



# Auckland Surf Park Community Solar Facility

## Glint and Glare Assessment

### AW Holdings 2021 Ltd

c/o **Barker & Associates**

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## Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
R01-v1.0	5 December 2025	Peter Hayman	Dr Peter Georgiou	Dr Peter Georgiou
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## Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with AW Holdings 2021 Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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## Executive Summary

SLR Consulting Australia (SLR) has been engaged by AW Holdings 2021 Ltd to carry out a Reflective Glare assessment of the amended proposal for the 5.3 MWdc Auckland Surf Park Community Solar Facility (herein the “Project”).

The Auckland Surf Park Community development is located within Auckland Council boundaries, just to the west of North Shore Airport, bounded by Route 31 (Dairy Flat Highway) to the west and Postman Road to the east. The amended solar facility is located centrally within the development with a north-south configuration of three separate areas of solar panels: North, Central and South.

The solar facility would deploy a Single-Axis Tracking (SAT) System in a  $\pm 60^\circ$  maximum tilt, 1-portrait (“1P”) configuration, with panels mounted on north-south rows tilting towards the east and west throughout the day.

### GLARE CONDITIONS ANALYSED

#### Aviation Glare

The potential for aviation glare was assessed at North Shore Airport, which lies just to the east of the Project.

#### Road and Rail Disability Glare

The potential for glare was assessed along the nearest surrounding carriageways:

- Dairy Flat Highway, Horseshoe Bush Road, Lascelles Drive, Postman Road, and Wilks Road.
- “NEW” Road, which intersects the development connecting Dairy Flat Highway and Postman Road.

There are no rail lines close enough to the Site to create the potential for disability glare.

#### Residential Nuisance Glare

The potential for glare was assessed at 37 surrounding dwellings located up to 1 km from the Site. This included newly planned residential areas to the immediate west of the Project’s three solar panel sub-arrays.

### GLARE SCENARIOS ANALYSED

The present study has examined glare potential for the following scenarios:

- “Baseline” Scenario: involving calculations with a Rest Angle of  $0^\circ$  and inclusion of the planned 1.5 m target height solar array perimeter vegetation screening.
- “Mitigation” Scenarios via variable Rest Angle: involving calculations with Rest Angle values of  $5^\circ$ ,  $10^\circ$ ,  $15^\circ$  and  $20^\circ$ .
- “Mitigation” Scenario via additional Vegetation Screening along the western perimeter of the Project’s solar arrays.

### GLARE ASSESSMENT MODELLING TOOL

The SANDIA Labs SGHAT software suite was used for the present study.

SGHAT PV Solar reflection predictions fall into two categories – refer **Section 4**.

- SGHAT GREEN - reflections with low potential to cause “after-image” impact.
- SGHAT YELLOW - reflections with potential to cause “after-image” impact.



## GLARE CRITERIA

### Criteria for Aviation Glare

- Landing Flight Paths: NO SGHAT YELLOW Category glare
- Air Traffic Control Tower: NO SGHAT GREEN or YELLOW Category glare

### Criteria for Road Traffic Disability Glare

- Any instance of potential SGHAT YELLOW Category glare warrants consideration of mitigation.

### Criteria for Residential Nuisance Glare

- The magnitude of potential SGHAT YELLOW Category glare is assessed via the amenity objectives shown in **Table 1**.

## GLARE ANALYSIS RESULTS

### BASELINE Scenarios

#### Aviation Glare

- NIL glare was predicted for Runway 03, Runway 21 and Runway 27.
- Substantial SGHAT YELLOW glare was predicted for Runway 09.

Note: the aerodrome does not have an ATCT.

#### Road Traffic Disability Glare

- NIL glare was predicted for ALL surrounding roads, including “NEW” Road within the development.

#### Residential Nuisance Glare

- NIL glare was predicted for Residences 1-29, which lie some distance from the Project.
- SGHAT YELLOW glare was predicted for Residences 30-37, all of which lie to the immediate west of the Project. The occurrence of reflections at these residences is due largely to their two-storey nature.

#### Detailed Analysis of Baseline Results

The reflection conditions predicted on Residences 30-37 were examined further in light of the observation (refer **Section 3**) that for very high Incidence Angles, it would almost always be the case that an observer would perceive reflections coming from virtually the same direction as the incoming direct solar rays themselves. Such a condition (refer **Figure 13**) would not constitute a glare situation as the intensity of the incoming direct solar ray itself would dominate the field of vision perceived by the observer.

SLR has examined the predicted reflections onto Residences Op30-37 in the above context.

- North Sub-Array Incidence Angle occurrence down to 79°.
- Central Sub-Array Incidence Angle occurrence down to 83°.
- South Sub-Array Incidence Angle occurrence down to 80°.

The “High Incidence Angle” condition shown in **Figure 13** therefore does not apply to reflections from the North and South sub-arrays and is somewhat borderline for the Central sub-array.



## Mitigation via Variable Rest Angle

Further modelling was undertaken to assess the influence of Rest Angle – refer results in **Table 4**. The focus of these simulations was on the potential glare for Runway 09 from the North sub-array and potential glare at Residences 30-37 (the two-storey dwellings located immediately to the west of the solar arrays) from all three sub-arrays.

### Regarding Aviation Glare

- SGHAT YELLOW glare for Runway 09 only occurs from the North sub-array; and
- All instances of glare are eliminated with a Rest Angle of 20° – note that these are EARLY MORNING reflections for the Runway 09 landing path and hence no restrictions are needed for the AFTERNOON Rest Angle.

SLR further examined the spatial distribution of the relevant reflections on the North sub-array – this is shown in **Figure 14**.

- As the Rest Angle INCREASES, the area within the North sub-array causing the SGHAT YELLOW glare of concern DECREASES, concentrated within the southern part of the sub-array.
- This suggests that the Rest Angle mitigation for the North sub-array could be staggered, with different sub-sections of the sub-array employing different Rest Angles.

### Mitigation Recommendation for AVIATION GLARE

Using the results of the variable Rest Angle simulations, a mitigation option has been developed which addresses aviation glare for Runway 09 – refer **Figure 15**.

- This option ALSO results in the elimination of ALL potential adverse reflections from the North sub-array onto the residences lying immediately to the west.

## Mitigation via Additional Perimeter Vegetation Screening

Additional modelling was undertaken to assess the influence of an increase in vegetation screening for the Central and South sub-arrays relevant to the potential impact on residences lying immediately to the west – refer results in **Table 5**.

This involved increasing the target height of the already planned perimeter vegetation to 4 m – note: only along the western perimeter of these two sub-arrays. **Table 5** shows the total annual minutes of potential SGHAT YELLOW glare for the increased Western Perimeter vegetation, summarised below:

### Aviation Glare

- Significant SGHAT YELLOW persists on Runway 09 from the North sub-array.

### Road Traffic Disability Glare

- NIL glare predicted for ALL roads (no change from Baseline Scenario).

### Residential Nuisance Glare

- NIL glare predicted for ALL residences from ALL sub-arrays.



## MITIGATION CONCLUSIONS

### Aviation Glare Mitigation / North Sub-Array

- Aviation glare from the proposed solar facility is restricted to potential glare on North Shore Airport's **Runway 09**.
- The Runway 09 glare condition only arises from the facility's **North Sub-Array**.
- Perimeter vegetation screening around the North Sub-Array is not an effective mitigation option at a feasible height.
- A mitigation solution involving restrictions to the solar panel SAT **Rest Angle** of the North Sub-Array has been developed – refer **Figure 15**.
  - The recommended restrictions **ONLY** apply to the **MORNING** Rest Angle.
  - No restrictions are required for the **AFTERNOON** Rest Angle.
- Finally, it is noted that the recommended Rest Angle mitigation solution **ALSO** eliminates all potential residential nuisance glare for the proposed dwellings to be located immediately to the west of the North Sub-Array.

### Residential Nuisance Glare Mitigation / Central & South Sub-Arrays

TWO options exist for the elimination of residential nuisance glare for the proposed dwellings to be located immediately to the west of the Central and South Sub-Arrays.

#### Option 1

- Restrict the **MORNING** Rest Angle to **5°** for the Central and South Sub-Arrays.
- Note that no restriction would be required for the **AFTERNOON** Rest Angle for the Central and South Sub-Arrays.

#### Option 2

- Increase the target height of the perimeter vegetation screening to **4 m** for the **WESTERN perimeters** only of the Central and South Sub-Arrays.

#### Option 2 - Interim Vegetation Growth Period

At the time of installation, the future Project-planned vegetation will likely not be planted at the target Option 2 4 m target height for the Central and South Sub-Array western perimeters. Accordingly, there will be an interim growth period before the proposed Option 2 additional vegetation screening for the Central and South Sub-Arrays reaches the 4 m target height (at which point **NIL** glare is predicted for all residences).

The following recommendation relevant to Option 2 is therefore made to ensure that the Project will result in **NIL** glare at all surrounding sensitive receptors during this interim growth period:

#### Central & South Sub-Arrays

- Restrict the **MORNING** Rest Angle to **5°** for the Central and South Sub-Arrays during the Interim Vegetation Growth Period.

The above mitigation recommendations are summarised in **Table 6**.



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## Acronyms and Abbreviations

PV Panel	Photovoltaic (PV) panels are designed to absorb solar energy and retain as much of the solar spectrum as possible in order to produce electricity.
Glare	Glare refers to the reflections of the sun off any reflective surface, experienced as a source of excessive brightness relative to the surrounding diffused lighting. Glare covers reflections: <ul style="list-style-type: none"> <li>. Which can be experienced by both stationary and moving observers (the latter referred to as “glint”).</li> <li>. Which are either specular or diffuse.</li> </ul>
Specular	A reflection which is essentially mirror-like – there is virtually no loss of intensity or angle dispersion between the incoming solar ray and outgoing reflection. 
Diffuse	A reflection in which the outgoing reflected rays are dispersed over a wide (“diffuse”) range of angle compared to the incoming (parallel) solar rays, typical of “rougher” surfaces. 
KVP	Key View Points (KVPs) are offsite locations where receivers of interest have the potential to experience adverse reflective glare.
Glare <b>AS/NZ 1158.2:2020</b>	Condition of vision in which there is a discomfort or a reduction in the ability to see, or both, caused by an unsuitable distribution or range of luminance, or to extreme contrast in the field of vision. Glare can take the form of: <ol style="list-style-type: none"> <li>(a) Disability Glare – glare that impairs the visibility of objects without necessarily causing discomfort. This is relevant to Motorist Disability Glare, a safety issue.</li> <li>(b) Discomfort Glare – glare that causes discomfort without necessarily impairing the visibility of objects. This is relevant to Residential Nuisance Glare, an amenity issue.</li> </ol>



## 1.0 Introduction

SLR Consulting Australia (SLR) has been engaged by AW Holdings 2021 Ltd to carry out a Reflective Glare assessment of the amended proposal for the 5.3 MWdc Auckland Surf Park Community Solar Facility (herein the “Project”).

The Auckland Surf Park Community development is located within Auckland Council boundaries, just to the west of North Shore Airport, bounded by Route 31 (Dairy Flat Highway) to the west and Postman Road to the east. The amended solar facility is located centrally within the development with a north-south configuration of three separate areas of solar panels: North, Central and South.

The solar facility would deploy a Single-Axis Tracking (SAT) System in a  $\pm 60^\circ$  maximum tilt, 1-portrait (“1P”) configuration, with panels mounted on north-south rows tilting towards the east and west throughout the day.

### 1.1 Glare Conditions Analysed

#### Aviation Glare

The potential for aviation glare was assessed at North Shore Airport, which lies just to the east of the Project.

#### Road and Rail Disability Glare

The potential for glare was assessed along the nearest surrounding carriageways:

- Existing roads: Dairy Flat Highway, Horseshoe Bush Road, Lascelles Drive, Postman Road, and Wilks Road.
- Future “New Road”, which intersects the development connecting Dairy Flat Highway and Postman Road.

There are no rail lines close enough to the Site to create the potential for disability glare.

#### Residential Nuisance Glare

The potential for glare was assessed at 37 surrounding dwellings located up to 1 km from the Site. This included newly planned residential areas to the immediate west of the Project’s three solar panel sub-arrays.

### 1.2 Structure of Report

The remainder of this report is structured as follows:

- **Section 2** describes the Project and surrounding environment.
- **Section 3** outlines the requirements of the impact assessment.
- **Section 4** provides background information regarding the calculation of reflectivity and glare.
- **Section 5** presents the glare modelling inputs.
- **Section 6** presents the analysis, results and proposed mitigations.



### 1.3 Statement of Qualifications

Over the past three decades SLR has conducted literally hundreds of reflective glare studies on buildings and solar facilities.

These studies have covered both:

- Daytime Reflective Glint & Glare; and
- Night-Time Illumination Glare.

Potential glare impacts include:

- Aviation Glare;
- Road and Rail Disability Glare; and
- Residential Nuisance Glare.

For reflective glare studies, SLR uses:

- The US FAA-approved ForgeSolar SGHAT software suite; and
- SLR's own in-house software for Threshold Increment (TI) Value computation.

The CV for the team lead for this study, Dr Peter Georgiou, is included in **Appendix B**. Peter is SLR's Global Technical Director for Solar Glare studies and has appeared as an Expert Witness regarding glare impact for solar facilities in New Zealand, Australia and Canada.



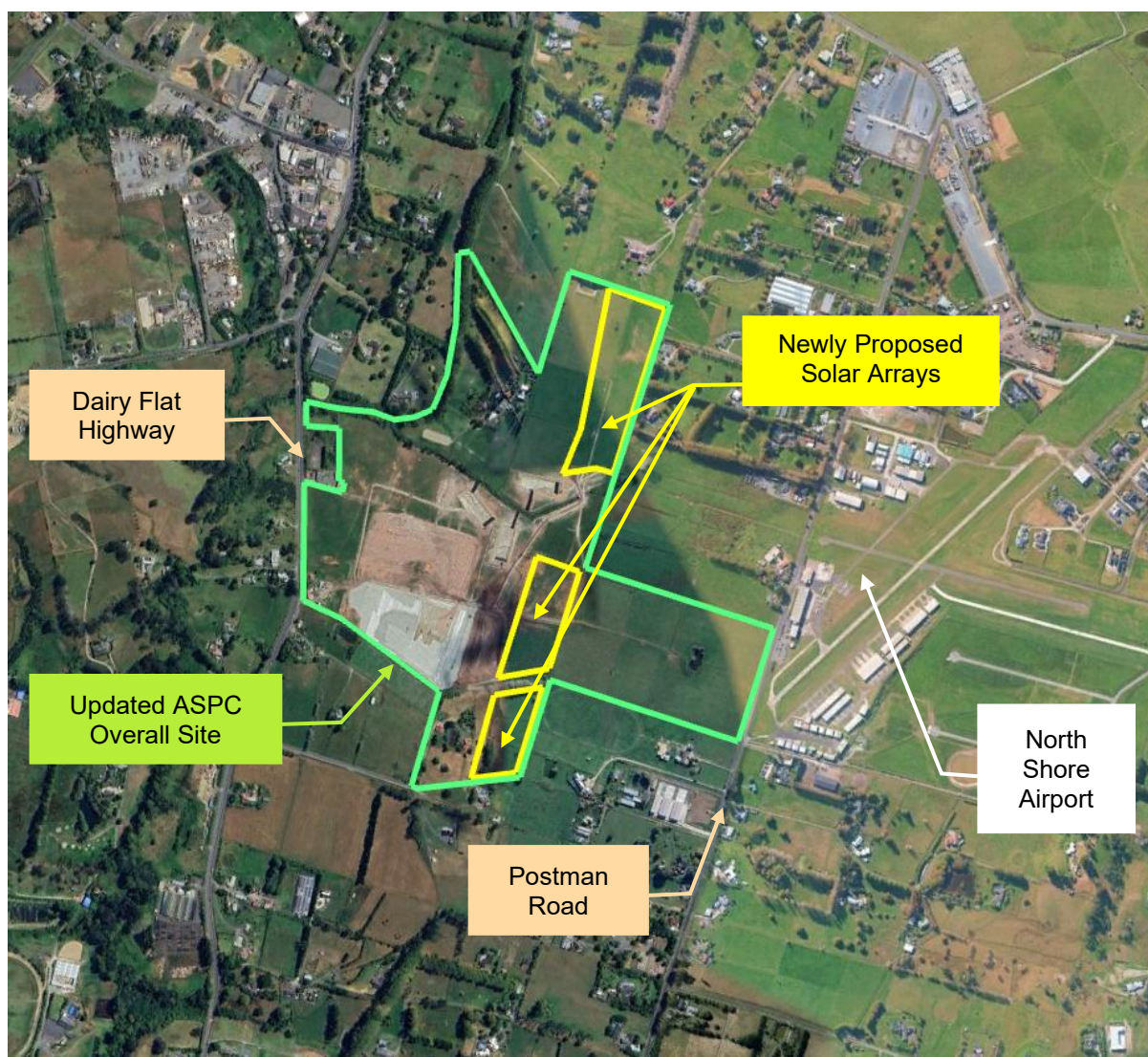
## 2.0 Auckland Surf Park Community Development

### 2.1 Site Location

A variation to its previous development approval is being submitted for the Auckland Surf Park Community (ASPC) Development - location shown in **Figure 1**.

- The development is located within Auckland Council boundaries, just to the west of North Shore Airport.
- The amended site is bounded by Route 31 (Dairy Flat Highway) to the west and Postman Road to the east. The site addresses are 1320 and 1350 Dairy Flat Highway, 89 and 105 Lascelles Drive, and 237 and 253 Postman Road, Dairy Flat, Auckland.
- The updated configuration of solar arrays within the overall development consists of three separated sub-arrays (North, Central and South) running in a north-south spine through the centre of the updated development footprint.

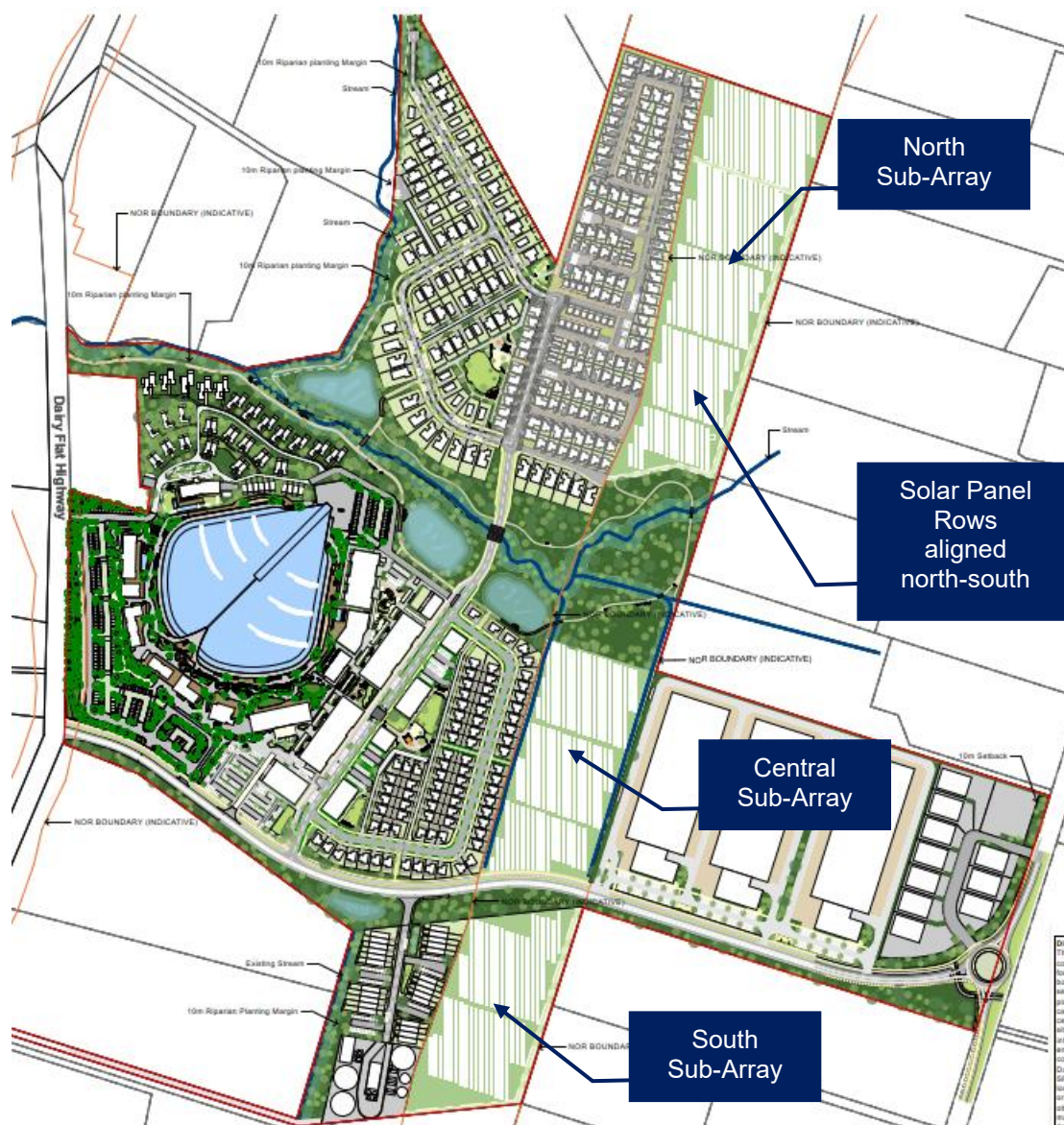
**Figure 1** ASPC – Location Map



## 2.2 Updated Solar Facility Overall Layout

The updated ASPC Solar Facility will comprise three separate sub-array blocks (North, Central and South) as shown in **Figure 2**) with solar panels oriented in north-south rows.

**Figure 2 ASPC Solar Farm Site Layout**



In terms of the relative heights of the Project site and surrounds, the ground elevations at the site vary modestly:

- Elevations (m) within the solar farm vary from RL61m (to the north) to RL59m (to the south) with a slight dip in between to RL56m in the area of the Central Sub-Array.

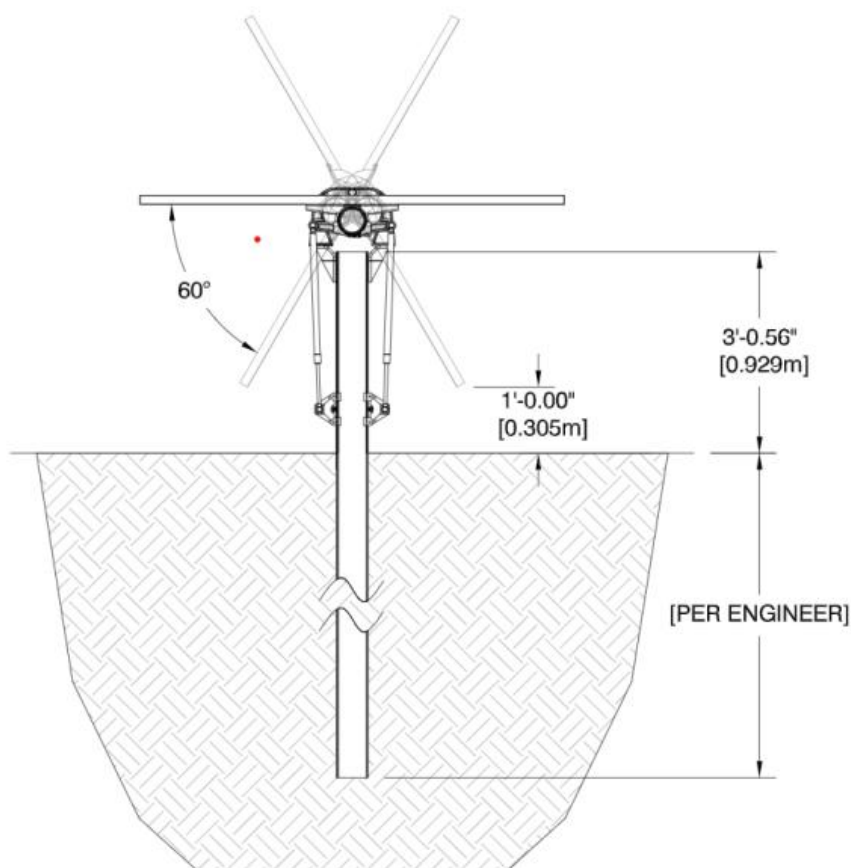


## 2.3 Panel Support System

The rows of panels will be supported by a Single-Axis Tracking (SAT) System in a 1-portrait (“1P”) configuration (refer **Figure 3**) with the following characteristics:

- The median height of the panels (at the support rotation point) will be approximately 1.2 m.
- The panels will have a maximum tilt of  $\pm 60^\circ$  facing east and west.
- The inter-row spacing of the panel rows will be approximately 5 m.
- The resulting ground coverage ratio will be approximately 46%.
- The SAT system will support “Back-Tracking”, such that panel orientation at the start and end of the day can have a “Rest” Angle of  $0^\circ$ , ie horizontal. Note that, overnight, panels are “stowed” at a reasonably steep angle (so as to avoid hail damage in the event of a severe storm).

**Figure 3 Sideview of Proposed Single-Axis Tracking Support System**



## 3.0 Requirements

There is currently no known local planning guidance within New Zealand for quantifying the impacts associated with solar reflections from PV panels covering Aviation Glare, Road and Rail Traffic Disability Glare or Residential Nuisance Glare.

### Aviation Glare

In relation to the potential impact of solar PV systems on aviation activity, guidance is available from the US Federal Aviation Administration (FAA) which regulates and oversees all aspects of American civil aviation. The FAA issued a Technical Guidance Policy in 2010 and a subsequent (over-riding) Interim Policy in 2013, which was updated again in 2018.

- FAA, “*Technical Guidance for Evaluating Selected Solar Technologies on Airports*”, Federal Aviation Administration, Washington, D.C., November 2010.
- FAA, “*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports*”, Federal Register, Oct. 23, 2013.
- FAA, “*Technical Guidance for Evaluating Selected Solar Technologies on Airports*”, Federal Aviation Administration, Washington, D.C., Version 1.1, April 2018.

The above interim policy and guidance notes the use of the ForgeSolar SGHAT software tool to assess aviation glare. SGHAT has been accepted by regulatory bodies globally including New Zealand’s Civil Aviation Authority (CAA).

In the above interim policy and guidance notes, the SGHAT glare criteria were:

- Airport Traffic Control Tower (ATCT): NO GREEN or YELLOW Glare
- Aircraft Landing: NO YELLOW Glare (GREEN is permissible)

In 2021 the FAA released updated guidance:

- FAA, “*FAA Aviation Administration Policy, Review of Solar Energy System Projects on Federally Obligated Airports*”, Federal Register, Vol.86, No.89, May 11, 2021.

In this updated policy:

- The FAA concluded that the glare from solar installations impacting on pilots is similar to the glare routinely experienced by pilots from bodies of water and glass-facade buildings.
- Accordingly, the FAA refined the scope of their policy to focus on the glare received by ATCTs (Air Traffic Control Towers) and no longer provide guidance as to the glare experienced by pilots on final (landing) approach.

SLR has taken a **precautionary approach** and has continued to include assessment of approach flightpaths, especially when they are in close proximity to a proposed solar facility, given that this will be a new source of potential glare.

In doing so we take into account the severity of the SGHAT predictions in terms of both their duration and the magnitude of predicted “YELLOW” zone glare, when recommending consideration of mitigation.

The potential for aviation glare was assessed at North Shore Airport, which lies less than 1 km from the nearest proposed solar arrays.



## Residential Nuisance Glare

SLR notes the criteria available in the New South Wales (NSW) Large Scale Solar Energy (LSSE) Guideline (2022). The LSSE Guideline categorises Residential Nuisance Glare as “High”, “Moderate” or “Low” impact, depending on the predicted minutes per day and/or hours per year of glare.

**Table 1** summarises the three impact levels and associated amenity objectives.

- When applying the LSSE Guideline to Residential Nuisance Glare, it is standard industry practice to use the occurrence of predicted SGHAT YELLOW glare, noting that SGHAT GREEN glare:
  - a) implies LOW potential for an after-image; and
  - b) is acceptable in terms of aviation glare for pilots on final landing approach.

**Table 1 Extract (Table 2) from NSW Large-Scale Solar Energy Guideline (2022)**

High glare impact	Moderate glare impact	Low glare impact
> 30 minutes per day > 30 hours per year	< 30 minutes & > 10 minutes per day < 30 hours & > 10 hours per year	< 10 minutes per day < 10 hours per year
Significant amount of glare that should be avoided.	Implement mitigation measures to reduce impacts as far as practicable.	No mitigation required.

## Road and Rail Traffic Disability Glare

There are no SGHAT nor LSSE Guideline criteria for Road and Rail Traffic Disability Glare.

Accordingly, when considering motorists and/or rail operators, the occurrence of SGHAT YELLOW glare for ANY number of minutes per day or hours per year is taken by SLR as necessitating consideration of mitigation, unless the reflection condition occurs at a time of day when the difference in angle between an incoming solar ray and its associated reflection is less than around 10°, in which case a motorist’s view would be completely dominated by the radiance level of the sun’s direct solar rays.



## 4.0 Background

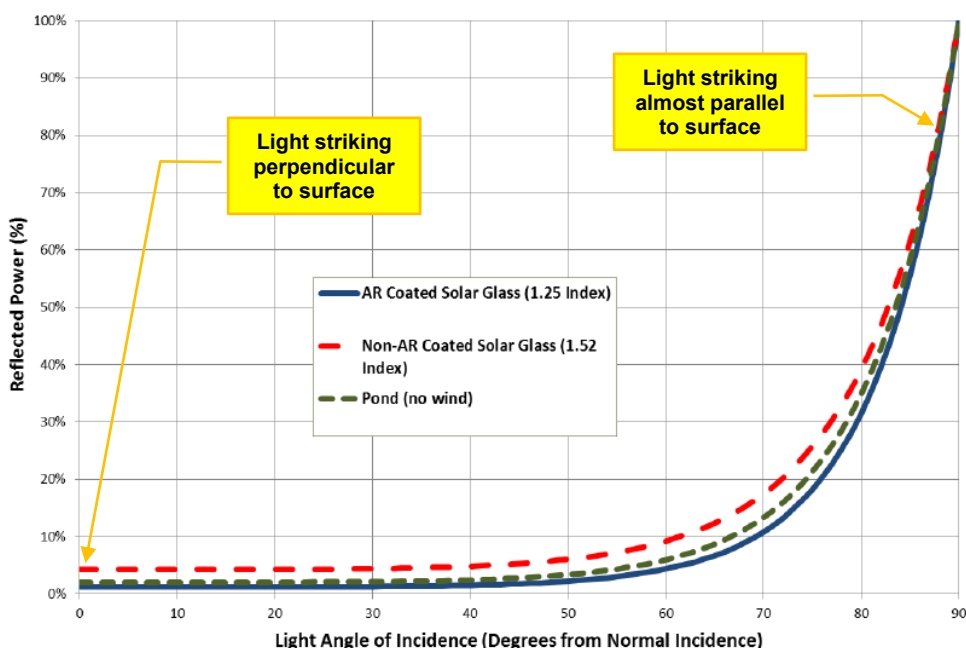
### 4.1 Solar Panel Reflectivity

Solar PV panels are designed to capture (absorb) the maximum possible amount of light within the layers below the front (external) surface and hence minimise reflections off the surface of each panel. Reflections are a function of:

- the angle at which the light is incident onto the panel (which will vary depending on the specific location, time of day and day of the year); and
- the index of refraction of the front surface of the panel and associated degree of diffuse (non-directional) versus specular (directional or mirror-like) reflection, which is a function of the surface texture of the front module (reflecting) surface.

Representative reflectivity curves are shown in **Figure 4**.

**Figure 4 Typical Reflectivity Curves as a Function of Incidence Angle**



- When an incoming solar ray strikes the surface of a solar PV panel close to perpendicular to the panel surface (ie LOW angle of “incidence”), reflectivity is minimal, less than 5% for all solar panel surface types.
- It is only when an incoming solar ray strikes the panel at increasingly HIGH “incidence” angles, ie approaching parallel to the panel, that reflectivity values increase. When this happens, reflections become noticeable and potentially at “glare” level – this can occur for all solar panel surface types.
- However, at VERY HIGH incidence angles, it would almost always be the case that an observer (motorist, resident, etc) would perceive reflections coming from virtually the same direction as the incoming solar rays themselves. Such a condition would not constitute a glare situation as the intensity of the incoming solar ray itself would dominate the field of vision perceived by the observer.



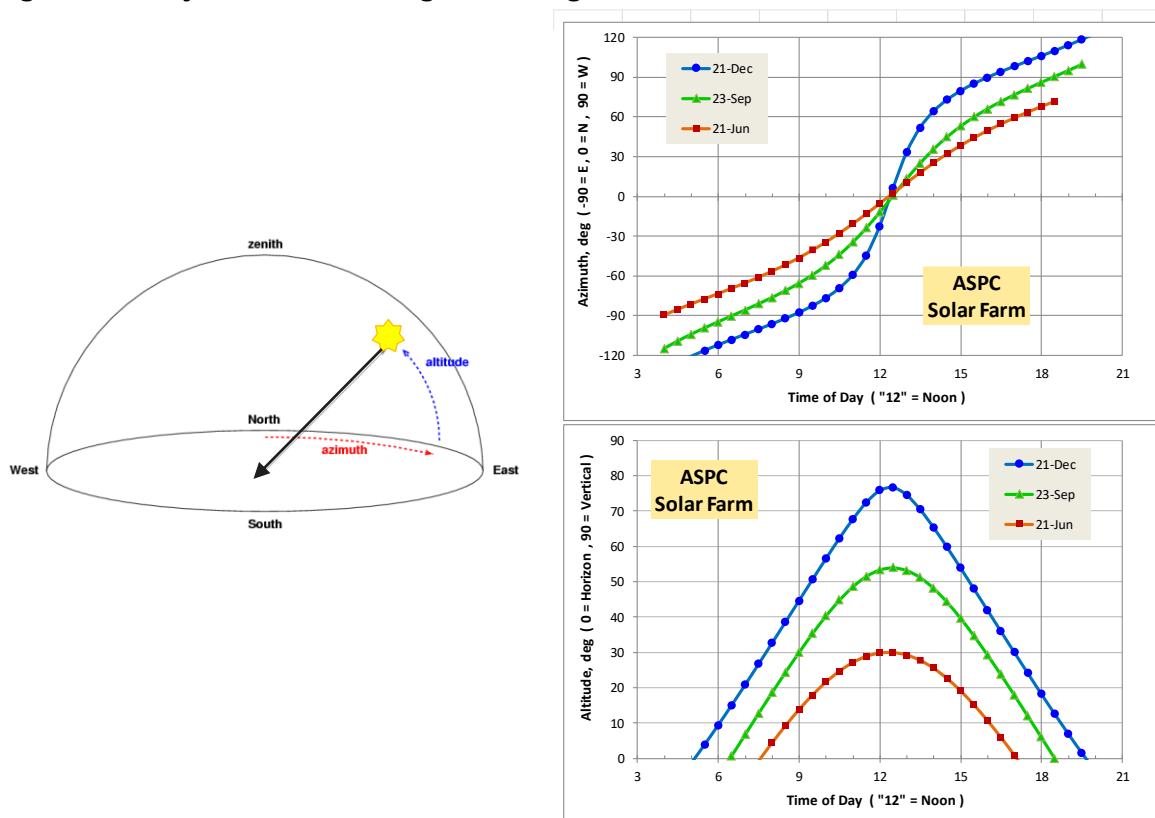
## 4.2 Project Site Solar Angles – Annual Variations

One of the challenging issues encountered with daytime solar panel glare is the varying nature of the associated reflections, whose occurrence will vary with time of day and day of the year as the sun's rays follow varying incoming angles between the two extremes of:

- Summer solstice – sunrise incoming rays from just south of east, maximum angle altitude rays at midday, sunset incoming rays from just south of west.
- Winter solstice – sunrise incoming rays from almost northeast, minimum angle altitude rays at midday, sunset incoming rays from almost northwest.

Any solar glare analysis must take into account the complete cycle of annual reflection variations noted above. The potential range of incoming solar angles at the Project site relevant to daytime glare is shown in **Figure 5**, with critical angles summarised in **Table 2**.

**Figure 5 Project Site Incoming Solar Angle Variations**



**Table 2 Key Annual Solar Angle Characteristics for Project Site**

Day of Year	Sunrise	Sunset	Sunrise-Sunset Azimuth Range	Max Altitude
Summer Solstice <sup>1</sup>	5:08 am	7:39 pm	±120° East & West of North	76.5°
Equinox	6:27 am	6:30 pm	±91° East & West of North	54°
Winter Solstice	7:35 am	5:05 pm	±60° East & West of North	30°

*Note 1: Times of day do not take into account Daylight Savings Time*

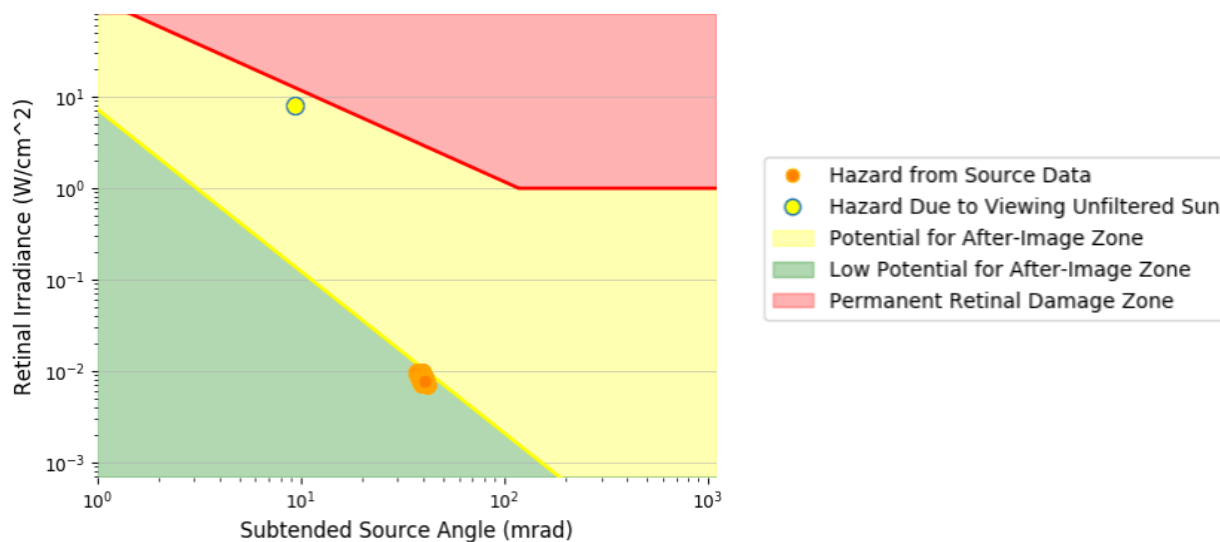


### 4.3 SGHAT Modelling Outputs

Modelling has been undertaken using the Forge Solar SGHAT software suite. This provides output in the form of an ocular hazard analysis plot, a sample of which is shown in **Figure 6**.

The analysis displayed in this plot is derived from solar simulations that extend over the entire calendar year in 1-minute intervals, sunrise to sunset.

**Figure 6 Example Solar Glare Ocular Hazard Plot (SGHAT Software Output)**



The following is noted regarding **Figure 6**.

- SGHAT ocular impact is a function of both the “retinal irradiance” (i.e. the light seen by the eye) and “subtended source angle” (i.e. how wide an arc of view the light appears to be arriving from).
- SGHAT ocular impact falls into three categories:
  - . GREEN: low potential to cause “after-image”
  - . YELLOW: potential to cause temporary “after-image”
  - . RED: potential to cause retinal burn (permanent eye damage)
- “After Image” is the term applied to a common retinal phenomenon that most people have experienced at some point or other, such as the effect that occurs when a photo with flash is taken in front of a person who then sees spots in front of their eyes for a few seconds. A more extreme example of “after-image” occurs when staring at the sun. “After-image” (also known as “photo bleaching”) occurs because of the de-activation of the cells at the back of the eye’s retina when subjected to a very bright light.
- The SGHAT plot provides an indication of the relative intensity of both the incoming reflection and the sources of light itself (i.e. the sun).
  - The occurrence of glare is shown in the plot as a series of **orange circles**, one circle for each minute that a reflection is visible.
  - A reference point is also shown in each SGHAT plot - the **yellow circle** with the **green outline** - representing the hazard level of viewing the sun directly without any filtering, i.e. staring at the sun.
  - In **Figure 6**, it can be seen that the reflection visible by the receiver is roughly 1,000 times less intense than the direct light from the sun itself.

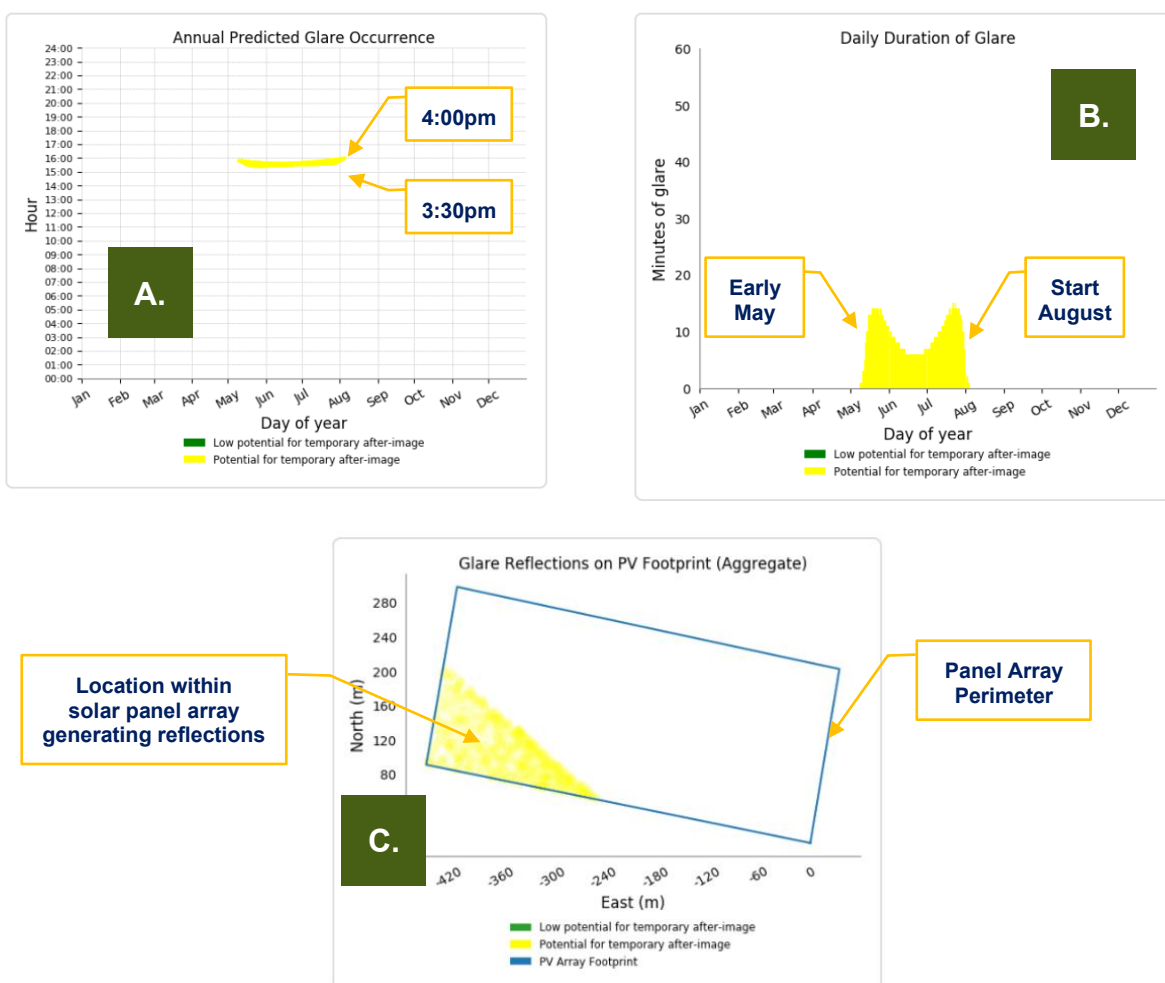


- Finally, in relation to PV Solar facilities, it is important to note that the third SGHAT Ocular Plot “RED” category is **not possible**, since standard PV modules do not focus reflected sunlight (as in a concave mirror).

In addition to the ocular hazard analysis plot, SGHAT also produces information which reveals the extent of visibility of reflections at any chosen receiver position, regardless of whether the reflections constitute a glare condition or not – refer example shown in **Figure 7**.

- Figure 7-A** shows the am/pm time periods when SGHAT YELLOW reflections are predicted to occur at a receptor throughout the year, in this case between around 3:30 pm and 4:00 pm.
- Figure 7-B** shows the months during the year and the minutes per day when SGHAT YELLOW reflections occur at the same position, in this case from early-May to the start of August (mid-winter), for periods ranging up to 13 minutes per day.
- Finally, **Figure 7-C** shows where within the solar farm panel array the SGHAT YELLOW reflection rays of interest are emanating from, in this case from panels near the southwest corner – this can be helpful in designing screening mitigation.

**Figure 7 Example Solar Glare Output Plots (SGHAT Software Output)**



## 4.4 Other Factors Relevant to Glare Prediction

### Weather

SGHAT model calculations (and indeed all commercially available glare models) assume CLEAR skies all year round.

The Dairy Flat area is either overcast or mostly cloudy just less than 29% of the time throughout the year.

This means that the total annual minutes of duration for any potential glare conditions predicted using SGHAT (or any “clear sky” glare model) should be reduced by an appropriate “overcast” factor, resulting in lower overall annual impacts.

- This however would only reduce the likely cumulative impact over the entire year.
- The maximum duration of glare on any one day predicted by SGHAT would not be affected.

### Terrain

Terrain features such as natural obstacles (vegetation, tree lines, etc) are not explicitly considered within SGHAT.

These however can be added to the simulation as so-called SGHAT “Obstructions” which can model vegetation/tree lines for example as solid, screening walls.

- In this case, it would be assumed that the screening vegetation has all-year-round dense coverage (ie evergreen species).

### Topography

While topography IS taken into account within SGHAT in terms of the placement (elevation) of solar panels and surrounding roadways and dwellings, etc, the potential blockage benefits of any intervening topography are not modelled within SGHAT.

This can only be overcome by an examination of the Viewshed Analysis often undertaken for such projects, which reveals which surrounding receivers (roadways, houses, etc) will be able to actually “see” the solar panels within a proposed facility and hence experience any potential reflections.

Alternatively, the “Elevation Profile” function available in Google Earth (or alternative mapping tools) may be able to identify surrounding receivers which do not have an unobstructed view of the proposed facility due to intervening topographic features.



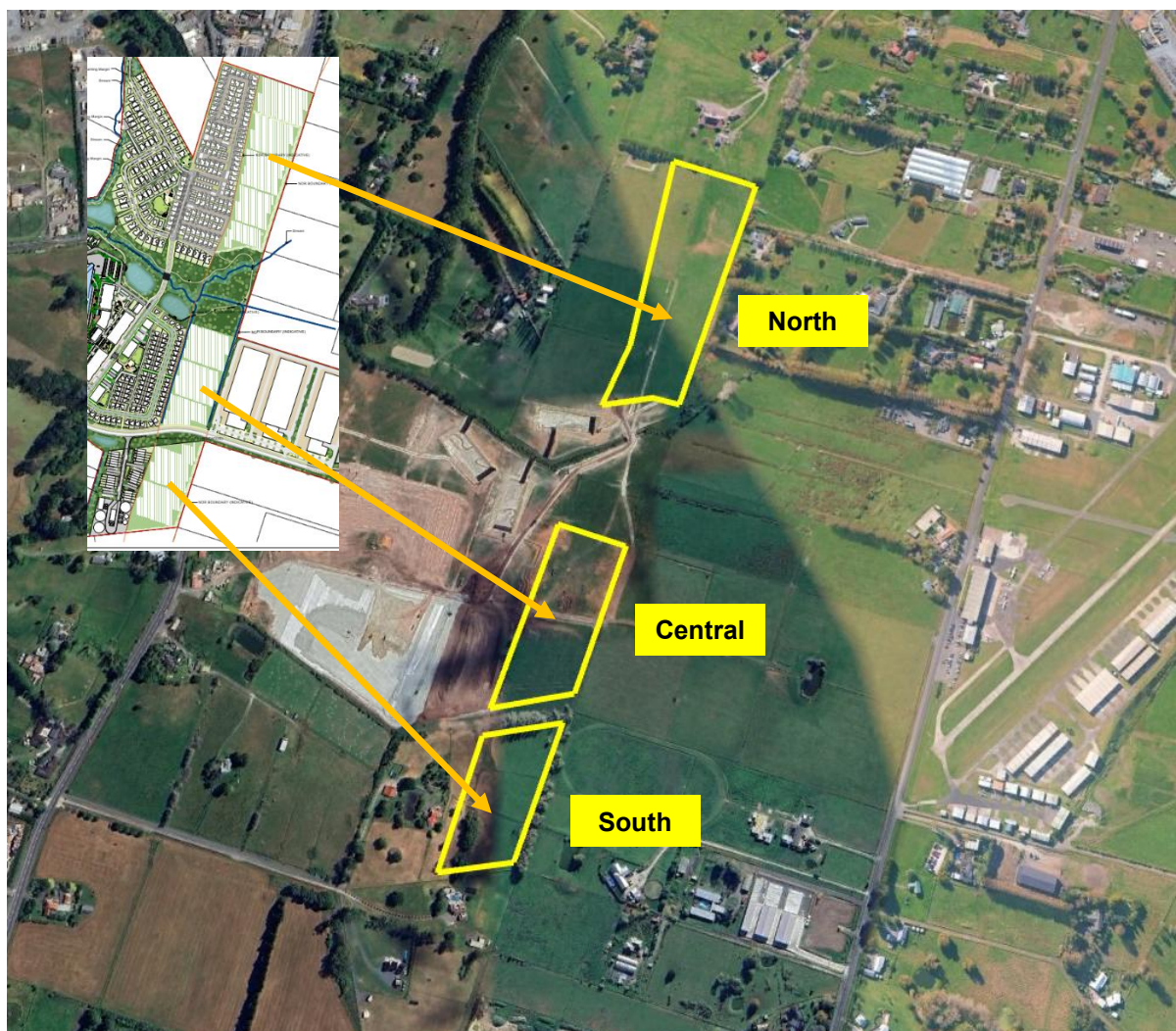
## 5.0 Glare Modelling Inputs

### 5.1 Panel Sub-Arrays

The Project was modelled as three “sub-arrays” – refer **Figure 8**.

- This was done to better follow the terrain of the site and give more detailed information as to which specific sub-areas of the proposed facility were responsible for potential glare occurrences.

**Figure 8 Modelling of Project PV Sub-Arrays 1-3**



## 5.2 Aviation Inputs

The potential for aviation glare was assessed at North Shore Airport (ICAO Code: NZNE). The aerodrome lies less than 1 km east of the Project Site - refer **Figure 9**.

The runways assessed are as follows:

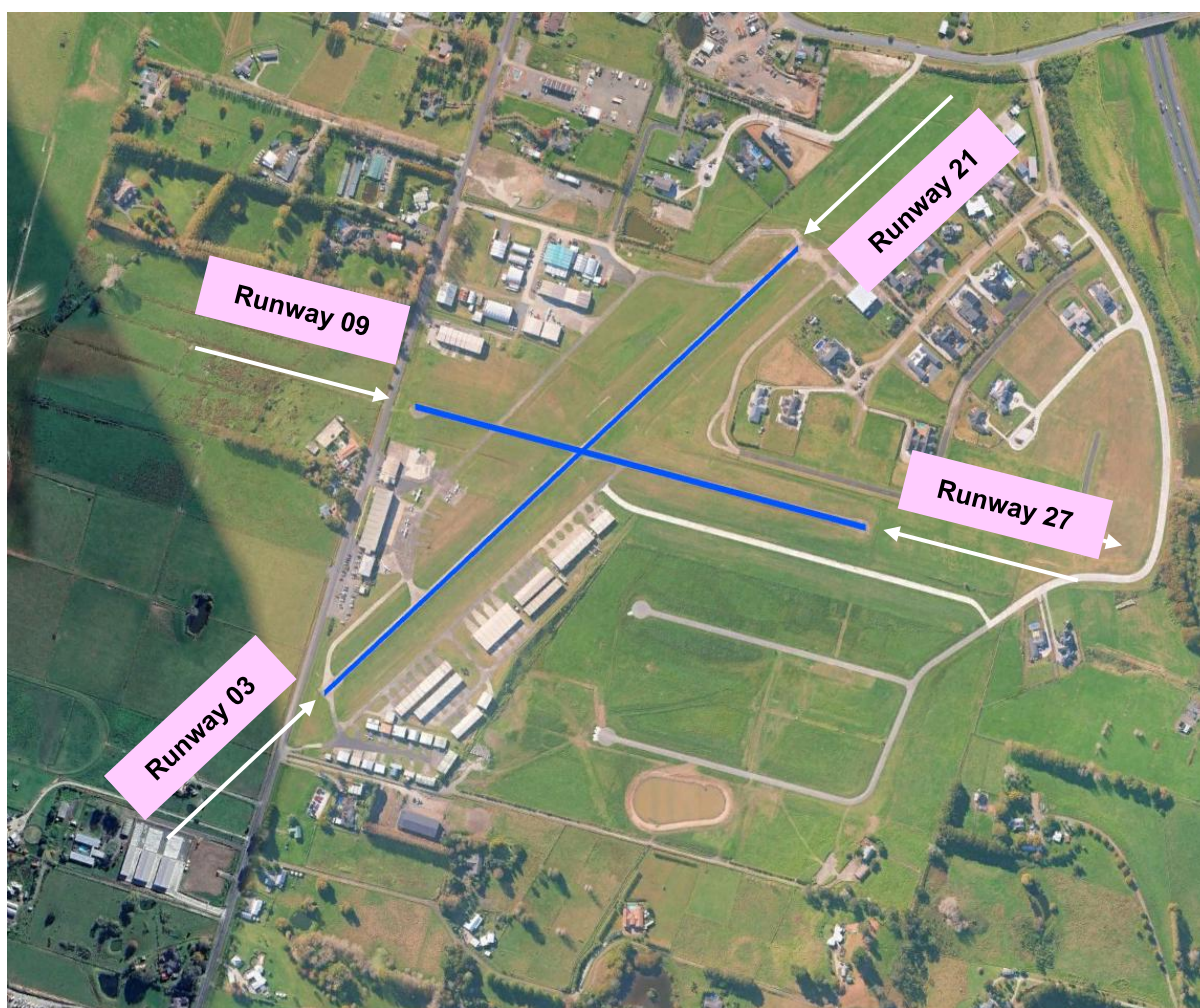
- Runway 03/21 791 m concrete
- Runway 09/27 560 m gravel

As per standard SGHAT protocol, the final approach paths for landing at the runways were modelled as follows:

- Landing flight path: length modelled = 3.2 km (measured from runway threshold)
- Landing flight path: glide angle = 3°
- Height above threshold = 5 m

The aerodrome does not have an Air Traffic Control Tower (ATCT).

**Figure 9 North Shore Airport – Assessed Runways**



### 5.3 Road, Rail and Residential Receptors

The road receptors included in the analysis are shown in **Figure 10**. Note that there are no rail lines close enough to the Site to create the potential for disability glare.

The motorist viewing height was based on the expected vehicle categories, as follows:

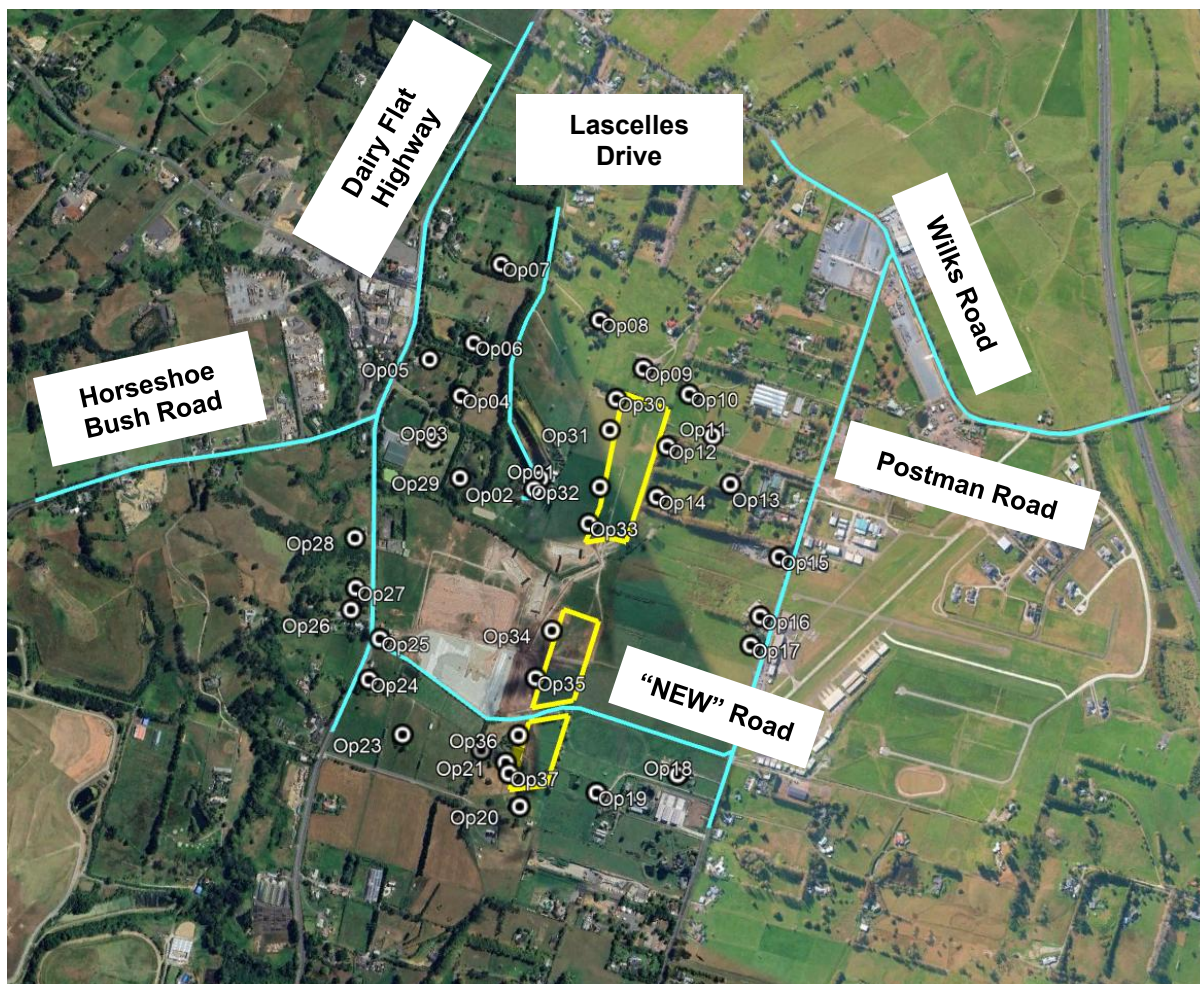
- 2.3 m for Dairy Flat Highway, Horseshoe Bush Road, Postman Road and Wilks Road (assumes heavy vehicle usage).
- 1.8 m for “NEW” Road intersecting the Site.
- 1.5 m for Lascelles Drive (assumes only local traffic).

The 37 surrounding dwellings included in the analysis are also shown in **Figure 10**.

- For surrounding residential dwellings, the observer height was set at 1.5 m and 4.5 m above the ground for single-storey dwellings and two-storey dwellings respectively.
- In SGHAT, the residences are numbered Op01 to Op37.
- Dwellings Op30-Op37 represent the future proposed residences to the west of the updated solar sub-arrays. These are two-storey dwellings.

The latitude and longitude coordinates of the representative residential locations shown in **Figure 10** can be found in **Appendix A**.

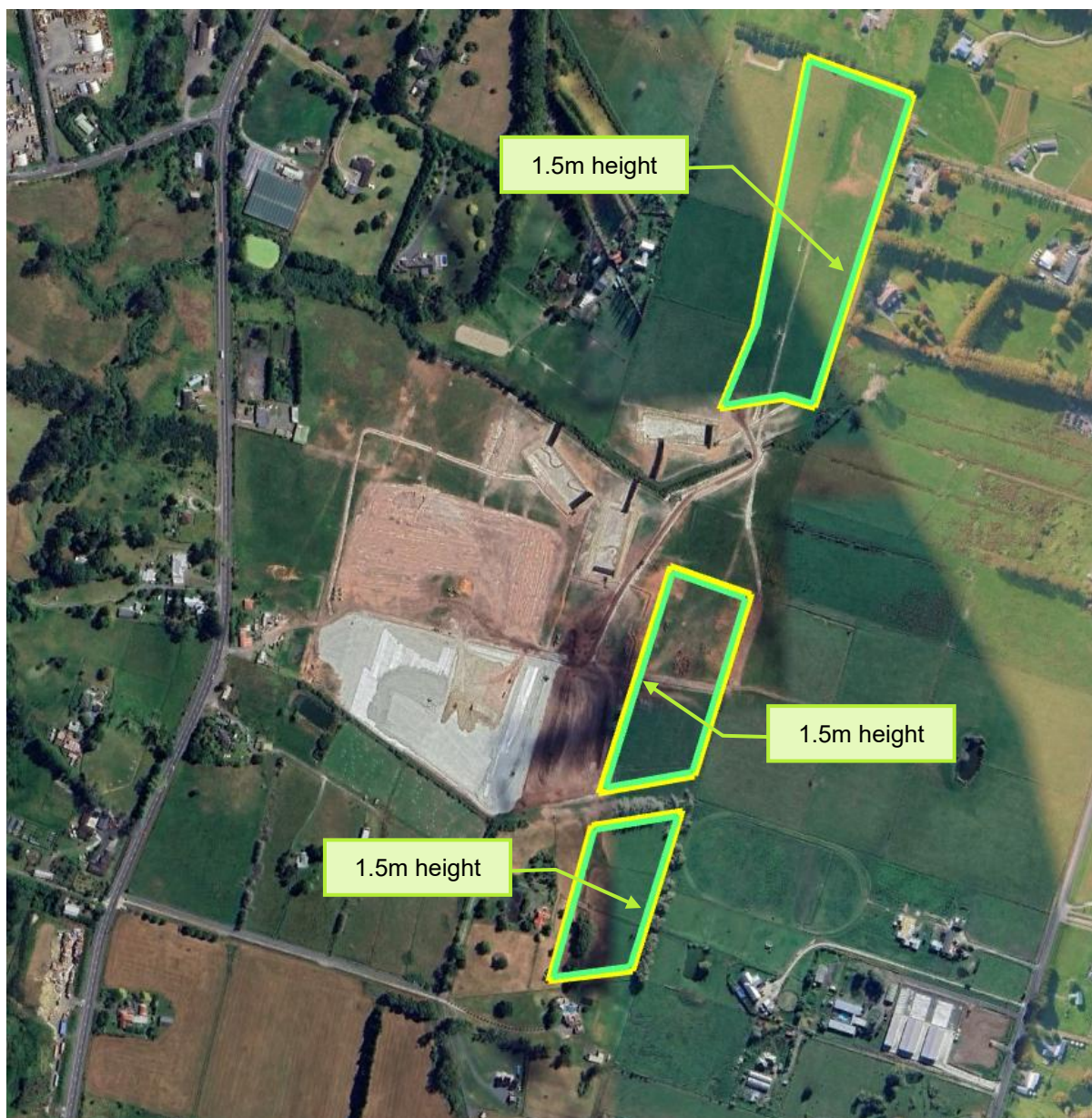
**Figure 10 Surrounding Road and Residential Receptor Locations**



## 5.4 Vegetation

Vegetation screening has been proposed for the three sub-arrays of the amended solar facility – refer **Figure 11**. This planting was included in the “Baseline” Scenario modelling geometry. It is currently proposed to have a target height of 1.5 m.

**Figure 11 Solar Array Vegetation Modelled in the “Baseline” Scenario**



## 6.0 Glare Modelling Results

### 6.1 “Baseline” Scenario

For the “Baseline” model simulation, the following assumptions were made:

- The Project was modelled using the three sub-arrays shown in **Figure 8**.
- The SAT Rest Angle was assumed to be **0°**.
- The median panel height was **1.2 m** (refer **Section 2.2**).
- The Baseline model included the vegetation shown in **Figure 11**.
- The model did not include any additional vegetation or other screening (eg buildings).
- No allowance was made for the impact of intervening sections of topography which could obscure the view of the facility for passing motorists or residences.

This run was designed to give an initial indication of potential locations of glare prior to considering screening and topographic influences and the need for mitigation.

**Table 3** shows the total annual minutes of potential SGHAT YELLOW glare with both the individual sub-array annual minutes of glare and the total over all sub-arrays.

- Cells in the table with no entry indicate NIL occurrence throughout the year of potential glare.
- The output for the road predictions includes an assessment of positions located continuously along the full stretch of each road shown in **Figure 10**.

The residential receiver results for Op01-Op37 in **Table 3** are shown with shading of the annual totals so as to identify the relevant LSSE Guideline impact category:

- Green Low Impact < 10min/day OR < 10hr/year
- Orange Moderate Impact 10-30min/day OR 10-30hr/year
- Red High Impact > 30min/day OR > 30hr/year

Note that the above colour-code categories only apply to the assessment of Residential Nuisance Glare.

**Table 3 Annual Minutes of SGHAT YELLOW Glare (Baseline Simulation)**

**Rest Angle = 0°**

Receptor	PV Sub-Array – refer Fig.8			Yearly Total
	North	Central	South	
NZNE Runway 03	-	-	-	-
NZNE Runway 21	-	-	-	-
NZNE Runway 09	10,877	-	-	<b>10,877</b>
NZNE Runway 27	-	-	-	-
Dairy Flat Highway	-	-	-	-
Horseshoe Bush Road	-	-	-	-
Lascelles Drive	-	-	-	-
“NEW” Road	-	-	-	-
Postman Road	-	-	-	-
Wilks Road	-	-	-	-



Receptor	PV Sub-Array – refer Fig.8			Yearly Total
	North	Central	South	
Res Op01	-	-	-	-
Res Op02	-	-	-	-
Res Op03	-	-	-	-
Res Op04	-	-	-	-
Res Op05	-	-	-	-
Res Op06	-	-	-	-
Res Op07	-	-	-	-
Res Op08	-	-	-	-
Res Op09	-	-	-	-
Res Op10	-	-	-	-
Res Op11	-	-	-	-
Res Op12	-	-	-	-
Res Op13	-	-	-	-
Res Op14	-	-	-	-
Res Op15	-	-	-	-
Res Op16	-	-	-	-
Res Op17	-	-	-	-
Res Op18	-	-	-	-
Res Op19	-	-	-	-
Res Op20	-	-	-	-
Res Op21	-	-	-	-
Res Op22	-	-	-	-
Res Op23	-	-	-	-
Res Op24	-	-	-	-
Res Op25	-	-	-	-
Res Op26	-	-	-	-
Res Op27	-	-	-	-
Res Op28	-	-	-	-
Res Op29	-	-	-	-
Res Op30	5773	-	-	5773
Res Op31	6857	-	-	6857
Res Op32	6326	-	-	6326
Res Op33	4698	-	-	4698
Res Op34	-	1149	-	1149
Res Op35	-	200	-	200
Res Op36	-	-	1290	1290
Res Op37	-	-	1704	1704



## 6.1.1 Baseline Model Results Summary

### Aviation Glare

- NIL glare was predicted for Runway 03, Runway 21 and Runway 27.
- Substantial SGHAT YELLOW glare was predicted for Runway 09.

Note: the aerodrome does not have an ATCT.

### Road Traffic Disability Glare

- NIL glare was predicted for ALL surrounding roads, including “NEW” Road within the development.

### Residential Nuisance Glare

- NIL glare was predicted for Residences 1-29, which lie some distance from the Project.
- SGHAT YELLOW glare was predicted for Residence 30-37, the future planned residences lying to the immediate west of the Project’s solar arrays. The occurrence of reflections at these residences is due largely to their two-storey nature.

## 6.1.2 Further Analysis of the Baseline Results

### Relevance of Angle of Incidence for Reflections

The SGHAT YELLOW category reflections predicted in the Baseline simulation were examined further to assess whether they would constitute Nuisance Glare.

The context of this assessment was made in light of the observation made in **Section 3**, where it was noted that for very high incidence angles, it would almost always be the case that an observer would perceive reflections coming from virtually the same direction as the incoming solar rays themselves.

Such a condition would not constitute a glare situation as the intensity of the incoming solar ray itself would dominate the field of vision perceived by the observer. This is illustrated in **Figure 6** where it can be seen that the retinal irradiance value of the sun is almost at the SGHAT “Permanent Retinal Damage” RED zone and three orders of magnitude higher than the solar reflections occurring at the time.

This latter condition has evolved into a globally adopted “acceptability” glare axiom, namely that a glare condition can only exist if the angle difference between an incoming solar ray (ie the direct sun) and its associated reflection is greater than approximately  $10^\circ$  – refer **Figure 13**.

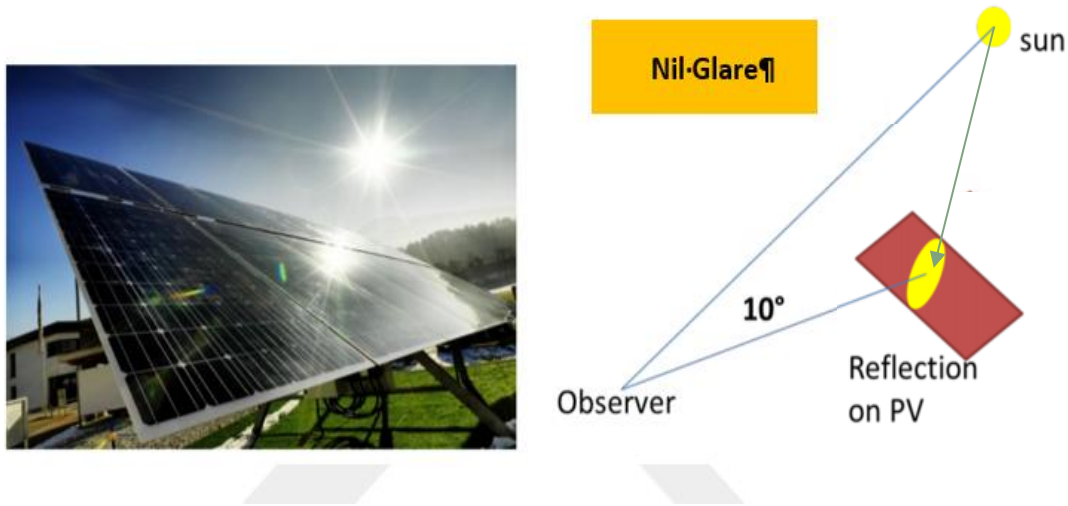
SLR has examined the predicted reflections onto Residences Op30-37 in the above context.

- North Sub-Array Incidence Angle occurrence      down to  $79^\circ$ .
- Central Sub-Array Incidence Angle occurrence      down to  $83^\circ$ .
- South Sub-Array Incidence Angle occurrence      down to  $80^\circ$ .

The “High Incidence Angle” condition shown in **Figure 13** therefore does not apply to reflections from the North and South sub-arrays and is somewhat borderline for the Central sub-array.

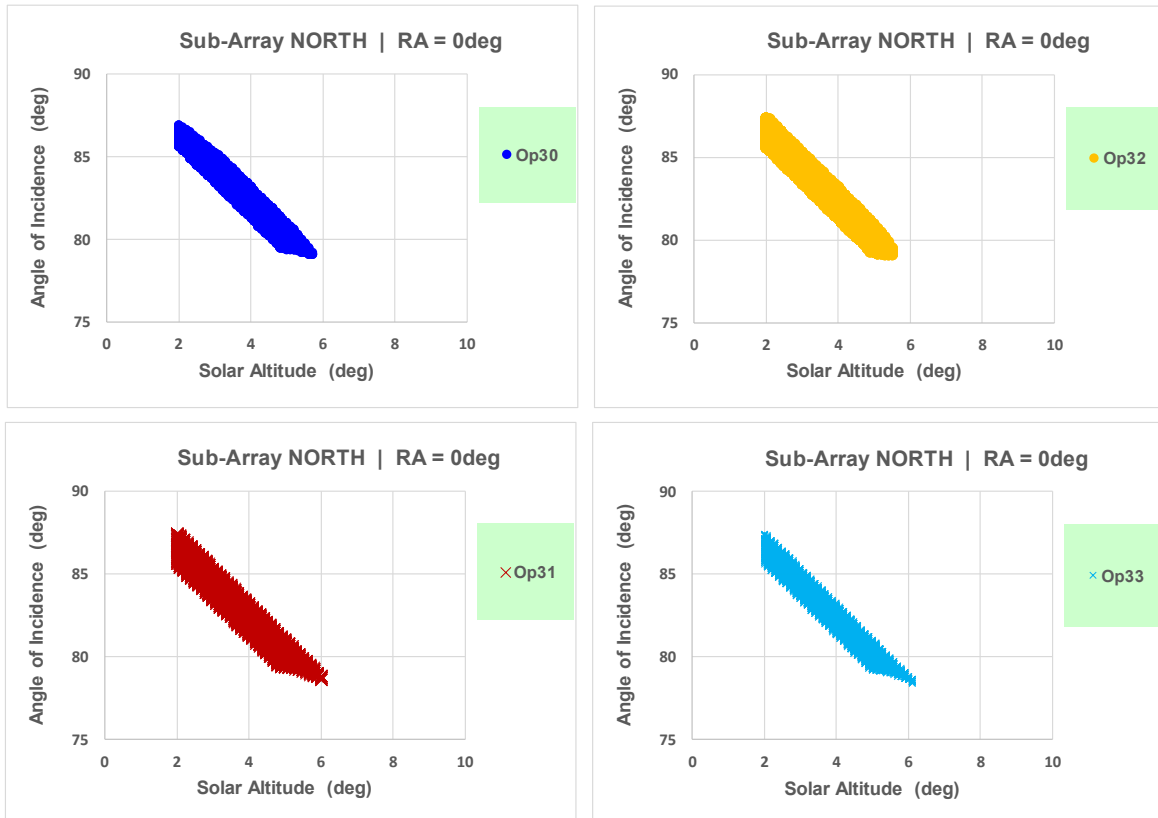


**Figure 12 Nil Glare Condition Applicable to High Incidence Angle Reflections**



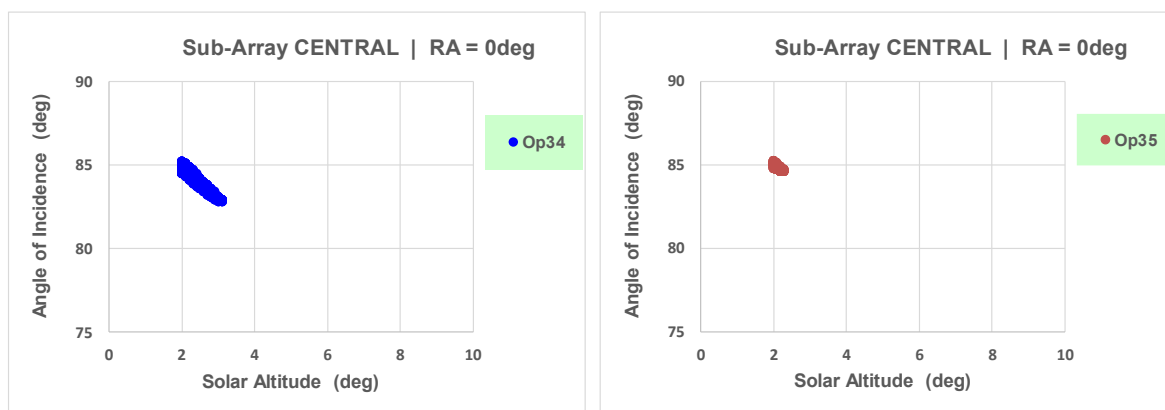
**Figure 13 Baseline Scenario – Rest Angle 0°**

**North Sub-Array & Residences Op30-33**

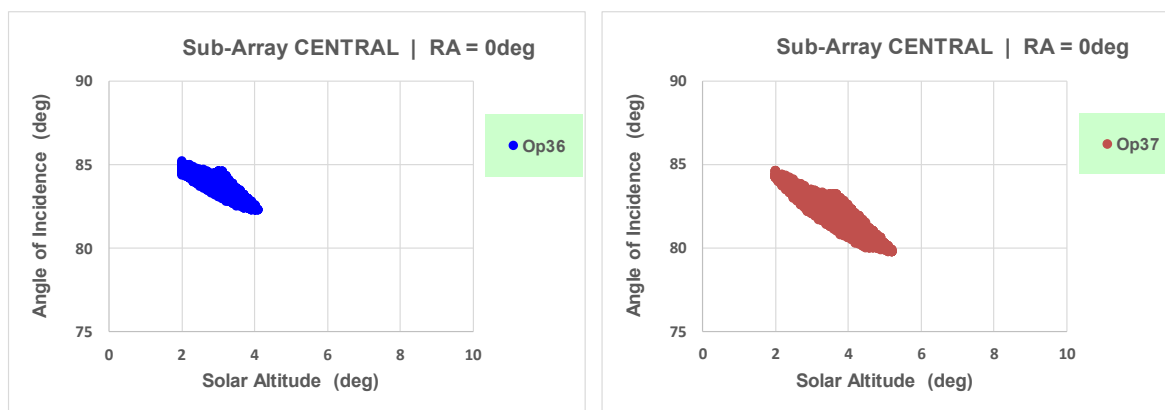


( Fig.14 cont'd )

### Central Sub-Array & Residences Op34-35



### South Sub-Array & Residences Op36-37



## 6.2 Mitigation Scenarios

### 6.2.1 Influence of Rest Angle

Further modelling was undertaken to assess the influence of Rest Angle:

- The Project was modelled using the same sub-arrays shown in **Figure 8**.
- The Rest Angle was varied as follows: **0° (Baseline)**, **5°**, **10°**, **15°** and **20°**.
- The median panel height remained as per **Section 2.2**.
- The Baseline model vegetation shown in **Figure 11** was retained.
- The model did not include any additional vegetation or other screening (eg buildings).
- No allowance was made for the impact of intervening sections of topography which could obscure the view of the facility for passing motorists or residences.



**Table 4** shows the SGHAT YELLOW glare results for ALL Rest Angles assessed, including the 0° Rest Angle Baseline Scenario for ease of comparison.

**Table 4 Annual Minutes of SGHAT YELLOW Glare (Variable FTA)**

**Rest Angle = 0° ( Baseline Scenario )**

Receptor	PV Sub-Array – refer Fig.8			Yearly Total
	North	Central	South	
NZNE Runways 03, 21 and 27	-	-	-	-
NZNE Runway 09	10,877	-	-	10,877
ALL Roadways	-	-	-	-
Res Op01-Op29	-	-	-	-
Res Op30	5773	-	-	5773
Res Op31	6857	-	-	6857
Res Op32	6326	-	-	6326
Res Op33	4698	-	-	4698
Res Op34	-	1149	-	1149
Res Op35	-	200	-	200
Res Op36	-	-	1290	1290
Res Op37	-	-	1704	1704

**Rest Angle = 5°**

Receptor	PV Sub-Array – refer Fig.8			Yearly Total
	North	Central	South	
NZNE Runways 03, 21 and 27	-	-	-	-
NZNE Runway 09	10,877	-	-	10,877
ALL Roadways	-	-	-	-
Res Op01-Op29	-	-	-	-
Res Op30	5773	-	-	5773
Res Op31	6857	-	-	6857
Res Op32	6326	-	-	6326
Res Op33	4698	-	-	4698
Res Op34	-	225	-	225
Res Op35-Op37	-	-	-	-

**Rest Angle = 10°**

Receptor	PV Sub-Array – refer Fig.8			Yearly Total
	North	Central	South	
NZNE Runways 03, 21 and 27	-	-	-	-
NZNE Runway 09	10,383	-	-	10,383
ALL Roadways	-	-	-	-
ALL Residences	-	-	-	-



( Table 4 cont'd )

**Rest Angle = 15°**

Receptor	PV Sub-Array – refer Fig.8			Yearly Total
	North	Central	South	
NZNE Runways 03, 21 and 27	-	-	-	-
NZNE Runway 09	4,728	-	-	4,728
ALL Roadways	-	-	-	-
ALL Residences	-	-	-	-

**Rest Angle = 20°**

Receptor	PV Sub-Array – refer Fig.8			Yearly Total
	North	Central	South	
NZNE ALL Runways	-	-	-	-
ALL Roadways	-	-	-	-
ALL Residences	-	-	-	-

**Rest Angle Scenario Summary – RUNWAY 09 Reflections**

**Rest Angle = 5°**

- No change to occurrence of SGHAT YELLOW glare from the North sub-array.

**Rest Angle = 10°**

- SGHAT YELLOW glare from the North sub-array reduced slightly.

**Rest Angle = 15°**

- SGHAT YELLOW glare from the North sub-array reduced substantially, but still significant.

**Rest Angle = 20°**

- ALL SGHAT YELLOW glare eliminated.

**Rest Angle Scenario Summary – Ops 30-37 Reflections**

**Rest Angle = 5°**

- Residences Op30-33 no change to occurrence of SGHAT YELLOW glare from the North sub-array.
- Residences Op34 reflections falls into the LOW impact category and hence no mitigation is required – applies to the Central sub-array.
- Residences Op35-37 all reflections eliminated – applies to the Central and South sub-arrays.

**Rest Angle = 10°**

- Residences Op30-37 all reflections eliminated – applies to all three sub-arrays.



## Discussion of Results for Aviation Glare

The Rest Angle Scenarios show that:

- SGHAT YELLOW glare only occurs from the North sub-array; and
- All instances of glare are eliminated with a Rest Angle of 20° – note that these are EARLY MORNING reflections for the Runway 09 glide path and hence no restrictions are needed for the AFTERNOON Rest Angle.

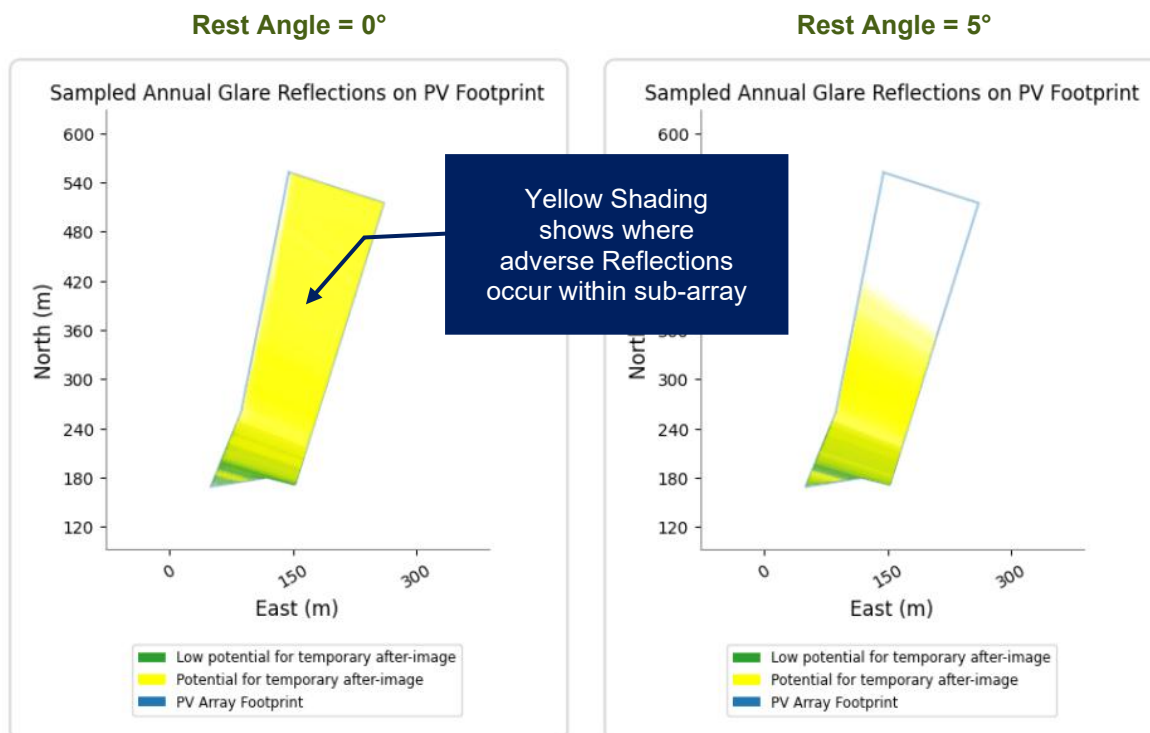
SLR has further examined the spatial distribution of the relevant reflections on the North sub-array – this is shown in **Figure 14**.

- As the Rest Angle INCREASES, the area within the North sub-array causing the SGHAT YELLOW glare of concern DECREASES, concentrated on the southern part of the sub-array.
- This suggest that the Rest Angle mitigation for the North sub-array could be staggered, with different sub-sections of the sub-array employing different Rest Angles.

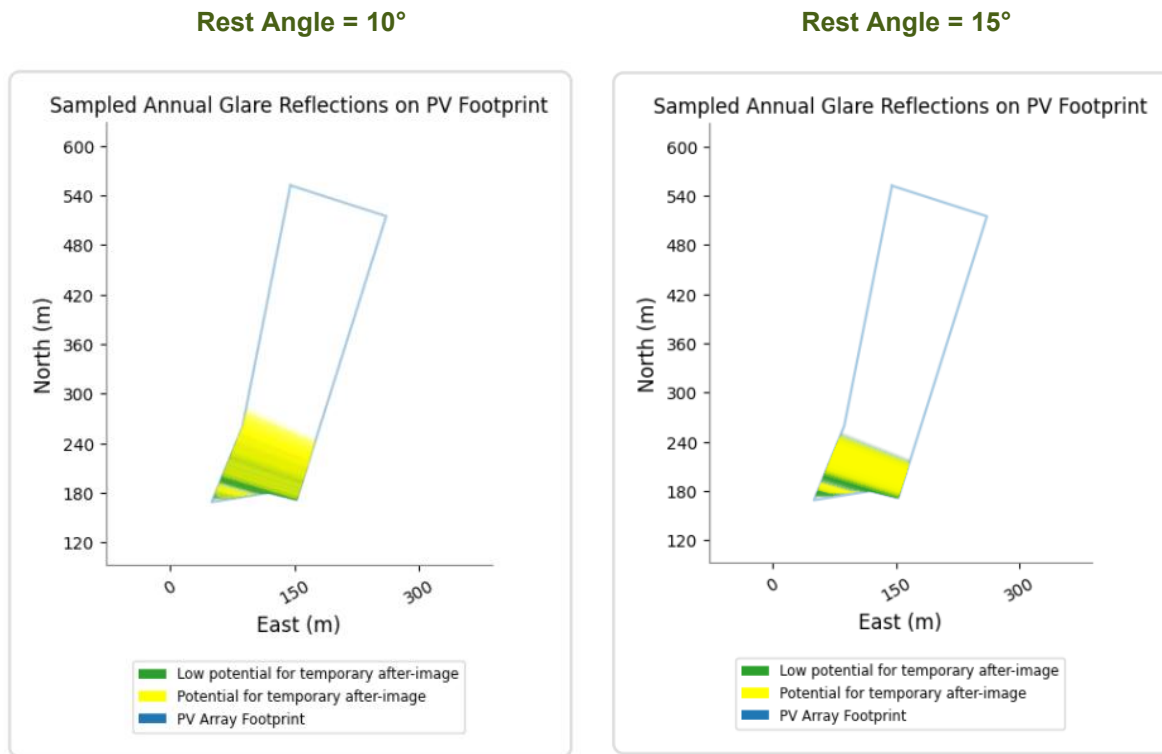
A mitigation option reflecting the above is shown in **Figure 15**.

This option ALSO results in the elimination of ALL potential adverse reflections from the North sub-array onto the adjacent residences lying immediately to the west.

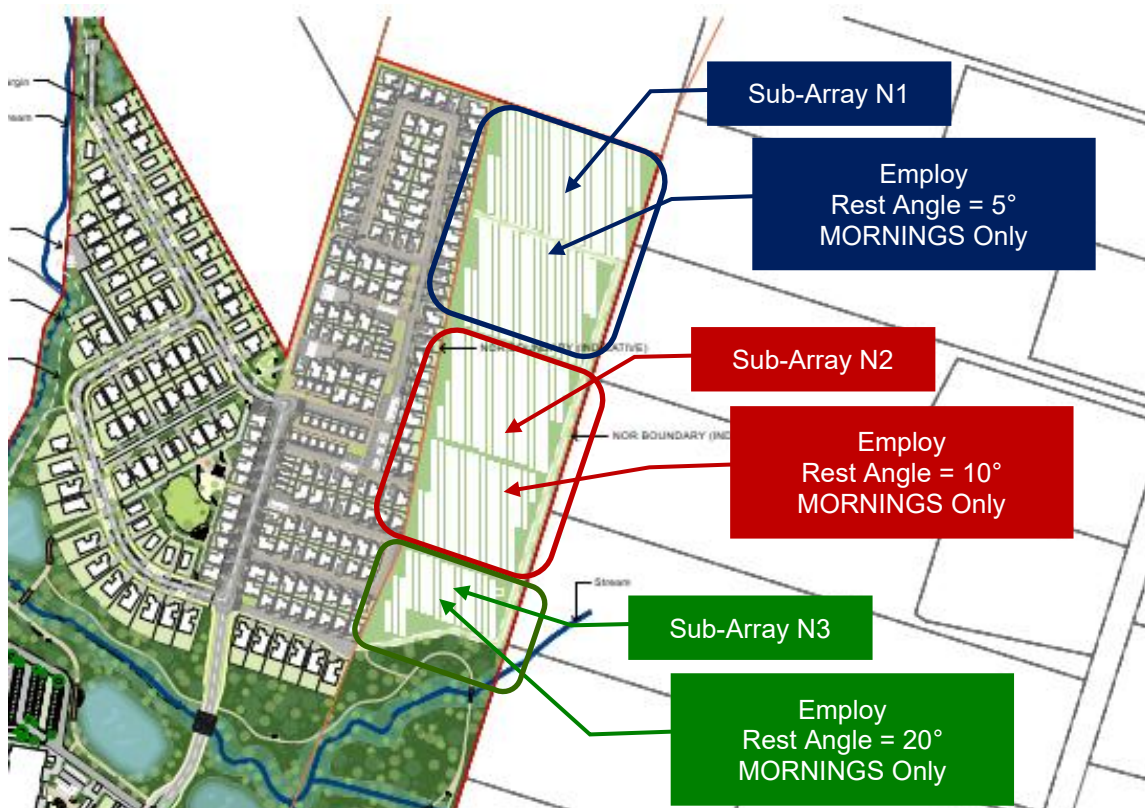
**Figure 14 North Sub-Array Reflections relevant to Aviation Glare (Runway 09)**



( Fig.14 cont'd )



**Figure 15 Recommended Rest Angle Mitigation for the North Sub-Array**



## 6.2.2 Alternative Mitigation for Dwellings via Additional Vegetation Screening

Additional modelling was undertaken to assess the influence of an increase in vegetation screening relevant to potential glare impact for residences lying immediately to the west of the solar arrays.

- The Project was modelled using the same sub-arrays shown in **Figure 8**.
- The Rest Angle was kept at **0°**.
- The median panel height remained as per **Section 2.2**.
- The Baseline model vegetation shown in **Figure 11** was retained.
- Additional vegetation was added running along the **WESTERN PERIMETERS** of the three solar sub-arrays to a target height of **4 m**.
- No allowance was made for the impact of intervening sections of topography which could obscure the view of the facility for passing motorists or residences.

**Table 5** shows the total annual minutes of potential SGHAT YELLOW glare with both the individual sub-array annual minutes of glare and the total over all sub-arrays.

**Table 5 Annual Minutes of SGHAT YELLOW Glare (NO Existing Vegetation)**  
**4 m Vegetation Screen on Western Perimeter of all Solar Sub-Arrays**

Receptor	PV Sub-Array – refer Fig.8			Yearly Total
	North	Central	South	
NZNE Runways 03, 21 and 27	-	-	-	-
NZNE Runway 09	8,805			<b>8,805</b>
ALL Roadways	-	-	-	-
Res Op01-Op37	-	-	-	-

### 4 m Vegetation Screen Scenario Summary

#### Aviation Glare

- Significant SGHAT YELLOW persists on Runway 09 from the North sub-array.

#### Road Traffic Disability Glare

- NIL glare predicted for ALL roads (no change from Baseline Scenario).

#### Residential Nuisance Glare

- NIL glare predicted for ALL residences from ALL sub-arrays.



## 6.3 Mitigation Conclusions

### Aviation Glare Mitigation / North Sub-Array

- Aviation glare from the proposed solar facility is restricted to potential glare on North Shore Airport's **Runway 09**.
- The Runway 09 glare condition only arises from the facility's **North Sub-Array**.
- Perimeter vegetation screening around the North Sub-Array is not an effective mitigation option at a feasible height.
- A mitigation solution involving restrictions to the solar panel SAT **Rest Angle** of the North Sub-Array has been developed – refer **Figure 15**.
  - The recommended restrictions **ONLY** apply to the **MORNING** Rest Angle.
  - No restrictions are required for the **AFTERNOON** Rest Angle.
- Finally, it is noted that the recommended Rest Angle mitigation solution **ALSO** eliminates all potential residential nuisance glare for the proposed dwellings to be located immediately to the west of the North Sub-Array.

### Residential Nuisance Glare Mitigation / Central & South Sub-Arrays

TWO options exist for the elimination of residential nuisance glare for the proposed dwellings to be located immediately to the west of the Central and South Sub-Arrays.

#### Option 1

- Restrict the **MORNING Rest Angle** to **5°** for the Central and South Sub-Arrays.
- Note that no restriction would be required for the **AFTERNOON** Rest Angle for the Central and South Sub-Arrays.

#### Option 2

- Increase the target height of the perimeter vegetation screening to **4 m** for the **WESTERN perimeters** only of the Central and South Sub-Arrays.

#### Option 2 - Interim Vegetation Growth Period

At the time of installation, the future Project-planned vegetation will likely not be planted at the target Option 2 4 m target height for the Central and South Sub-Array western perimeters. Accordingly, there will be an interim growth period before the proposed Option 2 additional vegetation screening for the Central and South Sub-Arrays reaches the 4 m target height (at which point NIL glare is predicted for all residences).

The following recommendation relevant to Option 2 is therefore made to ensure that the Project will result in NIL glare at all surrounding sensitive receptors during this interim growth period:

#### Central & South Sub-Arrays

- Restrict the **MORNING** Rest Angle to **5°** for the Central and South Sub-Arrays during the Interim Vegetation Growth Period.

The above mitigation recommendations are summarised in **Table 6**.



**Table 6 Proposed Glare Mitigation Strategy**

PV Sub-Array refer Fig.8 & Fig.15	Mitigation Recommendation
NORTH – N1	Restrict MORNING Rest Angle to <b>5°</b>
NORTH – N2	Restrict MORNING Rest Angle to <b>10°</b>
NORTH – N3	Restrict MORNING Rest Angle to <b>20°</b>
CENTRAL and SOUTH	<p><b>Option 1:</b> Restrict MORNING Rest Angle to <b>5°</b></p> <p><b>Option 2:</b> Increase Target Height of Perimeter Vegetation to <b>4m</b> for the WESTERN perimeters (only) of these two sub-arrays AND Restrict MORNING Rest Angle to <b>5°</b> during the interim vegetation growth period only ( ie between the installation of the perimeter vegetation and when the vegetation reaches its target height of 4m )</p>



## 7.0 Feedback

At SLR, we are committed to delivering professional quality service to our clients. We are constantly looking for ways to improve the quality of our deliverables and our service to our clients. Client feedback is a valuable tool in helping us prioritise services and resources according to our client needs.

To achieve this, your feedback on the team's performance, deliverables and service are valuable and SLR welcome all feedback via <https://www.slrconsulting.com/en/feedback>. We recognise the value of your time and we will make a \$10 donation to our Charity Partner - Lifeline, for every completed form.



# Appendix A Residential Receiver Coordinates

## Auckland Surf Park Community Solar Facility

### Glint and Glare Assessment

AW Holdings 2021 Ltd

SLR Project No.: 810.032023.00001

Revision: R01-v1.0

5 December 2025



The latitude and longitude coordinates, and elevation heights of the representative locations examined in this study are shown in **Table A-1**.

Note: the residences shown in the attached figure are labelled in the below table as “OP1” to “OP39” in the SGHAT software, OP stands for “Observation Point”.

**Table A-1 Latitude and Longitude of Sensitive Receivers Surrounding Site**

Name	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	-36.653078	174.646378	60.00	1.50
OP 2	-36.653418	174.646067	60.00	1.50
OP 3	-36.652264	174.643292	54.00	1.50
OP 4	-36.651117	174.643810	54.07	1.50
OP 5	-36.650360	174.642949	60.00	1.50
OP 6	-36.649742	174.644508	55.57	1.50
OP 7	-36.648101	174.645208	58.95	1.50
OP 8	-36.649357	174.647853	60.93	1.50
OP 9	-36.650542	174.649180	61.00	1.50
OP 10	-36.651137	174.650507	60.00	1.50
OP 11	-36.652101	174.650979	59.00	1.50
OP 12	-36.652312	174.649761	60.00	1.50
OP 13	-36.653218	174.651534	58.00	1.50
OP 14	-36.653573	174.649514	59.00	1.50
OP 15	-36.654896	174.653209	58.00	1.50
OP 16	-36.656235	174.652289	59.00	1.50
OP 17	-36.656747	174.652268	60.00	1.50
OP 18	-36.659683	174.650159	59.88	1.50
OP 19	-36.660182	174.648085	60.00	1.50
OP 20	-36.660466	174.645872	57.49	1.50
OP 21	-36.659528	174.645465	55.09	1.50
OP 22	-36.659136	174.644746	53.00	1.50
OP 23	-36.659006	174.642565	55.00	1.50
OP 24	-36.657784	174.641667	58.00	1.50
OP 25	-36.656762	174.641881	57.62	1.50
OP 26	-36.656134	174.641065	59.00	1.50
OP 27	-36.655570	174.641151	58.00	1.50
OP 28	-36.654363	174.641166	58.00	1.50
OP 29	-36.652958	174.644071	55.00	1.50
OP 30	-36.651235	174.648459	61.00	4.50
OP 31	-36.652022	174.648277	61.00	4.50
OP 32	-36.653352	174.647933	60.00	4.50
OP 33	-36.654143	174.647657	60.00	4.50
OP 34	-36.656603	174.646614	55.00	4.50
OP 35	-36.657605	174.646147	55.11	4.50
OP 36	-36.658982	174.645686	56.00	4.50
OP 37	-36.659783	174.645450	55.97	4.50





# **Appendix B Dr Peter Georgiou – CV for Solar Studies**

## **Auckland Surf Park Community Solar Facility**

### **Glint and Glare Assessment**

**AW Holdings 2021 Ltd**

SLR Project No.: 810.032023.00001

Revision: R01-v1.0

5 December 2025



Peter graduated from the University of Sydney (BSc, BEng-Civil HonsI) and spent the next 12 years at the University of Western Ontario's BLWT Laboratory, where he was engaged in post-graduate studies, R&D and consulting on a wide range of engineering projects (mainly high-rise buildings, long-span bridges and transmission line design) in North America, Southeast Asia and Europe. At BLWTL, Dr Georgiou was also involved in post-disaster investigations following major, destructive storm events. Using his studies into climatology and the potential influence of climate change, Peter assisted BLWT's Director, Professor Alan Davenport in the formative stages of the IDNDR (International Decade of Natural Disaster Reduction) - Professor Davenport was an influential driver of the IDNDR and one of Canada's key members.

In subsequent stints at the University of Sydney, and now at SLR (since 1999), Peter has led and carried out literally hundreds of commissions involving Climate and Climate Change, Wind Engineering, ESD and Sustainability, Hazard and Risk, and Solar (Reflectivity, Glare, Illumination) for projects located throughout Australasia, Southeast Asia, North and South America, Europe and the Middle East.

Peter is an APAC Global Technical Leader for Glare Studies. Peter has been involved for over three decades in studies (globally) in Daytime Reflective Glint & Glare and Night-Time Illumination Glare. These include SLR's SGHAT-related studies, involving aviation glare risk, and SLR's studies covering Road and Rail Disability Glare and Residential Nuisance Glare using SLR's special in-house software (developed by Peter) for Threshold Increment (TI) Value computation.

Aligned with these glare studies, Peter has been involved in many of SLR's renewable energy projects, also undertaking specialist Hazard & Risk Studies for Wind, Solar and BESS facilities as well as specialist work in EMR-EMI, Shadow Flicker, Blade Throw and Aviation Safeguarding.

## Education and Certifications

- Bachelor of Science, University of Sydney (1975)
- Bachelor of Civil Engineering (HONS I), University of Sydney (1977)
- Master of Engineering Science, University of Western Ontario (1979)
- Doctor of Philosophy, University of Western Ontario (1984)

## Project Experience – Solar Farm Glint and Glare

### Australian Projects

#### New South Wales

- Amaroo Solar Farm, Moree – 8MW FRANC Energy Systems
- Ashley Solar Farm – 8MW FRANC Energy Systems
- Baiada Oakburn Facility Rooftop Solar, Tamworth – 1MW Richard Crookes Construction
- Blind Creek Solar Farm, Bungendore – 350MW Stride Renewables
- Boggabri Solar Farm – 5MW Providence Asset Group
- Bomen Solar Farm – 100MW Bomen Solar Power Trust
- Back Henty Solar Farm, Culcairn – 8MW FRANC Energy Systems
- Coonamble Solar Farm, Warialda – 5MW Providence Climate Capital
- Finley Solar Farm – 5MW KDC Planners

• Glen Innes Solar Farm – 5MW	Providence Asset Group
• Gunnedah Solar Farm – 5MW	KDC Planners
• Gunning Solar Farm – 250MW	Canadian Solar
• Guyra Solar Farm – 5MW	KDC Planners
• Manilla Solar Farm – 7MW	KDC Planners
• Narrabri Solar Farm – 5MW	Providence Asset Group
• Narromine Solar Farm - 5MW	FRANC Energy Systems
• Oxley Park Solar Farm, Nevertire – 5MW	Providence Climate Capital
• Pine Ridge Solar Farm, West Wyalong – 5MW	Providence Asset Group
• South Tamworth Solar Farm – 5MW	KDC Planners
• Taminda Solar Farm, Tamworth – 9MW	ELTON Consulting
• Warialda Solar Farm – 5MW	Providence Climate Capital
• Warral Solar Farm – 5MW	Providence Asset Group
• Wee Waa Solar Farm – 5MW	FRANC Energy Systems
• Yarrabee Solar Farm – 900MW	Reach Solar Energy
<b>Queensland</b>	
• Broadsound Solar Farm – 377MW	Hadstone Energy
• Chinchilla Solar Farm – 20MW	Impact Investment Group
• North Creek Solar Facility, Coppabella – 150MW	TILT Renewables
• Eumundi Landfill Solar Farm – 5MW	Noosa Shire Council
• Lower Wonga Solar Farm – 350MW	LightsourceBP
• Gurambillara Energy Hub, Pinnacles – 400MW	365 Future Energy Pty Ltd
• Toowoomba Aerodrome Rooftop Solar – 2MW	ITP Renewables
<b>South Australia</b>	
• Oodnadatta Solar Farm – 1MW	SA Department of Energy & Mining
• Parafield Airport Rooftop Solar Facility – 0.2MW	Regen Energy
• Robertstown East Solar Farm – 236MW	AMP Power Australia
• Yalata Solar Farm – 1MW	SA Department of Energy & Mining
<b>Tasmania</b>	
• Weasel Solar Farm – 219MW	Robert Luxmoore
<b>Victoria</b>	
• Hazelwood Solar Farm – 500MW	Manthos Investments / Robert Luxmoore
• Laverton North Solar Farm – 2MW	Kuga Energy
• Melbourne Airport Mace Way Rooftop Solar – 0.5MW	Kuga Energy
• Springvale South Solar Farm - 30MW	Maddocks Lawyers
• Wangaratta Solar Farm – 40MW	Countrywide Energy / CleanPeak Energy
• Winton Refuelling Solar Facility, - 1MW	Lochard Energy
<b>Western Australia</b>	
• Broome Airport Hangar Solar Facility – 0.5MW	Royal Flying Doctor Service
• Collgar WEX Solar Farm, Norpa – 7.5MW	Avara Energy
• Gudai-Darri Solar Farm, Koodaideri – 34MW	Balance Service Group (for RIO TINTO)

- Narrogin Solar Farm – 300MW Land Insights
- Ngaangk Boodja Solar Farm, Merredin – 158MW Nomad Energy / Land Insights
- Perth Airport Terminal Building Solar Facility – 1MW Georgiou Group Pty Ltd
- Perth Airport Northern Precinct Solar Facility – 5MW NDY Management
- Port Hedland Solar Farm – 90MW Prestons Consulting (for ALINTA Energy)
- Project CERES Solar Farm, Burrup Peninsula – 24MW Perdaman Chemicals & Fertilisers

## Overseas Projects

### New Zealand

- Ahuroa Valley Solar Farm – 3MW Tie Trustee Ltd
- Auckland Surf Park I Solar Facility – 5MW AWH Holdings 2021 (LP)
- Auckland Surf Park II Solar Facility – 7MW INOVO
- Brook Road Solar Farm – 4MW DYang Trust
- Carterton Solar Farm – 150MW 4Sight Consulting
- Christchurch Airport Kowhai Park – 168MW Lightsource Development
- Dannevirke Solar Farm I – 20MW Tararua Council
- Dannevirke Solar Farm II – 76MW Tararua Council
- Drury Quarry Solar Farm – 9MW 4Sight Consulting
- Ford Road Solar, Waihi Solar Farm – 32MW Ford Road Solar LP
- Foxton Solar Farm – 200MW Solar-Gen JV
- Hawke's Bay Airport Solar Farm – 45MW Hawkes Bay Airport Ltd
- Ireland Road Solar Farm – 20MW Huachen Investment Holdings
- Marton Solar Farm Whales Line – 74MW 4Sight Consulting
- Marton Solar Farm Whales Line II – 103MW Harmony Energy
- Marton Solar Farm Pukepapa Road – 25MW Rangitikei Council
- Massey University Solar Facility – 8MW Energy Bay Ltd
- Opunake Solar Farm – 100MW 4Sight Consulting
- Pukemoremore Solar Farm – 202MW Waikato Regional Council
- Stratford Solar Farm – 180MW Stratford Solar LP
- Tauhara North Solar Farm – 55MW Energy Bay Ltd
- Tauhei Solar Farm – 185MW 4Sight Consulting
- UAWA Solar Farm Tolaga Bay – 12MW Eastland Generation Ltd
- Wairoa Solar Farm – 12MW Eastland Generation Ltd

### North America

- Clearfield County Solar Farm (Pennsylvania, USA) – 400MW Mineral Basin Solar Power
- Gleichen Solar Project (California, USA) – 17MW TIU Canada
- Palmdale Regional Airport, Northrop Grumman Solar (California, USA) – 8MW Catalyze
- Stanislaus County Solar Farm (California, USA) – 128MW Elevated Entitlements
- Timberlea Reservoir Solar (Alberta, CANADA) – 0.5MW Associated Engineering Alberta

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### South America

- Japeados Solar Farm (CHILE) - 226MW ENVIS Consulting
- Limonares Solar Farm (CHILE) – 125MW ENVIS Consulting
- Park Algarrobal Solar Farm (CHILE) – 224MW ENVIS Consulting

### Middle East

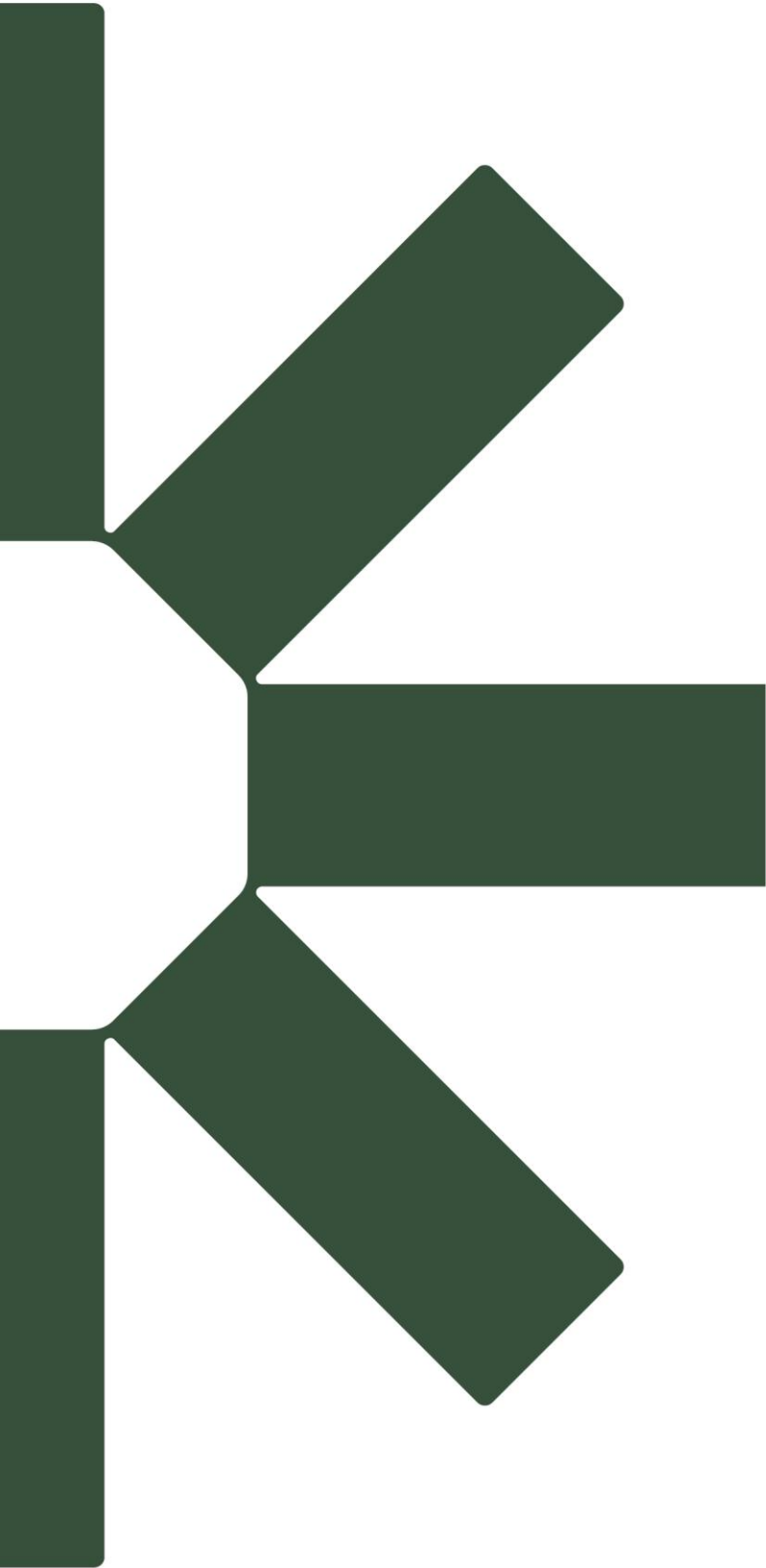
- Majmaah Solar Energy Park (SAUDI ARABIA) - 1,540MW ILF Consulting
- Tumair Solar Energy Park (SAUDI ARABIA) - 924MW ILF Consulting

### Europe

- Manchester Airport - World Logistics Rooftop Solar (UK) – 1MW MAG / Stafford

### Expert Witness

- AUC Proceedings 27077 - Vauxhall Solar Farm - Glint & Glare
- AUC Proceedings 27842 – Aira Solar Farm - Glint & Glare
- AUC Proceedings 27885 – Airport City Solar Farm - Glint & Glare
- AUC Proceedings 29274 – Hanna Aerodrome Solar Farm - Glint & Glare
- LEC Matter (MWRC v ITP) Mudgee (NSW, AU) Solar Farm - Glint & Glare
- Tararua District Council Hearing Panel - Mangamaire Road Solar Farm - Glint & Glare
- Waikato District Council Hearing Panel - Tauwhare Solar Farm - Glint & Glare



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