Technical Appendix 7: Glint and Glare Assessment

Kingston Solar Farm

21/12/2021

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power for good

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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 51 residential receptors, 47 road receptors and nine rail 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. 11 residential and nine 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 12 aviation assets within 30km of the Proposed Development. Two airfields, East Midlands Airport and Nottingham City Airport, required detailed assessment as the Proposed Development is located within their respective safeguarding buffer zones, which are outlined in **paragraph 7.64**.

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 40 residential receptors, 38 road receptors and nine rail receptors. Geometric analysis was also conducted at one runway and one (Air Traffic Control Tower) ATCT at East Midlands Airport, and two runways at Nottingham City Airport.

7.4. The assessment concludes that:

- Solar reflections are possible at 40 of 51 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **High** at 28 receptors, **Low** at three, and **None** at the remaining nine receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **Low** for two receptors and **None** at the remaining 38 receptors. Once mitigation was taken into consideration all impacts reduce to **None** for all non-landowner receptors**.** Two land-owner properties (Residential Receptors 12 and 40) impact remain **Low** due to the suns position in relation to the Proposed Development and being the dominant source of impact. Furthermore, mitigation has been implemented to ensure these impacts remain as **Low** as possible.

- Solar reflections are possible at 38 of 47 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.

- Solar reflections are possible at nine of nine rail 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 Aviation Assets is predicted at Nottingham City Airport. **Acceptable impacts** are predicted for Runway 09 at East Midlands Airport and **Unacceptable impacts** are predicted for the ATCT at East Midlands Airport. After consultation with East Midlands Airport, the impact upon the ATCT can be reduced to **Low** and therefore **acceptable**.

7.5. **No Mitigation** are required; however a number have been included as part of the LEMP, which will be submitted in conjunction to this Glint and Glare Assessment. These include Woodland planting is in field 6 next to Residential Receptor 40, with this planting keeping the impact to **Low** once fully grown. Hedgerows are proposed along the boundaries of the solar panels that are closest to Residential Receptor 12, this will ensure that impacts remain **Low** as there will only be top floor views into the Proposed Development and towards the sun.

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 significant effect** on all residential and road receptors. Aviation receptors are expected to receive **Low** but **acceptable impacts**. Therefore, impacts are **not significant** for all non-landowner receptors.

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 49.9MW solar farm with associated infrastructure (the "Proposed Development") on lands circa 1.3km south of Gotham and c. 0.75km northwest of East Leake, Nottinghamshire (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 a 49.9MW solar farm with bi-facial solar photovoltaic (PV) panels mounted on metal frames, new access tracks, underground cabling, perimeter fencing with CCTV cameras and access gates, two temporary construction compounds, 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 1.3km south of Gotham and c. 0.75km northwest of East Leake, Nottinghamshire; the approximate centre point of which is Grid Reference E453185, N328739. Comprising 16 agricultural fields and additional ancillary areas, the Application Site measures c. 80.65 hectares (ha) in total, with only c. 55.65 hectares accommodating the solar arrays themselves. See **Figure 1 of Volume 2: Planning Application Drawings** for details.

7.12. The Proposed Development Site is split into two sections, north and south, by an area of woodland, Leake New Wood. Both sections lie on elevated, gently undulating land ranging between 87 – 96m AOD. The northern section extends across several rectilinear agricultural fields largely contained by existing mixed woodland providing good screening for the wider area. These include Gotham Wood to the north, Cuckoo Bush to the east, Leake New Wood to the south and Crownend Wood to the west. The southern section is also surrounded by pockets of woodland including Oak Wood, Crow Wood and Ash Spinney.

7.13. The Application Site is in an area with an existing industrial presence with a telecoms mast located on the southwestern boundary of Field 7, a wood pole line along the boundary between Fields 7 and 8 and within the southern section of Fields 4 and 5 and overhead lines located along the southern boundary of Field 16 and the eastern boundary of Field 15 (See **Figure 3 of Volume 2: Planning Application Drawings** for field numbers).

7.14. The surrounding area is semi-rural in nature with the site being surrounded by agricultural fields and woodland in most directions. The area is however punctuated by individual farmsteads and Rushcliffe Golf Club is located on the eastern boundary of Field 15 in the southern section of the site. There are also various industrial brownfield sites within the locality including Charnwood Truck Services located directly southwest of Field 4. Additionally, there is a large-scale power station located beyond the A453, circa 1.58km north of the site which can currently be seen from Bridleway 12.

7.15. Recreational routes include a number of Bridleways (BW) which cross or abut the Site providing connectivity to the wider Kingston Estate. These include Gotham BW No. 10, 11 and 12 and West Leake BW's No. 5 and 13. West Leake BW No. 5, also known as the Midshires Way, is also a Long-Distance Walking Association (LDWA) Route bordering the southern boundary of Fields 15 and 16. While there are several field drains throughout the Application Site, it lies entirely within Flood Zone 1, an area described as having a "Low probability" of flooding.

7.16. The Application Site will be accessed from Wood Lane, which is an unadopted road. Delivery vehicles will exit the M1 at junction 24, signposted A453 Nottingham (S), onto the A453 and travel in a northeast direction for approximately 4.3km, before taking the exit onto West Leake Lane. This road will be travelled on in a southern direction for approximately 1.5km, before turning left onto Kegworth Road. Vehicles will travel northeast along this road for approximately 1.3km before turning right into Wood Lane.

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
  - Figure 7.3: Rail Based Receptors
  - Figure 7.4: PV Array Names
- 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: Aviation Receptor Glare Results 10 Degrees
- Appendix 7G: Aviation Receptor Glare Results 40 Degrees
- Appendix 7H: Rail Receptor Glare Results 10 Degrees
- Appendix 7I: Rail Receptor Glare Results 40 Degrees
- Appendix 7J: Visibility Assessment Evidence
- Appendix 7K: Solar Module Glare and Reflectance Technical Memo[1]

Statement of Authority

7.21. This Glint and Glare Assessment has been produced by Tom Saddington, Michael McGhee and David Thomson 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. David has an undergraduate degree in physics, as well as a MSc in sensor design and a MSc in nanoscience. He is an Environmental Engineer currently being trained in Glint and Glare assessments.

Definitions

[1] Sunpower Corporation (September 2009), T09014 Solar Module Glare and Reflectance Technical Memo

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.

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 7K** 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

[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

[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

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.

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.

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[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]' and 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 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.

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[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

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

Rushcliffe Borough Local Plan 2011 - 2031

7.38. The Rushcliffe Local Plan Part 1: Core Strategy[10] was adopted by the district council in December 2014.

The plan states in **Introduction** section:

"The Core Strategy sets out where and when new homes, jobs and infrastructure will be delivered; the steps that will be taken to ensure that development is sustainable and to the benefit of existing communities and new communities, recognising what is special and distinctive about Rushcliffe. This includes the historic environment, the culture and heritage, and the relationship between Rushcliffe's towns and villages, the countryside that surrounds them and the wider Nottingham area."

The plan states in **Policy 2 Climate Change Section 5:**

The extension of existing or development of new decentralised, renewable and low-carbon energy schemes appropriate for Rushcliffe will be promoted and encouraged, including biomass power generation, combined heat and power, wind, solar and micro generation systems, where these are compatible with environmental, heritage, landscape and other planning considerations. In line with the energy hierarchy, adjacent new developments will be expected to utilise such energy wherever it is feasible and viable to do so

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

[10] https://www.rushcliffe.gov.uk/planningpolicy/localplan/localplanpart1corestrategy/#d.en.27398

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 2021.

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 7K** outline the reflective properties of solar glass and compares it to other reflective surfaces. Although the exact figures in this report could be argued, 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, bodies of water and snow, 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.

7.49. The panel reflectivity has been modelled to assume an anti-reflective coating (ARC) which is the industry standard for photo-voltaic panels and further reduces the reflective properties of the PV panels.

Determination of Ocular Impact

7.50. 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.

7.51. 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.

7.52. 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).

7.53. 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.

7.54. 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.

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[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

7.55. 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 10 and 40 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 (10 and 40 degrees respectively) and assesses each receptor based on the worst-case effects.

7.56. 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

7.57. 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.

7.58. 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.

7.59. 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.

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

7.61. 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

7.62. 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.

7.63. 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.

7.64. 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

7.65. 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)

7.66. 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.

7.67. 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

7.68. 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.

7.69. 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.

7.70. 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)

7.71. 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.

7.72. 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.

7.73. 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

7.74. 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.
- The model assumes clear skies at all times and does not account for meteorological effects such as cloud cover, fog, or any other weather event which may screen the sun.

7.75. Due to these assumptions and limitations the model overestimates the number of minutes of glint and glare which are possible at each receptor and presents the worst-case scenario. Where glint and glare are predicted a visibility assessment is carried out to determine a more accurate, real-world prediction of the impacts.

BASELINE CONDITIONS

Ground Based Receptors Reflection Zones

7.76. 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.

7.77. 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.

7.78. 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.

7.79. **Figures 7.1, 7.2 and 7.3 of Appendix 7A** show the respective study areas whilst also subtracting from this the areas where solar reflections will not impact on ground-based receptors due to the reasons set out in **paragraphs 7.76 to 7.78.**

Residential Receptors

7.80. 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.

7.81. There are 11 residential receptors (Receptors 41 to 51) 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 7.76 to 7.78** of this report.

Table 7 - 1: Residential Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	452143	329625	Yes
2	451954	328934	Yes

3	451717	328787	Yes
4	451728	328638	Yes
5	451241	328644	Yes
6	451211	328634	Yes
7	451802	328356	Yes
8	451810	328301	Yes
9	451776	328107	Yes
10	451760	328072	Yes
11	452715	328398	Yes
12	453863	327926	Yes
13	453949	327690	Yes
14	453147	326638	Yes
15	453169	326630	Yes
16	454204	327170	Yes
17	454994	326874	Yes
18	455062	327184	Yes
19	455139	327426	Yes
20	455363	327470	Yes
21	455292	327590	Yes
22	455320	327751	Yes
23	454795	327504	Yes
24	454758	327749	Yes
25	454889	327767	Yes
26	454899	328209	Yes
27	454849	328336	Yes

28	454785	328425	Yes
29	454699	328555	Yes
30	454606	328679	Yes
31	453906	329357	Yes
32	453598	329727	Yes
33	453453	329627	Yes
34	453572	329595	Yes
35	453531	329460	Yes
36	453303	329528	Yes
37	453246	329540	Yes
38	453099	329449	Yes
39	453107	329333	Yes
40	452954	329027	Yes
41	454345	326346	No
42	454309	326373	No
43	453575	329857	No
44	453508	329826	No
45	453492	329732	No
46	452838	329635	No
47	452725	329481	No
48	452642	329379	No
49	452288	329621	No
50	453273	330039	No
51	452480	330192	No

Road / Rail Receptors

7.82. There are seven roads within the 1km study area that require a detailed glint and glare analysis. These are West Leake Lane, Gotham Road (west of the Proposed Development), Kegworth Road, Gypsum Way, Leake Road, Bunny Lane and Gotham Road (east of the Proposed Development). 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: of Appendix 7A** and the process of how these are calculated is explained in **paragraphs 7.76 to 7.78** of this report. Assessment points 200m apart are used.

Table 7 - 2: Road Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	451281	329579	Yes
2	451432	329449	Yes
3	451527	329274	Yes
4	451589	329084	Yes
5	451669	328901	Yes
6	451700	328705	Yes
7	451706	328506	Yes
8	451785	328325	Yes
9	451821	328128	Yes
10	451351	328755	Yes
11	451538	328827	Yes
12	451732	328870	Yes
13	451884	328994	Yes
14	452011	329149	Yes
15	452103	329313	Yes

16	452144	329493	Yes
17	453258	329584	Yes
18	453332	329400	Yes
19	453485	329274	Yes
20	453681	329246	Yes
21	453865	329318	Yes
22	453651	329616	Yes
23	453778	329461	Yes
24	454021	329225	Yes
25	454165	329086	Yes
26	454311	328948	Yes
27	454456	328811	Yes
28	454587	328662	Yes
29	454694	328493	Yes
30	454799	328323	Yes
31	454907	328155	Yes
32	455052	328017	Yes
33	455161	327852	Yes
34	455146	327661	Yes
35	455293	327551	Yes
36	455373	327367	Yes
37	455162	328082	Yes
38	455254	328260	Yes

39	453597	329807	No
40	453241	329784	No
41	453194	329977	No
42	453142	330145	No
43	452980	330040	No
44	452812	329931	No
45	452645	329820	No
46	452472	329720	No
47	452315	329596	No

7.84. There is one railway line within the 1km study area approximately 0.65km east of the Proposed Development which will require a detailed glint and glare analysis. The ground receptor no-reflection zones are clearly identifiable on **Figure 7.3 of Appendix 7A.**

7.85. **Table 7 - 3** shows a list of rail receptor points within the study area which are 200m apart.

Table 7 - 3: Rail Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	455340	328274	Yes
2	455287	328081	Yes
3	455234	327888	Yes
4	455181	327696	Yes
5	455129	327502	Yes
6	455074	327310	Yes
7	455020	327118	Yes
8	454966	326925	Yes
9	454901	326736	Yes

Aviation Receptors

7.86. Aerodromes within 30km of the proposed solar development can be found in **Table 7 - 4.**

Table 7 - 4: Airfields in close proximity

Airfield	Distance	Use
East Midlands Airport	5.85 km	International Airport
Nottingham City Airport	11.04 km	Licensed Aerodrome
Leicester Airport	27.88km	Licensed Aerodrome
Nottingham Heliport	10.6km	Small grass strip
Wymeswold Airfield	6.07km	Small grass strip
Oxton Airfield	26.59km	Unlicensed small grass strip
Watnall Airfield	18.1km	Unlicensed small grass strip
Langar Airfield	19.68km	Small grass strip
RAF Syerston	26.41km	Military
Derby Airport	25.91km	Licensed small grass strip
Twycross Airfield	28.33km	Small grass strip
Wharf Farm Airfield	27.62km	Small grass strip

7.87. East Midlands Airport and Nottingham City Airport require detailed assessments due to these airfields being within their respective safety buffer zones outlined in **paragraph 7.64**.

7.88. The other 10 airfields have not been deemed large enough or close enough (for their size) to warrant detailed assessments. This is in accordance with the buffer zones outlined in **paragraph 7.64**.

East Midlands Airport

7.89. East Midlands Airport (ICAO code EGNX) is designated as an international airport. It is located approximately 7NM (12.96km) southeast of Derby.

7.90. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 306ft (93.27m). It has one asphalt (ungrooved PFC) runway, the details of which are given in **Table 7 - 5** overleaf.

Table 7 - 5: Runways at East Midlands Airport

Runway Designation	True Bearing (°)	Length (m)	Width (m)

09	088.26	2893	45
27	268.29	2893	45

7.91. The threshold locations and heights of the runway at East Midlands Airport are given in **Table 7 - 6**.

Table 7 - 6: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
09	52° 49' 50.00"N	001° 20' 49.00"W	93.27
27	52° 49' 53.00"N	001° 18' 31.00"W	85.95

7.92. The Airport Reference Point (ARP) is located at the midway of the main runway. The actual location of the ARP is given in **Table 7 - 7**.

Table 7 - 7: East Midlands Airport Reference Point

	Latitude	Longitude	Eastings	Northings
ARP	52° 49' 52.00"N	001° 19' 34.00"W	445493	326170

7.93. The airport has an Air Traffic Control Tower (ATCT), the location and height of which is given in **Table 7 - 8.**

Table 7 - 8: East Midlands Airport Air Traffic Control Tower Location and Height

	Latitude	Longitude	Eastings	Northings	Height (m)
ATCT	52° 49' 35.00"N	001° 19' 56.00"W	445101	325632	151.49

Nottingham City Airport

7.94. Nottingham City Airport (ICAO code EGBN) is designated as a licensed aerodrome. It is located approximately 3NM (5.56km) southeast of Nottingham.

7.95. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 138ft (42.06m). It has two runways, one asphalt and one asphalt-concrete mix, the details of which are given in **Table 7 - 9**.

Table 7 - 9: Runways at Nottingham City Airport

Runway Designation	True Bearing (°)	Length (m)	Width (m)
03	028.70	821	23
21	208.70	821	23
09	088.10	1050	30
27	268.10	1050	30

7.96. The threshold locations and heights of the runways at Nottingham City Airport are given in **Table 7 - 10**.

Table 7 - 10: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
03	52° 55' 00.00"N	001° 04' 47.00"W	34.75
21	52° 55' 23.00"N	001° 04' 26.00"W	28.96
09	52° 55' 14.00"N	001° 05' 07.00"W	38.71
27	52° 55' 15.00"N	001° 04' 23.00"W	27.43

7.97. The Airport Refence Point (ARP) is located between the runways. The actual location of the ARP is given in **Table 7 - 11**.

7.98. Nottingham City Airport does not have an ATCT present.

Table 7 - 11: Nottingham City Airport Reference Point

	Latitude	Longitude	Eastings	Northings
ARP	52° 55' 11.00"N	001° 04' 45.00"W	462019	336208

IMPACT ASSESSMENT

7.99. 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

7.100. **Table 7 - 12** 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.

7.101. The 11 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.

7.102. **Appendix 7B and 7C** contains the detailed analysis of the glint and glare impacts. **Table 7 - 12** below shows the impact at each receptor.

Table 7 - 12: 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	No	No	0	0	None	40
2	Yes	No	7011	116.85	High	40
3	Yes	No	4610	76.83	High	40
4	Yes	No	3915	65.25	High	40
5	Yes	No	3827	63.78	High	40
6	Yes	No	3766	62.77	High	40
7	Yes	No	3646	60.77	High	40
8	Yes	No	3597	59.95	High	40
9	Yes	No	2989	49.82	High	40

10	Yes	No	2828	47.13	High	40
11	Yes	No	4522	75.37	High	40
12 (*)	Yes	Yes	4786	79.77	High	40
13 (*)	Yes	Yes	8168	136.13	High	40
14	Yes	No	149	2.48	Low	10
15	Yes	No	210	3.50	Low	10
16	No	Yes	5516	91.93	High	40
17	No	Yes	3760	62.67	High	10
18	No	Yes	8408	140.13	High	40
19	No	Yes	9549	159.15	High	40
20	No	Yes	7949	132.48	High	40
21	No	Yes	8140	135.67	High	40
22	No	Yes	7645	127.42	High	40
23	No	Yes	10906	181.77	High	40
24	No	Yes	8052	134.20	High	40
25	No	Yes	8069	134.48	High	40
26	No	Yes	3633	60.55	High	40
27	No	Yes	3617	60.28	High	40
28	No	Yes	3866	64.43	High	40
29	No	Yes	3187	53.12	High	40
30	No	Yes	2440	40.67	High	40
31	No	Yes	1	0.02	Low	40
32	No	No	0	0	None	40
33	No	No	0	0	None	40
34	No	No	0	0	None	40
35	No	No	0	0	None	40
36	No	No	0	0	None	40
37	No	No	0	0	None	40

38	No	No	0	0	**None**	40
39	No	No	0	0	**None**	40
40 (*)	No	Yes	3405	56.75	**High**	40

7.103. The asterisk (*) represents which residential receptors are land-owner properties.

7.104. As it can be seen in **Table 7 - 12** there is a **High** impact at 28 receptors, **Low** at three receptors and **None** impact for the remaining nine 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.

7.105. **Appendix 7J** 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.

Receptor 2

7.106. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a northern section of the western array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.107. The first image in **Appendix 7J** is an aerial view which shows the location of the receptor in relation to the Proposed Development (yellow pin) and the location from which the second image was taken (red pin). It also 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 is a street view image taken from the position of the red pin in the first image and has a view of the receptor and the vegetation to the north of the receptor. This image confirms that there is sufficient vegetation to screen all views of the Proposed Development. Therefore, the impact reduces to **None**.

Receptors 3 and 4

7.108. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a large central section of the western array in the Proposed Development can potentially impact on the receptors.

7.109. The first image in **Appendix 7J** is an aerial view which shows the location of the receptors in relation to the Proposed Development (yellow pins) and the location from which the second image was taken (red pin). It also shows that there is likely to be sufficient vegetation located to the west of the proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image is a street view image taken from the position of the red pin in the first image looking towards the Proposed Development. This image confirms that there is sufficient vegetation to screen all views into the Proposed Development. Therefore, the impact reduces to **None**.

Receptors 5 and 6

7.110. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from most of the western array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development, except a small southern section, can potentially impact on the receptors.

7.111. The first image in **Appendix 7J** is an aerial view which shows the location of the receptors in relation to the Proposed Development (yellow pins) and the location from which the second image was taken (red pin). It also shows that there is likely to be sufficient vegetation located to the west of the Proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image is a street view image taken from the position of the red pin in the first image and has a view of the vegetation to the west 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 7 - 10

7.112. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from the southern half of the western array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptors.

7.113. The first image in **Appendix 7J** is an aerial view which shows the location of the receptors in relation to the Proposed Development (yellow pins) and the location from which the second image was taken (red pin). It also shows that there is likely to be sufficient vegetation located to the west of the Proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image is a street view image taken from the position of the red pin in the first image, which has a view of the vegetation to the west 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**.

Receptor 11

7.114. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a southern section of the western array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.115. The first image in **Appendix 7J** is an aerial view which shows the location of the receptor in relation to the Proposed Development (yellow pin). It also shows that there is likely to be sufficient vegetation located to the southwest of the Proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image has been taken from Field 8 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) within the Application Site, with a view of the vegetation along the southern boundary of the Proposed Development where glint and glare is possible. 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

7.116. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a central section of the central array, and a northern section of the eastern array (see **Figure 7.4 of Appendix A for array names**), in the Proposed Development can potentially impact on the receptor.

7.117. The first image in **Appendix 7J** is an aerial view which shows the location of the receptor in relation to the Proposed Development (yellow pin). It also shows that there is likely to be sufficient vegetation located to the west of the eastern array in the Proposed Development to screen all views of the eastern array in the Proposed Development where glint and glare is possible. The second image is a photo from within Field 13 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking north-east towards the receptor which confirms that there is insufficient vegetation to screen most views of the central array in the Proposed Development. The third image is a photo from Field 15 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking south-east along the western boundary of the eastern array in the Proposed Development. This image confirms that there is sufficient vegetation to screen all views of the Eastern Array in the Proposed Development. The fourth and fifth images show that the impacts occur when the sun is directly behind the Proposed Development and low in the sky. The images in **Appendix 7J** show examples of where the sun will be in relation to the Proposed Development. In these images it shows the sun, areas where glare occurs from the Proposed Development and view from the receptor at the time of which glare impacts will occur. The reflections from the Proposed Development will be much less intense than the suns direct glare and therefore it will be this which will be the main impact on the residential receptors, not the reflections from the Proposed Development. Therefore, as the suns glare will be the main impact on these receptor points, during the times when glare occurs from the Proposed Development, the impact can be reduced to **Low**.

Receptor 13

7.118. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a central section of the central array, and a northern section of the eastern array (see **Figure 7.4 of Appendix A for array names**), in the Proposed Development can potentially impact on the receptor.

7.119. The first image in **Appendix 7J** is an aerial view which shows the location of the receptor in relation to the Proposed Development (yellow pin). It also shows that there is likely to be sufficient vegetation located to the west of the eastern array and to the west of the receptor to screen all views of both the central array and eastern array in the Proposed Development where glint and glare is possible. The second image is a photo from Field 14 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking north towards the receptor which confirms that there is sufficient vegetation to the west of the receptor to screen most views of the central array in the Proposed Development. The third image is a photo from Field 15 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking south-west towards the western boundary of the eastern array in the Proposed Development. This image confirms that there is sufficient vegetation to screen all views of the eastern array in the Proposed Development. Therefore, the impact reduces to **None**.

Receptors 14 and 15

7.120. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a small south-eastern section of the southern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptors.

7.121. The first image in **Appendix 7J** is an aerial view which shows the location of the receptors in relation to the Proposed Development (yellow pins) and the location from which the second and third images were taken (red pin). It also shows that there is likely to be sufficient vegetation located to the south-west of the Proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image is a ground level image taken from the position of the red pin in the first image and has a view towards the Proposed Development and of the topography of the area. The third image is a street view image taken from the position of the red pin in the first image which has a view of the vegetation to northeast of the receptors. These images confirm 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 16

7.122. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a southern section of the southern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptors.

7.123. The first image in **Appendix 7J** is an aerial view which shows the location of the receptor in relation to the Proposed Development (yellow pin). The second image is a photo from Field 16 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking along the southern boundary of field 16. This second image confirms that the hedgerow is sufficient to screen views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 17 - 19

7.124. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B and 7C** shows that reflections from the west of the western array, most of the central array except a small northern section, a large southern section of the eastern array and all of the southern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptors.

7.125. The first image in **Appendix 7J** is an aerial view which shows the location of the receptors in relation to the Proposed Development (yellow pins). The second image is a photo from Field 16 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking towards the receptors. This image confirms that there is sufficient vegetation along the south-eastern boundary of the Proposed Development to screen all views where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 20 and 21

7.126. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B and 7C** shows that reflections from most of the western array, except a small northern section, all of the central array, all of the eastern array and the north-eastern half of the southern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptors.

7.127. The first image in **Appendix 7J** is an aerial view which shows the location of the receptors in relation to the Proposed Development (yellow pins) and the locations from which the second and third images were taken. It also shows that there is likely to be sufficient vegetation and terrain to the west of the receptors and to the east of the Proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image is a street view image taken from the position of red pin 1 in the first image with a view towards the Proposed Development. This image confirms that the vegetation and terrain is sufficient to screen all views of the Proposed Development where glint and glare is possible. The third image is a street view image taken from the position of red pin 2 in the first image with a view towards the Proposed Development. This image confirms that the vegetation and terrain is sufficient to screen all views of the Proposed Development. Therefore, the impact reduces to **None**.

Receptor 22

7.128. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from most of the western array except a small norther section, most of the central array except a small southern section and most of the eastern array (see **Figure 7.4 of Appendix A for array names**) except a small southern section in the Proposed Development can potentially impact on the receptors.

7.129. The first image in **Appendix 7J** is an aerial view which shows the location of the receptor in relation to the Proposed Development (yellow pin) and the location from which the second image was taken (red pin). It also shows that there is likely sufficient vegetation and terrain to the east of the Proposed Development to screen all views of the Proposed Development where glint and glare is possible. The second image is a street view image taken from the position of the red pin in the first image looking towards the Proposed Development. This image confirms that there is sufficient vegetation and terrain to screen all views into the Proposed Development. Therefore, the impact reduces to **None**.

Receptors 23 - 25

7.130. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B and 7C** shows that reflections from most of the western array except a small north-eastern section, all of the central array, most of the eastern array except a small northern section and a northern section of the southern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptors.

7.131. The first image in **Appendix 7J** is an aerial view which shows the location of the receptors in relation to the Proposed Development (yellow pins). The second image is a photo from Field 15 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking towards the receptors. This image confirms that there is sufficient vegetation to the west of the receptors to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptors 26 - 30

7.132. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from all of the western array, most of the eastern array except a small southern section and a small northern section of the central array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptors.

7.133. The first image in **Appendix 7J** is an aerial view which shows the location of the receptors in relation to the Proposed Development (yellow pins) and the locations from which the second, third, fourth and fifth images were taken (red pins). It also 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 is a street view image taken from the position of red pin 1, looking northwest along the road in front of Receptor 26. This image confirms that there is sufficient vegetation to screen all views into the Proposed Development. The third image is a street view image taken from the position of red pin 2, looking north-west along the road in front of Receptor 27. This image confirms that there is sufficient vegetation to screen all views into the Proposed Development. The fourth image is a street view image taken from the position of red pin 3, looking north-west along the road in front of Receptor 28. This image confirms that there is sufficient vegetation to screen all views into the Proposed Development. The fifth image is a street view image taken from the position of red pin 4, looking west towards the Proposed Development. This image confirms that there is sufficient vegetation to screen all views into the Proposed Development. Therefore, the impact reduces to **None**.

Receptor 31

7.134. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that 1 minute of reflections from the western array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.135. The first image in **Appendix 7J** is an aerial view which shows the location of the receptor in relation to the Proposed Development (yellow pin) and the location from which the second image was taken (red pin). It also 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 is a street view image taken from the position of the red pin in the first image. This image confirms that the vegetation to the west of the receptor is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 40

7.136. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B** shows that reflections from a western section of the western array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.137. The first image in **Appendix 7J** is an aerial view which shows the location of the receptor in relation to the Proposed Development. It also shows that there is likely to be insufficient vegetation located to the west of the receptor to screen most views of the Proposed Development where glint and glare is possible. The second and third images show that the impacts occur when the sun is directly behind the Proposed Development and low in the sky. The images in **Appendix 7J** show examples of where the sun will be in relation to the Proposed Development. In these images it shows the sun, areas where glare occurs from the Proposed Development and view from the receptor at the time of which glare impacts will occur. The reflections from the Proposed Development will be much less intense than the suns direct glare and therefore it will be this which will be the main impact on the residential receptors, not the reflections from the Proposed Development. Therefore, as the suns glare will be the main impact on these receptor points, during the times when glare occurs from the Proposed Development, the impact can be reduced to **Low**.

Residential Area 1

7.138. This encompasses a number of residential receptors including those at receptor points 3 and 4 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on both receptors was **None.** Therefore, as per the assessment for these two receptors, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Residential Area 2

7.139. This encompasses a number of residential receptors including those at receptor points 7 and 8 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on both receptors was **None.** Therefore, as per the assessment for these two receptors, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Residential Area 3

7.140. This encompasses a number of residential receptors including those at receptor point 16 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on all receptors was **None.** Therefore, as per the assessment for this receptor, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Residential Area 4

7.141. This encompasses a number of residential receptors including those at receptor points 17 - 19 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on all receptors was **None.** Therefore, as per the assessment for these two receptors, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Residential Area 5

7.142. This encompasses a number of residential receptors including those at receptor points 20 and 21 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on both receptors was **None.** Therefore, as per the assessment for these two receptors, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Residential Area 6

7.143. This encompasses a number of residential receptors including those at receptor points 23 - 25 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on all receptors was **None.** Therefore, as per the assessment for these two receptors, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Residential Area 7

7.144. This encompasses a number of residential receptors including those at receptor points 26 and 27 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on both receptors was **None.** Therefore, as per the assessment for these two receptors, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Residential Area 8

7.145. This encompasses a number of residential receptors including those at receptor points 28 - 30 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on all receptors was **None.** Therefore, as per the assessment for these two receptors, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Residential Area 9

7.146. This encompasses a number of residential receptors including those at receptor points 32 - 35 (assessed above) (See **Figure 7.1: Appendix A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded that the impact on all receptors was **None.** Therefore, as per the assessment for these two receptors, the impacts on the other receptors within this area are assessed as being **None (worst case scenario)**.

Road Receptors

7.147. **Table 7 - 13** 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 7D and 7E.**

7.148. The nine 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 - 13: Potential for Glint and Glare Impact on Road Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact	Worst Case Tilt
1	0	0	0	None	40
2	0	0	0	None	40
3	0	85	0	High	40
4	10	1144	0	High	40
5	35	5127	0	High	40
6	32	4072	0	High	40
7	0	3727	0	High	40
8	340	3613	0	High	40
9	5	3072	0	High	40
10	0	4068	0	High	40
11	0	4649	0	High	40
12	0	5429	0	High	40
13	0	6262	0	High	40

14	0	1401	0	High	40
15	0	0	0	None	40
16	0	0	0	None	40
17	0	0	0	None	40
18	0	0	0	None	40
19	0	273	0	High	40
20	0	422	0	High	40
21	0	66	0	High	40
22	0	0	0	None	40
23	0	0	0	None	40
24	5	486	0	High	40
25	36	1030	0	High	40
26	75	1557	0	High	40
27	55	1936	0	High	40
28	8	2669	0	High	40
29	4	3902	0	High	40
30	45	3846	0	High	40
31	184	4144	0	High	40
32	387	5822	0	High	40
33	518	7773	0	High	40
34	940	9145	0	High	40
35	1575	8195	0	High	40
36	2538	8154	0	High	40
37	708	4347	0	High	40
38	616	2991	0	High	40

7.149. As can be seen in **Table 7-13**, there are 30 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.

7.150. **Appendix 7J** 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.

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

Rail Receptors

7.152. **Table 7 - 14** overleaf shows a summary of the modelling results for each of the Rail Receptor Points whilst the detailed results and ocular impact charts can be viewed in **Appendix 7H and 7I**.

7.153. The three 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 - 14: Potential for Glint and Glare Imapct on Rail Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact	Worst Case Tilt
1	667	2609	0	High	40
2	1027	3642	0	High	40
3	672	6331	0	High	40
4	604	9510	0	High	40
5	1285	10000	0	High	40
6	604	11283	0	High	40
7	730	8038	0	High	40
8	609	5122	0	High	40
9	721	1425	0	High	10

7.154. As can be seen in **Table 7 - 14**, there are nine receptor points which have potential glare impacts with the "potential for after-image" (yellow glare), which is a **High** impact. **Appendix 7H and 7I** 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.

7.155. **Appendix 7J** 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 taken, 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.

Receptor 1

7.156. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7I**, shows that all of the western array, a small northern section of the central array, a northern section of the Eastern Array and a northern section of the Southern Array(see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.157. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin) and the location from which the second image was taken (red pin). It also shows there is likely to be sufficient vegetation to the east of the Proposed Development to screen all views where glint and glare is possible. The second image is a street view image taken from where the red pin is located, looking west towards the Proposed Development and has a view of the vegetation and topography that is to the east of the Proposed Development. This second image confirms that there is sufficient vegetation and topography to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 2

7.158. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7I**, shows that all of the western array, a small northern section of the central array and a northern section of the eastern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.159. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin) and the location from which the second image was taken (red pin). It also shows there is likely to be sufficient vegetation to the east of the Proposed Development to screen all views where glint and glare is possible. The second image is a street view image taken from where the red pin is located, looking west towards the Proposed Development and has a view of the vegetation and topography that is to the east of the Proposed Development. This second image confirms that there is sufficient vegetation and topography to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 3

7.160. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7I**, shows that most of the western array except a small northern section, the northern half of the central array and the northern half of the eastern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.161. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin) and the location from which the second image was taken (red pin). It also shows there is likely to be sufficient vegetation to the east of the Proposed Development to screen all views where glint and glare is possible. The second image is a street view image taken from where the red pin is located, looking west towards the Proposed Development and has a view of the vegetation that is to the west of the receptor. This second image confirms that there is sufficient vegetation to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 4

7.162. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7I**, shows that a large south-western section of the western array, most of the central array except a small southern section and most of the eastern array (see **Figure 7.4 of Appendix A for array names**) except a small southern section in the Proposed Development can potentially impact on the receptor.

7.163. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin) and the location from which the second image was taken (red pin). It also shows there is likely to be sufficient vegetation and topography to the west of the railway line to screen all views of the Proposed Development where glint and glare is possible. The second image is a street view image taken from where the red pin is located, looking north along the railway line towards the receptor and has a view of the vegetation and topography that is to the west of the receptor. This second image confirms that there is sufficient vegetation and topography to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 5

7.164. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7I**, shows that a small north-western section of the western array, most of the central array except a small northern section, most of the eastern array (see **Figure 7.4 of Appendix A for array names**) except a small northern section and the northern half of the southern array in the Proposed Development can potentially impact on the receptor.

7.165. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin) and the location from which the second image was taken (red pin). It also shows there is likely to be sufficient vegetation and topography to the west of the railway line to screen all views of the Proposed Development where glint and glare is possible. The second image is a street view image taken from where the red pin is located, looking south along the railway line towards the receptor and has a view of the vegetation and topography that is to the west of the receptor. This second image confirms that there is sufficient vegetation and topography to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 6

7.166. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7I**, most of the central array except a northern section, a small southern section of the eastern array and most of the southern array (see **Figure 7.4 of Appendix A for array names**) except a small southern section in the Proposed Development can potentially impact on the receptor.

7.167. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin). The second image is a photo from Field 16 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking towards the receptor. This image confirms that there is sufficient vegetation along the southeast boundary of the Proposed Development to screen all views where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 7

7.168. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7I**, shows that a large south-western section of the central array and most of the southern array (see **Figure 7.4 of Appendix A for array names**) except a small north-eastern section in the Proposed Development can potentially impact on the receptor.

7.169. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin). The second image is a photo from Field 16 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking towards the receptor. This image confirms that there is sufficient vegetation along the southeast boundary of the Proposed Development to screen all views where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 8

7.170. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7I**, shows that a small southern section of the central array and the southern half of the southern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.171. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin). The second image is a photo from Field 16 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking towards the receptor. This image confirms that there is sufficient vegetation along the southeast boundary of the Proposed Development to screen all views where glint and glare is possible. Therefore, the impact reduces to **None**.

Receptor 9

7.172. The 'Glare Reflections on the PV Footprint' chart shown in **Appendix 7H**, shows that a small southern section of the southern array (see **Figure 7.4 of Appendix A for array names**) in the Proposed Development can potentially impact on the receptor.

7.173. The first image in **Appendix 7J** is an aerial image which shows the location of the receptor in relation to the Proposed Development (yellow pin). The second image is a photo from Field 16 (see **Figure 3 of Volume 2: Planning Application Drawings for field numbers**) of the Application Site looking towards the receptor. This image confirms that the topography and vegetation is sufficient along the southeast boundary of the Proposed Development to screen all views where glint and glare is possible. Therefore, the impact reduces to **None**.

Aviation Receptors

7.174. **Table 7 - 15** shows a summary of the modelling results for each of the runway approach paths as well as the ATCT, whilst the detailed results and ocular impact charts can be viewed in **Appendix 7F and 7G**.

Table 7 - 15: Summary of Glare Results

Component	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Worst Case Tilt angle
East Midlands Airport				
Runway 09	4887	0	0	40
Runway 27	0	0	0	N/A
ATCT	4937	0	0	10

Nottingham City Airport				
Runway 03	0	0	0	N/A
Runway 21	0	0	0	N/A
Runway 09	0	0	0	N/A
Runway 27	0	0	0	N/A

7.175. As can be seen in **Table 7 - 15**, Runway 09 and the ATCT at East Midlands Airport are affected only by green glint and glare from the Proposed Development. Therefore, impact on all runway aviation receptors at East Midlands Airport is **Low**, as deemed **acceptable** by the FAA guidance.

7.176. The impact on the East Midlands ATCT has been assessed and it shows that there will be 4937 minutes of green glare impacts predicted per year on the ATCT. Upon review of the ground elevation between the Proposed Development and the ATCT there are no blocking points with the Proposed Development and East Midlands Airport being at similar elevations of circa 90m AOD, the ATCT having an elevation circa 151m AOD, and a drop in elevation of circa 50m between them. Dense vegetation directly to the west of the Proposed Development may be sufficient to screen most views of the Proposed Development. Upon review of the sun's location in relation to the Proposed development when Green Glare is possible, it can be seen in **Appendix 7J** that the sun is located directly behind the Proposed Development at the times when Green Glare impacts the ATCT and therefore impacts can be reduced to **Low** and **Not Significant**. This was put forward to East Midlands Airport in a Consultation on 10th August 2021. In a response received on 19th August 2021, Diane Jackson (Aerodrome Safeguarding Officer) said that East Midlands Airport would likely agree to the impacts being reduced to **Low**.

7.177. As can be seen in **Table 7 - 15**, no runways or approach paths at Nottingham City Airport are affected by glint and glare from the Proposed Development. Therefore, impact on all aviation receptors at Nottingham City Airport is **None**.

GROUND BASED RECEPTOR MITIGATION

7.178. **No Mitigation** is required however, a number have been included within the LEMP, which will be submitted in conjunction to this Glint and Glare Assessment. This includes:

- Woodland planting in field 6 next to Residential Receptor 40 will ensure impacts remain **Low** at this receptor as it will offer further screening and limited views.
- Hedgerow to be implemented around panel boundaries that are closest to Residential Receptor 12 and will help ensure impacts remain **Low** at this receptor by screening views from the ground floor windows.

7.179. **Table 7 - 16, Table 7 - 17 and Table 7 - 18** 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 - 16: Potential Residual Glint and Glare Impacts on Residential Receptors

	Magnitude of Impact		
Receptor	After Geometric Analysis	After Visibility Analysis	Residual Impacts (Post Mitigation)
1	None	None	None
2	High	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	Low	Low
13	High	None	None
14	Low	None	None

15	Low	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	Low	None	None
32	None	None	None
33	None	None	None
34	None	None	None
35	None	None	None
36	None	None	None
37	None	None	None
38	None	None	None
39	None	None	None
40	High	Low	Low

Table 7 - 17: Potential Residual Glint and Glare Impacts on Road Receptors

	Magnitude of Impact		
Receptor	After Geometric Analysis	After Visibility Analysis	Residual Impacts (Post Mitigation)
1	None	None	None
2	None	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	None	None	None
16	None	None	None
17	None	None	None
18	None	None	None
19	High	None	None
20	High	None	None
21	High	None	None
22	None	None	None
23	None	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
36	High	None	None
37	High	None	None
38	High	None	None

Table 7 - 18: Potential Residual Glint and Glare Impacts on Rail Receptors

	Magnitude of Impact		
Receptor	After Geometric Analysis	After Visibility Analysis	Residual Impacts (Post Mitigation)
1	High	None	None
2	High	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

7.180. **Table 7 - 19, Table 7 - 20 and Table 7 - 21** show the overall impacts for all residential, road and rail receptors.

Table 7 - 19: Solar Reflections: Residential Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	28	0	0
Medium	0	0	0
Low	3	2	2
None	9	38	38

- **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

Table 7 - 20: Solar Reflections: Road Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	30	0	0
Medium	0	0	0
Low	0	0	0
None	8	38	38

- **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

Table 7 - 21: Solar Reflections: Rail Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	9	0	0
Medium	0	0	0
Low	0	0	0
None	0	9	9

- 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

SUMMARY

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

7.182. 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 51 residential receptors, 47 road receptors and nine rail 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. 11 residential and nine 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 12 aviation assets within 30km of the Proposed Development. Two airfields, East Midlands Airport and Nottingham City Airport, required detailed assessment as the Proposed Development is located within their respective safeguarding buffer zones, which are outlined in paragraph 7.64.

7.183. 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.

7.184. Geometric analysis was conducted at 40 residential receptors, 38 road receptors and nine rail receptors. Geometric analysis was also conducted at one runway and one (Air Traffic Control Tower) ATCT at East Midlands Airport, and two runways at Nottingham City Airport.

7.185. The assessment concludes that:

- Solar reflections are possible at 40 of 51 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **High** at 28 receptors, **Low** at three, and **None** at the remaining nine receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **Low** for two receptors and **None** at the remaining 38 receptors. Once mitigation was taken into consideration all impacts reduce to **None** for all non-landowner receptors. Two land-owner properties (Residential Receptors 12 and 40) impact remain **Low** due to the suns position in relation to the Proposed Development and being the dominant source of impact. Furthermore, mitigation has been implemented to ensure these impacts remain as **Low** as possible.

- Solar reflections are possible at 38 of 47 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.

- Solar reflections are possible at nine of nine rail 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 Aviation Assets is predicted at Nottingham City Airport. **Acceptable impacts** are predicted for Runway 09 at East Midlands Airport and **Unacceptable impacts** are predicted for the ATCT at East Midlands Airport. After consultation with East Midlands Airport, the impact upon the ATCT can be reduced to **Low** and therefore **acceptable**.

7.186. **No Mitigation** are required; however, a number have been included as part of the LEMP, which will be submitted in conjunction to this Glint and Glare Assessment. These include Woodland planting is in field 6 next to Residential Receptor 40, with this planting keeping the impact to **Low** once fully grown. Hedgerows are proposed along the boundaries of the solar panels that are closest to Residential Receptor 12, this will ensure that impacts remain **Low** as there will only be top floor views into the Proposed Development and towards the sun.

7.187. 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 significant effect** on all residential and road receptors. Aviation receptors are expected to receive **Low** but **acceptable impacts**. Therefore, impacts are **not significant** for all non-landowner receptors.

APPENDICES

Appendix 7A: Figures

- Figure 7.1: Residential Based Receptors
- Figure 7.2: Road Based Receptors
- Figure 7.3: Rail Based Receptors
- Figure 7.4: PV Array Names

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: Aviation Receptor Glare Results 10 Degrees

Appendix 7G: Aviation Receptor Glare Results 40 Degrees

Appendix 7H: Rail Receptor Glare Results 10 Degrees

Appendix 7I: Rail Receptor Glare Results 40 Degrees

Appendix 7J: Visibility Assessment Evidence

Appendix 7K: Solar Module Glare and Reflectance Technical Memo