REPORT

Enterprise Solar Power Project - Glare Assessment

Enterprise Solar GP Inc. on Behalf of Enterprise Solar LP.

Submitted to:

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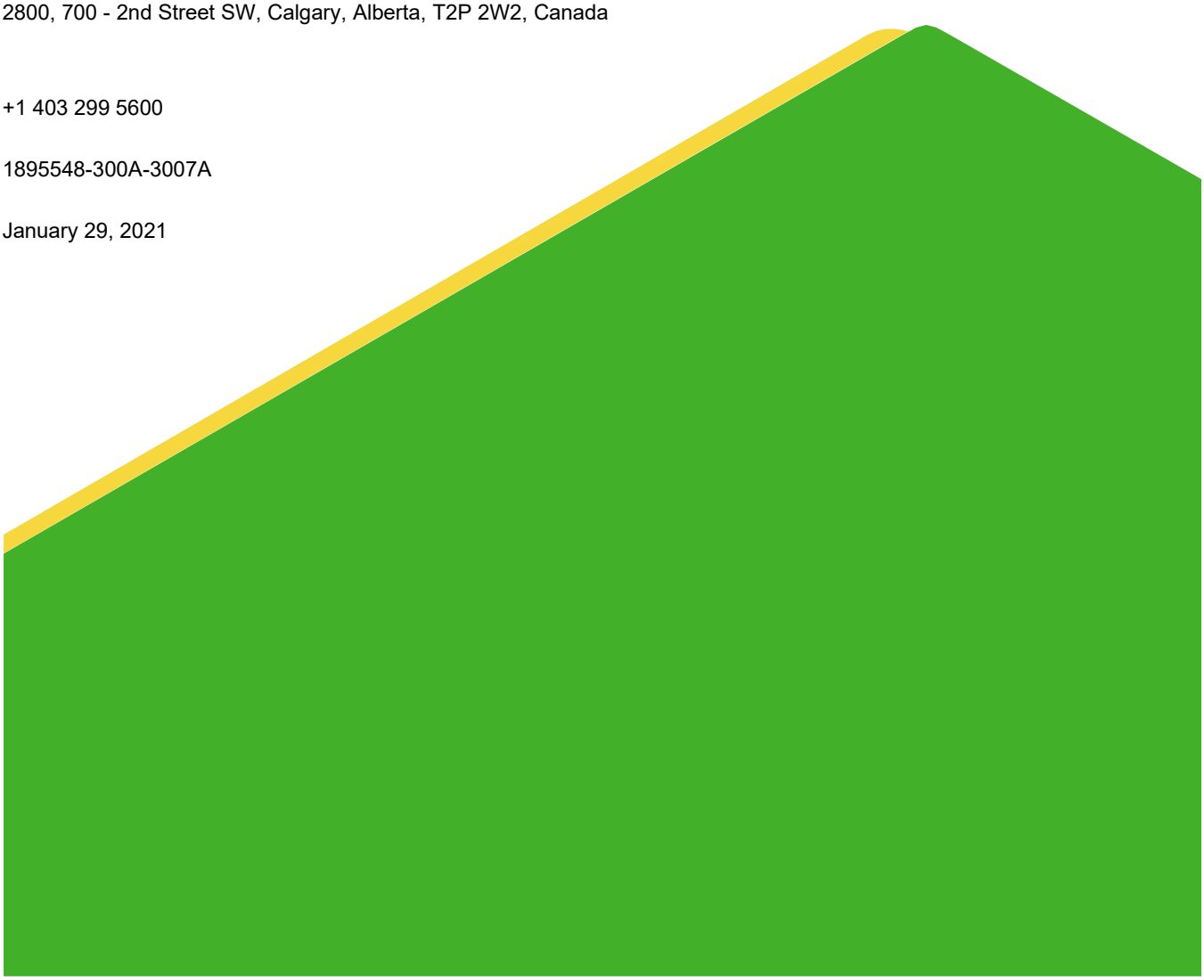

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1.0 INTRODUCTION

Enterprise Solar GP Inc. on behalf of Enterprise Solar LP. (the Proponent) is proposing to develop the Enterprise Solar Project (the Project) in the County of Vulcan. The Project will be located approximately 4 kilometres (km) southwest of the Town of Vulcan, in portions of Section 26 and 27, Township 16, Range 25, West of the Fourth Meridian. The maximum nameplate generating capacity of the Project will be up to 100 megawatts (MW).

Alberta Utilities Commission (AUC) Bulletin 2019-09 requires that applications for new solar power facilities in Alberta include a solar glare assessment. According to Bulletin 2019-09:

> *"The solar glare assessment must describe the time, location, duration and intensity of solar glare predicted to be caused by the project. It should also describe the potential impact upon dwellings and transportation routes surrounding the proposed solar energy project, and any mitigation measures proposed. Applicants are required to identify the software or tools used in their assessment, the assumptions of input parameters utilized, and the qualification of the person performing the assessment."* (AUC 2019)

RES retained Golder Associates Ltd. (Golder) to prepare a glare assessment for the Project. The results of Golder's glare assessment are summarized in this report.

2.0 ASSESSMENT METHODS

AUC Bulletin 2019-09 requires preparation of a glare assessment for the Project and sets out general assessment requirements. However, the AUC does not recommend or endorse a specific approach for modelling glare and does not establish specific criteria for assessing potential glare effects.

In the absence of detailed technical guidance for modelling or assessing glare, glare assessments for solar projects in Alberta typically make use of the Solar Glare Hazard Analysis Tool (SGHAT) developed by the United States Federal Aviation Administration (FAA). The FAA's SGHAT provides a method for modelling glare from solar power facilities, as well as criteria limits for assessing the magnitude of potential glare effects. When predicting glare levels, the SGHAT modelling method accounts for the path of the sun through the sky and the intensity of solar radiation, as well as the location, orientation, inclination, and reflectivity of the solar panels. The SGHAT then classifies potential glare effects at receptors based on the predicted brightness and size of the glare spot formed on the retina of an observer's eye. For each receptor, the magnitude of the potential glare effect is characterized using a colour-coded classification system:

- no glare – there are no glare effects
- green glare – glare is present but there is low potential for temporary after image
- yellow glare – glare is present with potential for temporary after image
- red glare – glare is present with potential for permanent eye damage

Figure 1 (reproduced from ForgeSolar 2020) presents a graph showing how the SGHAT classifies potential glare effects based on retinal irradiance (i.e., brightness of the glare spot on an observer's retina) and subtended source angle (i.e., size of the glare spot on the observer's retina).

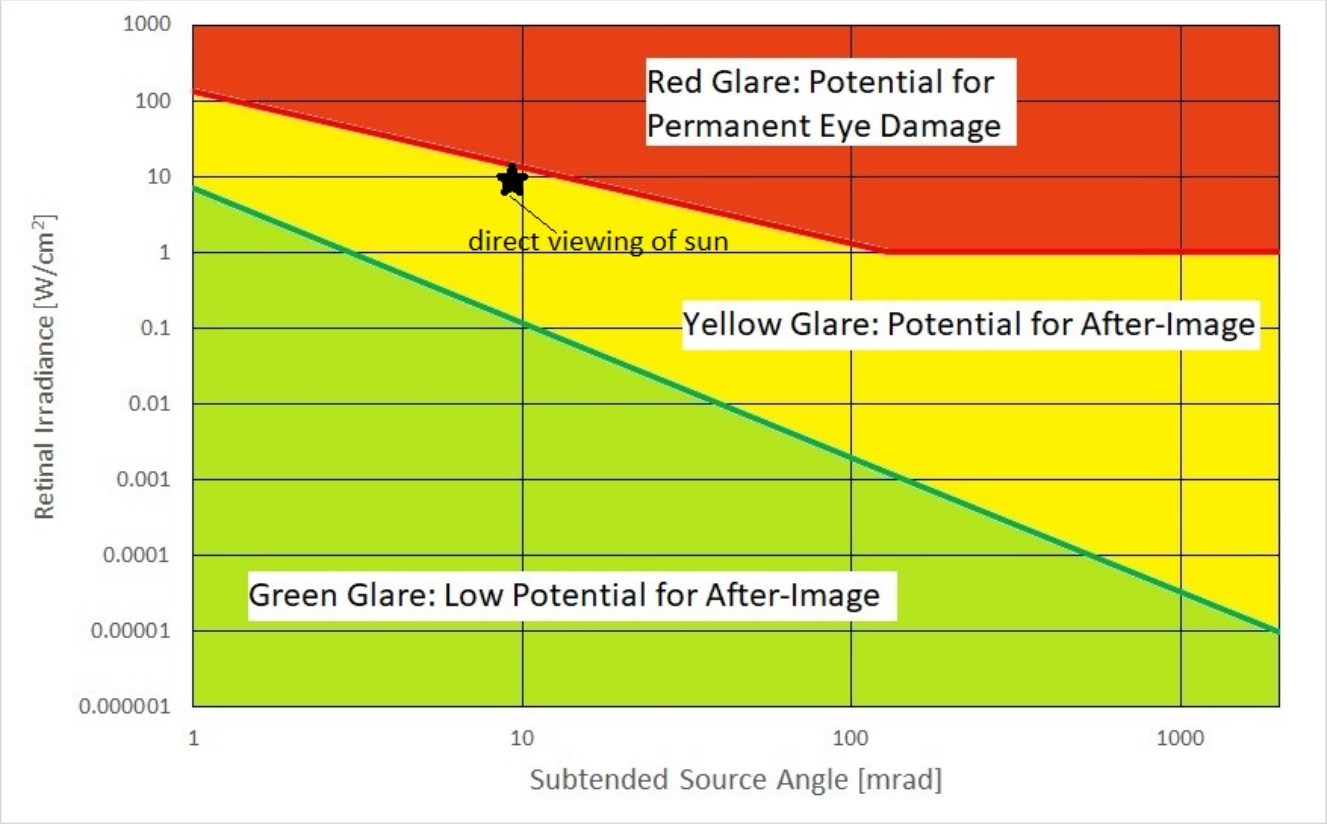


Figure 1: Glare Effect Classification System (reproduced from ForgeSolar 2020)

The Project glare assessment made use of the FAA's SGHAT as implemented in the ForgeSolar Glare Gauge® software program. Model inputs used to represent the Project in the modelling software are summarized in Table 1. The model inputs presented in Table 1 are a conservative representation of the Project; these model inputs will tend to overestimate Project glare effects.

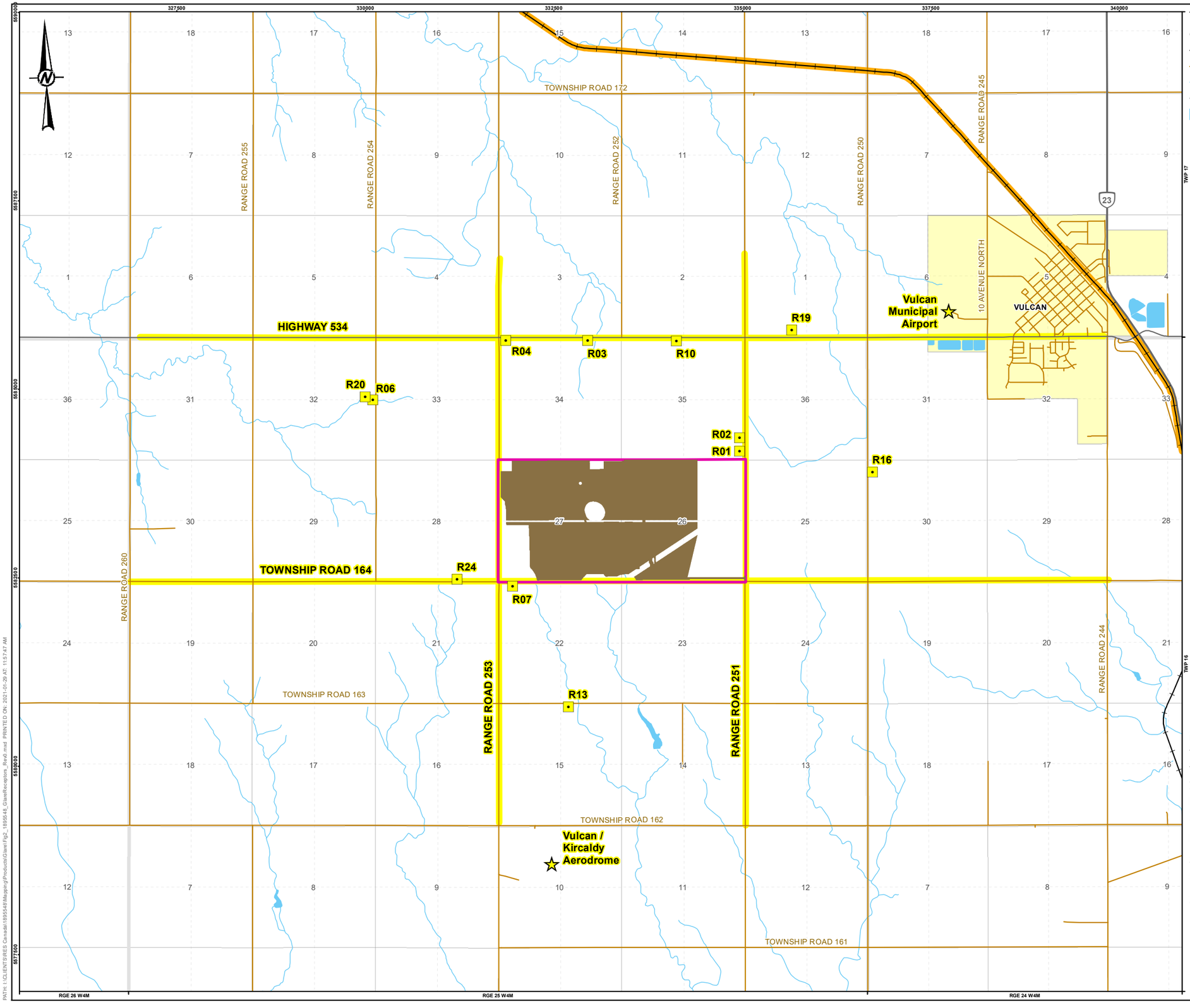
Table 1: Model Input Parameters for Project Glare Assessment

Model Input	Parameter Value	Comment
direct normal irradiance	peak value of 1000 watts per square metre (W/m^2); varies with time of day	this parameter represents the amount of solar radiation received by a surface normal to the sun
ocular transmission coefficient	0.5	this parameter represents the amount of light typically absorbed within the human eye before reaching the retina
pupil diameter	0.002 m	this is a typical value for the human eye under daytime conditions
eye focal length	0.017 m	this parameter represents the distance at which light rays intersect within the eye; this is a typical value for the human eye
sun subtended angle	9.3 milliradians (mrad)	this parameter represents the apparent size of the sun for an observer on the surface of the earth
number of solar arrays	4	the Project will consist of thousands of individual photovoltaic solar panels distributed across an area of approximately 250 ha; the SGHAT model breaks the Project up into four solar arrays to improve the accuracy of glare predictions
axis tracking	single	Project solar panels will be mounted on a tracking system that adjusts their inclination as the sun moves across the sky; use of axis tracking increases the amount of sunlight absorbed by the Project solar panels and thus reduces the amount of sunlight that is reflected to receptors in the environment
tilt of tracking axis	0°	this parameter represents the elevation of the tracking axis on which the Project solar panels rotate; a value of 0° indicates the Project solar panels will be installed on level ground
orientation	180°	this parameter represents the azimuthal orientation of the tracking axis measured clockwise from true north; a value of 180^0 indicates the Project solar panels will face south
maximum tracking angle	±50°	this parameter represents the maximum inclination of the Project solar panels around the tracking axis
panel material	smooth glass with anti-reflective coating	anti-reflective coating increases the amount of sunlight absorbed by the Project solar panels and thus reduces the amount of sunlight that is reflected to receptors in the environment
height above ground	2.5 m	this parameter represents the centroid of the Project solar panels

AUC Bulletin 2019-09 requires that glare assessments consider potential effects at *"…dwellings and transportation routes surrounding the proposed solar energy project…"* (AUC 2019). In accordance with this guidance, the Project glare assessment considered potential effects at 19 receptors:

- 12 occupied dwellings located within 2 km of the Project
- two airstrips located within 10 km of the Project
- the four closest roadways to the Project
- the Canadian Pacific (CP) rail line that runs north and east of the Project

The locations of the 19 receptors considered in the Project glare assessment are presented Figure 2. Table 2 provides coordinates and short description for each glare receptor.



LEGEND

- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- RAILROAD
- WATERBODY
- PROJECT AREA
- PROJECT LIMIT OF DISTURBANCE

GLARE RECEPTORS

- AIRSTRIP
- DWELLING
- ROAD
- RAILWAY

0 1,000 2,000

1:50,000 METRES

REFERENCE(S)

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PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT
ENTERPRISE SOLAR GP INC. ON BEHALF OF ENTERPRISE SOLAR LP

PROJECT
ENTERPRISE SOLAR

TITLE
GLARE RECEPTORS

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-29
DESIGNED	VY
PREPARED	LMS
REVIEWED	VY
APPROVED	AF

PROJECT NO.	PHASE	REV.	FIGURE
1895548	3000A	0	2

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25mm

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Table 2: Glare Receptors

Receptor Type	Receptor Name	Universal Transverse Mercator Coordinates[a] (Zone 12)		Description / Comment
		Easting (m)	Northing (m)	
Occupied Dwelling	R01	334778	5583879	occupied dwelling located east of the Project; modelled as a point receptor sensitive to glare in any direction
	R02	334784	5584054	occupied dwelling located east of the Project; modelled as a point receptor sensitive to glare in any direction
	R03	332806	5585404	occupied dwelling located north of the Project; modelled as a point receptor sensitive to glare in any direction
	R04	331721	5585442	occupied dwelling located north of the Project; modelled as a point receptor sensitive to glare in any direction
	R06	329933	5584712	occupied dwelling located west of the Project; modelled as a point receptor sensitive to glare in any direction
	R07	331707	5582181	occupied dwelling located south of the Project; modelled as a point receptor sensitive to glare in any direction
	R10	333984	5585364	occupied dwelling located north of the Project; modelled as a point receptor sensitive to glare in any direction
	R13	332398	5580559	occupied dwelling located south of the Project; modelled as a point receptor sensitive to glare in any direction
	R16	336528	5583545	occupied dwelling located east of the Project; modelled as a point receptor sensitive to glare in any direction
	R19	335517	5585462	occupied dwelling located northeast of the Project; modelled as a point receptor sensitive to glare in any direction
	R20	329836	5584755	occupied dwelling located west of the Project; modelled as a point receptor sensitive to glare in any direction
	R24	330975	5582296	occupied dwelling located west of the Project; modelled as a point receptor sensitive to glare in any direction
Airstrip	Vulcan / Kircaldy Aerodrome	332109	5578484	local airstrip located south of the Project; modelled using 2-mile flight paths with a 30˚ downward viewing angle and a 50˚ azimuthal viewing angle[b]
	Vulcan Municipal Airport	337605	5585644	local airstrip located northeast of the Project; modelled using 2-mile flight paths with a 30^0 downward viewing angle and a 50˚ azimuthal viewing angle[b]
Roadway	Highway 534	332679	5585434	roadway located immediately north of the Project; modelled using a line receptor with a 50˚ azimuthal viewing angle in both travel directions[b]
	Range Road 251	334811	5583003	roadway located immediately east of the Project; modelled using a line receptor with a 50˚ azimuthal viewing angle in both travel directions[b]
	Range Road 253	331543	5583069	roadway located immediately west of the Project; modelled using a line receptor with a 50˚ azimuthal viewing angle in both travel directions[b]
	Township Road 163	332634	5582198	roadway located immediately south of the Project; modelled using a line receptor with a 50˚ azimuthal viewing angle in both travel directions[b]

Table 2: Glare Receptors

Receptor Type	Receptor Name	Universal Transverse Mercator Coordinates[a] (Zone 12)		Description / Comment
		Easting (m)	Northing (m)	
Railway	CP rail line	337825	5587962	rail line running north and east of the Project; modelled using a line receptor with a 50° azimuthal viewing angle in both travel directions[b]

[a] Coordinates for airstrip receptors represent the location of the airstrip (i.e., end of the 2-mile flight path). Coordinates for roadway and railway receptors represent the closest point to the centre of the Project.
[b] Viewing angles for flight path, roadway, and railway receptors are consistent with standard values used in the FAA's SGHAT.

3.0 ASSESSMENT RESULTS

Table 3 presents glare predictions for each of the receptors considered in the Project glare assessment. As indicated in Table 3, the SGHAT model developed for the Project predicts there will be no glare at any of the 19 receptors considered in the assessment.

Table 3: Glare Assessment Results

Receptor Type	Receptor Name	Duration of Project Glare [minutes per year]			Comment
		Green Glare	Yellow Glare	Red Glare	
Occupied Dwelling	R01	0	0	0	no glare effect from the Project
	R02	0	0	0	no glare effect from the Project
	R03	0	0	0	no glare effect from the Project
	R04	0	0	0	no glare effect from the Project
	R06	0	0	0	no glare effect from the Project
	R07	0	0	0	no glare effect from the Project
	R10	0	0	0	no glare effect from the Project
	R13	0	0	0	no glare effect from the Project
	R16	0	0	0	no glare effect from the Project
	R19	0	0	0	no glare effect from the Project
	R20	0	0	0	no glare effect from the Project
	R24	0	0	0	no glare effect from the Project
Airstrip	Vulcan / Kircaldy Aerodrome	0	0	0	no glare effect from the Project
	Vulcan Municipal Airport	0	0	0	no glare effect from the Project
Roadway	Highway 534	0	0	0	no glare effect from the Project
	Range Road 251	0	0	0	no glare effect from the Project
	Range Road 253	0	0	0	no glare effect from the Project
	Township Road 163	0	0	0	no glare effect from the Project
Railway	CP rail line	0	0	0	no glare effect from the Project

4.0 CONCLUSION

RES is proposing to develop the Enterprise Solar Power Project in the County of Vulcan. The Project design incorporates features that will minimize potential glare effects. Project solar panels will have anti-reflective coating. Project solar panels will be mounted on a tracking system that adjusts their inclination as the sun moves across the sky. Both these design features will increase the absorption of incoming sunlight and reduce the amount of sunlight that is reflected towards receptors in the environment.

In accordance with AUC requirements (AUC 2019), a glare assessment was prepared for the Project. The glare assessment made use of a widely accepted SGHAT to predict Project glare levels and assess potential glare effects at 19 receptors in the Project area (i.e., 12 occupied dwellings, two local airstrips, the four closest roadways to the Project, and the closest rail line to the Project).

The SGHAT predicts there will be no Project glare at any of the 19 receptors considered in the glare assessment. As such, the glare assessment concludes there are no potential glare effects associated with the Project.

Signature Page

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https://golderassociates.sharepoint.com/sites/33937g/deliverables/glare assessment report/res enterprise - glare (rev1).docx

5.0 REFERENCES

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