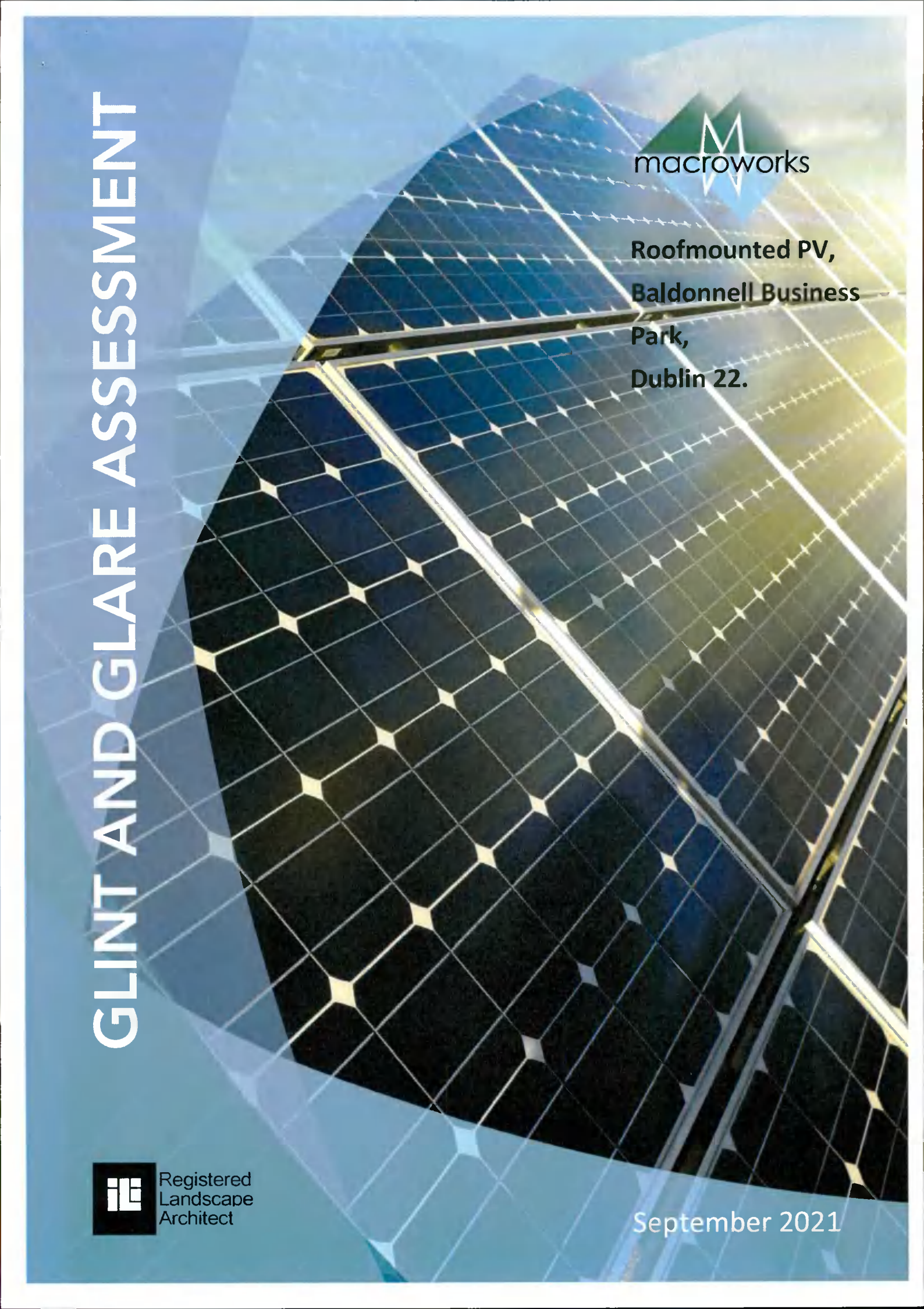
GLINT AND GLARE ASSESSMENT



macroworks

Roofmounted PV,

Baldonnell Business Park,

Dublin 22.

Registered Landscape Architect

September 2021

1 INTRODUCTION

Macro Works Ltd. were commissioned to undertake a glint and glare assessment for a proposed roof-mounted photovoltaic (PV) panel installation on the roof of the a proposed building in the Baldonnell Business Park, Dublin 22 (Figure 1 refers). The application site boundary adjoins Clonlara Road and Barney's Lane to the northwest and northeast respectively. PV panels are proposed on all but the northwesternmost roof pitch. Details of the locations of the proposed PV panels are indicated on Drawing GA-A-05. The ridge level of the building will be at 111.98m OD and the parapet level will be 112.85m OD. The PV panels will be attached to the flush with the surface of the roof. The PV panels will remain in a fixed position throughout the day and year (i.e. they will not rotate to track the movement of the sun).

Figure 1: Aerial view (Google Earth Pro) indicating the location of the proposed PV panel layout (red pin) for analysis by SGHAT.

2 STATEMENT OF AUTHORITY

Macro Works' relevant experience includes nineteen years of analysing the visual effects of a wide range of infrastructural and commercial development types. This experience includes numerous domestic and international wind and solar energy developments. Macro Works has assessed the effects of glint and glare for many solar development sites throughout Ireland to date.

3 METHODOLOGY

The process for dealing with aviation receptors is as follows:

1. The Federal Aviation Administration (FAA) approved Solar Glare Hazard Analysis Tool (SGHAT) is used to determine if any of these aviation receptors has the potential to theoretically experience glint or glare. This tool also calculates the intensity of such reflectance and whether it is acceptable by FAA standards.
2. SGHAT does not account for terrain screening or screening provided by surface elements such as existing vegetation or buildings, therefore the results of the SGHAT may need to be considered, in conjunction with an assessment of existing intervening screening that may be present, to establish if reflectance can actually be experienced at the receptors.
3. Finally, if necessary, additional assessment is undertaken using Macro Works' bespoke model which would into account any screening provided by any proposed mitigation measures.

4 GUIDANCE

Guidance has been prepared by the Federal Aviation Authority[1] to address the potential hazards that solar developments may pose to aviation activities, and this has been adopted for use by the Irish Aviation Authority. SGHAT was developed in conjunction with the FAA in harmony with this guidance and is commonly regarded as the accepted industry standard by aviation authorities internationally when considering the glint and glare effects upon aviation related receptors.

4.1 FEDERAL AVIATION AUTHORITY

Within the FAA's interim policy, a 'Review of Solar Energy System Projects on Federally Obligated Airports'[2] it states:

"To obtain FAA approval to revise an airport layout plan to depict a solar installation and/or a "no objection" to a Notice of Proposed Construction Form 7460–1, the airport sponsor will be required to demonstrate that the proposed solar energy system meets the following standards:

- *No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATCT) cab, and*
- *No potential for glare or "low potential for after-image" (shown in green in Figure 1* [Figure 2 refers]*) along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The*

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

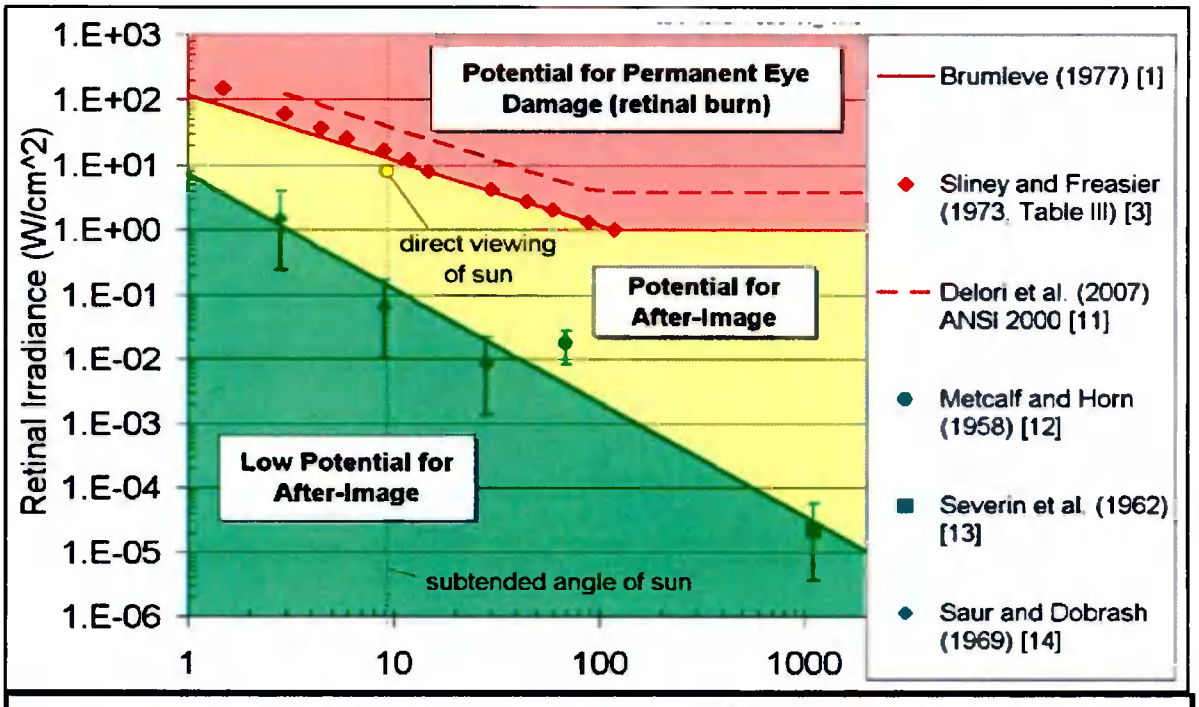
[2] Federal Aviation Administration (FAA). (2013). Department of Transportation - Federal Aviation Administration. *Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports*. Vol 78 (No 205), 63276-63279.

final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath."

In summary, glare at an ATCT is not acceptable but glare with a *"low potential for after-image"* is acceptable along final approach paths to runways.

4.2 SOLAR GLARE HAZARD ANALYSIS TOOL

The SGHAT was designed to determine whether a proposed solar energy project would result in the potential for ocular impact as depicted on the Solar Glare Hazard Analysis Plot (Figure 2 refers). SGHAT analyses ocular impact over the entire calendar year in one minute intervals from when the sun rises above the horizon until the sun sets below the horizon. One of the principal outputs from the SGHAT report is a glare plot per receptor that indicates the time of day and days per year that glare has the potential to occur. SGHAT plot classifies the intensity of ocular impact as either Green Glare, Yellow Glare or Red Glare. These colour classifications are equivalent to the FAA's definitions regarding the level of ocular impact e.g. 'Green Glare' in the SGHAT is synonymous with the FAA's *"low potential for after-image','* and so forth. The various correlations are illustrated on the Solar Glare Hazard Analysis Plot.



Solar Glare Ocular Hazard Plot: The potential ocular hazard from solar glare is a function of retinal irradiance and the subtended angle (size/distance) of the glare source. It should be noted that the ratio of spectrally weighted solar illuminance to solar irradiance at the earth's surface yields a conversion factor of ~100 lumens/W. Plot adapted from Ho et al., 2011.

Chart References: 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, J. Solar Energy Engineering, August 2011, Vol. 133, 031021-1 – 031021-9.

Figure 2: Figure 1 from the FAA Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports

5 IDENTIFICATION OF STANDARD RECEPTORS

Casement Aerodrome is located approximately 0.3km to the north of the proposed PV panels and Weston Airport is located approximately 7km to the northwest (heading c.333 degrees) thus warrant inclusion in this assessment (Figure 3 refers). There are four runway approaches at Casement Aerodrome; 04, 10, 22 and 28. The Air Traffic Control Tower (ATCT) at Casement Aerodrome is 9m Above Ground Level (AGL) and will be referenced as '3-ATCT' in this report. Weston Airport hosts just 1 operational runway with two potential approach paths; 07 and 25. The ATCT at Weston Airport has a structural elevation approximately 15m AGL and will be referenced as '2-ATCT' in this report.

Figure 3: Aerial view (Google Earth Pro) showing the location of the PV panels (red pin) relative to Casement Aerodrome and Weston Airport (yellow pins).

6 RESULTS

6.1 RUNWAY APPROACHES

The SGHAT results are contained in Appendix A and show that of the six runway approaches analysed, runway approaches 04, 10 and 28 at Casement Aerodrome have the theoretical potential to receive glare. In this instance, SGHAT calculated the potential glare to be *'Green Glare'*. SGHATs *'Green Glare'* classification regarding the intensity of the potential glare is synonymous with FAA's *'low potential for temporary after image'*. *'Green Glare' /* glare with a *'low potential for temporary after image,'* regardless of the number of minutes per year, is considered by the FAA to be an **acceptable level of reflectance effect for runway approaches**.

6.2 AIR TRAFFIC CONTROL TOWERS

The SGHAT results are contained in Appendix A and show that there is **no potential for glint and glare to occur at the ATCT in Weston Airport**.

The SGHAT results also show the theoretical potential for up to 1343 minutes of glare per year at the ATCT in Casement Aerodrome. SGHAT calculated this potential glare to be *'Green Glare'*. SGHATs *'Green Glare'* classification regarding the intensity of the potential glare is synonymous with FAA's *'low potential for temporary after image'*. *'Green Glare' /* glare with a *'low potential for temporary after image,'* regardless of the number of minutes per year, is considered by the FAA to be an unacceptable intensity of reflectance effect for an ATCT. This result is not unexpected or uncommon as the SGHAT software does not account for screening as a result of intervening terrain, buildings or vegetation, , therefore a 3D visibility analysis was undertaken from this ATCT.

6.2.1 Visibility Analysis

6.2.1.1 Air Traffic Control Tower at Casement Aerodrome

Results of 3D visibility analysis demonstrates that it is not possible for there to be inter-visibility between the ATCT at Casement Aerodrome with the proposed PV panels due to intervening parapet that encloses the roof of the proposed building which will block views of the PV panels (Figure 4 refers). Thus, there will be **no potential for glint or glare to occur at the ATCT at Casement Aerodrome**.

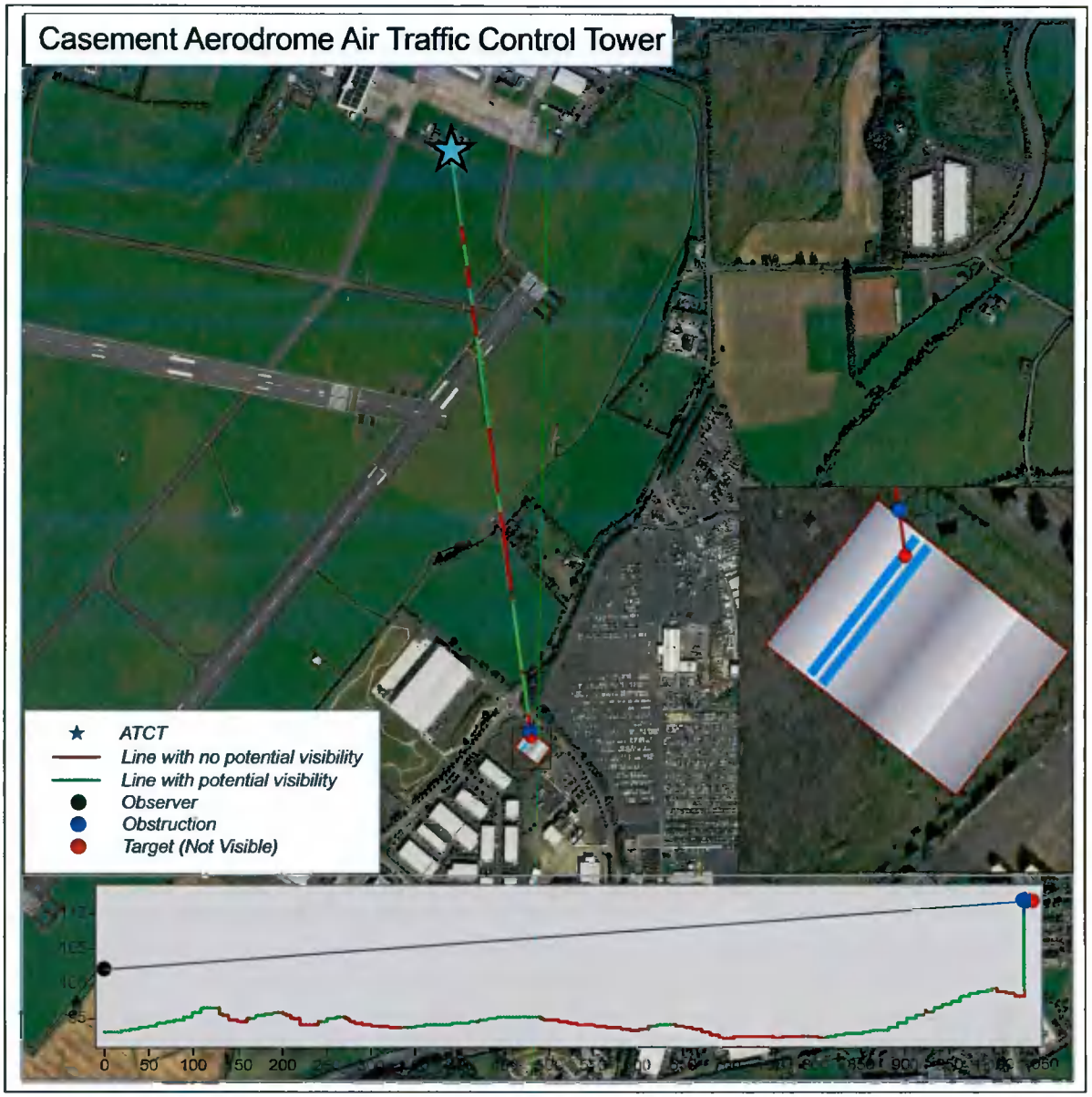


Figure 4: Showing visibility analysis from the ATCT at Casement Aerodrome towards the proposed PV panels.

7 OVERALL CONCLUSION

From the analysis and discussions contained herein, it is considered that there will not be any hazardous glint and glare effects upon the aviation receptors identified as a result of the proposed roof-mounted solar PV panels.

APPENDIX A:

SGHAT RESULTS – RUNWAYS APPROACHES AND AIR TRAFFIC CONTROL TOWERS (ATCT)