

LANCEFIELD SOLAR FARM

PRELIMINARY LANDSCAPE AND VISUAL IMPACT ASSESSMENT

**ADVERTISED
PLAN**

5TH DECEMBER 2022

FINAL PRELIMINARY ASSESSMENT REPORT
PREPARED FOR BNRG



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INTRODUCTION

BNRG (the applicant) plans to submit a Planning Application for the development of a solar installation at Cullys Road, Lancefield. The Project is located approximately 3.5 kilometres (km) south southwest of the township of Lancefield and approximately 60 km north of Melbourne (refer to **Figure 1**).

The Lancefield Solar Project (the Project) involves the erection of approximately 11,200 individual solar panels on approximately 13 hectares (ha) of the approximately 73.42ha subject site, as well as the installation of inverters, transformers and the construction of a battery energy system.

The Project is located at 313 Colliver's Road, Lancefield 3435, Lot 1 TP168495 (the site). The development will be situated to the north of Cullys Road.

This report has been prepared by Urbis Pty Ltd (Urbis) to provide a preliminary landscape visual impact assessment (LVIA) for inclusion in the Planning Application.

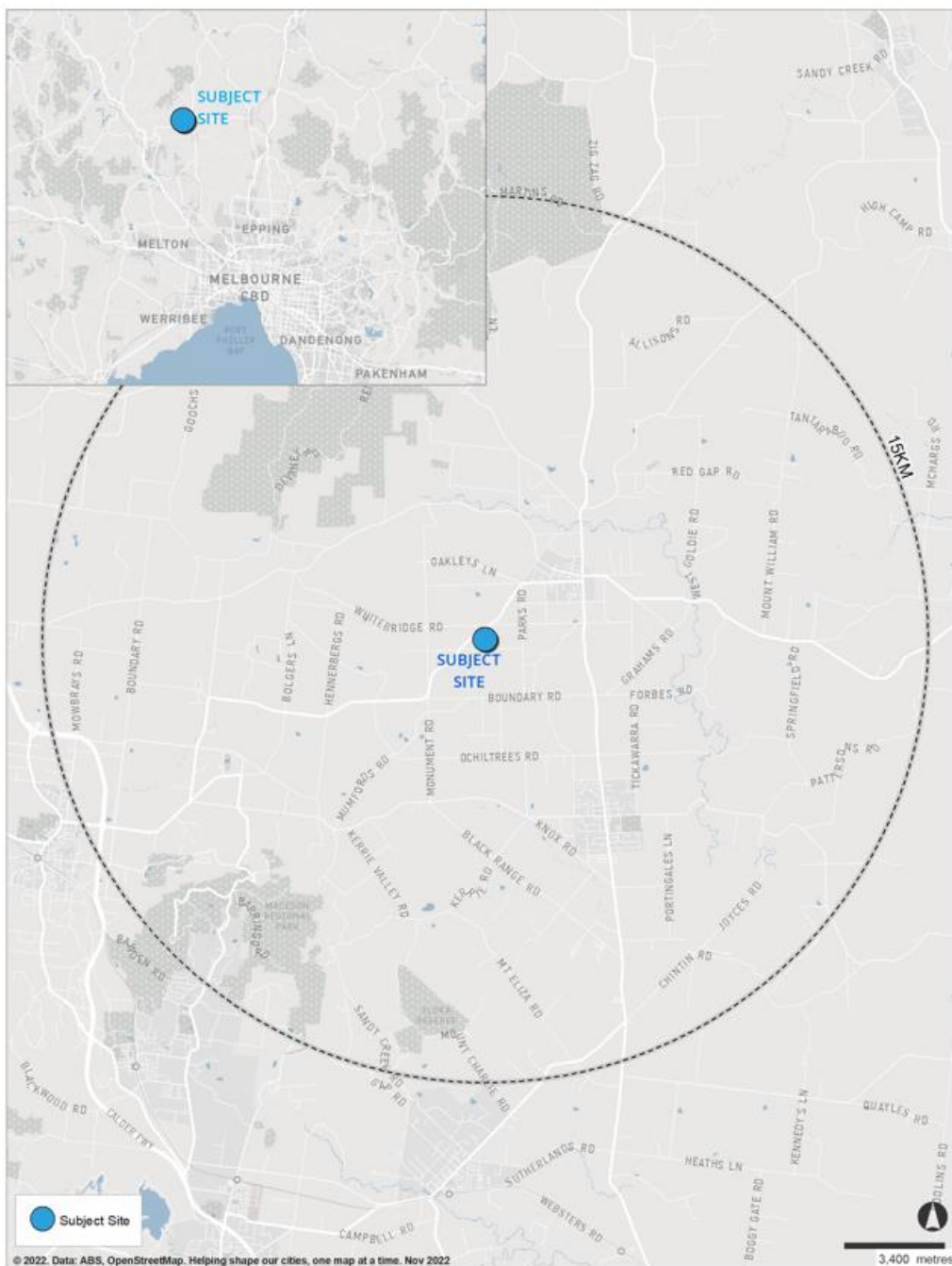


Figure 1 – Site location.

1. APPROACH

While there are no specific legislative requirements for the methodology of an assessment such as this in Victoria, the profession typically refers to the guidance offered by:

- Guidance for Landscape and Visual Impact Assessment (GLVIA), Third Edition, Landscape Institute and Institute of Environmental Management & Assessment (2013).

The methodology used for this Project, described below, conforms generally to the direction offered by the above guidelines as well as other proven assessment methodologies.

This preliminary assessment report assesses the landscape and visual impact of the Project, that is the day-to-day visual effects on people's views.

The method to measure visual impacts is based on the combination of the sensitivity of viewers to the proposed change and the magnitude of the Project on that visual setting or view.

The following study components were included as part of this assessment:

- Review the Project with regard to potential visual impacts.
- Characterisation of the existing landscape and visual setting.
- Qualitatively assess:
 - Visual modification at key viewpoints – How would the Project contrast with the landscape character of the surrounding setting?
 - Visual sensitivity at key viewpoints – How sensitive would viewers be to the Project?
 - Potential night-lighting impacts.
 - Potential glare or glint impacts.
- Propose visual impact mitigation and management measures.

1.1. ASSESSMENT OF LANDSCAPE AND VISUAL IMPACTS

The landscape and visual impact assessment is based on a detailed analysis of the landscape and visual setting and an assessment of the potential impacts of the Project on its viewshed.

The critical issues considered for this LVIA were:

- The number and location of sensitive viewing locations;
- The duration of the view – either static (generally long term - > 1 hour) and mobile (generally short term continually moving and static for no longer than 5 minutes);
- The degree to which the proposed works would be visible;
- The quality of the landscape setting; and
- The degree to which the Project contrasts or is compatible with the visual character of the setting – the visual modification level.

The assessment method assumed that if the Project would not be seen, there is no impact.

Level of Visual Impact N/A = Not Apparent, VL = Very Low, L = Low, M = Moderate, H = High		Viewer Sensitivity		
		H	M	L
Level of Visual Modification	H	H	H	M
	M	H	M	L
	L	M	L	L
	VL	L	VL	VL
	N/A	N/A	N/A	N/A

Table 1 – Visual Impact Matrix.

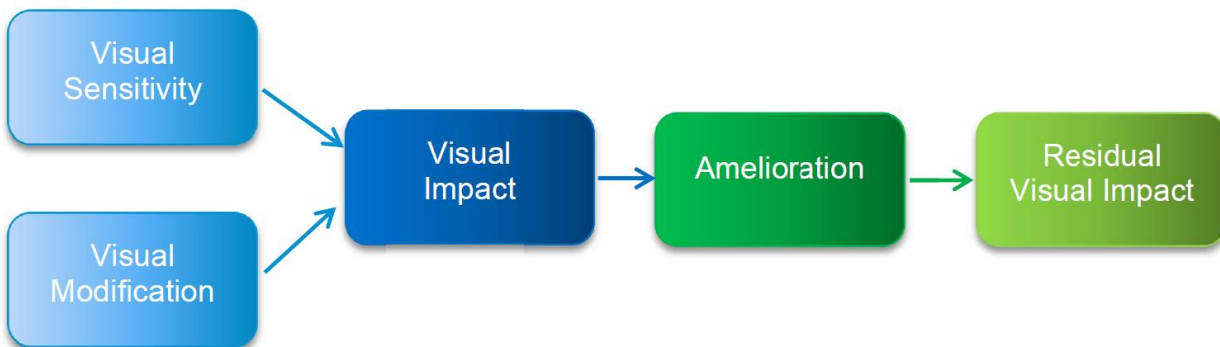


Diagram 1 – Visual Assessment Process.

1.1.1. Visual sensitivity

In this report, the approach to the visual sensitivity is consistent with the visual management system (United States Department of Agriculture Forest Service, 1995), Landscape Aesthetics – A Handbook for Scenery Management, Agricultural Handbook No. 701.

The visual sensitivity of development depends on a range of viewer characteristics. The primary characteristics used in this report include:

- Land use;
- Distance of the development from viewers; and
- Visibility from sensitive land use areas.

Visual sensitivity is a measure of how critically a change to the existing environment would be viewed from various land uses (refer to **Table 2**). Different activities have different sensitivity levels. For example, tourists on holiday would generally view changes to a landscape more critically than industrial workers in the same area. Similarly, individuals would view changes to the visual setting of their homes more critically than changes to the broader area in which they travel or work.

The next critical component to rating the visual sensitivity is the distance of the development from the identified visual use area. There are three viewing situations to consider:

- foreground (0 - 1 km);

- middleground (1 km – 4 km), and
- background (> 4 km).

As the distance increases from a proposed development to a sensitive land use area, the level of viewer sensitivity decreases based on a perceptual dis-association based on a reduction in relative proximity.

VISUAL USE AREA	FOREGROUND		MIDDLEGROUND		BACKGROUND
	Local Setting		Sub-Regional Setting		Regional Setting
	0 – 0.5 km	0.5 – 1 km	1 – 2 km	2 – 4 km	> 4 km
Residences/Townships	H	H	H	M	L
Tourism/Accommodation	H	H	H	M	L
Secondary Roads	M	L	L	L	VL
Local Roads	L	L	L	VL	VL
Agricultural Areas	L	L	L	VL	VL
Legend - H = High, M = Moderate, L = Low, VL = Very Low					

Table 2 – Typical Viewer (visual) Sensitivity

1.1.2. Visual modification to the existing setting

The level of visual modification resulting to a setting from a proposed development, or the degree to which the setting is modified, can be best measured as an expression of the visual interaction, or the level of visual contrast between the project and the existing visual environment.

A high level of magnitude, or a high degree of visual modification, will result if the major components of the project contrast strongly with the existing landscape.

A low level of magnitude, or a low degree of visual modification, will occur if there is little or minimal visual contrast and a high level of integration of form, line, shape, pattern, colour or texture values between the proposed development and the environment in which it sits. In this situation, the proposed development may be noticeable, but does not markedly contrast with the existing, already modified landscape.

The degree of magnitude or modification would generally decrease as the distance from the Project to various viewing locations increases.

1.2. LIGHTING IMPACTS

Australia does not have standards for the assessment of lighting impacts based on a range of night-time lighting environments. Therefore, the assessment of the impacts of lighting at night-time has been based on the United Kingdoms, Institute of Lighting Engineers (ILE) Guidance Notes for the Reduction of Obtrusive Light. This guidance note identifies four environmental zones for exterior lighting which are categorised by the degree of artificial lighting within an area. For example, national parks would be categorised as an intrinsically dark landscape (Category E1), where as a city centre with high levels of night-time activity would be categorised as a high district brightness area (Category E4).

Australian Standards do exist for the minimisation of light spill. Regardless of the existing brightness of a particular setting, it is a widely accepted principal that light spill, particularly upward light spill, be minimised wherever possible.

1.2.1. Lighting impact scenarios

Glow

Light glow is typically an upward projection of light that results in illumination of the night sky above a lighting source. It is intensified, or more visually apparent when foggy or cloudy as the light reflects or disperses of water droplets in the atmosphere. Glow is visible over significant distances.

Spill

Spill is light that falls on adjacent sensitive surfaces, both vertical and horizontal, and is most intrusive where it illuminates private open spaces or spills through windows.

Hot spots

Hot spots relate to concentrated areas of bright light in an otherwise less well illuminated setting. Hot spots will be most visible where are elevated.

Kinetic / movement

Lights that change colour or flash can draw the attention of a viewer. As the speed of the colour change or blink increases in speed, so too will its prominence of ability to draw attention.

1.2.2. Glare and glint impacts

Photovoltaic panels are designed to absorb sunlight and convert it to electricity. Minimising the light reflected from the panels is a goal of panel design, manufacture and installation. The dark, non-reflective nature of a solar array is generally considered to help minimise their visual contrast with the surrounding landscape.

The glare and glint assessment has been undertaken utilising ForgeSolar software, with the annual hours for green and yellow glare calculated for identified observation points, typically roads and residences.

Green glare has a low potential to cause an after-image when observed prior to a typical blink response time.

Yellow glare has the potential to cause an after-image when observed prior to a typical blink response time.

The analysis does not consider obstacles between the observation points and the proposed solar array that may obstruct observed glare, such as trees, topography and, buildings, etc., and can, therefore, be considered a worst-case scenario.

1.2.3. Residual impact

The effectiveness of the measures proposed in mitigating the landscape and visual impacts resulting from the Project is demonstrated by comparing the visual impact during initial operation with the residual impact when the proposed landscape measures have mostly matured, which is typically ten (10) years following initial establishment.

Generally, residual impacts would be reduced by at least one level where landscape measures have been proposed and matured due to filtering or inhibiting views to the Project.

1.3. LIMITATIONS OF THE ASSESSMENT

There are these following limitations associated with this assessment:

- The LVIA process aims to be objective and, as such, seeks to describe any changes factually. Potential changes resulting from the project have been defined. However, the significance of these changes requires qualitative (subjective) judgements to be made. Therefore, the conclusions to this assessment combine both objective measurement and subjective professional interpretation. This assessment has attempted to be objective, however, it is recognised that visual assessment can be highly subjective, and individuals are likely to associate different visual experiences to the study area;
- The impact assessment is focused on the current land uses and zoning; and
- Methodology of the construction works are currently unknown and dependent upon planning approvals. However, we have assumed that the impacts during construction and would result in a similar degree of visual impact to that of the operational phase assessment findings, pre-amelioration.

2. PROJECT CONTEXT AND SETTING APPRAISAL

2.1. PROJECT CONTEXT

The Project is located adjacent and to the north of Cullys Road, and to the south of Rochford Road and Collivers Road, which are approximately 185m and 495m, respectively, to the north (refer to **Figure 2**).

The Township of Lancefield is located approximately 3.5km to the north northeast, the settlement of Rochford approximately 2.4km to the southwest and the township of Romsey, approximately 6.5km to the south southeast.

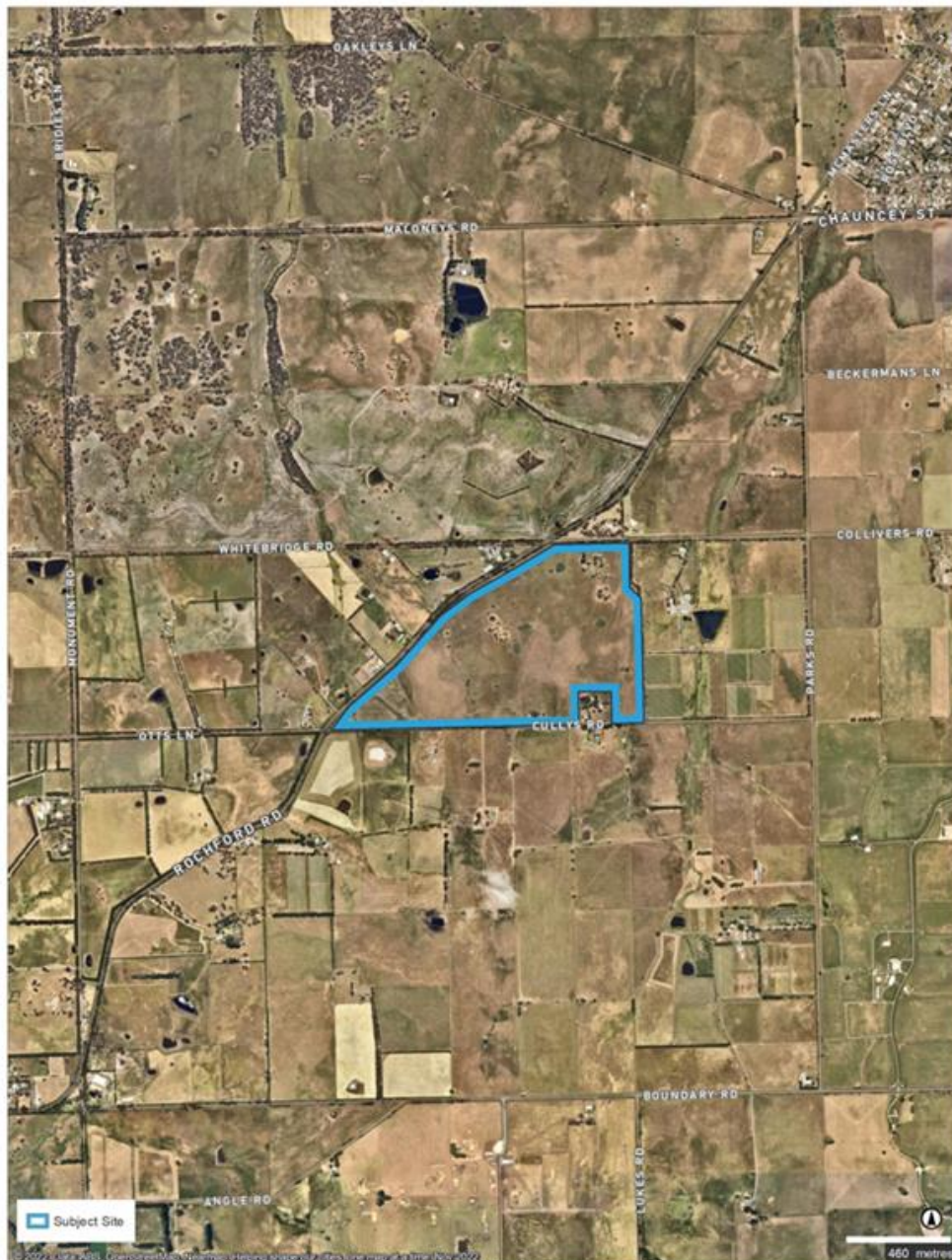


Figure 2 – Site context.

2.2. LAND USE AND ZONING

2.2.1. Land use

The land use of the Project and surrounding area is comprised predominately of grazing, cropping and viticulture.

Wineries with associated tourism uses are located to the north, northeast and southeast of the Project. Glen Eira at Lancefield is located approximately 340m to the north of the Project, Curly Flat Vineyard approximately 440m to the northeast of the Project and Parkside Winery and Farm approximately 1.1km to the southeast of the Project (refer to **Figure 3** and **4**). The vineyards have been assessed in detail in this report as a result of their tourism uses.

The infrastructure associated with the region includes sealed and unsealed roads and roadside power lines scales (refer to **Figure 5**).

The most significant road within the viewshed of the Project is Rochford Road, a “C” grade declared road, located approximately 170m to the northwest of the Project, linking Lancefield and Newham.

Newham and Romsey, the largest proximate areas of settlement other than Lancefield, are located outside of the sensitive viewshed of the Project, approximately 9km to the west and 6.5km to the south southeast, respectively.

Hanging Rock Reserve, a nationally recognised cultural and natural attraction, is also located outside of the visual catchment of the Project, approximately 9.5km to the southwest.



Figure 3 – Glenn Erin of Lancefield vineyard is located to the north of the Project (Source: glenerin.com.au).

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Figure 4 – Curly Flat Vineyard is located to the northeast of the Project (Source:curlyflat.com).



Figure 5 – Existing powerlines will connect the Project to the grid.

2.2.2. Zoning

The Project is located within the Macedon Ranges Shire Council.

The entirety of the Project site and much of the surrounding visual catchment, up to 2km distant, is zoned Farming Zone (FZ) within the Macedon Ranges Planning Scheme (refer to **Figure 6**).

None of the objectives of the planning scheme for FZ land relate to the protection of landscape or visual values.

A Significant Landscape Overlay – Schedule 2 (SLO 2) is located over an elevated landform, Western Hill, approximately 770m to the north of the Project (refer to **Figure 6**). The objectives of the overlay are specific to the land within the overlay and relate to the protection of landscape character values.

2.3. VEGETATION AND LANDSCAPE FORM

The Project area is generally flat to the south, to sloping and undulating to the north. It is mostly treeless, with only a small clump of substantial vegetation confined to the southeast corner. The elevation ranges from approximately 53m at its lowest point near the northwest corner, to approximately 543m at its northeast corner (refer to **Figure 7**). The entire Project area has a general average fall from the north to south of 1.3% and east to west of 4.8%.

The landscape of the surrounding area is gently to moderately undulating with occasional small hills and lightly incised drainage lines. Tall vegetation is primarily confined to roadsides and paddock boundaries, with scattered vegetation lining the drainage lines. Deep Creek, approximately 2.7km to the west, marks the transition to denser vegetation from there, westwards.

Western Hill at 576m is the tallest and most pronounced landform in the immediately surrounding area.

The vegetation is typically denser in the northwest, transitioning to a more rectilinear banded landscape in the east.

Residences are typically surrounded by dense, often exotic vegetation.

Occasional areas of elevated topography may allow for overlooking where taller vegetation is lacking, particularly to the southwest of the Project. Where combined with the banded vegetation, the result is mostly a visually compartmentalised landscape, with views to the Project area mostly screened.



Figure 6 – Land use zoning.

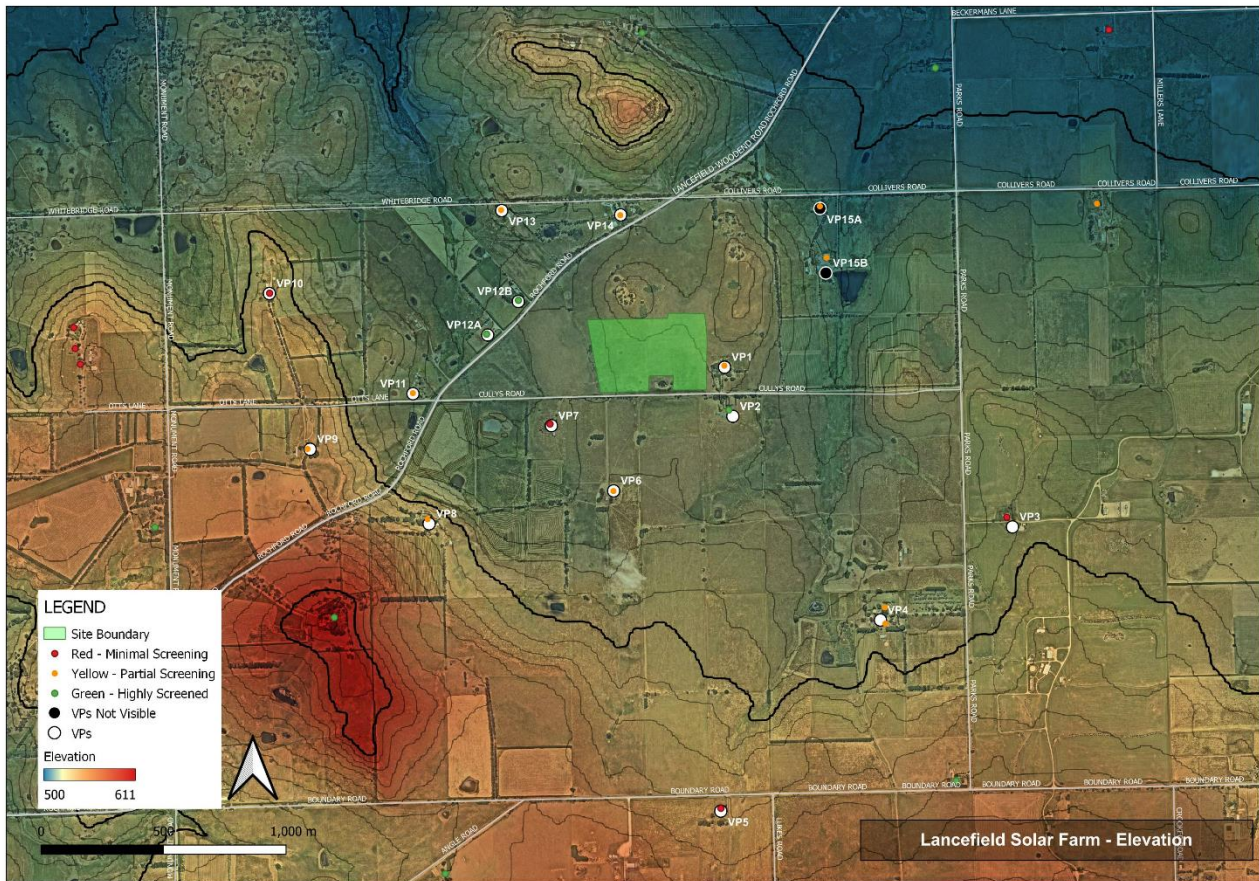


Figure 7 – Elevation of Project area and surrounds.

2.4. LANDSCAPE CHARACTER TYPE

Within the regional setting of the Project, the landscape character types have been identified using the assessment undertaken in the Macedon Ranges Landscape Assessment (2019)¹. The Project sits at the edge of two landscape character types, as described below:

- Landscape Character Type 1: Uplands - Area 1.5 Newham Rises.
- Landscape Character Type 2: Central Volcanic Plain - Area 2.3 Romsey & Lancefield Plains.

2.4.1. Area 1.5 Newham Rises

Key Landscape Features

- Important patches of remnant native vegetation.
- Gently undulating pastures and paddocks.
- Scattered hobby farms and lifestyle properties.

Landscape Values and Significance

Landscapes identified of significance are primarily located to the west and southwest of the landscape area and the Project, incorporating Hanging Rock and Jim Jim. However, Western Hill to the north of the Project (described as Rochford Road Hill in the Landscape Assessment) is also identified as being of significance.

¹ Claire Scott Planning, (2019). Macedon Ranges Landscape Assessment – Landscape Character Types & Areas and Landscape values and Significance.

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The area of interest is defined as being from the peak to the break in slope line, both of which are outside of the Project area.

2.4.2. Area 2.3 Romsey & Lancefield Plains

Key Landscape Features

- Relatively flat volcanic plain.
- Volcanic rises and eruption points throughout.
- Cleared and open farming landscape.
- Minimal native vegetation.
- Shelterbelts in paddocks and adjacent to roadsides.

Landscape Values and Significance

Most proximate to the Project is Melbourne Hill, located approximately 3.5km to the east, which is identified as being of significance.

2.5. SCENIC QUALITY

Leonard and Hammond (1984)² identify the broad landscape character type of the Project and surrounding area as Foothills. The scenic quality of the Foothills landscape character type is outlined below.

FOOTHILLS	
Description	Low to Moderate Scenic Quality
Landforms	<ul style="list-style-type: none">▪ Significant expanses of indistinctively rolling landform that are not dramatically defined by adjacent landform.
Vegetation	<ul style="list-style-type: none">▪ Vegetative patterns evident but of common pattern relative to the surrounding landscape character.▪ Extensive areas of similar vegetation and limited variation in colour or texture.
Waterforms	<ul style="list-style-type: none">▪ Intermittent streams.▪ Minor reservoirs.

2.6. ABSORPTIVE CAPABILITY

The definition of landscape absorptive quality is closely related to that of visual modification levels. It is generally applied at a broader scale than visual modification and is an assessment of how well a landscape setting is able to accommodate change or a development.

The key factors considered in determining absorptive capability are topography and vegetation. In areas of flatter topography, overlooking is not possible and a low and thin band of vegetation is able to screen views to a development from a given viewpoint. In areas of undulating or elevated topography, overlooking can occur and vegetation needs to be higher and denser to achieve effective screening. Intervening undulating topography also has the potential to block views in certain landscapes.

The landscape setting of the Project is generally gently to moderately undulating with vegetation confined to a rectilinear pattern reflecting property boundaries and roads. Within this landscape, overlooking is generally not possible from most non elevated sensitive viewpoints, and in these situations, even relatively low vegetation (up to eye-height) is effective at screening views.

² Leonard, M., Hammond, R., (1984). Landscape Character Types of Victoria.

Where the topography is more elevated, overlooking is possible and taller vegetation is required to screen views.

Topography – Moderate capability due to mostly slightly undulating topography, with some potential for overlooking.

Existing Vegetation – Generally low for cleared agricultural areas. Moderate to high capability where vegetation exists.

3. COMPONENTS OF THE PROJECT

3.1. KEY FEATURES

As illustrated in **Figure 8**, the Project involves the development of a solar energy facility on approximately 13 ha of the approximately 73.42 ha site. The works and components associated with the Project include:

- Approximately 11,200 modules mounted on single axis tracking solar panels arranged in a generally regular, rectilinear pattern comprised of modules of multiple panels;
- 1 central inverter;
- A 11 MWh battery energy system comprised of 8 units;
- A switch room;
- a shed to house maintenance equipment, 20 metres long x 14 metres wide x 4.84 metres tall;
- Installation of an all-weather access road (minimum width of 4 metres) around the site to provide access to panels and other equipment;
- 2m high perimeter security fencing;
- 1 x 45,000 litre water tank.
- Visual amelioration screen planting.

Lighting is not required for normal operations. However, localised lighting may be required for occasional night-time repairs or maintenance.

3.2. DETAIL OF PROJECT COMPONENTS

Solar Panels

Solar PV panels will be installed across the Project attached onto a single-axis tracker.

Each solar panel will measure 4.9 metres long by 2.4 metres wide. Once mounted on the frames and fully tilted, the panels will be capable of reaching an overall height of no more than 5.1 metres above ground level

The glass surfaced panels are coated to maximise daylight absorption, and thus minimise glare potential.



Mounted single axis tilting panels.

Mounting Frames

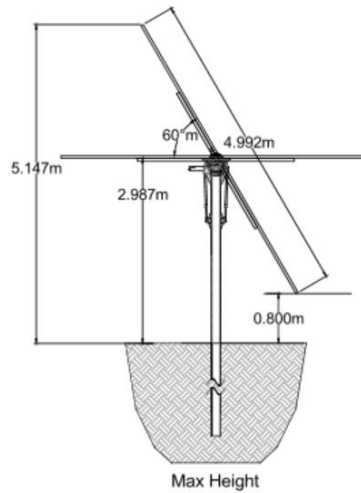
The panels will be attached to horizontal mounting frames. The panels will 'track' the sun in an east to west plane to maximise solar exposure. The mounting frames will be made of either galvanized aluminium or steel and will have a rough matte finish, rather than a polished finish.

The mounting frames are pile driven into the ground, and no concrete foundations are required. The base of the frame piles are



Solar panel module row – side elevation.

thin shapes, thus they have very little impact on the ground and do not require any prior excavation. At the end of their operational life when the site is decommissioned, the frame piles are simply pulled out from the ground causing minimal ground disturbance.



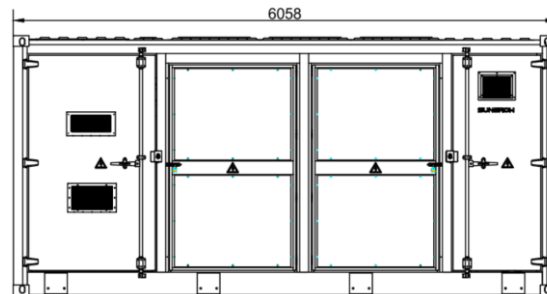
Self-powered tracker – side elevation

Central Inverter

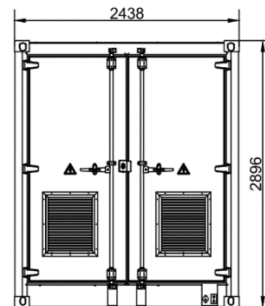
The panels generate Direct Current (DC) electricity which must be converted into Alternating Current (AC) before being fed into the local electricity grid network.

The transformer transforms electrical energy from one circuit to another and allows for the energy generated to be fed into the local grid network

The inverter is housed in a cabin-like structure mounted on a concrete base.



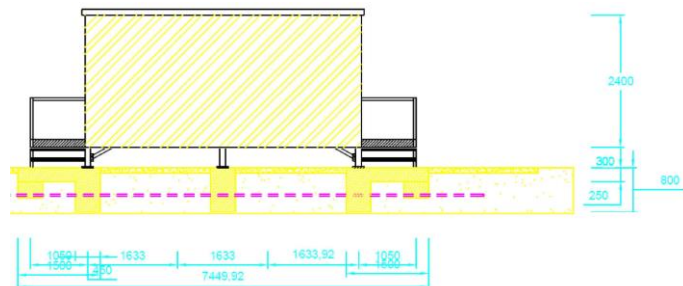
Central inverter – side elevation



Central inverter – end elevation

Switching Room

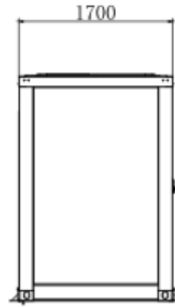
The switching room will have a footprint of approximately 7.5 metres x 3.5 metres and a maximum height of 2.7 metres



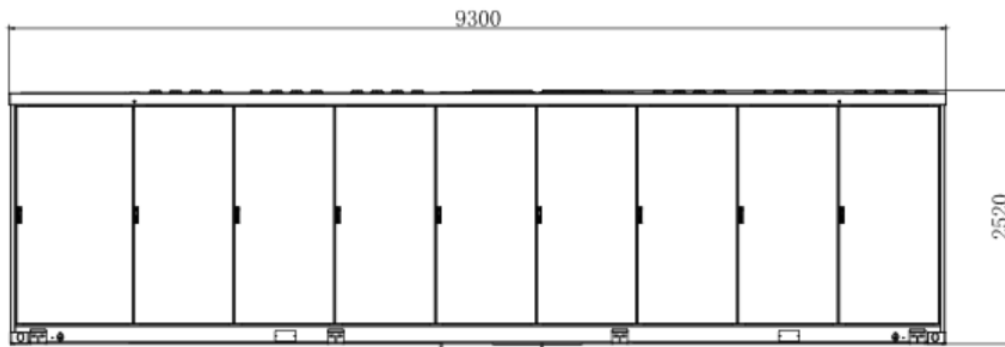
Switching room – front elevation

Battery Energy Storage System (BESS)

Installation of batteries housed inside a structure with the appearance of a shipping container constructed of steel measuring approximately 9.3 metres (length) x 1.7 metres (width) x 2.520 metres (height).



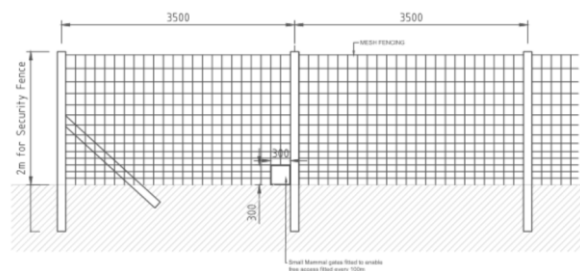
BESS – side elevation



BESS – front elevation

Perimeter Fence

A 2 m high mesh fence will be installed around the solar farm. The purpose of the fence is to deter theft or vandalism and prevent unauthorised access to the solar farm.



Perimeter fencing - elevation

Security Camera

In order to monitor the site and detect any unauthorised access, a motion sensor CCTV camera will be erected on a pole of approximately 4.5 m in height. The camera is directed into the solar farm, avoiding impinging on the privacy of nearby properties, and employ infrared technology so no lighting is required.



CCTV camera.

ADVERTISED PLAN

Maintenance Shed

The shed will measure 20 metres (long) x 14 metres (wide) x 4.84 metres (tall) and in a natural colour.



Maintenance storage shed - Example of colorbond corrugated steel

Water Tank

The single 45,000 litre water tank will be steel, circular and in a lighter/natural landscape colour.



Water tank – Example of colorbond corrugated steel

ADVERTISED PLAN

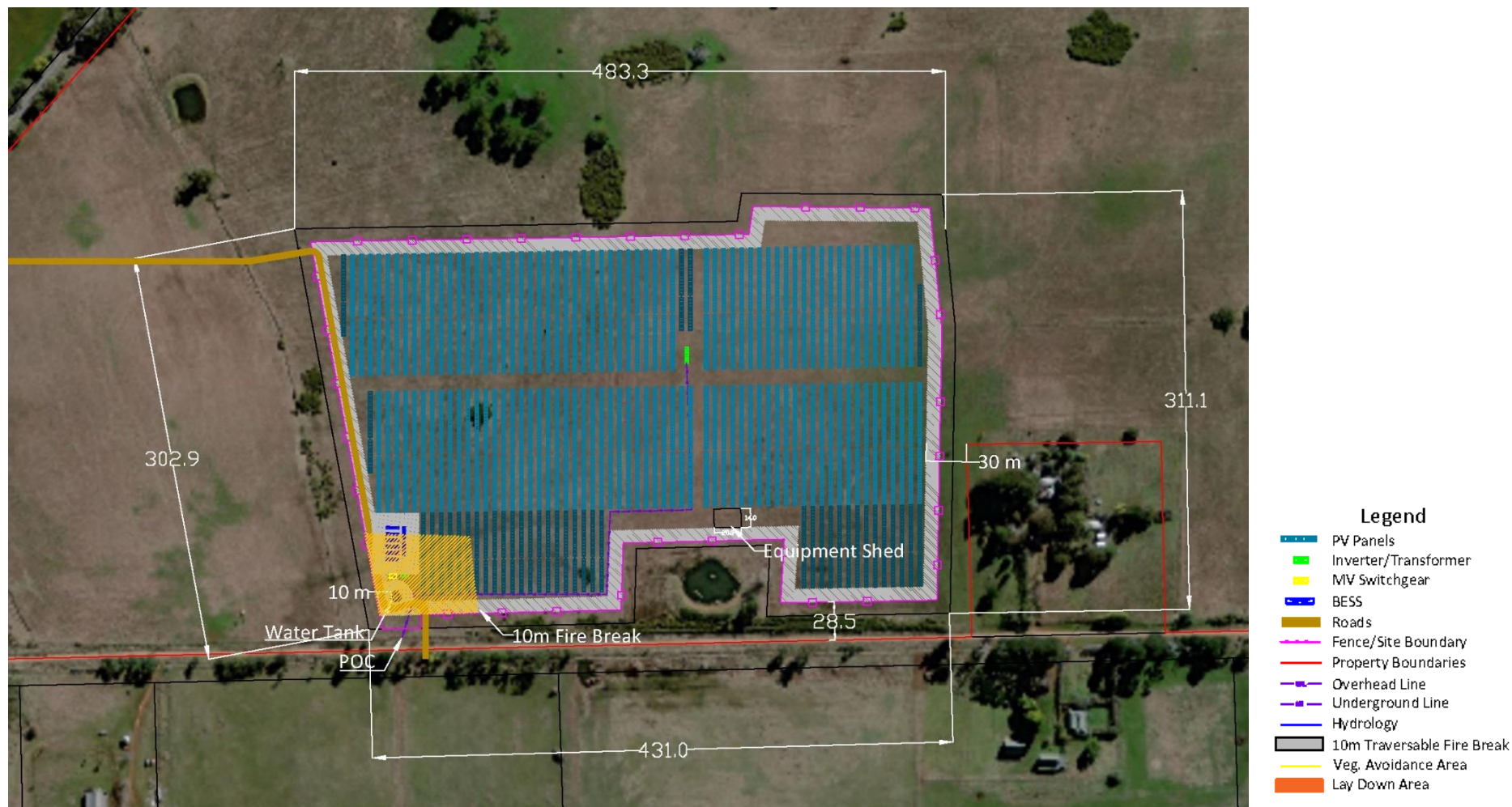


Figure 8 – Proposed development layout (Source: BNRG).

4. VISUAL IMPACT ASSESSMENT

4.1. VISIBILITY OF THE PROPOSAL

The viewshed is the area from which views of a proposed development may be possible. Given the relatively low profile of the components of the Project above ground level, the visual catchment will be limited and also partially confined by scattered vegetation and areas of localised elevated topography.

Figure 9 indicates the theoretical viewshed of the Project. It should be noted that the viewshed analysis is based on topography only and does not consider the screening effects of vegetation. As a result, it is essentially demonstrating a worst-case scenario. In reality, bands vegetation throughout the landscape and residential areas will further contribute to the screening of views towards the Project from most viewpoints.

The locations selected for photography and assessment are within the public realm, proximate to sensitive, privately owned land use areas.

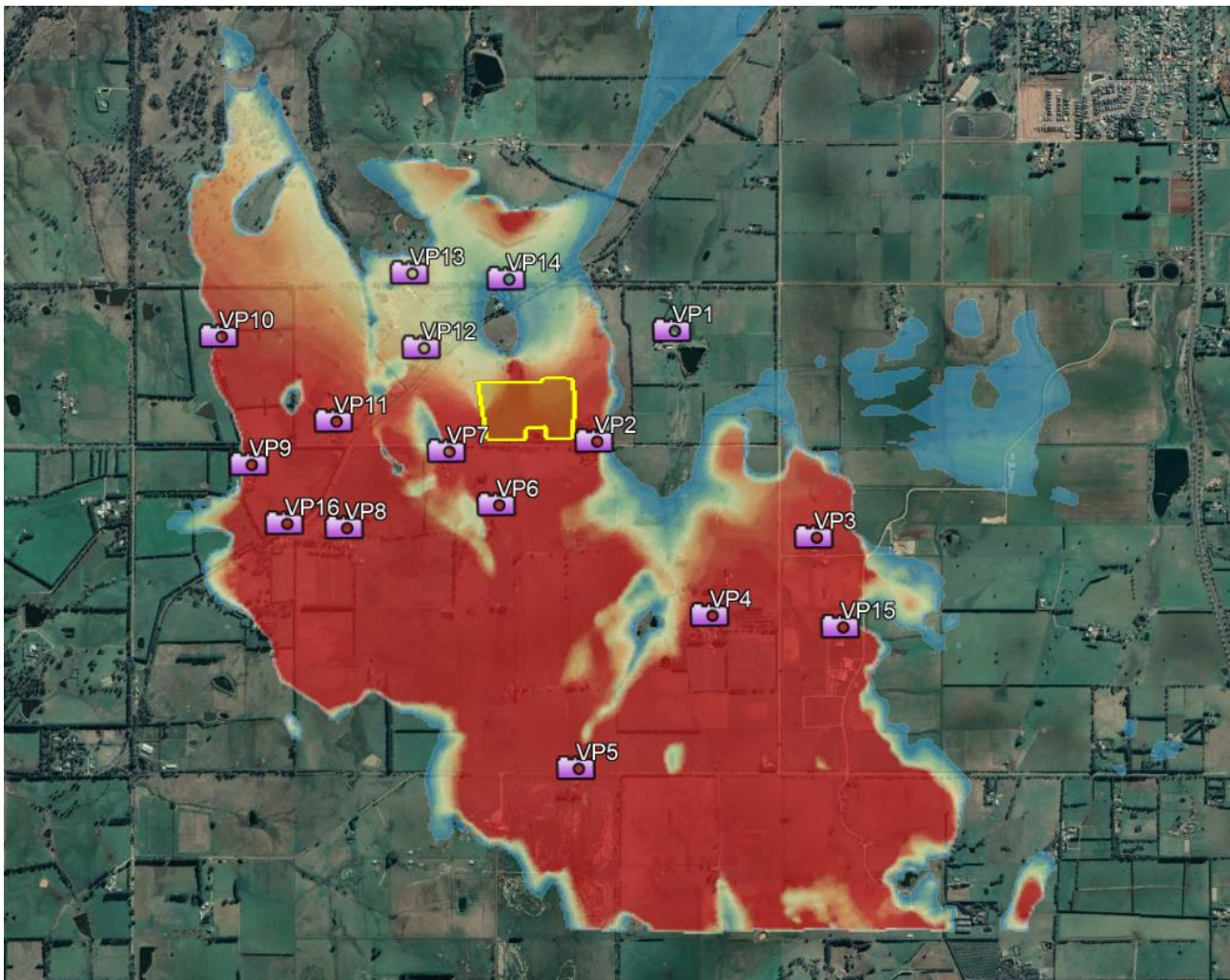


Figure 9 – Theoretical viewshed of the Project and assessed sensitive viewpoint locations.

4.2. SENSITIVE VIEWPOINTS

The viewpoint (VP) locations that are included in this assessment are from uses considered to be of higher sensitivity, such as tourism uses, transport routes and residences (refer to **Table 2** and **Figure 13**). Due to the typically low-profile form of the Project, the detailed assessment of viewpoints is confined to sensitive locations within 2 km of the Project, the area within which the Project will be most visible.

The residence/s of involved parties have not been assessed.

The locations selected for photography and assessment are mostly within the public realm, within proximity to the sensitive, privately owned visual use area. Photo simulations have been prepared for two of the three potentially highest impact viewpoints, these being VP7, VP11.

The photo simulations demonstrate the Project at the completion of construction without any landscaping and at 5 years following the establishment of landscape.

4.3. VISUAL IMPACT

This section includes a detailed assessment of the Project from the selected, highest sensitivity viewpoints, with a rating given for the level of visual modification and sensitivity which, when combined, result in a determination of the degree of overall visual impact for each viewing location.

4.3.1. The effect of residential vegetation on visual screening

In order to provide protection from the influences of the environment, particularly sun and wind, Australian rural residential gardens have traditionally developed a dense band of vegetation to surround an intimate and protected home yard. The effect of this in many instances has been to effectively contain the viewshed from the house and surrounding yard itself, screening views to the distance. The presence of foreground vegetation has a direct impact on the visibility of the Project and the context in which it will be viewed.

4.3.2. Residential viewpoint landscape setting typologies

Throughout the visual catchment, the majority of residences sit within a landscape that is comprised of medium to tall vegetation, with varying levels of density depending on either the extent of clearing or extent of planting.

The height and density of vegetation has a direct relationship to the visual exposure of the residence to the proposed development.

The following three setting typologies have been developed to assist the understanding of the influence of vegetation on the screening of views from residences.

The assessment has considered the overall screening effect of vegetation as it relates to the direction of views towards the wind farm. For example, if the vegetation at the perimeter of the residence is sparse on the side away from the direction of views to the wind farm and dense on the side where there may be potential views, the effect of screening vegetation reflects the side with views. The same applies for the converse situation.

Typology 1 - Rural Residential – Open or scattered tall vegetation

Views to external areas are minimally to partially filtered by scattered tall trees.

Influence on visibility and potential impact

Partial to open views of the proposed development will be possible over open pasture or below and between tall scattered trees. The potential exists for visual impact (refer to **Figure 10**).

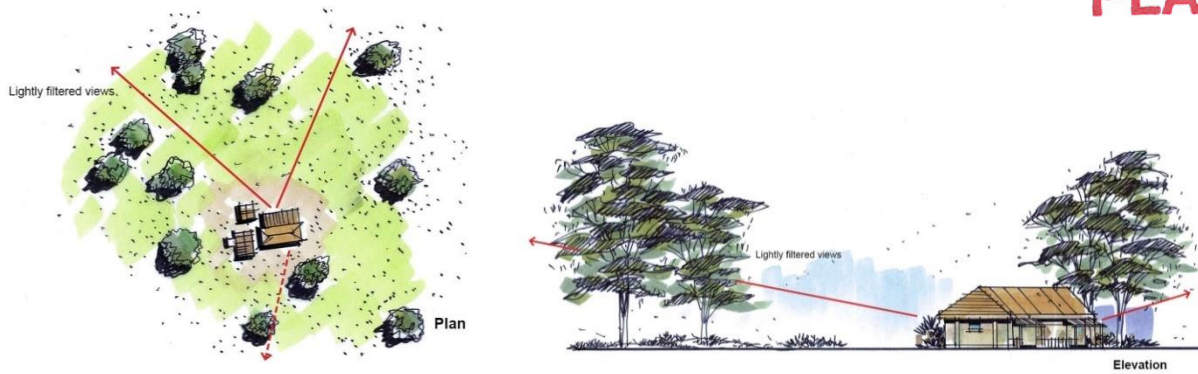


Figure 10 – Typology 1 – Typical plan and elevation.

Typology 2 - Rural Residential – Semi open tall vegetation

Views to external areas are partially to heavily screened by semi open, tall vegetation.

Influence on visibility and potential impact

Partial to fully screened views of the proposed development will only be possible where limited breaks in vegetation occur. The potential for visual impact is significantly reduced (refer to **Figure 11**).

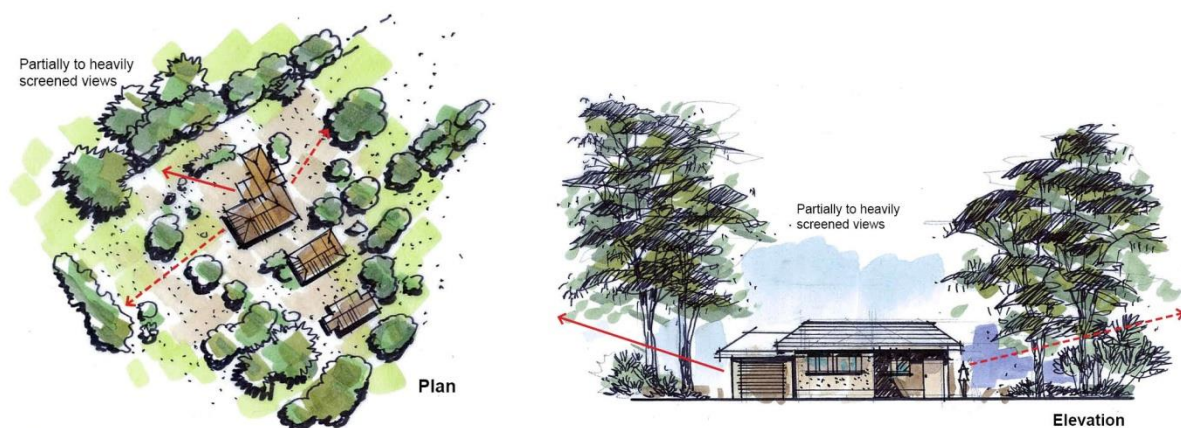


Figure 11 – Typology 2 – Typical plan and elevation.

Typology 3 - Rural Residential – Dense Tall Vegetation

Views to external areas heavily to fully screened by dense, tall vegetation.

Influence on visibility and potential impact

Views of the proposed development will not be possible and therefore any impacts are highly unlikely (refer to **Figure 12**).

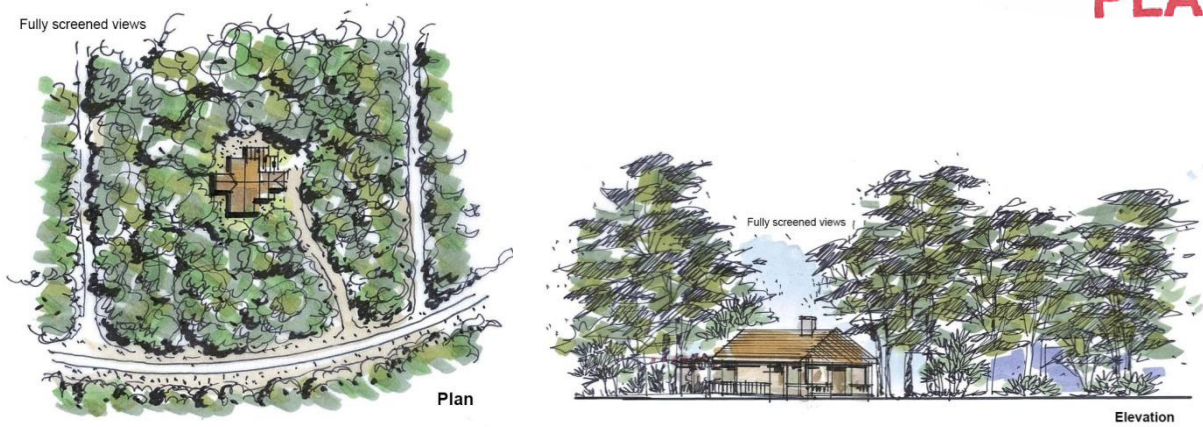


Figure 12 – Typology 3 – Typical plan and elevation.

4.3.3. Overview Assessment of Views from Residences

A desktop assessment was undertaken based on aerial photography and Google “Streetview” imagery and field surveys, of the potential degree of visibility from residences surrounding the Project, considering the following factors (refer to **Figure 13**):

- Proximity to the Project:
 - 0-2 km from Project boundary.
- Degree of vegetation present around the residence
 - Highly screened.
 - Partially screened.
 - Minimally screening.

Sensitive locations where views may or may not be possible, depending on the extent of surrounding vegetation are shown as:



Sensitive locations from which views are not possible due to intervening topography are shown as:



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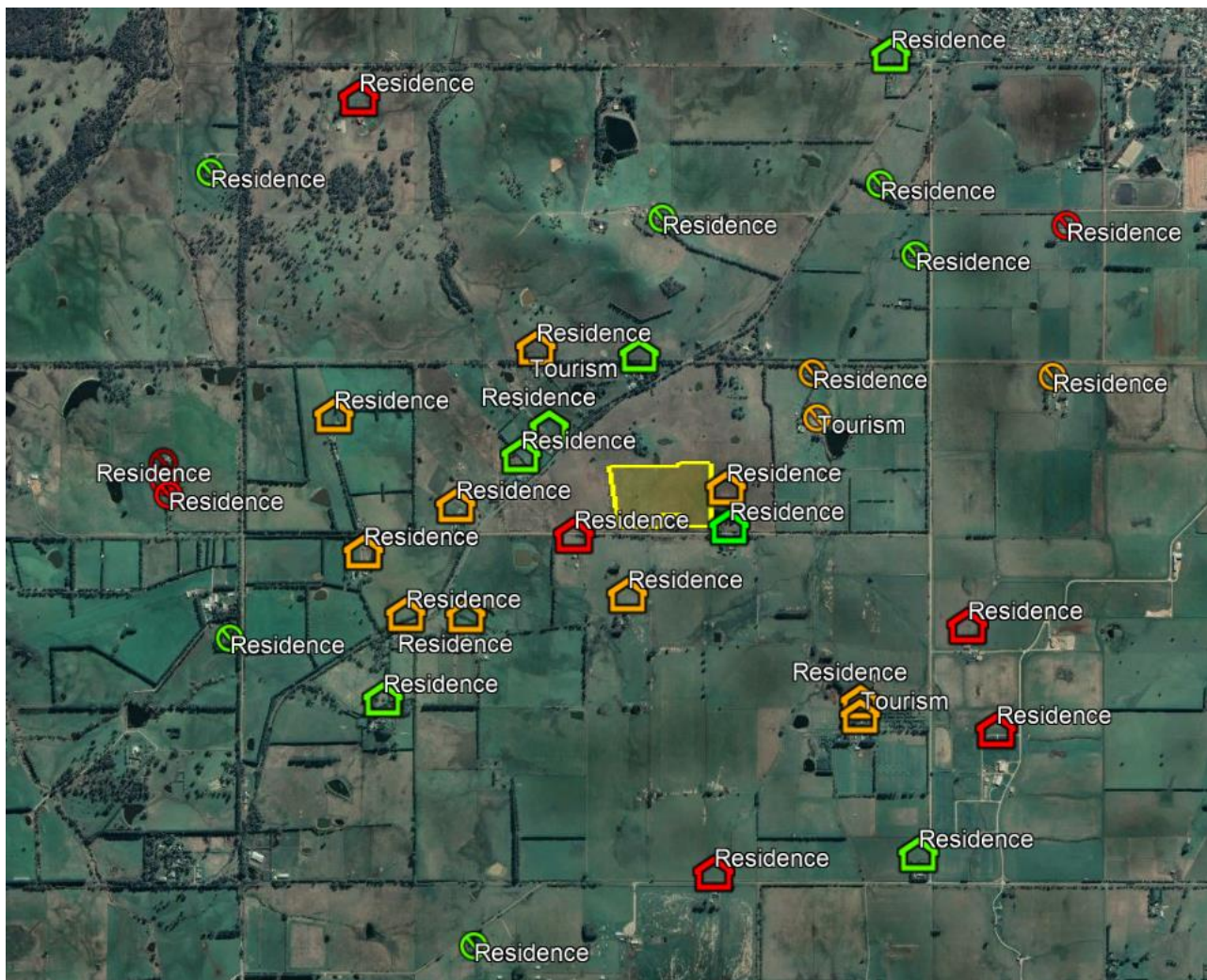


Figure 13 – Relative level of vegetation screening surrounding residences (Source: Google Earth).

VIEWPOINT 1 – CURLY FLAT VINEYARD ROAD

Photo Location	Parks Road, 90m south of Colliver's Road (refer to Figure 9).
Viewing Distance	550m to the Project (solar panels) from the winery. 1.1km to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationery. Frequency: Moderate.
Visual Use Area	Rural residence and tourism use – partially screened setting (refer to Figures 13 and 14).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential and tourism uses.
Visual Modification	NOT APPARENT – From this viewpoint, the Project will not be visible due to intervening topography (refer to Figures 9 and 15).
Visual Impact	NOT APPARENT – The Project is not visible for this viewpoint. As a result, there is no visual impact.
Proposed Amelioration	Visual amelioration is not required for this viewpoint.
Residual Impact	NOT APPARENT – As there is no visual impact, amelioration will not have any influence on the level of residual impact.



Figure 14 – VP1 – The landscape of the setting (Source: Google Earth).

ADVERTISED PLAN



Figure 15 – VP1 – View west towards the winery and Project from Parks Road, 90m south of Colliver's Road.

VIEWPOINT 2 – RESIDENCE AT 118 CULLYS ROAD

Photo Location	The driveway to the residence on Cullys Road (refer to Figure 9).
Viewing Distance	150 m to the Project (solar panels) from the residence. 110 m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – highly screened setting (refer to Figures 13 and 16).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	NOT APPARENT – From this viewpoint, the Project will not be visible due to dense vegetation around the residence and along the southern side of the road (refer to Figures 16 and 17).
Visual Impact	NOT APPARENT – The Project is not visible for this viewpoint. As a result, there is no visual impact.
Proposed Amelioration	Visual amelioration is not required for this viewpoint.
Residual Impact	NOT APPARENT – As there is no visual impact, amelioration will not have any influence on the level of residual impact.



Figure 16 – VP2 – The landscape of the setting (Source: Google Earth).

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Figure 17 – VP2 - Views towards the residence from Cullys Road, 20m east of the driveway to the residence. Dense vegetation screens views to the Project.



Figure 18 – VP2 - View towards the Project from the driveway on Cullys Road, southwest of the residence and surrounding vegetation.

VIEWPOINT 3 – RESIDENCE AT 290 PARKS ROAD

Photo Location	The driveway to the residence on Parks Road (refer to Figure 9).
Viewing Distance	1.3km to the Project (solar panels) from the residence. 1.2km to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – minimally screened setting (refer to Figures 13, 19 and 20).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	VERY LOW – From this viewpoint, the Project will be mostly obscured from view by scattered intervening vegetation throughout the landscape and areas of elevated topography (refer to Figures 21). As a result, it is anticipated that the degree of visual modification for this viewpoint will be very low.
Visual Impact	LOW – Given the relative lack of visibility of the Project, resulting in a very low visual modification level, when combined with a high level of sensitivity, the potential visual impact will be low.
Proposed Amelioration	Perimeter screen planting along western and southern Project boundary.
Residual Impact	VERY LOW – Ameliorative planting will further screen views to the Project and reduce the residual visual impact to very low, as it establishes over time.



Figure 19 – VP3 – The landscape of the setting (Source: Google Earth).

ADVERTISED PLAN



Figure 20 – VP3 - Views towards the residence from Parks Road, 110m north of the driveway to the residence.



Figure 21 – VP3 - View towards Project from Parks Road, 110m north of the driveway to the residence.

VIEWPOINT 4 – PARKSIDE WINERY AND RESIDENCE AT 271 PARKS ROAD

Photo Location	Parks Road at the driveway to the winery and residence (refer to Figure 9).
Viewing Distance	1,200m to the Project (solar panels) from the residence. 1,400m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Moderate.
Visual Use Area	Rural residence – Partially screened setting (refer to Figures 13 and 22).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the rural residential use.
Visual Modification	VERY LOW – From this viewpoint, the Project will be obscured from view by vegetation surrounding the residence, as well as intervening scattered vegetation and localised areas of elevated topography (refer to Figures 23 and 24). As a result, it is anticipated that the degree of visual modification for this viewpoint will be very low.
Visual Impact	LOW – Given the lack of visibility of the Project, resulting in a very low visual modification level, when combined with a high level of sensitivity, the potential visual impact will be low.
Proposed Amelioration	Perimeter screen planting along the southern boundary of the Project.
Residual Impact	VERY LOW – Ameliorative planting will further screen views to the Project and reduce the residual visual impact to very low as it establishes over time.



Figure 22 – VP4 - The landscape of the setting (Source: Google Earth).

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Figure 23 – VP4 - Views towards the residence from Cullys Road, 15m to the south of the driveway to the residence.



Figure 24 – VP4 - Views towards the Project from Parks Road, 80m to the north of the driveway to the winery and residence.

VIEWPOINT 5 – RESIDENCE AT 339 BOUNDARY ROAD

Photo Location	The driveway to the residence on Boundary Road (refer to Figure 9).
Viewing Distance	1,700 m to the Project (solar panels) from the residence. 1,690 m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Moderate.
Visual Use Area	Rural residence – minimally screened setting (refer to Figures 13, 25 and 26).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the rural residential use.
Visual Modification	LOW – From this slightly elevated viewpoint, the Project will be visible as a distant thin line between stands of intervening vegetation, backdropped by rising topography (refer to Figure 27).
Visual Impact	MODERATE – Given the partial visibility of the Project, resulting in a low visual modification level, when combined with a high level of sensitivity, the potential visual impact will be moderate.
Proposed Amelioration	Perimeter screen planting along the southern boundary of the Project.
Residual Impact	LOW – Ameliorative planting will further screen views to the Project and reduce the residual visual impact to low as it establishes over time.



Figure 25 – VP5 - The landscape of the setting (Source: Google Earth).

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Figure 26 – VP5 – View south towards the residence from Boundary Road, north of the residence.



Figure 27 – VP5 - Views north towards the Project from Boundary Road, north of the residence.

VIEWPOINT 6 – RESIDENCE AT 68 CULLYS ROAD

Photo Location	From Cullys Road to the north of the residence (refer to Figure 9). The residence is located approximately 400m south of Cullys Road.
Viewing Distance	435m to the Project (solar panels) from the residence. 55m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – partially screened setting (refer to Figures 13, 28 and 29).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the rural residential use.
Visual Modification	MODERATE – From this viewpoint, the southern frontage of the Project to Cullys Road will be visible (refer to Figure 30). As a result, it is anticipated that the degree of visual modification for this viewpoint will be moderate.
Visual Impact	HIGH – Given the extent of visibility of the Project, resulting in a moderate visual modification level, when combined with a high level of sensitivity, the potential visual impact will be high.
Proposed Amelioration	Perimeter screen planting along the Project's southern boundary.
Residual Impact	LOW – Ameliorative planting will screen views to the Project and reduce the residual visual impact to low as it establishes over time.

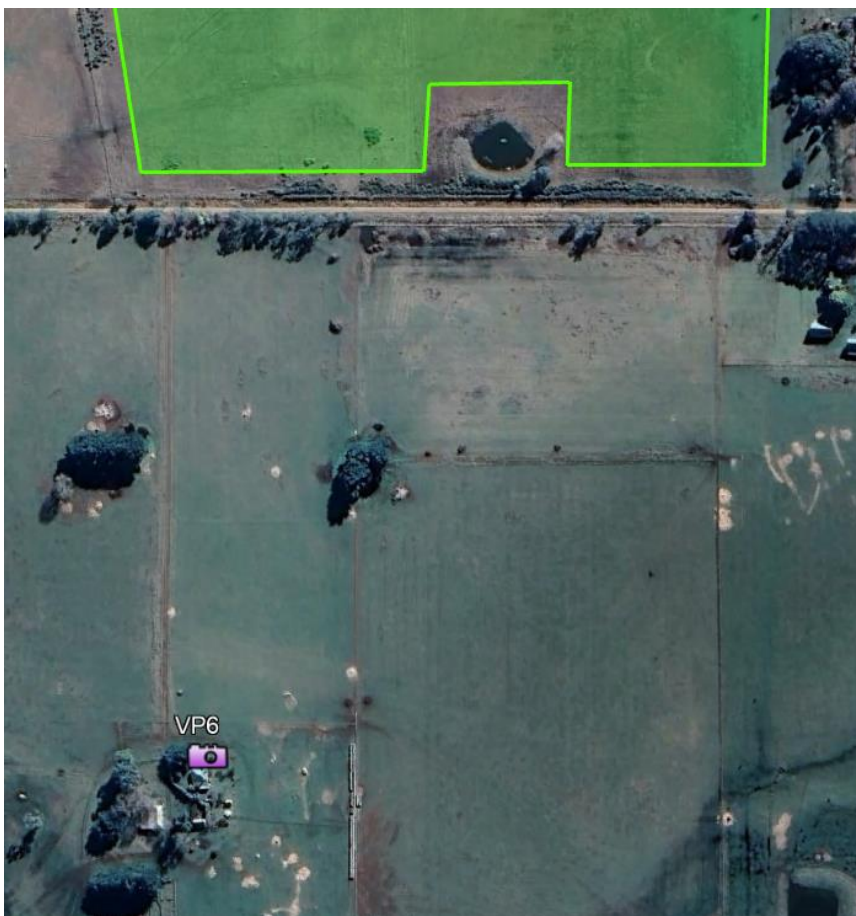


Figure 28 – VP6 - The landscape of the setting (Source: Google Earth).

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Figure 29 – VP6 – View south southwest towards the residence from Cullys Road, 150m east of the driveway to the residence.



Figure 30 – VP6 - View northeast towards the Project from Cullys Road, 150m to the east of the driveway to the residence.

VIEWPOINT 7 – RESIDENCE AT 50 CULLYS ROAD

Photo Location	The driveway to the residence on Cullys Road (refer to Figure 9).
Viewing Distance	265m to the Project (45,000l water tank) from the residence. 185m to the Project (45,000l water tank) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – minimally screened setting (refer to Figures 13, 31 and 32).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the rural residential use.
Visual Modification	MODERATE – From this viewpoint, the western boundary of the Project and limited parts of the southern boundary be visible (refer to Figure 33). As a result, it is anticipated that the degree of visual modification for this viewpoint will be moderate.
Visual Impact	HIGH – Given the extent of visibility of the Project, resulting in a moderate visual modification level, when combined with a high level of sensitivity, the potential visual impact will be high.
Proposed Amelioration	Perimeter screen planting along the Project's western boundary.
Residual Impact	LOW – Ameliorative planting will screen views to the Project and reduce the residual visual impact to low as it establishes over time.



Figure 31 – VP7 - The landscape of the setting (Source: Google Earth).

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Figure 32 – VP7 – View south southwest towards the residence from Cullys Road, 110m east of the driveway to the residence.



Figure 33 – VP7 - View northeast towards the Project from Cullys Road, 110m east of the driveway to the residence



**PROPOSED
DEVELOPMENT**

**DISTANCE TO PROJECT BOUNDARY - 120M
ORIGINAL PHOTO EXTENT - 50MM STANDARD VIEW**

Figure 34 – VP7 – Photo simulation view northeast towards the Project from Cullys Road adjacent to the residence.



Figure 35 – VP7 - Photo simulation view northeast towards the Project from Cullys Road adjacent to the residence with establishing ameliorative vegetation at 5 years.

VIEWPOINT 8 – RESIDENCE AT 351 ROCHFORD ROAD

Photo Location	From Rochford Road to the west of the residence from the driveway entrance (refer to Figure 9).
Viewing Distance	860 m to the Project (solar panels) from the residence. 970 m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – partially screened setting (refer to Figure 13 and 37).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	LOW – From this elevated viewpoint, views to the Project will be filtered by vegetation surrounding the residence (refer to Figure 38). Additionally, the overall field of view occupied will be relatively small. As a result, it is anticipated that the degree of visual modification to the visual setting from this viewpoint will be low.
Visual Impact	MODERATE – Given the low visual modification level, when combined with the high level of sensitivity, the potential visual impact will be moderate.
Proposed Amelioration	Perimeter screen planting along the Project's western and southern boundaries.
Residual Impact	LOW – Ameliorative planting along the Project's western and southern boundaries will reduce the extent of the Project visible, thereby reducing the level of residual impact to low.

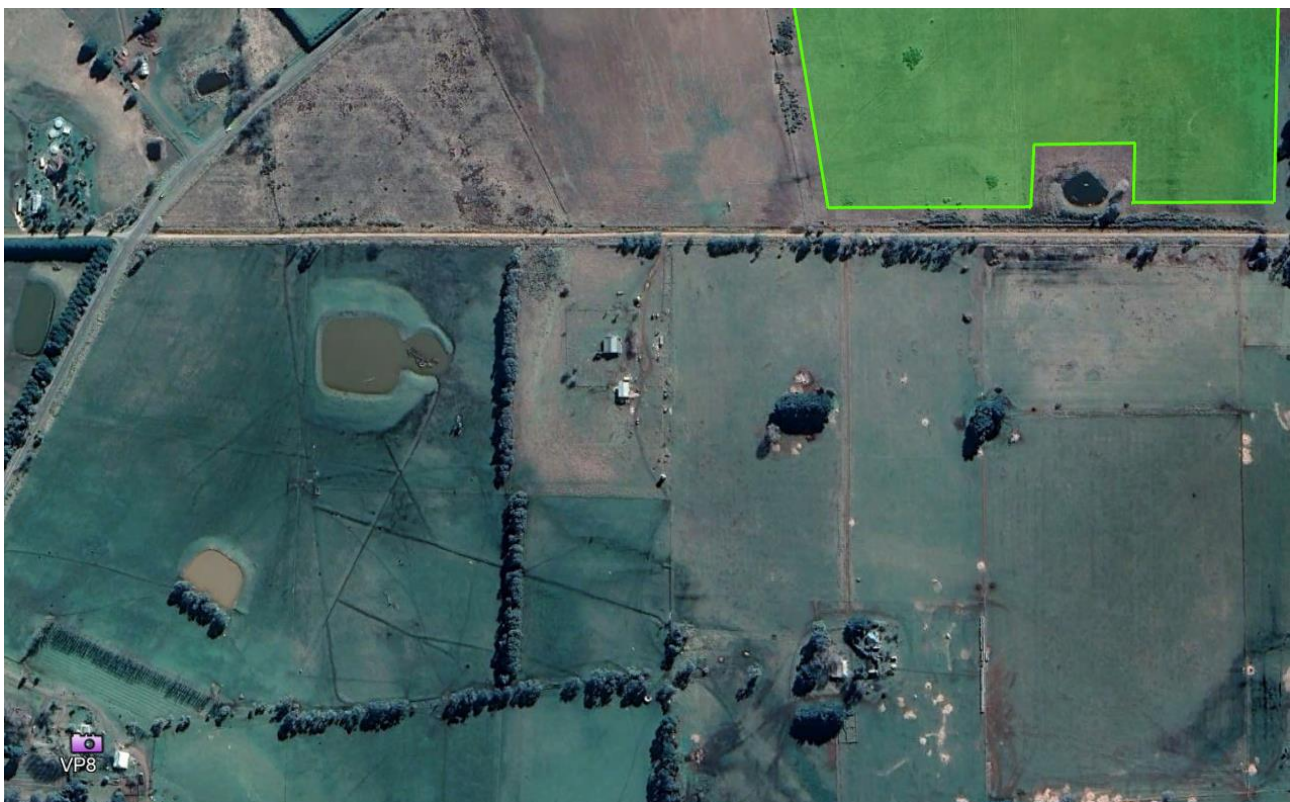


Figure 36 – The landscape setting of VP8 (Source: Google Earth).

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Figure 37 – VP8 – View towards the residence from Rochford Road.



Figure 38 – VP8 – Enlarged view towards the residence from the central part of the Project area showing partial filtering of views by surrounding vegetation.

VIEWPOINT 9 – RESIDENCE AT 51 OTTS LANE

Photo Location	From Otts Lane to the north of the residence (refer to Figure 9).
Viewing Distance	1.2km to the Project (solar panels) from the residence. 1.2km to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – partially screened setting (refer to Figures 13, 39 and 40).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	LOW – From this elevated viewpoint, views to the Project will be partly filtered by vegetation surrounding the residence (refer to Figure 41). Additionally, the overall field of view occupied will be relatively small. As a result, it is anticipated that the degree of visual modification to the visual setting from this viewpoint will be low.
Visual Impact	MODERATE – Given the low visual modification level, when combined with the high level of sensitivity, the potential visual impact will be moderate.
Proposed Amelioration	Tall perimeter screen planting along the Project's western boundary.
Residual Impact	LOW – Ameliorative planting along the Project's western boundary will reduce the extent of the Project visible, thereby reducing the level of residual impact to low.



Figure 39 – The landscape setting of VP9 (Source: Google Earth).

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Figure 40 – VP9 – View towards the residence on Otts Lane.



Figure 41 – VP9 – Enlarged view towards the residence from the central part of the Project area showing partial filtering of views by surrounding vegetation.

VIEWPOINT 10 – RESIDENCE AT 50 OTTS LANE.

Photo Location	The residence is located a significant distance from any publicly accessible point. As a result, no ground-based photography has been taken (refer to Figure 9).
Viewing Distance	1.3km to the Project (solar panels) from the residence.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – partially screened setting (refer to Figure 13 and Figure 42).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	LOW – From this elevated viewpoint, views to the Project will be partly screened by vegetation surrounding the residence (refer to Figure 43). Additionally, the overall field of view occupied will be relatively small. As a result, it is anticipated that the degree of visual modification to the visual setting from this viewpoint will be low.
Visual Impact	MODERATE – Given the low visual modification level, when combined with the high level of sensitivity, the potential visual impact will be moderate.
Proposed Amelioration	Tall perimeter screen planting along the Project's western boundary.
Residual Impact	LOW – Ameliorative planting along the Project's western boundary will reduce the extent of the Project visible, thereby reducing the level of residual impact to low.



Figure 42 – The landscape setting of VP10 (Source: Google Earth).



Figure 43 – VP10 – Enlarged view towards the residence from the central part of the Project area.

VIEWPOINT 11 – RESIDENCE AT 2 OTTS LANE

Photo Location	From Rochford Road to the east of the residence (refer to Figure 9).
Viewing Distance	770m to the Project (solar panels) from the residence. 670m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – Partially screened setting (refer to Figures 13, 44 and 45).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	MODERATE – From this viewpoint, the Project will be partly screened from view by vegetation surrounding the residence (refer to Figures 46 and 47). As a result, it is anticipated that the degree of visual modification for this viewpoint will be moderate.
Visual Impact	HIGH – Given the moderate visual modification level, when combined with a high level of sensitivity, the potential visual impact will be high.
Proposed Amelioration	Perimeter screen planting along the western boundary of the Project.
Residual Impact	LOW – Ameliorative planting will further screen views to the Project and reduce the residual visual impact to very low as it establishes over time (refer to Figure 48 and Figure 49).



Figure 44 – The landscape setting of VP11 (Source: Google Earth).

ADVERTISED PLAN



Figure 45 – VP11 – View toward the residence from Rochford Road.



Figure 46 – VP11 - View towards the Project from Rochford Road, east of the residence.



Figure 47 – VP11 – Photo simulation view west towards the Project from Rochford Road adjacent to the residence.



Figure 48 – VP11 - Photo simulation view west towards the Project from Rochford Road adjacent to the residence with establishing ameliorative vegetation at 5 years.



Figure 49 – VP11 - Photo simulation view west towards the Project from Rochford Road adjacent to the residence with establishing ameliorative vegetation at 10 years.

VIEWPOINT 12 – RESIDENCE AT 252 ROCHFORD ROAD

Photo Location	From the driveway to the residence on Rochford Road (refer to Figure 9). This viewpoint is representative of the adjacent residence to the south at 270 Rochford Road.
Viewing Distance	320m to the Project (solar panels) from the residence. 270m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – highly screened setting (refer to Figures 13, 50 and 51).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	NOT APPARENT – From this viewpoint, the Project will not be visible due to dense vegetation around the residence (refer to Figure 51).
Visual Impact	NOT APPARENT – The Project is not visible for this viewpoint. As a result, there is no visual impact.
Proposed Amelioration	Visual amelioration is not required for this viewpoint.
Residual Impact	NOT APPARENT – As there is no visual impact, amelioration will not have any influence on the level of residual impact.



Figure 50 – The landscape setting of VP12 (Source: Google Earth).

ADVERTISED PLAN



Figure 51 – VP12 – View towards the residence from Rochford Road showing the dense surrounding vegetation.



Figure 52 – VP12 - View towards the Project from Rochford Road opposite the driveway to the residence.

VIEWPOINT 13 – RESIDENCE AT 654 WHITEBRIDGE ROAD

Photo Location	Whitebridge Road at driveway to the residence (refer to Figure 9).
Viewing Distance	585m to the Project (solar panels) from the residence. 630m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – partially screened setting (refer to Figures 13, 53 and 54).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	VERY LOW – From this viewpoint, the Project will be mostly screened by clumps of intervening vegetation throughout the landscape as well as areas of localised elevated topography (refer to Figure 55). As a result, it is anticipated that the degree of visual modification to the visual setting from this viewpoint will be very low.
Visual Impact	VERY LOW – Given the very low visual modification level of the Project within the landscape setting, combined with a low visual sensitivity level, the potential visual impact will be very low.
Proposed Amelioration	Perimeter screen planting to the Project's western boundary.
Residual Impact	VERY LOW – The ameliorative screen planting will have minimal effect on the already low level of visibility.



Figure 53 – The landscape setting of VP13 (Source: Google Earth).

ADVERTISED PLAN



Figure 54 – VP13 - View south towards the residence from Whitebridge Road.



Figure 55 – VP13 - View southeast towards the Project from Whitebridge Road.

VIEWPOINT 14 – GLEN ERIN AT LANCEFIELD - VINEYARD AND ACCOMMODATION

Photo Location	Rochford Road, 130m south of the accommodation wing (refer to Figure 9).
Viewing Distance	480m to the Project (solar panels) from the accommodation wing. 340m to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationery. Frequency: Moderate to high.
Visual Use Area	Tourism and accommodation use – highly screened setting (refer to Figures 13, 56 and 57).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential and tourism uses.
Visual Modification	NOT APPARENT – From this viewpoint, the Project will not be visible due to intervening topography (refer to Figures 9 and 58).
Visual Impact	NOT APPARENT – The Project is not visible for this viewpoint. As a result, there is no visual impact.
Proposed Amelioration	Visual amelioration is not required for this viewpoint.
Residual Impact	NOT APPARENT – As there is no visual impact, amelioration will not have any influence on the level of residual impact.



Figure 56 – VP14 – The landscape of the setting (Source: Google Earth).

ADVERTISED PLAN



Figure 57 – VP14 – View north towards the accommodation wing from Rochford Road.



Figure 58 – VP14 – View south from Rochford Road to the Project.

VIEWPOINT 15 – RESIDENCE ON PARKS ROAD

Photo Location	Parks Road, west northwest of the residence (refer to Figure 9).
Viewing Distance	1.7km to the Project (solar panels) from the residence. 1.4km to the Project (solar panels) from the photo location.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Rural residence – minimally screened setting (refer to Figures 13, 59 and 60).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	VERY LOW – From this viewpoint, the Project will be mostly obscured from view by scattered intervening vegetation throughout the landscape as well as localised areas of elevated topography (refer to Figure 61). As a result, it is anticipated that the degree of visual modification for this viewpoint will be very low.
Visual Impact	LOW – Given the relative lack of visibility of the Project, resulting in a very low visual modification level, when combined with a high level of sensitivity, the potential visual impact will be low.
Proposed Amelioration	Perimeter screen planting along eastern and southern Project boundary.
Residual Impact	VERY LOW – Ameliorative planting will further screen views to the Project and reduce the residual visual impact to very low, as it establishes over time.



Figure 59 – VP15 – The landscape of the setting (Source: Google Earth).

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Figure 60 – VP15 - Views east southeast towards the residence from Parks Road.



Figure 61 – VP15 - View towards Project from Parks Road, 110m north of the driveway to the residence.

VIEWPOINT 16 – OLD ROCHFORD SCHOOL HOUSE ACCOMMODATION

Photo Location	From Rochford Road, 120m to the northwest of the accommodation (refer to Figure 9).
Viewing Distance	1.1km to the Project (solar panels) from the residence.
Duration of View and Frequency of View	Duration: Stationary. Frequency: Low.
Visual Use Area	Tourist accommodation – partially screened setting (refer to Figures 13, 62 and 63).
Visual Sensitivity	HIGH - Sensitivity of users is high based on the residential use.
Visual Modification	LOW – From this elevated viewpoint, views to the Project will be slightly filtered by vegetation surrounding the building (refer to Figure 64). Additionally, the overall field of view occupied will be relatively small the Project, As a result, it is anticipated that the degree of visual modification to the visual setting from this viewpoint will be low.
Visual Impact	MODERATE – Given the low visual modification level, when combined with the high level of sensitivity, the potential visual impact will be moderate.
Proposed Amelioration	Perimeter screen planting along the Project's southern and western boundary.
Residual Impact	LOW – Ameliorative planting along the Project's southern and western boundaries will reduce the extent of the Project visible, thereby reducing the level of residual impact to low.



Figure 62 – VP16 – The landscape of the setting (Source: Google Earth).

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Figure 63 – VP16 - View southeast towards the residence from Rochford Road.



Figure 64 – VP16 - View southwest towards the accommodation from the central part of the Project area.

4.3.4. Lighting impacts

The applicable environmental lighting zone for the Project area based on the ILE guidelines is Category E2³, which is a low district lighting area, which applies to rural residential areas and areas with secondary and local roads.

Within the Category E2 area the Project does not result in an increased lighting impact due to there being no requirement for operational lighting.

Some components may have external security lights. However, these are only used for urgent maintenance works during hours of darkness and are not permanently illuminated.

4.3.5. Glare and glint impacts

A Glint & Glare assessment has been prepared by Moir Landscape Architects (refer to **Appendix B**). The purpose of the report was to identify potential glint and glare impacts from the Project on the surrounding residential receptors (within 1,000 m of the Project), Road and Rail Receptors (within 1,000 m of the Project) and aviation receptors (within 5,000 m of the Project).

The potential to experience glint and glare was assessed for 2 dwelling receptors (OP02, and OP03) (refer to **Figure 65**). The assessment found that both of these dwelling receptors could potentially experience high annual 'Yellow' glare from the Project under the worst-case scenario simulated (0° resting angle). However, desktop analysis of the dwellings using aerial imagery indicates existing vegetation surrounding OP02 and OP03 will likely filter the potential glare experienced at these locations.

Under the worst-case scenario (0° resting angle) the assessment of road receptors identified that Cullys Road will potentially experience high 'Yellow Glare' from the Project. Desktop assessment of the aerial imagery indicates a lack of existing vegetation along the Project side of Cullys Road that may mitigate glare.

Further assessment of the scenarios with resting angles of 22° and 45° indicated no glare at the public and private receptors. Using a resting angle of 5° provided a significant reduction in 'Yellow' glare along Cullys Road.

Based on the assessment, setting the resting angle of the solar panels to 22° or 45° is recommended. This would eliminate all predicted glare from all assessed sensitive receptors within 1,000m of the Project.

As an additional mitigation action, supplementary planting along the southern and south eastern perimeter of the Project will likely assist in reducing potential glare to acceptable level for users of Cullys Road.

³ Guidance Notes for the reduction of Obtrusive Light GN01, Institution of Lighting Engineers (UK) (2005).

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5. AMELIORATION STRATEGIES

Actions exist to potentially ameliorate the landscape and visual impacts of the Project. These are outlined in the following sections.

5.1. ON-SITE ACTIONS

On-site actions relate to initiatives which can be undertaken within the boundaries of the Project area (refer to the *Landscape Plans*).

5.1.1. Perimeter screen planting

The most effective way to ameliorate views from high sensitivity viewpoints is to establish screen planting around the perimeter of the Project. The Project has exposed boundaries to the south and west which could potentially be planted with screening species to ameliorate views. Given the elevation of viewpoints to the southwest and west, the screen planting should include tall trees to reduce opportunities for overlooking.

A 2.3m high chain mesh security fence will be installed 5m inside the perimeter of the Project boundary. The 5m offset outside of the security fence will allow for screen planting.

Screen planting along the southern boundary will mitigate impacts to VP6 and VP7. Screen planting along the western boundary will mitigate impacts to VP11 and vehicles on Rochford Road.

The low-profile form of the majority of the Project, primarily the solar array, which is approximately 5 m in height at full tilt, will ensure that planting will be able to provide screening within a relatively short period of time.

5.1.2. Material selection

Although the majority of the Project is of a low profile, with a reflective finish through necessity, taller elements such as transformers and switching substations should be clad with non-reflective materials and be finished in a natural or neutral colour, as found in the landscape of the setting.

5.2. OFF-SITE ACTIONS

These actions relate to initiatives which can be undertaken outside of the project area and would require the consent of relevant landowners, utilities or authorities. However, the assessment has found that all required amelioration can be achieved on the Project site, and no off-site actions are required.

5.2.1. Powerlines

All powerlines for this site are proposed to be trenched. There are no overhead powerlines being proposed for this site.

6. CONCLUSION

6.1. LANDSCAPE CHARACTER IMPACTS

Although the Project results in a significantly different landscape character from the existing setting when viewed from the air, its low profile will ensure that from ground-based viewing locations, only localised changes to the landscape character will result.

The most visible changes to the landscape character of the existing setting will result to views from three adjacent residences. However, following amelioration, comprised of the establishment of locally indigenous screening vegetation along the Project boundaries, the landscape character will appear similar to the remainder of the regional agricultural landscape and other bands of vegetation that occur through the landscape of the region.

The landscape of the Project setting has a moderate landscape absorptive capacity, as despite providing some opportunities for overlooking, the undulating topography also provides visual screening. The scattered, and occasionally dense vegetation in the area surrounding the Project also provides visual screening, with the effectiveness of intervening vegetation screening, increasing with distance from the Project.

6.2. VISUAL IMPACTS

Prior to amelioration, three sensitive uses proximate to the Project will result in high levels of impact. These are:

- VP6 – Residence south of Culleys Road – High visual impact.
- VP7 – Residence south of Culleys Road - High visual impact.
- VP11 – Residence west of Rochford Road – High visual impact.

Apart from the above, overall, the Project is assessed as having either a low level of visual impact, or not being visible from surrounding sensitive viewpoints, primarily due to the limited number of sensitive viewpoints and the relative lack of visibility resulting from existing vegetation throughout the landscape and rising topography. The residual visual impact will typically reduce to very low after the establishment of amelioration measures.

6.3. LIGHTING IMPACTS

Within the Category E2 environmental lighting zone the Project does not result in an increased lighting impact due to there being no requirement for operational lighting. Therefore, the lighting impacts are considered low.

6.4. REFLECTION AND GLARE IMPACTS

Given the tilting solar panels with the ability to control the angle of tilt/stow, the potential for impact resulting from reflection or glare is considered to be low. Additionally, proposed screen planting along the southern and south eastern perimeter of the Project will further mitigate any impacts to Cullys Road.

DISCLAIMER

This report is dated 5TH December 2022 and incorporates information and events up to that date only and excludes any information arising, or event occurring, after that date which may affect the validity of Urbis Pty Ltd's (**Urbis**) opinion in this report. Urbis prepared this report on the instructions, and for the benefit only, of BNRG (**Instructing Party**) for the purpose of a Development Application (**Purpose**) and not for any other purpose or use. To the extent permitted by applicable law, Urbis expressly disclaims all liability, whether direct or indirect, to the Instructing Party which relies or purports to rely on this report for any purpose other than the Purpose, and to any other person which relies or purports to rely on this report for any purpose whatsoever (including the Purpose).

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This report has been prepared with due care and diligence by Urbis and the statements and opinions given by Urbis in this report are given in good faith and in the reasonable belief that they are correct and not misleading, subject to the limitations above.

APPENDIX A PHOTOSIMULATIONS

LANCEFIELD SOLAR FARM

VISUAL ASSESSMENT | PHOTOMONTAGES

PREPARED FOR

BNRG

NOVEMBER 2022





ORIGINAL PHOTO EXTENT - 50MM STANDARD VIEW



LANCEFIELD SOLAR FARM - VISUAL ASSESSMENT
VP7 : (PHOTO 7253) LOOKING ENE FROM CULLYS ROAD | EXISTING PHOTO : 2022-10-25 10:40 AEDT

**ADVERTISED
PLAN**

DATE: 2022-11-29
JOB NO: P0034444
DWG NO: VP_7A
REV: -



**PROPOSED
DEVELOPMENT**

**DISTANCE TO PROJECT BOUNDARY - 120M
ORIGINAL PHOTO EXTENT - 50MM STANDARD VIEW**



LANCEFIELD SOLAR FARM - VISUAL ASSESSMENT
VP7 : (PHOTO 7253) LOOKING ENE FROM CULLYS ROAD | PROPOSED DEVELOPMENT

**ADVERTISED
PLAN**

DATE: 2022-11-29
JOB NO: P0034444
DWG NO: VP_7C
REV: -

**ADVERTISED
PLAN**

**PROPOSED
DEVELOPMENT**

**DISTANCE TO PROJECT BOUNDARY - 120M
ORIGINAL PHOTO EXTENT - 50MM STANDARD VIEW**



LANCEFIELD SOLAR FARM - VISUAL ASSESSMENT

VP7 : (PHOTO 7253) LOOKING ENE FROM CULLYS ROAD | PROPOSED DEVELOPMENT WITH VEGETATION AT 5 YEARS GROWTH

DATE: 2022-11-29
JOB NO: P0034444
DWG NO: VP_7D
REV: -



ORIGINAL PHOTO EXTENT - 50MM STANDARD VIEW





**ADVERTISED
PLAN**

**PROPOSED
DEVELOPMENT**

**DISTANCE TO PROJECT BOUNDARY - 630M
ORIGINAL PHOTO EXTENT - 50MM STANDARD VIEW**



LANCEFIELD SOLAR FARM - VISUAL ASSESSMENT

VP11 : (PHOTO 7304) LOOKING ENE ACROSS ROCHFORD ROAD | PROPOSED DEVELOPMENT WITH VEGETATION AT 5 YEARS GROWTH

DATE: 2022-11-29
JOB NO: P0034444
DWG NO: VP_11D
REV: -

**ADVERTISED
PLAN**

**PROPOSED
DEVELOPMENT**

**DISTANCE TO PROJECT BOUNDARY - 630M
ORIGINAL PHOTO EXTENT - 50MM STANDARD VIEW**



LANCEFIELD SOLAR FARM - VISUAL ASSESSMENT

VP11 : (PHOTO 7304) LOOKING ENE ACROSS ROCHFORD ROAD | PROPOSED DEVELOPMENT WITH VEGETATION AT 10 YEARS GROWTH

DATE: 2022-11-29
JOB NO: P0034444
DWG NO: VP_11E
REV: -

APPENDIX B GLINT AND GLARE ANALYSIS

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moir
landscape architecture

Lancefield Solar Farm

Glint and Glare Assessment

Lancefield Solar Farm

Glint and Glare Assessment

Prepared for
BNRG Leeson

Issue
03

Date
22.11.2022

Project Number
2237

Revision	Date	Author	Checked	Comment
01	06.10.2022	RR	SW	WIP for review
02	11.11.2022	RR	SW	Revised Report
03	22.11.2022	RR	SW	Revised Report



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Moir Landscape Architecture (Moir LA) have been engaged by BNRG Leeson to provide a glint and glare assessment of the proposed Lancefield Solar Farm (the Project). The report will accompany the Environmental Impact Statement (EIS) prepared for the Project.

The Project is located along Rochford Road 2.65km northeast of Rochford and 3.5km southwest of the town of Lancefield in the Local Government Area of Macedon Ranges (refer to Figure 1). The subject land is approximately 11.69ha in area and is identified as Lot 1TP168495 and Lot 1LP90207, 313 Collivers Road Lancefield 3435.

The Glint and Glare Assessment has been prepared in accordance with the '*State of Victoria Department of Environment, Land, Water and Planning 2019: Solar Energy Facilities Design and Development Guidelines*' (the Guidelines).

In accordance with the Guidelines, the following has been assessed:

- Assessment of residential dwellings within 1 km of the proposed solar array that have a line of sight.
- All roads and rail lines within 1 km of the proposed solar array
- Aviation receptors within 5km of the proposed solar array.

Moir LA have undertaken this glint and glare assessment utilising the Solar Glare Hazard Analysis Tool (SGHAT). The SGHAT is used to evaluate glare resulting from solar farms at different receptors, based on proximity, orientation and specifications of the PV modules.

Glare modelling has been conducted to include both maximum and minimum tracker height to

provide a wider range of observed solar glare based on extremities. 'Shade-slope' backtracking function has been considered to simulate panels returning to a predefined angle after the maximum tilt angle has been attained.

A total of 15 free standing dwellings were identified within 1 km of the Project.

Of the 15 non-involved dwellings assessed, three (3) dwellings were identified as having potential to experience less than 10 hours of glare per year.

Five (5) route receptors were identified as part of the assessment. Based on glare assessment one (1) routes have the potential to experience more than 30 hours of glare per annum from the Project.

It is important to reiterate the assessment is based on a worst case scenario and does not take into account weather conditions, intervening elements such as vegetation and built structures.

Principles for mitigation to reduce potential glare have been included in this report in accordance with the Solar Energy Facilities Design and Development Guideline (DELWP) .

1.0 Introduction

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1.1 The purpose of this report

Moir Landscape Architecture (Moir LA) have been engaged by BNRG Leeson to provide a glint and glare assessment of the Project. The report will accompany the planning permit application prepared for the Project.

The Glint and Glare Assessment has been prepared in accordance with the Guidelines.

Glint is generally defined as a momentary flash of bright light while glare can be defined as continuous source of excessive brightness proportionate to ambient lighting (FAA, 2021).

While glint and glare impacts can be relatively uncommon, it is important to model and assess these impacts to ensure any potential significant impact is avoided or mitigated appropriately (DELWP 2019). Assessment needs to be undertaken to ensure that sensitive visual receptors such as road users, surrounding rail network, nearby buildings, air traffic controllers and pilots are not impacted by the proposed development (ForgeSolar, 2022).

1.2 Glint and glare key principles

The key principles for ensuring the Project can be undertaken whilst maintaining an acceptable level of amenity are outlined in the Guideline as follows:

- 1. Solar panels and associated buildings and infrastructure should be sited to reduce the likely impacts of glint and glare.**
- 2. Solar panels and other infrastructure should be constructed of materials and / or treated to minimise glint and glare.**
- 3. Solar Panels and associated buildings should be adjusted to avoid relative glare risks.**
- 4. If large scale solar energy development is likely to exceed the relevant criteria for glare and standards for glint, mitigation strategies should be adopted.**

1.3 Assessment requirements

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Table 1 provides an outline of the assessment requirements for the glint and glare report and where these have been addressed in the report.

Report Structure

Requirements for Glint and Glare Assessment:

Addressed in report:

A description of the proposed PV panels indicating:

- the axis of rotation and maximum tilt angle
- the light absorption efficiency and / or refractive index values at different angles.
- whether any backtracking is proposed and the time and duration of these operations.

Refer to:

Section 3.0: Project Overview

Results of the glint and glare analysis for each assessable receiver

Refer to:

Section 4.0: Residential Receptors

Section 5.0: Road and Rail Receptors

Section 6.0: Aviation Receptors

Identification of existing vegetation or built structures and a quantitative assessment of whether these features would eliminate or reduce the modelled impacts.

Refer to Summary Tables

A justification for excluding any modelled glare results because they would be insignificant due to the size, position and luminance of the glare source or high ambient luminance.

Section 2.2

Details of strategies to either avoid or mitigate impacts including re-siting or sizing the project, altering the tracking patterns, implementing vegetation screening, or entering neighbour agreements with landowners if all other measures have been exhausted.

Refer to:

Section 8.0: Mitigation Recommendations

Table 1 Overview of Report Structure

2.0 Study Method

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2.1 Overview of Study Method

The Glint and Glare Assessment has been prepared in accordance with the Guideline developed by DELWP 2019. The objective of the assessment to demonstrate that glint and glare would not pose a significant risk to road and route and aviation receptors and that nuisance from glare is minimised for residential locations in accordance with the objectives outlines in the Guidelines.



Refer to Section 4.0 Residential Receptors

Assess all residential dwellings within 1 km of the proposed solar array that have a line of sight.



Refer to Section 5.0 Road and Rail Receptors

Assess all roads and rail lines within 1 km of the proposed solar array.



Refer to Section 6.0 Aviation Receptors

Assess all air traffic control towers and take off / landing approaches to any runway or landing strip within 5 km of the proposed solar array.



Refer to Section 7.0 Performance Objectives

Summary of the assessment with reference to performance objectives.



Refer to Section 8.0 Mitigation Recommendations

Overview of proposed strategies to either avoid or mitigate impacts.

2.2 Assessment Methodology

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Moir LA have undertaken this glint and glare assessment utilising SGHAT developed by Sandia National Laboratories. The SGHAT is used to evaluate glare resulting from solar farms at different receptors, based on proximity, orientation and specifications of the PV modules. This tool is recognised by the Australian Government Civil Aviation Safety Authority (CASA).

SGHAT is used to indicate the nature of glare that can be expected at each potential receptor. Glare can be broadly classified into three categories and presented by the following three colours:

- **Green Glare:** Low potential for temporary after-image
- **Yellow Glare:** Potential for temporary after-image
- **Red Glare:** Retinal burn, not expected for PV.

Note: The main focus of this assessment is the yellow glare. Red glare is not expected for PV and green glare is low potential to cause after image and deemed negligible. (HO,2011)

The glare analysis tool used to assess the glint and glare hazard was run at a simulation interval of one minute, based on the reflectivity of solar rays off PV modules which typically lasts for at least one minute.

Modelling for the solar farms in the SGHAT tool is based on the following factors:

- Position of the sun over time with respect to the location of the proposed solar farm.
- Assessment is based on a worst case scenario assuming clear weather all year round, (ie. no consideration of cloud coverage).
- Tracking axis tilt, tracking axis orientation and properties of the PV modules.
- Potential to screen the impact by surrounding topography.

2.3 Modelling Assumptions

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The glare and glint impact is calculated utilising the geographic location, elevation, position of the sun and other vector calculations including module orientation, reflective environment and visual factors. Sun position is determined at every one (1) minute interval through out the year.

Although the SGHAT is an extensive tool to understand the impacts of potential glare, it does not consider weather conditions, separation between PV modules and existing surrounding vegetation (if present) between the Project and a sensitive receiver.

Single axis tracking PV panels capable of rotating to a maximum of 60° have been considered for this analysis. The trackers are oriented north south with a maximum pitch distance of 6.6 metres. Glare modelling has been conducted to correspond to both maximum and minimum tracker height to provide a wider range of observed solar glare based on the extremities.

The glint and glare effects of PV panels depends on the scale and type of infrastructure, the prominence and topography of the site relative to the surrounding environment, and any proposed screening measures to reduce visibility of the site.

Glare modelling has been conducted using the Shade-slope backtracking function within the SGHAT tool. Ground Coverage Ratio (GCR) calculations are used within the SGHAT tool for 'Shade-Slope' backtracking analysis. GCR is defined as the ratio of the array length (L) to proposed pitch distance (R) (Doubleday et al. 2016).

$$\text{GCR} = \frac{L}{R} .$$

For this assessment GCR is calculated considering L = 4.992m and R = 6.6m. The resulting GCR = 0.75

Section 3.0 provides an overview of the PV panel parameters used for the assessment.

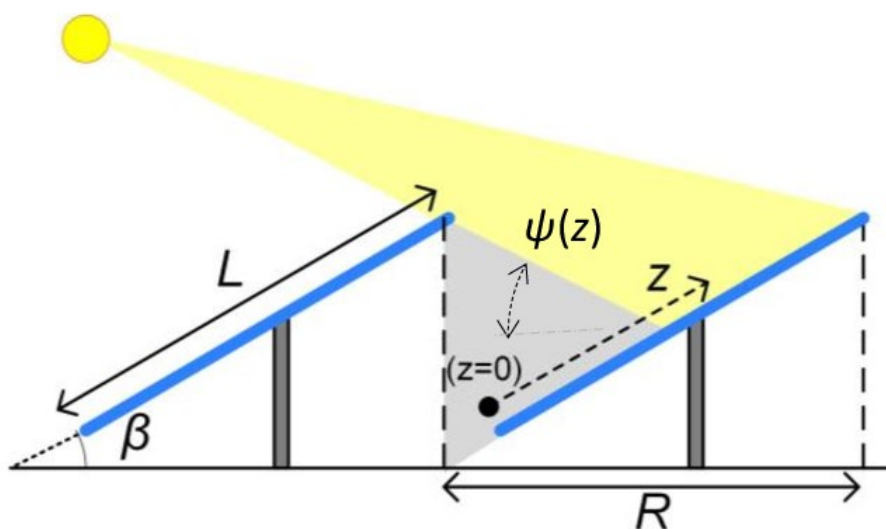


Image 01 Ground Coverage Ratio Calculations (Doubleday et al. 2016)

2.4 Backtracking Operations

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A single axis horizontal tracking system can be configured to do a 'backtracking' technique, which implies that when the sun is low in the sky in the morning or evening, the tracking system can adjust the panels to maximise solar capture while minimising overshadowing.

ForgeSolar uses a simplified model of backtracking. Single-axis trackers follow the movement of the sun as it moves east to west throughout the day. Yields are maximized, and light reflection is minimised when panels are directly facing the sun. In times when the sun is not in the tracking range, we assume that the panels instantaneously revert to their resting angle of 0° . Due to this, glare from the backtracking mechanism will be more conservatively simulated and at times of sunset and sunrise, when the sun is at a lower angle relative to the array, glare impacts will be more noticeable.

Variable angles of incidence of the sun relative to the panels may occur when the tracking system is performing a backtracking operation, and this variation is somewhat represented by SGHAT software in its recent update of 2022.

Shade-slope backtracking function within the SGHAT tool considers the lowest possible panel rotation angle during backtracking. Therefore, using 0° resting angle option is modelled to determine backtracking operations. This function simulates the impression of the panels returning to a predefined angle after the maximum tilt angle has been attained.

It is important to note that this backtracking modelling is not a realistic representation of how a backtracking technique would work in actuality but on the other hand, gives some idea of the potential glare consequences of shifting the PV panels away from the sun after the maximum tilt is reached.

The following parameters have been considered to simulate a typical backtracking process for the proposed development:

- A maximum tracking angle of 60° is considered to indicate a full rotational range of 120° .
- To simulate 'backtracking', 'resting angle' determined as 0° , assuming the PV modules move directly to 0° once maximum tilt of 60° is reached and represents a worst case scenario.
- To simulate glare experienced mid tracking an angle of 45° and 22° is considered assuming the PV modules move from the resting angle prior to arriving at the stowing angle.
- Night time angle (stowing angle after dark) of 5° is considered assuming the PV modules move directly to 5° once maximum tilt of 60° is reached and represents a worst case scenario.

3.0 Project Overview

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3.1 Site Context

The Project is located along Rochford Road 2.65km northeast of Rochford and 3.5km south west of the town of Lancefield in the Local Government Area of Macedon Ranges (refer to Figure 1). The subject land approximately measures 11.69ha in area and is identified as Lot 1TP168495 and Lot 1LP90207, 313 Collivers Road Lancefield 3435.

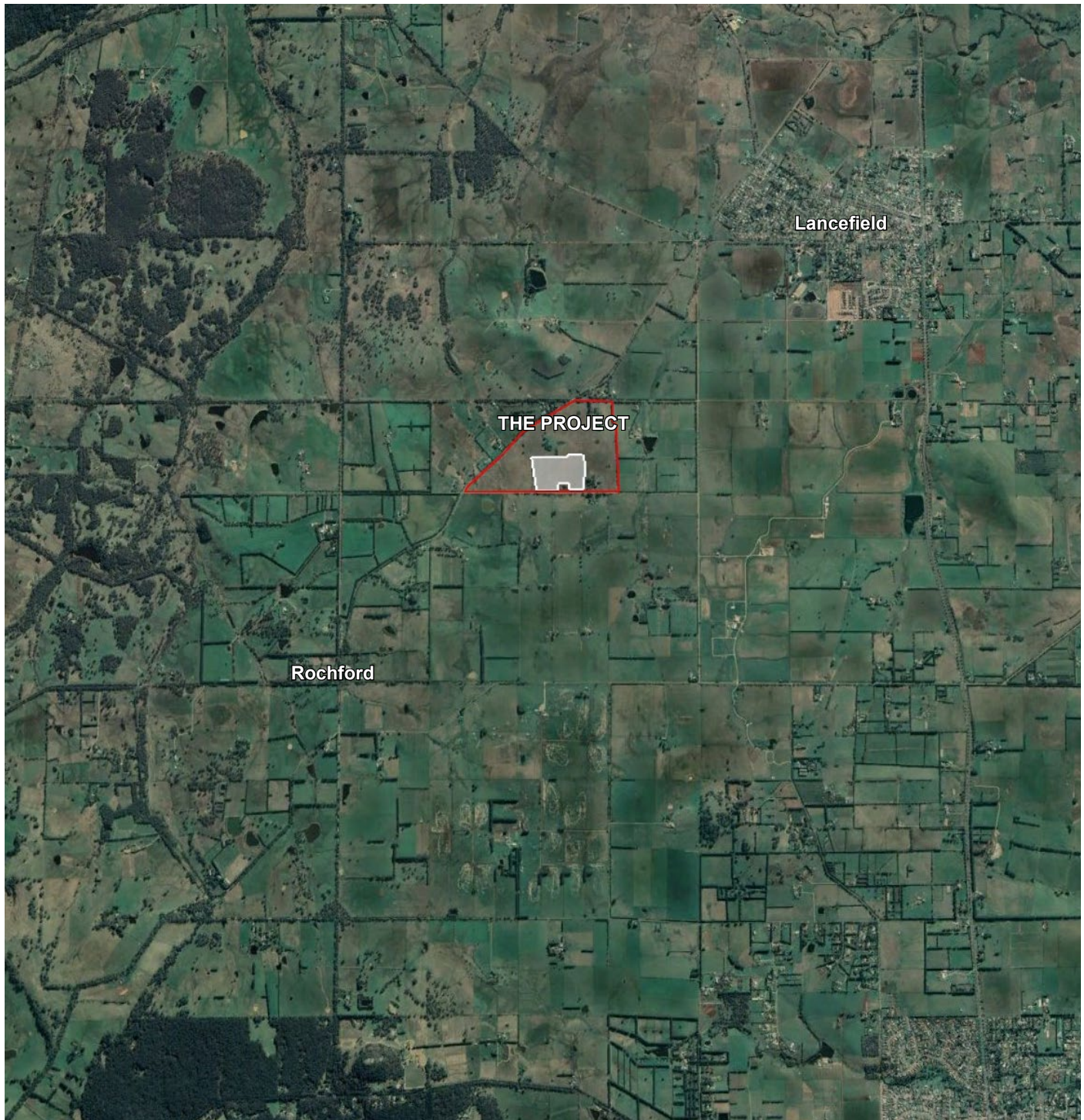


Figure 1 Project Site Context (Map Source: Google Earth, 2021)

3.2 Solar Panel Specifications

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Each module consists of P type Mono-crystalline cell type with a 2.0 mm, anti-reflection coated semi-tempered glass set in an anodised aluminium alloy frame (Suzhou Talesun Solar Technologies Co., Ltd. 2021).

To attain optimum solar energy collection, the project modelling has utilised a maximum rotational range of 120° . The panels are fixed on a tubular frame with a single axis tracking procedure. For accuracy, Glare analysis has been performed using minimum tracker height of 2.484m and maximum tracker height not exceeding 2.987m when facing at the highest angle

Refer to **Figure 2** for typical panel dimensions utilised for this assessment.

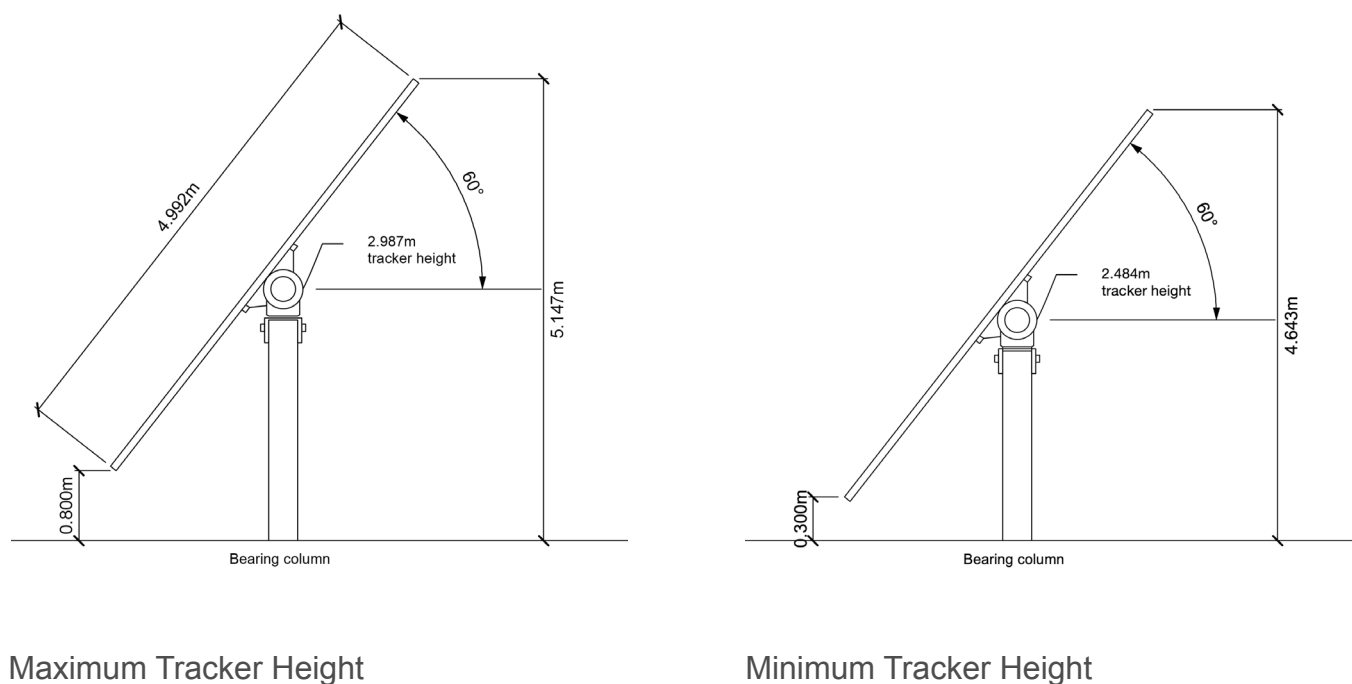


Figure 2 PV Parameters utilised for this assessment (provided by client)

General Solar PV system inputs:

Input Data	Units	Value	Comments
Time Zone	UTC	+10	VIC time Zone
Orientation of Array	Degrees	0	Rows aligned in north-south directions
PV Surface materials	-	Smooth Glass with Anti-Reflective Coating	Provided by the Client
Mounting Type	-	Single Axis Tracking	As per tracker data sheet

Single Axis Tracking Parameters

Axis Orientation	Degrees	0	Panels orientated north south
Module Offset angle	Degrees	0	Facing upwards Panels rotate during operation
Max tracking angle	Degrees	±60° (Range of 120°)	Panels following the Sun
Resting angle	Degrees	0°, 5°, 22° and 45°	Panels following the Sun, to represent backtracking and after dark stowing angles
Maximum Tracker Height	Metres	2.987	Provided by the Client
Minimum Tracker Height	Metres	2.48	Provided by the Client
Backtracking	-	Shade-Slope	Provided by the Client
Ground Coverage Ratio	-	0.76	Ratio of the Array length to the pitch distance as provided by the Client.

Table 2. Summary of modelling parameters**ADVERTISED
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3.3 Array layout

A single axis tracking system follows the sun's trajectory and rotates the panels across east to west. There will be an estimated 11,200 modules mounted on a north/south axis to slowly track movement of the sun. The rows of modules will be spaced approximately 6.6m apart to ensure no shading occurs and allows for ease of access for maintenance purposes.

Refer **Figure 3** for PV array areas.



Figure 3 PV Array Areas (Map Source: Google Maps, 2021)

4.0 Residential Receptors

4.1 Overview of methodology

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Table 4 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on residential receptors

Glint and Glare Requirements - Residential Receivers		
Scope	Methodology	Performance Objective
All residential viewpoints within 1km of the proposed solar array that have a line of sight.	Analysis of the daily and yearly glare impacts in minutes.	If glare is geometrically possible then measures should be taken to eliminate or reduce to an acceptable level, the occurrence of glare through design, orientation, landscaping or other screening measures
Representative viewpoints may be used for residential receivers that are clustered together.	All residential receivers must be assessed at a height of 1.5 m above ground level.	
Note: Modeling for residential receptors is calculated on a receptor height of 1.5 m AGL.		

Table 4. Residential Receptors Assessment Requirements (DELWP 2019)

Impact rating and performance objectives for glare impacts to residential dwellings			
Major Impact	Moderate Impact	Low Impact	No Impact
<i>Significant amount of glare that should be avoided</i>	<i>Implement mitigation measures to reduce impacts as far as practicable</i>	<i>No mitigation required</i>	<i>No mitigation required</i>

Table 5. Residential receptor impact rating and performance objectives (DELWP 2019)

4.2 Residential Receptors

A desktop assessment determined 15 free standing Observation Point (OP) receptors with a line of sight to the project within 1,000 m of the Project. (Refer to Figure 4 and Table 6)



Figure 4 Residential Receptors (Map Source: Google Maps, 2021)

Dwelling	Location	Elevation	Distance to the nearest solar panel	Yellow Glare (Hours Per Year):		Recommended Mitigation Measures
				Maximum Tracker Height	Minimum Tracker Height	
OP 01	68 Cullys Road Lancefield 3435	534m	0.43km	0	0	Not Required.
OP 02	118 Cullys Road Lancefield 3435	538m	0.14km	23.5	33.8	Existing vegetation and additional supplementary planting along southern boundary of the Project will likely filter the impact.
OP 03	117 Cullys Road Lancefield 3435	541m	0.08km	58.2	94.1	Existing vegetation and additional supplementary planting along eastern boundary of the Project will likely reduce the impact.
OP 04	50 Cullys Road Rochford 3442	530m	0.10km	0	0	Not Required.
OP 05	351 Rochford Road Rochford 3442	563m	0.91km	0	0	Not Required.
OP 06	2 Otts Lane Lancefield 3435	532m	0.74km	0	0	Not Required.
OP 07	Rochford Road Lancefield 3435	529m	0.70km	0	0	Not Required.
OP 08	270 Rochford Road Lancefield 3435	532m	0.44km	0	0	Not Required.
OP 09	252 Rochford Road Lancefield 3435	525m	0.33km	0	0	Not Required.
OP 10	654 Whitebridge Road Lancefield 3435	526m	0.54km	0	0	Not Required.
OP 11	200 Rochford Road Lancefield 3435	534m	0.42km	0	0	Not Required.
OP 12	300 Collivers Road Lancefield 3435	528m	0.56km	0	0	Not Required.
OP 13	115 Rochford Road Lancefield 3435	521m	0.62km	0	0	Not Required.
OP 14	263 Collivers Road Lancefield 3435	512m	0.64km	0	0	Not Required.
OP 15	263 Collivers Road Lancefield 3435	516m	0.53km	0	0	Not Required.

Table 6. Residential receptor assessment results

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Based on the desktop assessment two (2) dwellings will experience potential glare more than 30 hours per year.

Desktop analysis of the dwellings using aerial imagery along indicates existing vegetation surrounding OP02 and OP03 will likely reduce the potential glare experienced from the Project.

Assessment of the outputs with maximum tracker height indicates OP02 will experience potential 'Yellow' glare from mid April to very early September between 16:10 pm - 17:50 pm from the Project for about 23.5 hours per year.

Additionally, assessment of the output with minimum tracker height indicates OP02 will experience potential 'Yellow' glare from early April to early September approximately between 16:10m - 18:00pm from the Project for about 33.8 hours per year.

Assessment of the outputs with maximum tracker height indicates OP03 will experience potential 'Yellow' glare from early January to November between 16:10 pm - 19:50 pm from the Project for about 58.2 hours per year.

Similarly, assessment of the output for the same receptor (OP3), with minimum tracker height, indicates potential 'Yellow' glare experienced almost everyday from January to December approximately between 16:10m - 19:50pm from the Project for about 94.1 hours per year.

Existing vegetation surrounding the dwelling will likely help in reducing potential glare experienced at these locations. Mitigation measures in the form of proposed vegetation along the eastern and southern boundary of the Project will likely filter potential glare at these locations.

The time of day glare likely to be experienced is provided for each receptor in **Appendix A**.

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5.0 Road and Rail Receptors

5.1 Overview of Methodology

Table 7 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on road and railway line receptors.

Glint and Glare Requirements - Road & Rail		
Scope	Methodology	Performance Objective
All roads and rail lines within 1 km of the proposed solar array.	Solar glare analysis to identify whether glint and glare are geometrically possible within the forward looking eyeline of motorists and rail operators.	If glare is geometrically possible then measures should be taken to eliminate the occurrence of glare. Alternatively, the applicant must demonstrate that glare would not significantly impede the safe operation of vehicles or the interpretation of signals and signage.
<p>Note: Modeling for road receptors is calculated on a maximum height of 2.4 m AGL - representative of the eye level for truck drivers (Source: Austroads Ltd. 2021).</p> <p>Modeling for rail lines is based a representative eye height of 3 m AGL to represent the eye level of train drivers (Source: Transport Asset Standards Authority 2020).</p>		

Table 7. Road and Rail Receptor Assessment Requirements (DELWP 2019)

5.2 Road and Rail Receptors

A desktop assessment determined no rail lines located within 1 km of the Project. A total of 5 road receptors were identified within 1 km of the development footprint. These have been shown on Figure 5.

- Collivers Road
- Cullys Road
- Otts Lane
- Rochford Road
- Whitebridge Road



Figure 5 Rail Line and Road Receptors (Map Source: Google Maps, 2021)

5.3 Results of Glint and Glare Assessment - Road and Rail

5 route receptors were identified as part of the assessment. Based on glare assessment 3 routes will experience 'Yellow' glare from the Project. **Table 8** provides an overview of the annual glare experienced along the 5 routes.

Detailed glare impact outputs for each route is provided in **Appendix A**.

Road / Rail Receptor:	Approximate Distance to the Project:	Elevation:	Yellow Glare (Hours Per Year):		Existing screening factors:	Mitigation Recommendations:
			Maximum Tracker Height	Minimum Tracker Height		
Collivers Road	0.49km	514m	0	0	Not Required.	Not Required.
Cullys Road	0.01km	532m	201.4	232.2	A desktop assessment identified no existing vegetation along the road.	Additional screen planting along the southern boundary of the Project.
Otts Lane	0.69km	540m	0	0	Not Required.	Not Required.
Rochford Road	0.21km	545m	0	0	Not Required.	Not Required.
Whitebridge Road	0.50km	530m	0	0	Not Required.	Not Required.

Table 8. Road & Rail receptor assessment results

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Based on the desktop assessment one (1) road receptor will experience potential glare exceeding 30 hours per year.

Assessment of the outputs with minimum tracker height indicates Cullys Road to experience approximately 232.32 hours per year potential 'Yellow' glare from mid April to mid August between 06:50 am- 08:20 am and from mid March to very late September between 15:10 pm - 18:30 pm from the Project.

Similarly, assessment of the output with maximum tracker height indicates Cullys Road will experience potential annual 'Yellow' glare of approximately 201.4 hours from late April to mid August between 07:00 am- 08:15 am and from mid March to very late September between 15:10 pm - 18:30 pm from the Project. **(Refer to Appendix A)**

6.0 Aviation Receptors

6.1 Overview of Methodology

Table 9 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on aviation receptors.

Glint and Glare Requirements - Aviation Receptors		
Scope	Methodology	Performance Objective
All air traffic control towers and take off / landing approaches to any runway or landing strip within 5km of the proposed solar array.	Solar glare analysis that is worst case in all scenarios accounting for all aircraft using the airport (e.g. gliders, helicopters etc).	Any glint and glare should be avoided unless the aerodrome operator agrees that the impact would not be material (e.g. occurs at times when there are no flights or would not pose a safety risk to airport operations).
Note: Modeling for Flight Path receptors is calculated on a threshold crossing height of 50ft (15m) in 2 mile (3.21km) point ground elevation and the ±50 degree azimuthal and 30 degree vertical viewing angle representative of the pilot field view from cockpit. (Source: Rogers, 2015)		

Table 9. Aviation Receptor Assessment Requirements (DELWP 2019)

6.2 Aviation Receptors

A desktop assessment identified no landing strips within 5 km of the development footprint.

7.0 Performance Objectives

7.1 Summary of assessment results

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7.1.1 Residence Receptors

Table 5 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on residence receptors. The assessment undertaken by Moir LA has been summarised below:

Two (2) dwellings have been assessed as having a high glare rating (> 30 hours per year)

It is important to reiterate the assessment is based on a worst case scenario and does not take into account weather conditions, intervening elements such as vegetation and built structures.

Assessment of the outputs for the maximum and minimum tracker heights indicates OP02 will experience potential 'Yellow' glare of 23.5 and 33.8 hours per year respectively, approximately between 16:10 pm - 18:00 pm from mid April to very early September.

Similarly, considering the maximum tracker heights outputs, OP03 will experience potential 'Yellow Glare' of 58.2 hours per year from early January to December between 16:10 pm - 19:50 pm and 94.1 hours per year potential 'Yellow' glare almost everyday during the same timeframe from the Project when minimum tracker height is considered.

Existing vegetation surrounding the dwellings will likely reduce the potential to experience 'Yellow Glare' at these locations. Additionally, supplementary mitigation measures proposed in Section 8.0 of this report will assist in limiting the glare experienced at these locations.

Mitigation measures in the form of proposed and existing vegetation outlined in **Table 6** will help in reducing potential to experience glare at this location. The time of day glare likely to be experienced is provided for each receptor in **Appendix A**.

Assessment of the outputs for the maximum and minimum tracker heights indicates no glare experienced for dwelling receptors with different 'resting angle' of 5°, 22°, and 45°. (**Refer to Appendix A**)

7.1.2 Road and Rail Receptors

Table 7 provides an overview of the scope, methodology and performance objectives for assessment of glint and glare on Road receptors. The assessment undertaken by Moir LA has been summarised below:

One (1) road receptor have been assessed as having a high glare rating (> 30 hours per year)

It is important to reiterate the assessment is based on a worst case scenario and does not take into account weather conditions, intervening elements such as vegetation and built structures.

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Assessment of the outputs for the maximum and minimum tracker heights indicates Cullys Road will likely experience the highest amount of potential 'Yellow' glare of about 201.4 and 232.2 hours annual glare respectively from mid April to mid August between 06:50 am- 08:20 am and from mid March to very late September between 15:10 pm - 18:30 pm from the Project. **(Refer to Appendix A)**

Mitigation measures in the form of proposed and existing vegetation outlined in Table 8 will help in reducing potential glare experienced at this location. The time of day glare likely to be experienced is provided for each receptor in **Appendix A**.

Assessment of the outputs for the maximum and minimum tracker heights with a night time 'stowing angle' of 5° indicates Cullys Road will likely experience potential 'Yellow' glare of about 45.4 hours annual glare from very early May to mid August between 07:00 am- 08:10 am and 77.2 hours annual glare from very early May to very early August between 16:00 am- 17:30 pm. The time of day glare likely to be experienced is provided for each receptor in **Appendix A**.

No glare has been found when modelling was conducted using resting angles of 22° and 45°. **(Refer to Appendix A)**

8.0 Mitigation Measures

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An overview of mitigation measures required to reduce the potential impacts have been provided in the assessment tables in **Sections 4.0 - 6.0**.

An effective method for reducing the potential for glint and glare effect at residential receptors, road and rail receptors is to implement screen planting along the project boundary or as applicable at affected viewpoints.

Mitigation principles have been recommended to visually screen solar energy developments or other potential visual impacts (such as glint and glare). These will likely include vegetation screening, or the planting of trees and shrubs as a useful mitigation option at affected locations. On-site screening, such as perimeter planting, should be considered in the first instance. If this is unlikely to be effective, screening can be considered at affected locations.

Figure 7 illustrates the extent of on-site and proposed screening vegetation that will likely limit the potential glare experienced from the Project.

The assessment indicated that Cullys Road will experience potential 'Yellow' glare exceeding 30 hours per year. It is recommended that supplementary vegetation be proposed along the southern boundary of the Project to limit glare impacts to an acceptable level along the affected routes receptors.

Assessment of the outputs also indicated OP02 and OP03 as being a potential location to experience 'Yellow' glare from the Project. Mitigation methods proposed along the southern and southeastern perimeters of the Project will further limit glare impacts at these locations.

Details of the proposed landscaping including species has been included in the LVIA (prepared by others).



Figure 6 Mitigation Principles (Map Source: Google Maps, 2021)

9.0 Conclusion

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The purpose of this report is to identify potential glint and glare impacts from the Project on the surrounding residential receptors (within 1,000 m of the Project), Road and Rail Receptors (within 1,000 m of the Project) and aviation receptors (within 5,000 m of the Project).

Based on the assumptions and aforementioned parameters in this report, potential to experience glint and glare was assessed for 2 dwelling receptors (OP02, and OP03) will experience high annual 'Yellow' glare from the Project.

Desktop analysis of the dwellings using aerial imagery indicates existing vegetation surrounding OP02 and OP03 will likely filter the potential glare experienced at these locations.

Assessment of the road receptors identified Cullys Road will potentially experience high 'Yellow Glare' from the Project. Assessment based on the aerial imagery indicates lack of existing vegetation along Cullys Road. Supplementary planting along the southern perimeter of the Project will likely assist in reducing potential glare to acceptable level for this receptor.

Assessment of the scenarios with resting angles of 22° and 45° indicated no glare at the public and private receptors. Using a stowing angle of 5° provided a significant reduction in 'Yellow' glare along Cullys Road.

In addition to existing vegetation, supplementary planting along the southern and south eastern array boundary of the Project will further diminish glare impacts experienced at these roads.

Mitigation recommendations suggested in **Section 8** of this report will likely help to reduce the potential glare impacts along the affected routes and dwellings.

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FORGESOLAR GLARE ANALYSIS

Project: **2237 LANCEFIELD**

Site configuration: **Lancefield Solar Farm 20221102_0d_2484cmTracker**

Client: NGH

Created 02 Nov, 2022

Updated 07 Nov, 2022

Time-step 1 minute

Timezone offset UTC10

Site ID 78644.13479

Category 1 MW to 5 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2



Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	6,319	105.3	21,604	360.1	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	1,663	27.7	13,929	232.2
Otts Ln	0	0.0	0	0.0
Rochford Road	658	11.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	1,849	30.8	2,030	33.8
OP 3	1,756	29.3	5,645	94.1
OP 4	4	0.1	0	0.0
OP 5	389	6.5	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

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Component Data

PV Arrays

Name: PV array 1

Axis tracking: Single-axis rotation

Backtracking: Shade-slope

Tracking axis orientation: 0.0°

Max tracking angle: 60.0°

Resting angle: 0.0°

Ground Coverage Ratio: 0.76

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.298372	144.699931	534.73	2.48	537.22
2	-37.298819	144.699889	534.19	2.48	536.67
3	-37.298794	144.701425	538.08	2.48	540.56
4	-37.296997	144.701522	539.97	2.48	542.45
5	-37.296119	144.701442	539.50	2.48	541.98
6	-37.296081	144.699761	540.63	2.48	543.11
7	-37.296261	144.699719	539.81	2.48	542.29
8	-37.296244	144.696011	531.02	2.48	533.50
9	-37.298936	144.696556	532.68	2.48	535.17
10	-37.298933	144.698775	532.57	2.48	535.05
11	-37.298367	144.698811	533.28	2.48	535.77

Route Receptors

Name: Collivers Road

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291777	144.713106	510.51	2.40	512.91
2	-37.291794	144.710327	507.98	2.40	510.38
3	-37.291794	144.708310	505.71	2.40	508.11
4	-37.291777	144.705906	514.58	2.40	516.98
5	-37.291760	144.702781	534.87	2.40	537.27
6	-37.291768	144.701148	531.12	2.40	533.52
7	-37.291774	144.700641	530.04	2.40	532.44
8	-37.291742	144.700435	530.01	2.40	532.41

Name: Cullys Road
Path type: Two-way
Observer view angle: 50.0°

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Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299044	144.689079	529.42	2.40	531.82
2	-37.299055	144.689902	527.76	2.40	530.16
3	-37.299051	144.690766	525.00	2.40	527.40
4	-37.299051	144.692622	526.90	2.40	529.30
5	-37.299025	144.694502	530.28	2.40	532.68
6	-37.299046	144.696122	533.00	2.40	535.40
7	-37.299040	144.698598	532.34	2.40	534.74
8	-37.299037	144.700489	534.82	2.40	537.22
9	-37.299049	144.701744	539.06	2.40	541.46
10	-37.299051	144.702850	537.72	2.40	540.12
11	-37.299057	144.704071	532.40	2.40	534.80
12	-37.299065	144.705350	525.39	2.40	527.79
13	-37.299065	144.706838	520.21	2.40	522.61
14	-37.299117	144.709798	538.31	2.40	540.71
15	-37.299104	144.712002	537.25	2.40	539.65
16	-37.299104	144.713086	537.46	2.40	539.86

Name: Otts Ln
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299041	144.688902	529.86	2.40	532.26
2	-37.299037	144.688495	531.01	2.40	533.41
3	-37.299045	144.686971	537.30	2.40	539.70
4	-37.299058	144.685764	544.11	2.40	546.51
5	-37.299058	144.684471	557.48	2.40	559.88

Name: Rochford Road
 Path type: Two-way
 Observer view angle: 50.0°

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Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.303323	144.683760	581.28	2.40	583.68
2	-37.303152	144.684269	577.81	2.40	580.21
3	-37.302977	144.684854	572.88	2.40	575.28
4	-37.302832	144.685444	567.69	2.40	570.09
5	-37.302670	144.685959	563.33	2.40	565.73
6	-37.302491	144.686377	560.31	2.40	562.71
7	-37.302171	144.686860	554.74	2.40	557.14
8	-37.301761	144.687246	548.06	2.40	550.46
9	-37.301445	144.687461	543.67	2.40	546.07
10	-37.300937	144.687772	538.37	2.40	540.77
11	-37.300131	144.688271	532.48	2.40	534.88
12	-37.299073	144.688974	529.78	2.40	532.18
13	-37.298560	144.689458	526.93	2.40	529.33
14	-37.296665	144.692118	526.17	2.40	528.57
15	-37.296128	144.692907	525.90	2.40	528.30
16	-37.294980	144.694221	527.46	2.40	529.86
17	-37.294068	144.695348	528.73	2.40	531.13
18	-37.293445	144.696517	530.97	2.40	533.37
19	-37.292532	144.698631	534.35	2.40	536.75
20	-37.291680	144.700457	529.91	2.40	532.31
21	-37.290894	144.702212	527.51	2.40	529.91
22	-37.290455	144.703124	520.76	2.40	523.16
23	-37.290202	144.703548	517.69	2.40	520.09
24	-37.289751	144.704154	514.02	2.40	516.42
25	-37.289093	144.704753	510.58	2.40	512.98

Name: Whitebridge Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291823	144.700014	530.67	2.40	533.07
2	-37.291785	144.698721	533.31	2.40	535.71
3	-37.291776	144.697219	533.11	2.40	535.51
4	-37.291778	144.695107	531.16	2.40	533.56
5	-37.291778	144.692392	530.24	2.40	532.64
6	-37.291778	144.690171	517.36	2.40	519.76
7	-37.291805	144.688487	516.35	2.40	518.75
8	-37.291796	144.685772	521.38	2.40	523.78

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.302554	144.697070	538.07	1.50
OP 2	2	-37.299634	144.702466	537.98	1.50
OP 3	3	-37.298030	144.702255	539.93	1.50
OP 4	4	-37.300008	144.694238	530.26	1.50
OP 5	5	-37.303406	144.688473	560.62	1.50
OP 6	6	-37.298376	144.688112	531.90	1.50
OP 7	7	-37.296119	144.688120	528.29	1.50
OP 8	8	-37.296630	144.691341	524.22	1.50
OP 9	9	-37.295398	144.692816	524.56	1.50
OP 10	10	-37.292094	144.692212	527.20	1.50
OP 11	11	-37.292048	144.697252	532.80	1.50
OP 12	12	-37.291222	144.703357	527.00	1.50
OP 13	13	-37.291156	144.704529	519.29	1.50
OP 14	14	-37.292213	144.706894	511.67	1.50
OP 15	15	-37.294094	144.707090	513.56	1.50

Glare Analysis Results

Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	6,319	105.3	21,604	360.1	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	1,663	27.7	13,929	232.2
Otts Ln	0	0.0	0	0.0
Rochford Road	658	11.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	1,849	30.8	2,030	33.8
OP 3	1,756	29.3	5,645	94.1
OP 4	4	0.1	0	0.0
OP 5	389	6.5	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV: PV array 1 potential temporary after-image

Receptor results ordered by category of glare

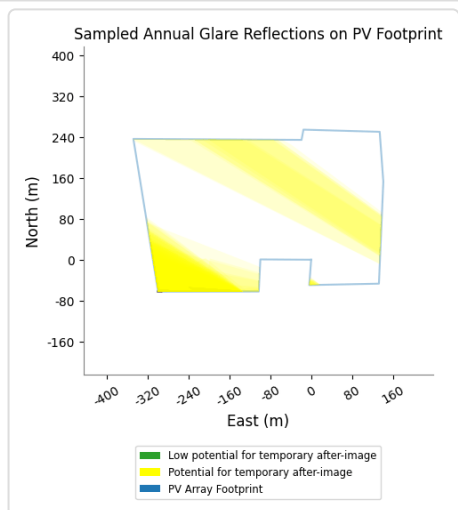
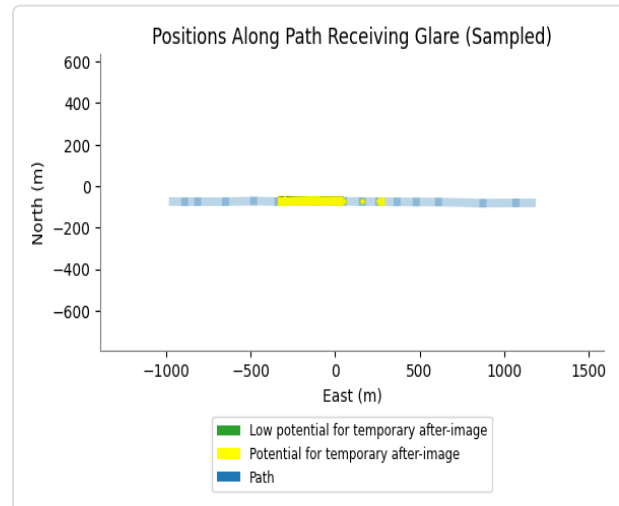
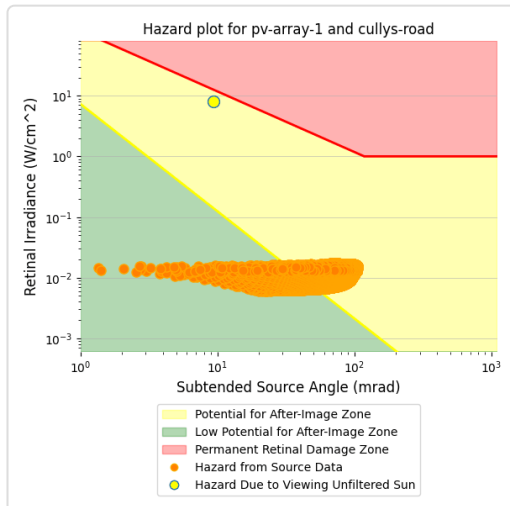
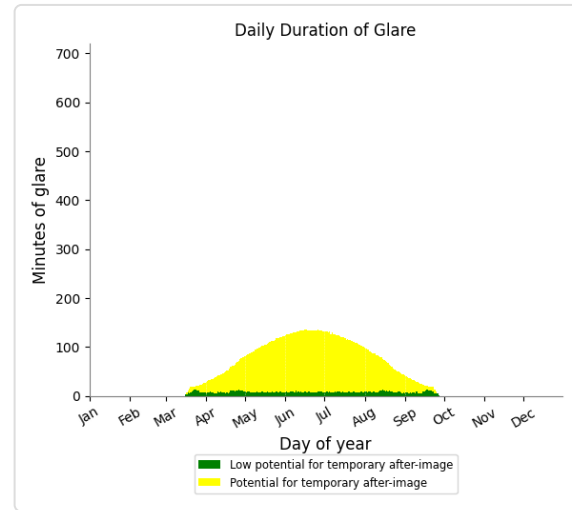
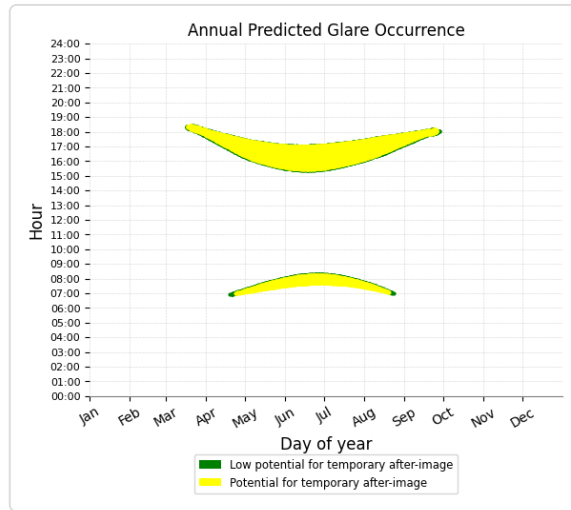
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Cullys Road	1,663	27.7	13,929	232.2
Rochford Road	658	11.0	0	0.0
Collivers Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 2	1,849	30.8	2,030	33.8
OP 3	1,756	29.3	5,645	94.1
OP 4	4	0.1	0	0.0
OP 5	389	6.5	0	0.0
OP 1	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV array 1 and Cullys Road

Receptor type: Route

13,929 minutes of yellow glare

1,663 minutes of green glare

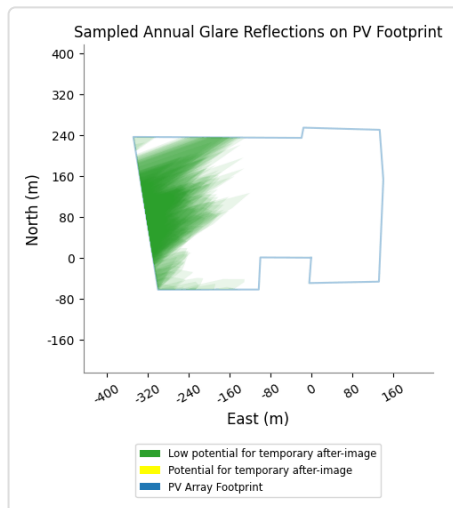
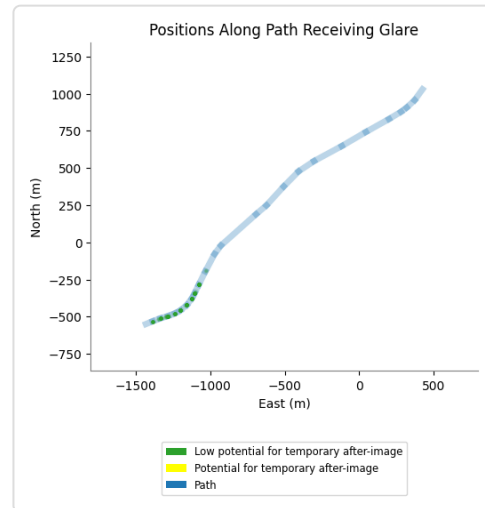
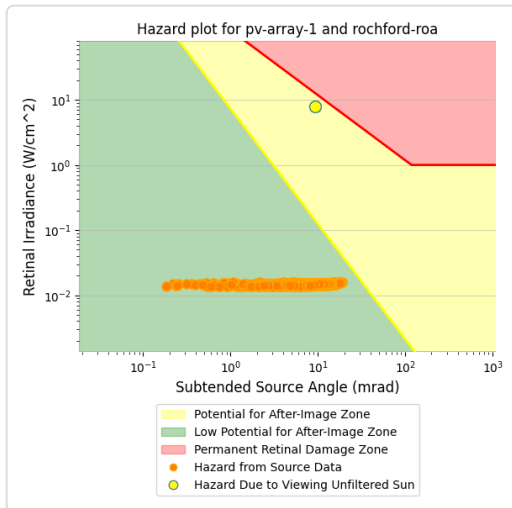
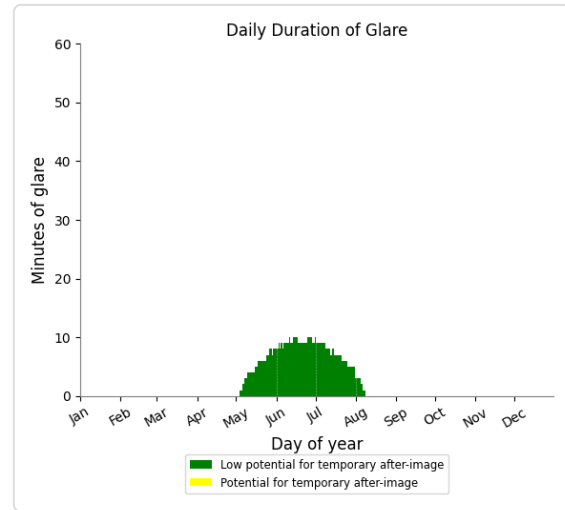
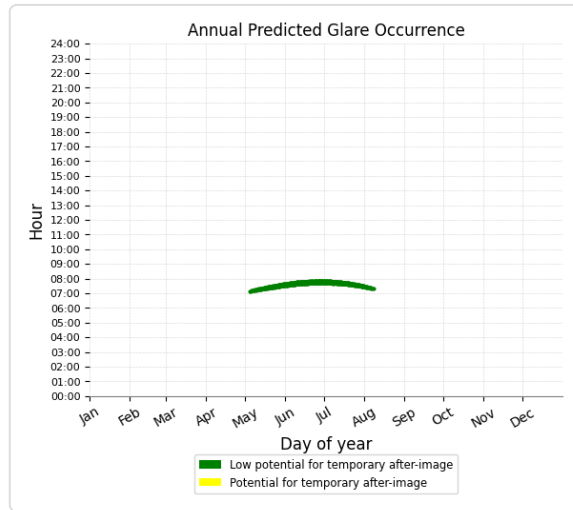


PV array 1 and Rochford Road

Receptor type: Route

0 minutes of yellow glare

658 minutes of green glare



PV array 1 and Collivers Road

Receptor type: Route

No glare found

PV array 1 and Otts Ln

Receptor type: Route

No glare found

PV array 1 and Whitebridge

Road

Receptor type: Route

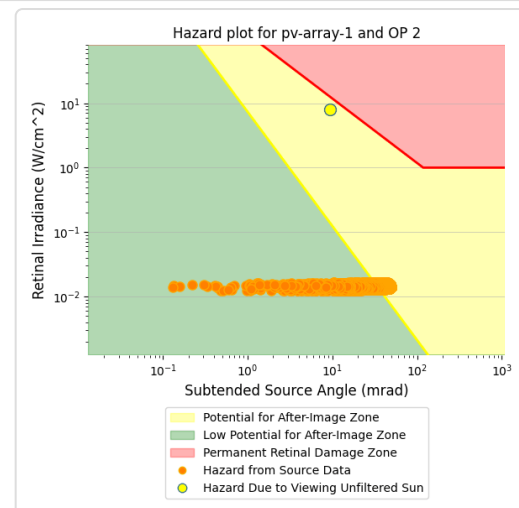
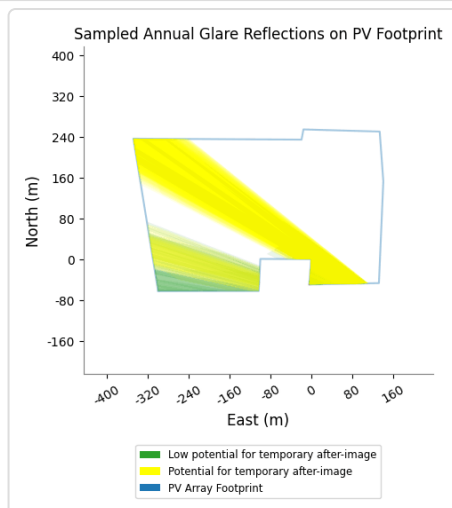
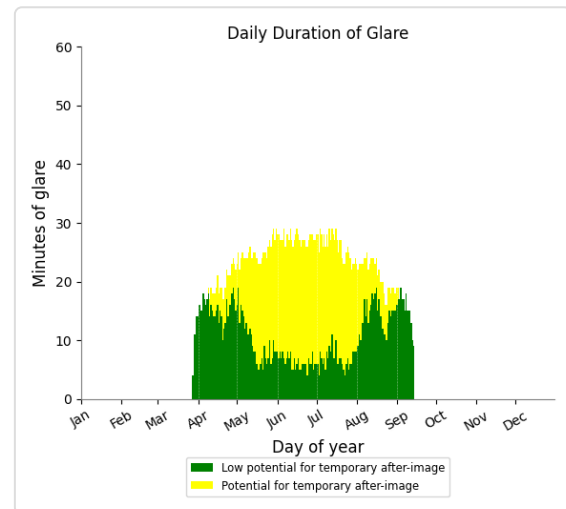
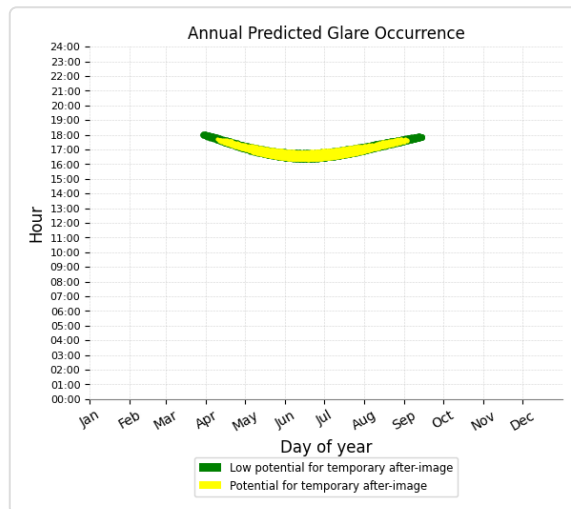
No glare found

PV array 1 and OP 2

Receptor type: Observation Point

2,030 minutes of yellow glare

1,849 minutes of green glare

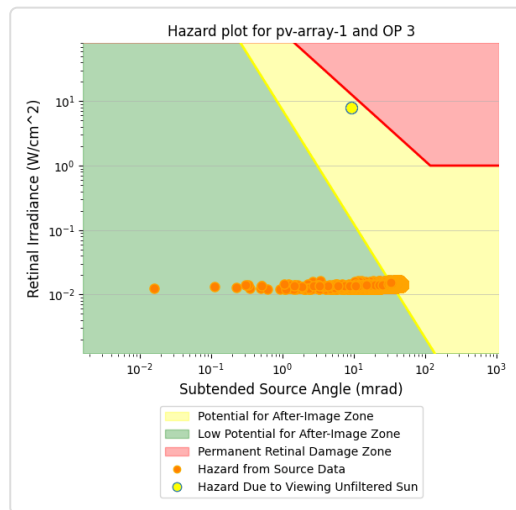
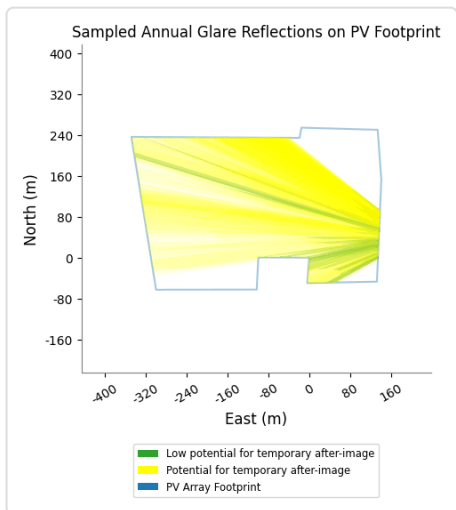
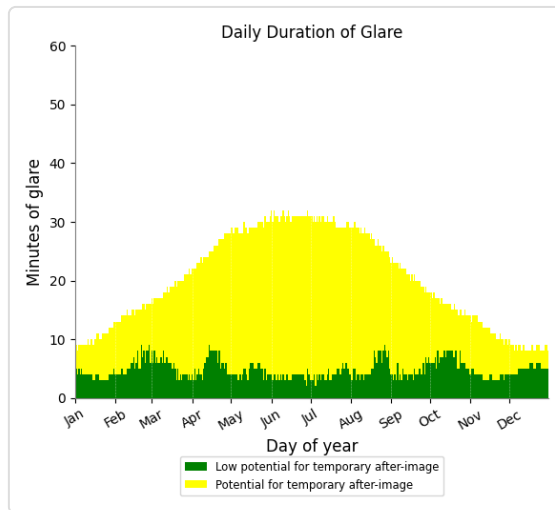
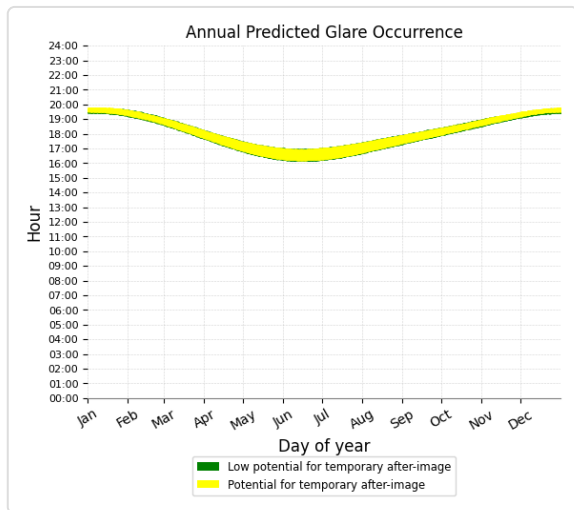


PV array 1 and OP 3

Receptor type: Observation Point

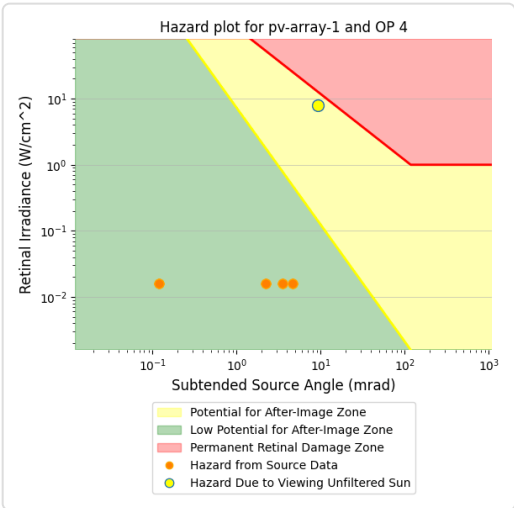
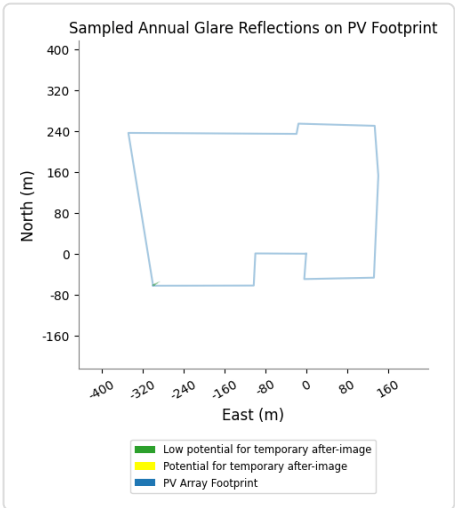
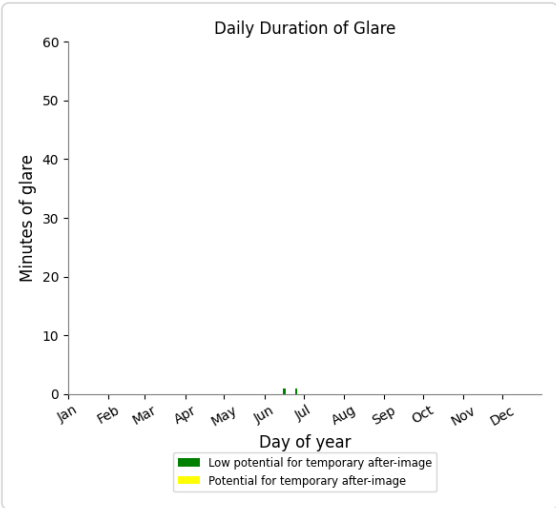
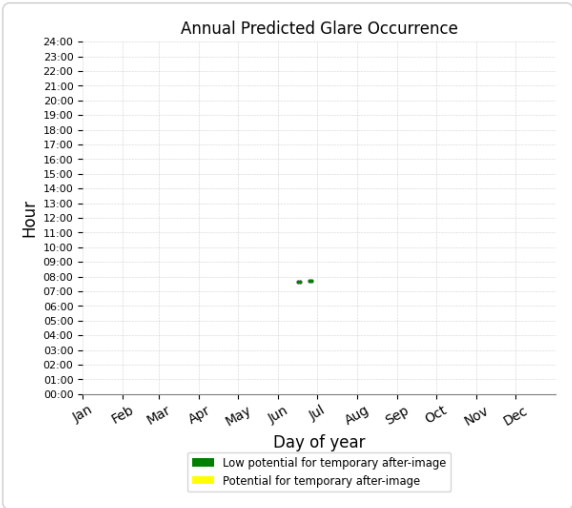
5,645 minutes of yellow glare

1,756 minutes of green glare



PV array 1 and OP 4

Receptor type: Observation Point
0 minutes of yellow glare
4 minutes of green glare

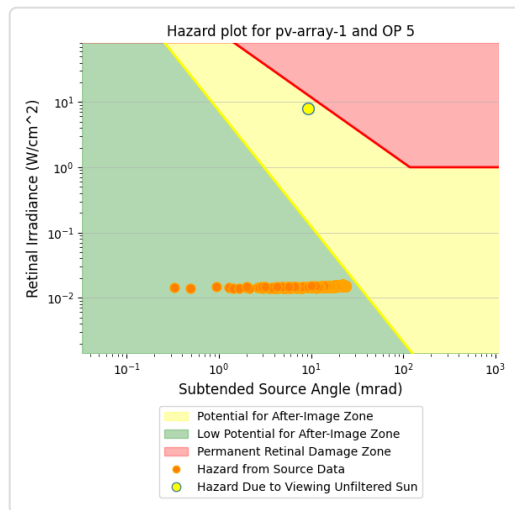
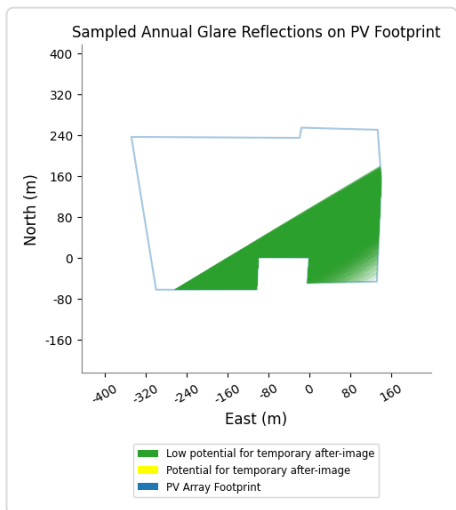
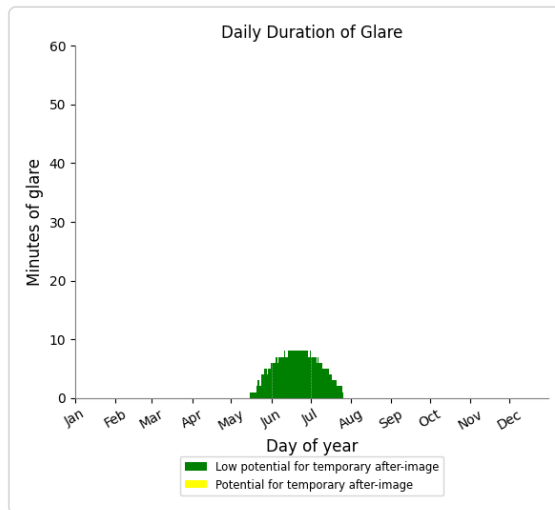
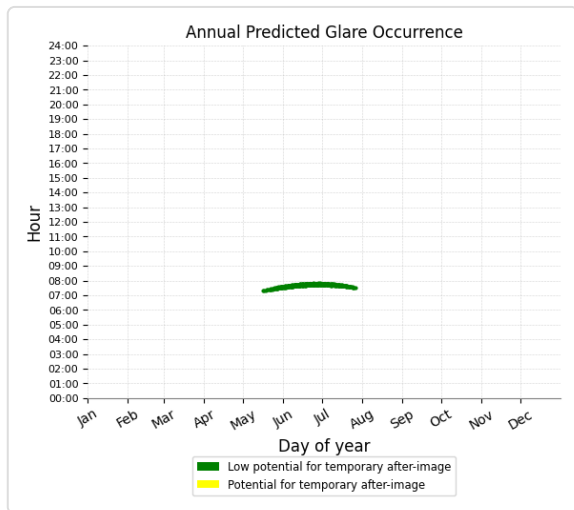


PV array 1 and OP 5

Receptor type: Observation Point

0 minutes of yellow glare

389 minutes of green glare



PV array 1 and OP 1

Receptor type: Observation Point

No glare found

PV array 1 and OP 6

Receptor type: Observation Point

No glare found

PV array 1 and OP 7

Receptor type: Observation Point

No glare found

PV array 1 and OP 8

Receptor type: Observation Point

No glare found

PV array 1 and OP 9

Receptor type: Observation Point

No glare found

PV array 1 and OP 10

Receptor type: Observation Point

No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV array 1 and OP 12

Receptor type: Observation Point
No glare found

PV array 1 and OP 13

Receptor type: Observation Point
No glare found

PV array 1 and OP 14

Receptor type: Observation Point
No glare found

PV array 1 and OP 15

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically 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 subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **2237 LANCEFIELD**

Site configuration: **Lancefield Solar Farm 20221102_0d_2987cmtRACKER**

Client: NGH

Created 01 Nov, 2022

Updated 07 Nov, 2022

Time-step 1 minute

Timezone offset UTC10

Site ID 78563.13479

Category 1 MW to 5 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2



Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	7,143	119.0	16,989	283.1	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	1,495	24.9	12,082	201.4
Otts Ln	0	0.0	0	0.0
Rochford Road	652	10.9	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	1,832	30.5	1,412	23.5
OP 3	2,786	46.4	3,495	58.2
OP 4	0	0.0	0	0.0
OP 5	378	6.3	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

**ADVERTISED
PLAN**

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.76
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.298372	144.699931	534.73	2.99	537.72
2	-37.298819	144.699889	534.19	2.99	537.18
3	-37.298794	144.701425	538.08	2.99	541.06
4	-37.296997	144.701522	539.97	2.99	542.95
5	-37.296119	144.701442	539.50	2.99	542.48
6	-37.296081	144.699761	540.63	2.99	543.61
7	-37.296261	144.699719	539.81	2.99	542.79
8	-37.296244	144.696011	531.02	2.99	534.00
9	-37.298936	144.696556	532.68	2.99	535.67
10	-37.298933	144.698775	532.57	2.99	535.56
11	-37.298367	144.698811	533.28	2.99	536.27

Route Receptors

Name: Collivers Road

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291777	144.713106	510.51	2.40	512.91
2	-37.291794	144.710327	507.98	2.40	510.38
3	-37.291794	144.708310	505.71	2.40	508.11
4	-37.291777	144.705906	514.58	2.40	516.98
5	-37.291760	144.702781	534.87	2.40	537.27
6	-37.291768	144.701148	531.12	2.40	533.52
7	-37.291774	144.700641	530.04	2.40	532.44
8	-37.291742	144.700435	530.01	2.40	532.41

Name: Cullys Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299044	144.689079	529.42	2.40	531.82
2	-37.299055	144.689902	527.76	2.40	530.16
3	-37.299051	144.690766	525.00	2.40	527.40
4	-37.299051	144.692622	526.90	2.40	529.30
5	-37.299025	144.694502	530.28	2.40	532.68
6	-37.299046	144.696122	533.00	2.40	535.40
7	-37.299040	144.698598	532.34	2.40	534.74
8	-37.299037	144.700489	534.82	2.40	537.22
9	-37.299049	144.701744	539.06	2.40	541.46
10	-37.299051	144.702850	537.72	2.40	540.12
11	-37.299057	144.704071	532.40	2.40	534.80
12	-37.299065	144.705350	525.39	2.40	527.79
13	-37.299065	144.706838	520.21	2.40	522.61
14	-37.299117	144.709798	538.31	2.40	540.71
15	-37.299104	144.712002	537.25	2.40	539.65
16	-37.299104	144.713086	537.46	2.40	539.86

Name: Otts Ln
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299041	144.688902	529.86	2.40	532.26
2	-37.299037	144.688495	531.01	2.40	533.41
3	-37.299045	144.686971	537.30	2.40	539.70
4	-37.299058	144.685764	544.11	2.40	546.51
5	-37.299058	144.684471	557.48	2.40	559.88

Name: Rochford Road
 Path type: Two-way
 Observer view angle: 50.0°



ADVERTISED PLAN

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.303323	144.683760	581.28	2.40	583.68
2	-37.303152	144.684269	577.81	2.40	580.21
3	-37.302977	144.684854	572.88	2.40	575.28
4	-37.302832	144.685444	567.69	2.40	570.09
5	-37.302670	144.685959	563.33	2.40	565.73
6	-37.302491	144.686377	560.31	2.40	562.71
7	-37.302171	144.686860	554.74	2.40	557.14
8	-37.301761	144.687246	548.06	2.40	550.46
9	-37.301445	144.687461	543.67	2.40	546.07
10	-37.300937	144.687772	538.37	2.40	540.77
11	-37.300131	144.688271	532.48	2.40	534.88
12	-37.299073	144.688974	529.78	2.40	532.18
13	-37.298560	144.689458	526.93	2.40	529.33
14	-37.296665	144.692118	526.17	2.40	528.57
15	-37.296128	144.692907	525.90	2.40	528.30
16	-37.294980	144.694221	527.46	2.40	529.86
17	-37.294068	144.695348	528.73	2.40	531.13
18	-37.293445	144.696517	530.97	2.40	533.37
19	-37.292532	144.698631	534.35	2.40	536.75
20	-37.291680	144.700457	529.91	2.40	532.31
21	-37.290894	144.702212	527.51	2.40	529.91
22	-37.290455	144.703124	520.76	2.40	523.16
23	-37.290202	144.703548	517.69	2.40	520.09
24	-37.289751	144.704154	514.02	2.40	516.42
25	-37.289093	144.704753	510.58	2.40	512.98

Name: Whitebridge Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291823	144.700014	530.67	2.40	533.07
2	-37.291785	144.698721	533.31	2.40	535.71
3	-37.291776	144.697219	533.11	2.40	535.51
4	-37.291778	144.695107	531.16	2.40	533.56
5	-37.291778	144.692392	530.24	2.40	532.64
6	-37.291778	144.690171	517.36	2.40	519.76
7	-37.291805	144.688487	516.35	2.40	518.75
8	-37.291796	144.685772	521.38	2.40	523.78

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.302554	144.697070	538.07	1.50
OP 2	2	-37.299634	144.702466	537.98	1.50
OP 3	3	-37.298030	144.702255	539.93	1.50
OP 4	4	-37.300008	144.694238	530.26	1.50
OP 5	5	-37.303406	144.688473	560.62	1.50
OP 6	6	-37.298376	144.688112	531.90	1.50
OP 7	7	-37.296119	144.688120	528.29	1.50
OP 8	8	-37.296630	144.691341	524.22	1.50
OP 9	9	-37.295398	144.692816	524.56	1.50
OP 10	10	-37.292094	144.692212	527.20	1.50
OP 11	11	-37.292048	144.697252	532.80	1.50
OP 12	12	-37.291222	144.703357	527.00	1.50
OP 13	13	-37.291156	144.704529	519.29	1.50
OP 14	14	-37.292213	144.706894	511.67	1.50
OP 15	15	-37.294094	144.707090	513.56	1.50

Glare Analysis Results

Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	7,143	119.0	16,989	283.1	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	1,495	24.9	12,082	201.4
Otts Ln	0	0.0	0	0.0
Rochford Road	652	10.9	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	1,832	30.5	1,412	23.5
OP 3	2,786	46.4	3,495	58.2
OP 4	0	0.0	0	0.0
OP 5	378	6.3	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

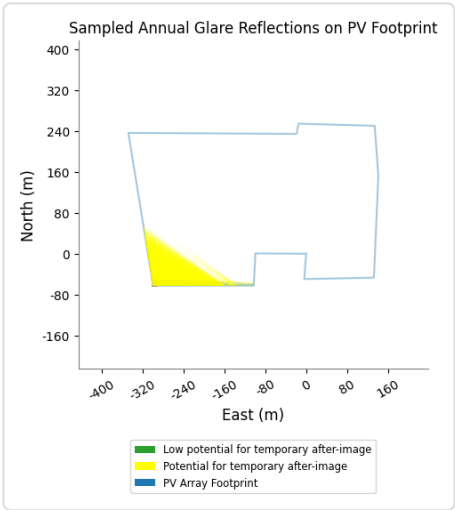
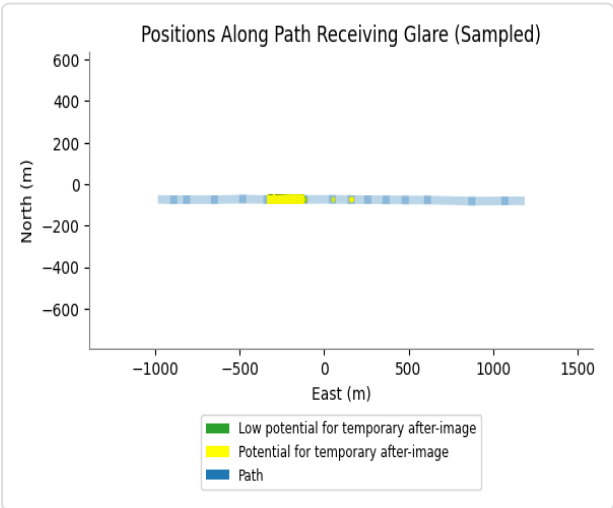
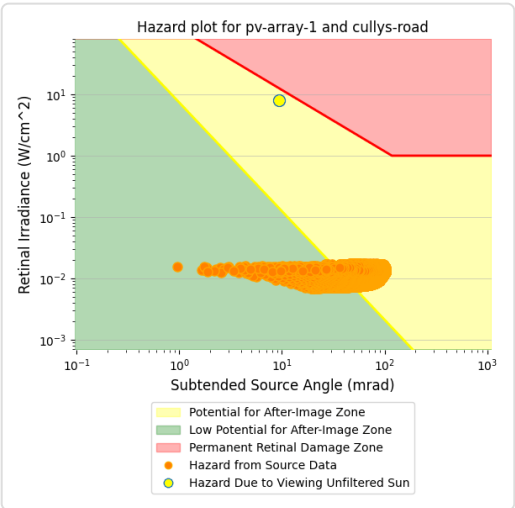
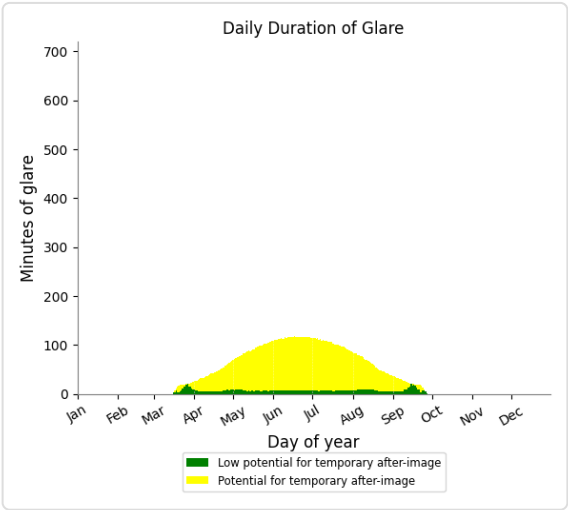
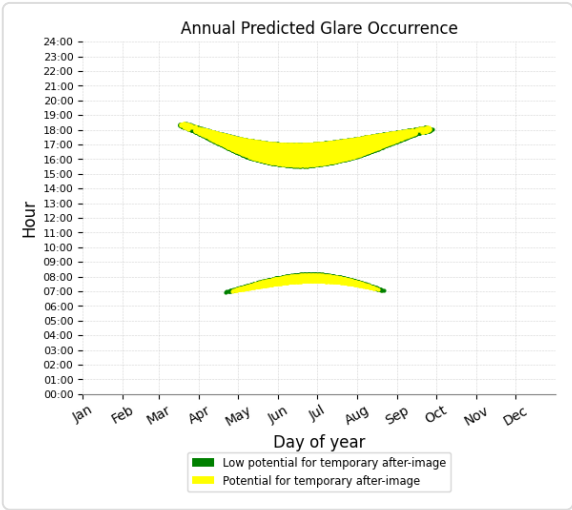
PV: PV array 1 potential temporary after-image

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Cullys Road	1,495	24.9	12,082	201.4
Rochford Road	652	10.9	0	0.0
Collivers Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 2	1,832	30.5	1,412	23.5
OP 3	2,786	46.4	3,495	58.2
OP 5	378	6.3	0	0.0
OP 1	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV array 1 and Cullys Road

Receptor type: Route
12,082 minutes of yellow glare
1,495 minutes of green glare

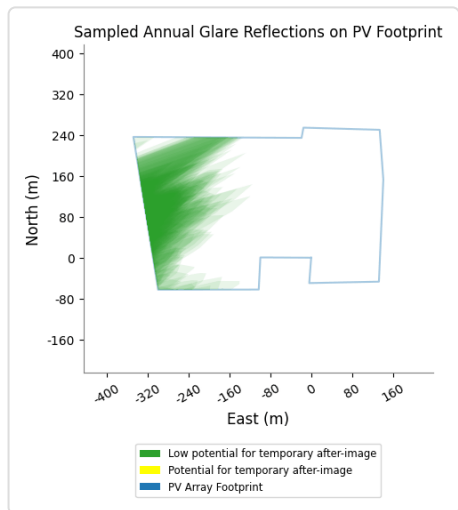
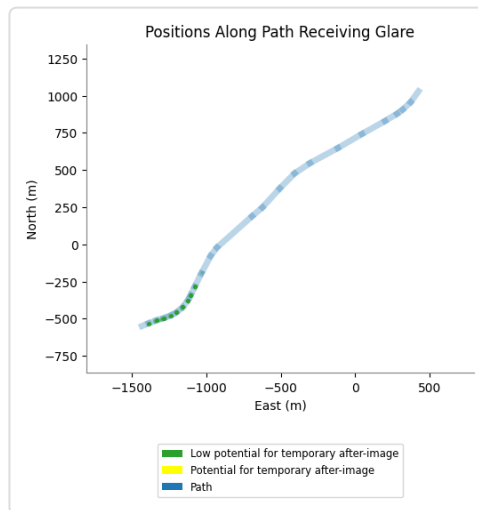
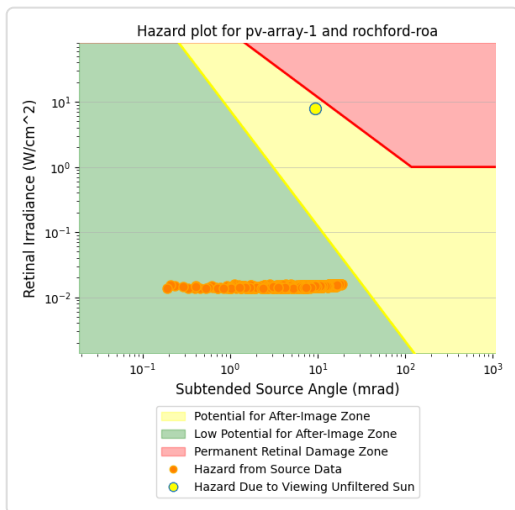
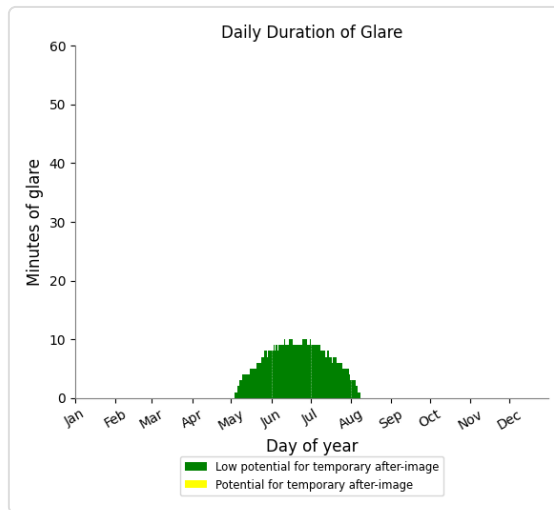
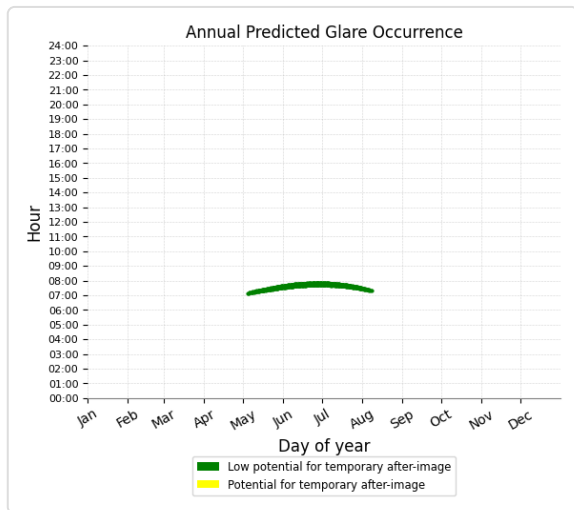


PV array 1 and Rochford Road

Receptor type: Route

0 minutes of yellow glare

652 minutes of green glare



PV array 1 and Collivers Road

Receptor type: Route
No glare found

PV array 1 and Otts Ln

Receptor type: Route
No glare found

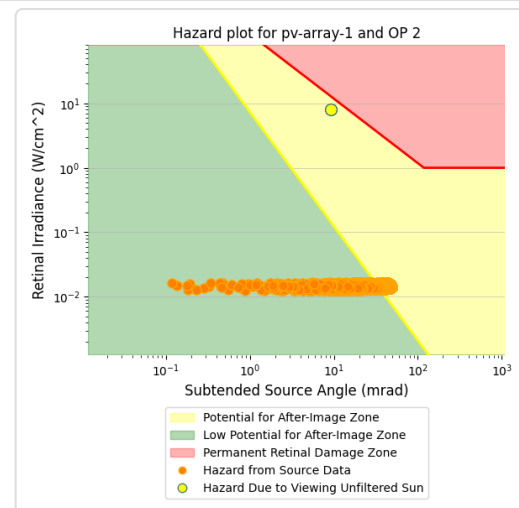
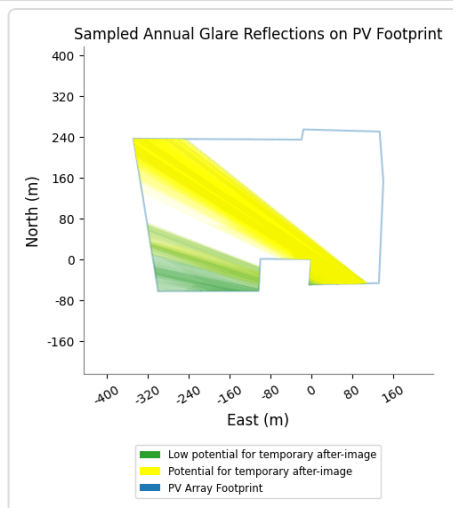
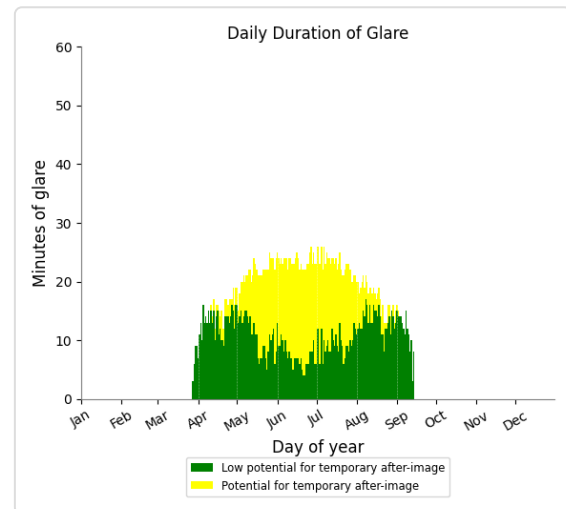
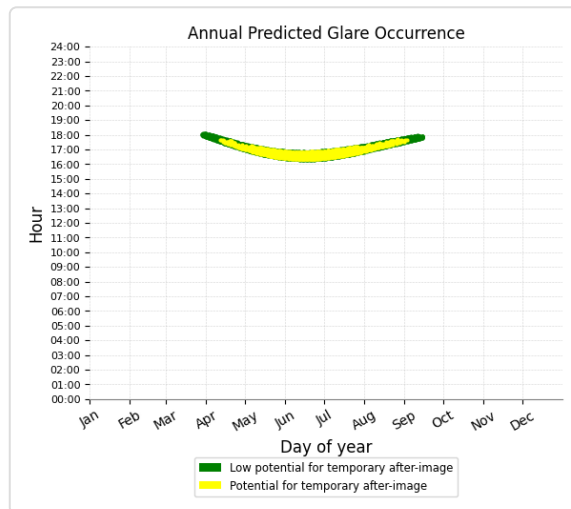
PV array 1 and Whitebridge

Road

Receptor type: Route
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
1,412 minutes of yellow glare
1,832 minutes of green glare

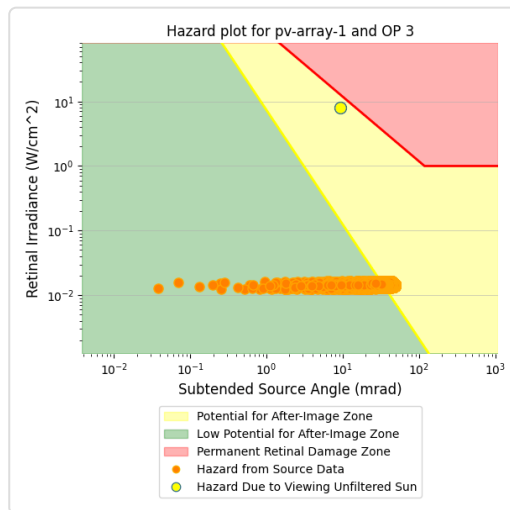
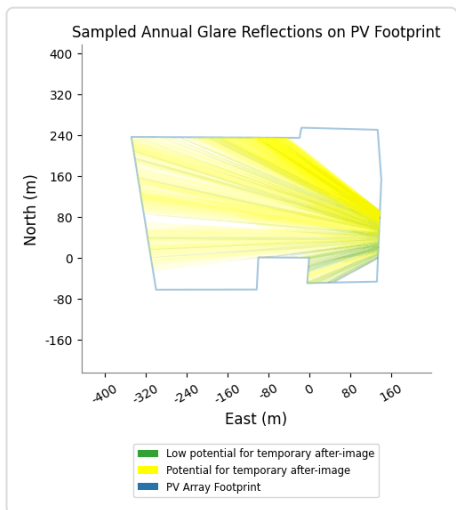
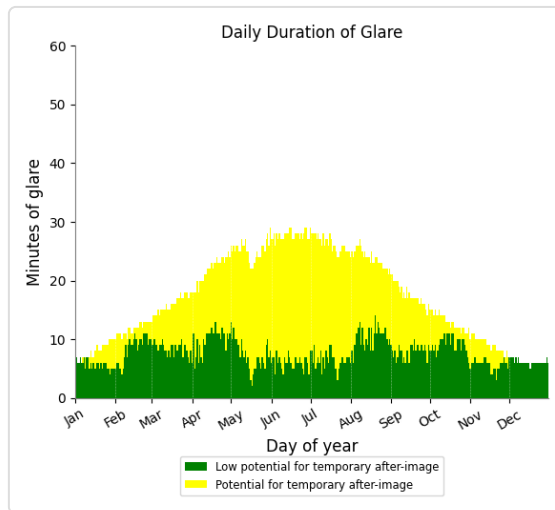
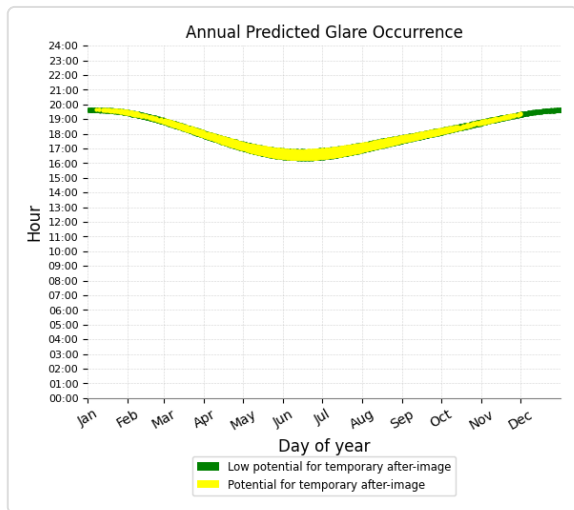


PV array 1 and OP 3

Receptor type: Observation Point

3,495 minutes of yellow glare

2,786 minutes of green glare

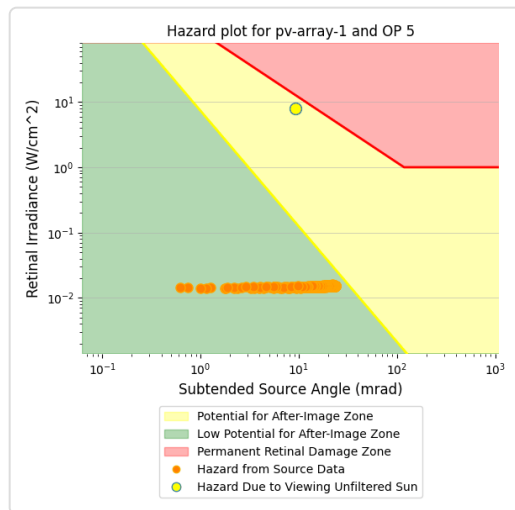
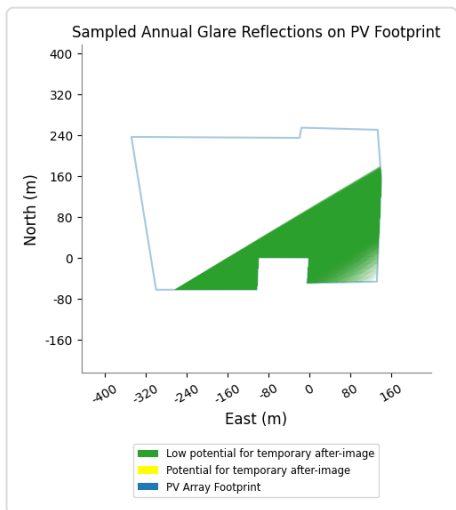
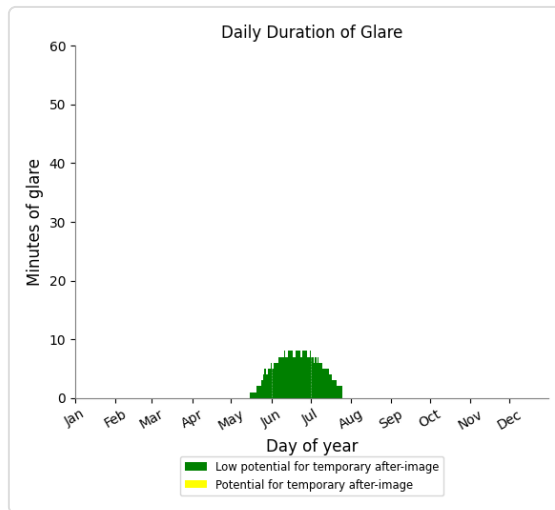
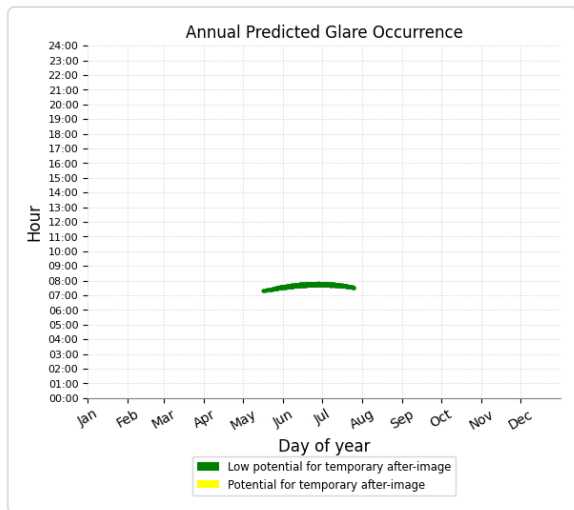


PV array 1 and OP 5

Receptor type: Observation Point

0 minutes of yellow glare

378 minutes of green glare



PV array 1 and OP 1

Receptor type: Observation Point

No glare found

PV array 1 and OP 6

Receptor type: Observation Point

No glare found

PV array 1 and OP 8

Receptor type: Observation Point

No glare found

PV array 1 and OP 4

Receptor type: Observation Point

No glare found

PV array 1 and OP 7

Receptor type: Observation Point

No glare found

PV array 1 and OP 9

Receptor type: Observation Point

No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV array 1 and OP 12

Receptor type: Observation Point
No glare found

PV array 1 and OP 13

Receptor type: Observation Point
No glare found

PV array 1 and OP 14

Receptor type: Observation Point
No glare found

PV array 1 and OP 15

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically 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 subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **2237 LANCEFIELD**

Site configuration: **Lancefield Solar Farm 20221102_5d_2484cmTracker**

Client: NGH

Created 14 Nov, 2022

Updated 14 Nov, 2022

Time-step 1 minute

Timezone offset UTC10

Site ID 79379.13479

Category 1 MW to 5 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2



Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV array 1	SA tracking	SA tracking	1,281	21.4	4,632	77.2	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	1,235	20.6	4,632	77.2
Otts Ln	0	0.0	0	0.0
Rochford Road	46	0.8	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

**ADVERTISED
PLAN**

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.76
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.298372	144.699931	534.73	2.48	537.22
2	-37.298819	144.699889	534.19	2.48	536.67
3	-37.298794	144.701425	538.08	2.48	540.56
4	-37.296997	144.701522	539.97	2.48	542.45
5	-37.296119	144.701442	539.50	2.48	541.98
6	-37.296081	144.699761	540.63	2.48	543.11
7	-37.296261	144.699719	539.81	2.48	542.29
8	-37.296244	144.696011	531.02	2.48	533.50
9	-37.298936	144.696556	532.68	2.48	535.17
10	-37.298933	144.698775	532.57	2.48	535.05
11	-37.298367	144.698811	533.28	2.48	535.77

Route Receptors

Name: Collivers Road

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291777	144.713106	510.51	2.40	512.91
2	-37.291794	144.710327	507.98	2.40	510.38
3	-37.291794	144.708310	505.71	2.40	508.11
4	-37.291777	144.705906	514.58	2.40	516.98
5	-37.291760	144.702781	534.87	2.40	537.27
6	-37.291768	144.701148	531.12	2.40	533.52
7	-37.291774	144.700641	530.04	2.40	532.44
8	-37.291742	144.700435	530.01	2.40	532.41

Name: Cullys Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299044	144.689079	529.42	2.40	531.82
2	-37.299055	144.689902	527.76	2.40	530.16
3	-37.299051	144.690766	525.00	2.40	527.40
4	-37.299051	144.692622	526.90	2.40	529.30
5	-37.299025	144.694502	530.28	2.40	532.68
6	-37.299046	144.696122	533.00	2.40	535.40
7	-37.299040	144.698598	532.34	2.40	534.74
8	-37.299037	144.700489	534.82	2.40	537.22
9	-37.299049	144.701744	539.06	2.40	541.46
10	-37.299051	144.702850	537.72	2.40	540.12
11	-37.299057	144.704071	532.40	2.40	534.80
12	-37.299065	144.705350	525.39	2.40	527.79
13	-37.299065	144.706838	520.21	2.40	522.61
14	-37.299117	144.709798	538.31	2.40	540.71
15	-37.299104	144.712002	537.25	2.40	539.65
16	-37.299104	144.713086	537.46	2.40	539.86

Name: Otts Ln
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299041	144.688902	529.86	2.40	532.26
2	-37.299037	144.688495	531.01	2.40	533.41
3	-37.299045	144.686971	537.30	2.40	539.70
4	-37.299058	144.685764	544.11	2.40	546.51
5	-37.299058	144.684471	557.48	2.40	559.88

Name: Rochford Road
 Path type: Two-way
 Observer view angle: 50.0°



ADVERTISED PLAN

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.303323	144.683760	581.28	2.40	583.68
2	-37.303152	144.684269	577.81	2.40	580.21
3	-37.302977	144.684854	572.88	2.40	575.28
4	-37.302832	144.685444	567.69	2.40	570.09
5	-37.302670	144.685959	563.33	2.40	565.73
6	-37.302491	144.686377	560.31	2.40	562.71
7	-37.302171	144.686860	554.74	2.40	557.14
8	-37.301761	144.687246	548.06	2.40	550.46
9	-37.301445	144.687461	543.67	2.40	546.07
10	-37.300937	144.687772	538.37	2.40	540.77
11	-37.300131	144.688271	532.48	2.40	534.88
12	-37.299073	144.688974	529.78	2.40	532.18
13	-37.298560	144.689458	526.93	2.40	529.33
14	-37.296665	144.692118	526.17	2.40	528.57
15	-37.296128	144.692907	525.90	2.40	528.30
16	-37.294980	144.694221	527.46	2.40	529.86
17	-37.294068	144.695348	528.73	2.40	531.13
18	-37.293445	144.696517	530.97	2.40	533.37
19	-37.292532	144.698631	534.35	2.40	536.75
20	-37.291680	144.700457	529.91	2.40	532.31
21	-37.290894	144.702212	527.51	2.40	529.91
22	-37.290455	144.703124	520.76	2.40	523.16
23	-37.290202	144.703548	517.69	2.40	520.09
24	-37.289751	144.704154	514.02	2.40	516.42
25	-37.289093	144.704753	510.58	2.40	512.98

Name: Whitebridge Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291823	144.700014	530.67	2.40	533.07
2	-37.291785	144.698721	533.31	2.40	535.71
3	-37.291776	144.697219	533.11	2.40	535.51
4	-37.291778	144.695107	531.16	2.40	533.56
5	-37.291778	144.692392	530.24	2.40	532.64
6	-37.291778	144.690171	517.36	2.40	519.76
7	-37.291805	144.688487	516.35	2.40	518.75
8	-37.291796	144.685772	521.38	2.40	523.78

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.302554	144.697070	538.07	1.50
OP 2	2	-37.299634	144.702466	537.98	1.50
OP 3	3	-37.298030	144.702255	539.93	1.50
OP 4	4	-37.300008	144.694238	530.26	1.50
OP 5	5	-37.303406	144.688473	560.62	1.50
OP 6	6	-37.298376	144.688112	531.90	1.50
OP 7	7	-37.296119	144.688120	528.29	1.50
OP 8	8	-37.296630	144.691341	524.22	1.50
OP 9	9	-37.295398	144.692816	524.56	1.50
OP 10	10	-37.292094	144.692212	527.20	1.50
OP 11	11	-37.292048	144.697252	532.80	1.50
OP 12	12	-37.291222	144.703357	527.00	1.50
OP 13	13	-37.291156	144.704529	519.29	1.50
OP 14	14	-37.292213	144.706894	511.67	1.50
OP 15	15	-37.294094	144.707090	513.56	1.50

Glare Analysis Results

Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	1,281	21.4	4,632	77.2	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	1,235	20.6	4,632	77.2
Otts Ln	0	0.0	0	0.0
Rochford Road	46	0.8	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV: PV array 1 potential temporary after-image

Receptor results ordered by category of glare

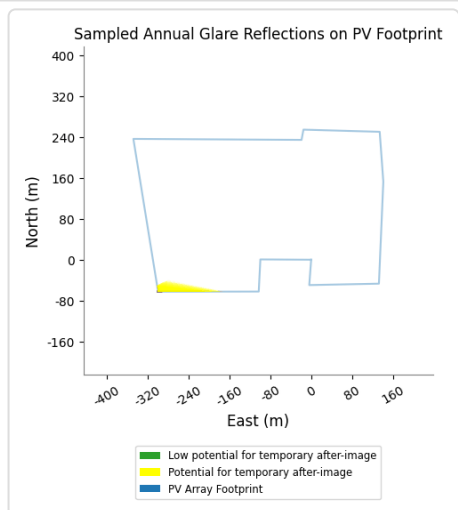
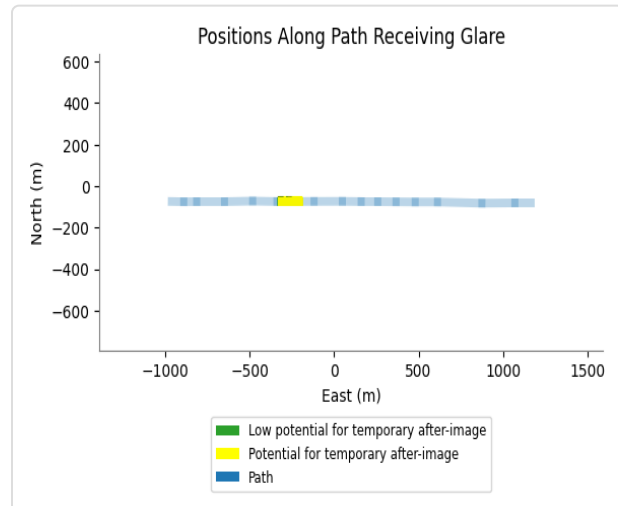
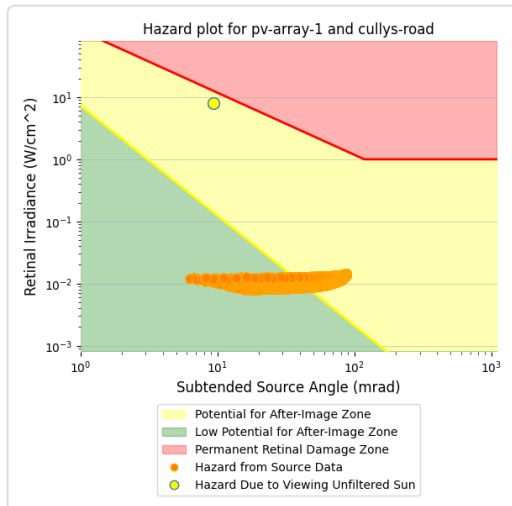
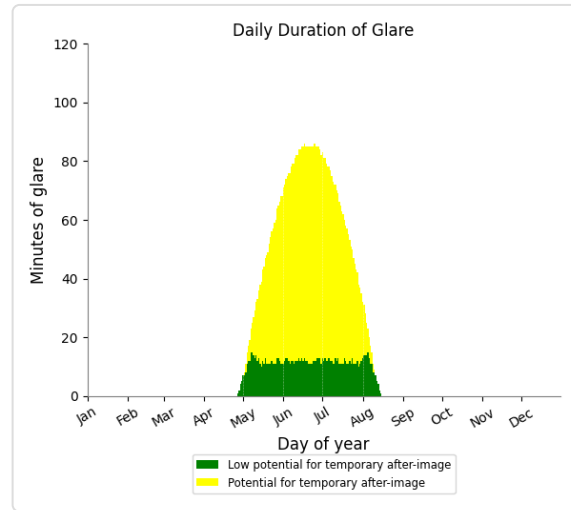
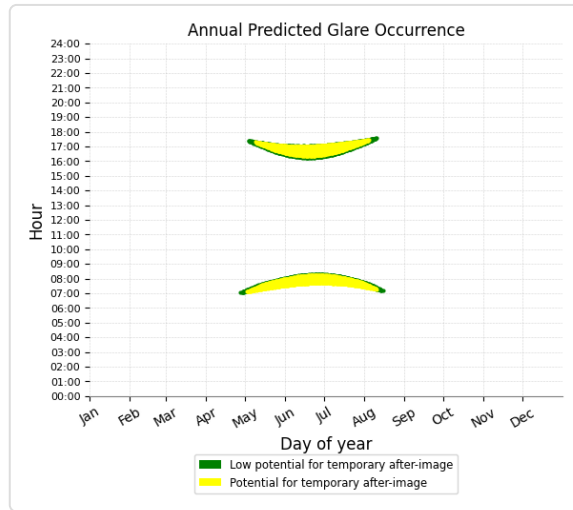
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Cullys Road	1,235	20.6	4,632	77.2
Rochford Road	46	0.8	0	0.0
Collivers Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV array 1 and Cullys Road

Receptor type: Route

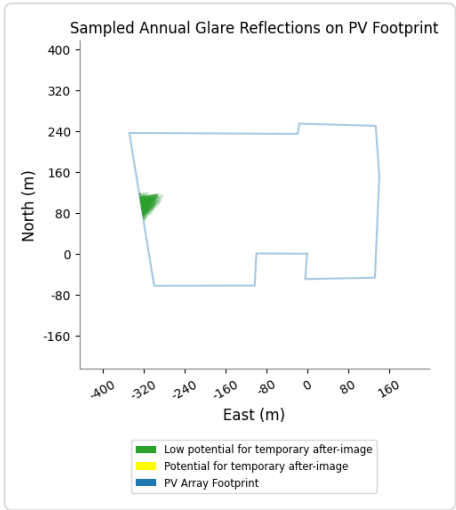
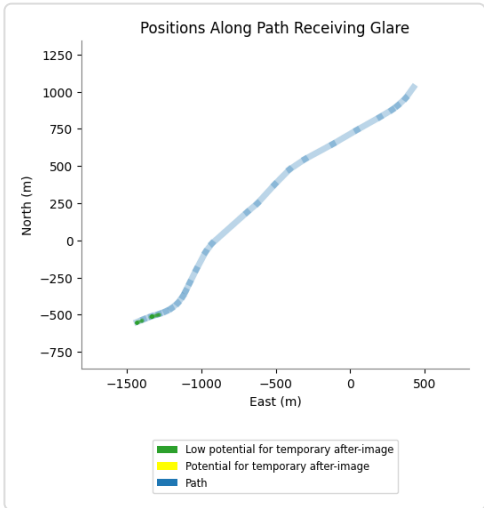
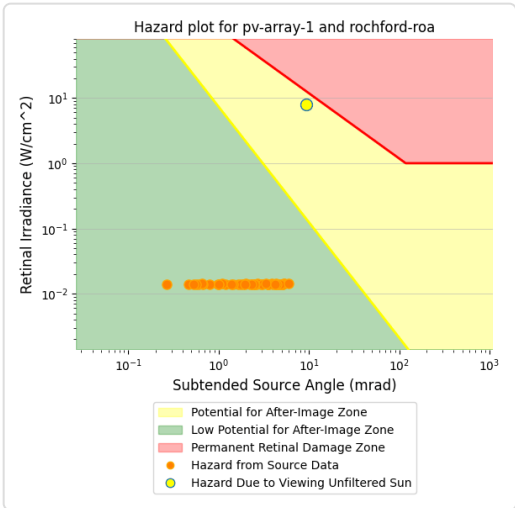
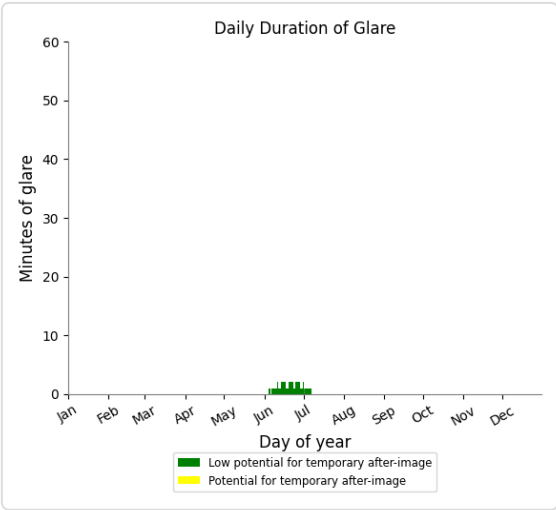
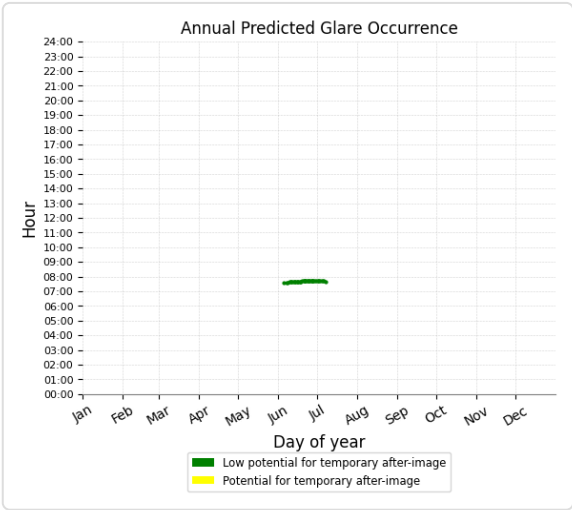
4,632 minutes of yellow glare

1,235 minutes of green glare



PV array 1 and Rochford Road

Receptor type: Route
0 minutes of yellow glare
46 minutes of green glare



PV array 1 and Collivers Road

Receptor type: Route
No glare found

PV array 1 and Otts Ln

Receptor type: Route
No glare found

PV array 1 and Whitebridge Road

Receptor type: Route
No glare found

PV array 1 and OP 1

Receptor type: Observation Point
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
No glare found

PV array 1 and OP 3

Receptor type: Observation Point
No glare found

PV array 1 and OP 4

Receptor type: Observation Point
No glare found

PV array 1 and OP 5

Receptor type: Observation Point
No glare found

PV array 1 and OP 6

Receptor type: Observation Point
No glare found

PV array 1 and OP 7

Receptor type: Observation Point
No glare found

PV array 1 and OP 8

Receptor type: Observation Point
No glare found

PV array 1 and OP 9

Receptor type: Observation Point
No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV array 1 and OP 12

Receptor type: Observation Point
No glare found

PV array 1 and OP 13

Receptor type: Observation Point
No glare found

PV array 1 and OP 14

Receptor type: Observation Point
No glare found

PV array 1 and OP 15

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically 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 subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **2237 LANCEFIELD**

Site configuration: **Lancefield Solar Farm 20221102_5d_2987cmH**

Client: NGH

Created 02 Nov, 2022

Updated 14 Nov, 2022

Time-step 1 minute

Timezone offset UTC10

Site ID 78643.13479

Category 1 MW to 5 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2



Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV array 1	SA tracking	SA tracking	968	16.1	2,721	45.4	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	930	15.5	2,721	45.4
Otts Ln	0	0.0	0	0.0
Rochford Road	38	0.6	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

**ADVERTISED
PLAN**

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.75
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.298372	144.699931	534.73	2.99	537.72
2	-37.298819	144.699889	534.19	2.99	537.18
3	-37.298794	144.701425	538.08	2.99	541.06
4	-37.296997	144.701522	539.97	2.99	542.95
5	-37.296119	144.701442	539.50	2.99	542.48
6	-37.296081	144.699761	540.63	2.99	543.61
7	-37.296261	144.699719	539.81	2.99	542.79
8	-37.296244	144.696011	531.02	2.99	534.00
9	-37.298936	144.696556	532.68	2.99	535.67
10	-37.298933	144.698775	532.57	2.99	535.56
11	-37.298367	144.698811	533.28	2.99	536.27

Route Receptors

Name: Collivers Road

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291777	144.713106	510.51	2.40	512.91
2	-37.291794	144.710327	507.98	2.40	510.38
3	-37.291794	144.708310	505.71	2.40	508.11
4	-37.291777	144.705906	514.58	2.40	516.98
5	-37.291760	144.702781	534.87	2.40	537.27
6	-37.291768	144.701148	531.12	2.40	533.52
7	-37.291774	144.700641	530.04	2.40	532.44
8	-37.291742	144.700435	530.01	2.40	532.41

Name: Cullys Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299044	144.689079	529.42	2.40	531.82
2	-37.299055	144.689902	527.76	2.40	530.16
3	-37.299051	144.690766	525.00	2.40	527.40
4	-37.299051	144.692622	526.90	2.40	529.30
5	-37.299025	144.694502	530.28	2.40	532.68
6	-37.299046	144.696122	533.00	2.40	535.40
7	-37.299040	144.698598	532.34	2.40	534.74
8	-37.299037	144.700489	534.82	2.40	537.22
9	-37.299049	144.701744	539.06	2.40	541.46
10	-37.299051	144.702850	537.72	2.40	540.12
11	-37.299057	144.704071	532.40	2.40	534.80
12	-37.299065	144.705350	525.39	2.40	527.79
13	-37.299065	144.706838	520.21	2.40	522.61
14	-37.299117	144.709798	538.31	2.40	540.71
15	-37.299104	144.712002	537.25	2.40	539.65
16	-37.299104	144.713086	537.46	2.40	539.86

Name: Otts Ln
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299041	144.688902	529.86	2.40	532.26
2	-37.299037	144.688495	531.01	2.40	533.41
3	-37.299045	144.686971	537.30	2.40	539.70
4	-37.299058	144.685764	544.11	2.40	546.51
5	-37.299058	144.684471	557.48	2.40	559.88

Name: Rochford Road
 Path type: Two-way
 Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.303323	144.683760	581.28	2.40	583.68
2	-37.303152	144.684269	577.81	2.40	580.21
3	-37.302977	144.684854	572.88	2.40	575.28
4	-37.302832	144.685444	567.69	2.40	570.09
5	-37.302670	144.685959	563.33	2.40	565.73
6	-37.302491	144.686377	560.31	2.40	562.71
7	-37.302171	144.686860	554.74	2.40	557.14
8	-37.301761	144.687246	548.06	2.40	550.46
9	-37.301445	144.687461	543.67	2.40	546.07
10	-37.300937	144.687772	538.37	2.40	540.77
11	-37.300131	144.688271	532.48	2.40	534.88
12	-37.299073	144.688974	529.78	2.40	532.18
13	-37.298560	144.689458	526.93	2.40	529.33
14	-37.296665	144.692118	526.17	2.40	528.57
15	-37.296128	144.692907	525.90	2.40	528.30
16	-37.294980	144.694221	527.46	2.40	529.86
17	-37.294068	144.695348	528.73	2.40	531.13
18	-37.293445	144.696517	530.97	2.40	533.37
19	-37.292532	144.698631	534.35	2.40	536.75
20	-37.291680	144.700457	529.91	2.40	532.31
21	-37.290894	144.702212	527.51	2.40	529.91
22	-37.290455	144.703124	520.76	2.40	523.16
23	-37.290202	144.703548	517.69	2.40	520.09
24	-37.289751	144.704154	514.02	2.40	516.42
25	-37.289093	144.704753	510.58	2.40	512.98

Name: Whitebridge Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291823	144.700014	530.67	2.40	533.07
2	-37.291785	144.698721	533.31	2.40	535.71
3	-37.291776	144.697219	533.11	2.40	535.51
4	-37.291778	144.695107	531.16	2.40	533.56
5	-37.291778	144.692392	530.24	2.40	532.64
6	-37.291778	144.690171	517.36	2.40	519.76
7	-37.291805	144.688487	516.35	2.40	518.75
8	-37.291796	144.685772	521.38	2.40	523.78

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.302554	144.697070	538.07	1.50
OP 2	2	-37.299634	144.702466	537.98	1.50
OP 3	3	-37.298030	144.702255	539.93	1.50
OP 4	4	-37.300008	144.694238	530.26	1.50
OP 5	5	-37.303406	144.688473	560.62	1.50
OP 6	6	-37.298376	144.688112	531.90	1.50
OP 7	7	-37.296119	144.688120	528.29	1.50
OP 8	8	-37.296630	144.691341	524.22	1.50
OP 9	9	-37.295398	144.692816	524.56	1.50
OP 10	10	-37.292094	144.692212	527.20	1.50
OP 11	11	-37.292048	144.697252	532.80	1.50
OP 12	12	-37.291222	144.703357	527.00	1.50
OP 13	13	-37.291156	144.704529	519.29	1.50
OP 14	14	-37.292213	144.706894	511.67	1.50
OP 15	15	-37.294094	144.707090	513.56	1.50

Glare Analysis Results

Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	968	16.1	2,721	45.4	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	930	15.5	2,721	45.4
Otts Ln	0	0.0	0	0.0
Rochford Road	38	0.6	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV: PV array 1 potential temporary after-image

Receptor results ordered by category of glare

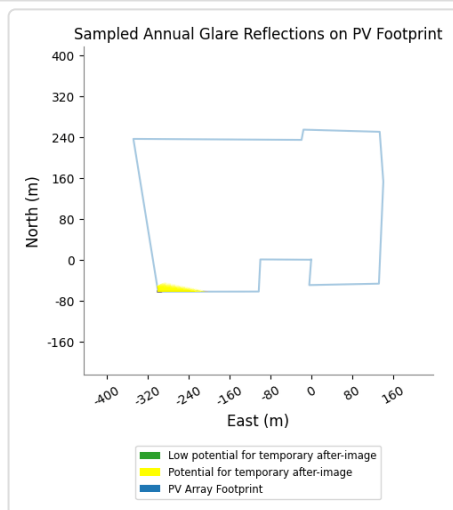
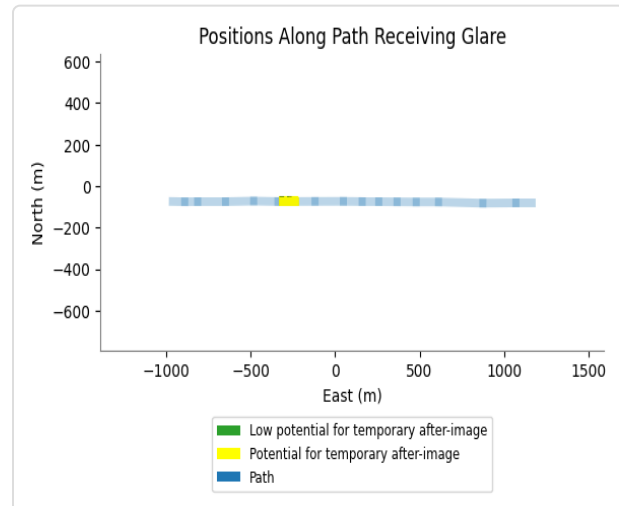
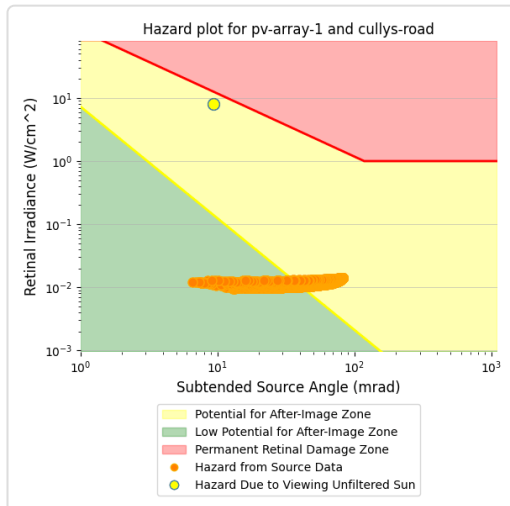
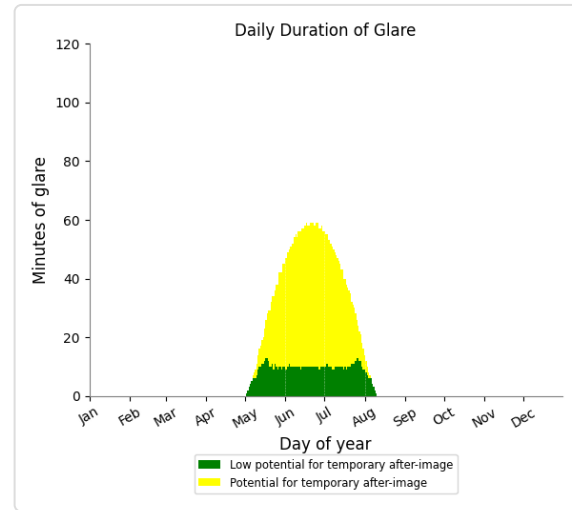
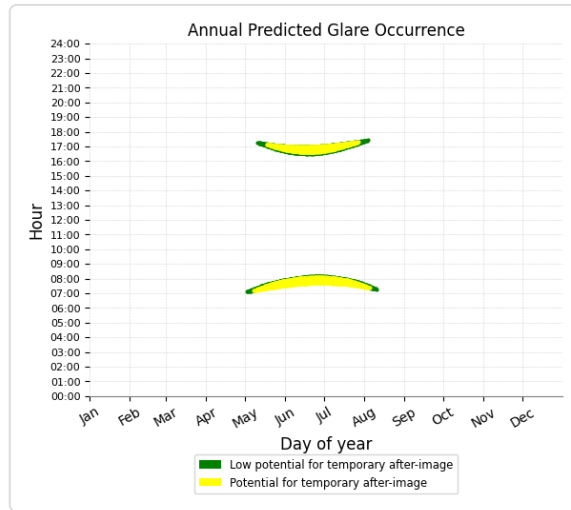
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OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV array 1 and Cullys Road

Receptor type: Route

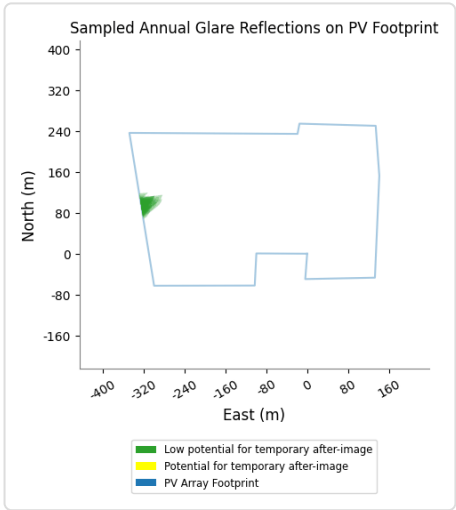
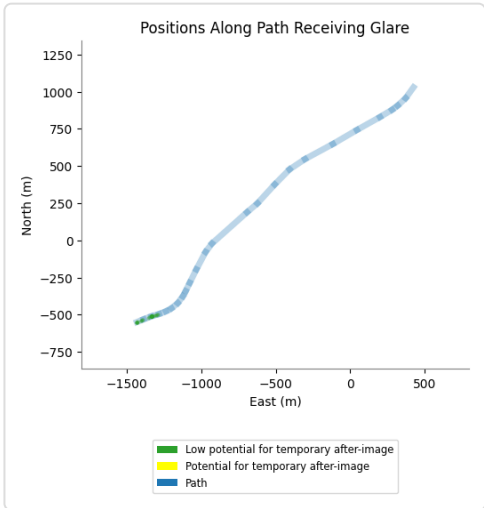
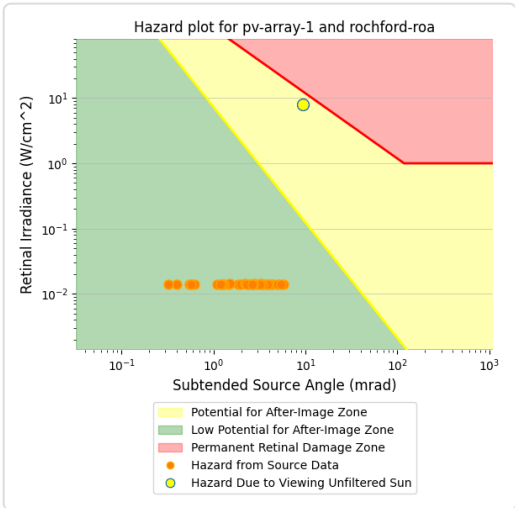
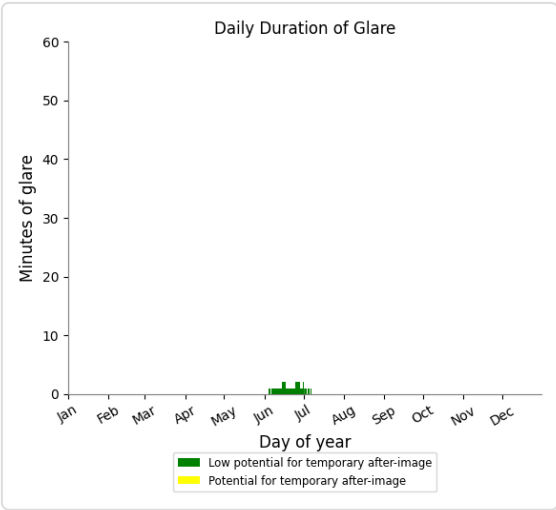
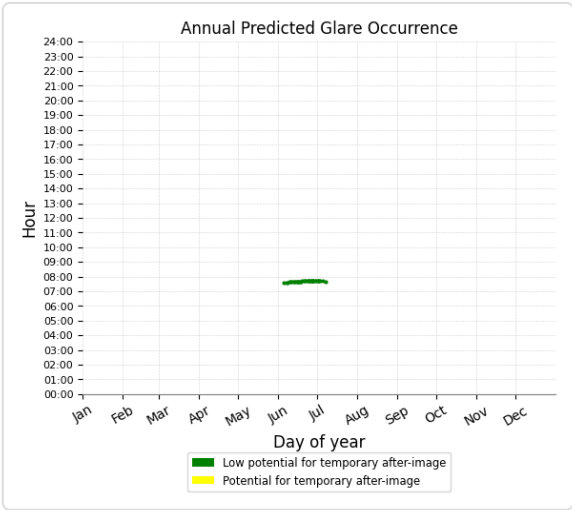
2,721 minutes of yellow glare

930 minutes of green glare



PV array 1 and Rochford Road

Receptor type: Route
0 minutes of yellow glare
38 minutes of green glare



PV array 1 and Collivers Road

Receptor type: Route
No glare found

PV array 1 and Otts Ln

Receptor type: Route
No glare found

PV array 1 and Whitebridge Road

Receptor type: Route
No glare found

PV array 1 and OP 1

Receptor type: Observation Point
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
No glare found

PV array 1 and OP 3

Receptor type: Observation Point
No glare found

PV array 1 and OP 4

Receptor type: Observation Point
No glare found

PV array 1 and OP 5

Receptor type: Observation Point
No glare found

PV array 1 and OP 6

Receptor type: Observation Point
No glare found

PV array 1 and OP 7

Receptor type: Observation Point
No glare found

PV array 1 and OP 8

Receptor type: Observation Point
No glare found

PV array 1 and OP 9

Receptor type: Observation Point
No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV array 1 and OP 12

Receptor type: Observation Point
No glare found

PV array 1 and OP 13

Receptor type: Observation Point
No glare found

PV array 1 and OP 14

Receptor type: Observation Point
No glare found

PV array 1 and OP 15

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

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The analysis does not automatically 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 subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **2237 LANCEFIELD**

Site configuration: **Lancefield Solar Farm 20221102_22d_2987cmH**

Client: NGH

Created 14 Nov, 2022

Updated 20 Nov, 2022

Time-step 1 minute

Timezone offset UTC10

Site ID 79380.13479

Category 1 MW to 5 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2



Summary of Results No glare predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

**ADVERTISED
PLAN**

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 22.0°
Ground Coverage Ratio: 0.75
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.298372	144.699931	534.73	2.48	537.22
2	-37.298819	144.699889	534.19	2.48	536.67
3	-37.298794	144.701425	538.08	2.48	540.56
4	-37.296997	144.701522	539.97	2.48	542.45
5	-37.296119	144.701442	539.50	2.48	541.98
6	-37.296081	144.699761	540.63	2.48	543.11
7	-37.296261	144.699719	539.81	2.48	542.29
8	-37.296244	144.696011	531.02	2.48	533.50
9	-37.298936	144.696556	532.68	2.48	535.17
10	-37.298933	144.698775	532.57	2.48	535.05
11	-37.298367	144.698811	533.28	2.48	535.77

Route Receptors

Name: Collivers Road

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291777	144.713106	510.51	2.40	512.91
2	-37.291794	144.710327	507.98	2.40	510.38
3	-37.291794	144.708310	505.71	2.40	508.11
4	-37.291777	144.705906	514.58	2.40	516.98
5	-37.291760	144.702781	534.87	2.40	537.27
6	-37.291768	144.701148	531.12	2.40	533.52
7	-37.291774	144.700641	530.04	2.40	532.44
8	-37.291742	144.700435	530.01	2.40	532.41

Name: Cullys Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299044	144.689079	529.42	2.40	531.82
2	-37.299055	144.689902	527.76	2.40	530.16
3	-37.299051	144.690766	525.00	2.40	527.40
4	-37.299051	144.692622	526.90	2.40	529.30
5	-37.299025	144.694502	530.28	2.40	532.68
6	-37.299046	144.696122	533.00	2.40	535.40
7	-37.299040	144.698598	532.34	2.40	534.74
8	-37.299037	144.700489	534.82	2.40	537.22
9	-37.299049	144.701744	539.06	2.40	541.46
10	-37.299051	144.702850	537.72	2.40	540.12
11	-37.299057	144.704071	532.40	2.40	534.80
12	-37.299065	144.705350	525.39	2.40	527.79
13	-37.299065	144.706838	520.21	2.40	522.61
14	-37.299117	144.709798	538.31	2.40	540.71
15	-37.299104	144.712002	537.25	2.40	539.65
16	-37.299104	144.713086	537.46	2.40	539.86

Name: Otts Ln
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299041	144.688902	529.86	2.40	532.26
2	-37.299037	144.688495	531.01	2.40	533.41
3	-37.299045	144.686971	537.30	2.40	539.70
4	-37.299058	144.685764	544.11	2.40	546.51
5	-37.299058	144.684471	557.48	2.40	559.88

Name: Rochford Road
 Path type: Two-way
 Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.303323	144.683760	581.28	2.40	583.68
2	-37.303152	144.684269	577.81	2.40	580.21
3	-37.302977	144.684854	572.88	2.40	575.28
4	-37.302832	144.685444	567.69	2.40	570.09
5	-37.302670	144.685959	563.33	2.40	565.73
6	-37.302491	144.686377	560.31	2.40	562.71
7	-37.302171	144.686860	554.74	2.40	557.14
8	-37.301761	144.687246	548.06	2.40	550.46
9	-37.301445	144.687461	543.67	2.40	546.07
10	-37.300937	144.687772	538.37	2.40	540.77
11	-37.300131	144.688271	532.48	2.40	534.88
12	-37.299073	144.688974	529.78	2.40	532.18
13	-37.298560	144.689458	526.93	2.40	529.33
14	-37.296665	144.692118	526.17	2.40	528.57
15	-37.296128	144.692907	525.90	2.40	528.30
16	-37.294980	144.694221	527.46	2.40	529.86
17	-37.294068	144.695348	528.73	2.40	531.13
18	-37.293445	144.696517	530.97	2.40	533.37
19	-37.292532	144.698631	534.35	2.40	536.75
20	-37.291680	144.700457	529.91	2.40	532.31
21	-37.290894	144.702212	527.51	2.40	529.91
22	-37.290455	144.703124	520.76	2.40	523.16
23	-37.290202	144.703548	517.69	2.40	520.09
24	-37.289751	144.704154	514.02	2.40	516.42
25	-37.289093	144.704753	510.58	2.40	512.98

Name: Whitebridge Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291823	144.700014	530.67	2.40	533.07
2	-37.291785	144.698721	533.31	2.40	535.71
3	-37.291776	144.697219	533.11	2.40	535.51
4	-37.291778	144.695107	531.16	2.40	533.56
5	-37.291778	144.692392	530.24	2.40	532.64
6	-37.291778	144.690171	517.36	2.40	519.76
7	-37.291805	144.688487	516.35	2.40	518.75
8	-37.291796	144.685772	521.38	2.40	523.78

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.302554	144.697070	538.07	1.50
OP 2	2	-37.299634	144.702466	537.98	1.50
OP 3	3	-37.298030	144.702255	539.93	1.50
OP 4	4	-37.300008	144.694238	530.26	1.50
OP 5	5	-37.303406	144.688473	560.62	1.50
OP 6	6	-37.298376	144.688112	531.90	1.50
OP 7	7	-37.296119	144.688120	528.29	1.50
OP 8	8	-37.296630	144.691341	524.22	1.50
OP 9	9	-37.295398	144.692816	524.56	1.50
OP 10	10	-37.292094	144.692212	527.20	1.50
OP 11	11	-37.292048	144.697252	532.80	1.50
OP 12	12	-37.291222	144.703357	527.00	1.50
OP 13	13	-37.291156	144.704529	519.29	1.50
OP 14	14	-37.292213	144.706894	511.67	1.50
OP 15	15	-37.294094	144.707090	513.56	1.50

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV array 1 and Collivers Road

Receptor type: Route
No glare found

PV array 1 and Cullys Road

Receptor type: Route
No glare found

PV array 1 and Otts Ln

Receptor type: Route
No glare found

PV array 1 and Rochford Road

Receptor type: Route
No glare found

PV array 1 and Whitebridge Road

Receptor type: Route
No glare found

PV array 1 and OP 1

Receptor type: Observation Point
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
No glare found

PV array 1 and OP 3

Receptor type: Observation Point
No glare found

PV array 1 and OP 4

Receptor type: Observation Point
No glare found

PV array 1 and OP 5

Receptor type: Observation Point
No glare found

PV array 1 and OP 6

Receptor type: Observation Point
No glare found

PV array 1 and OP 7

Receptor type: Observation Point
No glare found

PV array 1 and OP 8

Receptor type: Observation Point
No glare found

PV array 1 and OP 9

Receptor type: Observation Point
No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV array 1 and OP 12

Receptor type: Observation Point
No glare found

PV array 1 and OP 13

Receptor type: Observation Point
No glare found

PV array 1 and OP 14

Receptor type: Observation Point
No glare found

PV array 1 and OP 15

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically 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 subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **2237 LANCEFIELD**

Site configuration: **Lancefield Solar Farm 20221102_22d_2987cmH**

Client: NGH

Created 14 Nov, 2022

Updated 20 Nov, 2022

Time-step 1 minute

Timezone offset UTC10

Site ID 79380.13479

Category 1 MW to 5 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2



Summary of Results No glare predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

**ADVERTISED
PLAN**

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 22.0°
Ground Coverage Ratio: 0.75
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.298372	144.699931	534.73	2.99	537.72
2	-37.298819	144.699889	534.19	2.99	537.18
3	-37.298794	144.701425	538.08	2.99	541.06
4	-37.296997	144.701522	539.97	2.99	542.95
5	-37.296119	144.701442	539.50	2.99	542.48
6	-37.296081	144.699761	540.63	2.99	543.61
7	-37.296261	144.699719	539.81	2.99	542.79
8	-37.296244	144.696011	531.02	2.99	534.00
9	-37.298936	144.696556	532.68	2.99	535.67
10	-37.298933	144.698775	532.57	2.99	535.56
11	-37.298367	144.698811	533.28	2.99	536.27

Route Receptors

Name: Collivers Road

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291777	144.713106	510.51	2.40	512.91
2	-37.291794	144.710327	507.98	2.40	510.38
3	-37.291794	144.708310	505.71	2.40	508.11
4	-37.291777	144.705906	514.58	2.40	516.98
5	-37.291760	144.702781	534.87	2.40	537.27
6	-37.291768	144.701148	531.12	2.40	533.52
7	-37.291774	144.700641	530.04	2.40	532.44
8	-37.291742	144.700435	530.01	2.40	532.41

Name: Cullys Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299044	144.689079	529.42	2.40	531.82
2	-37.299055	144.689902	527.76	2.40	530.16
3	-37.299051	144.690766	525.00	2.40	527.40
4	-37.299051	144.692622	526.90	2.40	529.30
5	-37.299025	144.694502	530.28	2.40	532.68
6	-37.299046	144.696122	533.00	2.40	535.40
7	-37.299040	144.698598	532.34	2.40	534.74
8	-37.299037	144.700489	534.82	2.40	537.22
9	-37.299049	144.701744	539.06	2.40	541.46
10	-37.299051	144.702850	537.72	2.40	540.12
11	-37.299057	144.704071	532.40	2.40	534.80
12	-37.299065	144.705350	525.39	2.40	527.79
13	-37.299065	144.706838	520.21	2.40	522.61
14	-37.299117	144.709798	538.31	2.40	540.71
15	-37.299104	144.712002	537.25	2.40	539.65
16	-37.299104	144.713086	537.46	2.40	539.86

Name: Otts Ln
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299041	144.688902	529.86	2.40	532.26
2	-37.299037	144.688495	531.01	2.40	533.41
3	-37.299045	144.686971	537.30	2.40	539.70
4	-37.299058	144.685764	544.11	2.40	546.51
5	-37.299058	144.684471	557.48	2.40	559.88

Name: Rochford Road
 Path type: Two-way
 Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.303323	144.683760	581.28	2.40	583.68
2	-37.303152	144.684269	577.81	2.40	580.21
3	-37.302977	144.684854	572.88	2.40	575.28
4	-37.302832	144.685444	567.69	2.40	570.09
5	-37.302670	144.685959	563.33	2.40	565.73
6	-37.302491	144.686377	560.31	2.40	562.71
7	-37.302171	144.686860	554.74	2.40	557.14
8	-37.301761	144.687246	548.06	2.40	550.46
9	-37.301445	144.687461	543.67	2.40	546.07
10	-37.300937	144.687772	538.37	2.40	540.77
11	-37.300131	144.688271	532.48	2.40	534.88
12	-37.299073	144.688974	529.78	2.40	532.18
13	-37.298560	144.689458	526.93	2.40	529.33
14	-37.296665	144.692118	526.17	2.40	528.57
15	-37.296128	144.692907	525.90	2.40	528.30
16	-37.294980	144.694221	527.46	2.40	529.86
17	-37.294068	144.695348	528.73	2.40	531.13
18	-37.293445	144.696517	530.97	2.40	533.37
19	-37.292532	144.698631	534.35	2.40	536.75
20	-37.291680	144.700457	529.91	2.40	532.31
21	-37.290894	144.702212	527.51	2.40	529.91
22	-37.290455	144.703124	520.76	2.40	523.16
23	-37.290202	144.703548	517.69	2.40	520.09
24	-37.289751	144.704154	514.02	2.40	516.42
25	-37.289093	144.704753	510.58	2.40	512.98

Name: Whitebridge Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291823	144.700014	530.67	2.40	533.07
2	-37.291785	144.698721	533.31	2.40	535.71
3	-37.291776	144.697219	533.11	2.40	535.51
4	-37.291778	144.695107	531.16	2.40	533.56
5	-37.291778	144.692392	530.24	2.40	532.64
6	-37.291778	144.690171	517.36	2.40	519.76
7	-37.291805	144.688487	516.35	2.40	518.75
8	-37.291796	144.685772	521.38	2.40	523.78

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.302554	144.697070	538.07	1.50
OP 2	2	-37.299634	144.702466	537.98	1.50
OP 3	3	-37.298030	144.702255	539.93	1.50
OP 4	4	-37.300008	144.694238	530.26	1.50
OP 5	5	-37.303406	144.688473	560.62	1.50
OP 6	6	-37.298376	144.688112	531.90	1.50
OP 7	7	-37.296119	144.688120	528.29	1.50
OP 8	8	-37.296630	144.691341	524.22	1.50
OP 9	9	-37.295398	144.692816	524.56	1.50
OP 10	10	-37.292094	144.692212	527.20	1.50
OP 11	11	-37.292048	144.697252	532.80	1.50
OP 12	12	-37.291222	144.703357	527.00	1.50
OP 13	13	-37.291156	144.704529	519.29	1.50
OP 14	14	-37.292213	144.706894	511.67	1.50
OP 15	15	-37.294094	144.707090	513.56	1.50

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV array 1 and Collivers Road

Receptor type: Route
No glare found

PV array 1 and Cullys Road

Receptor type: Route
No glare found

PV array 1 and Otts Ln

Receptor type: Route
No glare found

PV array 1 and Rochford Road

Receptor type: Route
No glare found

PV array 1 and Whitebridge Road

Receptor type: Route
No glare found

PV array 1 and OP 1

Receptor type: Observation Point
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
No glare found

PV array 1 and OP 3

Receptor type: Observation Point
No glare found

PV array 1 and OP 4

Receptor type: Observation Point
No glare found

PV array 1 and OP 5

Receptor type: Observation Point
No glare found

PV array 1 and OP 6

Receptor type: Observation Point
No glare found

PV array 1 and OP 7

Receptor type: Observation Point
No glare found

PV array 1 and OP 8

Receptor type: Observation Point
No glare found

PV array 1 and OP 9

Receptor type: Observation Point
No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV array 1 and OP 12

Receptor type: Observation Point
No glare found

PV array 1 and OP 13

Receptor type: Observation Point
No glare found

PV array 1 and OP 14

Receptor type: Observation Point
No glare found

PV array 1 and OP 15

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically 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 subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **2237 LANCEFIELD**

Site configuration: **Lancefield Solar Farm 20221102_45d_2484cmTracker**

Client: NGH

Created 14 Nov, 2022

Updated 14 Nov, 2022

Time-step 1 minute

Timezone offset UTC10

Site ID 79384.13479

Category 1 MW to 5 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2



Summary of Results No glare predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

**ADVERTISED
PLAN**

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 45.0°
Ground Coverage Ratio: 0.76
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.298372	144.699931	534.73	2.48	537.22
2	-37.298819	144.699889	534.19	2.48	536.67
3	-37.298794	144.701425	538.08	2.48	540.56
4	-37.296997	144.701522	539.97	2.48	542.45
5	-37.296119	144.701442	539.50	2.48	541.98
6	-37.296081	144.699761	540.63	2.48	543.11
7	-37.296261	144.699719	539.81	2.48	542.29
8	-37.296244	144.696011	531.02	2.48	533.50
9	-37.298936	144.696556	532.68	2.48	535.17
10	-37.298933	144.698775	532.57	2.48	535.05
11	-37.298367	144.698811	533.28	2.48	535.77

Route Receptors

Name: Collivers Road

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291777	144.713106	510.51	2.40	512.91
2	-37.291794	144.710327	507.98	2.40	510.38
3	-37.291794	144.708310	505.71	2.40	508.11
4	-37.291777	144.705906	514.58	2.40	516.98
5	-37.291760	144.702781	534.87	2.40	537.27
6	-37.291768	144.701148	531.12	2.40	533.52
7	-37.291774	144.700641	530.04	2.40	532.44
8	-37.291742	144.700435	530.01	2.40	532.41

Name: Cullys Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299044	144.689079	529.42	2.40	531.82
2	-37.299055	144.689902	527.76	2.40	530.16
3	-37.299051	144.690766	525.00	2.40	527.40
4	-37.299051	144.692622	526.90	2.40	529.30
5	-37.299025	144.694502	530.28	2.40	532.68
6	-37.299046	144.696122	533.00	2.40	535.40
7	-37.299040	144.698598	532.34	2.40	534.74
8	-37.299037	144.700489	534.82	2.40	537.22
9	-37.299049	144.701744	539.06	2.40	541.46
10	-37.299051	144.702850	537.72	2.40	540.12
11	-37.299057	144.704071	532.40	2.40	534.80
12	-37.299065	144.705350	525.39	2.40	527.79
13	-37.299065	144.706838	520.21	2.40	522.61
14	-37.299117	144.709798	538.31	2.40	540.71
15	-37.299104	144.712002	537.25	2.40	539.65
16	-37.299104	144.713086	537.46	2.40	539.86

Name: Otts Ln
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299041	144.688902	529.86	2.40	532.26
2	-37.299037	144.688495	531.01	2.40	533.41
3	-37.299045	144.686971	537.30	2.40	539.70
4	-37.299058	144.685764	544.11	2.40	546.51
5	-37.299058	144.684471	557.48	2.40	559.88

Name: Rochford Road
 Path type: Two-way
 Observer view angle: 50.0°



ADVERTISED PLAN

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.303323	144.683760	581.28	2.40	583.68
2	-37.303152	144.684269	577.81	2.40	580.21
3	-37.302977	144.684854	572.88	2.40	575.28
4	-37.302832	144.685444	567.69	2.40	570.09
5	-37.302670	144.685959	563.33	2.40	565.73
6	-37.302491	144.686377	560.31	2.40	562.71
7	-37.302171	144.686860	554.74	2.40	557.14
8	-37.301761	144.687246	548.06	2.40	550.46
9	-37.301445	144.687461	543.67	2.40	546.07
10	-37.300937	144.687772	538.37	2.40	540.77
11	-37.300131	144.688271	532.48	2.40	534.88
12	-37.299073	144.688974	529.78	2.40	532.18
13	-37.298560	144.689458	526.93	2.40	529.33
14	-37.296665	144.692118	526.17	2.40	528.57
15	-37.296128	144.692907	525.90	2.40	528.30
16	-37.294980	144.694221	527.46	2.40	529.86
17	-37.294068	144.695348	528.73	2.40	531.13
18	-37.293445	144.696517	530.97	2.40	533.37
19	-37.292532	144.698631	534.35	2.40	536.75
20	-37.291680	144.700457	529.91	2.40	532.31
21	-37.290894	144.702212	527.51	2.40	529.91
22	-37.290455	144.703124	520.76	2.40	523.16
23	-37.290202	144.703548	517.69	2.40	520.09
24	-37.289751	144.704154	514.02	2.40	516.42
25	-37.289093	144.704753	510.58	2.40	512.98

Name: Whitebridge Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291823	144.700014	530.67	2.40	533.07
2	-37.291785	144.698721	533.31	2.40	535.71
3	-37.291776	144.697219	533.11	2.40	535.51
4	-37.291778	144.695107	531.16	2.40	533.56
5	-37.291778	144.692392	530.24	2.40	532.64
6	-37.291778	144.690171	517.36	2.40	519.76
7	-37.291805	144.688487	516.35	2.40	518.75
8	-37.291796	144.685772	521.38	2.40	523.78

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.302554	144.697070	538.07	1.50
OP 2	2	-37.299634	144.702466	537.98	1.50
OP 3	3	-37.298030	144.702255	539.93	1.50
OP 4	4	-37.300008	144.694238	530.26	1.50
OP 5	5	-37.303406	144.688473	560.62	1.50
OP 6	6	-37.298376	144.688112	531.90	1.50
OP 7	7	-37.296119	144.688120	528.29	1.50
OP 8	8	-37.296630	144.691341	524.22	1.50
OP 9	9	-37.295398	144.692816	524.56	1.50
OP 10	10	-37.292094	144.692212	527.20	1.50
OP 11	11	-37.292048	144.697252	532.80	1.50
OP 12	12	-37.291222	144.703357	527.00	1.50
OP 13	13	-37.291156	144.704529	519.29	1.50
OP 14	14	-37.292213	144.706894	511.67	1.50
OP 15	15	-37.294094	144.707090	513.56	1.50

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV array 1 and Collivers Road

Receptor type: Route
No glare found

PV array 1 and Cullys Road

Receptor type: Route
No glare found

PV array 1 and Otts Ln

Receptor type: Route
No glare found

PV array 1 and Rochford Road

Receptor type: Route
No glare found

PV array 1 and Whitebridge Road

Receptor type: Route
No glare found

PV array 1 and OP 1

Receptor type: Observation Point
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
No glare found

PV array 1 and OP 3

Receptor type: Observation Point
No glare found

PV array 1 and OP 4

Receptor type: Observation Point
No glare found

PV array 1 and OP 5

Receptor type: Observation Point
No glare found

PV array 1 and OP 6

Receptor type: Observation Point
No glare found

PV array 1 and OP 7

Receptor type: Observation Point
No glare found

PV array 1 and OP 8

Receptor type: Observation Point
No glare found

PV array 1 and OP 9

Receptor type: Observation Point
No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV array 1 and OP 12

Receptor type: Observation Point
No glare found

PV array 1 and OP 13

Receptor type: Observation Point
No glare found

PV array 1 and OP 14

Receptor type: Observation Point
No glare found

PV array 1 and OP 15

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically 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 subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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FORGESOLAR GLARE ANALYSIS

Project: **2237 LANCEFIELD**

Site configuration: **Lancefield Solar Farm 20221102_45d_2987cmH**

Client: NGH

Created 14 Nov, 2022

Updated 14 Nov, 2022

Time-step 1 minute

Timezone offset UTC10

Site ID 79381.13479

Category 1 MW to 5 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2



Summary of Results No glare predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

**ADVERTISED
PLAN**

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 45.0°
Ground Coverage Ratio: 0.75
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.298372	144.699931	534.73	2.99	537.72
2	-37.298819	144.699889	534.19	2.99	537.18
3	-37.298794	144.701425	538.08	2.99	541.06
4	-37.296997	144.701522	539.97	2.99	542.95
5	-37.296119	144.701442	539.50	2.99	542.48
6	-37.296081	144.699761	540.63	2.99	543.61
7	-37.296261	144.699719	539.81	2.99	542.79
8	-37.296244	144.696011	531.02	2.99	534.00
9	-37.298936	144.696556	532.68	2.99	535.67
10	-37.298933	144.698775	532.57	2.99	535.56
11	-37.298367	144.698811	533.28	2.99	536.27

Route Receptors

Name: Collivers Road

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291777	144.713106	510.51	2.40	512.91
2	-37.291794	144.710327	507.98	2.40	510.38
3	-37.291794	144.708310	505.71	2.40	508.11
4	-37.291777	144.705906	514.58	2.40	516.98
5	-37.291760	144.702781	534.87	2.40	537.27
6	-37.291768	144.701148	531.12	2.40	533.52
7	-37.291774	144.700641	530.04	2.40	532.44
8	-37.291742	144.700435	530.01	2.40	532.41

Name: Cullys Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299044	144.689079	529.42	2.40	531.82
2	-37.299055	144.689902	527.76	2.40	530.16
3	-37.299051	144.690766	525.00	2.40	527.40
4	-37.299051	144.692622	526.90	2.40	529.30
5	-37.299025	144.694502	530.28	2.40	532.68
6	-37.299046	144.696122	533.00	2.40	535.40
7	-37.299040	144.698598	532.34	2.40	534.74
8	-37.299037	144.700489	534.82	2.40	537.22
9	-37.299049	144.701744	539.06	2.40	541.46
10	-37.299051	144.702850	537.72	2.40	540.12
11	-37.299057	144.704071	532.40	2.40	534.80
12	-37.299065	144.705350	525.39	2.40	527.79
13	-37.299065	144.706838	520.21	2.40	522.61
14	-37.299117	144.709798	538.31	2.40	540.71
15	-37.299104	144.712002	537.25	2.40	539.65
16	-37.299104	144.713086	537.46	2.40	539.86

Name: Otts Ln
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.299041	144.688902	529.86	2.40	532.26
2	-37.299037	144.688495	531.01	2.40	533.41
3	-37.299045	144.686971	537.30	2.40	539.70
4	-37.299058	144.685764	544.11	2.40	546.51
5	-37.299058	144.684471	557.48	2.40	559.88

Name: Rochford Road
 Path type: Two-way
 Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.303323	144.683760	581.28	2.40	583.68
2	-37.303152	144.684269	577.81	2.40	580.21
3	-37.302977	144.684854	572.88	2.40	575.28
4	-37.302832	144.685444	567.69	2.40	570.09
5	-37.302670	144.685959	563.33	2.40	565.73
6	-37.302491	144.686377	560.31	2.40	562.71
7	-37.302171	144.686860	554.74	2.40	557.14
8	-37.301761	144.687246	548.06	2.40	550.46
9	-37.301445	144.687461	543.67	2.40	546.07
10	-37.300937	144.687772	538.37	2.40	540.77
11	-37.300131	144.688271	532.48	2.40	534.88
12	-37.299073	144.688974	529.78	2.40	532.18
13	-37.298560	144.689458	526.93	2.40	529.33
14	-37.296665	144.692118	526.17	2.40	528.57
15	-37.296128	144.692907	525.90	2.40	528.30
16	-37.294980	144.694221	527.46	2.40	529.86
17	-37.294068	144.695348	528.73	2.40	531.13
18	-37.293445	144.696517	530.97	2.40	533.37
19	-37.292532	144.698631	534.35	2.40	536.75
20	-37.291680	144.700457	529.91	2.40	532.31
21	-37.290894	144.702212	527.51	2.40	529.91
22	-37.290455	144.703124	520.76	2.40	523.16
23	-37.290202	144.703548	517.69	2.40	520.09
24	-37.289751	144.704154	514.02	2.40	516.42
25	-37.289093	144.704753	510.58	2.40	512.98

Name: Whitebridge Road
Path type: Two-way
Observer view angle: 50.0°

ADVERTISED PLAN



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.291823	144.700014	530.67	2.40	533.07
2	-37.291785	144.698721	533.31	2.40	535.71
3	-37.291776	144.697219	533.11	2.40	535.51
4	-37.291778	144.695107	531.16	2.40	533.56
5	-37.291778	144.692392	530.24	2.40	532.64
6	-37.291778	144.690171	517.36	2.40	519.76
7	-37.291805	144.688487	516.35	2.40	518.75
8	-37.291796	144.685772	521.38	2.40	523.78

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.302554	144.697070	538.07	1.50
OP 2	2	-37.299634	144.702466	537.98	1.50
OP 3	3	-37.298030	144.702255	539.93	1.50
OP 4	4	-37.300008	144.694238	530.26	1.50
OP 5	5	-37.303406	144.688473	560.62	1.50
OP 6	6	-37.298376	144.688112	531.90	1.50
OP 7	7	-37.296119	144.688120	528.29	1.50
OP 8	8	-37.296630	144.691341	524.22	1.50
OP 9	9	-37.295398	144.692816	524.56	1.50
OP 10	10	-37.292094	144.692212	527.20	1.50
OP 11	11	-37.292048	144.697252	532.80	1.50
OP 12	12	-37.291222	144.703357	527.00	1.50
OP 13	13	-37.291156	144.704529	519.29	1.50
OP 14	14	-37.292213	144.706894	511.67	1.50
OP 15	15	-37.294094	144.707090	513.56	1.50

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Collivers Road	0	0.0	0	0.0
Cullys Road	0	0.0	0	0.0
Otts Ln	0	0.0	0	0.0
Rochford Road	0	0.0	0	0.0
Whitebridge Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0

PV array 1 and Collivers Road

Receptor type: Route
No glare found

PV array 1 and Cullys Road

Receptor type: Route
No glare found

PV array 1 and Otts Ln

Receptor type: Route
No glare found

PV array 1 and Rochford Road

Receptor type: Route
No glare found

PV array 1 and Whitebridge Road

Receptor type: Route
No glare found

PV array 1 and OP 1

Receptor type: Observation Point
No glare found

PV array 1 and OP 2

Receptor type: Observation Point
No glare found

PV array 1 and OP 3

Receptor type: Observation Point
No glare found

PV array 1 and OP 4

Receptor type: Observation Point
No glare found

PV array 1 and OP 5

Receptor type: Observation Point
No glare found

PV array 1 and OP 6

Receptor type: Observation Point
No glare found

PV array 1 and OP 7

Receptor type: Observation Point
No glare found

PV array 1 and OP 8

Receptor type: Observation Point
No glare found

PV array 1 and OP 9

Receptor type: Observation Point
No glare found

PV array 1 and OP 10

Receptor type: Observation Point
No glare found

PV array 1 and OP 11

Receptor type: Observation Point
No glare found

PV array 1 and OP 12

Receptor type: Observation Point
No glare found

PV array 1 and OP 13

Receptor type: Observation Point
No glare found

PV array 1 and OP 14

Receptor type: Observation Point
No glare found

PV array 1 and OP 15

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not automatically 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 subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

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- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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