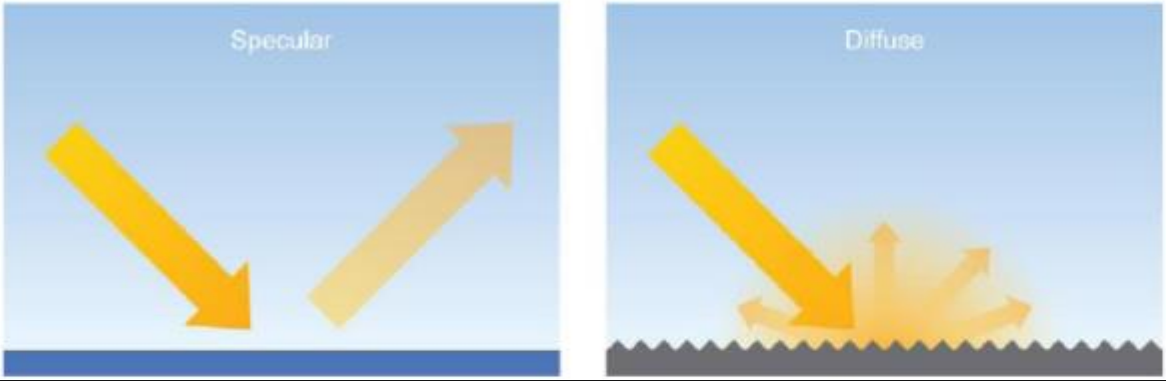
3.1.2 Reflectivity

"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.

FAA Order 7400.2, Procedures for Handling Airspace Matters, defines flash blindness as "generally, a temporary visual interference effect that persists after the source of illumination has ceased."

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, 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.

Figure 16: Different Types of Reflection



CSP systems use mirrors to maximize reflection and focus the reflected sunlight and associated heat on a design point to produce steam, which generates electricity. About 90 percent of sunlight is reflected. However, because the reflected sunlight is controlled and focused on the heat collecting element (HCE) of the system, it generally does not reflect back to other sensitive receptors. Another source of reflection in a CSP system is the light that contacts the back of the HCE and never reaches the mirror. Parts of the metal frame can also reflect sunlight. In central receiver (or power tower) applications, the receiver can receive concentrated sunlight that is up to a thousand times the sun's normal irradiance. Reflections from a central receiver, although approximately 90% absorptive, can still reflect a great deal of sunlight.

Solar PV and SHW panels are constructed of dark, light-absorbing materials and covered with an anti-reflective coating designed to maximize absorption and minimize reflection. However, the glass surfaces of solar PV and SHW systems also reflect sunlight to varying degrees throughout the day and year. The amount of reflected sunlight is based on the incidence angle of the sun relative to the light-sensitive receptor (e.g., a pilot or air traffic tower controller). The amount of reflection increases with lower incidence angles. In some situations, 100% of the sun's energy can be reflected from solar PV and SHW panels.

Because solar energy systems introduce new visual surfaces to an airport setting where reflectivity could result in glare that can cause flash blindness to those that require clear, unobstructed vision, project proponents should evaluate reflectivity during project siting and design."

Completing an Individual Glare Analysis

"Evaluating glare for a specific project should be an iterative process that looks at one or more of the methodologies described below. Airport sponsors should coordinate closely with the FAA's Office of Airports to evaluate the potential for glint and glare for solar projects on airport property. These data should include a review of existing airport conditions and a comparison with existing sources of glare, as well as related information obtained from other airports with experience operating solar projects.

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:

(1) A qualitative analysis of potential impact in consultation with the Air Traffic Control Tower, pilots, and airport officials

(2) A demonstration field test with solar panels at the proposed site in coordination with Air Traffic Control Tower personnel

(3) A geometric analysis to determine days and times when there may be an ocular impact.

The FAA should be consulted after completing each of the following steps to determine if potential reflectivity issues have been adequately considered and addressed.

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. Figure 17 provides an example of such a geometric analysis (not shown).

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 question23 but still requires further research to definitively answer.

The FAA Airport Facilities Terminal Integration Laboratory (AFTIL), located at the William J. Hughes Technical Centre at Atlantic City International Airport, provides system capabilities to evaluate control tower interior design and layout, site selection and orientation, height determination studies, and the transition of equipment into the airport traffic control tower environment. AFTIL regularly conducts computer assessments of potential penetrations of airspace for proposed airport design projects and has modelled the potential characteristics of glare sources, though not for solar projects. AFTIL may be a resource for regional FAA officials and sponsors who seek to evaluate the potential effects of glare from proposed solar projects."

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, where 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."

Appendix C: Assumptions, Limitations & Fixed Model Variables

1. The sun position and glare analysis will be determined throughout the year on a 1-minute basis.
2. The maximum amount of solar power striking surface normal to the sun per unit area (Peak direct normal irradiance, DNI) is set at 1,000 W/m^2. This will be scaled for each time step to account for changing sun position.
3. The average subtended angle of the sun as viewed from earth is 9.3 mrad.
4. The ocular transmission coefficient for the radiation that is absorbed in the eye before reaching the retina, is set to 0.5.[3,4]
5. Observer pupil diameter is set at the typical value of 0.002 m for daylight.[3,4]
6. Eye focal length for the distance between the nodal point (where rays intersect in the eye) and the retina is set at the typical value of 0.017 m. [3,4]
7. The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, models have been validated against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.[5]
8. The algorithm assumes that the PV array is aligned with a plane defined by the total heights (ground elevation plus PV array height) of the coordinates outlined in the Google map.
9. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors. As such, calculated DNI may vary from actual DNI experienced by observer.
10. The system output calculation is a DNI-based approximation that assumes clear, sunny skies all year-round.
11. Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
12. Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
13. Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
14. PV array tracking assumes the modules move instantly when tracking the sun, and when reverting to the rest position.

[3] Ho, C. K., Ghanbari, C. M., and Diver, R. B., 2011, Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation, ASME J. Sol. Energy Eng., 133.
[4] Sliney, D.H. and B.C. Freasier, 1973, Evaluation of Optical Radiation Hazards, Applied Optics, 12(1), p. 1-24.
[5] https://www.forgesolar.com/help/#assumptions