SELWYN DISTRICT COUNCIL

Review of Boffa Miskell Assessment of Glint and Glare at Buckleys Road Solar Farm

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CONTENTS

1 INTRODUCTION

1.1 Overview

At request of Selwyn District Council, the following report is based on a review of a Glare and Glint Study carried out by Boffa Miskell on a revised proposal for implementation of a Solar Farm located at Brookside in the Selwyn District.

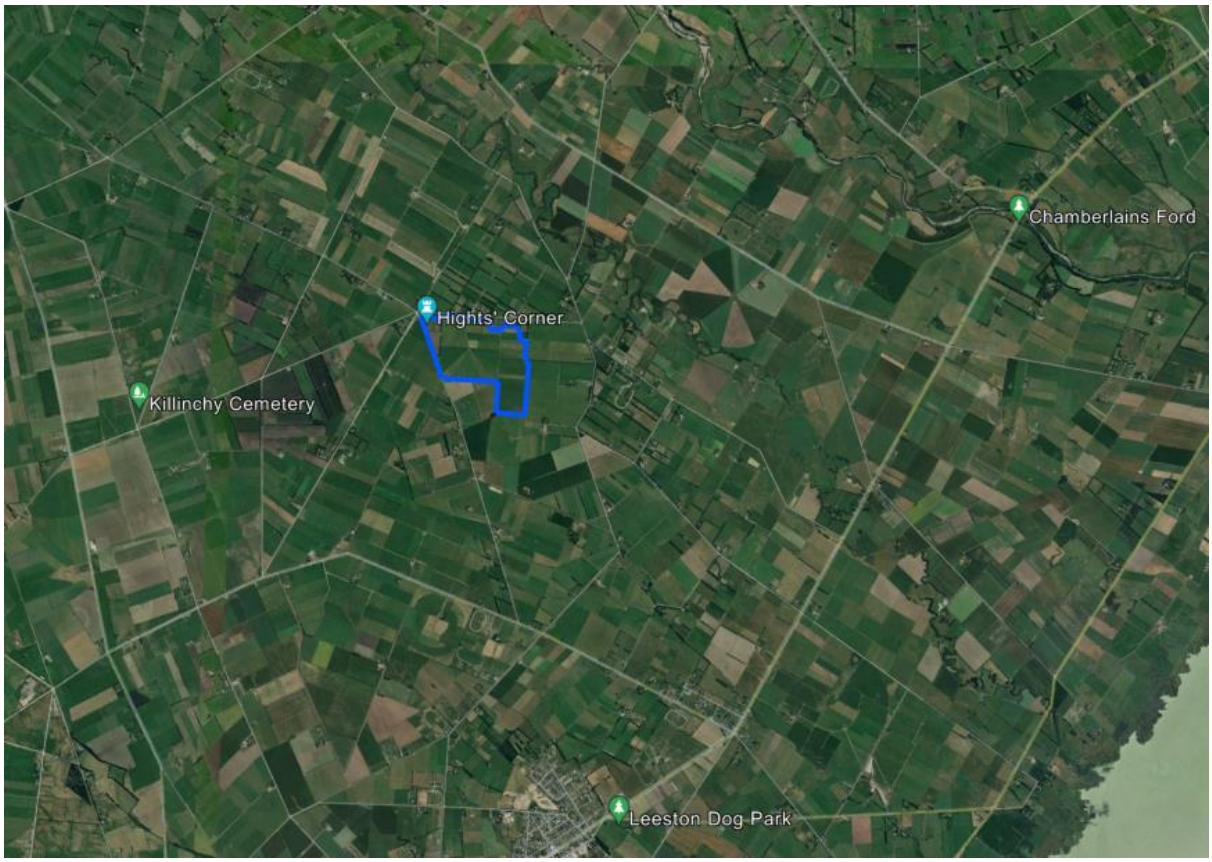


Figure 1. Brookside Solar Farm outlined in blue

1.2 Scope/Brief

Brief: To review report provided by Boffa Miskell on the Solar Farm at Brookside and assess the accuracy of findings in terms of impact of the potential glare and glint on surrounding dwellings as well as road users.

Scope :

i. To determine whether further information is required to complete the peer review
ii. Whether any additional mitigation measures should be used.
iii. Recommendations as to which parties are affected by the proposal.
iv. Recommended conditions of consent.

v. A written review of the proposal and the glare assessment, with specific comment on the suitability of the methodology used and the assumptions made and the reliability of the conclusion.

Figure 1.2 Site Boundary (Ref: Boffa Miskell Report Image 1)

1.3 Solar Panel Photovoltaic (PV) Array Information Considered

Technical Information on Solar Farm PV Array system

1. Single Axis Tracking System
2. PV panels 1.30m wide x 2.38m long
3. Rotation Axis Height 1.8m above ground level
4. Max height of panel 3m above ground level at max tilt angle of 60 degrees.
5. Reflectivity value < 4%.

System description below

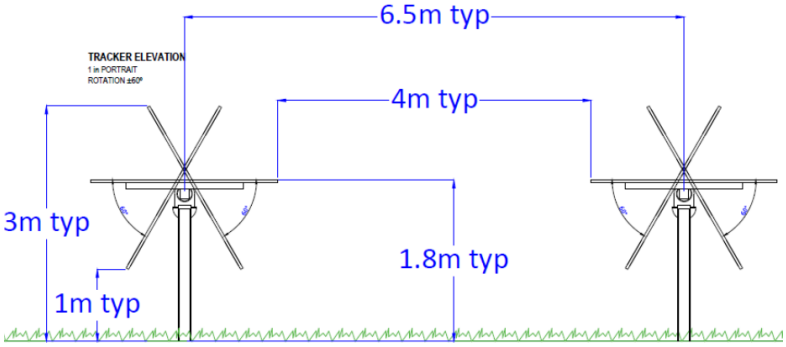


Figure 1.3 Keax Development PV Array set up (Ref. Boffa Miskell Report Image 3)

1.4 Methodology

This review considers the results of the Boffa Miskell Limited (BML) glint and glare analysis carried out on the proposed Solar Farm PV array considered for Brookside.

The review looks to verify the results obtained by BML based on the parameters of the Solar PV array being considered by Keax for the Brookside solar farm development.

It compares results based on use of the ForgeSolar, Solar Glare Hazard Analysis Tool and evaluation of potential glare on road users and dwellings.

For road users the BML assessment evaluation was based on 1.5m eye height for driver's receptors.

For residential dwellings, the BML assessment based on 1.8m receptor height for dwellings with single storey and 3.6m receptor eye height for dwellings with two storeys.

This review compares results against those obtained by BML for road users and dwellings as an initial reference.

It then considers any measures proposed by BML planned landscape plantings to mitigate any potential impact of glare from the solar farm on road users and dwellings in the immediate area of Brookside solar farm development.

Methodology around Mitigation Modelling

For Road Users

It is noted that the BML report does not include driver eye level hights for larger vehicles such as haulage vehicles and tractors etc which are a predominant feature of rural roads such as those surrounding the Solar Farm.

A typical driver eye level height for such vehicles is normally taken as 2.5m. The assessment should ideally have taken this height as the eye receptor level and based considerations on the results or simulation outcomes for this driver eye level.

This also provides a greater level of certainty that mitigation will cover all affected parties with regard to road users as it provides outcomes based on worst case scenarios.

For Residents of Dwellings

The Boffa Miskell Report considers 28 dwellings. (See below diagram).

The raw data provided by BML indicated that only the receptor eye level height of 1.8m above ground level was considered for the simulations carried out. A number of the

dwellings however are two storey for which the receptor eye level height is considered to be 3.6m as noted by Boffa Miskell.

This would represent a worst case value to be considered for dwellings.

Figure 1.4. Dwelling locations 1-28. (Ref BM report Viewpoint location Map Fig 2)

<u>Simulations carried out for this Report</u>

The simulations carried out for this report are based on the worst case eye level heights of 2.5m for driver eye levels and 3.6m for the 2 storey dwelling eye levels.

Simulations are based on a SAT with back tracking PV array system. Where 2m high mitigation shelterbelt plant species are considered, these will provide visual obstruction to the driver eye levels heights of 1.5m and dwelling levels of 1.8m that have been considered.

However, they will not provide visual obstruction of the PV arrays for the 2.5m receptor eye level for drivers of larger vehicles and 3.6m receptor eye level heights for residents of 2 storey dwellings.

Any landscape mitigation being planned therefore may also need to address these eye level heights where necessary as determined from the results for potential predicted glare for these eye receptor levels .

2. Executive Summary

This review evaluates the Boffa Miskell 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 Buckleys Road Solar Farm development.

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

KeaX Energy use of a Tracking Solar Array system has significantly reduced glare impacts compared to a Fixed Tilt Solar Array system and much larger area proposed for the Brookside Solar Farm development that had been submitted for consent previously.

The review agrees with the Boffa Miskell assessment for the predicted solar glare impact and that existing vegetation as well as proposed landscape should sufficiently mitigate any hazardous glare impacts to the neighbouring residents occupying single as well as two storey dwellings.

The Boffa Miskell assessment however, appeared to only address drivers of small vehicles where the assessed driver eye level height is taken to be 1.5m.
Given rural roads are likely to include large vehicles such as tractors, trucks, school buses and other large haulage vehicles, the reviewer considered it necessary to address these also as it presented worst case scenario in terms of driver eye level height and associated potential impact to road traffic safety.

For road users it was considered that 'yellow level' glare (or glare that had potential to cause flash-blindness) was required to be eliminated or reduced as far as practicable.

Although the review of the Boffa Miskell assessment determined that the duration of yellow glare for larger vehicle road traffic was in general greater than that for smaller vehicles, the difference was significant for only a couple of the roads and is detailed further in the results covered in this report.

As a result, it has been recommended that Boffa Miskell may wish to re-consider planned mitigation landscape planting heights to be increased from planned 3.5m to higher levels for some locations.

Overall, the reviewer believes that the Boffa Miskell solar glare assessment is comprehensive and well considered to enable solid justification on which to progress consent regarding potential solar glare from the proposed KeaX solar farm development and how it can be mitigated to largely eliminate impacts to less than minor levels.

3 BACKGROUND DATA

3.1 Array Proposed

The Buckleys Road Solar Farm PV array system being utilised is known as a Single Axis Tracking system. The data used by BML 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 without anti-reflective coating.

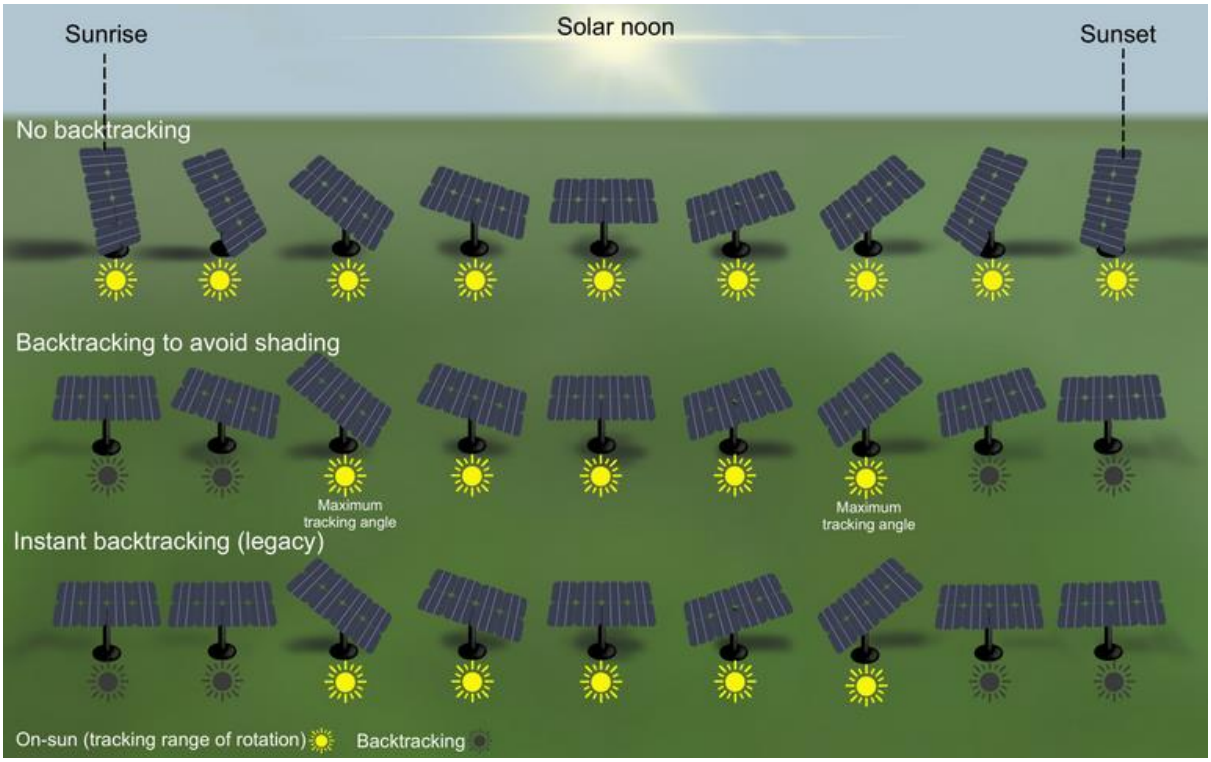


Figure 3.1 Backtracking strategies. (Reference ForgeSolar)

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 Boffa Miskell 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.

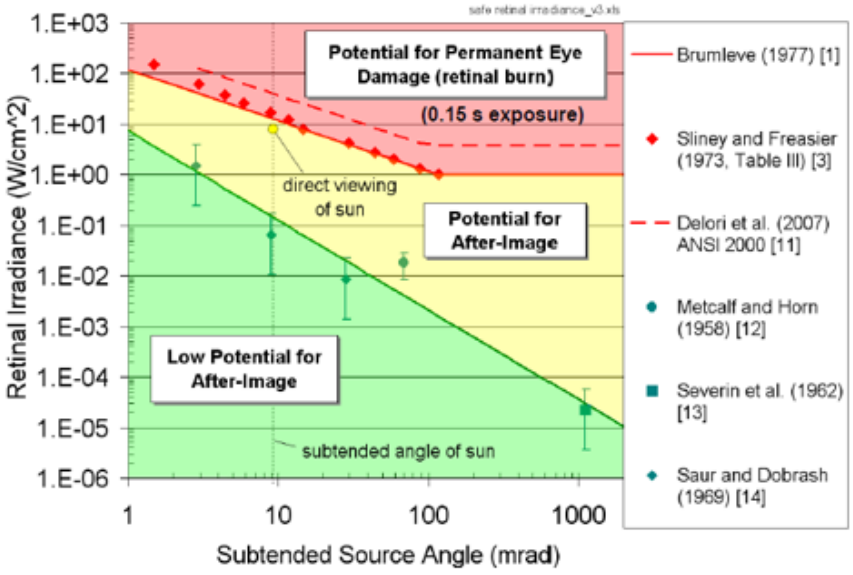


Figure 5.1: Potential ocular impact

"**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.

It is normally unlikely that red glare is created from any PV reflection but green and yellow level solar glare can be potentially be reflected.

The Boffa Miskell report assessment is based on tghese two levels of ptential glare.

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 vechicles, 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 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.

4 SOLAR GLARE ANALYSIS RESULTS

4.1 Impact on Dwellings

The following table summarises results from the BML report with an added column summarising and comparing results obtained from this independent review.

Where the results are similar this is addressed as concurrence with the BML 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 BML applied criteria then there is also agreement with the BML 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 BML assessment for single storey and reviewer (Velden Aviation Consulting Ltd -VACL) assessment for two storey dwellings. Overall, there is still very good agreement on glare impact between both sets of results as summarised in the table below. **Note:** For the results below no mitigation modelling has been applied. This is however considered in Section 5.

ID/ OP	Address/Viewing Audience	Description of potential glare effects (BML, 1.8m Receptor heights.) Based on 1.8m receptor level for single storey Dwelling only	VACL Review potential glare (Based on 1.8m and 3.6m Receptor heights for 1 or 2 storey dwellings.)
1	187 Buckleys Road	Modelling identifies no glare geometrically possible	Google Map image indicates single storey. No glare predicted.
2	150 Buckleys Road	Modelling identifies low potential for glare of a low duration (less than 10 min per day, totalling 1.6 hours per year). Effects are therefore considered to be low, no further mitigation is required.	Google Map indicates single Storey. Modelling concurs with BML. Duration less than 5 mins per day. Effect considered minimum so no further mitigation required.
3	115 Buckleys Road	Modelling identifies potential for glare of a low duration (less than 10 minutes per day, 3.3 hours per year). Effects are therefore considered to be low, no further mitigation is required.	Google Map indicates single storey. Total predicted Green and yellow glare 14.1 hours per annum. Duration less than 10 minutes per annum so unlikely to require mitigation.
4	105 Buckleys Road. Single Storey	The dwelling is surrounded by shelterbelts which screen the property from view. Modelling identifies potential for glare but of a low duration (less than 10 minutes per day, 0.4 hours per year), with low potential for glare also identified beneath this threshold. Effects are therefore considered to be low, no further mitigation is required.	Concur with BML
5	79 Buckleys Road Single Storey	The dwelling is surrounded by shelterbelts which screen the property from view. Modelling identifies potential for glare but of a low duration (less than 5 minutes per day, 0.4 hours per year), with low potential for glare also identified beneath this threshold. Effects are therefore considered to be low, no further mitigation is required.	Concur with BML

ID/ OP	Address/Viewing Audience	Description of potential glare effects (BML, 1.8m Receptor heights.) Based on 1.8m receptor level for single storey Dwelling only	VACL Review potential glare (Based on 1.8m and 3.6m Receptor heights for 1 or 2 storey dwellings.)
6	80 / 56 Buckleys Road Single Storey	The dwelling is surrounded by established planting which screens the property from view. Modelling identifies low potential for glare that is also short in duration (1.7hr per year). Effects are therefore considered to be low, no further mitigation is required.	Concur with BML
7	23 Buckleys Road Single Storey	Modelling identifies no glare geometrically possible	Concur with BML
7a	883 Caldwells Road	No dwelling on this property	N/A
8	932 Hanmer Road Single Storey	Modelling identifies no glare geometrically possible.	Concur with BML
9	381 Brookside and Irwell Road Single Storey	Modelling identifies no glare geometrically possible.	Concur with BML
10	375 Brookside and Irwell Road	Modelling identifies no glare geometrically possible.	Concur with BML
11	365 Brookside and Irwell Road	There is established vegetation between the dwelling and the site which screens the property from view. Modelling identifies low potential for glare that is also short in duration (0.6hr per year). Effects are therefore considered to be low, no further mitigation is required.	Concur with BML
12	870 Hanmer Road	This dwelling has no view of the proposed development. Modelling identifies potential for glare that is also of a low duration (less than 10 minutes per day, 2.5 hrs per year). Effects are therefore considered to be low, no further mitigation is required	Modelling dwelling as 2 storey given level not provided. Glare up to 7.5 hours per year. Duration slightly less than 10 mins per day. Effects considered still to be low so no mitigation required. Concur with BML.
13	851 Caldwells Road	No view is identified from the dwelling, with partial views from the wider property. Modelling identifies potential for glare that is also of a low duration (less than 10 minutes per day, 3.1 hrs per year). Effects are therefore considered to be low, no further mitigation is required	Dwelling level not provided so 2 storey assumed. Glare up to 7.5 hours per year. Duration slightly less than 10 mins per day. Effects considered low so no mitigation required. Concur with BML
14	821 Caldwells Road (2 land parcels)	Written approval provided	N/A
15	180 Grahams Road	Modelling identifies no glare geometrically possible.	Concur with BML
15a	198 Branch Drain Road	No dwelling on this property	N/A
16	191 Branch Drain Road	Modelling identifies no glare geometrically possible	Concur with BML
17	229 Branch Drain Road Single storey	No view is identified from the dwelling, due to surrounding screening. Modelling identifies only low potential for glare, of a short duration (0.9 hours per year). No further mitigation is required	Concur with BML

ID/ OP	Address/Viewing Audience	Description of potential glare effects (BML, 1.8m Receptor heights.) Based on 1.8m receptor level for single storey Dwelling only	VACL Review potential glare (Based on 1.8m and 3.6m Receptor heights for 1 or 2 storey dwellings.)
18	233 Branch Drain Road (Lot 1 DP 446980) Single Storey	Modelling identifies no glare geometrically possible.	Concur with BML
19	265 Branch Drain Road Single storey	Modelling identifies no glare geometrically possible.	Concur with BML
20	277 Branch Drain Road Two storeys	Modelling identifies no glare geometrically possible	Modelling identifies glare is geometrically possible for 2 storeys dwelling with eye level at 3.6m but is less than 10 hours per year (up to 6.9 hours per year glare). Duration less than 10 mins per day. Low impact therefore and no mitigation necessary.
21	313 Branch Drain Road Single storey	This dwelling obtains only a glimpsed view of the proposed development during the winter months. Mitigation proposed will screen views form this dwelling. Modelling identifies only low potential for glare, of a short duration (less than 5 minutes per day, 1.5 hours per year). No further mitigation is required.	Concur with BML for single storey at this site. Total hours per year >10 and max duration per day >10 mins if a 2 storey residence is considered at this dwelling in future.
22	324 Branch Drain Road Single Storey	Modelling identifies no glare geometrically possible	Concur with BML for single storey at this site. Total hours per year >10 and max duration per day >10 mins if a 2 storey residence is considered at this dwelling in future.
23	121 Irwell Rakaia Road	Modelling identifies no glare geometrically possible	2 Storey dwelling assumed. Results concur with BML
24	29 Irwell Rakaia Road	Modelling identifies no glare geometrically possible	At most 0.4 hours per year predicted for 2 storeys dwelling and less than 3mins per day. No further mitigation required. Concur with BML
25	43 Dunsandal and Brookside Road	Modelling identifies no glare geometrically possible	2 Storey dwelling assumed. Results concur with BML
26	15 Stewarts Road	Modelling identifies no glare geometrically possible	2 storey dwelling assumed. Results concur with BML
27	10 Stewarts Road	Modelling identifies no glare geometrically possible	1.3 hours total per year based on 2 storeys assumed. Duration Less than 5 mins per day. No further mitigation required. Concur with BML
28	414 Branch Drain Road	Modelling identifies no glare geometrically possible.	Two storey dwelling assumed. Results concur with BML
29	Lot 1 DP 77659 & Lot 2 DP 77659	No dwelling on this property	N/A

Dwelling Review General Comments

Apart from 115 Buckleys Road which appears to have a predicted annual glare of slightly more than 10 hours per annum, the review of BML glare assessments for dwellings largely 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 to be less than 10 minutes.

As such given the overall glare based on the Australian New South Wales Government solar farm guidelines, which are the more conservative of the international standards referenced by BML, mitigation against predicted potential solar glare is essentially not required for dwellings. In nearly all cases the predicted solar glare from the proposed solar farm PV array system is mostly less than 10 hours per year and less than 10 mins duration in any day.

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

4.2 Impact on Road Traffic

The following table provides predicted glare hours based on BML assessment for 1.5m driver eye level. (Ref Road Route Locations in **Appendix D**)

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
BrooksideandIrwellRoad	410	6.8	290	4.8
BuckleysRoad	161	2.7	252	4.2
CaldwellsRoad	146	2.4	807	13.4
HanmerRoad	383	6.4	664	11.1
SmythesRoad	23	0.4	0	0.0
BranchDrainRoad	0	0.0	0	0.0
DunsandelandBrooksideRoad	0	0.0	0	0.0
GrahamsRoad	0	0.0	0	0.0
IrwellRakaiaRoad	0	0.0	0	0.0
StewartsRoad	0	0.0	0	0.0

Table 4.2.1 Predicted glare levels based on 1.5m Driver eye level.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
BranchDrainRoad	80	1.3	269	4.5
BrooksideandIrwellRoad	438	7.3	277	4.6
BuckleysRoad	352	5.9	925	15.4
CaldwellsRoad	128	2.1	850	14.2
HanmerRoad	372	6.2	721	12.0
IrwellRakaiaRoad	35	0.6	107	1.8
SmythesRoad	10	0.2	8	0.1
DunsandelandBrooksideRoad	0	0.0	0	0.0
GrahamsRoad	0	0.0	0	0.0
StewartsRoad	0	0.0	0	0.0

Table 4.2.2 Predicted glare levels based on large vehicle driver eye level heights of 2.5m

Table 4.2.2 above indicates that some increase in duration of glare can be expected for the drivers of larger vehicles for which driver eye level is taken as 2.5m.

Direct comparison from the above tables total hours for yellow glare between small vehicle driver eye level at 1.5m and large vehicle driver eye level at 2.5m are provided below in Table 4.2.3 .

Road ID	BML Total hours p.a. yellow glare per year based on 1.5m driver eye level	VACL total hours p.a. yellow glare based on 2.5m driver eye level	Remarks
Branch Drain Road	0	4.8	Mitigation recommended
Brookside and Irwell Road	4.8	4.6	Mitigation recommended
Buckleys Road	4.2	15.4	Mitigation recommended
Caldwells Road	13.4	14.2	Mitigation recommended
Dunsandel and Brookside Rd	0	0	Mitigation not Required
Grahams Rd	0	0	Mitigation not Required
Hanmer Rd	11.1	12	Mitigation recommended
Irwell Rakaia Rd	0	2.4	Mitigation recommended
Smythes Rd	0	0.1	Mitigation not Required
Stewart Rd	0	0	Mitigation not Required

Table 4.2.3 Comparison of yellow glare hours per year for 1.5m and 2.5m driver eye levels

From Table 4.2.3 the assessment based on predicted glare for yellow levels are not expected to require any mitigation given the low or that there is no glare expected for the following roads: Dunsandel and Brookside Road, Grahams Road, Smythes Road and Stewart Road.

Branch Drain Road, Buckleys Road and Irwell Rakaia Road are highlighted in yellow however as they indicate significant difference between the BML assessed level and that obtained in this review.

The following table further considers the above results from the BML analysis for the 1.5m driver eye level and is compared against results obtained from this review with regard to a 2.5m driver eye level. The comparison takes into account the worst case scenario for larger vehicles such as tractors, haulage trucks, school buses etc. that also share the roads in question.

Assessment for the larger vehicles and hence higher driver eye level are addressed given the safety implications associated with potential glare for road traffic.

Figure 18 that is referred to in the BML analysis column is provided in **Appendix F**.

Road Name	BML Analysis Results based on 1.5m Driver Eye level.	BML Recommendations	VACL Analysis Results based on 2.5m Driver Eye level.	VACL Recommendations
Branch Drain Road	Modelling identifies no glare geometrically possible	No further mitigation required	Modelling predicts potential glare is along Branch Drain road for a total of 5.8 hours per year although for duration of less than 5 minutes per day between 5 and 6 am from mid-October to most of March.	Consider mitigation at points along road where glare is predicted. (See Section 5 on Mitigation)
Brookside and Irwell Road	Modelling identifies a small stretch of the road has the potential for glare approaching the bend in the road, as illustrated on **Figure 18**. Glare has the potential to occur between the months of Feb-May and August to November, between the hours of 5-8pm. Duration of the glare period during these times is predicted at less than 10 minutes per day	Potential glare available in the direction of travel towards the site would be screened by proposed planting along eastern site boundary.	A similar level of glare is predicted for driver eye level at 2.5m as for the smaller vehicle with driver eye level at 1.5m for approximately 12 hours per year.	Concur with BML
Buckleys Road	Modelling identifies a small stretch of the road potential for glare as illustrated on **Figure 18**. Glare has the potential to occur between the months of October to April between the hours of 5-6am in the morning	Potential Glare in the location of VPs 1 & 2 would be oblique to the direction of travel along the road corridor. Mitigation is not required, however,	A significant amount of glare would be experienced by drivers of larger vehicles at 15.4 hours per year compared to standard car at 4.2 hours per year . with durations of up to 10 mins	Consider mitigation at points along road where glare is predicted. (See Section 5 on Mitigation)

	and 5-8pm in the evening. Duration of the glare period during these times is predicted at less than 5 minutes per day. **Note :** Reference to **Figure 18** is provided in **Appendix F**	proposed planting along the site boundary would screen any potential glare from view.	per day for large vehicles and under 5 minutes per day for smaller vehicles. Mitigation is recommended contrary to BML conclusion.	
Caldwells Road	Modelling identifies a small stretch of the road has the potential for glare approaching the bend in the road, as illustrated on Figure 18. Glare has the potential to occur between the months of Potential glare identified at the junction of Caldwells and Hanmer Road in the location of VP6 would be mostly screened by proposed Boffa Miskell Ltd | Buckleys Road Solar Farm | Landscape Effects Assessment | 9 August 2023 21 April to September, between the hours of 4-6pm. Duration of the glare period during these times is predicted at 10 minutes per day or less	Potential glare identified at the junction of Caldwells and Hanmer Road in the location of VP6 would be mostly screened by proposed planting along eastern site boundary For the area where a gap in planting is proposed around the Wahi Taonga site, it is proposed to have no panel backtracking in this location, to avoid the effects of glare in alignment with the road corridor	Concur with BML in terms of type of PV system without backtracking or otherwise provide mitigation screening.	Concur with BML
Dunsandel and Brookside Road	Modelling identifies no glare geometrically possible	No further mitigation required.	Concur with BML	Concur with BML
Grahams Road	Modelling identifies no glare geometrically possible.	No further mitigation required.	Concur with BML	Concur with BML
Hanmer Road	Modelling identifies that a small stretch of the road has the potential for glare as illustrated on Figure 18. Glare has the potential to occur between the months of April to October between the hours of 4- 6pm. Duration of the glare period during these times is predicted at 10 minutes per day or less.	Potential glare identified at the junction of Caldwells and Hanmer Road in the location of VP6 would be mostly screened by proposed planting along eastern site boundary. For the area where a gap in planting is proposed around the Wahi Taonga site, it is proposed to have no panel backtracking in this location, to avoid the effects of glare in alignment with the road corridor.	The amount of predicted glare per year as well as durations are essentially the same for small as well as large vehicles for this road.	Concur with the approach taken by BML to mitigate impacts of this glare.
Irwell Rakaia Road	Modelling identifies no glare geometrically possible	No further mitigation required.	Modelling predicts some glare of up to 2.4 hours is possible, so mitigation is recommended particularly as it is prevalent near the main intersection.	Recommend some mitigation to remove glare at points along Solar farm boundary adjacent to road where glare is prevalent.

Smythes Road	Modelling identifies low potential for glare from a limited location only.	No further mitigation required.	Minimal amount of glare predicted at up to 0.4 hours per year for both small and large vehicles. Duration less than 2-3 mins per day between 8am and 9 am from mid -Maty to mid-July.	Although minimal glare, review of existing vegetation or other screening to reduce this further may need to be considered.
Stewarts Road	Modelling identifies no glare geometrically possible	No further mitigation required.	Modelling indicates no glare predicted. Concur with BML.	Concur with BML.

Table 4.2.4 Glare Impact on Road Users BML and VACL Comparison

Based on the results associated with predicted solar glare for road users, mitigation will need to be considered as per the recommendations in Table 4.2.4 above.

Mitigation modelling based on landscape planting as proposed by BML is considered in Sections 5 and 5.3 more specifically.

5. MITIGATION CONSIDERATIONS

5.1 Glare Mitigation Requirements for Dwellings

The Australian New South Wales Government Guidelines on Large Scale Solar Energy Development as referenced by the BML report has the following for dwellings in relation to glare impacts. (Section 5.6 Glint and Glare, Page 32).

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.

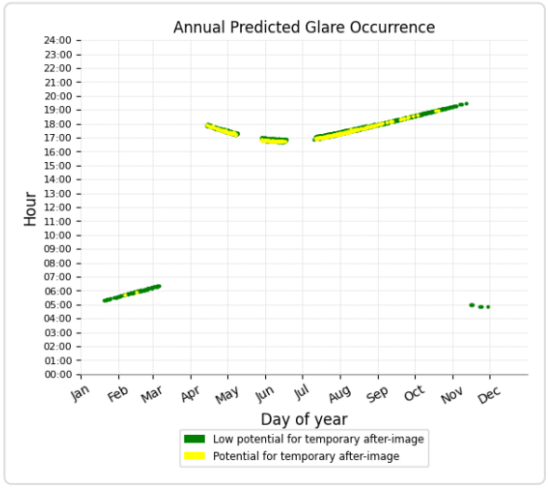
The results from the BML report indicate that for the single storey dwellings where receptor eye heights of 1.8m is considered, there are no significant impacts predicted due to solar glare reflected from the prosed solar farm development.

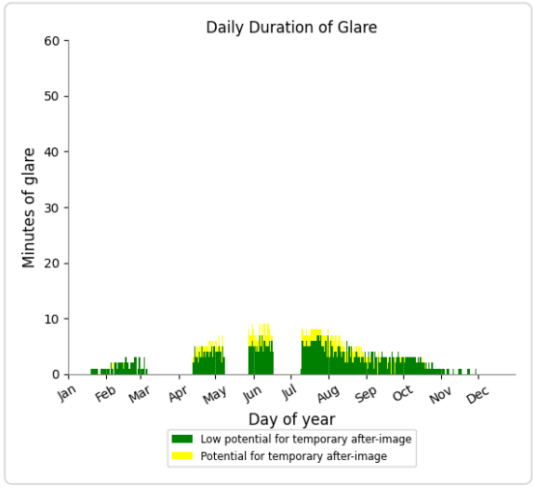
Table 2: Impact rating and performance objectives for glare impacts to residential dwellings

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

For dwellings, only 115 Buckleys Road appears to indicate total glare per annum greater than 10 hours. This is with no mitigation such as existing vegetation or planned landscape planting considered. This is illustrated in the plots below showing annual predicted glare occurrence and daily duration of glare.





Once existing vegetation surrounding 115 Buckleys Road is taken into account as well as any planned landscaping, further assessment shows that this essentially mitigates any glare predicted for the dwelling at 115 Buckleys road.

As per results outcome in section 4.1 predicted glare impacts to both single and two storey dwellings are predominantly within the more conservative guidelines of Table 5.1 where this is considered to have low glare impact. As such this review agrees with the BML assessment that no mitigation requirements are really needed for the dwellings considered based on the solar farm PV array system proposed.

Existing vegetation around dwellings and also planned landscaping for visual screening (as per Landscape Plan in **Appendix E**) 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 by BML 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.

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

As noted by BML report, the Forge Solar utility that was used identifies two levels of glare. 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.

5.3 Mitigation of Glare to Road Users

Of the road routes considered around the Brookside solar farm site, and based on table 4.2.3, solar glare impacts were predicted for the following roads.

1. Branch Drain Road
2. Brookside and Irwell Road.
3. Buckleys Road
4. Caldwell Road
5. Hanmer Road
6. Irwell Rakaia Road

Figure 5.3.1 provides an example of footprint and associated road route for Branch Drain road. The ForgeSolar Solar Glare hazard analysis software does not initially take into account any existing or planned vegetation that provide screening unless it is specifically modelled.

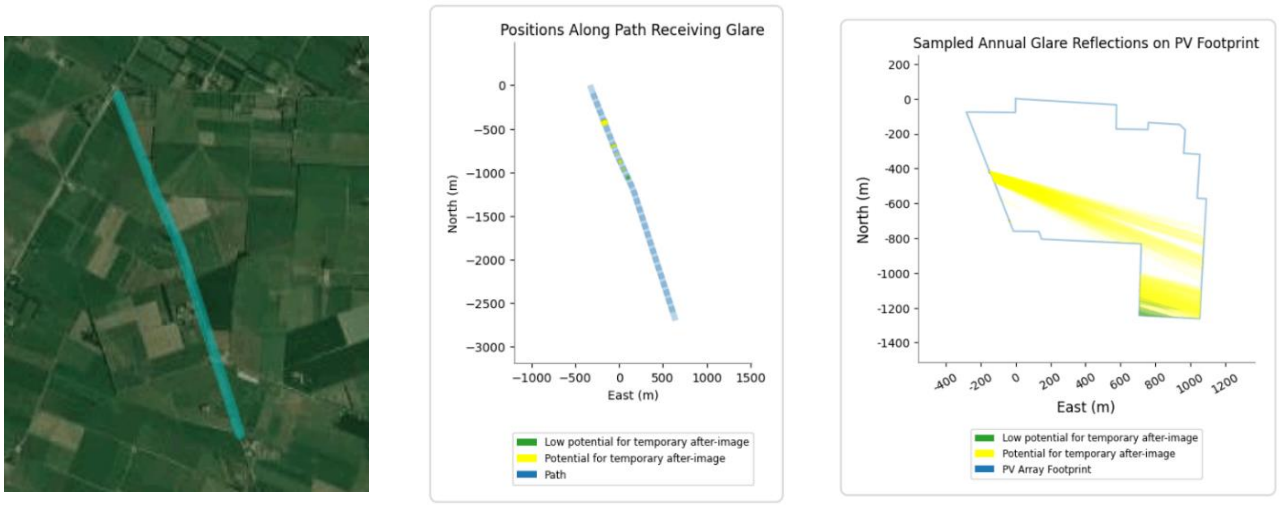


Figure 5.3.1 *Branch Drain Road Solar Glare Plots*

Figure 5.3.2 Existing Vegetation along Branch Drain Road as per view point 1 in Figure 5.3.3

Figure 3: Landscape Plan

Figure 5.3.3 Boffa Miskall Landscape Plan around Buckleys Road Solar Farm

The landscape plan as proposed by Boffa Miskell in Figure 5.3.3 indicate existing vegetation as well as plans for additional planting. (**Appendix D** provides this in more detail along with the Legend)

Table 5.3 shows the results of predicted glare when the above vegetation and planned landscape plantings, upon reaching at least 3.5m in height, are taken into account and modelled on the solar glare software utility as obstruction to any potential glare. The glare is reduced to less than minor levels with potential yellow glare essentially eliminated.

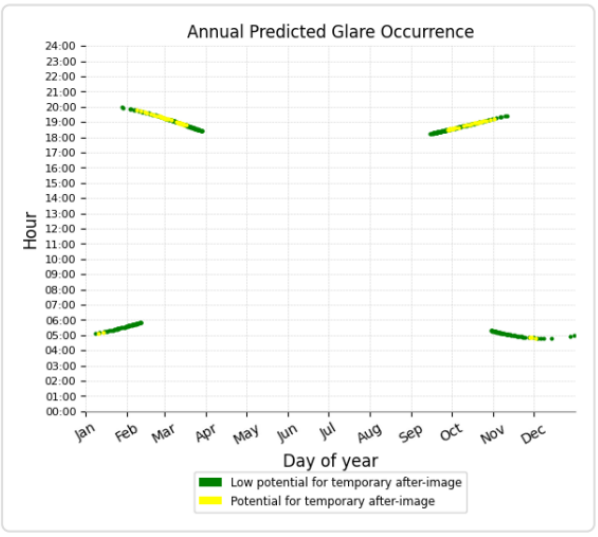
Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

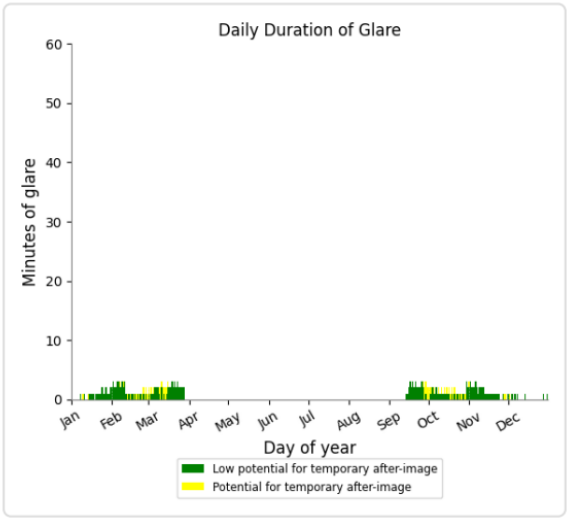
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
BranchDrainRoad	35	0.6	34	0.6
BrooksideandIrwellRoad	464	7.7	6	0.1
BuckleysRoad	208	3.5	58	1.0
CaldwellsRoad	774	12.9	36	0.6
DunsandelandBrooksideRoad	0	0.0	0	0.0
GrahamsRoad	0	0.0	0	0.0
HanmerRoad	174	2.9	0	0.0
IrwellRakaiaRoad	19	0.3	84	1.4
SmythesRoad	0	0.0	0	0.0
StewartsRoad	0	0.0	0	0.0

Table 5.3 Predicted glare with existing and planned vegetation screening taken into account

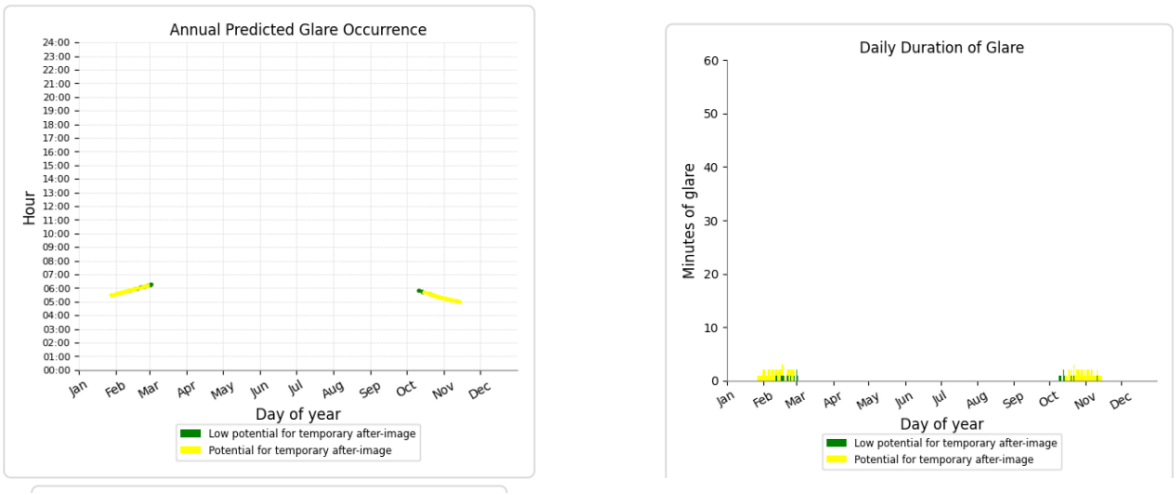
From Table 5.3 only two of the road routes, Irwell Rakai and Buckleys Roads, considered are expected to have yellow glare lasting an hour or more per annum.

Plots for the annual predicted glare occurrence and daily duration of glare are provided below.





Buckleys Road Annual Predicted Occurrence and Daily Duration of Glare.



Irwell Rakaia Annual Predicted Occurrence and Daily Duration of Glare

Although the predicted yellow glare is minimal and likely to have less than minor impact , any further mitigation required to eliminate it completely should be easily addressed by considering plantings with growth to heights of more than 3.5m. These may only be required at very localised areas if needed at all.

6. SUMMARY AND CONCLUSION OF RESULTS FOR BROOKSIDE SOLAR FARM

Brookside Solar Farm impacts on nearby Dwellings

The analysis provided by BML was for a Single Axis Tracking PV system based on the parameters as described in Sections 1.3 and 3.1.

Overall, the independent assessment results of this report correspond well with the BML assessment for road user driver eye level heights of 1.5m and dwelling based on 1.8m for eye level heights for residents. This is shown in the comparison of results from BML and this review check in **Appendix A**.

The BML 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 (See **Appendix B**).

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.

Boffa Miskell assessment of the impacts and mitigations proposed for the dwellings is covered comprehensively and very well and there is good agreement with the results they have obtained.

Brookside Solar Farm impact on adjacent Road Traffic

It was surprising that BML 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 are for road traffic are largely based on this rather than a focussed direct ahead viewpoint.

Boffa Miskells 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, additional mitigation measures that consider having plantings to at least 3.5m would be essential to minimise glare to acceptable levels to ensure less than minor impact.

Conclusion

Parties most likely to be affected are drivers of large vehicles such as tractors who are not likely to be travelling as fast as other large haulage vehicle drivers. A number of the dwelling owners are likely to be farmers who own tractors.

Glare should be minimised if not eliminated at intersections where such traffic is likely to slow down and possibly even stop before crossing or turning into another road and suddenly be faced with glare when doing so.

Safety impacts are therefore more significant for road traffic whether it is for less than 10 minutes a day or less than a minute.

As per the Australian NSW Government guidelines applying to Aviation or Road and Rail users , ***" 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***."

Where predicted glare impact to road traffic would be substantially reduced with the proposed landscape plantings and as well as existing vegetation, consideration may need to be given to establishing plant heights greater than 3.5m to reduce this glare as far as practicable.

7. RECOMMENDATIONS

The analysis and simulations performed are based on information and data received from Selwyn District Council and based on the Boffa Miskell Limited glint and glare Reports provided, and in particular the Glint and Glare study based of their report. The following are offered as recommendations for consent.

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

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

3. With regard to road routes where there is predicted glare, that consideration be given to interim mitigation measures before proposed plantings reach full maturity heights of 3.5m after 5 years. 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 road traffic may have greater impact.

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]: Boffa Miskell Report : Buckleys Road Solar Farm, Landscape Effects Assessment Prepared for KeaX Energy, 9 August 2023
[2]: Boffa Miskell, Buckleys Solar Farm, Application for Resource Consent and Assessment of Environment Effects, Prepared for KeaX Limited, 9 August 2023
[3]: Brookside Solar Farm, Location Plan, Site Overview, Date 13 July, Rev 0
[4]: Appendix 4, Site Layout and Battery Plan
[5]: ForgeSolar analysis report brooks-230730-2241-399_b2055mm_V2
[6]: Email Correspondence

APPENDIX A: Comparison Boffa Miskell and Review Check Yellow Glare

Receptor	BML Result		VACL Review Check	
	min	hr	min	hr
BranchDrainRoad	0	0.0	0	0.0
BrooksideandIrwellRoad	290	4.8	289	4.8
BuckleysRoad	252	4.2	248	4.1
CaldwellsRoad	807	13.4	807	13.4
DunsandelandBrooksideRoad	0	0.0	0	0.0
GrahamsRoad	0	0.0	0	0.0
HanmerRoad	664	11.1	664	11.1
IrwellRakaiaRoad	0	0.0	0	0.0
SmythesRoad	0	0.0	0	0.0
StewartsRoad	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	196	3.3	190	3.2
OP 4	22	0.4	19	0.3
OP 5	24	0.4	23	0.4
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	148	2.5	148	2.5
OP 13	184	3.1	184	3.1
OP 14	154	2.6	154	2.6
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
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0

APPENDIX B:BML Assessment Data for Dwellings with 1.8m eye level height.

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-43.701199	172.280025	37.00	1.80
OP 2	2	-43.700745	172.284686	36.00	1.80
OP 3	3	-43.701957	172.288641	34.00	1.80
OP 4	4	-43.701927	172.289858	34.00	1.80
OP 5	5	-43.701743	172.292807	34.00	1.80
OP 6	6	-43.701175	172.295232	33.00	1.80
OP 7	7	-43.702019	172.299039	33.00	1.80
OP 8	8	-43.704427	172.304607	31.48	1.80
OP 9	9	-43.706263	172.307928	31.00	1.80
OP 10	10	-43.706442	172.308488	31.00	1.80
OP 11	11	-43.707253	172.309372	31.00	1.80
OP 12	12	-43.710731	172.305301	30.00	1.80
OP 13	13	-43.708835	172.301892	31.00	1.80
OP 14	14	-43.713405	172.297355	31.00	1.80
OP 15	15	-43.719466	172.287119	32.00	1.80
OP 16	16	-43.719891	172.286002	32.00	1.80
OP 17	17	-43.717450	172.283961	33.00	1.80
OP 18	18	-43.716398	172.283152	33.00	1.80
OP 19	19	-43.713937	172.283424	33.00	1.80
OP 20	20	-43.712090	172.280581	34.18	1.80
OP 21	21	-43.710159	172.281167	35.00	1.80
OP 22	22	-43.708609	172.281496	35.00	1.80
OP 23	23	-43.706051	172.263789	41.00	1.80
OP 24	24	-43.702129	172.273681	39.00	1.80
OP 25	25	-43.699187	172.272123	40.00	1.80
OP 26	26	-43.699269	172.277433	38.00	1.80
OP 27	27	-43.700411	172.277929	38.00	1.80
OP 28	28	-43.701144	172.277003	38.00	1.80

APPENDIX C -Comparison Single and Two Storey Dwelling Levels

i. *Ref BML ForgeSolar Report- ForgeSolar-analysis-report-brooks-230730-2241-399_B_2055mm_V2 based on single storey)* ***No mitigation is assumed***.

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
OP 1	0	0.0	0	0.0
OP 2	94	1.6	0	0.0
OP 3	653	10.9	196	3.3
OP 4	280	4.7	22	0.4
OP 5	192	3.2	24	0.4
OP 6	102	1.7	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	38	0.6	0	0.0
OP 12	303	5.0	148	2.5
OP 13	256	4.3	184	3.1
OP 14	280	4.7	154	2.6
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	53	0.9	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	88	1.5	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0

ii. *Ref VACL ForgeSolar Analysis with Dwelling levels set according to number of storeys 1.8m and 3.6m). No mitigation assumed.*

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
OP 1	0	0.0	0	0.0
OP 2	94	1.6	0	0.0
OP 3	653	10.9	190	3.2
OP 4	269	4.5	19	0.3
OP 5	188	3.1	23	0.4
OP 6	103	1.7	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	37	0.6	0	0.0
OP 12	277	4.6	171	2.9
OP 13	233	3.9	210	3.5
OP 14	246	4.1	183	3.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	55	0.9	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	377	6.3	38	0.6
OP 21	82	1.4	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	19	0.3	3	0.1
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	67	1.1	12	0.2
OP 28	0	0.0	0	0.0

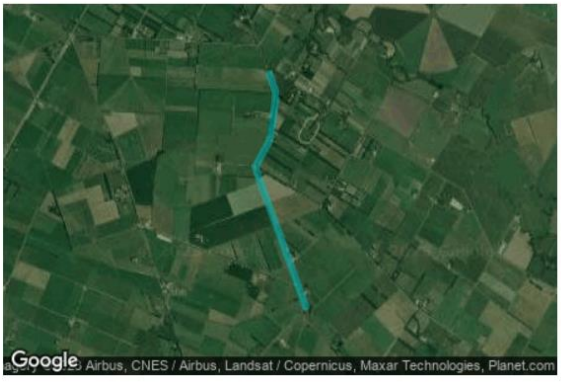
APPENDIX D:Route Receptors

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

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

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

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



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

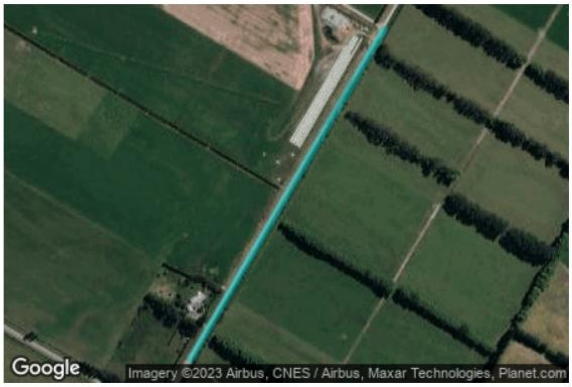
Name: GrahamsRoad
Path type: Two-way
Observer view angle: 50.0°

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

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

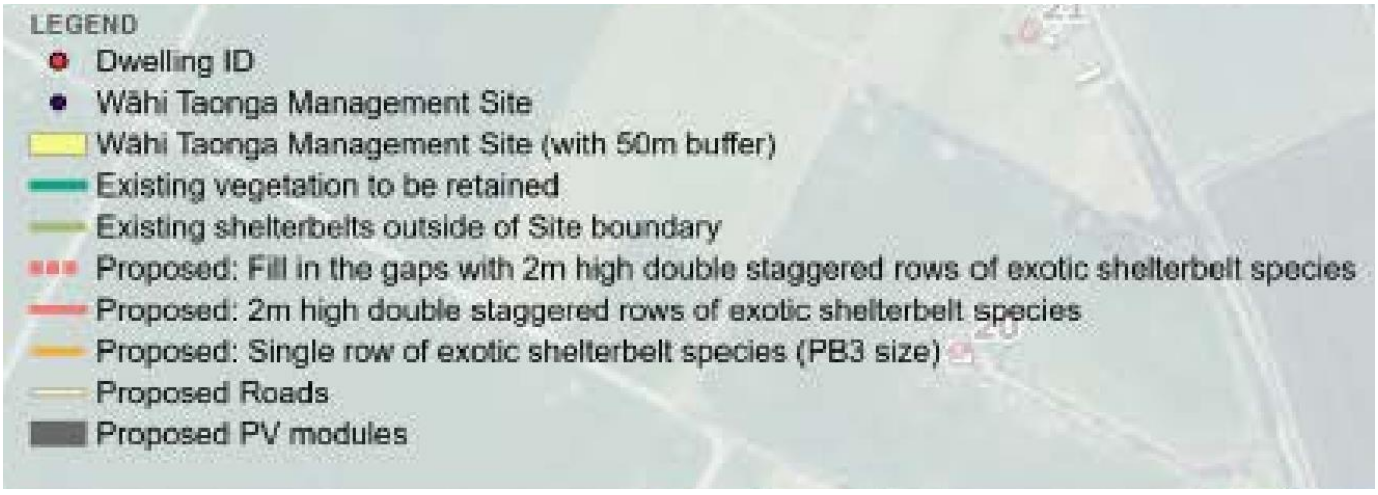
Name: SmythesRoad
Path type: Two-way
Observer view angle: 50.0°

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

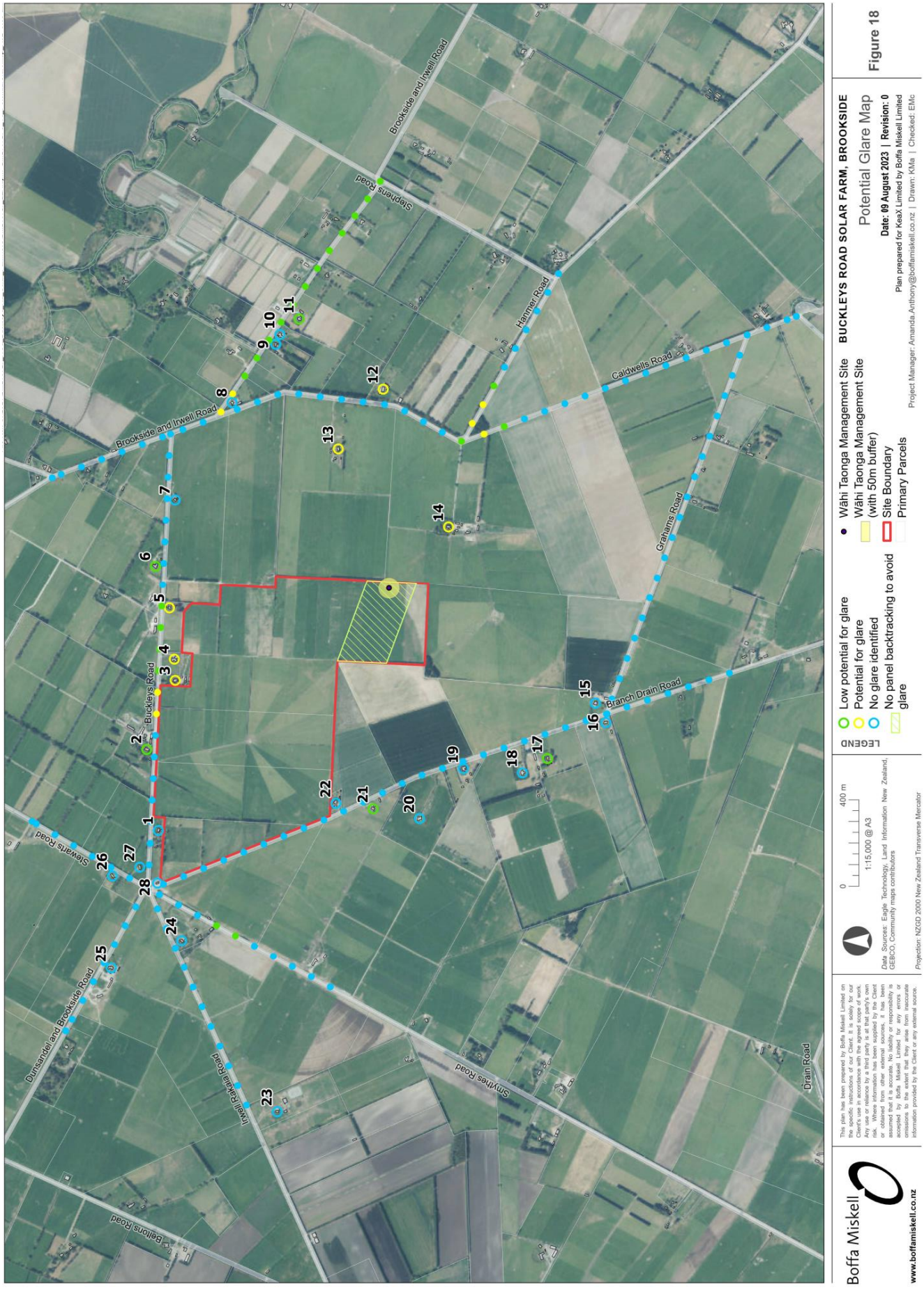


APPENDIX E:Landscape Plan

Figure 3: Landscape Plan



APPENDIX F: Potential Glare Map Road Routes (Figure 18)



Velden Aviation Consulting Ltd

To: Richard Bigsby , Selwyn District Council

From: Rudi Van der Velden, Consultant Velden Aviation Consulting Ltd

Date: 25 October 2023

Addendum to Velden Aviation Consulting Report : *Selwyn District Council - Review of Boffa Miskell Assessment of Glint and Glare at Buckleys Roads Solar Farm, Dated 21 September 2023.*

Reference: Boffa Miskell Memorandum 24 October 2023 as attached. (Attachment A)

Addendum Note:

With reference to BM memorandum and notification that further assessment has been carried out for a larger vehicle 2.5m driver eyesight height.

Velden Aviation Consulting Ltd is satisfied with the Boffa Miskell further assessment and mitigation considerations based on their resultant amendment to eliminate backtracking for roads deemed to be susceptible to glare, for the period until road corridor plantings are established at a height of at least 3m.

On this basis it can be expected that recommendations 2 and 3 proposed in the Velden Aviation report dated 21 September 2023 are satisfied with the further assessment and mitigation proposed by Boffa Miskell and conclusions they have reached.

Attachment A : Boffa Miskell Memorandum 24 October to Selwyn District Council

Boffa Miskell

Memorandum

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Attention:	Richard Bigsby at SDC
Company:	Boffa Miskell Ltd
Date:	24 October 2023
From:	Emma McRae, Principal Landscape Architect
Message Ref:	Buckleys Road Solar Farm: Further Information request - Glint and Glare
Project No:	BM210727

Introduction

The following memo provides further information as requested by Selwyn District Council in their s92 request of 29th September 2023. The letter states:

The applicant's Glint & Glare analysis in Appendix 13 was reviewed and assessed on behalf of the Council. The review identified that the applicant's assessment did not consider 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. There would be a greater safety impact associated with glare impacts on larger vehicles. The eye heights for these vehicles are considered around 2.5m.

With regard to road routes where there is predicted glare at an eye height of 2.5m, please advise what interim mitigation measures will be used before the proposed plantings reach the minimum height that they will be maintained at. This could include the planting of more established trees at 3m or greater, or appropriate vegetation in the small local areas where predicted glare levels for road traffic may have greater impact.

Additional analysis

In response to this, further analysis has been carried out on the roads surrounding the site. A bare earth analysis with an eye height of 2.5m was analysed to determine the incidence of glare at this eye height. The findings are outlined in Table 1 below:

Table 1: Glint and Glare Analysis of nearby Roads at 2.5m eye height
*Refer to **Figure 18** in the Landscape Assessment Graphic Supplement*

Road Name	Analysis results	Recommendations
Branch Drain Road	Modelling identifies that a small stretch at the northern end of the road has the potential for glare. This coincides with existing vegetation of approximately 3m height on the boundary of Branch Drain Road (see VP14).	No further mitigation required.
Brookside and Irwell Road	Modelling identifies a small stretch of the road has the potential for glare approaching the bend in the road, as illustrated on **Figure 18**. Glare has the potential to occur between the months of February to May and August to November, between the hours of 5-8pm.	Potential glare available in the direction of travel towards the site would be screened by existing vegetation as illustrated on Figure 19 along eastern site boundary. This vegetation is

	Duration of the glare period during these times is predicted at less than 10 minutes per day.	between 3 and 10m in height and is visible in the right-hand side of VP3 on Figure 10.
Buckleys Road	Modelling identifies a small stretch of the road potential for glare as illustrated on **Figure 18**. Glare has the potential to occur between the months of October to April between the hours of 5-6am in the morning and 5-8pm in the evening. Duration of the glare period during these times is predicted at less than 10 minutes per day.	Potential Glare in the location of VPs 1 & 2 would be oblique to the direction of travel along the road corridor. Mitigation is not required, however, proposed planting along the site boundary would screen any potential glare from view.
Caldwells Road	Modelling identifies a small stretch of the road has the potential for glare approaching the bend in the road, as illustrated on **Figure 18**. Glare has the potential to occur between the months of April to September, between the hours of 4-6pm. Duration of the glare period during these times is predicted at 10 minutes per day or less.	For potential glare identified at the junction of Caldwells and Hanmer Road in the location of VP6, it is proposed to have no panel backtracking in this location, to avoid the effects of glare in alignment with the road corridor until planting achieves a height of 3m where it would screen views from higher vehicles. For the area of the Wahi Taonga site where there is no planting, no backtracking is proposed to eliminate glare.
Dunsandel and BrooksideRoad	Modelling identifies no glare geometrically possible.	No further mitigation required.
Grahams Road	Modelling identifies no glare geometrically possible.	No further mitigation required.
Hanmer Road	Modelling identifies that a small stretch of the road has the potential for glare as illustrated on **Figure 18**. Glare has the potential to occur between the months of April to October between the hours of 4-6pm. Duration of the glare period during these times is predicted at 10 minutes per day or less.	For potential glare identified at the junction of Caldwells and Hanmer Road in the location of VP6, it is proposed to have no panel backtracking in this location, to avoid the effects of glare in alignment with the road corridor until planting achieves a height of 3m where it would screen views from higher vehicles. For the area of the Wahi Taonga site where there is no planting, no backtracking is proposed to eliminate glare.
Irwell Rakaia Road	Modelling identifies potential glare of less than 5 minutes per day between 5 and 7am in February/March and September/October at northern end of the road. Existing vegetation at the corner of Irwell Rakaia Rd and along Branch Drain Road (see VP14) would screen this glare from view.	No further mitigation required.
Smythes Road	Modelling identifies potential for glare from a limited location and duration (less than 2 mins per day) only.	No further mitigation required.
Stewarts Road	Modelling identifies no glare geometrically possible	No further mitigation required.

Conclusion

Further analysis at 2.5m high on a bare earth scenario has identified that four roads (Brookside and Irwell, Buckleys Road, Caldwells Road and Hanmer Road) in the vicinity of the site have the potential for glare visible to road travellers in higher vehicles. Potential glare from Buckleys Road is not orientated in the direction of travel for road users, therefore no further mitigation is required. Potential glare from Brookside and Irwell Road will be screened by existing tall shelterbelt vegetation. For potential glare from Hanmer and Caldwells Roads, the area of no backtracking will be extended to the southeastern quadrant of the site to avoid the potential for glare while proposed planting establishes to a height where it would screen viewers in higher vehicles.