Appendix K. Glint and Glare Study

Waipara Solar Farm
Glint and glare study

Final Report

Revision 01
December 2023

ENGINEERING | STRATEGY | ANALYTICS | CONSTRUCTION

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We were established in 2003 and operate out of offices in Canberra (Head Office), Sydney, North Coast NSW, and Adelaide. We are part of the international ITPEnergised Group, one of the world's largest, most experienced, and respected specialist engineering consultancies focussing on renewable energy, energy efficiency, and carbon markets. The Group has undertaken over 2,000 contracts in energy projects encompassing over 150 countries since it was formed in 1981.

Our regular clients include governments, energy utilities, financial institutions, international development donor agencies, project developers and investors, the R&D community, and private firms.

ABOUT THIS REPORT

This report assesses the glint and glare impact of the proposed Waipara Solar Farm located west of Waipara, New Zealand. It was commissioned by Far North Solar Farm (FNSF).

ABBREVIATIONS

AC	Alternating current
CASA	Civil Aviation Safety Authority
DC	Direct current
FAA	Federal Aviation Administration (United States)
FNSF	Far North Solar Farm
ha	Hectare
ITP	ITP Renewables
MW	Megawatt, unit of power (1 million Watts)
MWp	Megawatt-peak, unit of power at standard test conditions; used to indicate PV system capacity
OP	Observation point
PV	Photovoltaic
SGHAT	Solar Glare Hazard Analysis Tool

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EXECUTIVE SUMMARY

ITP Renewables conducted a glint and glare assessment for a solar farm proposed by Far North Solar Farm west of Waipara, Central Hawkes Bay. Our analysis divided the array into 12 sections and modelled the glare received at 57 observation points and along 18 routes. The GlareGauge analysis was conducted for two scenarios:

1. Array rest angle of 0° as the base case scenario
2. Array rest angle of 3° as an option to mitigate glare impacts

The results of the GlareGauge analysis using a rest angle of 0° indicated that 34 observation points 10 road routes received green glare, while one observation point and 2 road routes received yellow glare. Yellow glare has the potential to cause after-image to observers, while green glare has low potential to cause after-image.

Using a rest angle of 3° reduced the glare impact for all receptors, with 5 road routes receiving green glare and no receptors receiving yellow glare. In particular, the NZ State Highways were not subjected to any yellow glare over the year. In this scenario, the glare impact is low and further mitigation is not required.

1 INTRODUCTION

1.1 Overview

Far North Solar Farm (FNSF) has requested a glint and glare assessment for a proposed solar photovoltaic (PV) installation located west of Waipara, in the Central Hawkes Bay. This assessment will be submitted as part of the resource consent process for the project. It includes:

- Identification of potential receptors of glint and glare from the proposed solar farm
- Assessment of the glint and glare hazard using the Solar Glare Hazard Analysis Tool (SGHAT) GlareGauge analysis

1.2 Glint and Glare

The United States Federal Aviation Administration (FAA) defines glint and glare as follows:[1]

- **Glint** is a momentary flash of bright light
- **Glare** is a continuous source of excessive brightness relative to ambient lighting.

Glint and glare can occur when light reflected off a surface (reflector) is viewed by a person (receptor). Glint typically occurs when either the receptor or the reflector is moving, while glare typically occurs when the reflector and receptor are completely, or nearly, stationary. For a transparent material (e.g., glass, water) the quantity of light reflected depends on the surface itself (i.e., material and texture), and the angle at which the light intercepts it (angle of incidence). More light is reflected at higher angles of incidence as shown in Figure 1.

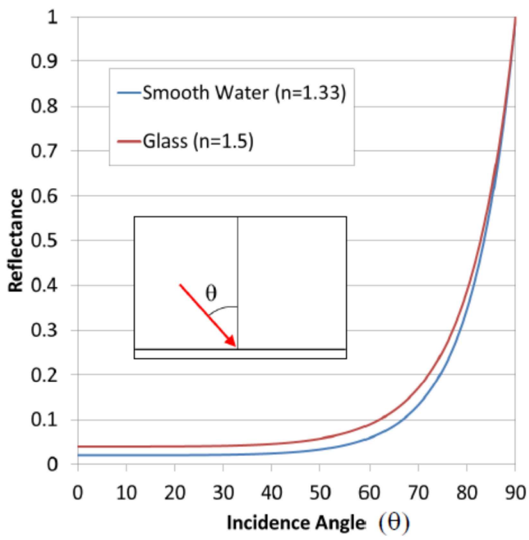

Figure 1: Angles of incidence and increased levels of reflected light

[1] Federal Aviation Administration [FAA], 2018

Potential visual impacts from glint and glare include distraction and temporary afterimage; at its worst, it can cause retinal burn. The ocular hazard caused by glint or glare is a function of:

1. The intensity of the glare upon the eye (retinal irradiance)
2. The subtended angle of the glare source (i.e., the extent to which the glare occupies the receptor's field of vision; dependent on size and distance of the reflector).

The severity of the ocular hazard can be divided into three levels, as shown in Figure 2:

- **Green glare**, which has low potential to cause temporary afterimage
- **Yellow glare**, which has potential to cause temporary afterimage
- **Red glare**, which can cause retinal burn and is not expected for PV.

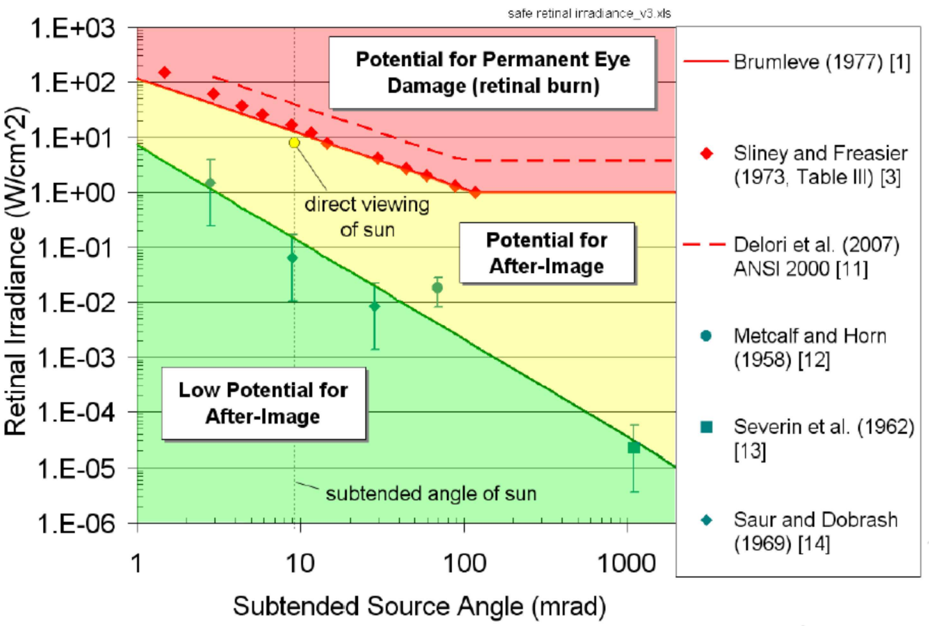

Figure 2: Classification of glare based on severity of ocular effects

1.3 Glare from Solar PV

Solar photovoltaic (PV) cells are designed to absorb as much light as possible to maximise efficiency (generally around 98% of the light received). To limit reflection, solar cells are constructed from dark, light-absorbing material and are treated with an anti-reflective coating. PV modules generate less glare than many other surfaces, as shown in Figure 3.

The small percentage of light reflected from PV modules varies depending on the angle of incidence. Figure 4 shows an example of this with a solar module. A larger angle of incidence will result in a higher percentage of reflected light.

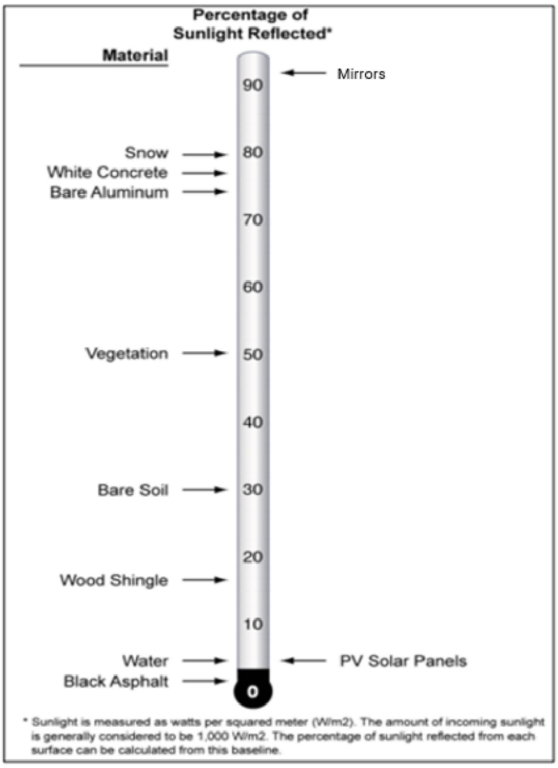

Figure 3: Typical percentage of sunlight reflected from different surfaces (Source: Adapted from Journal of Airport Management, 2014)

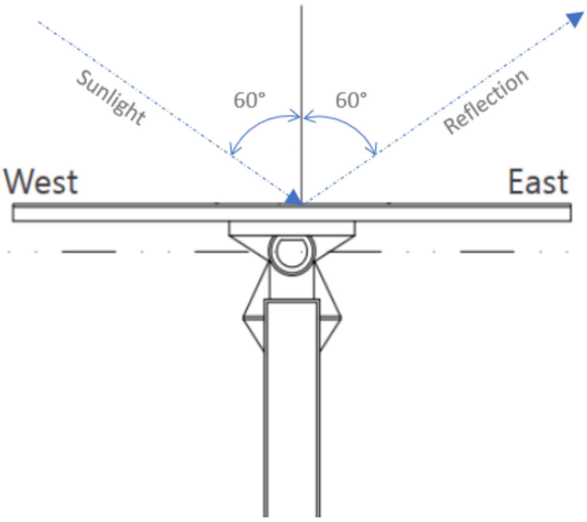

Figure 4: Typical sunlight reflection off the surface of a solar module

The two most common PV mounting structures are fixed tilt and single axis tracking. Fixed tilt arrays are stationary, while single axis tracking arrays rotate the receiving surface of the modules from east to west throughout the day as the sun moves across the sky.

In a fixed tilt PV array, since the sun is moving but the modules are stationary, the angle of incidence varies as the sun moves across the sky. It is smallest around noon when the sun is overhead and largest in the early morning and late afternoon when the sun is near the horizon. There is therefore a higher potential for glare at these times.

The angle of incidence for a single axis tracking system varies less as the reflective surface of the modules rotates on a horizontal axis to follow the sun. Single axis tracking arrays therefore generate less glare than fixed tilt arrays. The tracking varies throughout the year to match seasonal changes in the sun's path (see Figure 5).

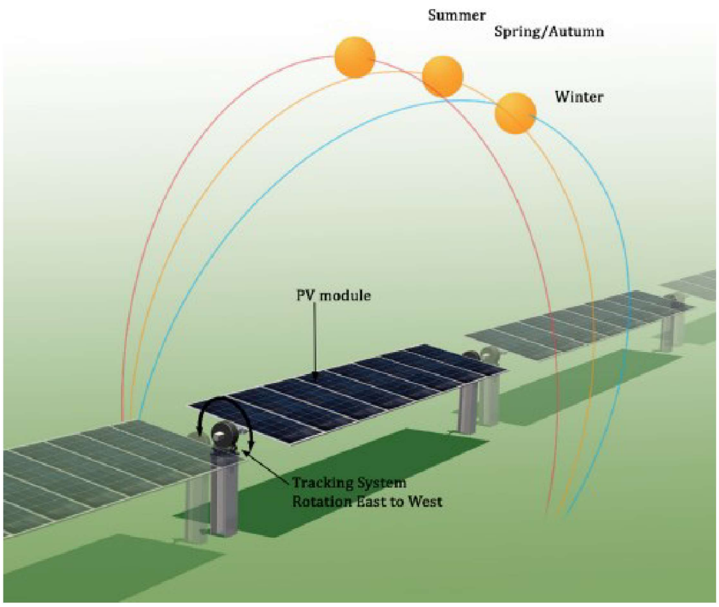

Figure 5: Sun position relative to PV modules on a horizontal single-axis tracking system

2 PROJECT DESCRIPTION

2.1 Site Overview

FNSF is proposing a solar farm at the location described in Table 1. The site is located immediately northwest of Waipara in Central Hawkes Bay. An indicative layout is displayed in Figure 6.

Table 1: Site Information

Parameter	Description
Title Nos.	Section 3 SO 17514, Lot 1 DP 320376
Address	66-380 Waipara Flat Road, Waipara
Council	Hurunui District Council
Project area	180.8 ha

2.2 Solar Farm Details

Table 2 summarises the details of the proposed solar farm.

Table 2: Solar farm information

Parameter	Description
Solar farm name	Waipara Solar Farm
Capacity	144 MWp
Mounting system	Single-axis tracking

FNSF is proposing to construct a solar farm with a capacity of 144 MWp on a 181 ha site. There will be approximately 252,400 solar modules installed in single-axis tracking tables running north to south. Panels are arranged in a dual portrait configuration, with tracker rows of 13 or 26 modules in length. The solar farm will include 30 medium voltage (MV) inverters, each with a capacity of 4.2 MVA.

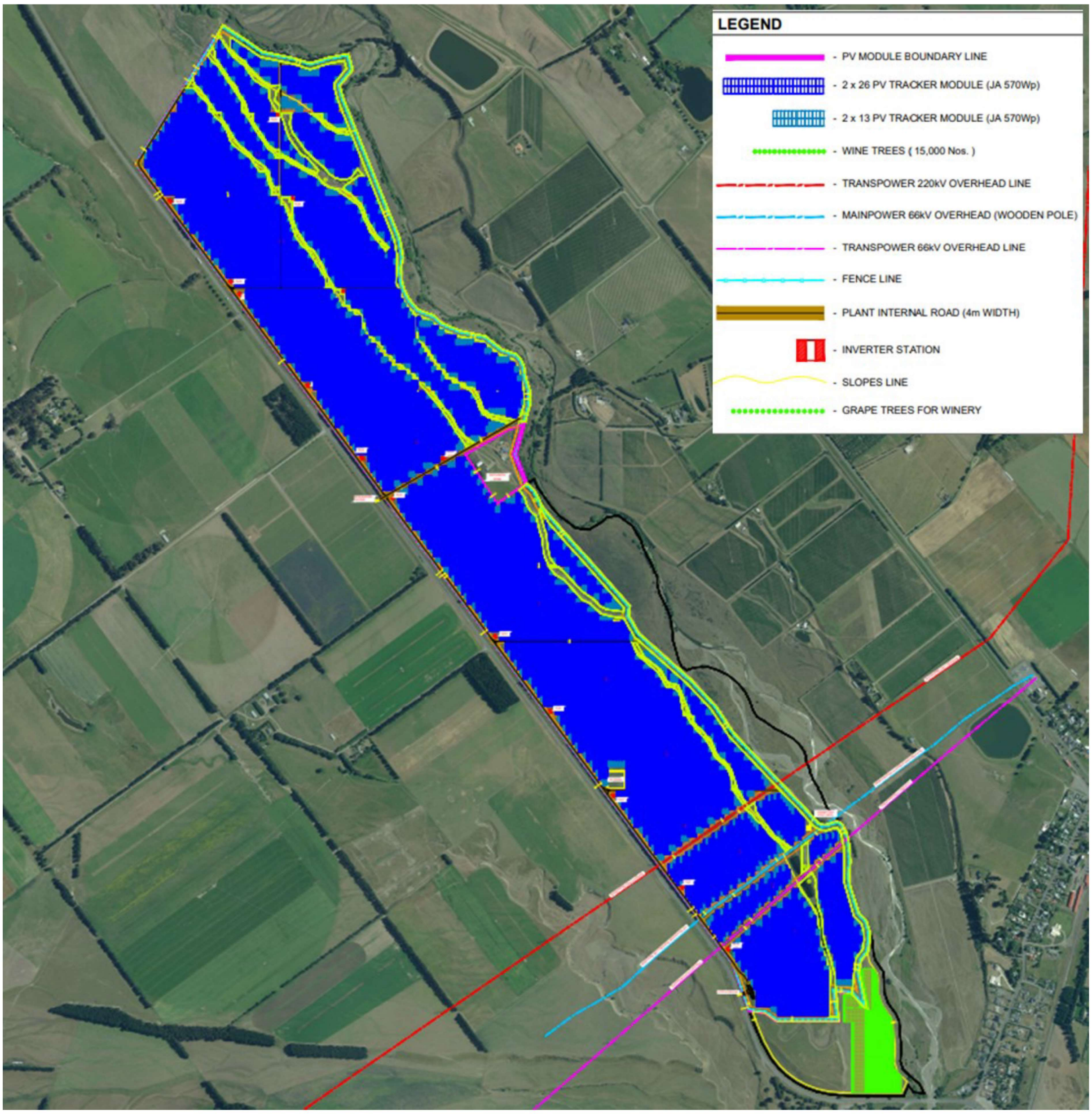

Figure 6: Waipara Solar Farm Preliminary PV layout

3 ANALYSIS

3.1 Overview

The Solar Glare Hazard Analysis Tool (SGHAT) was developed by Sandia National Laboratories to evaluate glare resulting from solar farms at different viewpoints, based on the location, orientation, and specifications of the PV modules. This tool was required by the United States FAA for glare hazard analysis near airports until 2021 and is also recognised by the Australian Government Civil Aviation Safety Authority (CASA).

The GlareGauge software uses SGHAT to provide an indication of the type of glare expected at each potential receptor. It runs with a simulation timestep of one minute. Glint lasting for less than one minute is unlikely to occur from the sun on PV modules due to their slow movement.

3.2 Assumptions

The visual impact of a solar farm depends on the scale and type of infrastructure, the prominence and topography of the site relative to the surrounding environment, and any proposed screening measures to reduce visibility of the site. Our model includes selected obstructions[2] as described in Section 3.3.2.

Atmospheric conditions such as cloud cover influence light reflection and the resulting impact on visual receptors. GlareGauge does not model varying atmospheric conditions; instead, the model assumes clear sky conditions, with a peak direct normal irradiance (DNI) of 1,000 W/m^2 which varies throughout the day.

Table 3 details the parameters used in the SGHAT model. GlareGauge default settings were adopted for the analysis time interval, direct normal irradiance, observer eye characteristics and slope error. The height of the observation points for road users was assumed to be 1.5 m for cars and 2.5 m for trucks and railways. The height for a person standing was assumed to be 1.65 m.

Table 3: SGHAT specification inputs

Parameters	Input
Time zone	UTC+13:00
Module surface material	Smooth glass with ARC (anti-reflective coating)
Module tracking	Single Axis Tracking with backtracking

[2] In the GlareGauge model, obstructions are opaque barriers that block the transmission of incident and reflected light

Parameters	Input
Maximum tilt angle	±55˚
Module axis orientation	0°
Height of modules above ground	2.4 m (height from the ground to the table centre)

3.3 Model construction

3.3.1 Study area

This assessment considers potential visual receptors (e.g., residences and road users) within 3 km of the site. There is no formal guidance on the maximum distance for glint and glare assessments; however, the significance of a reflection decreases with distance for two main reasons:

1. The solar farm appears smaller (smaller subtended angle), and glare has less impact
2. Visual obstructions (e.g., terrain, vegetation) may block the view of the solar farm

Glint and glare impacts beyond 3 km are highly unlikely. This choice of distance is conservative and is based on existing studies and assessment experience.

3.3.2 Model components

The model (see Figure 7) was constructed as follows:

- The array was divided into 12 separate PV objects based on the general arrangement (see Figure 8).
- Receptors were placed at 57 observation points, 17 road routes, and 1 rail route (see Figure 9 and Figure 10). Truck routes were included for highways.
- 21 observation points and 7 road routes were excluded (see Figure 11, Figure 12, and Appendix A).
- Per the General Arrangement,[3] revegetation zones and boundary screening vegetation were included in the model as obstructions with a height of 3 m (revegetation) or 5 m (boundary screening), as shown in Figure 8.

In some instances, a single OP is used in the model to denote a few buildings located close together, as the received glare is generally not very sensitive to precise locations (assuming that line of sight is not impacted by obstructions). We have excluded buildings in towns that are not on the edge facing the solar farm, as their line of sight is obstructed by surrounding buildings.

[3] Document titled 2023-09-19-Genesis-WPR_GA-143.8MWp_JA-570_Tr_2P_Tree-parcel

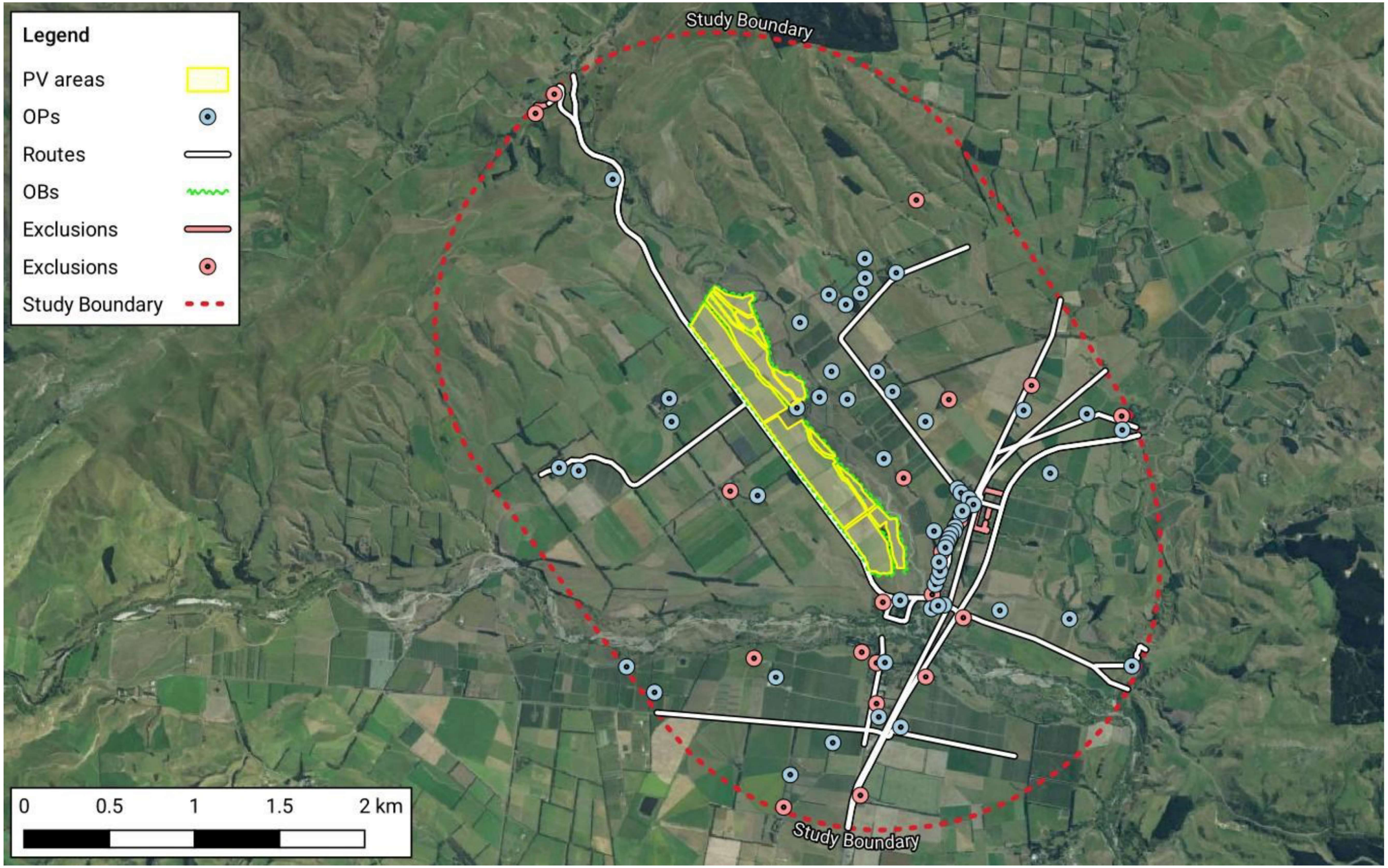

Figure 7: Model showing study area, arrays, receptors, and obstructions.

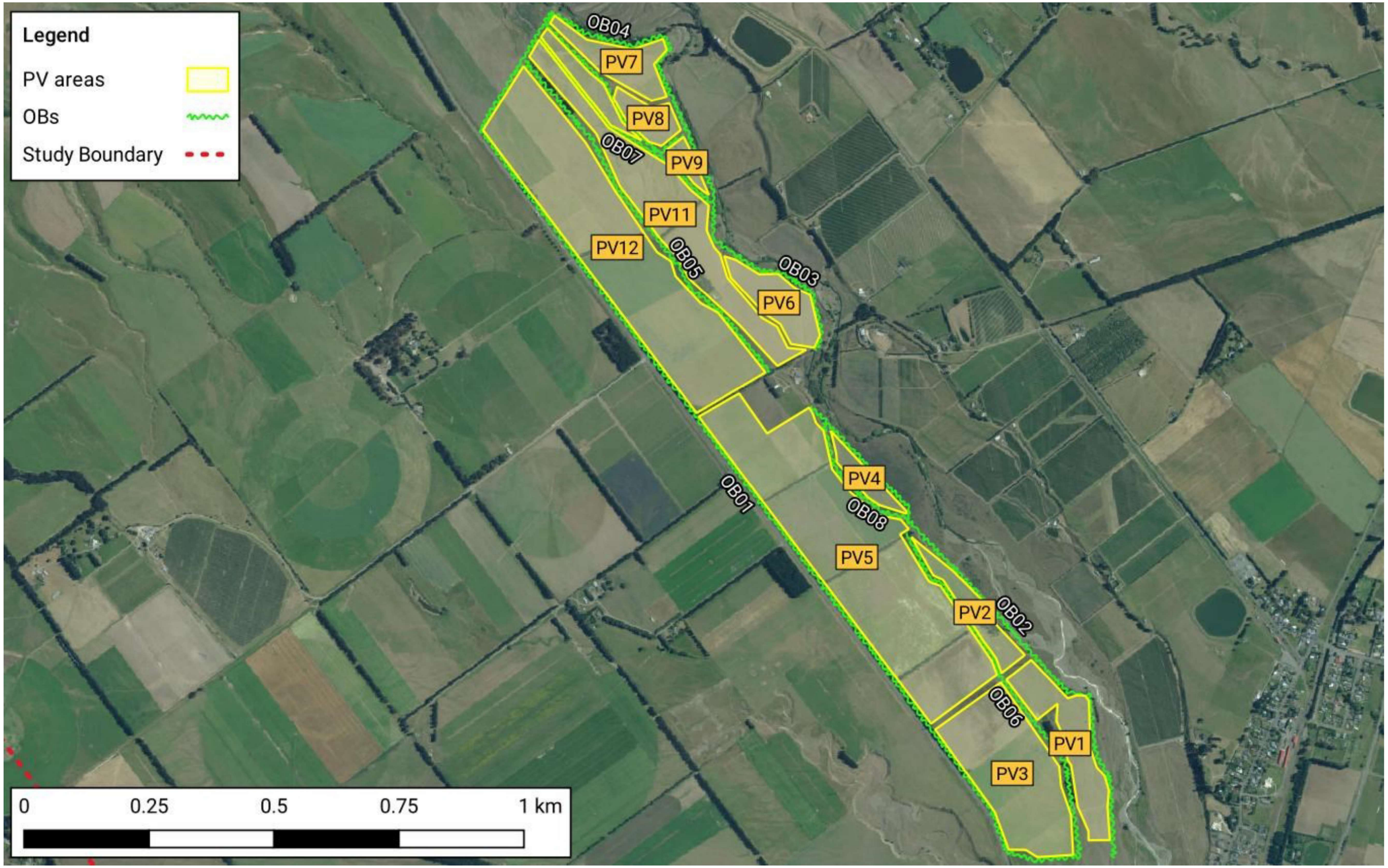

Figure 8: PV array sections and obstructions

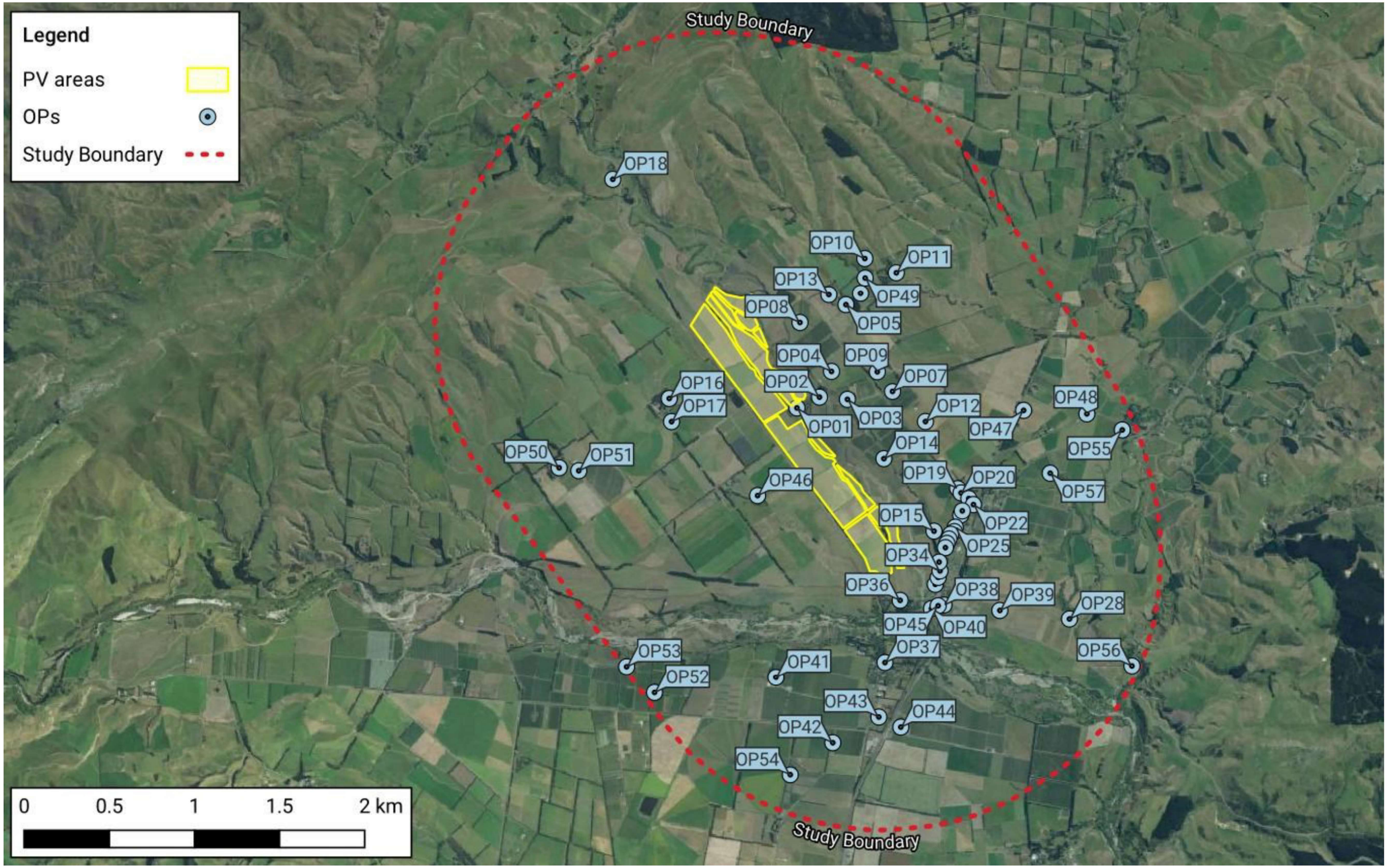

Figure 9: Observation points

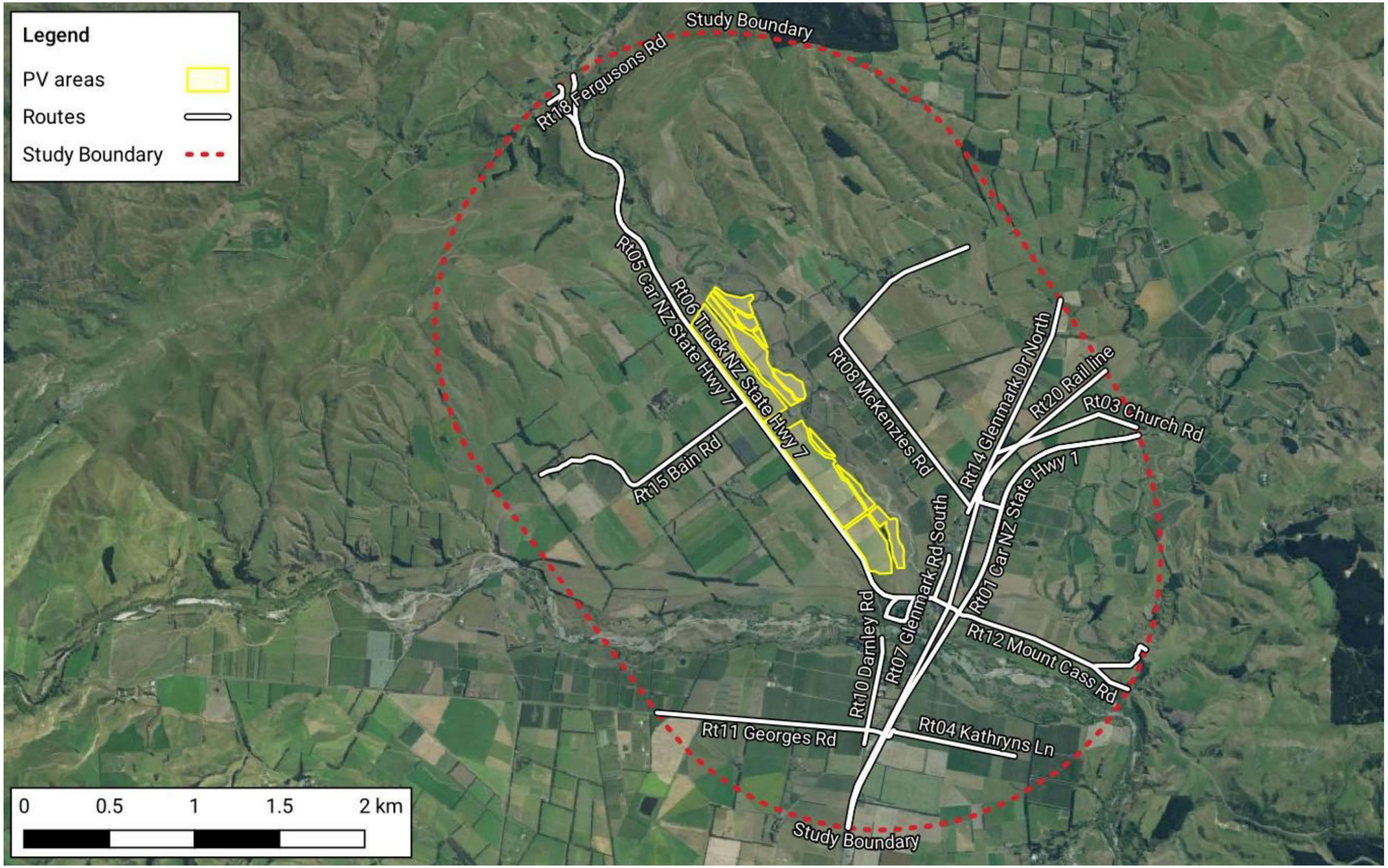

Figure 10: Routes

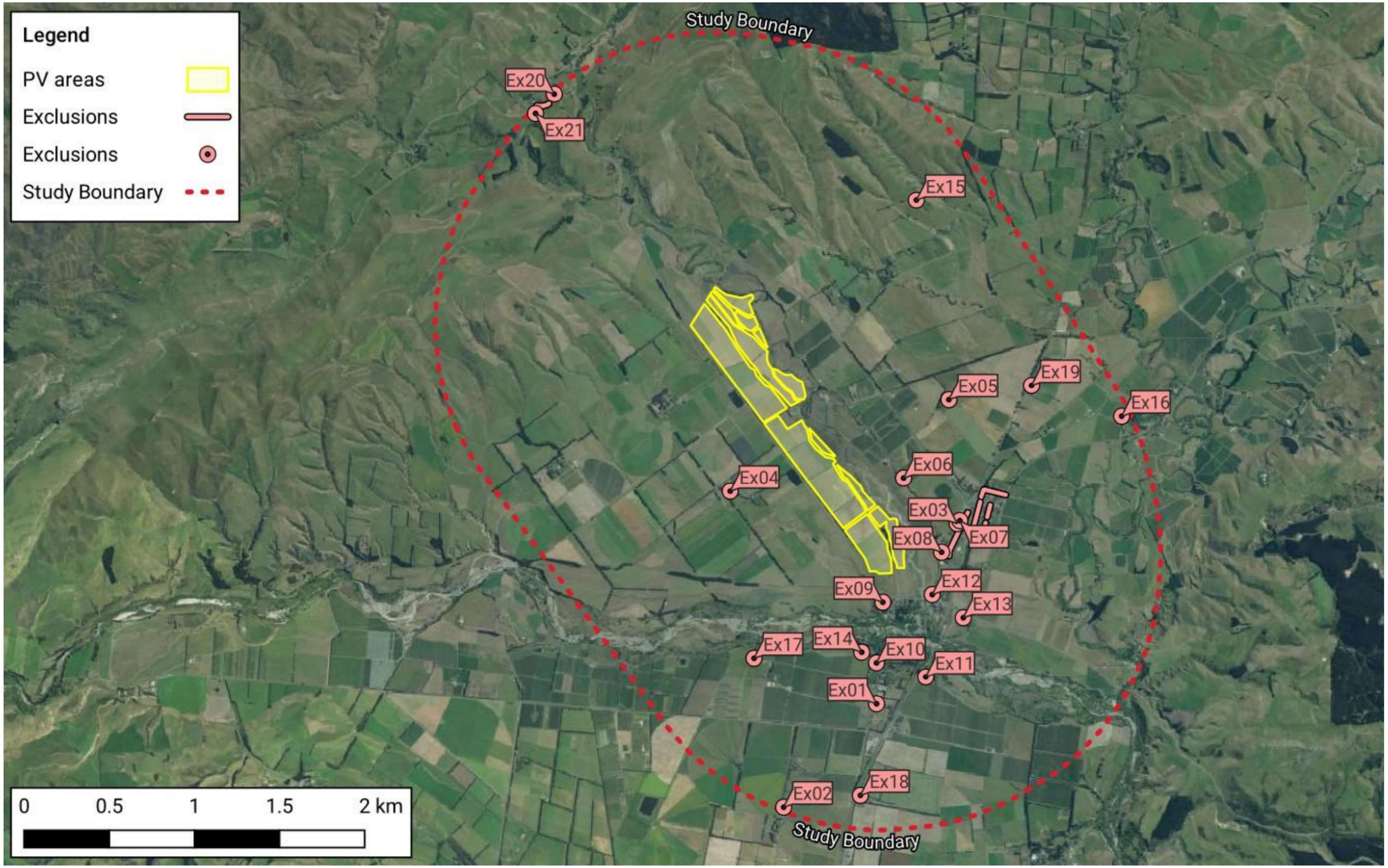

Figure 11: Excluded receptors.Excluded receptors are detailed in Appendix A.

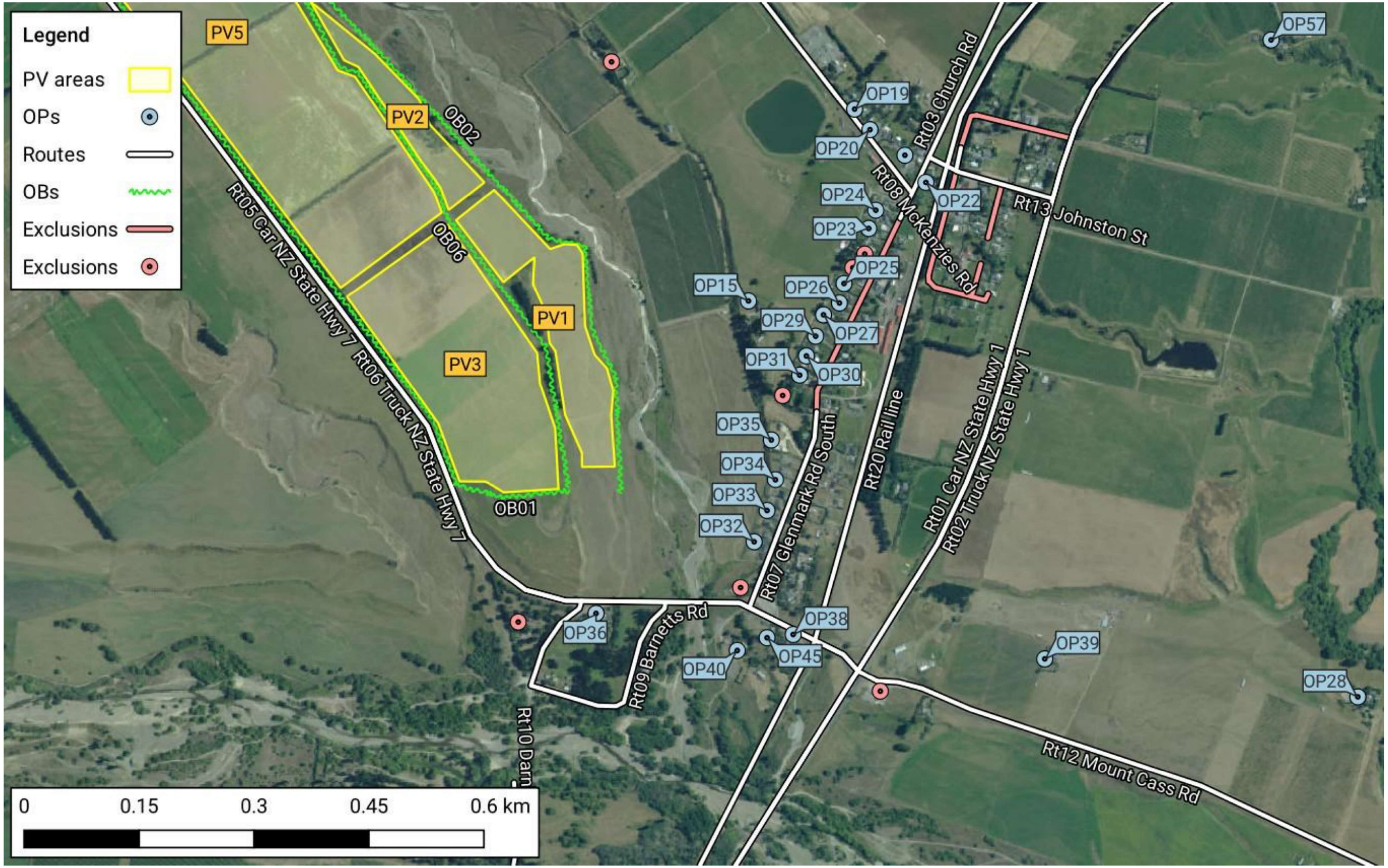

Figure 12: Receptors and exclusions southeast of site

3.4 Results

Our results are presented below for two scenarios

1. Array rest angle of 0° as the base case scenario
2. Array rest angle of 3° as an option to mitigate glare impacts

3.4.1 0° Rest Angle Results

The results of the GlareGauge analysis (Appendix B) are summarised in Table 4. Over the period of a year, the analysis identified 12,778 minutes (~213 hours) of cumulative green glare and 990 minutes (~17 hours) spread across 10 routes and 34 observation points.

The glare received each day varied across the year. For observation points where some glare occurred, the impact is described qualitatively. No observation points or routes received more than 14 minutes of green glare or more than 7 minutes of yellow glare in any single day. The time of day at which glare was observed varied between observation points and across the year. In general, most glare occurred in the early mornings or late evenings, when the array is backtracking.

Table 4: Glare potential at each receptor with 0° rest angle.

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
OP01	-43.0447, 172.7342	0	0	None
OP02	-43.0435, 172.7374	270	61	Up to 2 minutes of yellow glare between 4:30 pm and 5:15 pm, from 7 May to 10 June.
OP03	-43.0438, 172.7414	0	0	None
OP04	-43.0408, 172.7391	160	0	Up to 6 minutes of green glare between 4:30 pm and 5:00 pm, from 17 May to 17 June.
OP05	-43.0338, 172.7413	52	0	Up to 4 minutes of green glare between 6:00 pm and 8:00 pm, on 2 January, from 20 March to 4 April, and from 8-9 September.
OP06	-43.0326, 172.7434	68	0	Up to 4 minutes of green glare between 6:15 pm and 7:00 pm, from 12-24 March and from 19 September to 1 October.
OP07	-43.043, 172.7479	165	0	Up to 4 minutes of green glare between 4:45 pm and 5:15 pm, from 29 May to 15 July.
OP08	-43.0356, 172.7346	219	0	Up to 5 minutes of green glare between 4:45 pm and 6:15 pm, from 11 April to 12 June and from 15-31 August.
OP09	-43.0409, 172.7457	216	0	Up to 4 minutes of green glare between 4:45 pm and 5:15 pm, from 17 May to 20 July.
OP10	-43.0289, 172.744		0	None
OP11	-43.0304, 172.7485	41	0	Up to 3 minutes of green glare between 6:15 pm and 7:00 pm, from 6- 12 March and from 30 September to 12 October.
OP12	-43.0461, 172.7527	62	0	Up to 3 minutes of green glare between 4:45 pm and 5:15 pm, from 10 June to 4 July.
OP13	-43.0327, 172.7388	53	0	Up to 5 minutes of green glare between 6:15 pm and 7:00 pm, from 11- 25 March and from 1-2 October.
OP14	-43.05, 172.7467	208	0	Up to 9 minutes of green glare between 4:30 pm and 5:00 pm, from 23 May to 16 June.
OP15	-43.0577, 172.7538	44	0	Up to 5 minutes of green glare between 4:30 pm and 5:15 pm, from 5-12 May and from 2 June to 18 June.

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
OP16	-43.0436, 172.7158	0	0	None
OP17	-43.0461, 172.7161	0	0	None
OP18	-43.0204, 172.7077	0	0	None
OP19	-43.0532, 172.7573	411	0	Up to 12 minutes of green glare between 4:30 pm and 6:15 pm, from 4 May to 19 June and from 14-15 September.
OP20	-43.0537, 172.7577	302	0	Up to 9 minutes of green glare between 4:30 pm and 5:15 pm, from 11 May to 16 June.
OP21	-43.0543, 172.7589	304	0	Up to 10 minutes of green glare between 4:30 pm and 5:15 pm, from 11 May to 16 June.
OP22	-43.0549, 172.7595	290	0	Up to 8 minutes of green glare between 4:30 pm and 5:15 pm, from 13 May to 16 June.
OP23	-43.056, 172.7577	177	0	Up to 9 minutes of green glare between 4:30 pm and 5:00 pm, from 26 May to 16 June.
OP24	-43.0556, 172.7579	204	0	Up to 9 minutes of green glare between 4:30 pm and 5:00 pm, from 22 May to 16 June.
OP25	-43.0573, 172.7569	0	0	None
OP26	-43.0577, 172.7568	40	0	Up to 4 minutes of green glare between 4:30 pm and 5:00 pm, from 23 May to 18 June.
OP27	-43.058, 172.7562	25	0	Up to 5 minutes of green glare between 4:30 pm and 5:00 pm, from 29 May to 18 June.
OP28	-43.067, 172.7733	136	0	Up to 6 minutes of green glare between 4:45 pm and 5:15 pm, from 5 May to 3 June.
OP29	-43.0585, 172.756	58	0	Up to 6 minutes of green glare between 4:30 pm and 5:15 pm, from 5-15 May and from 31 May to 18 June.
OP30	-43.059, 172.7557	203	0	Up to 7 minutes of green glare between 4:15 pm and 5:30 pm, from 3 May to 14 June.
OP31	-43.0594, 172.7555	181	0	Up to 7 minutes of green glare between 4:30 pm and 5:15 pm, from 5 May to 4 June.
OP32	-43.0633, 172.754	0	0	None
OP33	-43.0626, 172.7544	0	0	None

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
OP34	-43.0619, 172.7547	114	0	Up to 7 minutes of green glare between 4:30 pm and 5:00 pm, from 21 May to 15 June.
OP35	-43.0609, 172.7546	184	0	Up to 7 minutes of green glare between 4:30 pm and 5:15 pm, from 12 May to 14 June.
OP36	-43.065, 172.7489	0	0	None
OP37	-43.0715, 172.7467	0	0	None
OP38	-43.0655, 172.7552	0	0	None
OP39	-43.0661, 172.7633	118	0	Up to 7 minutes of green glare between 4:30 pm and 5:00 pm, from 24 May to 14 June.
OP40	-43.0659, 172.7534	0	0	None
OP41	-43.0731, 172.731	0	0	None
OP42	-43.08, 172.7392	0	0	None
OP43	-43.0773, 172.7458	0	0	None
OP44	-43.0784, 172.749	0	0	None
OP45	-43.0656, 172.7544	0	0	None
OP46	-43.0539, 172.7284	0	0	None
OP47	-43.045, 172.7668	57	0	Up to 4 minutes of green glare between 5:00 pm and 6:00 pm, from 24 April to 13 May and from 30 July to 19 August.
OP48	-43.0454, 172.7759	53	0	Up to 4 minutes of green glare between 5:15 pm and 6:00 pm, from 19 April to 4 May and from 15-24 August.
OP49	-43.031, 172.744	46	0	Up to 3 minutes of green glare between 6:45 pm and 7:15 pm, from 6-14 March and from 29 September to 11 October.
OP50	-43.0509, 172.6999	0	0	None
OP51	-43.0512, 172.7027	0	0	None

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
OP52	-43.0746, 172.7135	67	0	Up to 5 minutes of green glare between 7:45 am and 8:15 am, from 19 July to 6 August.
OP53	-43.0719, 172.7095	0	0	None
OP54	-43.0834, 172.733	0	0	None
OP55	-43.0471, 172.781	49	0	Up to 4 minutes of green glare between 5:15 pm and 6:00 pm, from 20 April to 4 May and from 13-22 August.
OP56	-43.072, 172.7823	217	0	Up to 10 minutes of green glare between 4:30 pm and 5:15 pm, from 11 May to 18 June.
OP57	-43.0516, 172.7706	69	0	Up to 2 minutes of green glare between 4:45 pm and 5:30 pm, from 19 May to 24 July.
RT01	Car NZ State Hwy 1	269	0	Up to 6 minutes of green glare between 4:45 pm and 6:15 pm, from 5 April to 30 May and from 12 July to 7 September.
RT02	Truck NZ State Hwy 1	279	0	Up to 6 minutes of green glare between 4:45 pm and 6:15 pm, from 5 April to 31 May and from 12 July to 7 September.
RT03	Church Rd	400	0	Up to 8 minutes of green glare between 4:45 pm and 6:15 pm, from 5 April to 7 September.
RT04	Kathryns Ln		0	None
RT05	Car NZ State Hwy 7	1,242	492	Up to 4 minutes of yellow glare between 5:00 am and 6:45 am, on 12 January, from 21 January to 9 November, and from 22-23 November.
RT06	Truck NZ State Hwy 7	1,344	437	Up to 7 minutes of yellow glare between 4:45 am and 6:45 am, from 12 January to 19 March and from 23 September to 23 November.
RT07	Glenmark Rd South		0	None
RT08	McKenzies Rd	1,649	0	Up to 11 minutes of green glare between 4:30 pm and 8:00 pm, on 11 January, from 5-19 March, from 1 April to 10 September, from 23 September to 7 October, from 3-14 December, and from 27-31 December.
RT09	Barnetts Rd	0	0	None

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
RT10	Darnley Rd	0	0	None
RT11	Georges Rd	497	0	Up to 8 minutes of green glare between 7:45 am and 8:30 am, from 16 May to 28 July.
RT12	Mount Cass Rd		0	None
RT13	Johnston St	770	0	Up to 11 minutes of green glare between 4:30 pm and 5:30 pm, from 7 May to 6 August.
RT14	Glenmark Dr North	0	0	None
RT15	Bain Rd	0	0	None
RT16	Loffhagen Dr	0	0	None
RT17	Weka Pass Loop Rd	0	0	None
RT18	Fergusons Rd	0	0	None
RT19	Symonds Rd	1,442	0	Up to 14 minutes of green glare between 4:30 pm and 6:00 pm, from 15 April to 27 August.
RT20	Rail line	23	0	Up to 2 minutes of green glare between 5:45 pm and 6:15 pm, from 8-14 April and from 28 August to 3 September.
		12,778	**990**	

3.4.2 3° Rest Angle Results

The results of the GlareGauge analysis with a 3° array rest angle (Appendix B) are summarised in Table 5 for receptors that were subject to some glare when the array used a rest angle of 0°. Over the period of a year, the analysis identified 1,675 minutes (~28 hours) of cumulative green glare spread across 5 routes. In particular, the NZ State Highways were not subjected to any yellow glare over the year. This is an 87% reduction in green glare and a 100% reduction in yellow glare when compared to a rest angle of 0°.

Table 5: Glare potential with 3° rest angle

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
OP02	-43.0435, 172.7374	0	0	None
OP04	-43.0408, 172.7391	0	0	None
OP05	-43.0338, 172.7413	0	0	None
OP06	-43.0326, 172.7434	0	0	None
OP07	-43.043, 172.7479	0	0	None
OP08	-43.0356, 172.7346	0	0	None
OP09	-43.0409, 172.7457	0	0	None
OP11	-43.0304, 172.7485	0	0	None
OP12	-43.0461, 172.7527	0	0	None
OP13	-43.0327, 172.7388	0	0	None
OP14	-43.05, 172.7467	0	0	None
OP15	-43.0577, 172.7538	0	0	None
OP19	-43.0532, 172.7573	0	0	None
OP20	-43.0537, 172.7577	0	0	None
OP21	-43.0543, 172.7589	0	0	None
OP22	-43.0549, 172.7595	0	0	None
OP23	-43.056, 172.7577	0	0	None
OP24	-43.0556, 172.7579	0	0	None
OP26	-43.0577, 172.7568	0	0	None
OP27	-43.058, 172.7562	0	0	None
OP28	-43.067, 172.7733	0	0	None
OP29	-43.0585, 172.756	0	0	None
OP30	-43.059, 172.7557	0	0	None
OP31	-43.0594, 172.7555	0	0	None

Receptor	Location	Green (min/yr)	Yellow (min/yr)	Daily glare potential
OP34	-43.0619, 172.7547	0	0	None
OP35	-43.0609, 172.7546	0	0	None
OP39	-43.0661, 172.7633	0	0	None
OP47	-43.045, 172.7668	0	0	None
OP48	-43.0454, 172.7759	0	0	None
OP49	-43.031, 172.744	0	0	None
OP52	-43.0746, 172.7135	0	0	None
OP55	-43.0471, 172.781	0	0	None
OP56	-43.072, 172.7823	0	0	None
OP57	-43.0516, 172.7706	0	0	None
RT01	Car NZ State Hwy 1	0	0	None
RT02	Truck NZ State Hwy 1	0	0	None
RT03	Church Rd	0	0	None
RT05	Car NZ State Hwy 7	297	0	Up to 5 minutes of green glare between 4:45 am and 5:45 am, , from 9 November to 4 February.
RT06	Truck NZ State Hwy 7	357	0	Up to 6 minutes of green glare between 4:45 am and 5:45 am, from 4 November to 8 February.
RT08	McKenzies Rd	132	0	Up to 4 minutes of green glare between 4:30 pm and 5:00 pm, from 29 May to 13 July.
RT11	Georges Rd	0	0	None
RT13	Johnston St	92	0	Up to 3 minutes of green glare between 4:30 pm and 5:00 pm, from 29 May to 13 July.
RT19	Symonds Rd	797	0	Up to 13 minutes of green glare between 4:30 pm and 5:30 pm, from 2 May to 10 August.
RT20	Rail line	0	0	None
Total		**1,675**	**0**	

4 SUMMARY

The results of the GlareGauge analysis using a rest angle of 0° indicated that 34 observation points 10 road routes received green glare, while one observation point and 2 road routes received yellow glare. Yellow glare has the potential to cause after-image to observers, while green glare has low potential to cause after-image.

Using a rest angle of 3° reduced the glare impact for all receptors, with 5 road routes receiving green glare and no receptors receiving yellow glare. In particular, the NZ State Highways were not subjected to any yellow glare over the year. In this scenario, the glare impact is low and further mitigation is not required.

5 REFERENCES

Federal Aviation Administration (FAA), 2018. Solar Guide: Technical Guidance for Evaluating Selected Solar Technologies on Airports. Retrieved from the FAA website: https://www.faa.gov/airports/environmental/

Thompson, R., Ave, I., Anne, D., Jan, M., David, S. and Robert, C., 2013. Interim policy, FAA review of solar energy system projects on federally obligated airports.

Barrett, S., Devita, P., Ho, C. and Miller, B., 2014. Energy technologies' compatibility with airports and airspace: Guidance for aviation and energy planners. Journal of Airport Management, 8(4), pp.318-326.

APPENDIX A. EXCLUDED RECEPTORS

Table 6: Excluded receptors

Receptor	Location	Justification
Exc 01	-43.0748, 172.7402	Business and not a residence.
Exc 02	-43.0851, 172.7315	View of solar farm obscured by surrounding vegetation
Exc 03	-43.0566, 172.7575	View of solar farm obscured by surrounding vegetation
Exc 04	-43.053, 172.7252	View of solar farm obscured by surrounding vegetation
Exc 05	-43.0434, 172.756	View of solar farm obscured by surrounding vegetation
Exc 06	-43.0524, 172.75	View of solar farm obscured by surrounding vegetation
Exc 07	-43.0571, 172.7571	View of solar farm obscured by surrounding vegetation
Exc 08	-43.0594, 172.7543	View of solar farm obscured by surrounding vegetation
Exc 09	-43.0658, 172.746	View of solar farm obscured by surrounding vegetation
Exc 10	-43.0716, 172.7477	View of solar farm obscured by surrounding vegetation
Exc 11	-43.0743, 172.7544	View of solar farm obscured by surrounding vegetation
Exc 12	-43.0647, 172.7535	Building is a business, not a residence
Exc 13	-43.066, 172.7572	Building is a business, not a residence
Exc 14	-43.0714, 172.7433	Building is a business, not a residence
Exc 15	-43.0224, 172.7532	Building is a business, not a residence
Exc 16	-43.0452, 172.7823	Building is a business, not a residence
Exc 17	-43.0712, 172.7286	Buildings are sheds, not residences
Exc 18	-43.0847, 172.7445	View of solar farm obscured by surrounding vegetation

Exc 19	-43.0417, 172.7685	View of solar farm obscured by surrounding vegetation
Exc 20	-43.0109, 172.6994	View of solar farm is obscured by hills
Exc 21	-43.0127, 172.6989	View of solar farm is obscured by hills
Exc Route 1	Glenmark Drive	View of solar farm obscured by surrounding vegetation and buildings
Exc Route 2	Ferguson Avenue	View of solar farm obscured by surrounding vegetation
Exc Route 3	Anzac St	View of solar farm obscured by surrounding vegetation
Exc Route 4	South section of Townend Street	View of solar farm obscured by surrounding vegetation and buildings
Exc Route 5	North section of Townend Street	View of solar farm obscured by vegetation to the south
Exc Route 6	Loffhagen Drive	View of solar farm obscured by surrounding vegetation
Exc Route 7	Fergusons Road	View of solar farm obscured by hills

APPENDIX B. FORGESOLAR GLARE ANALYSIS

We have attached the analysis reports exported from ForgeSolar:

- ForgeSolar analysis OP1-40 0deg
- ForgeSolar analysis OP41-57 0deg
- ForgeSolar analysis OP1-40 3deg
- ForgeSolar analysis OP41-57 3deg

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