Technical Appendix 7: Glint and Glare Assessment

Derril Water Solar Farm

01/03/2021

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EXECUTIVE SUMMARY

7.1. This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km survey area around the Application Site is considered adequate for the assessment of ground-based receptors, whilst a 30km study area is chosen for aviation receptors. Within 1km of the Application Site, there are 70 residential receptors and 61 road receptors which were considered. As per the methodology section, where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for full assessment as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group has been assessed in detail. 20 residential and 26 road-based receptors were dismissed as they are located within the no reflection zones and therefore, will not be impacted upon by the Proposed Development. There were four aviation assets within 30km of the Proposed Development. However, no airfields required detailed assessment as the Proposed Development is located outside of their respective safeguarding buffer zones, which are outlined in **paragraph 7.63**.

7.2. The solar panels will face south and will be inclined at an angle of between 10 and 40 degrees and at a height of 2.8m above ground level (AGL). As the panels will be fixed in this position, points at the tops of the panels have been used to determine the worst-case impacts on receptors.

7.3. Geometric analysis was conducted at 50 residential receptors and 35 road receptors. Following an initial assessment, rail receptors were scoped out as assets that will be impacted upon from the Proposed Development as the closest rail receptor falls outside of the 1km study area.

7.4. The assessment concludes that:

- Solar reflections are possible at 42 of 50 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **High** at 35 receptors, **Medium** at three receptors, **Low** at four, and **None** at the remaining eight receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts remain **High** at two receptors and reduce to **None** at the remaining 48 receptors. Once mitigation was taken into consideration, impacts remain **High** for Receptor 39 (Landowner) and reduce to **None** for Receptor 44. Therefore, overall impacts are **High** for Receptor 39 and **None** for all remaining receptors.

- Solar reflections are possible at 32 of 35 road receptors assessed within the 1km study area. Upon reviewing the actual visibility of the road receptors, glint and glare impacts reduce to **None** at all receptors.

- **No impact** on train drivers or railway infrastructure is predicted.

- **No impact** on Aviation Assets is predicted.

7.5. Mitigation measures recommended include the infilling of hedgerows and planting of a berm along the eastern boundary of Field 3. These mitigation measures will screen all views to Residential Receptor 44 (landowner). Therefore, reducing its impact to **None**.

7.6. The effects of glint and glare and their impact on local receptors has been analysed in detail and once mitigation measures have been introduced there is predicted to be **No effect** on all residential receptors except for Residential Receptor 39, which is owned by the landowners. Therefore, impacts are not deemed to be significant.

INTRODUCTION

Background

7.7. Neo Environmental Ltd has been appointed by Renewable Energy Systems (RES) Ltd (the "Applicant") to complete a Glint and Glare Assessment for a proposed 42MW solar farm and associated infrastructure (the "Proposed Development") on lands circa 1.2km southwest of the village of Pyworthy, Devon (the "Application Site").

7.8. Please see **Figure 4 of Volume 2: Planning Application Drawings** for the layout of the Proposed Development.

Development Description

7.9. The Proposed Development will consist of the construction of bi-facial solar photovoltaic (PV) panels mounted on metal frames, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, a temporary construction compound, substation and all ancillary grid infrastructure and associated works.

7.10. The Proposed Development will result in the production of clean energy from a renewable energy resource (daylight) and will also involve additional landscaping including hedgerow planting and improved biodiversity management.

Site Description

7.11. The Application Site is located on lands circa 1.2km southwest of the village of Pyworthy and c. 1.8km southeast of Bridgerule in Torridge, Devon; the approximate centre point of which is Grid Reference E229936, N101914. Comprising 28 agricultural fields, the Application Site measures 66.33 hectares (ha) in total. See **Figure 1 of Volume 2: Planning Application Drawings** for details.

7.12. Land within the Application Site itself is gently undulating, ranging between 95 - 125m AOD and consists of fields typically of medium scale and generally well enclosed by a mixture of dense treelines, hedgerows and woodland shelter belt, limiting visibility for local settlements and receptors (See **Figure 3 of Volume 2: Planning Application Drawings** for field numbers).

7.13. The Application Site is in an area with existing electricity infrastructure, with a solar farm present c. 0.3km southeast and another c. 1.2km to the southwest. Additionally, the electrical Pyworthy Substation is located c. 75m from the northern parcel's eastern boundary, adjacent to Field 16, where the Proposed Development will connect.

7.14. The local area is generally agricultural in nature, punctuated by individual properties and farmsteads; the nearest residential areas are Hopworthy and Yeomadon, located 0.7km northeast and southeast respectively. Recreational Routes include two Public Rights of Way (PRoW); one which passes the southeastern boundary of the Application Site (linking Crinacott Farm and Northmoor Farm, both outside the Application Site) and another which passes east of the adjacent substation.

7.15. While there are a number of drains and water courses throughout the Application Site, it is mostly contained within Flood Zone 1, an area described as having a "Low probability" of flooding. The exception to this is a small part of the Application Site within Flood Zone 2 and 3, towards the eastern boundary of Field 16. These areas have been avoided within the Proposed Development footprint.

7.16. The Application Site will be accessed from four existing entrance points on the unnamed minor road which splits the site into northern and southern parcels. From the western boundary of the site, the road runs in a southwestern direction for c. 0.5km before turning in a general east-northeast direction through the eastern section of the Application Site.

Scope of Report

7.17. Although there may be small amounts of glint and glare from the metal structures associated with the solar farm, the main source of glint and glare will be from the panels themselves and this will be the focus of this assessment.

7.18. Solar panels are designed to absorb as much light as possible and not to reflect it. However, glint can be produced as a reflection of the sun from the surface of the solar PV panel. This can also be described as a momentary flash and may be an issue due to visual impact and viewer distraction on ground-based receptors and on aviation.

7.19. Glare is significantly less intense in comparison to glint and can be described as a continuous source of bright light, relative to diffused lighting. This is not a direct reflection of the sun, but a reflection of the sky around the sun.

7.20. This report will concentrate on the impacts of glint and its effect on local receptors and will be supported with the following Figures and Appendices.

- Appendix 7A: Figures
  - Figure 7.1: Residential Receptors
  - Figure 7.2: Road Based Receptors
- Appendix 7B: Residential Receptor Glare Results 10 Degrees
- Appendix 7C: Residential Receptor Glare Results 40 Degrees
- Appendix 7D: Road Receptor Glare Results 10 Degrees

- Appendix 7E: Road Receptor Glare Results 40 Degrees
- Appendix 7F: Visibility Assessment Evidence
- Appendix 7G: Solar Module Glare and Reflectance Technical Memo[1]

Statement of Authority

7.21. This Glint and Glare Assessment has been produced by Tom Saddington and Michael McGhee of Neo Environmental. Having completed a civil engineering degree in 2012, Michael has produced Glint and Glare assessments for over 1GW of solar farm developments across the UK and Ireland. Tom has an undergraduate degree in Bioengineering and graduated with an MSc in Environmental and Energy Engineering in January 2020. He has been working on various technical assessments including glint and glare reports for numerous solar farms in Ireland and the UK.

Definitions

7.22. This study examined the potential hazard and nuisance effects of glint and glare in relation to ground-based receptors, including the occupants of surrounding dwellings as well as road users. The Federal Aviation Guidance (FAA) in their "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[2] have defined the terms 'Glint' and 'Glare' as meaning;

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

7.23. Glint and glare are essentially the unwanted reflection of sunlight from reflective surfaces. This study used a multi-step process of elimination to determine which receptors had the potential to experience the effects of glint and glare. It then examined, 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] Sunpower Corporation (September 2009), T09014 Solar Module Glare and Reflectance Technical Memo

[2] 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

General Nature of Reflectance from Photovoltaic Panels

7.24. In terms of reflectance, photovoltaic solar panels are not highly reflective surfaces. They are designed to absorb sunlight and not to reflect it. Nonetheless, photovoltaic panels have a flat polished surface, which omits 'specular' reflectance rather than a 'diffuse' reflectance, which would occur from a rough surface. Several studies have shown that photovoltaic panels (as opposed to Concentrated Solar Power) have similar reflectance characteristics to water, which is much lower than glass, steel, snow and white concrete by comparison (see **Appendix 7G** for details). Similar levels of reflectance can be found in rural environments from shed roofs and the lines of plastic mulch used in cropping. In terms of the potential for reflectance from photovoltaic panels to cause hazard and / or nuisance effects, there have been several studies undertaken in respect of schemes in close proximity to airports. The most recent of these was compiled by the Solar Trade Association (STA) in April 2016 which used a number of case studies and expert opinions, including from Neo Environmental. The summary of this report states that "*the STA does not believe that there is cause for concern in relation to the impact of glint and glare from solar PV on aviation and airports…*"[3].

Time Zones / Datum's

7.25. Locations in this report are given in Eastings and Northings using the 'British National Grid' grid reference system unless otherwise stated.

7.26. England uses British Summer Time (BST, UTC + 01:00) in the summer months and Greenwich Mean Time (UTC+0) in the winter period. For the purposes of this report all time references are in GMT.

[3] Solar Trade Association. (April 2016). *Summary of evidence compiled by the Solar Trade Association to help inform the debate around permitted development for non - domestic solar PV in Scotland. Impact of solar PV on aviation and airports.* Available at: http://www.solar-trade.org.uk/wp-content/uploads/2016/04/STA-glint-and-glare-briefing-April-2016-v3.pdf

LEGISLATION AND GUIDANCE

National Planning Policy Guidance (NPPG) on Renewable and Low Carbon Energy (UK)[4]

7.27. Paragraph 013 (Reference ID: 5-013-20150327) sets out planning considerations that relate to large scale ground-mounted solar PV farms. This determines that 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. Considerations to be taken into account by local planning authorities are;

- *"the proposal's visual impact, the effect on landscape of glint and glare 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."*

Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems

7.28. As outlined within the BRE document 'Planning Guidance for the Development of Large Scale Ground Mounted Solar PV Systems'[5]

"Glint may be produced as a direct reflection of the sun in the surface of the solar PV panel. It may be the source of the visual issues regarding viewer distraction. Glare is a continuous source of brightness, relative to diffused lighting. This is not a direct reflection of the sun, but rather a reflection of the bright sky around the sun. Glare is significantly less intense than glint.

Solar PV panels are designed to absorb, not reflect, irradiation. However, the sensitivities associated with glint and glare, and the landscape/ visual impact and the potential impact on aircraft safety, should be a consideration. In some instances, it may be necessary to seek a glint and glare assessment as part of a planning application. This may be particularly important if 'tracking' panels are proposed as these may cause differential diurnal and/or seasonal impacts.

[4] NPPG Renewable and Low Carbon Energy. Available at: http://planningguidance.communities.gov.uk/blog/guidance/renewable-and-low-carbon-energy/particular-planning-considerations-for-hydropower-active-solar-technology-solar-farms-and-wind-turbines/#paragraph_012

[5] BRE (2013) *Planning Guidance for the Development of Large Scale Ground Mounted Solar PV Systems*. Available at: https://www.bre.co.uk/filelibrary/pdf/other_pdfs/KN5524_Planning_Guidance_reduced.pdf

The potential for solar PV panels, frames and supports to have a combined reflective quality should be assessed. This assessment needs to consider the likely reflective capacity of all of the materials used in the construction of the solar PV farm."

Interim CAA Guidance – Solar Photovoltaic Systems (2010)

7.29. There is little guidance on the assessment of glint and glare from solar farms with regards to aviation safety. The Civil Aviation Authority (CAA) has published interim guidance on 'Solar Photovoltaic Systems[6]', they also intend to undertake a review of the potential impacts of solar PV developments upon aviation, however this is yet to be published.

7.30. The interim guidance identifies the key safety issues with regards to aviation, including *"glare, dazzling pilots leading them to confuse reflections with aeronautical lights."* It is outlined that solar farm developers should be aware of the requirements to comply with the Air Navigation Order (ANO), published in 2009. In particular, developers should take cognisant of the following articles of the ANO[7], including:

- *"Article 137 – Endangering safety of an aircraft – A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft."*
- *Article 221 - Lights liable to endanger – "A person must not exhibit in the United Kingdom any light which:*
  - *a) by reason of its glare is liable to endanger aircraft taking off or from landing at an aerodrome; or*
  - *b) by reason of its liability to be mistaken for an aeronautical ground light liable to endanger aircraft"*
- *Article 222 – Lights which dazzle or distract – "A person must not in the United Kingdom direct or shine any light at any aircraft in flight so as to dazzle or distract the pilot of the aircraft."*

7.31. Relevant studies generally agree that there is potential for glint and glare from photovoltaic panels to cause a hazard or nuisance for surrounding receptors, but that the intensity of such reflections is similar to that emanating from still water. This is considerably lower than for other manmade materials such as glass, steel or white concrete (SunPower – 2009).

[6] CAA (2010) Interim CAA Guidance – Solar Photovoltaic Systems. Available at: http://www.enstoneflyingclub.co.uk/files/caa_view_on_solar_panel_instalations.pdf?PHPSESSID=8900a41db8a205da84fca7bbc14eae69

[7] CAA (2015) Air Navigation: The Order and Regulations. Available at: http://publicapps.caa.co.uk/docs/33/CAP%20393%20Fourth%20edition%20Amendment%201%20April%202015.pdf

7.32. These Articles are considered within the assessment of glint and glare of the Proposed Development.

US Federal Aviation Administration Policy

7.33. The US Federal Aviation Administration (FAA) in their Solar Guide (Federal Aviation Authority, 2010)[8] incorporates a chapter on the impact and assessment of glint from solar panels. It concludes that (although subject to revision):

"…evidence suggests that either significant glare is not occurring during times of operation or if glare is occurring, it is not a negative effect and is a minor part of the landscape to which pilots and tower personnel are exposed."

7.34. The current policy (Federal Register, 2013)[9] requires an ocular impact assessment be assessed at 1-minute intervals from when the sun rises above the horizon until the sun sets below the horizon. Specifically, the developer must use the 'Solar Glare Hazard Analysis Tool' (SGHAT) tool specifically and reference its results as this was developed by the FAA and Sandia National Laboratories as a standard and approved methodology for assessing potential impacts on aviation interests, although it notes other assessment methods may be considered. The SGHAT tool has since been licensed to a private organisation who were also involved in its development and it is the software model used in this assessment.

7.35. Crucially, the policy provides a quantitative threshold which is lacking in the UK guidance. This outlines that a solar development will not automatically receive an objection on glint grounds if low intensity glint is visible to pilots on final approach. In other words, low intensity glint with a low potential to form a temporary after-image would be considered acceptable under US guidance. Due to the lack of legislation and guidance within Ireland, this US document has been utilised as guidance for this report.

7.36. The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection, the following two criteria must be met:

- No potential for glint or glare in the existing or planned Air Traffic Control Tower (ATCT)
- No potential for glare (glint) or "low potential for after-image" along the final approach path for any existing or future runway landing thresholds (including planned or interim

[8] FAA (2010), Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide-print.pdf

[9] FAA (2013), Interim Policy, *FAA Review of Solar Energy System Projects on Federally Obligated Airports*. Available at https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

phases), as shown by the approved layout plan (ALP). The final approach path is defined as 2 miles from 50 feet above the landing threshold using a standard 3-degree glide path.

7.37. The geometric analysis included later in this report, which defines the extent and time at which glint may occur, is required by the FAA as the methodology to be used when assessing glint and glare impacts on aviation receptors. This report will follow the methodology required by the FAA as it offers the most robust assessment method currently available.

Review of Local Plan

North Devon and Torridge Local Plan 2011 - 2031

7.38. The North Devon and Torridge Local Plan (2011 – 2031)[10] was adopted by the district council in October 2018.

The plan states in **Introduction** section:

"The purpose of the North Devon and Torridge District Local Plan (the Local Plan) is to set out the long-term vision for how the towns, villages and countryside of northern Devon will develop and evolve in the period up to 2031. The Local Plan will set out how this vision will be delivered through a strategy of supporting, distributing and delivering sustainable development and growth."

7.39. There are no policies within the current adopted local plan which are of relevance for this report.

[10] https://consult.torridge.gov.uk/portal/planning/localplan/adoption/interactive?pointId=5051463

METHODOLOGY

7.40. A desk-based assessment was undertaken to identify when and where glint and glare may be visible at receptors within the vicinity of the Proposed Development, throughout the day and the year.

Sun Position and Reflection Model

Sun Data Model

7.41. The calculations in the solar position calculator are based on equations from Astronomical Algorithms[11]. The sunrise and sunset results are theoretically accurate to within a minute for locations between +/- 72° latitude, and within 10 minutes outside of those latitudes. However, due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary from calculations.

Solar Reflection Model

7.42. The position of the sun is calculated at one-minute intervals of a typical year, in this instance the year assessed is 2020.

7.43. In order to determine if a solar reflection will reach a receptor, the following variables are required:

- Sun position;
- Observer location; and
- Tilt, orientation, and extent of the modules in the solar array.

7.44. The model assumes that the azimuth and horizontal angle of the sun is the same across the whole solar farm. 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.

7.45. Once the position of the sun is known for each time interval, a vector reflection equation determines the reflected sun vector, based on the normal vector of the solar array panels. This assumes that the angle of reflection is equal to the angle of incidence reflected across a normal plane. In this instance the plane being the vector which the solar panels are facing.

7.46. On knowing the vector of the solar reflection, the azimuth is calculated and the horizontal reflection from multiple points within the solar farm. These are then compared with the

[11] Jean Meeus, *Astronomical Algorithms* (Second Edition), 1999

azimuth and horizontal angle of the receptor from the solar farm to determine if it is within range to receive solar reflections.

7.47. The solar reflection in the model is considered to be specular as a worst-case scenario. In practice the light from the sun will not be fully reflected as solar panels are designed to absorb light rather than reflect it. The previous text and **Appendix 7G** outline the reflective properties of solar glass and compares it to other reflective surfaces. Although the exact figures in this report are not conclusive, it is included as a visual guide and it agrees with most other reports, in that solar glass has less reflective properties than other types of glass and that the amount of reflective energy drops as the angle of incidence decreases.

7.48. Most modern panels have a slight surface texture which should have a small effect on diffusing the solar radiation further; although, this has not been modelled to conform with the worst-case scenario assessment.

Determination of Ocular Impact

7.49. The software used for this assessment is based on the Sandia Laboratories Solar Glare Hazard Analysis Tool (SGHAT). This tool is specifically mentioned in the FAA guidance as the software which should be used in this type of assessment.

7.50. Determination of the ocular impact requires knowledge of the direct normal irradiance, PV module reflectance, size and orientation of the array, optical properties of the PV module, and ocular parameters. These values are used to determine the retinal irradiance and subtended source angle used in the ocular hazard plot.

7.51. The ocular impact[12] of viewed glare 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).

7.52. Green glare can be ignored when looking at ground based and some aviation receptors. Green glare does not cause temporary flash blindness and happens at an instant with very slight disturbance. As per FAA guidelines mitigation is only required for green glare when affecting an Air Traffic Control Tower, but not for when affecting pilots. Therefore, it can be assumed that green glare is acceptable for ground-based receptors.

7.53. The subtended source angle represents the size of the glare viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles can result in glare of high intensity, even if the retinal irradiance is low.

[12] Ho, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation, Journal of Solar Energy Engineering-Transactions of the Asme, 133(3).

Relevant Parameters of the Proposed Development

7.54. The photovoltaic panels are oriented in a southwards direction to maximise solar gain and will remain in a fixed position throughout the day and during the year (i.e. they will not rotate to track the movement of the sun). The panels will face south and will be inclined at an angle of between 15 and 30 degrees. The panel tilt angle which will result in the worst-case impacts at the receptor point will change depending on the orientation between the receptor point and the Proposed Development. Therefore, this report considers the impacts from the minimum and maximum panel angles (15 and 30 degrees respectively) and assesses each receptor based on the worst-case effects.

7.55. The maximum above ground level height of the panels is 2.8m and points at the top of the panels are used to determine the potential for glint and glare generation.

Identification of Receptors

Ground Based Receptors

7.56. Glint is most likely to impact upon a ground-based receptor close to dusk and dawn when the sun is at its lowest in the sky. Therefore, any effect would likely occur early in the day or late in the day, reflected to the west at dawn and east at dusk.

7.57. A 1km study area from the panels was deemed appropriate for the assessment of ground-based receptors as this seemed to contain a good spread of residential and road receptors in most directions from the Proposed Development. The further distance a receptor is from a solar farm, the less chance it has of being affected by glint and glare due to scattering of the reflected beam and atmospheric attenuation, in addition to obstructions from ground sources, such as any intervening vegetation or buildings.

7.58. An observer height of 2m was utilised for residential receptors, as this is a typical height for a ground-floor window. Upper floor windows are not analysed geometrically; however, are considered as part of the visual analysis. With regards to road users, a receptor height of 1.5m was employed as this is typical of eye level. Rail driver's eye level was assumed to be 2.75m above the rail for signal signing purposes and therefore this is the height used for assessment purposes.

7.59. An assessment was undertaken to determine zones where solar reflections will never be directed near ground level.

7.60. Where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for full assessment as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group has been analysed in detail with the worst-case impacts attributed to that receptor.

Aviation

7.61. Glint is only considered to be an issue with regards to aviation safety when the solar farm lies within close proximity to a runway, particularly when the aircraft is descending to land. En-route activities are not considered an issue as the flight will most likely be at a higher altitude than the solar reflection.

7.62. Should a solar farm be proposed within the safeguarded zone of an aerodrome, a full geometric study may be required (depending on the orientation from the Proposed Development) which would determine if there is potential for glint and glare at key locations, most likely on the descent to land.

7.63. Buffer zones to identify aviation assets vary depending on the safeguarding criteria of that asset. All aerodromes within 30km will be identified, however generally the detailed assessments are only required within: 20km for licensed aerodromes, 10km for military aerodromes and 5km for small aerodromes.

Magnitude of Impact

Static Receptors

7.64. Although there is no specific guidance set out to identify the magnitude of impact from solar reflections, the following criteria has been set out for the purposes of this report:

- High - Solar reflections impacts of over 30 hours per year or over 30 minutes per day
- Medium - Solar reflections impacts between 20 and 30 hours per year or between 20 minutes and 30 minutes per day
- Low - Solar reflections impacts between 0 and 20 hours per year or between 0 minutes and 20 minutes per day
- None - Effects not geometrically possible or no visibility of reflective surfaces likely due to high levels of intervening screening

Moving Receptors (Road and Rail)

7.65. Again, no specific guidance is available to identify the magnitude of impact from solar reflections on moving receptors except in aviation, however it is thought that a similar approach should be applied to moving receptors as aviation, based on the ocular impact and the potential for after-image.

7.66. The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection the following criteria must be met:

- No potential for glare (glint) or "low potential for after-image" along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the approved layout plan (ALP).

Moving Receptors (Aviation)

Approach Paths

7.67. Each final approach path which has the potential to receive glint is assessed using the Solar Glare Hazard Analysis Tool (SGHAT) model. The model assumes an approach bearing on the runway centreline, a 3-degree glide path with the origin 50 ft (15.24 m) above the runway threshold.

7.68. The computer model considers the pilots field of view. The azimuthal field of view (AFOV) or horizontal field of view (HFOV) as it is sometimes referred, refers to the extents of the pilot's horizontal field of view measured in degrees left and right from directly in front of the cockpit. The vertical field of view (VFOV) refers to the extents of the pilot's vertical field of view measured in degrees from directly in front of the cockpit. The HFOV is modelled at 90 degrees left and right from the front of the cockpit whilst the VFOV is modelled at 30 degrees.

7.69. The FAA guidance states that there should be no potential for glare or '*low potential for after-image'* at any existing or future planned runway landing thresholds in order for the proposed Development to be acceptable.

Air Traffic Control Tower (ATCT)

7.70. An air traffic controller uses the visual control room to monitor and direct aircraft on the ground, approaching and departing the aerodrome. It is essential that air traffic controllers have a clear unobstructed view of aviation activity. The key areas on an aerodrome are the views towards the runway thresholds, taxiways and aircraft bays.

7.71. The FAA guidance states that no solar reflection towards the ATCT should be produced by a proposed solar development (see Legislation and Guidance section above), however this should be assessed on a site by site basis and will depend on the operations at a particular aerodrome.

7.72. In order to determine the impact on the ATCT, the location and height of the tower will need to be fed into the SGHAT model and where there is a potential for 'low potential for After-Image' or more, then mitigation measures will be required.

Assessment Limitations

7.73. Below is a list of assumptions and limitations of the model and methods used within this report:

- The model does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
- The model 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.
- Due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary slightly from calculated positions.
- The model does not account for the effects of diffraction; however, buffers are applied as a factor of safety.

BASELINE CONDITIONS

Ground Based Receptors Reflection Zones

7.74. In the northern hemisphere, there will never be solar reflections due south of a solar PV development as the position of the sun is always south. Furthermore, due to the slant of a solar panel (where the sun is due south, with an azimuth angle of 180 degrees), reflections will be directed skyward and not impact on ground-based receptors. The ground-based receptor reflection zone is a procedure which eliminates certain areas in order to reduce the assessment procedure, much in the same way a zone of theoretical visibility (ZTV) map allows a Landscape Architect to focus their assessment on areas where the solar PV development will be visible.

7.75. Based on the relatively flat topography in the study area, solar reflections between five degrees below the horizontal plane to five degrees above it are described as near horizontal. Reflections from the proposed solar farm within this arc have the potential to be seen by receptors at or near ground level.

7.76. Further analysis showed that this will only occur between the azimuth of 232.2 degrees and 294.4 degrees in the western direction (late day reflections) and 65.4 degrees and 126.2 degrees in the eastern direction (morning reflections) and therefore any ground-based receptor outside these arcs will not have any impact from solar reflections.

7.77. **Figure 7.1 and 7.2 of Appendix 7A** show the respective study areas whilst also subtracting from this from the areas where solar reflections will not impact on ground-based receptors due to the reasons set out in **paragraphs 7.74 to 7.76.**

Residential Receptors

7.78. Residential receptors located within 1km of the Application Site have been identified in **Table 7-1** below. Glint was assumed to be possible if the receptor is located within the ground-based receptor zones outlined previously.

7.79. There are 20 residential receptors (Receptors 51 to 70) which are within the no-reflection zones and are clearly identifiable in **Figure 7.1: Appendix 7A.** The process of how these are calculated is explained in **paragraphs 7.74 to 7.76** of this report.

Table 7 - 1: Residential Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	228470	102361	Yes

2	228419	102047	Yes
3	228499	102037	Yes
4	228696	101977	Yes
5	228819	101909	Yes
6	228906	102031	Yes
7	229031	102095	Yes
8	229089	102088	Yes
9	228703	101860	Yes
10	228715	101809	Yes
11	228697	101777	Yes
12	228340	101316	Yes
13	228220	101252	Yes
14	228549	101082	Yes
15	228468	100695	Yes
16	228580	100666	Yes
17	229046	100936	Yes
18	229064	100908	Yes
19	229278	100855	Yes
20	229149	100790	Yes
21	229853	100905	Yes
22	229887	100909	Yes
23	229881	100952	Yes
24	229854	101002	Yes
25	230536	100739	Yes

26	230549	100713	Yes
27	230599	100732	Yes
28	230612	100756	Yes
29	230633	100790	Yes
30	230641	100819	Yes
31	230934	100999	Yes
32	230959	101018	Yes
33	230468	101499	Yes
34	230459	101527	Yes
35	231081	102168	Yes
36	231072	102661	Yes
37	230472	102948	Yes
38*	229703	102142	Yes
39*	229683	102119	Yes
40*	229709	102102	Yes
41*	229818	101990	Yes
42*	229545	101867	Yes
43*	229501	101816	Yes
44*	229440	101503	Yes
45	228911	102845	Yes
46	228898	102833	Yes
47	228875	102818	Yes
48	228850	102805	Yes
49	228834	102806	Yes

50	228800	102802	Yes
51	229256	100535	No
52	229283	100501	No
53	229744	100164	No
54	229860	100632	No
55	230201	102960	No
56	230048	102919	No
57	230003	102911	No
58	230036	102894	No
59	230062	102817	No
60	229701	102722	No
61	229456	102661	No
62	229509	103129	No
63	229494	103131	No
64	229479	103125	No
65	229512	103108	No
66	229477	103075	No
67	229445	103064	No
68	229001	102888	No
69	228968	102874	No
70	228930	102853	No

7.80. Within **Table 7 – 1**, (*) denotes the residential receptors which are landowner houses.

Road / Rail Receptors

7.81. The closest railway line to the Application Site is over 1km to the east and due to its distance and orientation, glint and glare effects from the Proposed Development will not be possible. Effects on rail have therefore been scoped out of the rest of this assessment.

7.82. There are six roads within the 1km study area that require a detailed glint and glare analysis which are all unnamed. There are some minor roads which serve dwellings; however, these have been dismissed as vehicle users of these roads will likely be travelling at low speeds and therefore there is a negligible risk of safety impacts from glint and glare.

7.83. The ground receptor no-reflection zones are clearly identifiable on **Figure 7.2: Appendix 7A** and the process of how these are calculated is explained in **paragraphs 7.74 to 7.76** of this report. Assessment points 200m apart are used.

Table 7 - 2: Road Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	228346	102781	Yes
2	228530	102766	Yes
3	228728	102791	Yes
4	230397	102944	Yes
5	230597	102942	Yes
6	230795	102963	Yes
7	231055	102108	Yes
8	230860	102070	Yes
9	230666	102046	Yes
10	230466	102060	Yes
11	230266	102072	Yes
12	230074	102041	Yes
13	229880	101993	Yes
14	229692	101924	Yes

15	229502	101954	Yes
16	229318	102033	Yes
17	229133	102109	Yes
18	228950	102031	Yes
19	228772	101939	Yes
20	228373	102485	Yes
21	228460	102308	Yes
22	228511	102115	Yes
23	228617	101953	Yes
24	228683	101780	Yes
25	228693	101601	Yes
26	228771	101417	Yes
27	228869	101236	Yes
28	228969	101063	Yes
29	229056	100885	Yes
30	229215	100867	Yes
31	229400	100857	Yes
32	230338	100729	Yes
33	230519	100784	Yes
34	230685	100892	Yes
35	230821	101039	Yes
36	228911	102867	No
37	229083	102968	No

38	229268	103039	No
39	229451	103113	No
40	229644	103160	No
41	229821	103245	No
42	230002	103330	No
43	229059	103431	No
44	229148	103252	No
45	229235	103072	No
46	229331	102899	No
47	229484	102773	No
48	229666	102796	No
49	229823	102901	No
50	230018	102921	No
51	230205	102912	No
52	229544	100732	No
53	229732	100680	No
54	229914	100602	No
55	230110	100578	No
56	230269	100459	No
57	230424	100334	No
58	230194	100592	No
59	230028	100447	No
60	229916	100281	No

61	229803	100116	No

Aviation Receptors

7.84. Aerodromes within 30km of the proposed solar development can be found in **Table 7-3.**

Table 7 - 3: Airfields in close proximity

Airfield	Distance	Use
Gorrel Farm Airfield	16.2 km	Small Grass Strip
Sheepwash Airfield	17.9 km	Small Grass Strip
Davidstow Moor	21.3 km	Davidstow Flying Club
Brentor Airfield	28.2 km	Dartmoor Gliding Club

7.85. As none of the airfields in **Table 7- 3** are located within their respective safeguarding buffer zones, outlined in **paragraph 7.63**, they have not been assessed further due to their size.

IMPACT ASSESSMENT

7.86. Following the methodology outlined earlier in this report, geometrical analysis comparing the azimuth and horizontal angle of the receptors from the Proposed Development and the solar reflection was conducted. Although this assessment did not take into account obstructions such as vegetation and buildings, discussion on the potentially impacted receptors is provided where necessary.

Ground Based Receptors

Residential Receptors

7.87. **Table 7-4** identifies the receptors that will experience solar reflections based on solar reflection modelling and whether the reflections will be experienced in the morning (AM), evening (PM), or both.

7.88. The 20 receptors which were within the no reflection zones outlined previously have been excluded from the detailed modelling as they will never receive any glint and glare impacts from the Proposed Development.

7.89. **Appendix 7B and 7C** contains the detailed analysis of the glint and glare impacts. **Table 7-4** below shows the impact at each receptor.

Table 7 - 4: Potential for Glint and Glare impact on Residential Receptors

	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact	Worst Case Tilt
Receptor	AM	PM	Minutes	Hours		
1	Yes	No	1215	20.3	Medium	10
2	Yes	No	1693	28.2	Medium	10
3	Yes	No	2115	35.3	High	10
4	Yes	No	3909	65.2	High	40
5	Yes	No	5478	91.3	High	40
6	Yes	No	6157	102.6	High	40
7	Yes	No	6633	110.6	High	40
8	Yes	No	8232	137.2	High	40
9	Yes	No	4024	67.1	High	40

10	Yes	No	4092	68.2	High	40
11	Yes	No	4239	70.7	High	40
12	Yes	No	4804	80.1	High	40
13	Yes	No	4110	68.5	High	40
14	Yes	No	3392	56.5	High	40
15	Yes	No	1453	24.2	Medium	40
16	Yes	No	1019	17.0	Low	10
17	Yes	No	2432	40.5	High	10
18	Yes	No	2305	38.4	High	10
19	Yes	No	1036	17.3	Low	40
20	Yes	No	1065	17.8	Low	40
21	No	Yes	3431	57.2	High	10
22	No	Yes	2239	37.3	High	10
23	No	Yes	5193	86.6	High	10
24	No	Yes	7322	122.0	High	40
25	No	Yes	5094	84.9	High	10
26	No	Yes	4684	78.1	High	10
27	No	Yes	5295	88.3	High	10
28	No	Yes	5789	96.5	High	10
29	No	Yes	6376	106.3	High	10
30	No	Yes	6838	114.0	High	10
31	No	Yes	7489	124.8	High	10
32	No	Yes	7329	122.2	High	10
33	No	Yes	7613	126.9	High	10
34	No	Yes	8037	134.0	High	10
35	No	Yes	876	14.6	Low	10
36	No	No	0	0.0	None	N/A
37	No	No	0	0.0	None	N/A

38	Yes	Yes	7755	129.3	High	10
39	Yes	Yes	7659	127.7	High	40
40	Yes	Yes	7405	123.4	High	10
41	Yes	Yes	12879	214.7	High	10
42	Yes	Yes	8950	149.2	High	40
43	Yes	Yes	8206	136.8	High	40
44	Yes	Yes	9855	164.3	High	40
45	No	No	0	0.0	None	N/A
46	No	No	0	0.0	None	N/A
47	No	No	0	0.0	None	N/A
48	No	No	0	0.0	None	N/A
49	No	No	0	0.0	None	N/A
50	No	No	0	0.0	None	N/A

7.90. As it can be seen in **Table 7-4** there is a **High** impact at 35 receptors, **Medium** at three receptors, **Low** at four receptors and **None** impact for the remaining eight receptors. **Appendix 7B and 7C** shows detailed analysis of when the glare impacts are possible, whilst also showing which parts of the solar farm the solar glint is reflected from.

7.91. **Appendix 7F** shows Google Earth images that give an insight into how each receptor will be impacted by the glint and glare from the Proposed Development. There is a mixture of images used, which include aerial, ground level and street level. The aerial images show the location of the receptor with the solar farm drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The area of the solar farm from where reflections may be possible has been drawn as a yellow polygon. The ground level terrain is based on the height data of the surrounding land showing no intervening vegetation or buildings. The white and yellow polygons can be seen in this view also. The street view gives a good indication as to whether the area of the solar farm where reflections are theoretically possible will be visible from the receptor point. Also, where appropriate images that have been taken from within the Application Site have been used to show up to date imaging. Additionally, when referring to Array 1, 2, 3 and 4 below, Array 1 is the area that is northwest, Array 2 is the area southwest, Array 3 is the area that is northeast and Array 4 is the area that is southeast.

Receptor 1

7.92. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from the northern half of Array 1 of the Proposed Development can potentially impact on the receptor.

7.93. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor and along the northern boundary of the Proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 10 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view of the vegetation along the northern boundary of the Proposed Development. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 2 and 3

7.94. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from all of Array 1, a northern section of Array 2 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.95. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation to the east of the receptors. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 4

7.96. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from the southern half of Array 1, a northern section of Array 2, a northwest section of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptor.

7.97. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation to the east of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 5

7.98. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from the southern half of Array 1, a northern section of Array 2, a northwest section of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptor.

7.99. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation to the east of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 6 - 8

7.100. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from the southern half of Array 1, a northern section of Array 2, a northwest section of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.101. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor and along the northern boundary of the Proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 10 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view of the vegetation to the east of Receptor 8. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 9

7.102. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from the southern half of Array 1, a northern section of Array 2, a northwest section of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptor.

7.103. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation to the east of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 10 and 11

7.104. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from the southern half of Array 1, a northern section of Array 2, a western section of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.105. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor and along the western boundary of Array 2 to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 8 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view of the vegetation along the western boundary of Array 2. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 12 and 13

7.106. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from all of Array 1, a central section of Array 2 and all, except a southwest section, of Array 4 of the Proposed Development can potentially impact on the receptors.

7.107. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptors and of the vegetation to the east of the receptors. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 14

7.108. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of Array 2 and all, except a northern section, of Array 4 of the Proposed Development can potentially impact on the receptor.

7.109. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptor and of the vegetation to the east of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 15 and 16

7.110. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from the southern half of Array 4 of the Proposed Development can potentially impact on the receptors.

7.111. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the east of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptors and of the vegetation to the east of the receptors. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 17 and 18

7.112. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.113. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient farm buildings located to the east of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the farm buildings to the east of the receptors. This second image confirms that the farm buildings are sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 19 and 20

7.114. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.115. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the northeast of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the vegetation to the northeast of the receptors. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 21 - 24

7.116. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of Array 2 and a southern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.117. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is sufficient vegetation located to the northwest of the receptors and along the southern boundary of Array 4 to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 25 and 26

7.118. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of Array 2 and a southern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.119. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the north of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptors. This second image shows that the receptors are set back below the hedgerow to the north due to the topography of the land. This second image confirms that the vegetation and topography of the land is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 27 and 28

7.120. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of Array 2 and a southern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.121. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the north of the receptors to screen all views of the Proposed

Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptors. This second image shows that the receptors are set back below the hedgerow to the north due to the topography of the land. This second image confirms that the vegetation and topography of the land is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 29

7.122. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern section of Array 2 and a southern section of Array 4 of the Proposed Development can potentially impact on the receptor.

7.123. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the north of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptor. This second image shows that the receptor is set back below the hedgerow to the north due to the topography of the land. This second image confirms that the vegetation and topography of the land is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 30

7.124. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a southern half of Array 2 and a southern section of Array 4 of the Proposed Development can potentially impact on the receptor.

7.125. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view towards the receptor. This second image shows that the receptor is a single-story dwelling which will have its views screened by the hedgerow to the front of the receptor. This second image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 31 and 32

7.126. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from all of Array 2 and the southern half of Array 4 of the Proposed Development can potentially impact on the receptors.

7.127. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient farm buildings and vegetation located to the northwest of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the farm buildings and vegetation to the northwest of the receptors. This second image confirms that the farm buildings and vegetation are sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 33 and 34

7.128. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from the southern half of Array 1, all, except a southern section, of Array 2 and a central section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.129. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 24 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view towards the receptors. This second image confirms that the topography and vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 35

7.130. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a northern section of Array 1, all, except a western section, of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptor.

7.131. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient buildings and vegetation located to the west of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken where the red dot is located on the aerial image and has a view of the buildings and vegetation to the west of the receptor. This second image confirms that the buildings and vegetation are sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 38 - 40

7.132. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a central section of Array 1, a northern section, of Array 2, all, except a northwest section, of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.133. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 10 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which has a view towards the receptors. This second image shows that Receptor 39 is still visible. The third image has been taken within the Application Site in Field 16 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which shows no receptors are visible from Array 3 due to the topography. Therefore, the impact remains **High** for Receptor 39 but impacts reduce to **None** for receptors 38 and 40.

Receptor 41

7.134. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a central section of Array 1, a northern section of Array 2, all, except a northwest section of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptor.

7.135. The first image in **Appendix 7F** is an aerial view which shows the location of the receptor in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptor to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 16 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which shows no receptors are visible from Array 3 due to topography. The third image has been taken within the Application Site in Field 14 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which shows no receptors are visible from Array 1. The fourth image has been taken within the Application Site in Field 18 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which shows the topography of the field sloping away to the southeast with sufficient hedgerows being shown from the shading on the image. The second, third and fourth images confirm that there is sufficient topography and vegetation to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 42 and 43

7.136. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a southeast section of Array 1, a northern section of Array 2, the southern half of Array 3 and a northern section of Array 4 of the Proposed Development can potentially impact on the receptors.

7.137. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is likely to be sufficient vegetation located to the west of the receptors to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 8 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which shows no receptors are visible from Array 3. This third image shows that no receptors are visible from Array 3 due to topography. Therefore, the impact reduces to **None**.

Receptor 44

7.138. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a central section of Array 2 and a central section of Array 4 of the Proposed Development can potentially impact on the receptor.

7.139. The first image in **Appendix 7F** is an aerial view which shows the location of the receptors in relation to the Proposed Development. Also, it shows that there is sufficient vegetation located to the northeast of the receptors to screen all views of Array 4 of the Proposed Development where glint and glare is possible. The second image has been taken within the Application Site in Field 4 (for field numbers, See **Figure 3 of Volume 2: Planning Application Drawings**), which shows the receptor is visible from Array 2. Therefore, the impact remains **High**.

Road Receptors

7.140. **Table 7-5** shows a summary of the modelling results for each of the Road Receptor Points whilst the detailed results and ocular impact charts can be viewed in **Appendix 7C and 7D.**

7.141. The 26 receptors within the no reflection zones outlined previously have been excluded from the detailed modelling as they will never receive glint and glare impacts from the Proposed Development.

Table 7 - 5: Potential for Glint and Glare impact on Road Based Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact	Worst Case Tilt
1	16	57	0	**High**	10

2	0	100	0	High	10
3	0	6	0	High	10
4	0	0	0	None	N/A
5	0	0	0	None	N/A
6	0	0	0	None	N/A
7	1709	1587	0	High	10
8	1173	3073	0	High	10
9	366	5051	0	High	10
10	1436	11626	0	High	10
11	212	3295	0	High	40
12	38657	68703	0	High	10
13	1735	17072	0	High	10
14	7056	14727	0	High	10
15	241	13561	0	High	40
16	4816	17047	0	High	40
17	727	9048	0	High	40
18	849	6568	0	High	40
19	1808	4738	0	High	40
20	112	660	0	High	10
21	347	1213	0	High	10
22	1335	1366	0	High	10
23	2037	2648	0	High	40
24	3337	3976	0	High	40
25	3165	4897	0	High	40
26	961	6782	0	High	40
27	11	6117	0	High	40
28	0	1797	0	High	40

29	378	2036	0	**High**	40
30	236	1886	0	**High**	40
31	16	62	0	**High**	40
32	292	3591	0	**High**	10
33	1724	6295	0	**High**	10
34	1900	7755	0	**High**	10
35	1866	8133	0	**High**	10

7.142. As can be seen in **Table 7-5**, there are 32 receptor points analysed in detail that have potential glare impacts and have the "potential for after-image" (yellow glare) which is a **High** impact. **Appendix 7D and 7E** shows detailed analysis of when the glint and glare impacts are possible, whilst also showing from which parts of the solar farm the solar glint is reflected from.

7.143. **Appendix 7F** shows Google Earth images that give an insight into how each receptor will be impacted by the glint and glare from the Proposed Development. There is a mixture of images used, which include ground level and street level. The ground level views show the location of the receptor with the solar farm drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The area of the solar farm from where reflections may be possible has been drawn as a yellow polygon. The ground level terrain is also based on the height data of the surrounding land showing no intervening vegetation or buildings. The white and yellow polygons can be seen in this view also. The street view gives a good indication as to whether the area of the solar farm where reflections are theoretically possible will be visible from the receptor point.

7.144. As can be seen in **Appendix 7F**, views into the Proposed Development where glint and glare is possible are blocked through a mixture of vegetation and topography for all road receptors. Therefore, their impacts are reduced to **None.**

7.145. Receptors 34 and 35, which are located approximately 850m southeast of the Proposed Development on an unnamed road, have their views blocked by the hedgerow. But, within **Appendix 7F** there appears to be glimpses of the Proposed Development at those receptors aforementioned. However, the Google Earth images are taken at a height of 2.5m, therefore the hedgerow is approximately 2.5m in height, which will screen the views from the drivers along these roads as it is assumed the eye level will be at approximately 1.5m in height.

GROUND BASED RECEPTOR MITIGATION

7.146. Mitigation is required to ensure views from Residential Receptor 44 (landowner) into the Proposed Development is screened. This includes:

- Infill planting of the hedgerow to the west of the receptor along with a berm along the eastern boundary of Field 3 which will screen all views from Residential Receptor 44; therefore, reducing impacts to **None**.

7.147. **Tables 7-6 and 7-7** show the impacts at each stage of the glint and glare analysis, with the final residual impacts considered once the mitigation is in place.

Table 7 - 6: Potential Residual Glint and Glare Impacts on Residential Receptors

	Magnitude of Impact		
Receptor	After Geometric Analysis	After Visibility Analysis	Residual Impacts
1	Medium	None	**None**
2	Medium	None	**None**
3	High	None	**None**
4	High	None	**None**
5	High	None	**None**
6	High	None	**None**
7	High	None	**None**
8	High	None	**None**
9	High	None	**None**
10	High	None	**None**
11	High	None	**None**
12	High	None	**None**
13	High	None	**None**
14	High	None	**None**
15	Medium	None	**None**

16	Low	None	None
17	High	None	None
18	High	None	None
19	Low	None	None
20	Low	None	None
21	High	None	None
22	High	None	None
23	High	None	None
24	High	None	None
25	High	None	None
26	High	None	None
27	High	None	None
28	High	None	None
29	High	None	None
30	High	None	None
31	High	None	None
32	High	None	None
33	High	None	None
34	High	None	None
35	Low	None	None
36	None	None	None
37	None	None	None
38 *	High	None	None
39 *	High	High	High
40 *	High	None	None
41 *	High	None	None
42 *	High	None	None
43 *	High	None	None

44	High	High	None
45	None	None	None
46	None	None	None
47	None	None	None
48	None	None	None
49	None	None	None
50	None	None	None

7.148. Within **Table 7 – 6**, (*) denotes the residential receptors which are landowner houses.

Table 7 - 7: Potential Residual Glint and Glare Impacts on Road Receptors

	Magnitude of Impact		
Receptor	After Geometric Analysis	After Visibility Analysis	Residual Impacts
1	High	None	None
2	High	None	None
3	High	None	None
4	High	None	None
5	None	None	None
6	None	None	None
7	None	None	None
8	None	None	None
9	None	None	None
10	High	None	None
11	High	None	None
12	High	None	None
13	High	None	None
14	High	None	None
15	High	None	None

16	High	None	None
17	High	None	None
18	High	None	None
19	High	None	None
20	High	None	None
21	High	None	None
22	High	None	None
23	High	None	None
24	High	None	None
25	High	None	None
26	High	None	None
27	High	None	None
28	High	None	None
29	High	None	None
30	High	None	None
31	High	None	None
32	High	None	None
33	High	None	None
34	High	None	None
35	High	None	None

SUMMARY

7.149. As identified by UK policy, glint and glare is recognised as a potential impact which needs to be considered for a proposed solar development.

7.150. This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km survey area around the Application Site is considered adequate for the assessment of ground-based receptors, whilst a 30km study area is chosen for aviation receptors. Within 1km of the Application Site, there are 70 residential receptors and 61 road receptors which were considered. As per the methodology section, where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for full assessment as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group has been assessed in detail. 20 residential and 26 road-based receptors were dismissed as they are located within the no reflection zones and therefore, will not be impacted upon by the Proposed Development. There were four aviation assets within 30km of the Proposed Development. However, no airfields required detailed assessment as the Proposed Development is located outside their respective safeguarding buffer zones, which are outlined in **paragraph 7.63**.

7.151. The solar panels will face south and will be inclined at an angle of between 10 and 40 degrees and at a height of 2.8m above ground level (AGL). As the panels will be fixed in this position, points at the tops of the panels have been used to determine the worst-case impacts on receptors.

7.152. Geometric analysis was conducted at 50 residential receptors and 35 road receptors. Following an initial assessment, rail receptors were scoped out as assets that will be impacted upon from the Proposed Development as the closest rail receptor falls outside of the 1km study area.

7.153. The assessment concludes that:

- Solar reflections are possible at 42 of 50 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **High** at 35 receptors, **Medium** at three receptors, **Low** at four, and **None** at the remaining eight receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts remain **High** at two receptors and reduce to **None** at the remaining 48 receptors. Once mitigation was taken into consideration, impacts remain **High** for Receptor 39 (Landowner) and reduce to **None** for Receptor 44 (landowner). Therefore, overall impacts are **High** for Receptor 39 and **None** for all remaining receptors.

- Solar reflections are possible at 32 of 35 road receptors assessed within the 1km study area. Upon reviewing the actual visibility of the road receptors, glint and glare impacts reduce to None at all receptors.

- No impact on train drivers or railway infrastructure is predicted.

- No impact on Aviation Assets is predicted.

7.154. Mitigation measures recommended include the infilling of hedgerows and planting of a berm along the eastern boundary of Field 3. These mitigation measures will screen all views to Residential Receptor 44 (landowner). Therefore, reducing its impact to None.

7.155. The effects of glint and glare and their impact on local receptors has been analysed in detail and once mitigation measures have been introduced there is predicted to be No effect on all residential receptors except for Residential Receptor 39, which is owned by the landowners. Therefore, impacts are not deemed to be significant.