WAIMAKARIRI DISTRICT COUNCIL

Review of Vector PowerSmart Assessment of Solar Farm Glint and Glare at 87 Upper Sefton Road Ashley

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1 INTRODUCTION

1.1 Overview

At request of Waimakariri District Council, the following report is based on a review of a Glare and Glint Study carried out by Vector PowerSmart (VPS) on the implementation of a Solar Farm located at 87 Upper Sefton Road, Ashley.

Figure 1. Upper Sefton Road Solar Farm location outlined in blue

1.2 Scope/Brief

Brief: Velden Aviation Consulting (VAC) is to review the report provided by Vector PowerSmart for Solar Bay at Ashley and assess the accuracy of findings in terms of impact of the potential glint and glare on surrounding dwellings as well as road users and for any nearby railroad and airfields.

Scope :

1. Review report and parameter information it provides with regard to glint and glare. Associated correspondence and input data into modelling software.
2. Independent assessment to corroborate results of Vector PowerSmart assessment, using the same utility by ForgeSolar that Vector PowerSmart have used for Fixed Tilt Array, Single Axis tracking with 1 Solar Panel size (1P) and Single Axis tracking with 2P size.
   Review and Comparison of results and record any differences to evaluate report conclusion offered. Dwellings as well as road users to be assessed and compared against Vector report. Covers fixed Array as well as Tracking Array type analysis. Include written review.
3. Review of mitigation measures, investigate any shortfalls and investigate additional measures where required.
4. Review of any major impacts to both residents' dwellings and road users. Consideration of specifics to any party and potential additional mitigation.

5. Conclusion outcomes and determination of potential shortfalls and associated mitigation requirements as part of any potential consent conditions. Written report follow up and clarifications.

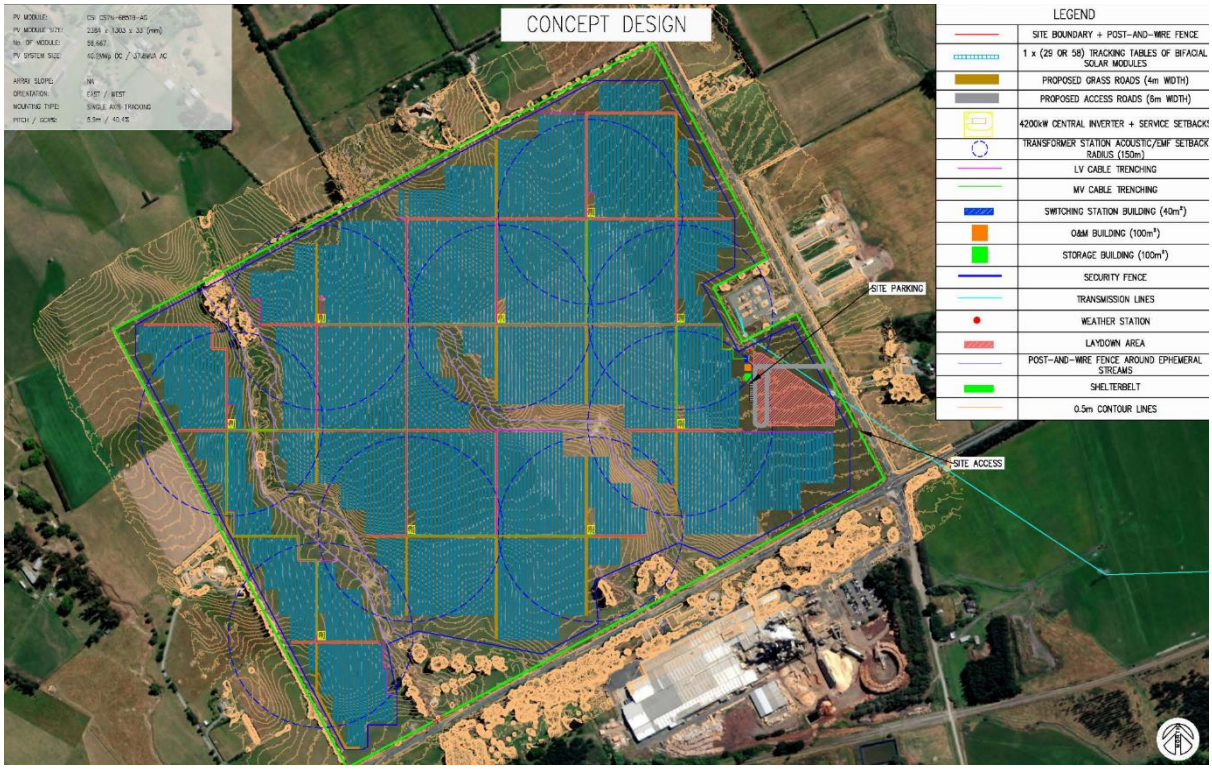
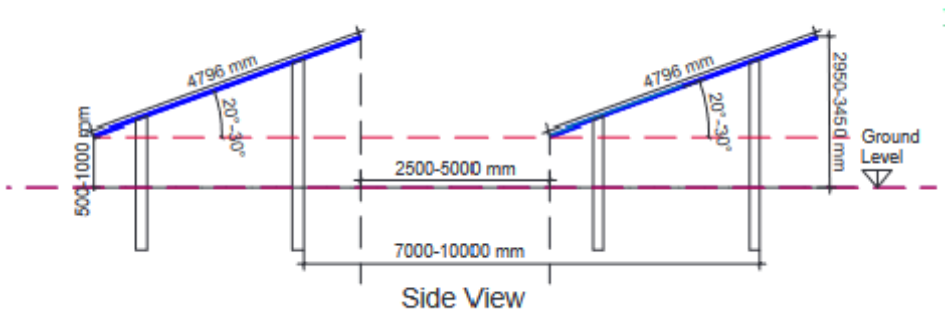


Figure 1.2 Site Boundary (Ref: Vector PowerSmart Concept Design, Appendix page 4, RMM Landscape Assessment Report 11 Oct 2023)

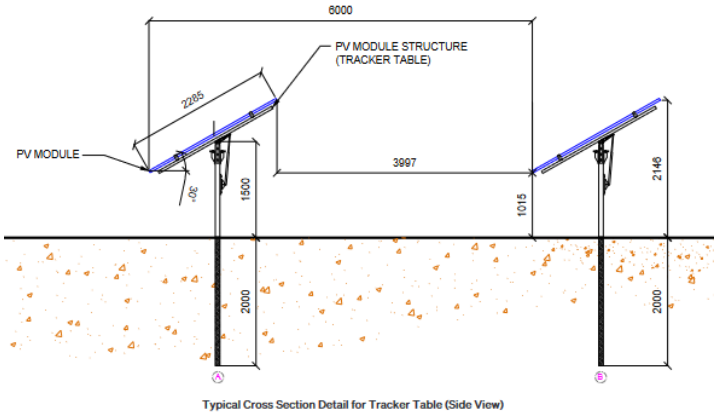
1.3 Solar Panel Photovoltaic (PV) Array Options Information Considered

Technical Information on Solar Farm PV Array system

Fixed Tilt Array : Mean 1.8m above ground , Tilt 25 degs, Orientation 0 degs (True north), smooth glass with Anti-Reflective Coating (ARC).

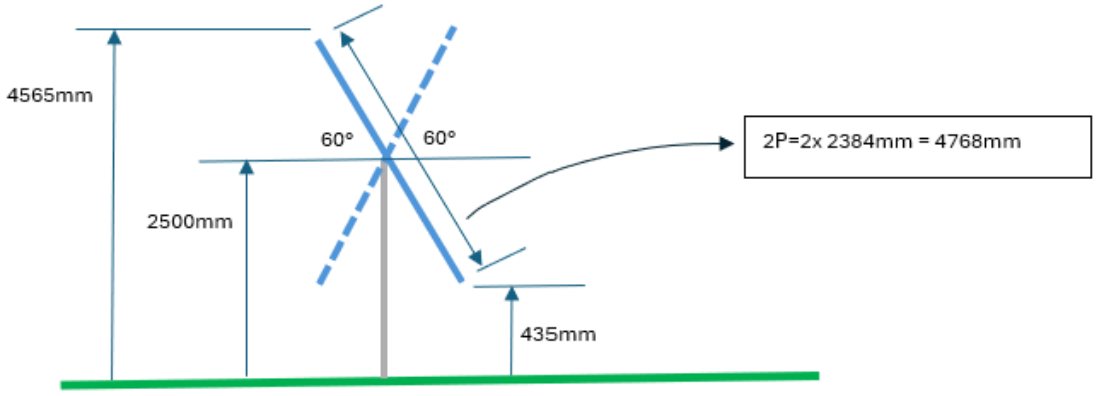


SAT (1P) : Mean height above ground 1.5m, tracking +/-60 degs, tracking axis orientation 0 degs. (East-West tracking). Backtracking -shade slope, panels smooth glass with ARC.



Typical Cross Section Detail for Tracker Table (Side View)

SAT (2P) : Mean height above ground 2.5m, tracking +/-60 degs, tracking axis orientation 0 degs. (East-West tracking). Backtracking -shade slope, panels smooth glass with ARC.



1.4 Solar Farm Modelling Data

With reference to Figure 1.4 below, the VPS report considers 21 dwellings (noted by red markers), three road routes (noted by blue lines) and a 2m high shelterbelt (noted by orange line) to provide obstruction screening of the solar farm view and potential glare.

Figure 1.4. Dwelling locations (observation points 1-21), Road Routes (blue lines) and shelterbelts (orange lines surrounding the solar farm. (Ref Vector PowerSmart Glint and Glare Assessment report Fig 5, Page 9 of 21)

1.5 Important Notes on Methodology and Modelling Comparison

This review considers the results of the VPS glint and glare analysis carried out on the proposed Solar Farm PV arrays considered for Upper Sefton Road at Ashley.

The review looks to compare the results obtained by VPS based on use of the ForgeSolar, Solar Glare Hazard Analysis Tool (SGHAT) and evaluation of potential glare on road users, dwellings.

It is not known if VPS used local terrain data derived from council maps or specifically from Google Map data as utilised in the ForgeSolar utility as no indication was provided in the VPS report.

At the time of reviewer assessment for this report, no information was received on this matter with regard to initial data utilised by VPS. The reviewer considered that VPS use of ForgeSolar Google map data appeared the most likely based on the solar PV array location outlines used.

The overall comparison of PV array perimeter vertices correlated well however in terms of approximate coordinates used and heights of terrain at these points as well as for the dwellings and roads that were assessed.

As such, Velden Aviation Consulting (VAC) reviewer therefore utilised the same approach in determination of the same perimeter data but did not use as many data points for the same perimeters, road lengths and shelterbelts as the VPS modelling.

Vector PowerSmart (VPS) Modelling

For residential dwellings, the VPS assessment based receptor height for dwellings as 1.7m and are assumed to be single storey for each dwelling.

For road users the VPS assessment evaluation was based on 1.8m eye level for drivers receptors.

For the shelterbelt's mitigation obstruction considered, the VPS assessment used a simulated upper edge height of 2m.

Velden Aviation Consulting (VAC) Modelling

Based on previous assessment considerations with other authorities, normally both single and two storey residential dwellings need to be considered, with 1.8m receptor eye height considered as standard for single storey dwellings assuming seated person and including house foundations and floor, and 3.6m receptor eye height for dwellings with two storeys.

Also, for solar farm potential glare impacts on road users, two types of vehicles are believed to be more representative of a typical road user for a rural demographic. This considers smaller or standard vehicles with seated driver eye height around 1.5m and for larger vehicles normally found on rural roads such as tractors, school buses and haulage vehicles for which driver eye heights are normally taken as 2.5m.

Given VPS receptor eye level heights of 1.7m for dwellings and 1.8m for road users, based on the solar farm PV array options (Fixed Tilt , SAT-1P, SAT-2P) and the respective heights to the top of these arrays it is likely the 2m high shelterbelt obstruction will not provide sufficient mitigation to road users of larger vehicles or for residents of two storey dwellings.

Rough Milne Mitchell (RMM) Landscape Architects for Solar Bay, noted that proposed new shelterbelts are planned to reach up to a height of 4m for most roads and up to 6m for 189 Beatties Road (Ref: Conclusion, Bullet point 7, Page 34 of their report). It is understood that these are measures proposed by RMM for planned landscape plantings to mitigate any potential view and impact of glare from the solar farm on road users and dwellings in the immediate area of the Ashley solar farm development.

As such, for this review, shelterbelt heights simulating these levels are considered with results compared against VPS outcomes to establish mitigation effectiveness based on RMM landscape architects' heights of established plantings.

2. Executive Summary

This review evaluates the Vector PowerSmart (VPS) Glare Assessment Report in terms of conclusions reached with regard to potential glare impacts on neighbouring dwellings and roads in the vicinity of the proposed upper Sefton Road, Ashley Solar Farm development.

This independent review of the VPS report is based on utilisation of the same software utility used by VPS and developed by ForgeSolar that is used to assess solar glare hazards.

While the review agrees with a significant part of the VPS assessment for the predicted solar glare impact, it is noted that there were also a number of aspects that were not considered by VPS that were considered important and more representative of the local environment.

For instance, VPS assesses glint and glare impacts on dwellings based on receptor heights of 1.7m and road routes receptor eye levels of 1.8m and considers vegetation mitigation screens such as shelterbelts at heights of 2m.

This review compares glint glare assessment for additional heights of 3.6m for dwellings given there are two storey dwellings and for drivers of large vehicles such as farm vehicles, tractors, haulage vehicles, school buses etc often found on rural roads with eye level heights around 2.5m.
Additionally, this included impact assessment being done on nearby airfields such as Rangiora aerodrome and the nearby railway line which were not considered in the VPS assessment.
The assessment also takes into account the Landscape Architect proposed landscape plantings and established heights of 4m and 6m that would provide vegetation mitigation or screening against potential glare.

The Australian New South Wales Government Guidelines on Solar Developments is also considered as a standard criteria on which to base degrees and rating of impact on potential solar glare.

While generally there is good correlation overall from the Velden Aviation Consulting reviewer with the VPS glint and glare assessment, the above aspects and variations are also taken into consideration in this report.

A conclusion with recommendations is provided that will hopefully offer further guidance to making informed decisions that assist with progressing resource consent considerations for this development.

3 BACKGROUND DATA

3.1 Array Proposed

The Upper Sefton Road Solar Farm PV array system being utilised considers both Fixed Tilt arrays as well as Single Axis Tracking system. The data used by VPS during their analysis was based on the following Tracking System parameters.

1. *Backtracking System*

Backtracking is used to provide various strategies that rotate the modules away from the sun to reduce shading. These strategies typically take effect when the sun's position lies outside the range of rotation defined by the **maximum tracking angle** of the PV panels, or when substantial shading occurs, depending on the strategy selected.

2. *Shade Backtracking*. Used when the PV panels are on flat ground
3. *Resting Angle*. The angle of rotation when the sun is outside of the tracking range. In the PV system considered this is 0 degrees.
4. *PV panel material*. Smooth glass with anti-reflective coating.

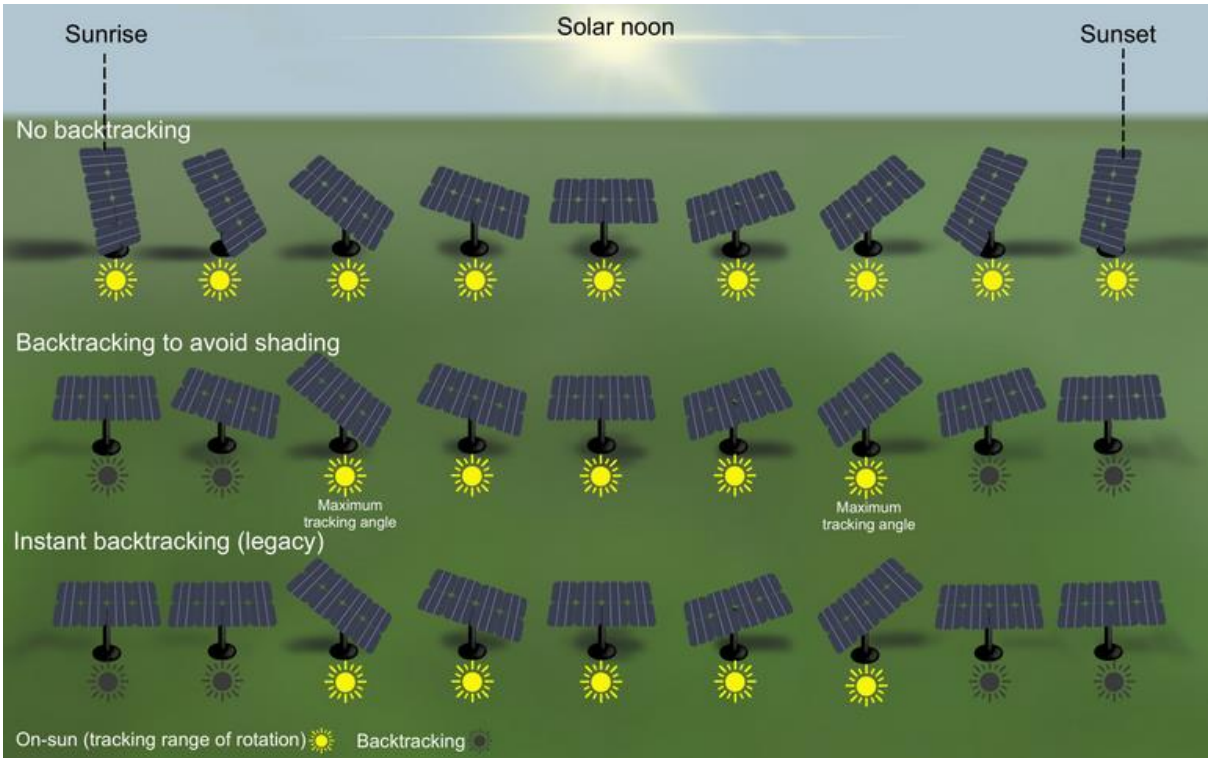


Figure 3.1 Backtracking strategies. (Reference ForgeSolar)

3.2 Solar Glare Impact Analysis

Solar Glare Impact

Although most PV solar panels have anti-glare coatings to minimise glare as much as possible there is always some residual glare present that has potential to create a hazard.

The VPS Glare Assessment is based on analysis using the ForgeSolar solar glare hazard analysis software utility. This provides glare assessment associated with impact to the human eye in terms of levels of glare and its hazard potential.

General Consideration

Solar glare hazard analysis (SGHA) is based on potential to cause damage to any observer's eyes.

The chart in the figure below applies a colour code of green, yellow or red depending on the hazard potential and any PV arrays causing issues to designated observation points.

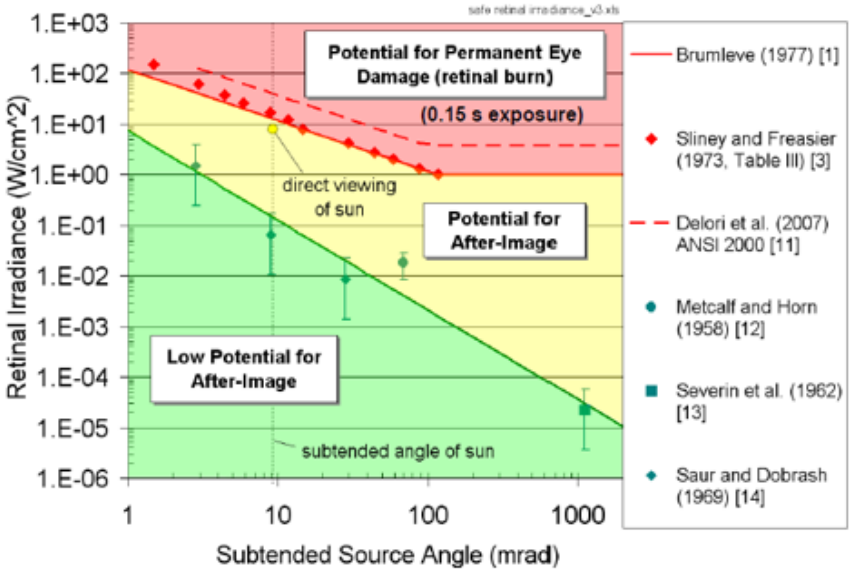


Figure 5.1: Potential ocular impact

"**Green zone**" glare is considered to have low potential to cause after –image (flash blindness) when observed prior to a typical blink response.

"**Yellow zone**" glare is considered to have potential to cause after image (flash blindness) when observed prior to a typical blink response time.

"**Red Zone**" glare is considered to have high potential to cause permanent eye damage.

Typically green and yellow glare are experienced from solar arrays compared to red glare which is rarely experienced from any PV reflection.

Although any PV arrays that create issues that fall in the green zone have low potential for after-image, and less chance of ocular damage over time, this is seen as less of a problem for dynamic or moving receptors such as vehicles, trains or aircraft.

Use of SGHA comes with the following assumptions applied;

1. Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
2. Several 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.
3. The subtended source angle (glare spot size) is constrained by the PV array footprint size.
4. Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
5. Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
6. The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
7. 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.

It should be added that solar glare is experienced every day, however static occupational observation points such as fgor residents of dwellings does not necessarily mean that solar glare impacts the predominant direction the observer is looking.

Most dwellings have blinds as well as tinted windows that limit glare. This should not be seen as a precursor for mitigating glare however.

These are considerations that can be taken into account when deciding overall impact of solar glare from proposed PV arrays.

3.3 Solar Glint and Glare Standards and Mitigation

VPS makes specific reference to the United States Federal Aviation Administration (FAA) glare requirements which is limited criteria pertaining to airfields and assocciated air traffic control towers that may be located on these aerodromes.

The reviewer agrees with the VPS assumption that there is no apparent guidance from New Zealand Civil Aviation Authority (NZCAA) or the NZ Transport Agency Waka Kotahi and as such the FAA criteria are normally acceptable.

It should be understood however that FAA criteria apply to airfields only and do not relate to any standards that may be applicable to road users, residents of dwellings or railroad users.

While a number of standards exist in both the Europe and the U.S. in relation to solar farm developments impact on the general public, the reviewer from of Velden Aviation Consulting considers standards provided by the Australian New South Wales Government Guidelines on Large Scale Solar Energy Development can be applied as they also become increasingly adopted within New Zealand. (See Table 3.3 below)

These standards are also generally more conservative than those from other countries.

3.3.1 Glare Mitigation for Requirements for Dwellings

Table 2: Impact rating and performance objectives for glare impacts to residential dwellings

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.

Table 3.3 Australia NSW Government Guidelines for glare impacts on Dwellings

As noted in the guidelines, glare should ideally be reduced to a point where less than 10 mins per day and less than 10 hours per year is considered. As such, any mitigation measures being considered should be such that it reduces potential glare to dwellings to meet low glare impact durations. This should ideally apply to both green and yellow levels of glare.

3.3.2 Glare Mitigation for Requirements for Road Users

Due to greater safety concerns associated with road users, ideally glare should be minimised as far as practicable. This should especially be the case at or near intersections where glare may create a greater potential hazard.

It should be noted that the more conservative Australian Guidelines as shown in Table 3.4 below on solar glare for road users, does not provide any duration or time limits on glare apart from that it should be addressed as far as practicable.

This allows for a wide degree of subjectivity in terms of what amount of glare and duration is considered to impact on road safety. This may range from being impacted by glare during critical moments on the road such as being struck by glare when overtaking or encountering it while approaching, crossing, or turning at an intersection when there is oncoming traffic. The difficulty is in weighing up risks associated with each scenario and the likelihood of each in terms of major incident occurrence.

Table 7: Glint and glare requirements

	Scope	Methodology	Performance objective
Road and rail	All roads and rail lines within 1km 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.

Table 3.4 Australian Solar Farm Guidelines on Glint and Glare Assessment Approach for Road Users.

The Forge Solar utility that was used identifies levels of glare needing to be considered. This has been covered in section 3.2 in relation to green, yellow and red glare.
Green glare is less of an issue for dynamic situations such as for moving traffic as this level of glare is low level and the duration is expected to be very small due to traffic moving quickly past areas of potential reflection.
Yellow level glare would have greater impact due to causing short duration flash blindness and hence is more important to address and mitigate as far as practicable.
Red glare must be avoided due to potential ocular damage with mitigation a necessity.
As such green glare is expected to be of minimal and less than minor impact to road and rail users and where there is yellow or red glare, efforts should be made to mitigate this.

3.3.3 Glare Mitigation Requirements for Airfields

Although it is noted that VPS assessment did not take into account potential impacts of glare on any nearby airfields, it is recommended that such an assessment is considered.

Potential glint and glare impacts should be assessed in relation to nearby airfields paticularly within a 10 nautical mile radius of a major airfield and generally within 5 to 10 km of smaller non commerciial airfields.

The Ashley solar farm development at Upper Sefton road is approximately 6 to 7 km from Rangiora aerodrome as shown in Figure 3.2 below. **Appendix B** provides information from the New Zealand Civil Aviation Authority Aeronautical Information Publication on the layout of the Rangiora airfield which involves up to 6 runway approaches.

Although only a club airfield, with no Air Traffic Control Tower or any flight information service, potential impact is considered only for pilots on approach for each of the runways. This is based on a typical approach angle of 3 degrees from the runway threshold and typically out to 2 NM.

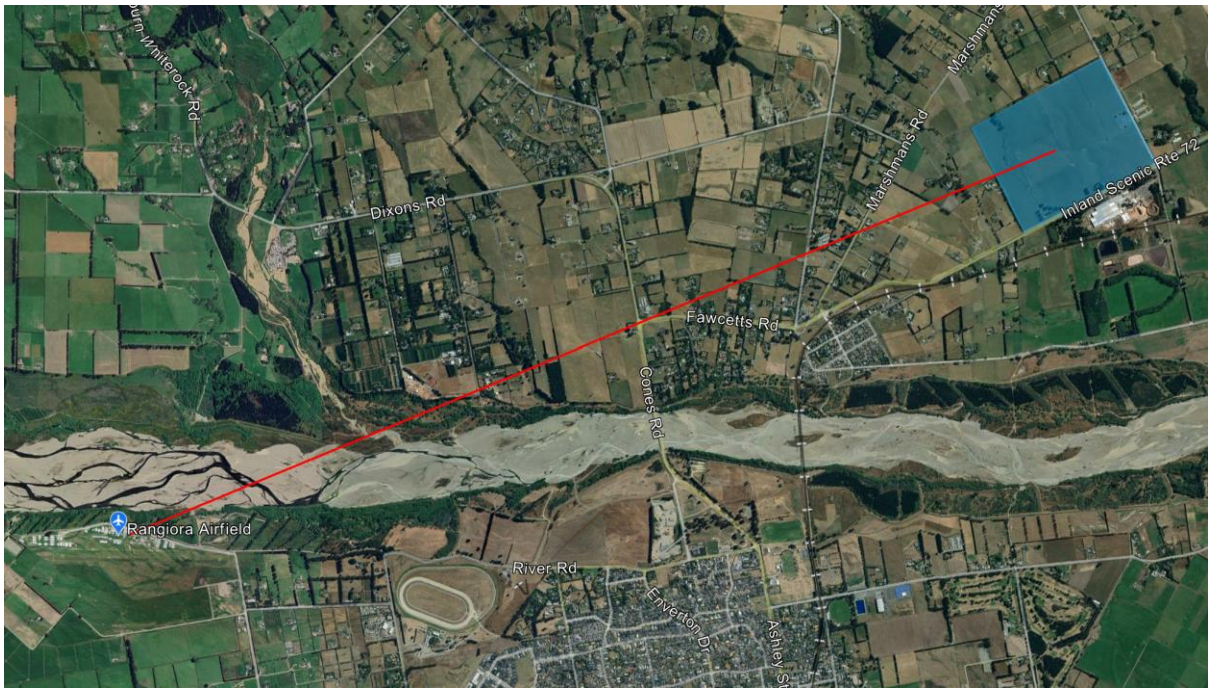


Figure 3.2 Rangiora airport approximately 6-7 km from propsoed solar farm development.

3.3.4 Glare Mitigation Requirements for Railways

As per Table 3.4 relating to the NSW Solar Development Guidelines, measures should be taken to eliminate the occurance of glare and or 'demonstrate that glare would not significantly impede the safe operation of vehicles or interpretation of signals and signnage.'

As with road users, for rail this should be interpreted as mitigating both yellow and red glare to a minor or less than minor impact level.

4 SOLAR GLARE ANALYSIS RESULTS

4.1 Impact on Rangiora Airport

With no VPS assessment done to potential impact of the Ashley Solar Farm on Rangiora aerodrome the reviewer considered this an important aspect that needed to be covered due to its proximity to the aerodrome.

As such the following tables provide results based on potential impact of glare to pilot approaches of each of the runways for each of the solar array systems proposed. See **Figure 4.1.**

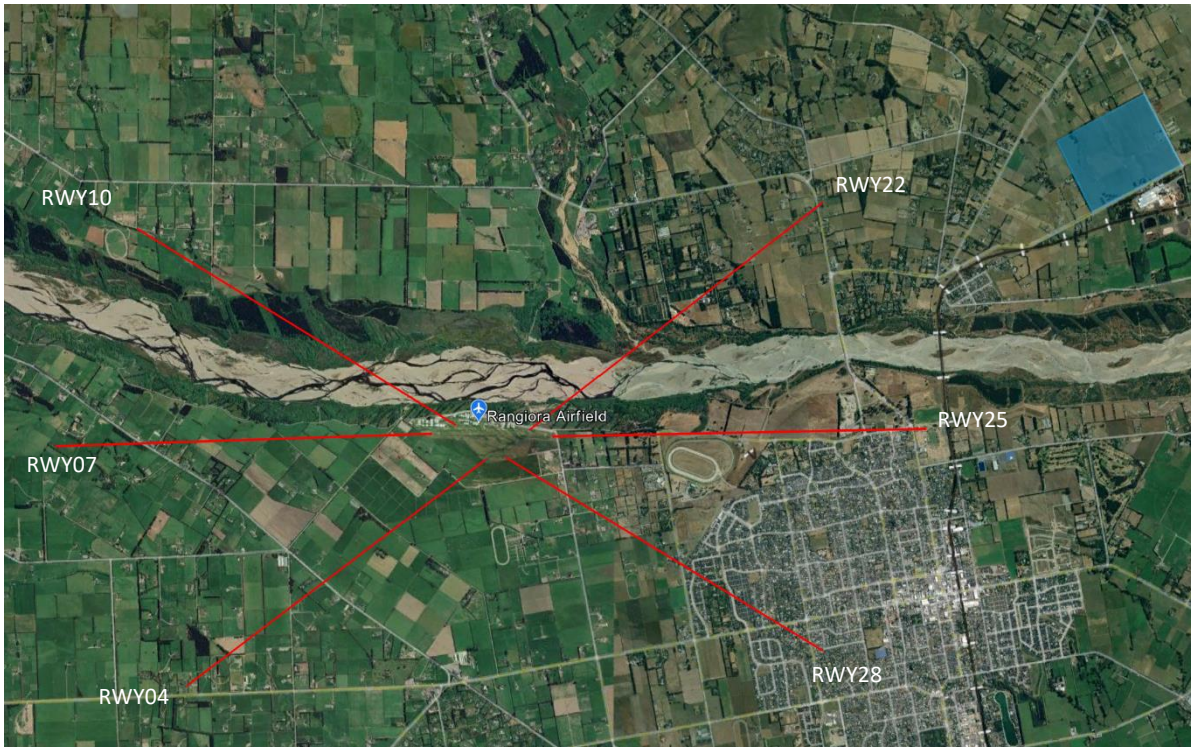


Figure 4.1 Rangiora aerodrome Runway approaches

Fixed Tilt System -PV Array 1

Runway Approach	Result	Remarks
RWY07 (FP1)	No predicted glare	No mitigation necessary
RWY25 (FP2)	No predicted glare	No mitigation necessary
RWY10 (FP3)	No predicted glare	No mitigation necessary
RWY28 (FP4)	No predicted glare	No mitigation necessary
RWY22 (FP5)	No predicted glare	No mitigation necessary
RWY04 (FP6)	No predicted glare	No mitigation necessary

Fixed Tilt System – PV Array 2

Runway Approach	Result	Comment
RWY07 (FP1)	No predicted glare	No mitigation necessary
RWY25 (FP2)	No predicted glare	No mitigation necessary
RWY10 (FP3)	No predicted glare	No mitigation necessary
RWY28 (FP4)	Green Glare predicted 1.8 hours per year.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY22 (FP5)	No predicted glare	No mitigation necessary
RWY04 (FP6)	No predicted glare	No mitigation necessary

SAT – 1P PV Array 1

Runway Approach	Result	Comment
RWY07 (FP1)	Green glare 14.3 hours p.a.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY25 (FP2)	No predicted glare	No impact
RWY10 (FP3)	No predicted glare	No impact
RWY28 (FP4)	Green glare 19.3 p.a.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY22 (FP5)	No predicted glare	No impact
RWY04 (FP6)	Green Glare 14.9 p.a.	Since only green level glare Less than minor impact. No mitigation necessary.

SAT – 1P PV Array 2

Runway Approach	Result	Comment
RWY07 (FP1)	Green glare 4.4 hours p.a.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY25 (FP2)	No predicted glare	No impact
RWY10 (FP3)	No predicted glare	No impact
RWY28 (FP4)	Green glare 13.1 p.a.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY22 (FP5)	No predicted glare	No impact
RWY04 (FP6)	Green Glare 3.5 p.a.	Since only green level glare Less than minor impact. No mitigation necessary.

SAT – 2P PV Array 1

Runway Approach	Result	Comment
RWY07 (FP1)	Green glare 15.2 hours p.a.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY25 (FP2)	No predicted glare	No impact
RWY10 (FP3)	No predicted glare	No impact
RWY28 (FP4)	Green glare 20.0 p.a.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY22 (FP5)	No predicted glare	No impact
RWY04 (FP6)	Green Glare 17.2 p.a.	Since only green level glare Less than minor impact. No mitigation necessary.

SAT- 2P PV Array2

Runway Approach	Result	Comment
RWY07 (FP1)	Green glare 18.24 hours p.a.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY25 (FP2)	No predicted glare	No impact
RWY10 (FP3)	No predicted glare	No impact
RWY28 (FP4)	Green glare 22.9 p.a.	Since only green level glare Less than minor impact. No mitigation necessary.
RWY22 (FP5)	No predicted glare	No impact
RWY04 (FP6)	Green Glare 16.6 p.a.	Since only green level glare Less than minor impact. No mitigation necessary.

Based on the results above for each of the solar array systems proposed for the Ashley solar farm development, only green glare (low impact glare) is experienced for each of the runway approaches at Rangiora airfield.

FAA criteria can be considered and are applicable for potential impacts of solar glare from solar array system developments near airfields.

Due to the dynamic nature of aircraft on approach and given pilots do not experience glare directly in front of them when coming into land, the speed of the aircraft also means the duration of low impact glare would pass very quickly. The FAA does not consider green glare to have any significant impact compared to yellow level glare and is therefore considered acceptable.

As such the potential glare impact on operations at Rangiora airfield due to the Ashley solar farm development should be less than minor.

4.2 Impact on nearby Railway

Figure 4.2 Railway location (light blue line) adjacent to Ashley Solar Farm Development

The proximity of the railway line to Ashley solar farm is shown in Figure 4.2.
The distance considered is up to 1km from the railway line to the solar farm. This also takes into account any road crossings and signals that are likely to be encountered by the train driver looking directly down the track.
Although there was no VPS assessment of impacts to railways to enable any results comparison, the following tables provide assessment results carried out by VAC for each of the Solar PV array systems being considered.

It should be noted that glare assessment was based on train driver eye level of 2.5m.
Also, it is based on RMM proposed plantings such as shelterbelts reaching final height of 4m along the Upper Sefton Road along the side of the proposed solar farm.

Array type	Glare Impact on Train Driver		Comments
	Green Glare	Yellow Glare	
Fixed Tilt- PV Array 1	13.4 hrs p.a.	1.0 hrs p.a.	Yellow glare is encountered but minor at less than 10mins per day and not in direction of line of travel. No mitigation required
Fixed Tilt PV Array 2	No green glare	No yellow glare	No mitigation required
SAT 1P Array 1	3.9 hrs p.a.	No yellow glare	Green glare only. no mitigation required
SAT 1P Array 2	No green glare	No yellow glare	No mitigation required

SAT 2P Array 1	3.8 hours p.a.	No yellow glare	Green glare only. no mitigation required
SAT 2P Array 2	6.2 hours p.a.	1 min per year yellow glare	Green glare and effectively no yellow glare. No mitigation required

Tabel 4.2 Results for impact of Ashley solar farm on adjacent railway line with 2.5m train driver eye level height

Although table 4.2 indicates that potential green and yellow glare may be encountered by train drivers heading south, this appears mainly for a fixed tilt array system at PV Array 1 location.
This is also mostly green level glare which is not significant for dynamically moving vehicles due to its low level impact. The yellow level glare is also of short duration as indicated in the plots below which show it is less than 5 minutes duration between 6pm and 7pm and during months of early Feb to late April and from mid-September to end of October. (See Figure 4.3 below)

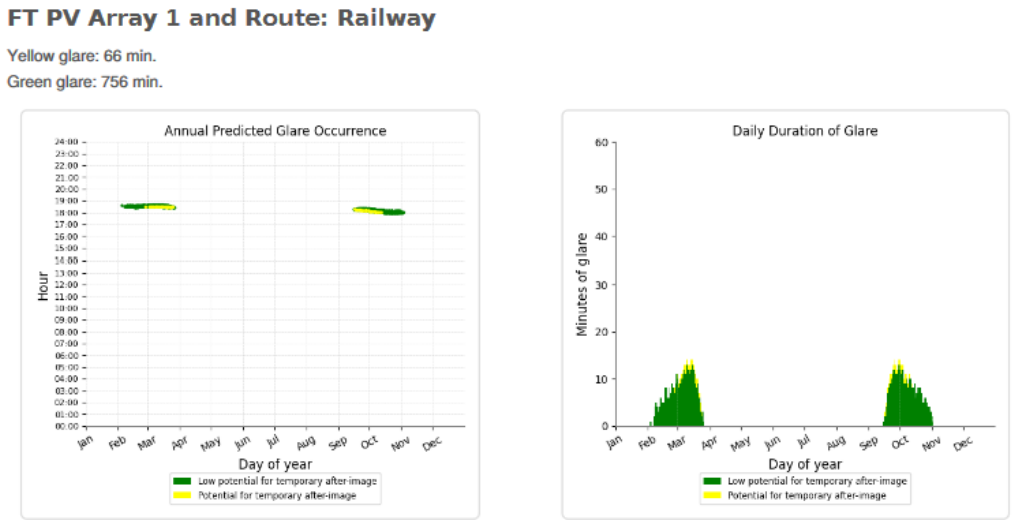
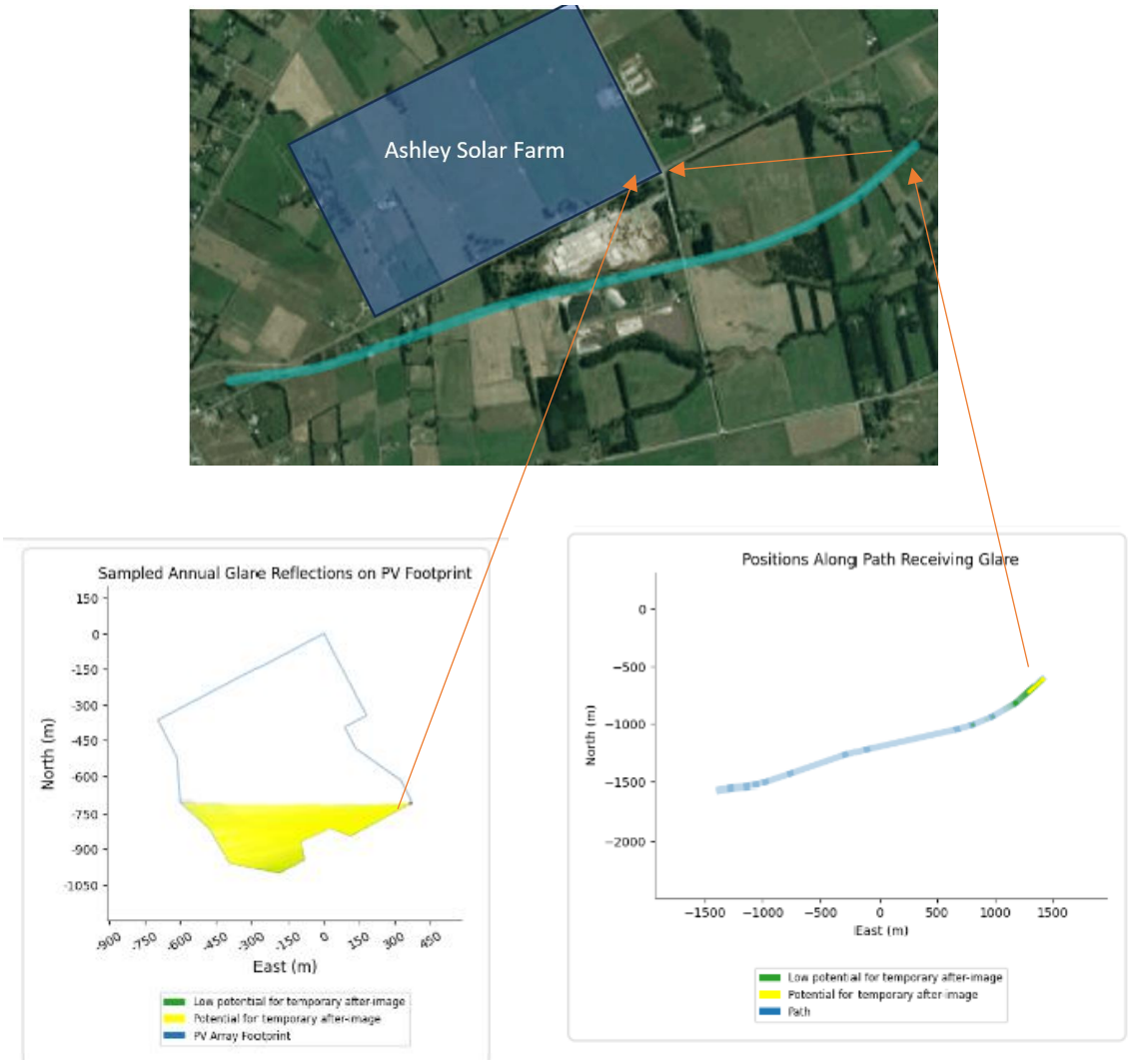


Figure 4.3 Predicted glare occurrence for Rail for FT PV array 1

The footprint below and location on the railway path indicates where this is happening.



Although a 4m shelterbelt is expected to obscure any view for the train driver at this point the mechanism by which the simulation may be showing yellow glare or in fact any glare from this point is if either the height of the terrain at the driver location and the solar farm location is significantly different.

A terrain height profile review indicated this is the case. (See Figure 4.4 . Obtained from Waimakariri District Council Website on 3D GIS terrain information https://gisservices.waimakariri.govt.nz/apps/lightside.html)

Figure 4.4 Terrain elevation profile on left from point on rail line where glare is encountered to Ashley solar farm site (elevation profile represented along orange line).

This glare is not on direct line of travel and also near the extreme of train driver's peripheral vision. The peripheral vision for drivers of moving vehicles is normally taken as ± 50 degrees on either side of direction of travel .

Given also that glare levels do not appear to occur near the Beatties Road railway crossing it is not expected to impact on any railway crossing signals.

Existing vegetation between the railway line and the Ashley solar farm is also expected to obscure any view to the train driver so glare impacts overall are expected to be minor to less than minor for the railway line in the vicinity noted.

4.3 Impact on Dwellings

The following compares results from the VPS report with an added column summarising and comparing results obtained from this independent review for shelter belt heights according to RMM Landscape Architects and for worse case scenarios of dwellings with two storeys with receptor eye levels at 3.6m.

Where the results are similar this is addressed as concurrence with the VPS assessment. Where no dwelling level is provided this is assumed to be two storey which provides a worst case scenario. Where this has less than 10 hours per year and less than 10 minutes per day as per applied criteria from the Australin NSW Solar Development Guidelines then there is also agreement with the VPS recommendation with regard to mitigation not being required.

Appendix C provides a summary of amount of glare that can be expected for each dwelling based both on VPS assessment for single storey and VAC reviewer assessment for two storey dwellings. Overall, there is still very good agreement on glare impact between both sets of results as summarised in the tables below.

Fixed Tilt PV Array 1 : Average Height 1.8m. (See **Appendix C** for Simulation Results)

ID/ OP	Address/Viewing Audience	VPS description of potential glare effects (1.7m Receptor heights.) and 2m high shelter belt	VAC Review potential glare (Based on Receptor heights of 1.8m for 1 storey and 3.6m for 2 storey dwellings. And RMM shelter belt final heights of 6m and 4m	VAC Reviewer Remarks
OP 1	Single storey residence	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP 2	Two storey residence	Green Glare only. Max 271 mins pa and 4 mins per day.	Green glare 80.9 hours and yellow glare 9.8 hours predicted.	**Although yellow glare is less than 10 hours p.a. combined green and yellow glare is greater than 10 hours p.a. and mitigation is recommended**
OP3	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP4	Single storey	Green Glare only, max 19 mins pa and 1min per day	Green Glare only 5.7 hours p.a.	Concur with VPS no mitigation required
OP5	Two Storey	Green Glare only, max 30 mins pa and 1min per day	Green Glare only 12.3 hours p.a. predicted.	Concur with VPS no mitigation required
OP6	Single Storey	Green Glare only, max 58 mins pa and 1min per day	No glare predicted	Concur with VPS no mitigation required
OP7	Single storey	Green Glare only, max 145 mins pa and 2min per day	No glare predicted	Concur with VPS no mitigation required

OP8	Single Storey	Green Glare only, max 78 mins pa and 1 min per day	No glare predicted	Concur with VPS no mitigation required
OP9	Single Storey	Green Glare only, max 23 mins pa and 2 min per day	No glare predicted	Concur with VPS no mitigation required
OP10	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP11	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP12	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP13	Single storey	Green Glare only, max 139 mins pa and 4 min per day. Plus, 5mins of yellow glare p.a.	No glare predicted	Concur with VPS no mitigation required
OP14	Two storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP15	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP16	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP17	Single Storey	Green Glare only, max 312 mins pa and 3 min per day	No glare predicted	Concur with VPS no mitigation required
OP18	Single Storey assumed (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP19	Single Storey (doesn't appear to be a dwelling based on Google Earth)	Green Glare only, max 78 mins pa and 2 min per day	Up to 20.4 hours p.a. green glare and 0.7 hours p.a. yellow glare predicted	**Further investigation recommended to determine need for additional mitigation .**
OP20	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP21	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required

Fixed Tilt PV Array 2 : Average Height 1.8m. (See Appendix XX for Simulation Results)

ID/ OP	Address/Viewing Audience	VPS description of potential glare effects (1.7m Receptor heights.) and 2m high shelter belt	VAC Review potential glare (Based on Receptor heights of 1.8m for 1 storey and 3.6m for 2 storey dwellings. And RMM shelter belt final heights of 6m and 4m	VAC Reviewer Remarks
OP 1	Single storey residence	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP 2	Two storey residence	Green Glare only. Max 792 mins pa and 5 mins per day.	Green glare 74.7 hours and yellow glare 7.58 hours predicted.	**Although yellow glare is less than 10 hours p.a. combined green and yellow glare is greater than 10 hours p.a. and mitigation is recommended**
OP3	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP4	Single storey	No Glare found	Green Glare only 5.7 hours p.a.	Concur with VPS no mitigation required
OP5	Two Storey	No Glare found	Green Glare only 12.3 hours p.a. predicted.	Concur with VPS no mitigation required
OP6	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP7	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP8	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP9	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP10	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP11	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP12	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP13	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP14	Two storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP15	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP16	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required

OP17	Single Storey	Green Glare only. Max 20 mins pa and 1 min per day.	No glare predicted	Concur with VPS no mitigation required
OP18	Single Storey assumed (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP19	Single Storey (doesn't appear to be a dwelling based on Google Earth)	Green Glare only, max 71 mins pa and 2 min per day	Up to 20.4 hours p.a. green glare and 0.7 hours p.a. yellow glare predicted	Concur with VPS no mitigation required
OP20	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP21	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required

SAT 1P PV Array 1 : Average Height 1.5m. (See Appendix XX for Simulation Results)

ID/ OP	Address/Viewing Audience	VPS description of potential glare effects (1.7m Receptor heights.) and 2m high shelter belt	VAC Review potential glare (Based on Receptor heights of 1.8m for 1 storey and 3.6m for 2 storey dwellings. And RMM shelter belt final heights of 6m and 4m	VAC Reviewer Remarks
OP 1	Single storey residence	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP 2	Two storey residence	Green Glare only. Max 478 mins pa and 6 mins per day.	Green glare 11.27 hours and yellow glare 8.8 hours predicted.	**Mitigation is recommended**
OP3	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP4	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP5	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP6	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP7	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP8	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required

OP9	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP10	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP11	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP12	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP13	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP14	Two storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP15	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP16	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP17	Single Storey	Green Glare only. Max 20 mins pa and 1 min per day.	No glare predicted	Concur with VPS no mitigation required
OP18	Single Storey assumed (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP19	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP20	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP21	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required

SAT 1P PV Array 2 : Average Height 1.5m. (See Appendix XX for Simulation Results)

ID/ OP	**Address/Viewing Audience**	**VPS description of potential glare effects (1.7m Receptor heights.) and 2m high shelter belt**	**VAC Review potential glare (Based on Receptor heights of 1.8m for 1 storey and 3.6m for 2 storey dwellings. And RMM shelter belt final heights of 6m and 4m**	
OP 1	Single storey residence	No Glare found	No glare predicted	Concur with VPS no mitigation required

OP 2	Two storey residence	Green Glare only. Max 574 mins pa and 68 mins per day.	Green glare 107.9 hours and yellow glare 14.5 hours predicted.	**Additional Mitigation is recommended or should be investigated.**
OP3	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP4	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP5	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP6	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP7	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP8	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP9	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP10	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP11	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP12	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP13	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP14	Two storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP15	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP16	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP17	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP18	Single Storey assumed (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP19	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP20	Single Storey (doesn't appear to be a dwelling	No Glare found	No glare predicted	Concur with VPS no mitigation required

	based on Google Earth)			
OP21	Single Storey	Green Glare only. Max 418 mins pa and 6 min per day. AND Max 19 mins p.a. of yellow glare	No glare predicted	Concur with VPS no mitigation required

SAT 2P PV Array 1 : Average Height 1.5m. (See Appendix XX for Simulation Results)

ID/ OP	Address/Viewing Audience	VPS description of potential glare effects (1.7m Receptor heights.) and 2m high shelter belt	VAC Review potential glare (Based on Receptor heights of 1.8m for 1 storey and 3.6m for 2 storey dwellings. And RMM shelter belt final heights of 6m and 4m	VAC Reviewer Remarks
OP 1	Single storey residence	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP 2	Two storey residence	Green Glare only. Max 403 mins pa and 6 mins per day.	Green glare 107.9 hours and yellow glare 14.5 hours predicted.	**Additional Mitigation is recommended or should be investigated.**
OP3	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP4	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP5	Two Storey	Green Glare only. Max 16 mins pa and 2 mins per day.	No glare predicted	Concur with VPS no mitigation required
OP6	Single Storey	Green Glare only. Max 26 mins pa and 2 mins per day.	No glare predicted	Concur with VPS no mitigation required
OP7	Single storey	Green Glare only. Max 62 mins pa and 7 mins per day.	No glare predicted	Concur with VPS no mitigation required
OP8	Single Storey	Green Glare only. Max 44 mins pa and 3 mins per day.	No glare predicted	Concur with VPS no mitigation required
OP9	Single Storey	Green Glare only. Max 47 mins pa and 6 mins per day.	No glare predicted	Concur with VPS no mitigation required
OP10	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP11	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP12	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP13	Single storey	Green Glare only. Max 125 mins pa and 6 mins per day.	No glare predicted	Concur with VPS no mitigation required
OP14	Two storey	No Glare found	No glare predicted	Concur with VPS no mitigation required

OP15	Single storey	Green Glare only. Max 73 mins pa and 4 mins per day.	No glare predicted	Concur with VPS no mitigation required
OP16	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP17	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP18	Single Storey assumed (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP19	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP20	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP21	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required

SAT 2P PV Array 2 : Average Height 1.5m. (See Appendix XX for Simulation Results)

ID/ OP	Address/Viewing Audience	VPS description of potential glare effects (1.7m Receptor heights.) and 2m high shelter belt	VAC Review potential glare (Based on Receptor heights of 1.8m for 1 storey and 3.6m for 2 storey dwellings. And RMM shelter belt final heights of 6m and 4m	VAC Reviewer Remarks
OP 1	Single storey residence	Green Glare only. Max 30 mins pa and 15 mins per day.	No glare predicted	Concur with VPS no mitigation required
OP 2	Two storey residence	Green Glare only. Max 1773 mins pa and 118 mins per day.	Green glare 93.3 hours and yellow glare 35.4 hours predicted.	**Additional Mitigation is recommended or should be investigated.**
OP3	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP4	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP5	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP6	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required

OP7	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP8	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP9	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP10	Two Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP11	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP12	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP13	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP14	Two storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP15	Single storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP16	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP17	Single Storey	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP18	Single Storey assumed (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP19	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP20	Single Storey (doesn't appear to be a dwelling based on Google Earth)	No Glare found	No glare predicted	Concur with VPS no mitigation required
OP21	Single Storey	No Glare found	Green glare only 0.3 hours p.a. predicted.	Concur with VPS no mitigation required

Dwelling Review General Comments

Considerations around predicted glare impact is based on the Australian New South Wales Government solar farm guidelines, these are the more conservative of the international standards. It recommends that mitigation against predicted potential solar glare is

essentially required for dwellings where predicted glare is expected to exceed 10 hours per year whether green or yellow or combination of both.

In most cases the predicted solar glare from the proposed Ashley solar farm PV array system is less than 10 hours per year and less than 10 mins duration in any day.

The review of VPS glare assessments for dwellings generally agrees with the results where in most cases the glare is expected to be less than 10 hours per year and with any daily maximum duration predicted to be less than 10 minutes.

This is based on predicted glare impacts on these dwellings once the RMM Landscape architects planned vegetation plantings have reached matured heights.

The assessment does not consider any existing vegetation or planned landscaping to provide some screening and as such this should further reduce impact of solar glare to most dwellings.

Observation Point 2 appears to be a two storey residential dwelling that is likely to experience the greatest amount of glare. There appears to be existing vegetation already surrounding the property and further analysis needs to be undertaken to determine the height of this or otherwise landscape architects need to consider vegetation types, location and heights of this to further mitigate predicted glare to this dwelling.

4.4 Impact on Road Traffic

The following tables provide predicted glare hours based on VPS assessment for 1.8m driver eye level compared VAC consideration of driver eye level height of 2.5m relating to drivers of larger vehicles such as tractors, school buses, haulage vehicles etc typically found on rural roads. (Ref Road Route Locations and results in **Appendix D**)

Comparisons are made for each of the PV array types being considered for Ashley Solar farm.

4.4.1 FT -Road Routes

PV Array 1

Road ID	Vector PowerSmart Total hours p.a. yellow glare per year based on 1.8m driver eye level	VACL total hours p.a. yellow glare based on 2.5m driver eye level	Remarks
Beatties Road	No glare found	No glare predicted	No mitigation considered necessary
Marshmans Road	Green glare only 15 mins p.a. With max of 2 mins per day.	No glare predicted	No mitigation considered necessary
Upper Sefton Road	Green glare 145 mins pa. and yellow glare up to 176 mins p.a. at up to 5 mins per day	Green glare up to 8.1 hours p.a. and yellow glare up to 8.2 hours p.a.	**Further mitigation measures are considered necessary or need to be reviewed also with consideration to existing vegetation.**

Table 4.4.1 Comparison of yellow glare hours per year for 1.8m and 2.5m driver eye levels

PV Array 2

Road ID	Vector PowerSmart Total hours p.a. yellow glare per year based on 1.8m driver eye level	VACL total hours p.a. yellow glare based on 2.5m driver eye level	Remarks
Beatties Road	No glare found	No glare predicted	No mitigation considered necessary
Marshmans Road	No glare found	No glare predicted	No mitigation considered necessary
Upper Sefton Road	Green glare 76 mins pa. at up to 2 mins per day	Green glare up to 4.6 hours p.a. and yellow glare up to 1 min p.a.	Although minimal yellow glare, further mitigation could be recommended to mitigate as far as

			practicable. See Note on risks to road users

Table 4.4.2 Glare Impact on Road Users VPS and VACL Comparison

4.4.2 SAT 1P – Road Routes

PV Array 1

Road ID	Vector PowerSmart Total hours p.a. yellow glare per year based on 1.8m driver eye level	VACL total hours p.a. yellow glare based on 2.5m driver eye level	Remarks
Beatties Road	Green glare 90 mins pa. and yellow glare up to 307 mins p.a. at up to 7 mins per day	No glare predicted	No mitigation considered necessary
Marshmans Road	No glare found	No glare predicted	No mitigation considered necessary
Upper Sefton Road	Green glare 74 mins pa. and yellow glare up to 32 mins p.a. at up to 3 mins per day	Green glare up to 3.5 hours p.a. and yellow glare up to 0.4 hours p.a.	**Although minimal yellow glare, mitigation recommended due to yellow glare with obstruction at 2m and before planned vegetation reaches full height at 4m.**

PV Array 2

Road ID	Vector PowerSmart Total hours p.a. yellow glare per year based on 1.8m driver eye level	VACL total hours p.a. yellow glare based on 2.5m driver eye level	Remarks
Beatties Road	No glare found	No glare predicted	No mitigation considered necessary
Marshmans Road	No glare found	Green glare 2.1 hours p.a.	No mitigation considered necessary
Upper Sefton Road	Green glare 664 mins pa. and yellow glare up to 498 mins p.a. with ,max 56 mins of either glare per day	Green glare up to 4.5 hours p.a.	**Mitigation necessary due to yellow glare with obstruction at 2m and before planned vegetation reaches full height at 4m.**

4.4.3 SAT 2P Road Routes

PV Array 1

Road ID	Vector PowerSmart Total hours p.a. yellow glare per year based on 1.8m driver eye level	VACL total hours p.a. yellow glare based on 2.5m driver eye level	Remarks
Beatties Road	Green glare 126 mins pa. and yellow glare up to 304 mins p.a. with ,max 7 mins of either glare per day	No glare predicted	No mitigation considered necessary
Marshmans Road	Green glare only 71 mins pa. with max 3 mins of either glare per day	No glare predicted	No mitigation considered necessary
Upper Sefton Road	Green glare 25 mins pa. and yellow glare up to 4 mins p.a. with max 1 mins of either glare per day	Green glare up to 5.9 hours p.a.	**Although minimal yellow glare mitigation is recommended due to yellow glare with obstruction at 2m and before planned vegetation reaches full height at 4m.**

PV Array 2

Road ID	Vector PowerSmart Total hours p.a. yellow glare per year based on 1.8m driver eye level	VACL total hours p.a. yellow glare based on 2.5m driver eye level	Remarks
Beatties Road	No glare found	No glare predicted	No mitigation considered necessary
Marshmans Road	No glare found	Geen glare only up to 3.1 hours p.a.	No mitigation considered necessary
Upper Sefton Road	Green glare only 32 mins pa. at up to 4 mins per day	Green Glare up to 42.9 hours p.a. and yellow glare up to 32.4 hours p.a.	**Additional mitigation should be investigated due to significant yellow glare for this type of PV array.**

Road Routes Review General Comments

Given the greater safety implications relating to impacting glare on road users, mitigation measures should be considered as far as practicable.

The worst case scenario relating to drivers' eye level heights of 2.5m are considered to be more representative of the type of traffic that could be expected on rural roads around and adjacent to the proposed Ashley Solar farm. This includes traffic such as tractors and other large farm vehicles, school buses and large freight and haulage vehicles.

It is noted from the RMM Landscape architect report (Reference page 18)

'As assessed in the Glint and Glare Report18 , when the shelterbelt is 2m tall potential glare from a tilting solar table may exacerbate the visual effects, not a fixed solar table. There is an approximate 7-minute window per day, between April and August when glare may be experienced. This is a mix of green and yellow glare, in which the Glint and Glare Report recommends that yellow glare has a moderate impact and should be mitigated. The proposed shelterbelt will assist with mitigation.

When the shelterbelt is 4m tall there may be a 5-minute window of time per day, between 4pm and 6pm during the months of May to August when glare may be experienced. Additionally, this may only be experienced from an approximate 200m stretch of this road near the intersection with Upper Sefton Road. This window of time is very short and may only be experienced by the few people travelling north along this road during this time of the day.'

The reviewer believes that whether there are many road users or just a few, that the same level of risk to each of them still applies. i.e. the risk of glare remains the same to all users although the probability of an incident may vary based on the number of users.

The VAC reviewer believes however that risk management applies equally to the few road users as much as to the many and hence considers reduction of the risk as far as practicable applies to any road user. In such circumstances where there is perceived risk of yellow glare, this should be reduced as far practicable to all road users.

5. MITIGATION CONSIDERATIONS

5.1 Glare Mitigation Requirements for Dwellings

As mentioned previously , the Australian New South Wales Government Guidelines on Large Scale Solar Energy Development has the following for dwellings in relation to glare impacts.

As indicated any glare of over 10 hours ideally per year and more than 10 minutes per day should have mitigation measures to reduce impacts.

Table 2: Impact rating and performance objectives for glare impacts to residential dwellings

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.

Table 5.1 Australia NSW Government Guidelines for glare impacts on Dwellings

Also, from the RMM Landscape Assessment Report (Proposed Solar Farm 87 Upper Sefton Road, Ashley, dated 11 October 2023), the methodology and terminology references Te Tangi a te Manu Aotearoa NZ Landscape assessment guidelines in relation to rating scales and levels of impact. See below

The table included in Figure 2 outlines the rating scales that are referred to in this report. The table included in Figure 3 is a comparative scale for the RMA s95 notification determination test and the RMA s104D 'gateway' test for non-complying activities (the latter is not relevant).

Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High

Figure 2. The seven-point landscape and visual effects rating scale. [2]

Very Low	Low	Low - Moderate	Moderate	Moderate - High	High	Very High
Less than Minor	Minor		More than Minor		Significant	

Figure 3. The comparative scale of degree of effects. [3]

Where possible, the VAC reviewer has also referenced the same terminology based on previous RMA and Resource Consent application reviews in relation to glint and glare assessments. As such the degree of effects such as 'minor' and 'less than minor' etc have been described where considered appropriate based on result outcomes.

The results from the VPS report do not indicate whether observation points relate to single or two storey dwellings but that only a 1.8m observation point or receptor eye level height

has been considered. Overall VPS indicate there are no significant impacts predicted due to solar glare reflected from the proposed solar farm development. This is also based on a shelterbelt screen height of 2m.

There is no VPS glint and glare assessment based on the effectiveness of final shelter belt heights as proposed by RMM Landscape Architects where such planned vegetation offer final outcomes of mitigation of potential glare once the proposed plantings are fully established.

As such a comparison had been made by the VAC reviewer to take this into account based on final vegetation screening levels of 4m and 6m being reached.

The VPS consideration of the 2m shelterbelt is important however as it would take into account any potential interim glare impacts on dwellings (as well as road users etc) before the proposed mitigation plantings reach the planned heights once fully mature.

As such this review agrees with the VPS assessment, with the exception of dwellings in the results of tables in section 4.3 Impact on Dwellings.

That is, where the reviewer has concurred with VPS, no mitigation requirements are really needed for the dwellings considered based on the solar farm PV array systems proposed as impacts are considered to be minor to less than minor.

It is expected that existing vegetation around dwellings and also planned landscaping for visual screening (as per Landscape Plan) should reduce any low level glare impacts to the dwellings even further.

5.2 Glare Mitigation Requirements for Road Users

Due to greater safety concerns associated with road users, ideally glare should be minimised as far as practicable. This should especially be the case at or near intersections where glare may create a greater potential hazard.

It should be noted that the more conservative Australian Guidelines referenced as shown in Table 5.2 below on solar glare for road users, does not provide any duration or time limits on glare apart from that it should be addressed as far as practicable.

Table 7: Glint and glare requirements

	Scope	Methodology	Performance objective
Road and rail	All roads and rail lines within 1km 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.

Table 5.2 Australian Solar Farm Guidelines on Glint and Glare Assessment Approach for Road Users.

As noted by VPS report, the Forge Solar utility that was used identifies three levels of glare. Red glare however is not encountered in results from either Vector or the reviewers' assessments so is not considered further.
This has been covered in section 3.2 in relation to green and yellow glare.
Green glare is less of an issue for dynamic situations such as for moving traffic as this level of glare is low level and the duration is expected to be very small due to traffic moving quickly past areas of potential reflection.
Yellow level glare would have greater impact due to causing short duration flash blindness and hence is more important to address and mitigate as far as practicable.

As mentioned, mitigation requirements for road users are of greater necessity to reduce risks to acceptable levels where impacts can be considered minor to less than minor.

6. SUMMARY AND CONCLUSION OF RESULTS FOR ASHLEY SOLAR FARM

Ashley Solar Farm impacts on Rangiora Aerodrome

Given there was no VPS assessment made on the Ashley solar farm development potential impacts on operations at Rangiora aerodrome, no comparisons could be made for any results.

It was however considered necessary by the VAC reviewer to take potential impact from the Ashley solar farm into account due to its the proximity to Rangiora aerodrome.

As such an analysis was undertaken based on all six runway approaches.

While it was determined that green level glare was potentially possible from the solar farm as viewed by pilots on a few of the approaches to the aerodrome, based on FAA criteria this was seen as having minimal impact and could therefore be considered as being less than minor.

Ashley Solar Farm impacts on nearby Railway Line

While not addressed as part of the VPS glint and glare assessment, no comparison could be made by VAC reviewer to determine any concurrence or correlation of results with regard to glare impacts to nearby railway traffic.

Given the proximity of the railway line (within 1 km of the Ashley Solar Farm development) the reviewer deemed it necessary to take this into account. This is especially the case where there are road and railway crossings and potential risks that glare impacts may pose at these points.

Overall, the results of the assessment of potential impact to train drivers indicated that there would be minimal impact based on planned vegetation landscaping as well as existing vegetation that is likely to obscure view of the solar farm to the train driver.

As such the impact was considered minor to less than minor.

Ashley Solar Farm impacts on Dwellings

The analysis provided by VPS was for Fixed Tilt and Single Axis Tracking PV systems based on one panel (1P) and two panels (2P) being considered.

The Vector assessment only considered dwelling heights receptor points of 1.8m or equivalent to single storey dwellings. Also, only a 2m height shelterbelt obstruction was considered to provide any mitigation.

While VPS assessment considered FAA criteria, it should be noted that this applies to Aerodrome operations only and not to dwellings or road and rail users.

While there is significant existing vegetation already around the dwellings and adjacent roads surrounding the proposed Ashley solar farm development, these were not taken into

account in either the VPS or the VAC reviewer assessment given the overwhelming associated data to take into account when modelling this. (**Note:** This otherwise needs to be addressed on a case by case basis for each dwelling being considered).

It is believed however that the existing vegetation should significantly contribute to mitigation of predicted solar glare impacts along with any planned landscaping already considered by the Solar Bay landscape planners.

The reviewer considers however that given the height of the top of the solar arrays varies in heights of 2.146m for SAT 1P, 4.532m for SAT- 2P, and up to 3.45m for Fixed Tilt arrays, that a 2m height modelled by VPS for a shelterbelt would essentially be too low.

It is noted that Landscape Architects Rough Milne Mitchell have stated that the solar farm will only be constructed once the shelterbelt is 2m high. (Ref. Page 8, RMM Landscape Assessment Report).

"Also, that the shelterbelt will be maintained at a height of 6m along the sites northern boundary line and the remainder of the shelterbelt, including along Upper Sefton Road and Beatties Road will be maintained at height of 4m tall."

The Vector assessment did not appear to base their review on the 3.6m dwelling heights based on the data input for the dwelling receptor eye levels which appeared to be set for 1.8m. for all the dwellings.

As mentioned in Section 5 mitigation, it is noted that the VPS assessment with 2m shelterbelt obstruction is important however as it provides information around potential glare during the interim stages of the solar farm implementation.

The results however indicate that there is little difference to predicted glare impacts for assessment for both single and two storey levels for the dwellings considered and once planned landscape planting measures are in place, potential impacts should be minor to less than minor.

Ashley Solar Farm impact on adjacent Road Traffic

It was surprising that VPS did not base analysis on the worst case eye height associated with larger vehicles such as tractors and other large vehicles such as trucks, buses, and haulage vehicles etc, that would frequently use these roads given the greater safety impact associated with glare impacts on road traffic. The eye heights for these are considered around 2.5m.

The ForgeSolar utility also considers drivers field of view to be ±50 degrees based on research. As such results for road traffic are largely based on this rather than a focussed direct ahead viewpoint.

The RMM Landscape Architects proposal around landscaping as well as consideration of existing vegetation should largely mitigate the majority of predicted yellow glare to road traffic.

As noted in some areas, such as for Upper Sefton road, additional mitigation measures should be considered where having plantings higher than currently planned may be required to minimise glare to acceptable levels to ensure less than minor impact.

7. RECOMMENDATIONS

The analysis and simulations performed are based on information and data received from Waimakariri District Council and based on the glint and glare reports provided, and in particular the Vector PowerSmart Limited Glint and Glare report.
The following are offered as recommendations for consent.

1. Given the VPS report and glare analysis is based on the PV parameters provided, it is recommended that should any of these differ then a new glint and glare study be carried out to verify that the results have not changed significantly with regard potential glare to either the residents of dwellings or road users.

2. That further investigation be carried out on existing vegetation around dwellings where glare appears significant based on assessment outcomes and to determine the effectiveness of these to mitigate glare as part of a more specific detailed assessment for these dwellings.

3. That any mitigation landscape planting being considered by Solar Bay be based on road user driver height of 2.5m so as to take into account drivers of larger vehicles which are just as likely to be using the roads as standard cars.

4. With regard to road routes where there is predicted glare, that consideration be given to interim mitigation measures beyond 2m shelterbelts before proposed plantings reach full maturity heights of 4m and 6m. This could be to include planting of more established trees at 3m or higher or appropriate vegetation in the small local areas where predicted glare levels for dwellings and road traffic may have greater impact.

5. That where landscape architects have proposed vegetation plantings near road intersections, that measures are taken to ensure that these do not themselves present a safety hazard by obscuring drivers views of oncoming traffic.

8. IMPORTANT NOTES

While care is taken on the input data accuracy it is based on what information has been provided by the client and any noted assumptions.

While the overall results from the ForgeSolar glare analysis simulation generally provide an accurate analysis of potential glare based on comparison of simulation against actual installations, these are based on implementation of PV array systems as per tilts and orientations provided.

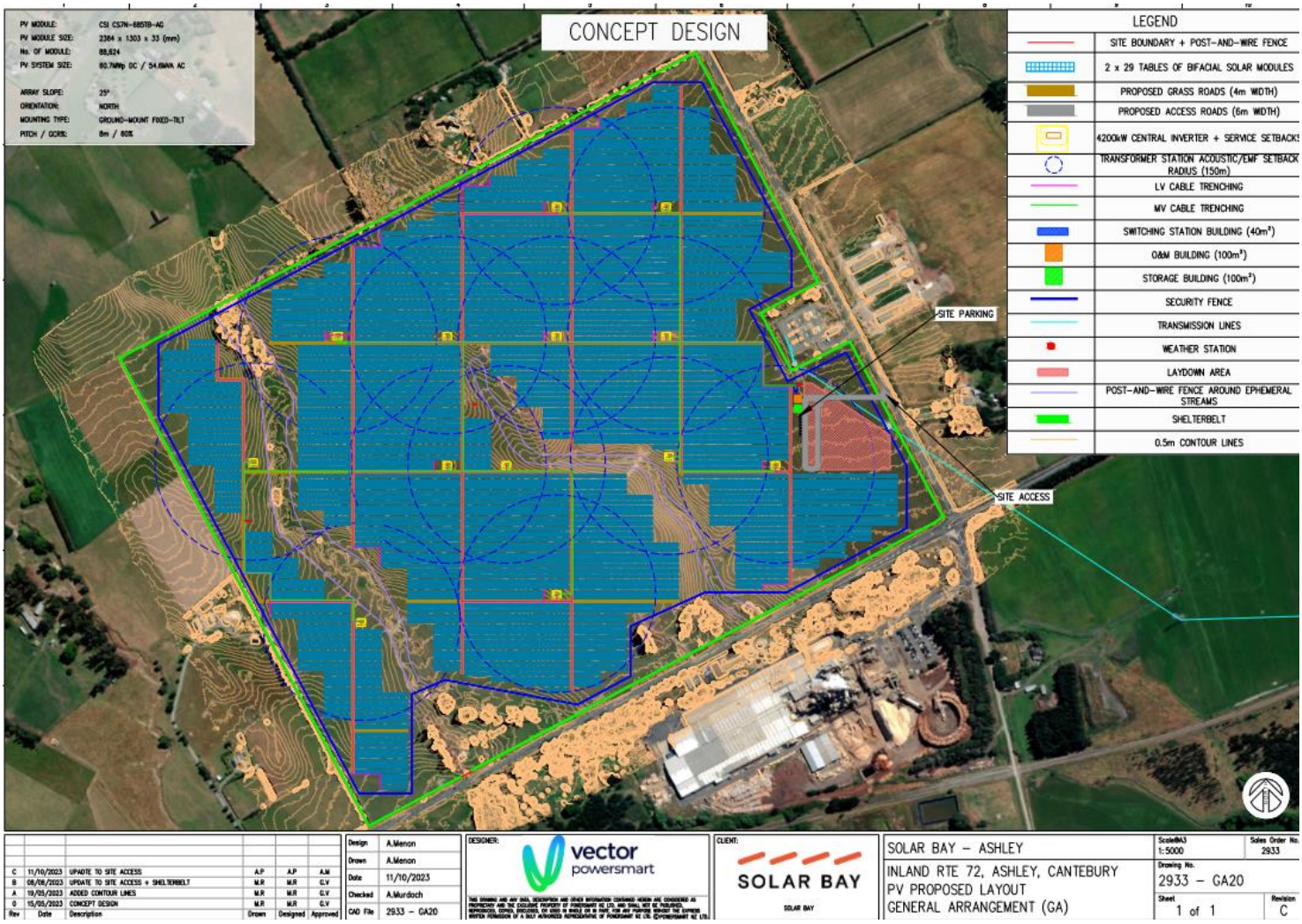
The algorithm does not rigorously represent the detailed geometry of a system. Detailed features such as gaps between modules, variable height of the PV array, and support structures may impact on glare results.

The algorithm does not consider obstacles, either man made or natural, between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills buildings, etc.

Reference Documents

[1]: RC235259 Concept Plans Energy Bay Limited 87 Upper Sefton Road Sefton
[2]: RC235259 Glint ands Glare Reports Energy Bay Ltd Upper Sefton Road Sefton
[4]: RC235259 Landscape Assessment and Plans Energy Bay Ltd 87 Upper Sefton Road Sefton
[5]: RC235259 Site Visit Photos (Provided by WDC)
[6]: Aeronautical Information Publication : Rangiora Aerodrome Information
[6]: Email Correspondence

APPENDIX A: Solar Bay Ashley Solar Farm Concept Design General Arrangement



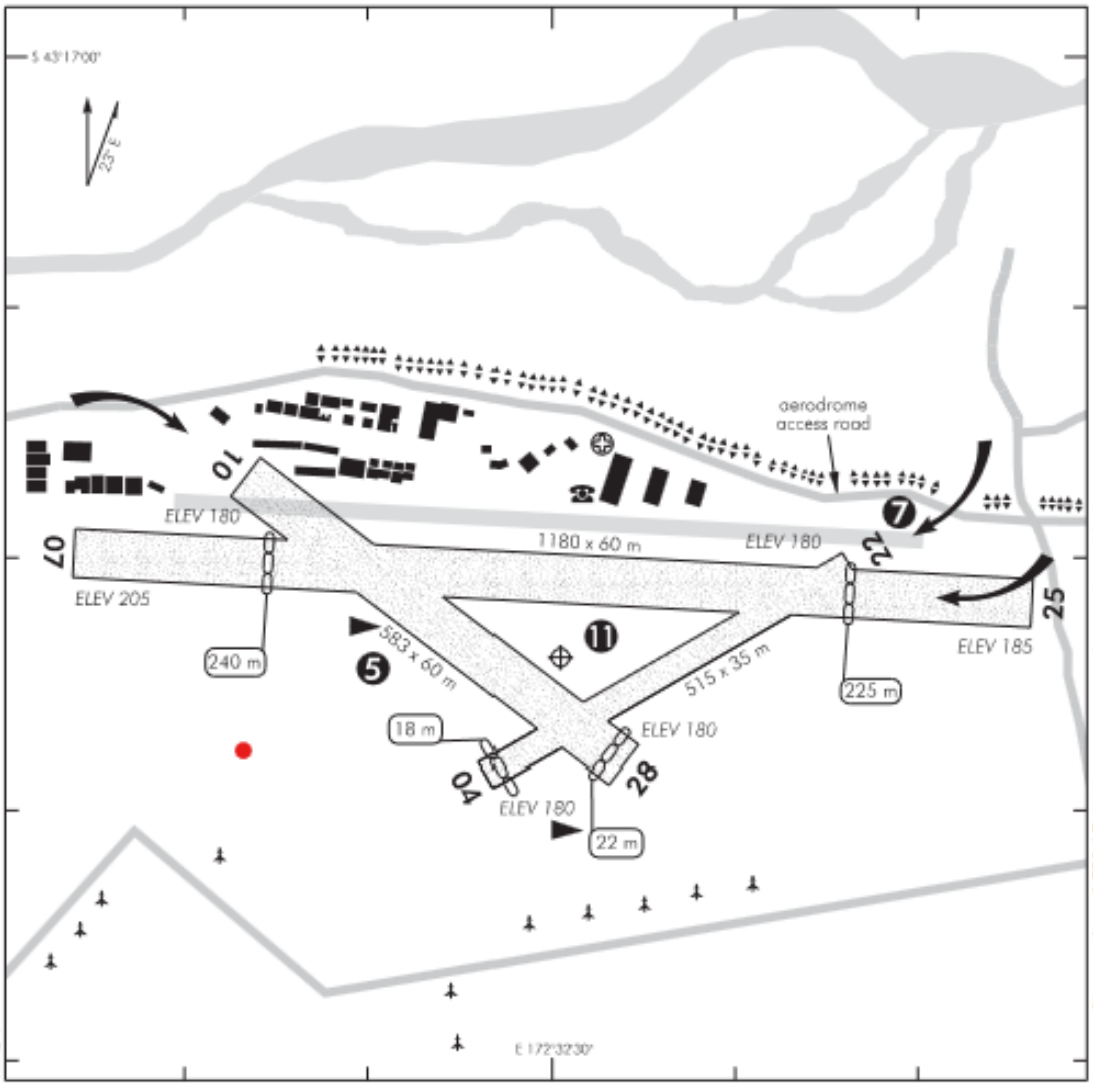
APPENDIX B: Rangiora Aerodrome Information

ELEV 180

NZRT NON-CERTIFICATED

UNATTENDED: 120.2

RANGIORA AERODROME



1. Circuit: RWY 04, 07, 28 — Left hand
   RWY 10, 22, 25 — Right hand
2. **CAUTION:** Helicopter 180° and straight-in autorotations.
3. Vacate runways via the most expeditious route.
4. Some patches of loose stones on movement areas.

❺ Helicopter hover training area.

6. Standard overhead join recommended.

❼ RWY 04/22 not available when road traffic is using aerodrome access road.

8. **CAUTION:** Two private airfields in close proximity 1.8 NM SW, Fernside Fields (circuits to the north), Barradale (circuits to the south).
9. Helicopters may join and depart at low level but must come to a stationary hover to check for traffic prior to crossing active vector.
10. Make radio call on final approach advising intended runway.

⓫ Triangular area between runways reserved for helicopter auto-rotation training. Keep clear.

12. No parachute operations permitted.

*S 43 17 24 E 172 32 30**

Effective: 13 SEP 18

RANGIORA AERODROME

Non-Certificated Aerodrome 3 NM WNW of Rangiora

RANGIORA
OPERATIONAL DATA

NZRT

RWY

RWY	SFC	Strength	Gp	Slope	ASDA	Take-off distance 1:20	1:30	1:40	LDG DIST
04 22	Gr	ESWL 820	4	Nil		515 497			497 515
07 25	Gr	ESWL 820	8	0.52D 0.52U		955 940			940 955
10 28	Gr	ESWL 820	5	Nil		561 583			583 561

LIGHTING

Nil

FACILITIES

Fuel: BP Jet A1, Avgas 100, Swipecard.

Z Energy Avgas 100, access via Z card.

Limited repairs.

SUPPLEMENTARY

Operator: Waimakariri District Council, Private Bag 1005, Rangiora.
Tel (03) 313 6136 Fax (03) 313 4432

Available for general use without the permission of the operator.

Landing fees: Payable for all aircraft.

An automatic recording system for monitoring landings is installed.

APPENDIX C – Overall Results Dwellings Observation Points

FT PV Array 1 – Results

Total 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
Beatties Road	0	0.0	0	0.0
Railway	805	13.4	61	1.0
Route 1- Marshmans Road	0	0.0	0	0.0
Route 3 - Upper Sefton Road	483	8.1	493	8.2
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
FP 3	0	0.0	0	0.0
FP 4	57	0.9	0	0.0
FP 5	0	0.0	0	0.0
FP 6	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	4,853	80.9	590	9.8
OP 3	0	0.0	0	0.0
OP 4	342	5.7	0	0.0
OP 5	737	12.3	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
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	1,222	20.4	44	0.7
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

FT PV Array 2 – Results

PV: FT PV Array 2 potential temporary after-image

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 3 - Upper Sefton Road	274	4.6	1	0.0
Beatties Road	0	0.0	0	0.0
Railway	0	0.0	0	0.0
Route 1- Marshmans Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
FP 3	0	0.0	0	0.0
FP 4	0	0.0	0	0.0
FP 5	0	0.0	0	0.0
FP 6	0	0.0	0	0.0
OP 2	4,481	74.7	451	7.5
OP 4	342	5.7	0	0.0
OP 5	737	12.3	0	0.0
OP 1	0	0.0	0	0.0
OP 3	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
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

PV: SAT 1P 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
Route 3 - Upper Sefton Road	207	3.5	22	0.4
Railway	235	3.9	0	0.0
Beatties Road	0	0.0	0	0.0
Route 1- Marshmans Road	0	0.0	0	0.0
FP 1	350	5.8	0	0.0
FP 4	473	7.9	0	0.0
FP 6	559	9.3	0	0.0
FP 2	0	0.0	0	0.0
FP 3	0	0.0	0	0.0
FP 5	0	0.0	0	0.0
OP 2	669	11.2	528	8.8
OP 1	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
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

PV: SAT 1P PV Array 2 potential temporary after-image

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 1- Marshmans Road	128	2.1	0	0.0
Route 3 - Upper Sefton Road	2,730	45.5	0	0.0
Beatties Road	0	0.0	0	0.0
Railway	0	0.0	0	0.0
FP 1	129	2.1	0	0.0
FP 4	311	5.2	0	0.0
FP 6	58	1.0	0	0.0
FP 2	0	0.0	0	0.0
FP 3	0	0.0	0	0.0
FP 5	0	0.0	0	0.0
OP 2	6,473	107.9	868	14.5
OP 3	20	0.3	0	0.0
OP 1	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
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

PV: SAT 2P 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
Route 3 - Upper Sefton Road	170	2.8	184	3.1
Railway	363	6.0	0	0.0
Beatties Road	0	0.0	0	0.0
Route 1- Marshmans Road	0	0.0	0	0.0
FP 1	478	8.0	0	0.0
FP 4	635	10.6	0	0.0
FP 6	713	11.9	0	0.0
FP 2	0	0.0	0	0.0
FP 3	0	0.0	0	0.0
FP 5	0	0.0	0	0.0
OP 2	706	11.8	597	9.9
OP 1	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
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0

PV: SAT 2P PV Array 2 potential temporary after-image

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Railway	370	6.2	1	0.0
Route 3 - Upper Sefton Road	228	3.8	498	8.3
Route 1- Marshmans Road	103	1.7	0	0.0
Beatties Road	0	0.0	0	0.0
FP 1	162	2.7	0	0.0
FP 4	415	6.9	0	0.0
FP 6	125	2.1	0	0.0
FP 2	0	0.0	0	0.0
FP 3	0	0.0	0	0.0
FP 5	0	0.0	0	0.0
OP 2	5,600	93.3	2,122	35.4
OP 21	17	0.3	0	0.0
OP 1	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
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0

APPENDIX D:Route Receptors Results

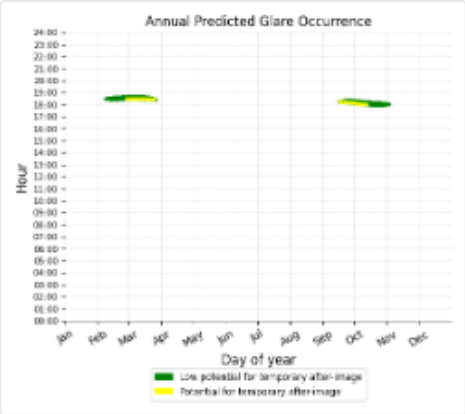
PV: FT PV Array 1 potential temporary after-image

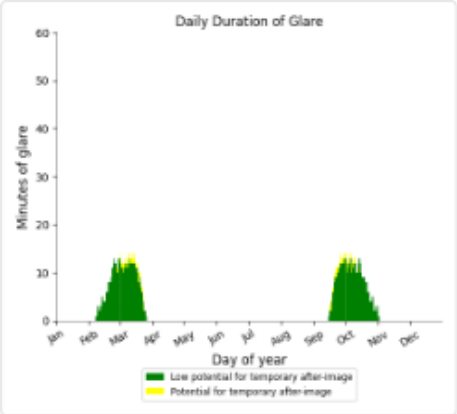
Receptor results ordered by category of glare

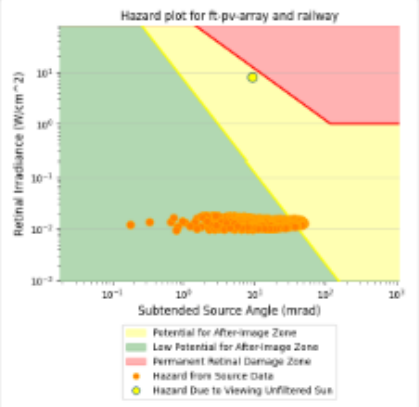
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Railway	805	13.4	61	1.0
Route 3 - Upper Sefton Road	209	3.5	492	8.2
Beatties Road	0	0.0	0	0.0
Route 1- Marshmans Road	0	0.0	0	0.0

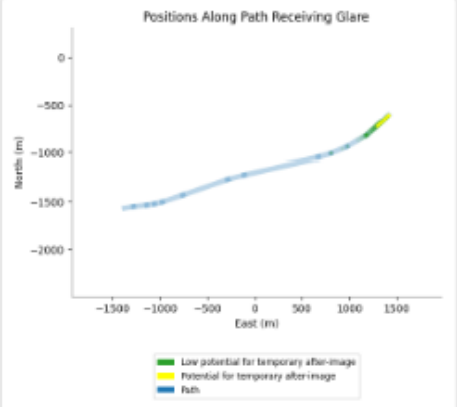
FT PV Array 1 and Route: Railway

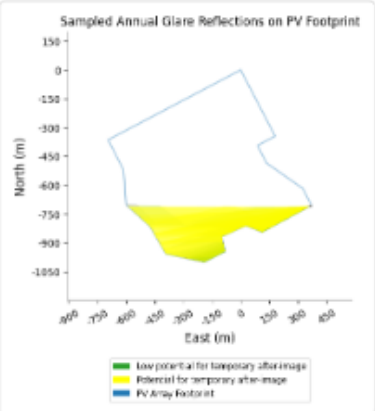
Yellow glare: 61 min.
Green glare: 805 min.







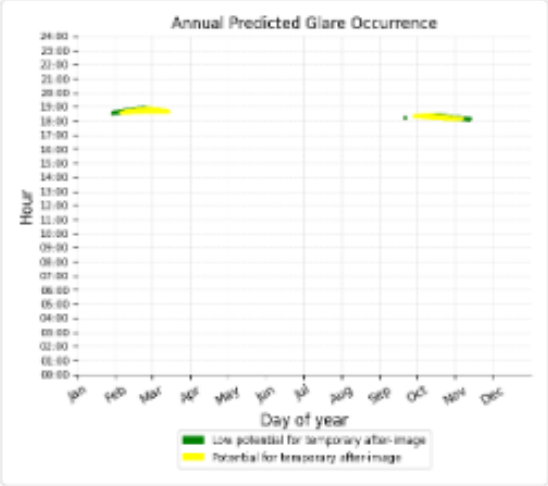


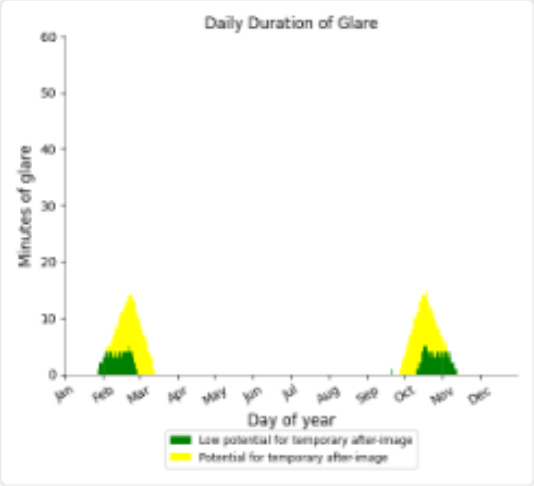


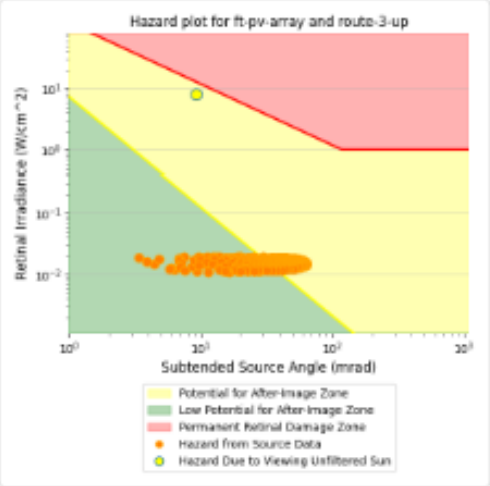
FT PV Array 1 and Route: Route 3 - Upper Sefton Road

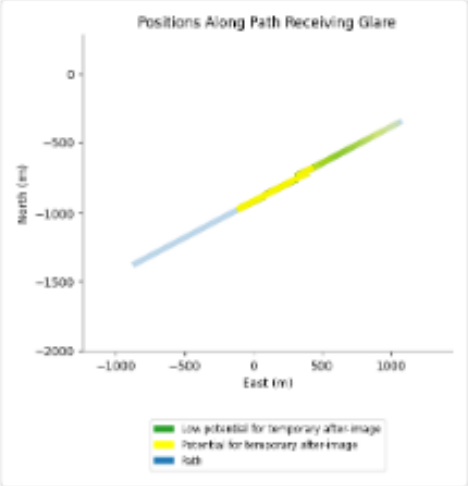
Yellow glare: 492 min.

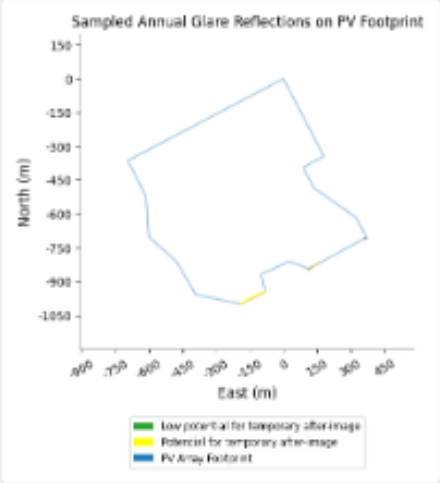
Green glare: 209 min.











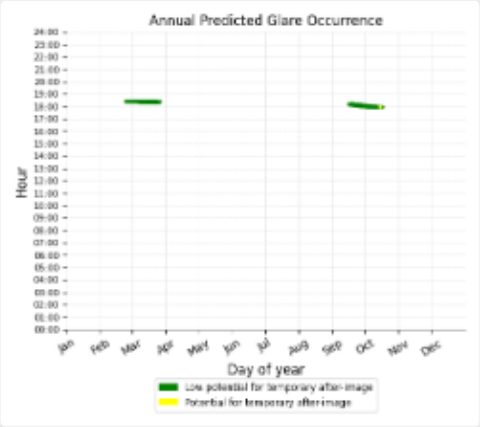
PV: FT PV Array 2 potential temporary after-image

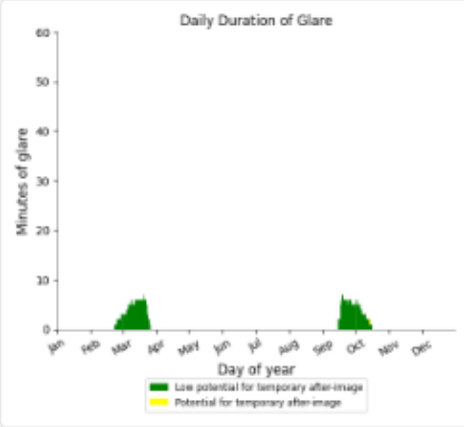
Receptor results ordered by category of glare

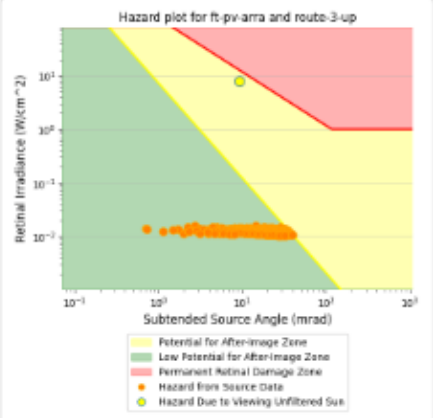
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 3 - Upper Sefton Road	274	4.6	1	0.0
Beatties Road	0	0.0	0	0.0
Railway	0	0.0	0	0.0
Route 1- Marshmans Road	0	0.0	0	0.0

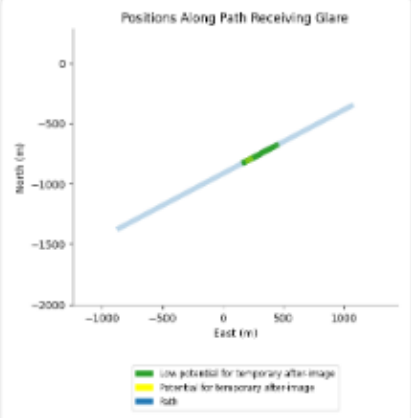
FT PV Array 2 and Route: Route 3 - Upper Sefton Road

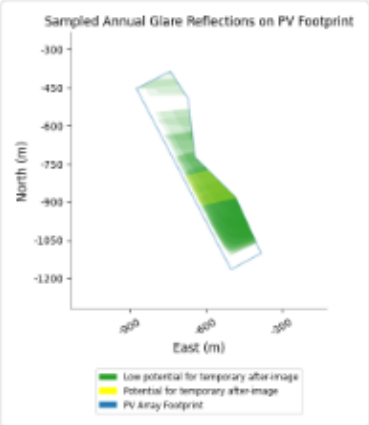
Yellow glare: 1 min.
Green glare: 274 min.











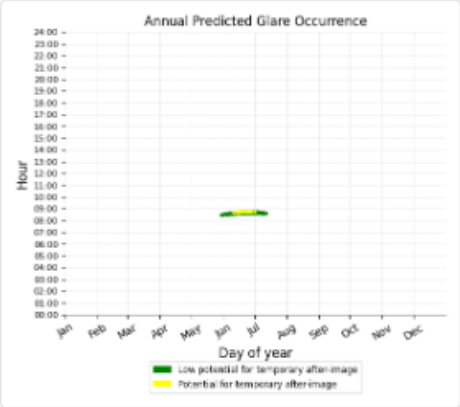
PV: SAT 1P PV Array 1 potential temporary after-image

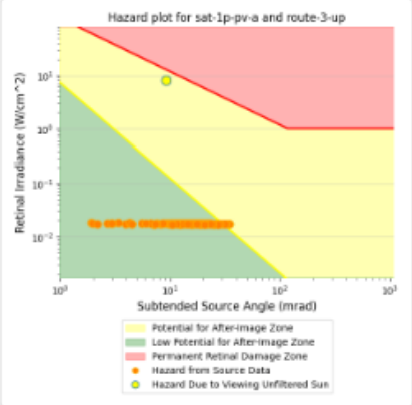
Receptor results ordered by category of glare

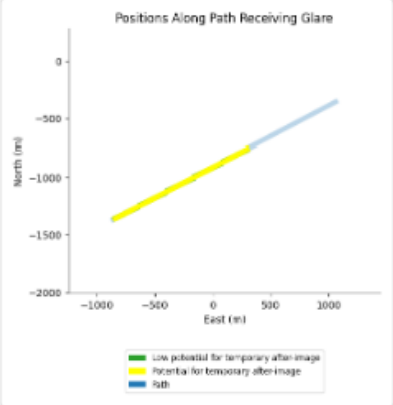
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 3 - Upper Sefton Road	207	3.5	22	0.4
Railway	235	3.9	0	0.0
Beatties Road	0	0.0	0	0.0
Route 1- Marshmans Road	0	0.0	0	0.0

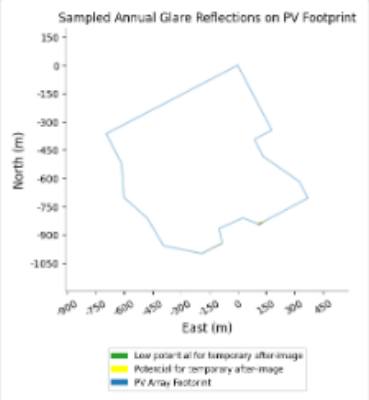
SAT 1P PV Array 1 and Route: Route 3 - Upper Sefton Road

Yellow glare: 22 min.
Green glare: 207 min.





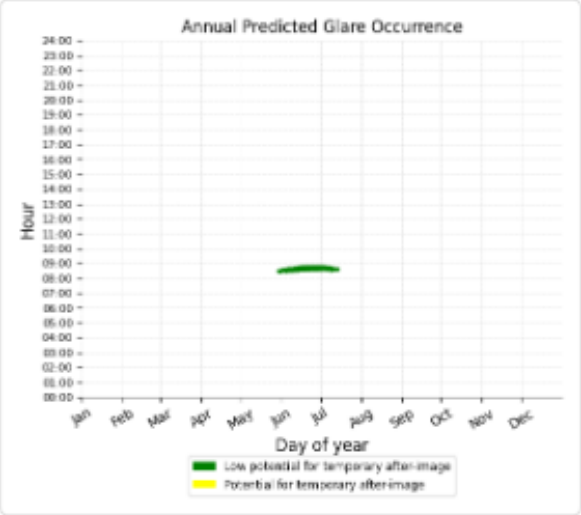


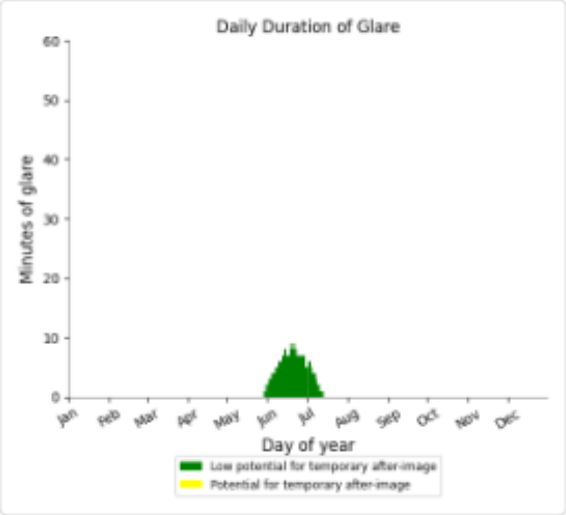


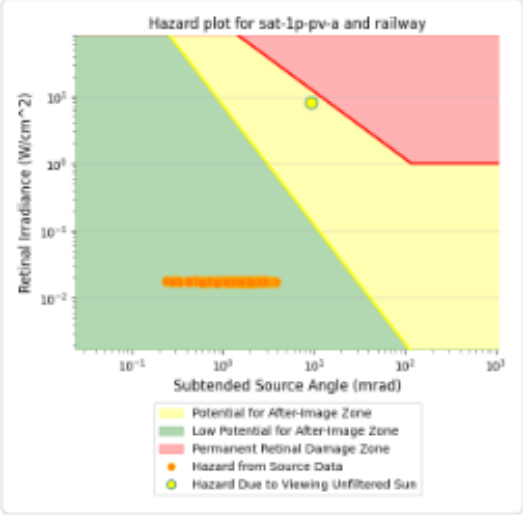
SAT 1P PV Array 1 and Route: Railway

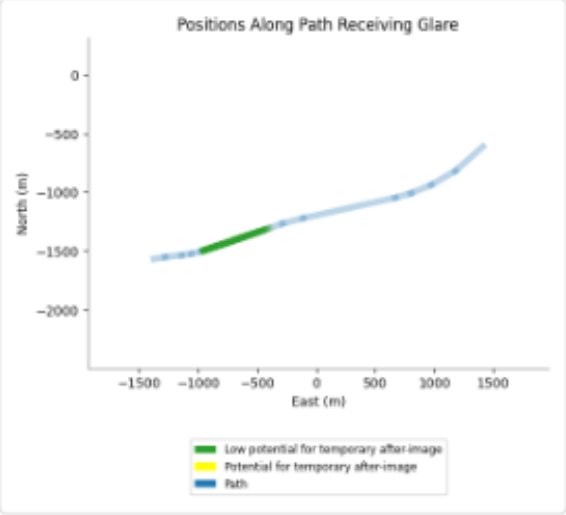
Yellow glare: none

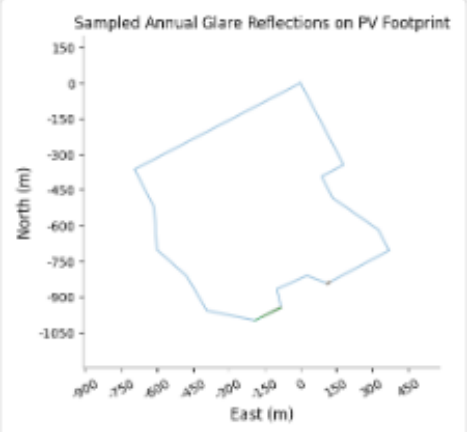
Green glare: 235 min.











PV: SAT 2P PV Array 1 potential temporary after-image

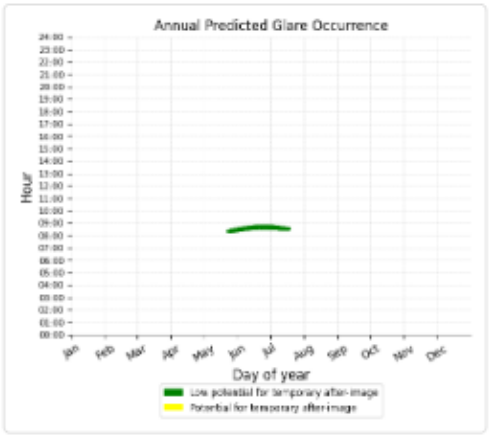
Receptor results ordered by category of glare

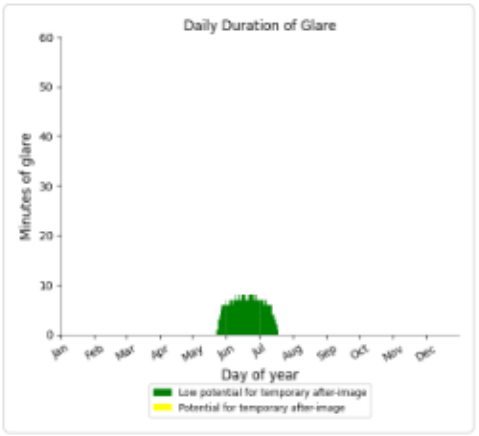
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Railway	228	3.8	0	0.0
Route 3 - Upper Sefton Road	352	5.9	0	0.0
Beatties Road	0	0.0	0	0.0
Route 1- Marshmans Road	0	0.0	0	0.0

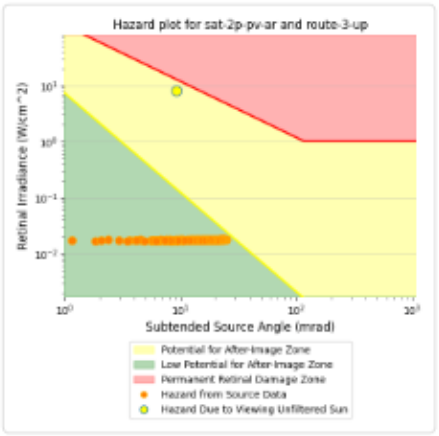
SAT 2P PV Array 1 and Route: Route 3 - Upper Sefton Road

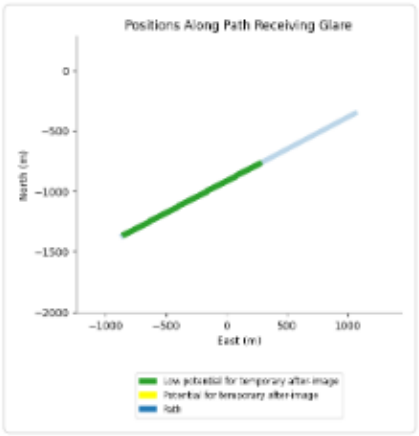
Yellow glare: none

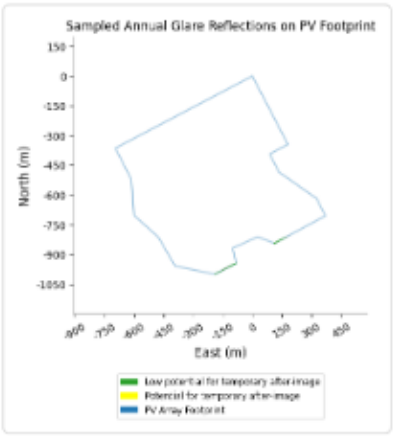
Green glare: 352 min.











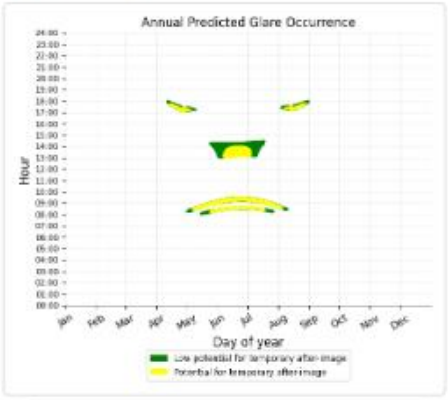
PV: SAT 2P PV Array 2 potential temporary after-image

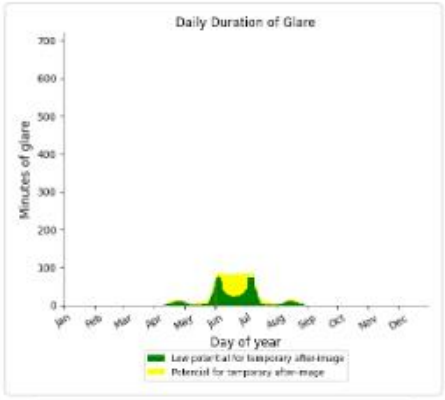
Receptor results ordered by category of glare

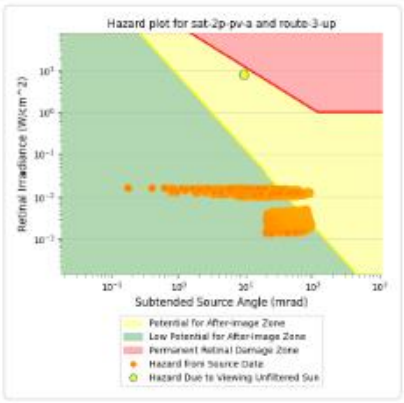
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 3 - Upper Sefton Road	2,574	42.9	1,942	32.4
Railway	370	6.2	0	0.0
Route 1- Marshmans Road	189	3.1	0	0.0
Beatties Road	0	0.0	0	0.0

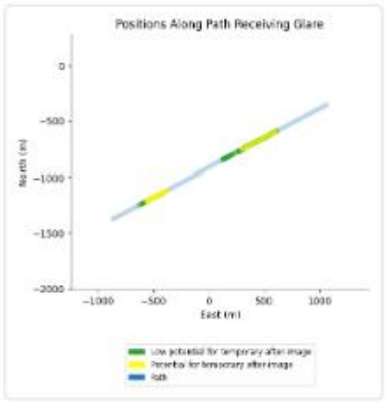
SAT 2P PV Array 2 and Route: Route 3 - Upper Sefton Road

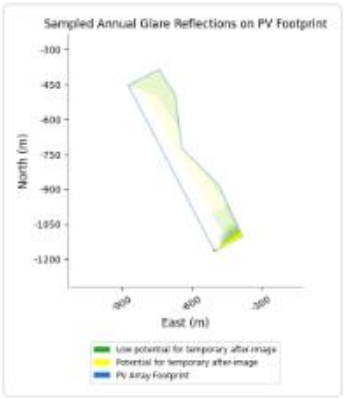
Yellow glare: 1,942 min.
Green glare: 2,574 min.







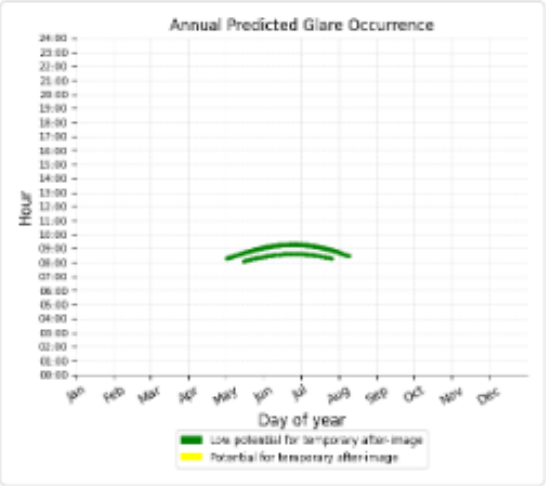


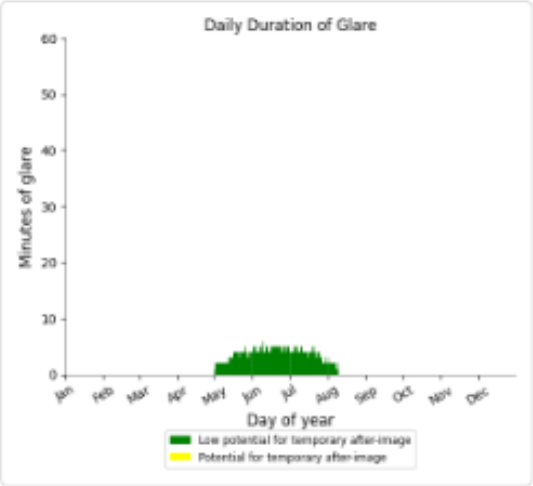


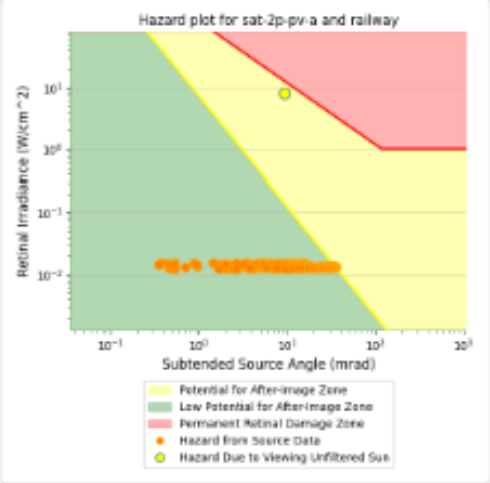
SAT 2P PV Array 2 and Route: Railway

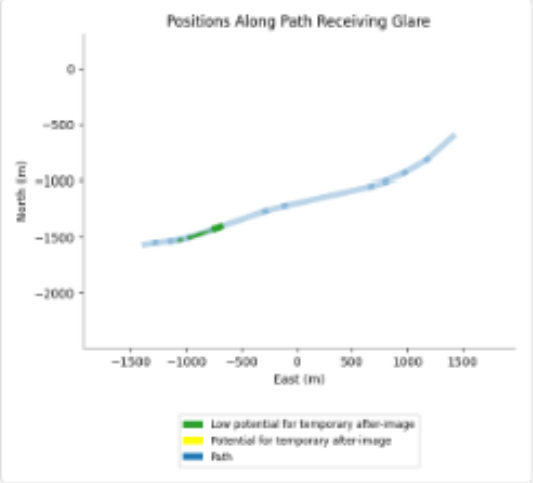
Yellow glare: none

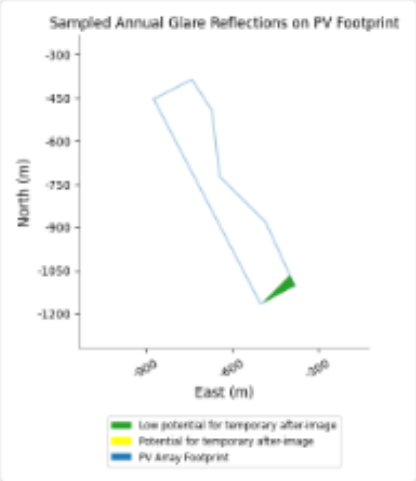
Green glare: 370 min.







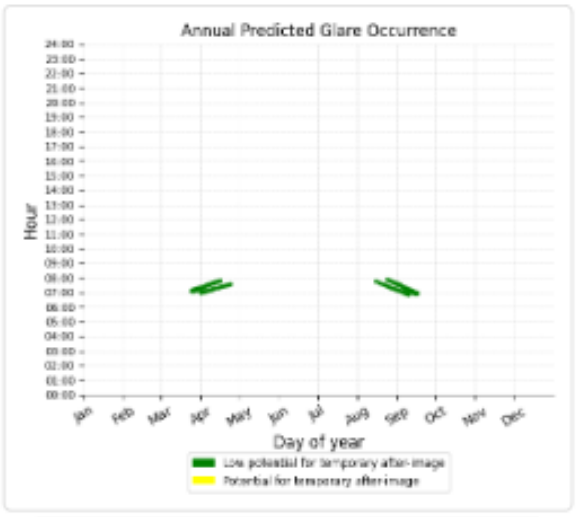


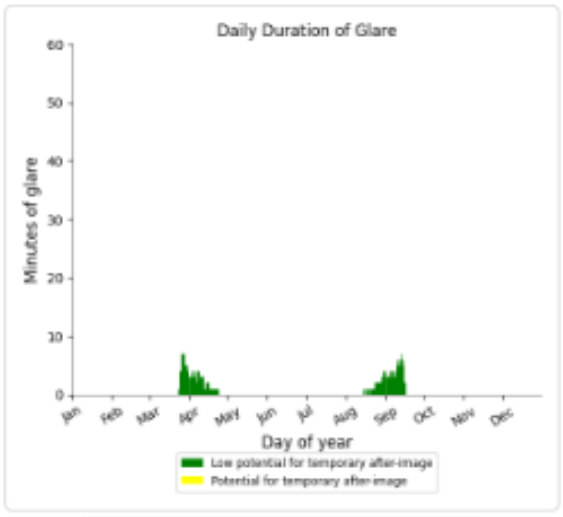


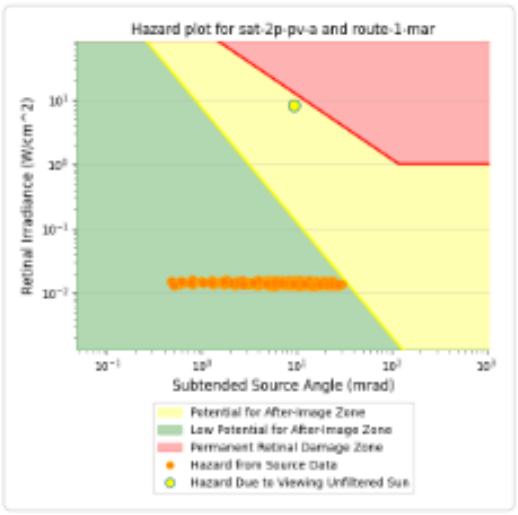
SAT 2P PV Array 2 and Route: Route 1- Marshmans Road

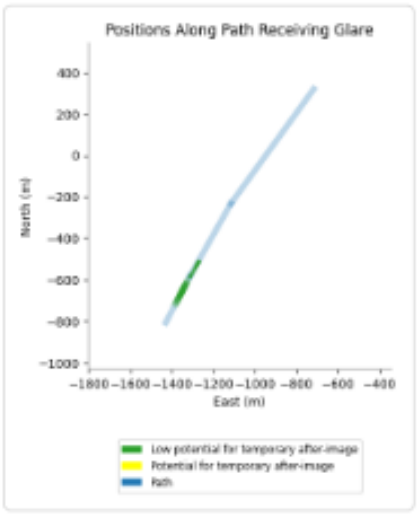
Yellow glare: none

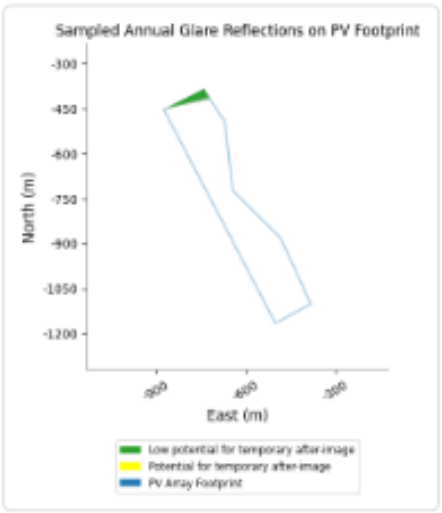
Green glare: 189 min.











SAT 2P PV Array 2 and Route: Beatties Road

No glare found