

GLINT AND GLARE ASSESSMENT

Woodhouse Park Lifestyle Centre Roof-Mounted Solar Array

Applicant: Manchester City Council

Version 1.0

EXPERTISE | KNOWLEDGE | SUPPORT

Document Version Control

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Document Abbreviations

Abbreviation	
RM	Roof-mounted
PV	Photovoltaic
MCC	Manchester City Council
MAN	Manchester Airport
AGL	Above Ground Level
FAA	Federal Aviation Association
CAST	Combined Aerodrome Safeguarding Team
ATCT	Air Traffic Control Tower
AOD	Above Ordnance Datum

Document Attachments

Document Title	Description
Appendix 3.1	Aviation Receptors Map

1. EXECUTIVE SUMMARY

This report presents the findings of a glint and glare assessment undertaken for the proposed roof-mounted (RM) solar photovoltaic (PV) array at Woodhouse Park Lifestyle Centre, Portway, Wythenshawe, M22 1QW. The assessment has been prepared on behalf of Manchester City Council to evaluate the potential impacts of glint and glare on Manchester Airport due to the proximity of the array.

The initial assessment was carried out using a bare-earth model, which does not account for built structures, topography, or vegetation. Initial results assume uninterrupted sunshine throughout the year to identify the full theoretical extent (worst-case) of potential glint and glare impacts, herein referred to as the baseline model.

Real-world weather data from the local Met Office weather station, Woodford, was applied to provide more realistic results. An adjustment factor of 32% was applied, sourced from long-term average annual sunlight hour data.

The assessment concludes that all aviation receptors pass the criteria set by the FAA from the baseline results. All receptors, excluding flight path 23R/05L, receive no glare. As flight path 23R/05L receives green glare only, this receptor also passes FAA criteria. Therefore, no further assessment or mitigation was required.

2. INTRODUCTION

2.1. Project Details

Cogeo Planning & Environmental Services Ltd has been requested by Manchester City Council to carry out a glint and glare assessment for the proposed roof-mounted (RM) solar array installation at Woodhouse Park Lifestyle Centre, Portway, Wythenshawe, M22 1QW. The site location and layout are shown in Figure 2.1.

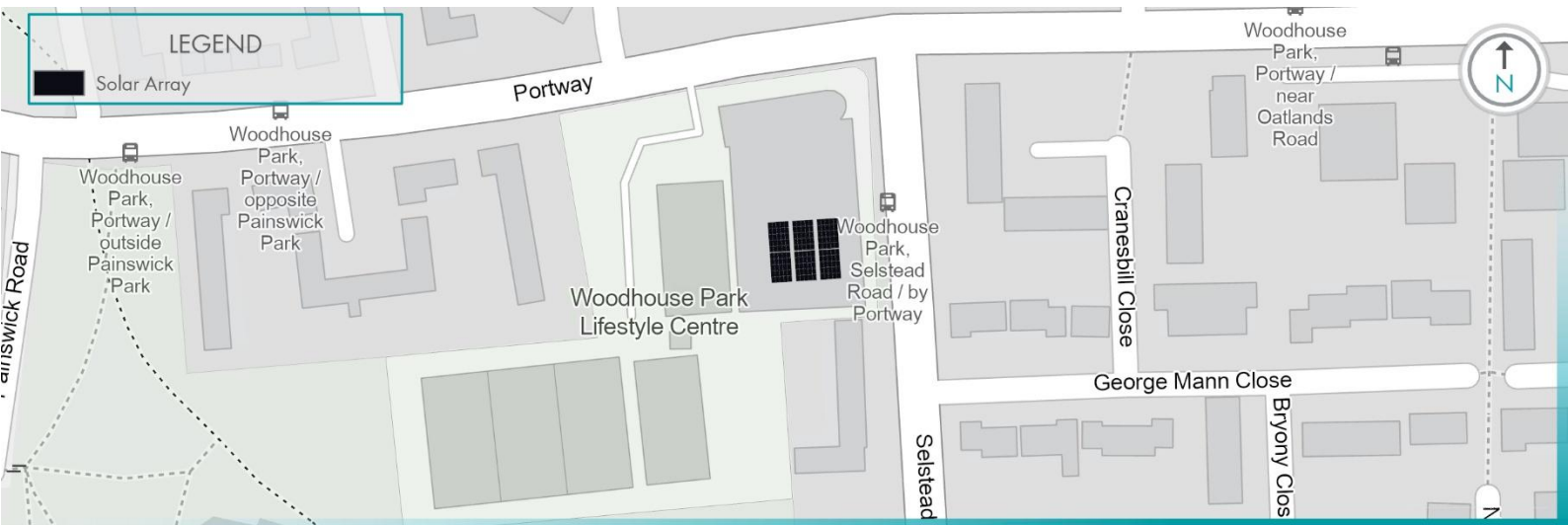


Figure 2.1 Development Location

2.2. Proposed Development

Table 2.1 provides details of the proposed development and the parameters used in creating the glint and glare model. The array was divided into three sections to allow detailed analysis within the software, however, results are combined for an overall assessment of the proposed development.

Table 2.1 Project Specification

Development	Parameter	Detail
Solar Array	Height of Panels (m)	8.8 AGL (lowest)
		12.3 AGL (highest)
	Angle of Panels (°)	20
	Azimuth angle of the panels (°)	176

2.3. Requirement for Assessment

The glint and glare assessment has been undertaken to give a thorough overview of any potential impacts of glint and glare on Manchester Airport due to the close proximity of the array.

2.4. Glint and Glare Definition

Glint and glare relating to solar panels are defined as:

Glint	Direct reflection of sunlight
Glare	Less intense, continuous source of brightness

Solar panels are designed to absorb sunlight rather than reflect it; therefore, glint and glare are considered to be of low risk within the UK.

The 2010 Federal Aviation Administration (FAA)¹ guidance illustrates the relative reflectance of solar panels compared to other surfaces. It should be noted that solar panel technology has advanced since the publication of this guidance, achieving reflectivity values as low as 3%.

Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has shared characteristics with that of a mirror. A diffuse reflection will reflect incoming light and scatter it in many directions. The reflectivity values within the FAA guidance, presented in Table 2.2, shows that solar panels have a similar reflectivity intensity to water. This is confirmed in a study conducted by Riley and Olsen (2011)².

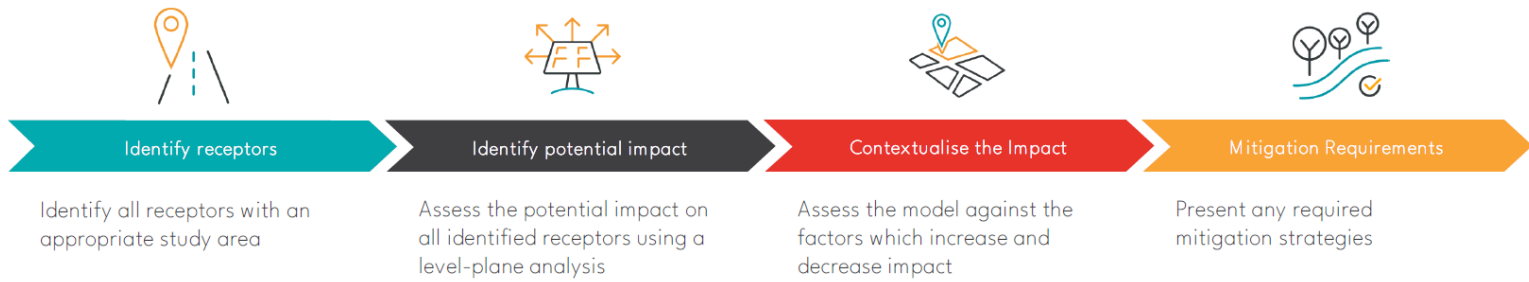
Table 2.2 Surface Reflection Values

Surface	Reflection
Snow	80
White Concrete	77
Bare Aluminium	74
Vegetation	50
Bare Soil	30
Wood Shingle	17
Water	5
Solar Panels	5
Black Asphalt	2

¹ Technical Guidance for Evaluating Selected Solar Technologies on Airports:
<https://www.faa.gov/sites/faa.gov/files/airports/environmental/FAA-Airport-Solar-Guide-2018.pdf>

² Riley and Olsen (2011) A Study of the Hazardous Glare Potential to Aviators from utility-Scale Flat-Plate Photovoltaic Systems

3. METHODOLOGY



The methodology for a glint and glare assessment follows a 4-step process.

3.1. Receptors

Glint and glare receptors are identified in three categories:

1. Observation Points – static receptors requiring a level of amenity protection, i.e. residences, workplaces, fixed public viewpoints, heritage assets;
2. Transport routes – dynamic terrestrial receptors experiencing varying exposure through movement, i.e. roadways, railways, tramways;
3. Aviation – air travel receptors on departure or arrival at an aerodrome, i.e. airport flight paths, glider flightpaths, helicopter landing approaches and air traffic control towers (ATCT).

This assessment considers receptors within category 3 only.

3.1.1. Aviation Receptors

Aviation is defined by two different parameters for assessment:

1. Observer Points – ATCT
2. Flight Path Receptors

The Air Traffic Control towers have been assessed using information provided by the Civil Aviation Authority (CAA) and NATS, using confirmed locations and tower heights where available. Table 3.1 provides information on the Aviation Observer Points assessed.

Table 3.1 Aviation Observation Points

Number	Type	Longitude	Latitude	Observer Height
OPI	Manchester Airport ATCT	-2.2796028	53.357742	60m

Table 3.2

Table 3.2 details all airport flight paths that have been assessed to a 2-mile (3.22km) approach distance at a 3° descent angle. All receptors are shown in Appendix 3.1.

Table 3.2 Airport Flight Path Receptors

Airport	Runway & Approach	Longitude	Latitude
Manchester Airport	05L/23R	-2.28778	53.34757
	23R/05L	-2.25927	53.36133
	05R/23L	-2.31058	53.33202
	23L/05R	-2.27719	53.34818

3.2. Assessment of Potential Impact

There is no specific methodology for assessing the effect of glint and glare on a receptor due to the unpredictability of weather patterns, movement of receptors within the landscape, and minor variances in onsite topography and vegetation.

To assess the impact of glint and glare on receptors, industry-standard software is used to analyse potential impacts in a level plane environment, i.e. an environment with no topography, vegetation, or buildings. This model assumes 365 days of sunshine and does not account for receptor angle, distance, movement or orientation.

3.2.1. Observer Points & Route Receptors

For observer points and route receptors, the ocular impact of solar glare is quantified into three categories³:

- **Green** - low potential to cause after-image (*flash blindness*)
- **Yellow** - potential to cause a temporary after-image
- **Red** - potential to cause retinal burn (*permanent eye damage*)

These categories assume a typical blink response in the observer. Note that retinal burn is typically not possible for PV glare since PV modules do not focus reflected sunlight⁴.

3.2.2. Aviation Receptors

The FAA sets out the following essential criteria to be met for solar energy systems located on airport property:

- No glare of any kind for Air Traffic Control Tower(s) at cab height.
- No 'yellow' glare for any flight path from threshold to 2 miles.

³ Ho (2011) Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation, ASME J. Sol. Energy Eng., 133.

⁴ ForgeSolar Glint and Glare Analysis

3.3. Weather Conditions

Software outputs consider clear skies year-round; therefore, present an unrealistic scenario for glare, a correction factor is applied to all results to reflect the real-world weather conditions of the locality. This is achieved by using the sunshine hours from Woodford weather station, the geographically closest to the development. In this instance, Woodford weather station predicts an average of 32% annual daylight hours with unobscured sunshine⁵.

3.4. Impact Analysis

Following industry standard modelling and consideration of local weather conditions, an initial impact analysis can be conducted. This concludes whether a receptor is assessed against the worst-case scenario for impact. This stage is a pass/fail for whether further analysis is required, as the assessment had been conducted in a level-plane scenario. Table 3.3 and Table 3.4 detail the analysis criteria. Any receptors that are theoretically impacted are subject to further contextual analysis.

Table 3.3 Impact Analysis Criteria

Receptor Type	Criteria	Result
Aviation Receptors	Receptor does not fail any one of the criteria set out in sub-section 3.2.2, drawn from the FAA 2021 and 2013 policy	Further Assessment Not Required
	Receptor fails any one of the criteria set out in sub-section 3.2.2 Table 3.4, drawn from the FAA 2021 & 2013 policy	Further Assessment Required

Table 3.4 Aviation FAA Criteria

Component	Description
Analysis Parameters	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	Flight path receptor(s) do not receive yellow glare
ATCT(s)	Receptor(s) marked as ATCT do not receive glare

3.5. Context Analysis

For receptors identified as having a potential impact, a further analysis is conducted using topography and intervening features to assess the potential impact. Where intervening features impact the line of sight, further analysis is conducted to consider mitigating factors. These include:

- Orientation
- View Angle
- Distance
- Vegetative Screening
- Sensitivity

⁵ Met Office Location-specific long-term averages Woodford: <https://www.metoffice.gov.uk/research/climate/maps-and-data/location-specific-long-term-averages/gcqrn04p>

- Movement
- Directivity
- Sunlight intensity
- Time of year

Guidance recommends assessment of residential receptors where a potential line of sight exists to the development and states that the significance of glare reduces with greater distance to the array.

3.6. Impact Significance

To determine the significance of the glare impacts, the following criteria have been used to guide the analysis, when adjusted for the real-world scenario. This is considered alongside contextual analysis.

For static receptors only:

- **No Impact** - No glare because of the proposed development
- **Low** - Solar reflections impact between 0 and 30 hours per year or between 0 minutes and 30 minutes per day
- **Moderate** - Solar reflections impact between 30 and 40 hours per year or between 30 minutes and 40 minutes per day
- **High** - Solar reflections impact of over 40 hours per year or over 40 minutes per day

The following criteria in Table 3.5 have been used to guide the significance analysis of all receptors.

Table 3.5 Definition of Impact Significance

Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No Mitigation required.
Low	A solar reflection is geometrically possible, however any impact is considered to be small, such that mitigation is not required, e.g. intervening screening will limit the view of the reflecting solar panels significantly.	No Mitigation required.
Moderate	A solar reflection is geometrically possible and visible, however, it occurs under conditions that do not represent a worst-case.	Whilst the impact may be acceptable, consultation and/or further analysis should be undertaken to determine the requirement for mitigation and/or recommendations for or against mitigation should be made by an expert on a case-by-case basis with suitable reasoning.

Impact Significance	Definition	Mitigation Requirement
High	A solar reflection is geometrically possible and visible under conditions that will produce a significant impact. Mitigation and consultation is recommended.	Mitigation will be required if the proposed development is to proceed.

3.7. Mitigation

Where a context analysis raises further concern that mitigation is required, specific recommendations are made to ameliorate the potential impact. For roof-mounted arrays, the accepted mitigation is to select a lower reflectivity panel.

Only receptors with a Moderate and High Impact Analysis when adjusted for real-world scenarios have been considered for mitigation.

4. RESULTS

4.1. Modelled Glare Prediction

All results from the impact assessment model are presented to demonstrate the theoretical impact based on the level-plane analysis, specifying the time of year and the earliest and latest time of impact. This allows further assessment of both the duration of impact and the intensity of impact. They do not consider intervening features or typography; as such, these baseline results present a worst-case scenario.

The results are derived from the input parameter data detailed in sub-sections 2.2 and 3.1 of this report.

Following the completion of this assessment, the following receptors will not be impacted by the proposed solar array; therefore, they have not been considered further in this assessment. Table 4.1 details receptors not subject to further assessment.

Table 4.1 Receptors Not Impacted by Glint & Glare

Receptor Name	Reason for No Further Assessment
Manchester Airport ATCT	No Impact
05L/23R	No Impact
05R/23L	No Impact
23L/05R	No Impact

4.1.1. Aviation Receptors

Table 4.2 details the overall results for hours of glare per annum adjusted for weather data to provide a baseline.

Table 4.2 Aviation Receptors Type of Glare (hour/annum)

Receptor	Hours of Glare per annum		
	Green	Yellow	Red
Flight Path: 23R/05L	48 hours 12 minutes	0	0

4.2. Impact Analysis

Utilising the modelled glare prediction, a significance analysis is conducted to determine receptors to be considered for a further contextual assessment. Receptors that do not require further assessment do not meet the significance threshold as detailed in Section **Error! Reference source not found.** Exceedances are denoted in **red**, with results below the threshold for further analysis shown in **green**.

4.2.1. Aviation Receptors

Table 4.3 Aviation Receptors Impact Analysis

Receptor	Result Against FAA Criteria	Further Assessment Required
Flight Path: 23R/05L	Pass	No

5. IMPACT SIGNIFICANCE

All receptors pass the significance threshold criteria set by FAA guidance, therefore no further assessment is required, as the only flight path to receive glare, 23R/05L receives green glare only.

6. MITIGATION REQUIREMENTS

As all aviation receptors' baseline results have passed the criteria set by the FAA, no mitigation is required.

7. CONCLUSION

Initial results show the predicted glare times based on bare-earth terrain and utilise the current maximum solar design and layout. All aviation receptors pass the criteria set out by FAA guidance. All receptors, excluding flight path 23R/05L receive no glare from the proposed solar array. As flight path 23R/05L receives green glare only, this receptor also passes FAA criteria.

Appendix 3.1

Aviation Receptors Map

-  Solar Array
-  ATCT
-  2-Mile Flight Path
-  No Glare
-  Green Glare

Map Details
Glint & Glare Assessment Map showing the location of the proposed solar array at Woodhouse Park Lifestyle Centre, Portway, Wythenshawe, M22 1QW. The assessed receptors at Manchester Airport are shown along with their result.

Scale: 1:40,000 @ A3



Client Name	Manchester City Council
Site Name	Woodhouse Park RM PV
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