Submission on Proposed Kaipara District Plan

Form 5 Submission on publically notified proposal for policy statement or plan, change or variation

Clause 6 of Schedule 1, Resource Management Act 1991

To: Kaipara District Council - District Plan Review

Date received: 30/06/2025

Submission Reference Number #:117

This is a submission on the following proposed plan (the **proposal**): Proposed Kaipara District Plan

Submitter:
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Attachments:
220103-Glint-glare-effects-mitigation-01032023.pdf

Appendix-P-Glint-and-Glare.pdf

I wish to be heard: Yes
I am willing to present a joint case: No

Could you gain an advantage in trade competition in making this submission?
- **No**

If you have answered yes to the above question, are you directly affected by an effect of the subject matter of the submission that:

(a) adversely affects the environment; and
(b) does not relate to trade competition or the effects of trade competition
- **No**

Submission points

Point 117.1

Section: General Approach

Sub-section: Other approvals may be needed

Provision:

You may need to obtain an authority for your proposal or activity separate to any resource consent required under this District Plan. For example:

1. **Building consent:**
   Resource consent granted for a development does not include building consent. Separate application to council must be made for a building consent.
2. **Regional consent:**
   Resource consent may also be required under a regional plan of the **Northland Regional Council**.
3. **Kaipara District Council Engineering Standards:**
   Engineering standards apply in addition to the provisions of this District Plan. These are critical for Council's acceptance of vested infrastructure.
4. **Bylaws:**
   For example, Council bylaws address signs on roads, solid waste, trade waste, food safety and the use of geothermal resources.
5. **Activities in the road corridor:**
   Excavations, trenching, and structures within the road corridor require a permit from Council under the **Corridor Access Request process**. Vehicle crossings onto the road reserve require approval through a Corridor Access Request and must be constructed to Council's standards.

Support / Amend / Oppose: Amend

Submission:

The current KDC Engineering standards do not align with the requirements for crossings, driveways and road ways.

Relief sought

Alignment of the standards - having room for interpretation and lack of alignment creates confusion and slows processing.

Point 117.2

Section: Definitions

Sub-section: DEF2 Definitions

Provision:

ARTIFICIAL OUTDOOR	means any exterior or non-residential interior lighting that emits directly

LIGHTING into the outdoor environment and includes signs.

Support / Amend / Oppose: Amend

Submission:

This does not cover reflective surfaces which can cause significant changes to natural environments, thinking in particular renewable energy sources mainly solar panels - both on a commercial scale and in a residential resilience context.

There only needs to be an amendment if this is something the council wants to consider for the future, in not doing anything allows broader scope for investment and renewable infostructure on a larger scale this will also leave the interpretation of visual pollution very open.

Relief sought

Define if artificial lighting also includes reflective surfaces such as solar panels.

Point 117.3

Section: Vision for Kaipara

Sub-section: Objectives

Provision:
SD-VK-04 Rural lifestyle development

Support / Amend / Oppose: Support

Submission:

Support the expanded provision for development of the rural lifestyle / micro farm

Relief sought

Support

Point 117.4

Section: Financial Contributions

Provision:

Overview

Support / Amend / Oppose: Oppose

Submission:

The development contributions are not clearly specific as to what charges are for which service, where the money will be held and for the development of what ... Paparoa for example has no development contributions as there is no planned infostructure works - this lacks foresight, this is a 10 year plan the reality is there will be a need there and it needs to be planned for! Even if the actual provisions of infostructure are not put into place for the next 20 years the development contributions should be taken and put into a trust investment fund so that when the time comes there has been a compounded interest investment that is available for the works - thus reducing the burden for future generations.

Relief sought

Clear easy to understand contributions that are non-negotiable for all areas that allow for future development.

Point 117.5

Section: Renewable Electricity Generation

Provision:

REG - Renewable Electricity Generation

Support / Amend / Oppose: Oppose

Submission:

There needs to be more thought and structure put into the way we move forward with renewable energy and the Kaipara District. Do we want to become a renewables "exporter" to Auckland? Do we want to continue to have the shackles of North Power around infostructure location? Are we willing to have our skyline "polluted" with rows of droning and vibrating wind turbines and the shimmering glare of solar panel farms in our lounge room windows of our decades old family farm house from across a valley ? What happens at the end of the life of a panel or a turbine which landfill is it going into and in what form?

I'm not a NIMBY - more of a protector of the future. Below are some links to some standards that should be reviewed in the process of creation of KDC standards for these types of developments

DIN 4150-3:1999 - Structural vibration - Effects of vibration on structures (FOREIGN STANDARD)

DIN 4150-3:1999 Structural vibration - Part 3: Effects of vibration on structures | Building CodeHub

Relieving a Glaring Problem | American Solar Energy Society

Relief sought

Addition of standards for renewables in Kaipara

Point 117.6

Section: Transport

Sub-section: Rules

Provision:

All zones except: **PREC1 - Awakino Precinct**	1. **Activity status:** Permitted **Where:** a. Each site shall provide and maintain at least one vehicle crossing so as to enable all	2. **Activity status when compliance not achieved:** Restricted Discretionary 3. **Matters over which discretion is restricted:**

and **PREC2 - Cove Road North Precinct**	vehicle types to pass freely to and from the site; b. New roads, private access ways, rights of way and driveways are designed and constructed in accordance with the **Kaipara District Council Engineering Standards 2011**; c. Driveways must be constructed in accordance with the **Kaipara District Council Engineering Standards 2011**; d. Vehicle access near existing railway level crossings must comply with TRAN-S8; e. For new vehicle crossings on to State Highways compliance with the New Zealand Transport Agency engineering requirements; f. For new or upgrades to vehicle crossings on to roads controlled by Kaipara District Council compliance with **Kaipara District Council Engineering Standards 2011** or alternative engineering standards with the agreement of Council; g. Each site shall be provided with and maintain a driveway to the following standard: i. Formed with an all-weather surface; ii. For driveways of greater than 100m, a passing bay shall be provided no further apart than 1 per 50m; iii. For a driveway servicing up to 6 dwellings the minimum width of 3.0m; iv. For driveways services between 7 and 10 dwellings a minimum width of 5.5m; v. For driveways servicing more than 10 dwellings a width of 6m; h. Maximum gradient shall be 1:5 for sealed and 1:8 for gravel	a. Adverse effects on the safe, efficient and effective operation of the transport network; b. The ability to provide for emergency vehicle access; c. The extent and effect of any non-compliance with any relevant rule or standard and any relevant matters of discretion in the infringed rule(s) or standard(s); d. Traffic generation by the activities to be served by the access; e. Location, design, construction and materials of the vehicle access; f. Safety for all users of the access and/or intersecting road including but not limited to vehicle occupants or riders and pedestrians; g. Mitigation to address safety and/or efficiency, including access clearance requirements for emergency services; h. The extent to which the safety and efficiency of rail and road operations will be adversely affected; i. The outcome of any consultation with the rail or road controlling authority; and j. Any characteristics of the proposed use or site that will make compliance unnecessary.

	driveway; i. Internal manoeuvring area sufficient that vehicles using the driveway do not need to reverse manoeuvre onto a road or shared driveways is provided; j. Access and manoeuvring areas shall comply with the **New Zealand Building Code acceptable solutions C/AS1 Part 8.1 (Fire Service Vehicular Access 2010)**; k. Stormwater drainage for at least a 10% AEP rainfall event sufficient that surface ponding does not occur and discharge from the driveway does not result in adverse effects to adjoining properties or roads; l. Where a private driveway is gated: i. The gates shall be located at least 13m from the edge of the public road carriageway (with an 80 or 100km/h speed limit) where the gate opens into the site, or ii. The gates shall be located 13m plus the gate width where it opens toward the road, unless onto a State Highway (where gate setbacks may be higher and are required to be complied with); iii. Turning provisions are provided such that a 90th percentile car may enter the driveway and turn around, without passing the gates or affecting through traffic on the public road. **Note:** *All new roads and vehicle access points that intersect a state highway require the approval of the New Zealand Transport Agency.*	

Support / Amend / Oppose: Oppose

Submission:

This standard does not align with the above mentioned standard...

Relief sought

This standard does not align with the above mentioned standard. Alignment is needed for clarity.

Point 117.7

Section: Transport

Sub-section: Standards

Provision:

TRAN-S6	**Accessible carparking**

Support / Amend / Oppose: Support

Submission:

Accessible parking is needed with longer life expectancy.

Relief sought

None

Point 117.8

Section: Transport

Sub-section: Rules

Provision:

TRAN-R4	**Vehicle access**

Support / Amend / Oppose: Oppose

Submission:

To put it bluntly these standards are higher than the existing infostructure standards - essentially you could be entering a driveway that has to be of a higher standard than the road you have left!

Relief sought

Water down the standards / requirements - they are going to get in the way of development

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Point 117.9

Section: Transport

Sub-section: Connectivity and integration:

Provision:

TRAN-P2	**Design of the network**

Support / Amend / Oppose: Amend

Submission:

there needs to be an addition of a Paper Road stopping policy - this will help tidy the region up and allows for the stopping of paper roads at time of subdevision. See TCDC guide Road Stopping Guide | TCDC

Relief sought

Inclusion of paper road stopping policy/ guideline

Point 117.10

Section: Subdivision

Sub-section: Rules

Provision:

SUB-R3	**Subdivision to create new allotments**

Support / Amend / Oppose: Oppose

Submission:

The likes of 901 Pukehuia Road, Pukehuia was an unnotified subdivision and is still zoned as Rural not as Rural Lifestyle, there needs to be consistency as well as the allowance for future developments like this... this is a great way to develop Kaipara and to roll this back will make development harder.

Relief sought

Make Rural lifestyle development a priority by removing red tape not adding it!

Point 117.11

Section: Light

Sub-section: Rules

Provision:

All zones	1. **Activity status:** Permitted **Where:** a. Artificial outdoor lighting must	2. **Activity status when compliance not achieved:** Restricted Discretionary

	not exceed 10 lux (both horizontal and vertical illuminance) between the hours of 22:00 and 07:00 measured at the following points: i. on the boundary of any site zoned General residential zone or; ii. at the boundary of any other site containing an existing residential unit; and b. Lighting must be measured and assessed in accordance with AS/NZS 4282:2023 Control of the Obtrusive Effects of Outdoor Lighting; and c. For externally illuminated surfaces such as artificially lit building facades, lighting shall be measured in accordance with CIE 150:2017 Guide on the limitation of the effects of obtrusive light from outdoor lighting installations, Second Edition.	**3. Matters over which discretion is restricted:** a. Operational or functional purpose of the artificial outdoor lighting; b. Effect of light spill on the amenity and character values of the surrounding environment; c. Adverse effects on the health, safety and wellbeing of people and communities; d. Adverse effects on the land transport network; e. Cumulative effect of lighting and glare in the locality; and f. Effects on light spill and views of the night sky and intrinsically dark landscapes.

Support / Amend / Oppose: Amend

Submission:

Include the reflection/glare of solar panels to the light guidelines

Relief sought

Include the reflection/glare of solar panels to the light guidelines

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Point 117.12

Section: General Residential Zone

Sub-section: Rules - General residential zone

Provision:

GRZ-R12	Multi-unit development

Support / Amend / Oppose: Amend

Submission:

There needs to be a provision / understanding around high density housing - I know there seems to be little to no chance of this happening in the foreseeable future but this is a provision for the next decade and we know from challenges faced in other districts that high density housing can be "bulldozed" through where there is little to no policy to work with. Central government can often get involved and create new laws that allow the high-density development of certain areas... our recommendation is a number of car parks on site for the number of bedrooms - we suggest one carpark per bedroom.

Relief sought

All accommodation both residential and commercial has the provision of one car park per bedroom.

Point 117.13

Section: Rural Lifestyle Zone

Sub-section: Rules

Provision:

RLZ-R18	**Domestic animal boarding/breeding**

Support / Amend / Oppose: Oppose

Submission:

There needs to be clearer boundaries around what is and isn't permitted. with an increase in population Domestic animal boarding and breeding should be allowed in rural lifestyle areas due to more people being in the area with pets and the increasing demand for animals as companions. There should be a curfew on cats and a strict cap to free roaming cats. Dogs could be capped at say 15 dogs over the age of 9 months of age.

Relief sought

Cat Curfew to daylight hours and only 1 free ranging cat per property the animal must be desexed

Maximum of 15 dogs over the age of 9 months per property at any one time.

Point 117.14

Section: General Residential Zone

Sub-section: Rules - General residential zone

Provision:

GRZ-R20	**Any activity not otherwise provided for**

Support / Amend / Oppose: Oppose

Submission:

Communal housing is how Māori have always lived - not allowing this in rural lifestyle areas goes against the very backbone of how our country has developed and evolved - allowing communal housing will open the area to both first peoples and immigrants alike.

Relief sought

Communal live a non discretionary activity.

Point 117.15

Section: Subdivision

Sub-section: Rules

Provision:

SUB-R4	Small lot subdivision

Support / Amend / Oppose: Amend

Submission:

HPL is not shown on the district plan and has been used for some rural subdivision in the past...a micro farm can be very highly productive and be great use of the land.

Relief sought

Adding highly productive land as a layer on the District plan map

Glint and Glare Considerations for FNSF Solar Farms

Introduction

Far North Solar Farm Limited (FNSF) has commissioned Renewable Engineering Group Ltd (REG) to investigate the effects of glint and glare from solar farms for each of FNSF's sites being consented. This has provided insight into the causes and mitigation of these effects on neighbours, nearby roads and in one case, an adjacent airstrip.

The investigation has included running a full glint and glare study at one site, and reviewing studies and mitigation plans from other solar farms in New Zealand and overseas.

The conclusion that has been drawn is that glint and glare is less of a concern as more experience with solar farms is gained. This is demonstrated by the case of solar farms being constructed and operated by airports, with studies recommending mitigation that is similar or less than the standard visual screening that FNSF plans for every solar farm proposed.

With each new solar farm, FNSF proposes a high degree of screen planting on all boundaries, with a target height that exceeds the height of the panels, the use of tracking panels in many sites, which removes most of the glint and glare potential, and siting solar farm away from populated areas.

Cause of glint and glare

Solar panels have a large, flat glass panel that faces the sun. A large number of panels can create multiple opportunities for a reflection (similar to a window flash from a car or house).
People could consider that the effect could be many times that of a single window glint, and occur more often or for longer than what may have been experienced without being near a solar farm.

We consider that solar farm glint and glare is less than expected for several reasons:

- The solar panel glass is a matt finish, which is designed to absorb light rather than reflect it;
- The panels are not mounted at an angle that is as likely to reflect towards an observer due to the panel facing directly towards the sun, as much as possible; and
- The solar farms are located in generally flat and rural sites.

Reflectivity

As the solar panels are very carefully designed to absorb light, rather than reflect it, research has shown that panels reflect less than glass, bodies of water, many house roofs and even some sealed surfaces. The small patterns and pits in the glass, as well as the glass material itself, means that any reflections are more random in direction and of less of a magnitude than experienced from window glass. The papers referenced below cover this matter well.

Angle of refraction

The angle of incidence determines the angle of refraction, so the positioning of the panel is a key factor. The experience at the site with the adjacent airstrip showed that fixed tilt, north facing panels can create glint and glare as the panels do not turn towards the sun, so have reflections towards some points of view, including on the ground, at a few times per year.

The higher the angle of tilt towards the north, the greater the chance of a downwards reflection at some times of the day on specific days of the year. This can occur at very low or very high sun angles. The low angles tended to be mornings and evenings in summer, and the higher angles when the sun was at or above the angle of the panels, causing a ground reflection.

This effect is greatly reduced with tracking solar systems, as the panels face either east or west, and are flat at noon. This means the reflection is always upwards (away from all ground based observation points) once the sun is even slightly above the horizon. The reflection is also generally to the south, and in-line with the sun itself, which is a direction that is already receiving natural glare.

Screening

In all the studies we have reviewed, the mitigation for glint and glare was to propose screening to a height equal to the panel height. This was to prevent the worst-case situations from very low sun angles being reflected at a low angle towards observation points. With screening in place, the low angles of reflection will be stopped by the trees.

In all FNSF's solar farms, trees are proposed for screening on all sides, planted early in the project and maintained at either 3m or 4m height. Where trees already are in place on the boundaries, these will be trimmed to a similar height, possibly higher if they are on a southern boundary.

Use of backtracking to maximise solar production and minimise glint and glare

Tracking solar systems (single axis trackers, which have a north south axis and tilt from east to west) aim to maximise the angle of incidence of the sun on the panels. This places the panels flat at noon (causing the glint to be upwards at an angle equal to the sun angle, but southwards into the sky) and have higher tilt angles earlier in the day. If the system did not allow for self-shading (where one row of tilted panels would shade the rows behind) the reflections at dawn and dusk would be low and not in the same position as the real sun.

However, there is no value in having panels shade each other, as this would reduce electricity generation significantly. To avoid this, the trackers use a backtracking algorithm, which lowers the panels to prevent shading. The result is that low angles of the sun generate low panel angles, reflecting the sunlight upwards, rather than forward towards the sun (and possible observers). The reflections that do occur are caught by the screening and are unlikely to be an issue due to the screening in the line of the sun. Backtracking prevents the very high angles of panels that are most likely to cause glint and glare.

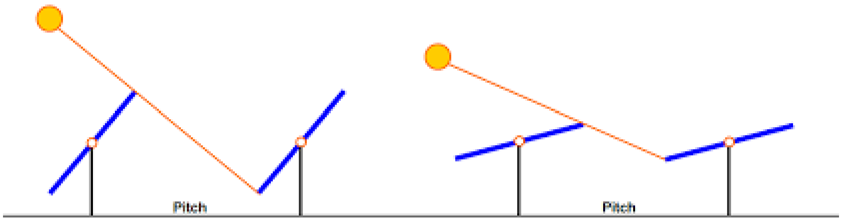


Figure 1. Example of how panel tilt decreasing after the start of shading, therefore avoiding high tilt angles that may cause low angle reflections (i.e. towards ground observers).

Summary

FNSF's solar farms are located on flat locations that minimise the number of locations that overlook the solar panels.

All FNSF's solar farms are designed and consented with high levels of tree screening, covering as many boundaries as possible, and maintained to a height that exceeds the height of the panels.

In areas where fixed tilt panels are used and there is a chance of glint and glare, studies have been conducted to minimise the issue. This was adjacent to an airstrip, where screening would not be between the solar farm and the approaching aircraft. The panels have been re-orientated to minimise the effect.

Even with screening, single axis tracking systems minimise glint and glare by directing the reflection upwards and towards the sun. Back-tracking algorithms reduce the high angles of the panel early and late in the day, preventing any low angle reflections.

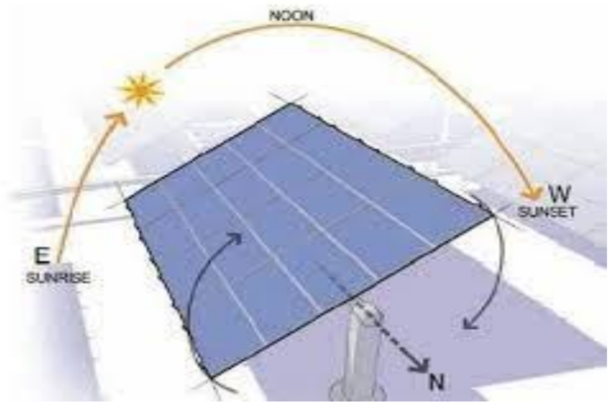
All glint and glare studies with tracking solar systems have recommended screening to remove the effects. As all FNSF's solar farms are screened by design, we consider that they have already achieved the outcomes that such a study might recommend.

References:
Glint and glare study for Tauhei solar farm:
https://www.epa.govt.nz/assets/Uploads/Documents/Fast-track-consenting/Tauhei-Solar-Farm/Application-documents/Appendix-H-Solar-Photovoltaic-Glint-and-Glare-Study-25Aug21.pdf

National Renewable Energy Laboratories:
https://www.nrel.gov/state-local-tribal/blog/posts/research-and-analysis-demonstrate-the-lack-of-impacts-of-glare-from-photovoltaic-modules.html

Solar Photovoltaic Glint and Glare Study - GOV.UK (Page 47 has table)
https://www.nottinghamshire.gov.uk/planningsearch/DisplayImage.aspx?doc=cmVjb3JkX251bWJlcj02NjY5JmZpbGVuYW1lPVxcbnMwMS0wMDI5XGZpbGVkYXRhMiRcREIwMy0wMDMwXFNoYXJlZEFwcHNcRExHU1xQbGFuc1xQTEFOTklOR1xGLTMzNzNcMTMgQXBwZW5kaXggRSBHbGludCBhbmQgR2xhcmUgQXNzZXNzbWVudC5wZGYmaW1hZ2VfbnVtYmVyPTEzJmltYWdlX3R5cGU9cGxhbm5pbmcmbGFzdF9tb2RpZmllZF9mcm9tX2Rpc2s9MTcvMDkvMjAxNSAwODo0OTozMA==

Solar mounting options:



Single Axis tracker


Fixed tilt solar farm


East-West solar mounting

Appendix P

Solar Photovoltaic Glint and Glare Study

Marton Solar Farm

Glint and Glare Assessment

4Sight Consulting Limited

201 Victoria Street, Auckland Central,
Auckland, 1010

Prepared by:

SLR Consulting Australia

Level 11, 176 Wellington Parade,
East Melbourne VIC 3002, Australia

SLR Project No.: 810.V30450.00001

24 November 2023

Revision: R02-v1.2

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
R02-v1.2	24 November 2023	Peter Hayman	Peter Georgiou	Peter Georgiou
R02-v1.2	8 November 2023	Peter Hayman	Peter Georgiou	Peter Georgiou
R02-vR02-v1.2	26 October 2023	Peter Hayman	Peter Georgiou	Peter Georgiou
	Click to enter a date.			
	Click to enter a date.			

Basis of Report

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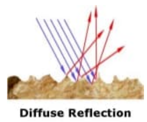
Acronyms and Abbreviations

PV Panel	Photovoltaic (PV) panels are designed to absorb solar energy and retain as much of the solar spectrum as possible in order to produce electricity.
Glare	Glare refers to the reflections of the sun off any reflective surface, experienced as a source of excessive brightness relative to the surrounding diffused lighting. Glare covers reflections: . Which can be experienced by both stationary and moving observers (the latter referred to as "glint"). . Which are either specular or diffuse.
Specular	A reflection which is essentially mirror-like – there is virtually no loss of intensity or angle dispersion between the incoming solar ray and outgoing reflection. 
Diffuse	A reflection in which the outgoing reflected rays are dispersed over a wide ("diffuse") range of angle compared to the incoming (parallel) solar rays, typical of "rougher" surfaces. 
KVP	Key View Points (KVPs) are offsite locations where receivers of interest have the potential to experience adverse reflective glare.
Glare **AS/NZ 1158.2:2020**	Condition of vision in which there is a discomfort or a reduction in the ability to see, or both, caused by an unsuitable distribution or range of luminance, or to extreme contrast in the field of vision. Glare can include: (a) Disability Glare – glare that impairs the visibility of objects without necessarily causing discomfort. (b) Discomfort Glare – glare that causes discomfort without necessarily impairing the visibility of objects.
Threshold Increment (TI) **AS/NZ 4282:2019**	TI is the measure of disability glare expressed as the percentage increase in contrast required between an object and its background for it to be seen equally well with a source of glare present. Higher TI values correspond to greater disability glare.

1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by 4Sight Consulting Limited to carry out a Reflective Glare assessment of the proposed 73.5 MWac Marton Solar Farm (the "Project").

The Project is located to the south of the township of Marton, bounded by Whales Line to the south and Pukepapa Road to the west. It comprises:

- Blocks ("sub-arrays") of panels following the various natural and man-made breaks throughout the site with 165,696 panels mounted on a fixed tilt support system.
- Also included on the site are inverter areas and power stations.

The following potential glare conditions have been considered:

- Daytime — Reflective glare (and glint) arising from the solar PV panels within the facility.
- Night-time — Illumination glare from 24/7 operational security lighting within the facility (if such lighting is required).

1.1 Structure of Report

The remainder of this report is structured as follows:

- Section 2 describes the Project and surrounding environment.
- Section 3 outlines the requirements of the impact assessment.
- Section 4 provides background information regarding the calculation of reflectivity and glare.
- Section 5 presents the analysis, results and proposed mitigations covering Road Traffic Disability Glare and Residential Nuisance Glare.
- Section 6 presents a qualitative analysis covering night-time illumination glare.

2.0 Proposed Marton Solar Farm Project

2.1 Site Location

The Project is seeking development approval for a 73.5 MWac solar facility at the location shown in **Figure 1**. The site is bounded by Whales Line to the south and Pukepapa Road to the west. The northern boundary of the site is approximately 1.5 km south of the outskirts of Marton.

In terms of the relative heights of the Project site and surrounds, the ground elevations at the site are reasonably flat, with a general and essentially linear fall in elevation from west to east of approximately 12 m.

Figure 1 Marton Solar Farm – Location Map

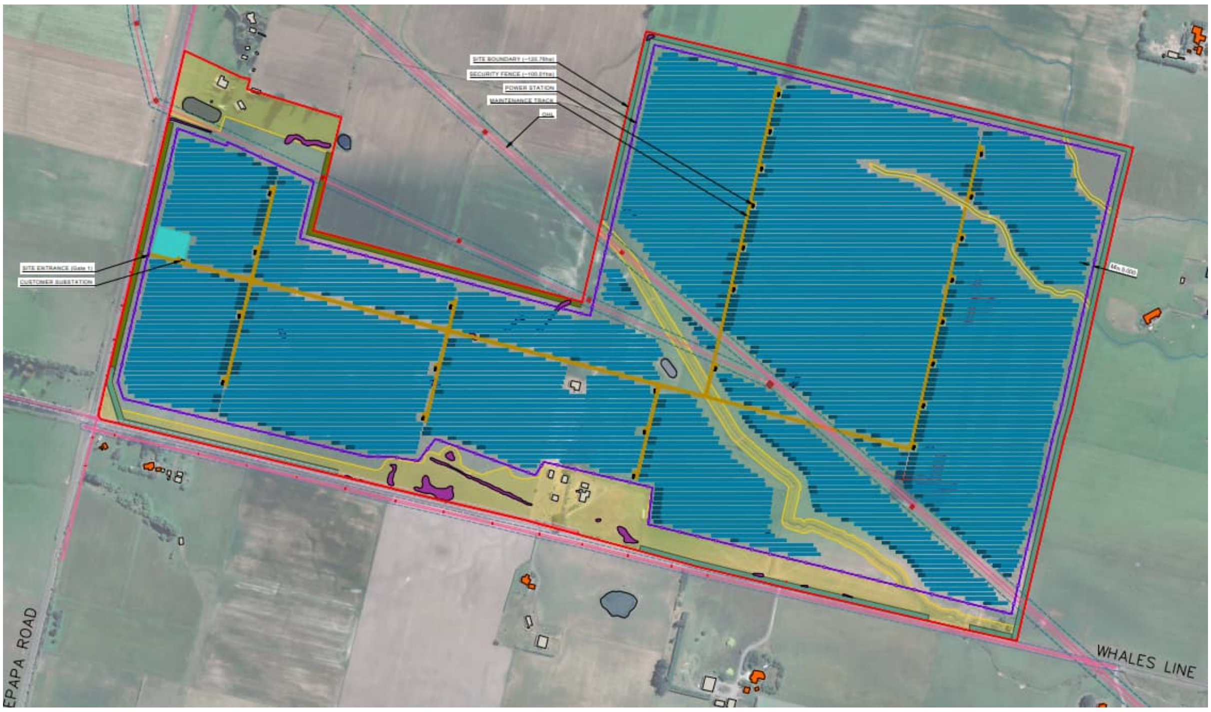
2.2 Site Description and Key Project Components

From a Reflective Glare point of view, the key components of the Project are:

- The photovoltaic (PV) modules in relation to their daytime reflective glare potential; and
- The facility's security/emergency lighting design in relation to potential night-time illumination glare issues, if such 24/7 lighting is incorporated into the Project – note: detailed plans of this are not yet available.

The proposed ground-mounted array (refer **Figure 2**) would consist of fixed tilt angled rows of panels facing north, supporting 625 W solar panels (165,696 panels in total).

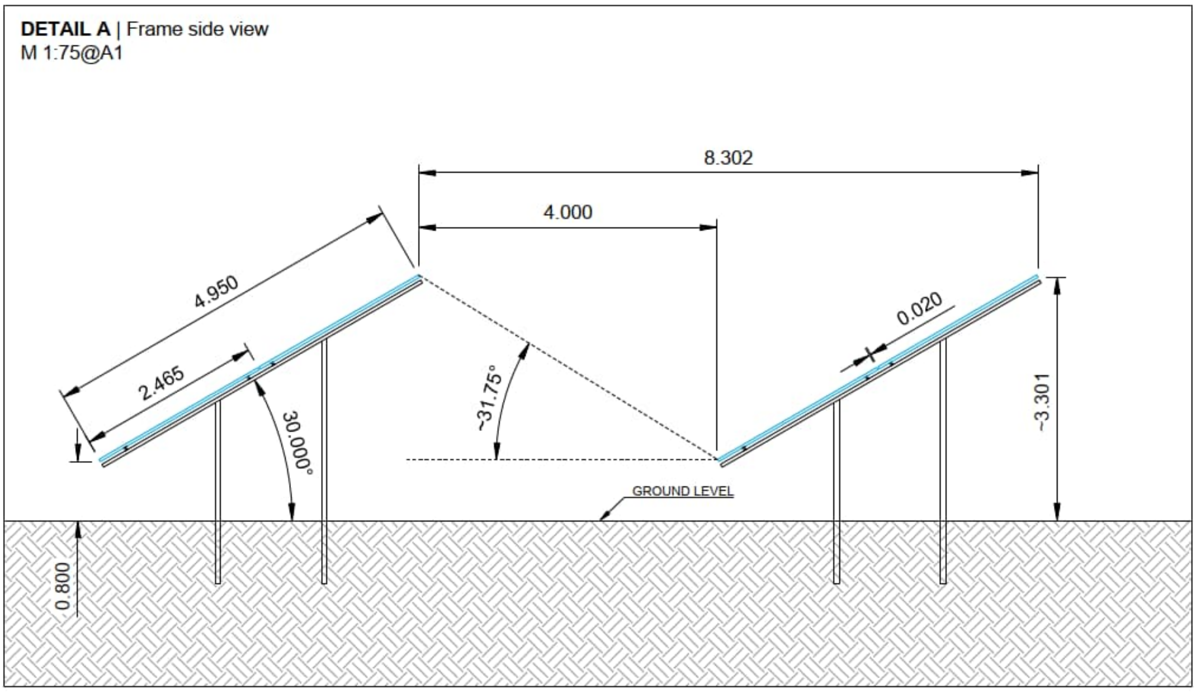
Figure 2 Site Layout



The rows of panels will be set up in a nominal 30° tilt, 2-portrait ("2P") configuration (refer **Figure 3**) with a maximum height to the top of the panels of ~3.30 metres (m) above ground level. The ground coverage ratio will be approximately 52%.

It is understood that the ultimate tilt angle and hence height above ground may vary, depending on the final panel and support structure selection and local ground conditions.

Figure 3 Fixed Tilt Panel Support System – Sideview from West



3.0 Requirements

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

Aviation Glare

With regard to aviation glare, the Forge Solar SGHAT software tool has been generally accepted by regulatory bodies throughout New Zealand. The SGHAT impact criteria are:

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

For this assessment, there are no airfields close enough to the Project site and further analysis in relation to aviation glare is not required.

Residential Nuisance Glare

SLR notes the criteria available in the newly-released New South Wales (NSW) Large Scale Solar Energy (LSSE) Guideline (2022). The LSSE Guideline classifies Residential Nuisance Glare into “High”, “Moderate” and “Low” impact levels by minutes per day and/or hours per year. **Figure 4** summarises the three impact levels and associated amenity objectives.

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

Figure 4 Extract from NSW Large-Scale Solar Energy Guideline (2022)

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.

Road and Rail Traffic Disability Glare

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

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

4.0 Background

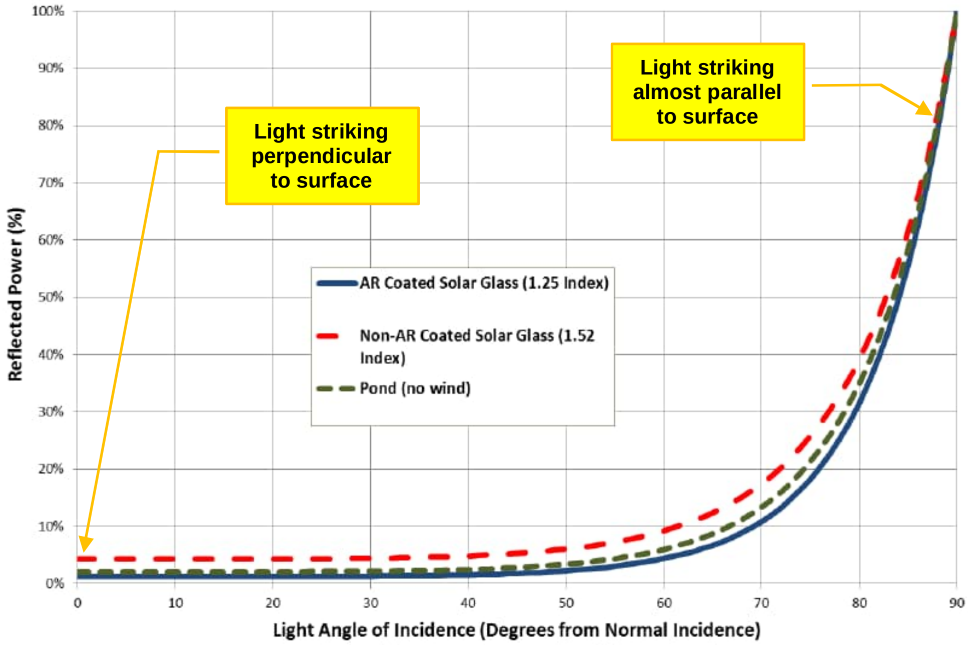
4.1 Solar Panel Reflectivity

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

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

Representative reflectivity curves are shown in **Figure 5**.

Figure 5 Typical Reflectivity Curves as a Function of Incidence Angle



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

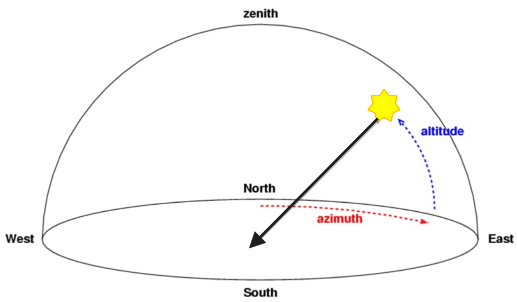
4.2 Project Site Angles – Annual Variations

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

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

Any solar glare analysis must take into account the complete cycle of annual reflection variations noted above. The potential range of incoming solar angles at the Project site relevant to daytime glare is shown in **Figure 6**, with critical angles summarised in **Table 1**.

Figure 6 Project Site Incoming Solar Angle Variations



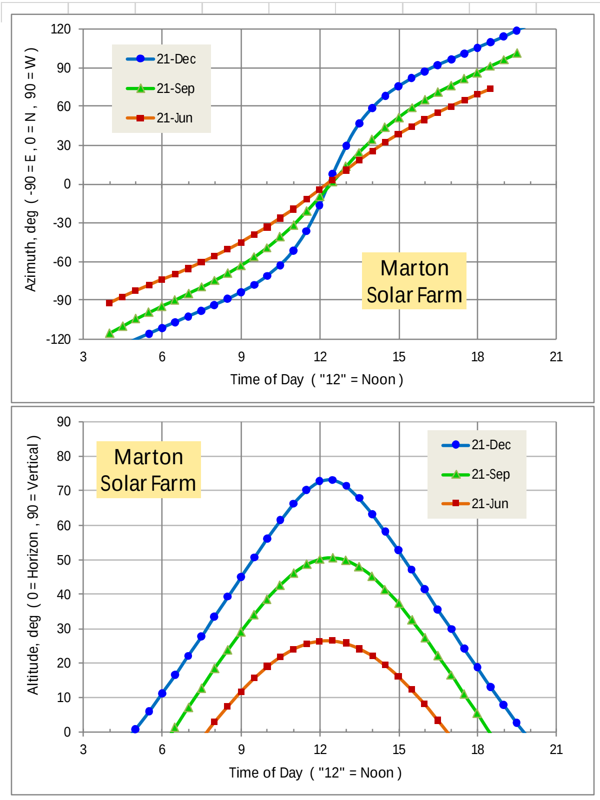


Table 1 Key Annual Solar Angle Characteristics for Project Site

Day of Year	Sunrise	Sunset	Sunrise-Sunset Azimuth Range	Max Altitude
Summer Solstice [1]	4:55 am	7:46 pm	±121° East & West of North	73°
Equinox	6:23 am	6:27 pm	±90° East & West of North	50.5°
Winter Solstice	7:43 am	4:51 pm	±59° East & West of North	26.5°

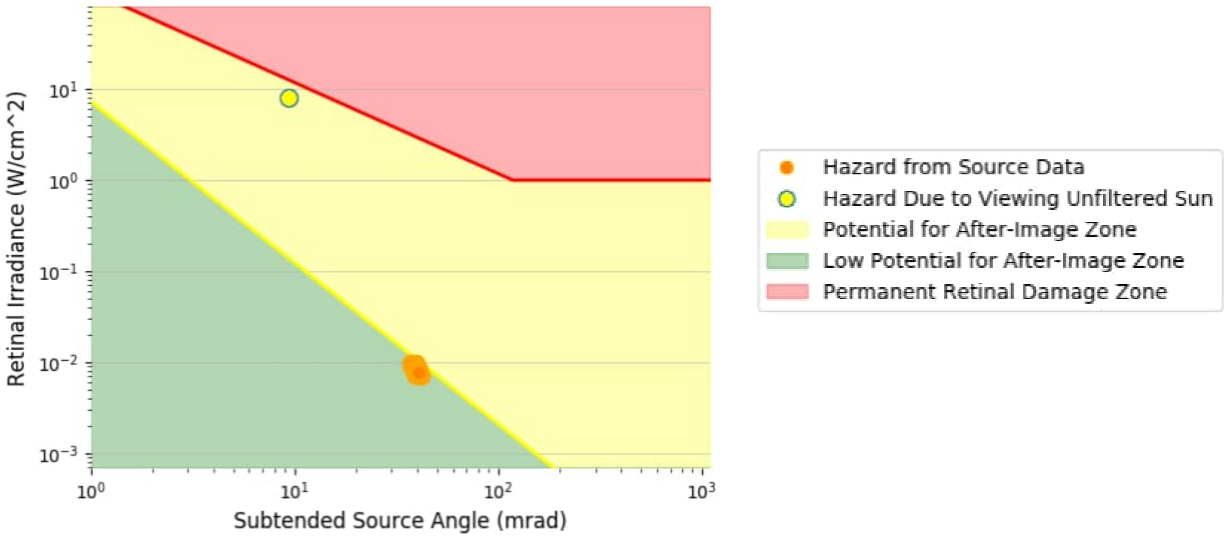
Note 1: Times of day do not take into account Daylight Savings Time

4.3 Modelling Outputs

Modelling has been undertaken using the Forge Solar SGHAT software suite. This provides output in the form of an ocular hazard analysis plot, a sample of which is shown in **Figure 7**.

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

Figure 7 Example Solar Glare Ocular Hazard Plot (SGHAT Software Output)



The following is noted regarding **Figure 7**.

- SGHAT ocular impact is a function of both the “retinal irradiance” (ie the light seen by the eye) and “subtended source angle” (ie how wide an arc of view the light appears to be arriving from).
- SGHAT ocular impact falls into three categories:
  - . GREEN: low potential to cause “after-image”
  - . YELLOW: potential to cause temporary “after-image”
  - . RED: potential to cause retinal burn (permanent eye damage)
- “After Image” is the term applied to a common retinal phenomenon that most people have experienced at some point or other, such as the effect that occurs when a photo with flash is taken in front of a person who then sees spots in front of their eyes for a few seconds. A more extreme example of “after-image” occurs when staring at the sun. “After-image” (also known as “photo bleaching”) occurs because of the de-activation of the cells at the back of the eye’s retina when subjected to a very bright light.
- The SGHAT plot provides an indication of the relative intensity of both the incoming reflection and the sources of light itself (ie the sun).

  . The occurrence of glare is shown in the plot as a series of **orange circles**, one circle for each minute that a reflection is visible.

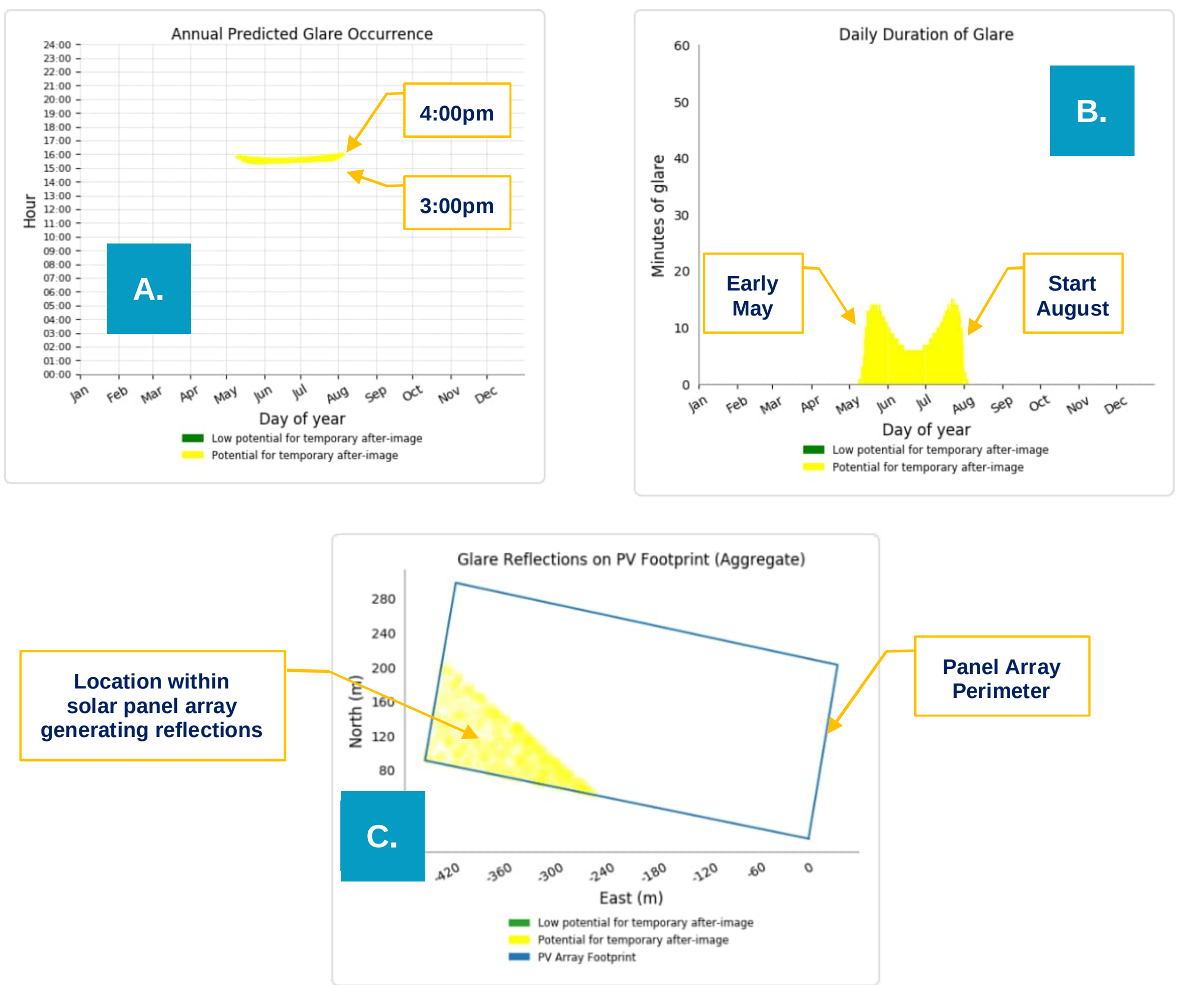
  . A reference point is also shown in each SGHAT plot, the **yellow circle** with the **green outline**, representing the hazard level of viewing the sun without filtering, ie staring at the sun.
- In **Figure 7**, it can be seen that the reflection visible by the receiver is roughly 1,000 times less intense than the light from the sun.

- Finally, in relation to PV Solar facilities, it is important to note that the third SGHAT Ocular Plot "RED" category is not possible, since standard PV modules do not focus reflected sunlight.

In addition to the above "assessment" output, the SGHAT software package also produces information which reveals the extent of visibility of reflections at any chosen receiver position, regardless of whether the reflections constitute a glare condition or not. An example is shown in **Figure 8**.

- **Figure 8-A** shows the am/pm time periods when reflections occur at a specific receptor throughout the year, in this case between around 3:30 pm and 4:00 pm.
- **Figure 8-B**\ shows the months during the year and the minutes per day when reflections occur at a specific position, in this case from early-May to the start of August, for periods ranging up to 13 minutes per day.
- Finally, **Figure 8-C** shows where within the solar farm panel array the reflection rays of interest are emanating from, in this case from panels near the southwest corner.

Figure 8 Example Solar Glare Output Plots (SGHAT Software Output)



4.4 Other Factors Relevant to Glare Prediction

Weather

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

Marton receives approximately 2,800 hours of sunshine per annum, implying that the sky is either overcast or mostly cloudy roughly 36% of the time throughout the year.

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

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

Terrain

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

These however can be added to the simulation as so-called "obstructions" which can model tree lines for example as solid (obstructing) walls. In this case, it would be assumed that the vegetation has dense coverage and is of an evergreen species.

Topography

Similarly, topography is not modelled within SGHAT.

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

Alternatively, the "Elevation Profile" function available in Google Earth (or alternative mapping tools) may be able to identify sensitive receivers which do not have a view of the proposed facility.

5.0 Glare Impacts

5.1 Modelling Inputs

The Project was modelled as a number of smaller "sub-arrays" – refer **Figure 9**.

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

Two heights were used to model the panels in each sub-array to capture the range in heights of the proposed "2P" array geometry (refer **Figure 3**).

- A "LOW" version at 1.4 m above ground.
- A "HIGH" version at 2.6 m above ground.

Figure 9 Modelled Sub-Arrays 1-6

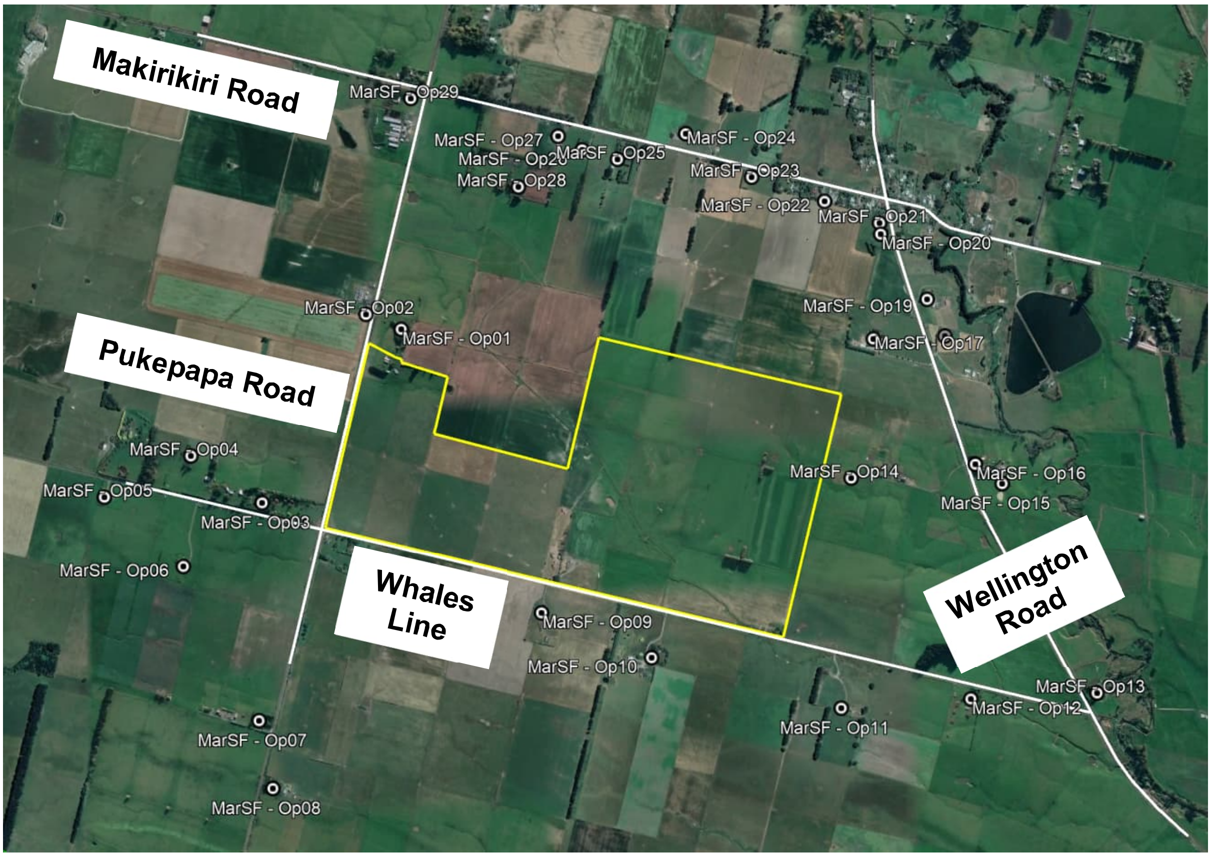
The roadways included in the analysis are shown in **Figure 10**.

- A conservative scenario involving a large truck with a motorist viewing height of 2.3 m was used for Wellington Road. For the remaining carriageways (Makirikiri Road, Whales Line and Pukepapa Road) a motorist viewing height of 1.8 m was used, relevant to smaller vans and light trucks.

The 29 representative residential locations included in the analysis are also shown in **Figure 10**.

- For surrounding residential dwellings, the observer height was set at 1.5 m above the ground.

Figure 10 Roadway and Surrounding Receiver Locations



The latitude and longitude coordinates of the 29 representative locations shown in **Figure 10** can be found in **Appendix A**.

5.2 Road Traffic Disability Glare - Baseline Results

A baseline model was initially run with no vegetation or other obstructions included, and without intervening sections of topography which could obscure the view of the facility for passing motorists. This was run to give an initial indication of potential locations of glare prior to considering the need for mitigation.

Table 2 shows the total annual minutes of potential SGHAT "Yellow" glare, with both the individual sub-array minutes of glare and the yearly total over all panel sub-arrays.

The results for both panel heights, "LOW" and "HIGH", are shown **Table 2.**

Table 2 Annual Total Minutes of Roadway "Yellow" Glare (Baseline Model)

Array Panel Height = "LOW"

Road	PV Sub-Array						Yearly Total
	1	2	3	4	5	6	
Makirikiri Road	74	430	3		482	79	**1068**
Pukepapa Road							
Wellington Road							
Whales Line	22			67	643	453	**1185**

Array Panel Height = "HIGH"

Road	PV Sub-Array						Yearly Total
	1	2	3	4	5	6	
Makirikiri Road	100	616	29		404	76	**1225**
Pukepapa Road							
Wellington Road							
Whales Line	8			61	492	256	**817**

Discussion

The results in **Table 2** show that the "LOW" and "HIGH" simulations gave similar results. The "LOW" case gave slightly higher glare predicted for Makirikiri Road and slightly lower glare for Whales Line.

As noted in **Section 3**, the occurrence of SGHAT YELLOW glare for ANY number of minutes per day or hours per year is taken by SLR as necessitating consideration of mitigation, unless the glare condition occurs at a time of day when the difference in angle between an incoming solar ray and its associated reflection is less than around 10°.

Existing Vegetation

For the next simulation, existing area of dense vegetation "obstructions" were added to the SGHAT model.

An example is shown in **Figure 11**, showing a motorist view heading west along Makirikiri Road at a location predicted by SGHAT to create glare potential from sub-arrays 1, 2, 3, 5 and 6 – refer **Table 2**.

Figure 11 Example Existing Vegetation (Makirikiri Road)

The SGHAT results for the "HIGH" case and WITH the addition of existing vegetation are shown in **Table 3**.

- The occurrence of SGHAT YELLOW glare along Makirikiri Road was eliminated.
- Some SGHAT YELLOW glare remained along Whales Line.

Table 3 Annual Total Minutes of Roadway "Yellow" Glare (with Existing Vegetation)

Road	PV Sub-Array						Yearly Total
	1	2	3	4	5	6	
Makirikiri Road							
Pukepapa Road							
Wellington Road							
Whales Line				53	139		**192**

5.3 Residential Observer Glare – Baseline Results

The Baseline results for the "HIGH" case showed uniformly higher levels of glare for the 29 sensitive receivers compared to the "LOW" case. These are shown in **Table 4**, with shading of the annual totals used to identify the relevant LSSE Guideline impact category:

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

Table 4 Annual Total Minutes of Residential "Yellow" Glare ("HIGH" case, NO existing Vegetation)

Residence	PV Sub-Array						Yearly Total
	1	2	3	4	5	6	
OP1	155						155
OP2	5						5
OP3				64	131	418	613
OP4				166	483	872	1521
OP5					20		20
OP6							
OP7							
OP8							
OP9							
OP10							
OP11							
OP12							
OP13							
OP14	1944	1601					3545
OP15		17					17
OP16	706	458					1164
OP17		1573	648			18	2239
OP18	786	1446	273				2505
OP19		966	394			18	1378
OP20							
OP21							
OP22							
OP23							
OP24							
OP25							
OP26							
OP27							
OP28							
OP29							

In the absence of existing vegetation and intervening topography effects, **Table 4** indicates the following potential glare conditions:

- "High" Category Locations 14, 17 and 18
- "Moderate" Category Locations 3, 4, 16 and 19
- "Low" Category Locations 1, 2, 5 and 15
- All other locations were predicted to receive NO SGHAT YELLOW glare.

The existing vegetation surrounding many of the residences close to the proposed facility where "baseline" potential glare is predicted (refer **Table 4**) is substantial, as can be seen for example in **Figure 12** for residence SGHAT ID Op17.

Figure 12 Example Vegetation Surrounding Nearby Residences

Residence Op 17

Table 5 shows the results for the "HIGH" case WITH the addition of existing vegetation.

- It can be seen that all potential glare is eliminated with the exception of residence ID Op14.

Table 5 Annual Total Minutes of Residential "Yellow" Glare ("HIGH" case, WITH Existing Vegetation)

Residence	PV Sub-Array						Yearly Total
	1	2	3	4	5	6	
OP1							
OP2							
OP3							
OP4							
OP5							
OP6							
OP7							
OP8							
OP9							
OP10							
OP11							
OP12							
OP13							
OP14	1944	1601					3545
OP15							
OP16							
OP17							
OP18							
OP19							
OP20							
OP21							
OP22							
OP23							
OP24							
OP25							
OP26							
OP27							
OP28							
OP29							

5.4 Mitigating Simulation – Future Planned Vegetation

The next stage of SGHAT modelling involved the addition of the future planned vegetation for the Project, which includes a combination of Native Revegetation Planting, Wetland Planting and Hedgerow Planting ranging from 2.5 m to 15 m in height – refer **Figure 13**.

Figure 13 Marton Solar Farm – Proposed Vegetation Concept Plan

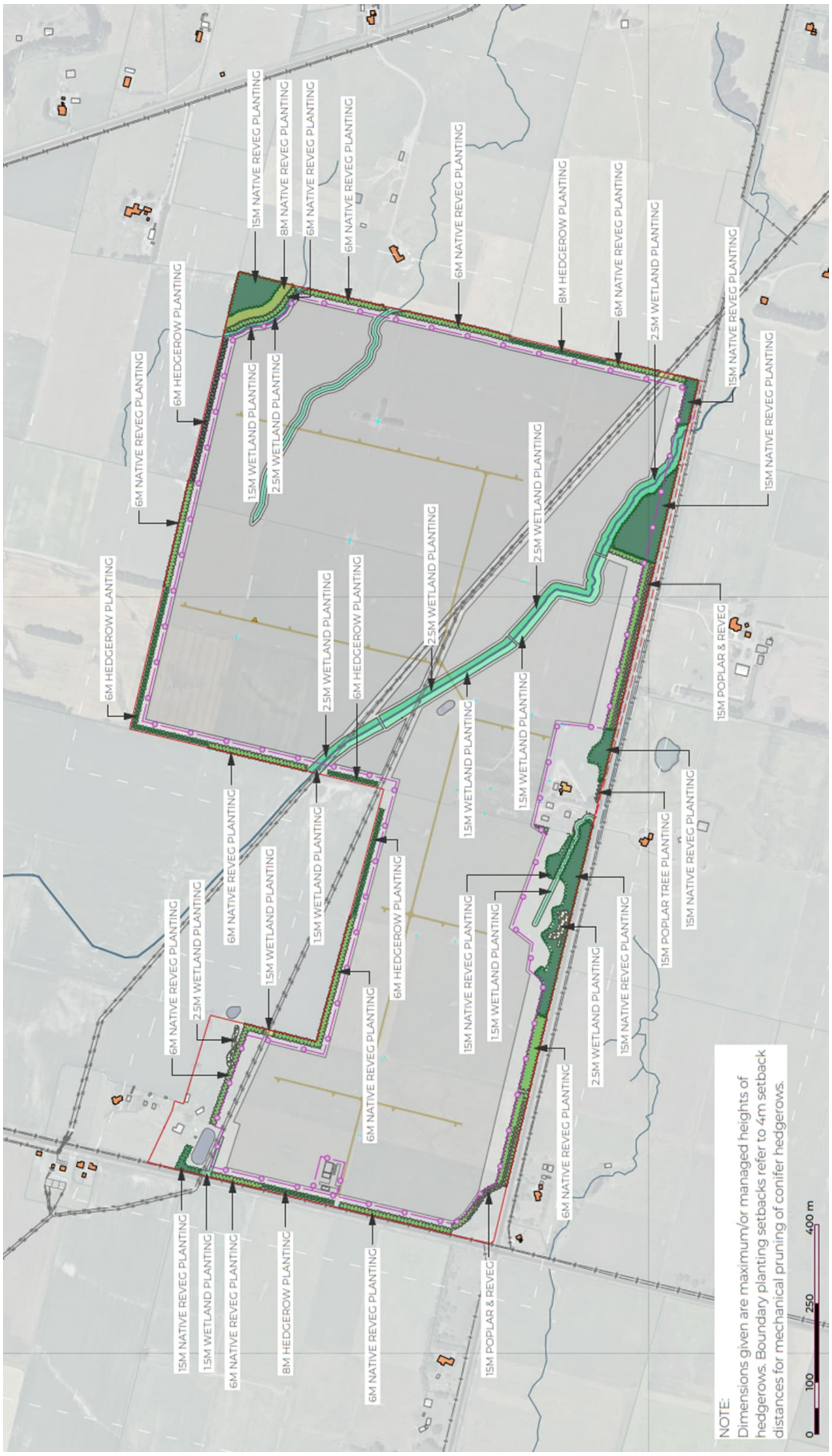


Figure 14 shows that the proposed planting essentially encircles the entire Project boundary with a vegetation barrier of a minimum 6 m height.

Figure 14 "Full Perimeter" Planting Proposed for the Facility

With the proposed planting, the SGHAT predictions yielded:

- ZERO Motorist Disability Glare for ALL surrounding roadways.
- ZERO Residential Nuisance Glare for ALL surrounding residences

The above result was achieved even without the assistance of the Viewshed Analysis undertaken for the Project which shows that many receiver locations surrounding the proposed facility (roads and residences) do not actually have a line of sight towards the site.

5.5 Sensitivity Analysis

In **Section 2.2** it was noted that the ultimate tilt angle and mounting height above ground of the Project solar panels may vary from the "nominal" values modelled in the preceding discussion, namely a tilt angle of 30° and maximum height above ground of ~3.30 m – refer **Figure 3**. The value for these input parameters would be subject to the commercially panel designs available at the time of panel selection, local ground conditions, etc.

To assess the sensitivity of the nominal value results to potential variations, the following was considered:

- Changes in Tilt Angle ranging from 20° to 30°, with the associated change in height of the panel mid-points used in the "LOW" and "HGH" simulations.

Primarily as a result of the "full perimeter" planting (refer **Figure 14**) proposed for the facility, none of the above variations in Tilt Angle and associated panel height resulted in a change to the overall "zero glare" predicted outcome.

6.0 Night-Time Illumination Glare

6.1 Background and Criteria

Guidance on the management of light spill from outdoor lighting impacting on residents, transport users, transport signalling systems and astronomical observations, can be found in:

- AS/NZS 4282-2019 *Control of the Obtrusive effects of Outdoor Lighting*.

The adverse effects of light spill from outdoor lighting are influenced by several factors:

- Topology: light spill is more likely to be perceived as obtrusive if the lighting installation is located higher up than the observer. Lighting installations are usually directed towards the ground and an observer could hence have a direct view of the luminaire.
- Surrounding Terrain: hills, trees, buildings, fences and general vegetation have a positive effect by shielding the observer from the light installation.
- Existing Lighting Environment: light from a particular light source is seen as less obtrusive if it is located in an area where the lighting levels are already high, eg in cities. The same lighting installation would be seen as far more bothersome in a less well-lit rural residential area.
- Zoning: a residential area is seen as more sensitive compared to commercial areas where high lighting levels are seen as more acceptable.

Typical illuminance levels for a variety of circumstances are given in **Table 6** for comparison.

Table 6 Typical Illuminance Levels for Various Lighting Scenarios

Lighting Scenario	Horizontal Illuminance (lux)
Moonless overcast night	0.0001
Quarter Moon	0.01
Full Moon	0.1
Twilight	10
Indoor office	300
Overcast day	1,000
Indirect sunlight clear day	10,000-20,000
Direct sunlight	100,000-130,000

Key objectives for technical lighting parameters in AS/NZS 4282-2019 are summarised in **Table 7**.

- Limits for luminous intensity for *curfew hours* apply in directions where views of bright surfaces of luminaires are likely to be troublesome to residents, from positions where such views are likely to be maintained.
- The vertical illuminance limits for *curfew hours* apply in the plane of the windows of habitable rooms or dwellings on nearby residential properties.
- The vertical illuminance criteria for *pre-curfew hours* apply at the boundary of nearby residential properties in a vertical plane parallel to the boundary.

- Limits for luminous intensity for *pre-curfew* hours apply to each luminaire in the principal plane, for all angles at and above the control direction.
- Values given in **Table 7** are for the direct component of illuminance, ie no reflected light is taken into account.

Table 7 Recommended Maximum Values of Light Technical Parameters (AS4282-2019)

Light Technical Parameter	Time of Operation	Zone "A4"	Zone "A3"	Zone "A2"	Zone "A1"	Zone "A0"
Illuminance in vertical plane (E_v)	Pre-curfew hours	25 lx	10 lx	**5 lx**	2 lx	ALARP [1]
	Curfew hours	5 lx	2 lx	**1 lx**	0.1 lx	0 lx
Luminous Intensity emitted by luminaires (I)	Pre-curfew hours	25,000 Cd	12,500 Cd	**7,500 Cd**	2,500 Cd	ALARP [1]
	Curfew hours	2,500 Cd	2,500 Cd	**1,000 Cd**	500 Cd	0 Cd

Zone A0	"Intrinsically Dark", eg UNESCO Starlight Reserve; IDA Dark Sky Parks; major optical observatories; no road lighting, unless specifically required by the relevant road controlling authority
Zone A1	"Dark", eg relatively uninhabited rural areas; no road lighting, unless specifically required by the relevant road controlling authority
Zone A2	"Low District Brightness", eg sparsely inhabited rural and semi-rural areas
Zone A3	"Medium District Brightness", eg suburban areas in towns and cities
Zone A4	"High District Brightness", eg town and city centres and other commercial areas; residential areas abutting commercial areas
ALARP	As low as reasonably practical

The Project is located in a rural area with the potential to impact on surrounding residential properties.

- These properties would be classed as being in a Zone "A2" area – refer **Table 7**.

The applicable limits for adverse spill light will also depend on the time of operation for the lighting installation, ie Pre-curfew or Curfew hours.

For the Project, it is understood that night-time security/emergency lighting may be incorporated at some site areas, emergency access routes, etc, suggesting the application of the more restrictive limit relevant to *Curfew hours*.

Accordingly:

- Light spill from the Project onto the facades of the surrounding residential dwellings should be kept below 1 lux during Curfew hours as required by AS/NZS 4282-2019.

6.2 Night-Time Illumination Glare – Assessment and Mitigation

Areas within the Project site have been marked for a sub-station, fire access routes and egress, etc, and some of these may need to be operational 24/7.

The only potential for future night-time illumination glare would be associated with the nearest thoroughfares and residential and other sensitive receivers to the Project.

The recommendations set out below are therefore aimed at achieving the best lighting performance (taking into account safety considerations) while having a minimal impact on the surrounding properties, carriageways and nocturnal fauna.

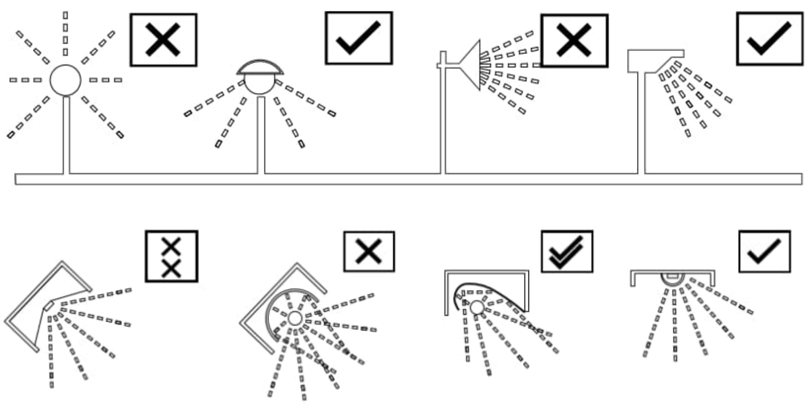
In terms of any future potential night-time lighting, the adopted goal of limiting night-time light spill to no more than 1 lux falling on the nearby residential facades during curfew hours is expected to be easily achieved given the distances to the nearest residential and other receivers from the Project's infrastructure.

Accordingly, the potential for any future nuisance glare will be very low.

AS/NZS 4282-2019 sets out general principles that should be applied when designing outdoor light to minimise the potential adverse effects of a light installation. It is expected that these will be applied to the design of the project lighting.

- Direct lights downward as much as possible and use luminaires that are designed to minimise light spill, eg full cut-off luminaires where no light is emitted above the horizontal plane, ideally keeping the main beam angle less than 70°. Less spill-light means that more of the light output can be used to illuminate the area and a lower power output can be used, with corresponding energy consumption benefits, but without reducing the illuminance of the area – refer **Figure 15**.
- Do not waste energy and increase light pollution by over-lighting.
- Wherever possible use floodlights with asymmetric beams that permit the front glazing to be kept at or near parallel to the surface being lit.

Figure 15 Luminaire Design Features that Minimise Light Spill (refer AS/NZS 4282-2019, Section A3.2)



7.0 Feedback

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

To achieve this, your feedback on the team's performance, deliverables and service are valuable and SLR welcome all feedback via https://www.slrconsulting.com/en/feedback. We recognise the value of your time and we will make a $10 donation to our 2023 Charity Partner - Lifeline, for every completed form.

Appendix A Residential Receiver Coordinates

Marton Solar Farm

Glint and Glare Assessment

4Sight Consulting Limited

SLR Project No.: 810.V30450.00001

24 November 2023

Revision: R02-v1.2

The latitude and longitude coordinates, as elevation height of the 29 representative locations examined in this study are shown in **Table A-1**.

Table A-1 Latitude and Longitude of 29 Sensitive Receivers Surrounding Site

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-40.103930	175.362369	138.00	1.50
OP 2	2	-40.103382	175.360918	139.00	1.50
OP 3	3	-40.109427	175.356420	140.00	1.50
OP 4	4	-40.107877	175.353588	140.00	1.50
OP 5	5	-40.109395	175.349961	136.00	1.50
OP 6	6	-40.111495	175.353234	136.00	1.50
OP 7	7	-40.116428	175.356440	134.00	1.50
OP 8	8	-40.118537	175.356977	134.00	1.50
OP 9	9	-40.112849	175.368250	131.00	1.50
OP 10	10	-40.114354	175.372808	128.00	1.50
OP 11	11	-40.116025	175.380962	122.00	1.50
OP 12	12	-40.115604	175.386209	118.00	1.50
OP 13	13	-40.115523	175.391482	114.10	1.50
OP 14	14	-40.108679	175.381370	124.00	1.50
OP 15	15	-40.108724	175.387640	120.00	1.50
OP 16	16	-40.108139	175.386318	120.78	1.50
OP 17	17	-40.104159	175.382092	125.00	1.50
OP 18	18	-40.104066	175.385155	121.78	1.50
OP 19	19	-40.102888	175.384313	123.83	1.50
OP 20	20	-40.100685	175.382422	129.00	1.50
OP 21	21	-40.099934	175.381408	130.00	1.50
OP 22	22	-40.099725	175.380282	131.00	1.50
OP 23	23	-40.099037	175.377029	133.00	1.50
OP 24	24	-40.097583	175.374424	135.00	1.50
OP 25	25	-40.098280	175.371324	136.00	1.50
OP 26	26	-40.098028	175.370103	136.00	1.50
OP 27	27	-40.097770	175.368992	137.00	1.50
OP 28	28	-40.099161	175.367380	137.00	1.50
OP 29	29	-40.096483	175.362667	140.15	1.50

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