

Tilbuster 2 Solar Farm

Landscape and Visual Impact Assessment

Enerparc Australia Pty Ltd

07 March 2025

→ **The Power of Commitment**



Project name		Stage 2 Tilbuster Solar Farm					
Document title		Tilbuster 2 Solar Farm Landscape and Visual Impact Assessment					
Project number		12636761					
File name		12636761_Tilbuster 2 Solar Farm LVIA					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	D. Taylor	L. King		S. Murphy		05/11/24
S4	1	L. King	S. Murphy		S. Murphy		07/03/25

GHD Design Pty Ltd
Contact: Daniela Taylor, Graduate Landscape Architect
133 Castlereagh Street, 133 Castlereagh Street
Sydney, New South Wales 2000, Australia
T +61 2 9239 7100 | **E** sydmall@ghd.com | **ghd.com/design**

© GHD 2025
This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Acknowledgement of Country

GHD acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land, water and sky throughout Australia on which we do business. We recognise their strength, diversity, resilience and deep connections to Country. We pay our respects to Elders of the past, present and future, as they hold the memories, knowledges and spirit of Australia. GHD is committed to learning from Aboriginal and Torres Strait Islander peoples in the work we do.



Contents

1.	Introduction	1
1.1	Background	1
1.2	Proposal overview	1
1.3	Purpose of this report	3
1.4	Structure of this report	3
1.5	Scope and limitations	3
2.	Methodology	5
2.1	Study area	5
2.2	Site inspection	6
2.3	Landscape and visual impact assessment guidance	6
2.4	Existing landscape and visual environment	6
2.5	Landscape character assessment	7
2.6	Preliminary visual impact assessment	8
2.6.1	Zone of theoretical visibility	8
2.6.2	Preliminary assessment tools	8
2.7	Detailed visual impact assessment	10
2.7.1	Visual sensitivity	11
2.8	Photomontage preparation	12
3.	Proposal description	13
3.1	Solar array	13
3.2	Internal access tracks	13
3.3	Security fencing, CCTV and weather stations	15
3.4	Traffic and access	15
3.5	Construction	16
3.6	Lighting	16
3.7	Decommissioning	16
4.	Legislation and Policy	17
4.1	New England North West Regional Plan 2041	17
4.2	Armidale Regional Local Strategic Planning Statement	17
4.3	Armidale Regional Local Environment Plan 2012	17
5.	Existing landscape and visual environment	20
5.1	Regional and local context	20
5.2	Existing environment	20
5.2.1	Topography and hydrology	20
5.2.2	Vegetation communities	22
5.2.3	Land use and built form	24
5.2.4	Heritage and Indigenous cultural values	24
5.2.5	Landscape character	27
6.	Landscape character assessment	32
6.1	LCZ1 - Tilbuster rural productive land	32
6.2	LCZ2 - Duval Nature Reserve and bushland	32

7.	Preliminary visual impact assessment	34
7.1	Sensitive receivers	34
7.2	Zone of theoretical visibility	34
7.3	Preliminary visual impact assessment	34
8.	Detailed visual impact assessment	38
8.1	VP01 – Snake Gully	41
8.2	VP02 – Taits Gully	42
8.3	VP03 – New England Highway	43
8.4	VP04 – Varuna	44
8.5	VP05 – Hillwood	45
8.6	VP06 – Tilthorpe	46
8.7	VP07 – Annaleey	47
8.8	VP08 – Tilbuster North	48
8.9	VP09 – Ravenswood (south)	49
8.10	VP10 – Ravenswood (north)	50
8.11	VP11 – Minmai	51
8.12	VP12 – Uralba	52
9.	Cumulative impacts	53
10.	Glint and glare	55
11.	Mitigation measures	57
11.1	Performance objectives	57
11.2	Proposed mitigation measures	57
11.2.1	Construction	57
11.2.2	Landscape character	58
11.2.3	Visual amenity	58
11.2.4	Landscape plan	58
12.	Conclusion	59
12.1	Summary of landscape character impacts	59
12.2	Visual impact assessment	59
13.	References	60

Table index

Table 1.1	Glint and glare SEARs	3
Table 2.1	Landscape character impact rating matrix (adapted from the Transport Guideline 2023)	7
Table 2.2	Visual sensitivity rating table	11
Table 2.3	Visual impact rating table	11
Table 4.1	Key land zone objectives	17
Table 5.1	Vegetation classes	22
Table 5.2	LCZ1 key characteristics	29
Table 5.3	LCZ2 key characteristics	30
Table 6.1	LCZ1 landscape character impact assessment	32
Table 6.2	LCZ2 landscape character impact assessment	32

Table 7.1	Preliminary visual assessment results	36
Table 8.1	Visual receivers not requiring a detailed viewpoint assessment	38
Table 8.2	Visual receivers requiring a detailed viewpoint assessment	39
Table 8.3	VP01 viewpoint summary and assessment	41
Table 8.4	VP02 viewpoint summary and assessment	42
Table 8.5	VP03 viewpoint summary and assessment	43
Table 8.6	VP04 viewpoint summary and assessment	44
Table 8.7	VP05 viewpoint summary and assessment	45
Table 8.8	VP06 viewpoint summary and assessment	46
Table 8.9	VP07 viewpoint summary and assessment	47
Table 8.10	VP08 viewpoint summary and assessment	48
Table 8.11	VP09 viewpoint summary and assessment	49
Table 8.12	VP10 viewpoint summary and assessment	50
Table 8.13	VP11 viewpoint summary and assessment	51
Table 8.14	VP12 viewpoint summary and assessment	52
Table 9.1	Major projects in the vicinity of the proposal for consideration of cumulative visual impacts	53
Table 10.1	Glint and glare assessment summary	55
Table 11.1	Visual performance objectives (adapted from the Technical Supplement)	57
Table 12.1	Landscape character impact summary	59
Table 12.2	Summary of visual impact assessment ratings	59

Figure index

Figure 1.1	Site context	2
Figure 2.1	Study area	5
Figure 2.2	Preliminary visual impact assessment stages	9
Figure 2.3	Detailed visual impact assessment steps	10
Figure 3.1	Solar array example – Wagga Wagga Solar Farm (source: Terrain Solar)	13
Figure 3.2	Proposal overview	14
Figure 3.3	Security fencing example	15
Figure 4.1	Land zoning	19
Figure 5.1	Topography	21
Figure 5.2	Vegetation communities	23
Figure 5.3	Land Use	25
Figure 5.4	Heritage	26
Figure 5.5	Landscape character zones	28
Figure 5.6	Typical aerial view (source: Nearmaps)	30
Figure 5.7	Typical ancillary buildings and infrastructure	30
Figure 5.8	Typical cleared, flat rural land	30
Figure 5.9	Typical rural property with associated fencing	30
Figure 5.10	Typical aerial view (Nearmaps)	31
Figure 5.11	Typical bushland on sloping terrain	31
Figure 5.12	Typical unsealed access road within bushland	31
Figure 5.13	Typical bushland	31

Figure 7.1	Zone of theoretical visibility	35
Figure 7.2	Preliminary assessment tool	36
Figure 8.1	Viewpoints	40
Figure 8.2	Baseline panoramic photograph – VP01	41
Figure 8.3	Baseline panoramic photograph – VP02	42
Figure 8.4	Baseline panoramic photograph – VP03	43
Figure 8.5	Baseline panoramic photograph – VP04	44
Figure 8.6	Baseline panoramic photograph – VP05	45
Figure 8.7	Baseline panoramic photograph – VP06	46
Figure 8.8	Baseline panoramic photograph – VP07	47
Figure 8.9	Baseline panoramic photograph – VP08	48
Figure 8.10	Baseline panoramic photograph – VP09	49
Figure 8.11	Baseline panoramic photograph – VP10	50
Figure 8.12	Baseline panoramic photograph – VP11	51
Figure 8.13	Baseline panoramic photograph – VP12	52

Appendices

Appendix A	Wireframes and photomontages
Appendix B	Glint and Glare Assessment
Appendix C	Landscape plan

Glossary

Term	Definition
AHD	Australian Height Datum
APZ	Asset Protection Zone
AS	Australian Standard
CCTV	Closed circuit television
EIS	Environmental Impact Statement
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
GIS	Geographic Information System
ha	hectares
km	Kilometre
kV	Kilovolt
LCZ	Landscape Character Zone
LVIA	Landscape and Visual Impact Assessment
LEP	Local Environment Plan
LGA	Local Government Area
LSPS	Local Strategic Planning Statement
m	Metre
mm	Millimetres
MW	Megawatt
MWh	Megawatt per hour
NPWS	National Parks and Wildlife Service
OP	Observation points
PCT	Plant Community Type
PV	Photovoltaics
REZ	Renewable Energy Zone
RL	Reduced level
RP	New England North West Regional Plan 2041
SEARs	Secretary's Environmental Assessment Requirements
SSD	State Significant Development
VP	Viewpoint
ZTV	Zone of theoretical visibility
Development footprint	The area of the proposal site that would be directly impacted by the proposal (during construction, operation and decommissioning)
Impact	The effect of a proposal, which can be adverse or beneficial, when measured against an existing condition
Landscape	A holistic area comprised of its various parts including landform, vegetation, buildings, villages, towns, cities and infrastructure
Landscape character	The combined quality of built, natural and cultural aspects which make up an area and provide its unique sense of place

Term	Definition
Landscape character zone	An area of landscape with similar properties or strongly defined spatial qualities, distinct from areas immediately nearby
Magnitude	The apparent size of a solar energy project in the landscape or when viewed from a given viewpoint
Sensitivity	The capacity of a landscape or viewpoint to absorb the impacts from a proposed land use change and/or built form
Study area	Consists of land in the vicinity of, and including, the proposal. The study area is a wider area surrounding the proposal, including land that has the potential to be indirectly impacted by the proposal.
The Guideline	<i>Guideline for landscape character and visual impact assessment - Environmental impact assessment practice note EIA-N04 - Version 2.3</i> (Transport for NSW, 2023)
The project	The approved Tilbuster Solar Farm (SSD 9619) project
The proposal	Construction, operation and decommissioning of Tilbuster 2 Solar Farm
Proposal site	The site within which the proposal is located, namely Lot 4 DP800611, 11915 New England Highway, Black Mountain NSW 2365
The Technical Supplement	<i>Technical Supplement - Landscape and Visual Impact Assessment, Large-Scale Solar Energy Guideline</i> (NSW Department of Planning and Environment, 2022)
View	The sight of a landscape or scene
Viewpoint	A location within the public or private domain with a potential view of a large-scale solar energy project
Viewshed	The area within which the proposal can be seen at eye level above ground. Its extent will usually be defined by a combination of landform, vegetation and built elements.
Visibility	The state or fact of being visible or seen
Visual impact	The impact on views from private and public places. It is determined by considering the visual magnitude and sensitivity
Visual receiver	Individuals and/or groups of people who have the potential to be affected by views of or towards the proposal
Zone of theoretical visibility	A map, usually digitally produced, showing areas of land within which a development is theoretically visible
3D	Three dimensional

1. Introduction

1.1 Background

Enerparc Australia Pty Ltd (Enerparc) is developing the Tilbuster Solar Farm (State Significant Development (SSD) 9619), which was approved under Section 2.22 and Clause 20 of Schedule 1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 3 March 2022. The Tilbuster Solar Farm (the project) is located approximately 15 kilometres (km) north of Armidale in the Armidale Regional local government area (LGA), refer to Figure 1.1.

The project involves the construction, operation and decommissioning of a new solar farm with a generating capacity of 150 megawatts (MW) and 15 MW/30 MW per hour (MWh) of battery energy storage. The solar farm will connect to the existing Transgrid 330 kilovolt (kV) transmission line, which traverses the site and connects Dumaresq substation to Armidale substation.

Due to design refinements made in response to ecological and heritage constraints identified during the preparation of the Environmental Impact Statement (EIS), the project was approved with a lower MW capacity than originally anticipated. As a result, Enerparc have acquired adjacent land and propose developing Stage 2 of the project to maximise the generation potential of the site (the proposal).

The proposal is located on land adjoining the project and would make use of transmission, storage and construction facilities on that site.

1.2 Proposal overview

The proposal involves the construction, operation and decommissioning of a ground-mounted photovoltaic (PV) solar array, which would generate approximately 140 MW, in addition to the 150 MW generated by the project.

The proposal site is located at Lot 4 DP800611, 11915 New England Highway, Black Mountain NSW 2365. The proposal site has an area of approximately 250 hectares (ha), with the proposed development to be constructed on approximately 140 ha of this land.

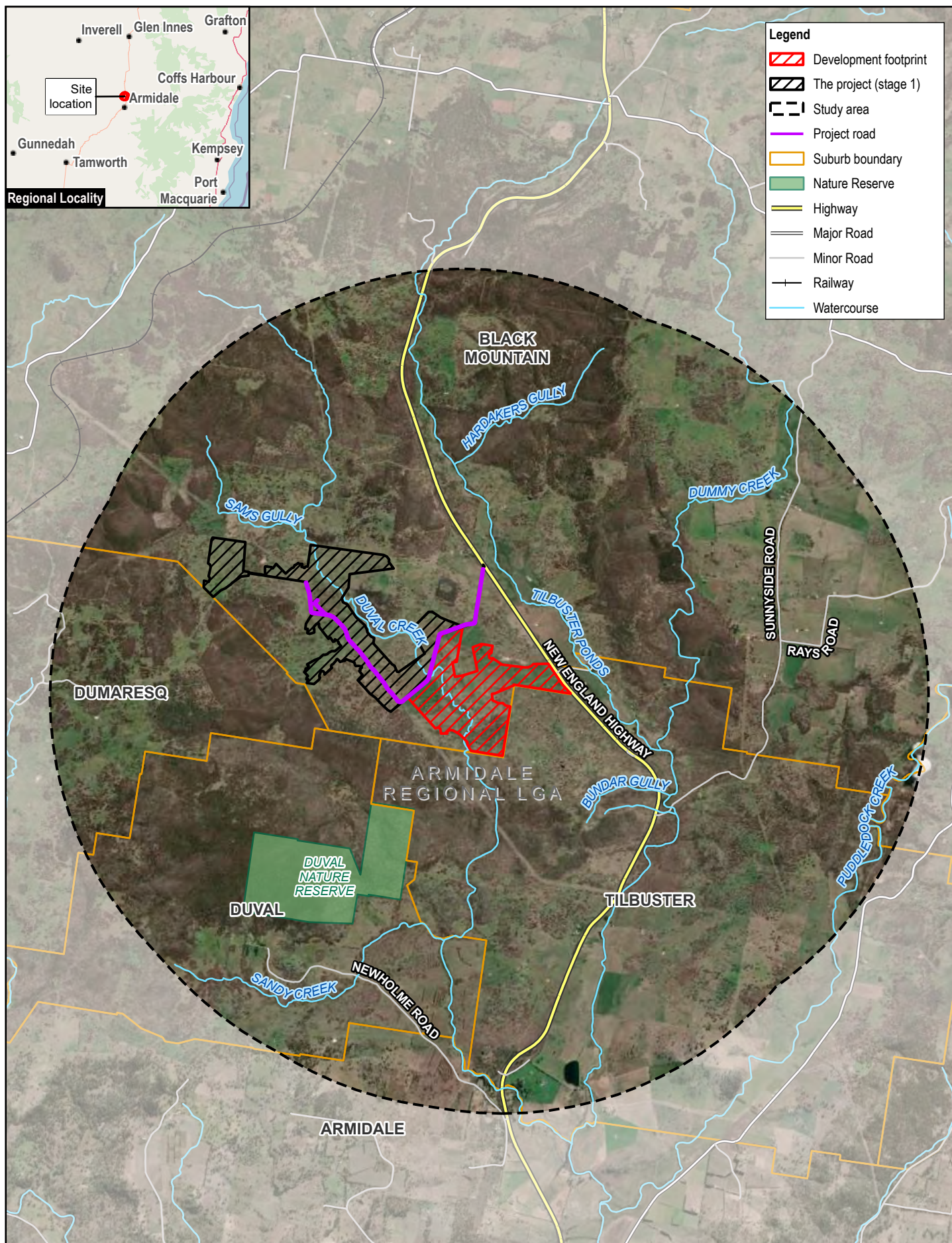
In total, the construction phase of the proposal is expected to take nine months, and the facility is expected to operate for around 30 years or extended pending further approvals. The proposal would be constructed as part of the overall construction of the approved project. This would reduce the construction period for the proposal and minimise impacts on the community.

The primary access point for light and heavy vehicles during construction and operation would be via an existing access off the New England Highway, currently under construction for the project. Temporary construction compounds and laydowns areas would also be located on the project site.

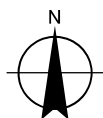
Construction of the proposal is anticipated to take nine months, with work commencing, pending approval, in early 2025. Up to 100 construction workers would be required.

Up to five full time equivalent operations and maintenance staff and service contractors would operate the proposal, as part of the operation of the approved project. Existing transmission and storage infrastructure within the approved project footprint would be used to connect the proposal to the national electricity grid.

Refer to Section 3 of this report for more information on the indicative layout for the proposal, including the location of solar PV panels, associated infrastructure and internal access roads.



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres



Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

Site context

FIGURE 1-1

1.3 Purpose of this report

The purpose of this Landscape and Visual Impact Assessment (LVIA) is to address the requirements of the Secretary's environmental assessment requirements (SEARs) for the proposal, issued 18 April 2024, as summarised in Table 1.1. The LVIA has been prepared with reference to the *Large-Scale Solar Energy Guideline* (the Guideline; DPE 2022) and the *Technical Supplement - Landscape and Visual Impact Assessment, Large-Scale Solar Energy Guideline* (the Technical Supplement, DDPE 2022). The methodology used in the assessment is further described in Section 2.

Table 1.1 Glint and glare SEARs

Issue	SEARs	Where addressed
Landscape and Visual Impact	Provide an assessment of the likely visual impacts (including night lighting) of all components of the development on surrounding residences (including approved developments, lodged development applications and dwelling entitlements) and key locations, scenic or significant vistas and road corridors in the public domain, prepared in accordance with the <i>Large-Scale Solar Energy Guideline 2022</i> (Technical Supplement – Landscape and Visual Impact Assessment).	This report

1.4 Structure of this report

The following is an overview of the report structure used for undertaking this LVIA. The methodology is based on the relevant policies, frameworks and previous experience undertaking LVIA's for infrastructure and renewable projects.

- **Section 1 - Introduction:** provides background information and an overview of the proposal and assessment.
- **Section 2 - Methodology:** describes the methodology used for the purposes of this assessment.
- **Section 3 - Proposal description:** describes the proposed development, with emphasis on identifying the key sources of potential impacts relevant to this assessment.
- **Section 4 – Legislation and policy:** provides an overview of relevant legislation and policy.
- **Section 5 – Existing landscape and visual environment:** provides an overview and describes the landscape and visual environment within the study area.
- **Section 1 – Landscape character assessment:** assesses the impacts of the proposal on the landscape character.
- **Section 7 – Preliminary visual impact assessment:** identifies viewpoints that will require a detailed visual impact assessment.
- **Section 8 – Detailed visual impact assessment:** provides a comprehensive assessment of the visual impacts on viewpoints identified in the preliminary assessment.
- **Section 9 – Cumulative impacts:** provides a discussion of potential cumulative impacts.
- **Section 10 – Glint and Glare:** provides a summary of the glint and glare assessment.
- **Section 11 – Mitigation measures:** recommends mitigation measures in response to issues arising in the assessment during construction, operation, decommissioning and rehabilitation phases of the proposal.
- **Section 12 – Conclusion:** presents a summary of the LVIA.

1.5 Scope and limitations

This report has been prepared by GHD Design for Enerparc Australia Pty Ltd and may only be used and relied on by Enerparc Australia Pty Ltd for the purpose agreed between GHD Design and Enerparc Australia Pty Ltd as set out in Section 1.3 of this report.

GHD Design otherwise disclaims responsibility to any person other than Enerparc Australia Pty Ltd arising in connection with this report. GHD Design also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD Design in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD Design has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD Design described in this report. GHD Design disclaims liability arising from any of the assumptions being incorrect.

2. Methodology

2.1 Study area

For the purposes of this assessment, the proposal site and study area are defined as follows:

- Proposal site - The site within which the proposal is located, namely Lot 4 DP800611, 11915 New England Highway, Black Mountain NSW 2365.
- Study area - The area investigated that includes the footprint of the proposal and surrounding area, with the potential to be directly or indirectly affected by the proposal. The area of investigation covered by this LVIA comprises a radius of five km from the proposal site. This study area has been established in accordance with the Technical Supplement and is shown in Figure 2.1.

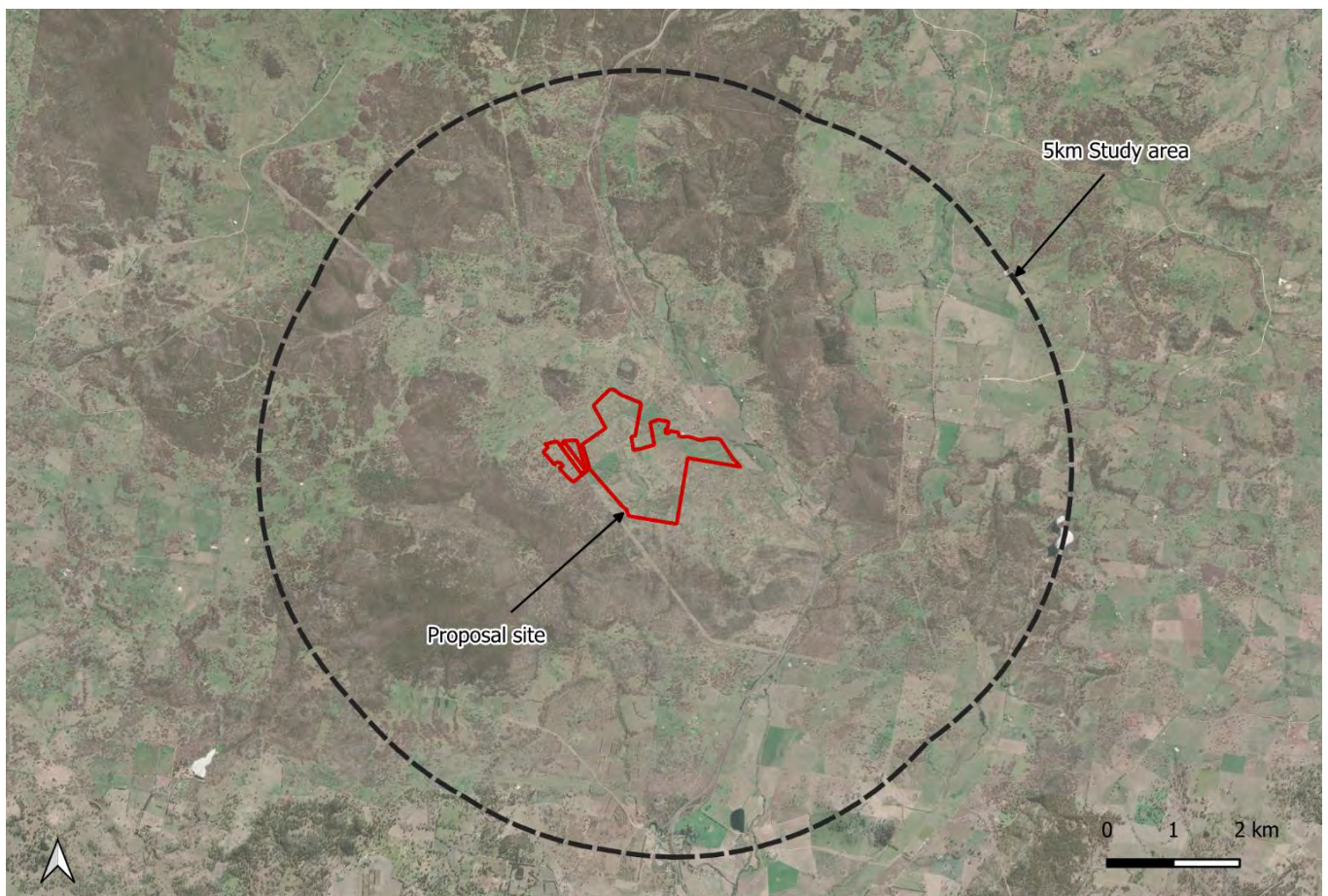


Figure 2.1 Study area

2.2 Site inspection

A site inspection was undertaken by two GHD Landscape Architects on 29 and 30 July 2024. The weather was mostly sunny and all photos were taken between the hours of 9:00 am and 4:00 pm when the most daylight was present. Private properties were accessed for photography where permitted by the private property owners. The purpose of the inspection was to:

- Review the site and landscape character of the overall study area.
- Review publicly accessible locations identified in the desktop study as likely to provide views of the proposal, including from roads, car parks, trails and other publicly accessible areas.
- Review those visual receiver locations identified as part of the preliminary visual impact assessment that might require detailed assessment.
- Undertake panoramic photography from identified viewpoints to use in the detailed visual impact assessment.

2.3 Landscape and visual impact assessment guidance

This LVIA has been prepared as per the Technical Supplement as required by the SEARs.

Additional guidelines used in the preparation of this report include:

- *Guideline for landscape character and visual impact assessment - Environmental impact assessment practice note EIA-N04 - Version 2.3* (Transport for NSW, 2023).
- *Guidelines for Landscape and Visual Impact Assessment, 3rd Edition* (Landscape Institute and Institute of Environmental Management & Assessment, 2013).
- *Cumulative Impact Assessment Guidelines for State Significant Projects* (NSW Department of Planning and Environment, 2022).

2.4 Existing landscape and visual environment

A landscape baseline assessment has been performed to establish the existing landscape character and its sensitivity within the study area. This includes determination of key landscape and spatial elements, features and values. The existing environmental analysis is based on desktop analysis including geographic information systems (GIS) mapping, along with a site-visit to confirm the assumptions made as part of the desktop assessment are validated.

The analysis of the existing environment identifies and describes the elements that make up the landscape in the study area. The following are landscape features relevant to the proposal that have been considered in this LVIA, adapted from the Technical Supplement:

- Landform, natural drainage, water bodies and other physical influences.
- Ecological characteristics and land cover including the quality and type of vegetation cover.
- Influence of human activity, including land use and zoning, and the character of any settlements and buildings.
- Key landscape features or attributes of the landscape associated with high visual interest or quality including natural, cultural or agricultural features.
- Aesthetic and perceptual aspects of the landscape, that contribute to the distinctive character of the landscape (such as its scale, complexity, openness, tranquillity or wildness).
- Aspects of the landscape that have important aboriginal cultural heritage value with the exception of artefacts and tangible values that would be assessed in detail as part of an Aboriginal Cultural Heritage Assessment), including why they are valuable to the community.
- The overall character and condition of the landscape.
- Sensitive land use designations, zonings and heritage listings.
- The location of any other proposed, operational or approved solar infrastructure within the area that may create direct or indirect cumulative impacts with the proposal.

2.5 Landscape character assessment

Landscape character, as described in Transport for NSW's *Guideline for landscape character and visual impact assessment - Environmental impact assessment practice note EIA-N04 - Version 2.3* (the Transport Guideline) is the 'combined quality of built, natural and cultural aspects that make up an area and provide its unique sense of place' (Transport for NSW, 2023).

To assess landscape character impacts, **landscape character zones (LCZ)** are identified and mapped. LCZs divide the landscape based on common distinguishing visual characteristics including landforms and major land cover patterns. These patterns are formed by combinations of vegetation, water bodies, landforms and land use, from which the key landscape features can also be identified. LCZs for the proposal are defined and described using text and site photos. Landscape character **impacts** are then determined and assessed by evaluating the sensitivity of the landscape and the magnitude of the proposal's impacts in that area.

Sensitivity:

Sensitivity refers to how sensitive the landscape is to the proposed change. The sensitivity of the landscape character type should be rated based on the inherent capability of the area to absorb changes from the proposal.

Magnitude:

Magnitude refers to the physical scale of the solar energy development and should be assessed based on the following factors:

- Size and scale including:
 - The extent of existing landscape elements that may be lost and the contribution of that element to the character of the landscape.
 - The extent to which the proposal becomes a minor or major element in the landscape and its dominance in the visual catchment.
 - The extent to which the proposal changes the key characteristics of the landscape, which are critical to its distinctive character.
- Geographical area – the area of the landscape over which the effects will be experienced, having regard to the nature and scale of the proposal's effects. This could vary from the immediate setting of the site to larger scales where the proposal may influence several LCZs.
- Duration and reversibility of the effects on the landscape.

Each LCZ is assigned a sensitivity and magnitude rating (low, moderate or high), that is then used to determine the overall landscape character impact. Table 2.1 provides the matrix used to determine the overall landscape character impact based on the assigned sensitivity and magnitude ratings.

Table 2.1 Landscape character impact rating matrix (adapted from the Transport Guideline 2023)

		Magnitude		
		High	Moderate	Low
Sensitivity	High	High	High-Moderate	Moderate
	Moderate	High-Moderate	Moderate	Moderate-Low
	Low	Moderate	Moderate-Low	Low

2.6 Preliminary visual impact assessment

The Technical Supplement requires a two-stage process to determine visual impacts including a preliminary and detailed visual impact assessment.

2.6.1 Zone of theoretical visibility

The zone of theoretical visibility (ZTV) was prepared as part of the preliminary stage to inform the assessment. The map was prepared using the following parameters:

- A viewing height of 1.5 metres (m), which is the average within the typical viewing level range of an adult.
- Multiple points on the proposed solar panel array, using a height of 4 m.

The GIS software digitally determines the likely extent over which the features would be visible or not visible.

In interpreting the ZTV, the following constraints apply:

- Landform only is considered, i.e. does not include other screening features such as buildings and trees that may obscure views of the proposal.
- It does not consider the effect of distance. The greater the distance from the proposal, the lower the visual impact, as the development will take up a smaller portion of the view.

The detailed visual impact assessment considers the effects of distance and screening factors such as vegetation in obscuring views towards the proposal.

2.6.2 Preliminary assessment tools

The preliminary visual assessment stage is used to identify viewpoints that require a detailed assessment in the detailed visual impact assessment stage. Preliminary assessment tools provided in the Technical Supplement are used to undertake this assessment. The tools are designed to identify where community and landholder consultation should be focused, and to eliminate the need to assess viewpoints that are likely to experience very low visual impacts.

The tools rely on quantitative data collected during the desktop assessment, including:

- 'The vertical and horizontal field of view that a development is likely to occupy when viewed from each viewpoint, and is influenced by distance, height elevation changes, and width of a project.'

The preliminary assessment tools focus on viewpoints particularly with views to the solar array component of the proposal. The methodology for the preliminary visual assessment, is outlined in Figure 2.2.

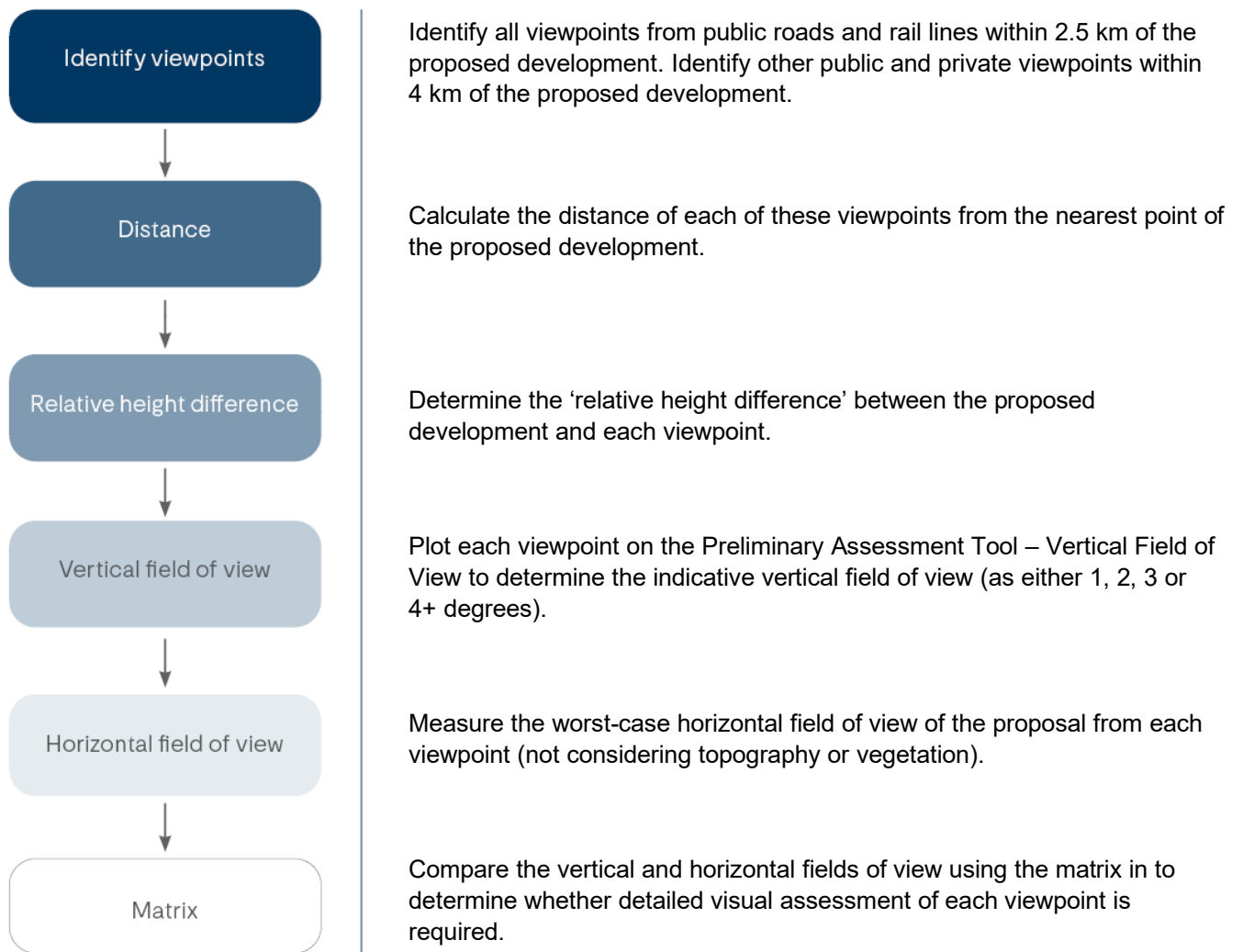


Figure 2.2 Preliminary visual impact assessment stages

2.7 Detailed visual impact assessment

The detailed visual impact assessment is used to undertake a more comprehensive assessment of the visual impacts on specific viewpoints identified in the preliminary assessment to define viewpoint locations. The detailed assessment is prepared in accordance with the following steps shown in Figure 2.3 as adapted from the Technical Supplement:

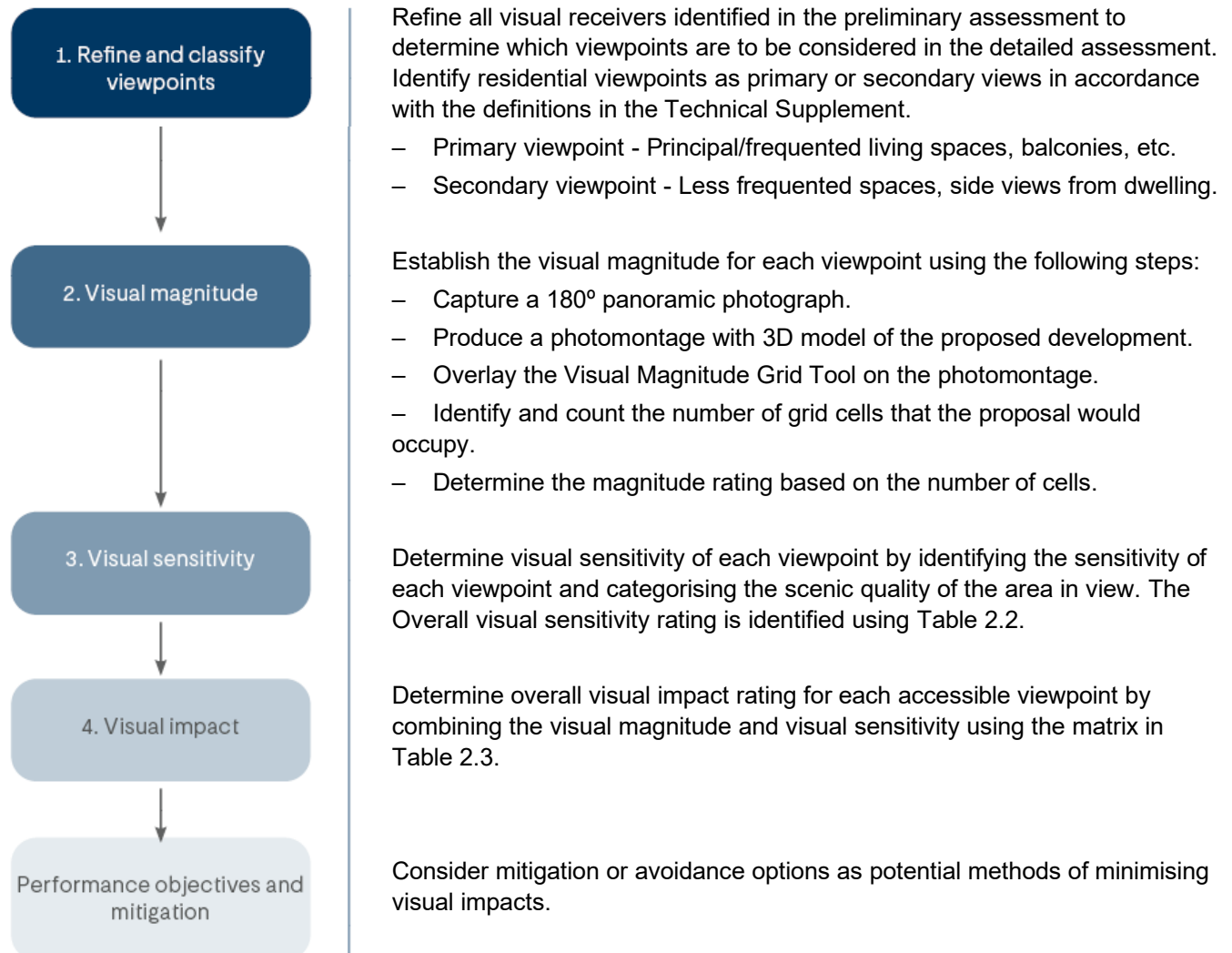


Figure 2.3 Detailed visual impact assessment steps

2.7.1 Visual sensitivity

Sensitivity refers to the qualities of an area, the number and type of receivers and how sensitive the existing character of the setting is to the proposed nature of change. Visual sensitivity, defined in the Technical Supplement 'refers to the quality of the existing view and how sensitive the view is to the proposed change. In some cases, visual sensitivity is also related to the direction of the view and where it can be viewed from (such as a resident's living room). The visual sensitivity is determined by identifying the sensitivity of each viewpoint and categorising the scenic quality of the area in view' (DPE, 2022b).

For example, a significant change that is not frequently seen may result in a low visual sensitivity although it's impact on a landscape may be high. Generally, the following principles are considered:

- Visual sensitivity decreases as the viewing time decreases.
- Visual sensitivity decreases as the number of potential viewers decreases.
- Visual sensitivity can also be related to viewer activity (e.g. a person viewing an affected site whilst engaged in recreational activities will be more strongly affected by change than someone passing a scene in a car travelling to a desired destination).

Sensitivity ratings are defined as 'High', 'Moderate' and 'Low' and 'Very Low' based on the scenic quality and receptor sensitivity, refer Table 2.2 (adapted from the Technical Supplement).

Table 2.2 Visual sensitivity rating table

		Scenic quality		
		High	Moderate	Low
Viewpoint sensitivity	High	High	High	Moderate
	Moderate	High	Moderate	Moderate
	Low	Moderate	Low	Low
	Very low	Low	Very low	Very low

Table 2.3 Visual impact rating table

		Visual sensitivity			
		High	Moderate	Low	Very low
Magnitude	Very high	High	High	Moderate	Moderate
	High	High	Moderate	Moderate	Low
	Moderate	Moderate	Moderate	Low	Low
	Low	Moderate	Low	Low	Very low
	Very low	Low	Low	Very low	Very low

2.8 Photomontage preparation

Photomontages are representations of the proposal that are superimposed onto a viewpoint taken while on fieldwork to represent the visual impact of the proposal on that select viewpoint location. The process for generating these images involves computer generation of a wire frame perspective view of the proposal.

This process includes:

- Capture of viewpoints with a Canon EOS digital SLR through a 50 millimetre (mm) fixed focal lens, which closely represents the central field of vision of the human eye.
- Building a 3D model of the proposal site based on available digital topographic information.
- Matching 3D models to the viewpoint locations using software to superimpose onto viewpoint image.
- Using a render model into a viewpoint image to a 'realistic' level illustrating the scale and position in relation to the that viewpoint location.

3. Proposal description

The following sections provide a summary of the proposal and its location and includes details relating to the main visual components that have potential to impact the landscape character and visual amenity within the study area.

3.1 Solar array

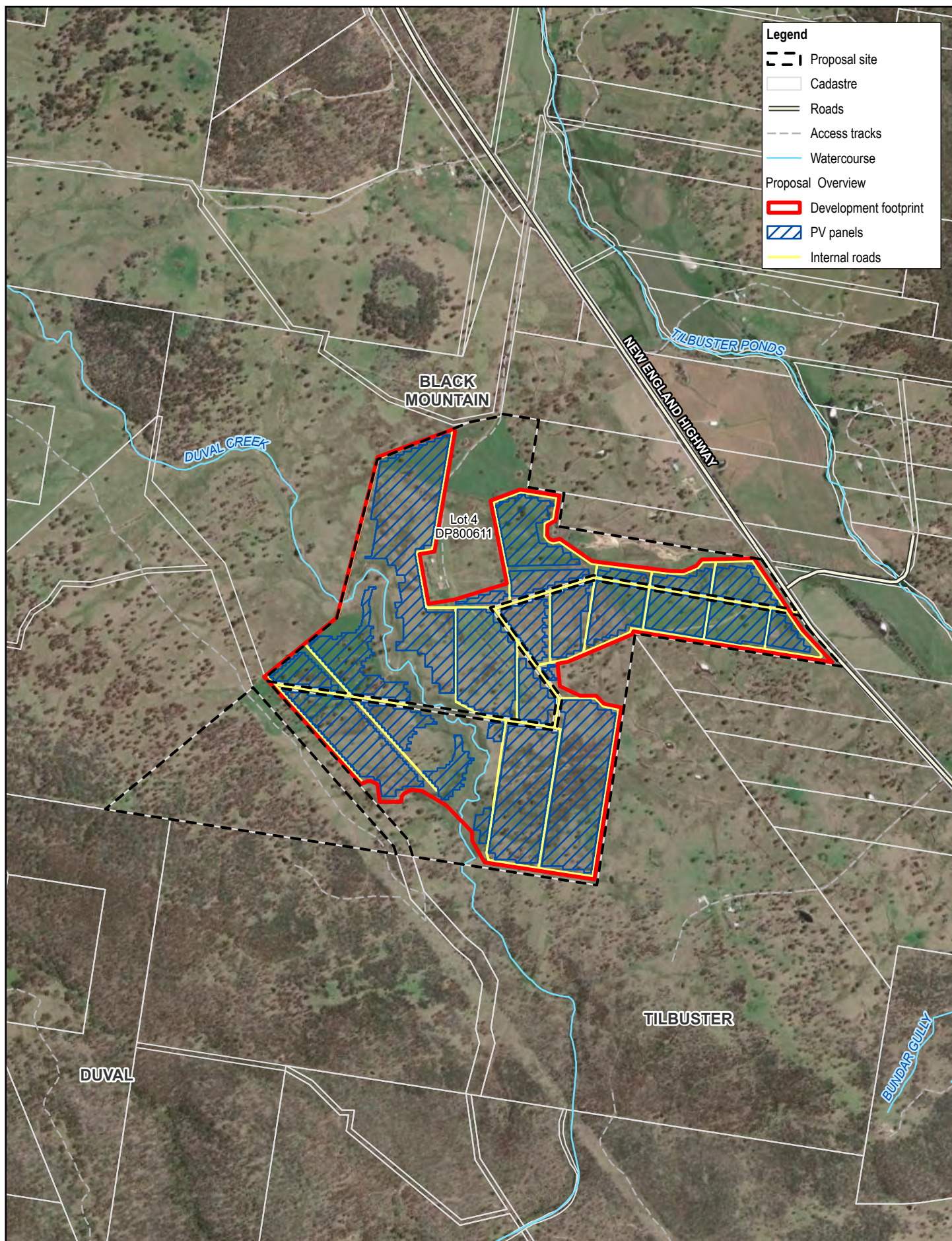
The proposal would involve the installation of approximately 203,184 bifacial PV solar panels across the proposal site with an estimated 140 MW capacity. The panels would be arranged in a series of rows, approximately 5.6 m apart, positioned to maximise the solar resources available at a tilt of about 18 degrees. The solar arrays would be installed through pile driving on ground-mounted single axis fixed frames, in rows configured roughly in a north-south direction. Refer to Figure 3.1 for an indicative solar array footprint.



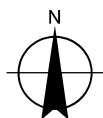
Figure 3.1 Solar array example – Wagga Wagga Solar Farm (source: Terrain Solar)

3.2 Internal access tracks

Approximately 9 km of internal wet weather access roads would be constructed to provide access to the various areas of the proposal site for construction as well as on-going operations and maintenance. The layout of the proposed internal access roads is shown in Figure 3.2.



Paper Size ISO A4
0 150 300 450 600
Metres



Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Proposal overview

FIGURE 3-2

3.3 Security fencing, CCTV and weather stations

A security fence approximately 2.4 m high would be constructed around the perimeter of the site. The final location of the security fence would be dependent on the final layout. A minimum 10 m wide asset protection zone (APZ) will be maintained inside the fence to provide for bush fire control and tanker access. The security fencing would be constructed using cast concrete footings for posts and fencing mesh. Fencing will restrict public access to the proposal site and is required under Australian Standard (AS) 1725.2010 Parts 1-5. Closed circuit television (CCTV) cameras and security lighting would also be provided at certain locations around the perimeter of the site, see Figure 3.3. Approximately three weather stations will be distributed within the solar array and mounted on either a concrete pad or drive steel piles.



Figure 3.3 Security fencing example

3.4 Traffic and access

The proposal would be accessed via the approved Stage 1 access road off the New England Highway (A15), an unnamed Crown road, refer Figure 3.2. This road will be sealed and widened as part of the approved Stage 1 project. The approved project will also upgrade the intersection of the unnamed road with the New England Highway. This site access would be used by the proposal during construction and operation and the proposal will have direct access to this road from the proposal site.

Major solar components would be delivered to the Port of Newcastle or Botany, Sydney and transported to the proposal site by truck via the New England Highway through the main centres of Muswellbrook, Tamworth and Armidale, or from Botany via the Pacific Motorway and Hunter Expressway. Light vehicles would also access the proposal site from this direction or from the north via the New England Highway through Glen Innes, Tenterfield, Stanthorpe, Warwick and Brisbane.

3.5 Construction

Construction would be undertaken in number of stages and the main, anticipated visual activities associated during construction are outlined below:

- Site preparation and earthworks including:
 - The installation of the piles supporting the solar panels.
 - Decommissioning of dams currently within the development footprint, which would involve filling the dams with soil excavated from other parts of the site.
 - Excavation of cable trenches.
- Establishment of temporary construction facilities (it is anticipated that some or most of the construction compound would be located on the Stage 1 approved project site and therefore as not included in the LVIA for this proposal).
- Construction of internal access tracks.
- Installation of PV panels and associated infrastructure.
- Removal of temporary construction facilities and rehabilitation of disturbed areas.
- Site rehabilitation and landscaping would be undertaken in key areas to provide screening and potential habitat. Native, endemic species would be used.

3.6 Lighting

There would be no permanently lit night lighting within the proposal site. All operational lighting would be designed to reduce disturbance to neighbouring properties and would be utilised only when there are staff onsite or during emergency situations.

Security lighting (likely infra-red) and CCTV cameras would be installed on posts up to 3 m high adjacent to the security fencing. These would only be activated when the automatic security system senses an unauthorised site entry.

3.7 Decommissioning

The proposed life of the proposal is 30 years, after which a decision will be made to either decommission or repower the facility, subject to approval requirements. If the proposal is decommissioned, all above ground structures will be removed and the site rehabilitated generally to its pre-existing land use, as far as practicable.

4. Legislation and Policy

The following section provides an overview of relevant legislation and policy objectives for landscape and visual amenity within the study.

4.1 New England North West Regional Plan 2041

The *New England North West Regional Plan 2041* (RP; DPE 2022) establishes a 20-year strategic land use planning framework for the region, aiming to protect and enhance the region's assets and plan for a sustainable future. Design principles within this guideline which are relevant to the proposal include:

- Outcome 12: Protect regional biodiversity and areas of High Environmental Value.
- Outcome 17: Celebrate local character.

4.2 Armidale Regional Local Strategic Planning Statement

The *Advancing our region: Toward 50,000 Local Strategic Planning Statement* (LSPS; ARC 2024) aims to meet the community's future social, economic and environmental needs by addressing important strategic land use planning and development issues. The LSPS identifies planning priorities, actions, monitoring and reporting to achieve its strategic vision and key objectives. The Armidale region is part of the New England Renewable Energy Zone (REZ) which is the largest REZ in Australia. Future renewable energy projects, including the proposal will need to co-exist with rural industries and the LSPS outlines principles which can help this happen including:

- B.3 – Our indigenous history and heritage - *Our region embraces our First Nation's history and heritage which continues to shape the future of our region.*
- C.2 – Our biodiversity and national parks - *Our region cherishes our globally significant world heritage natural areas and extensive natural landscapes.*
- C.4 – Our renewable energy - *Our region is a climate-positive community that supports and plays an active role in achieving Australia's carbon targets.*

While of greater relevance to the proposal design, this guideline also informs the mitigation measures identified in this LVIA.

4.3 Armidale Regional Local Environment Plan 2012

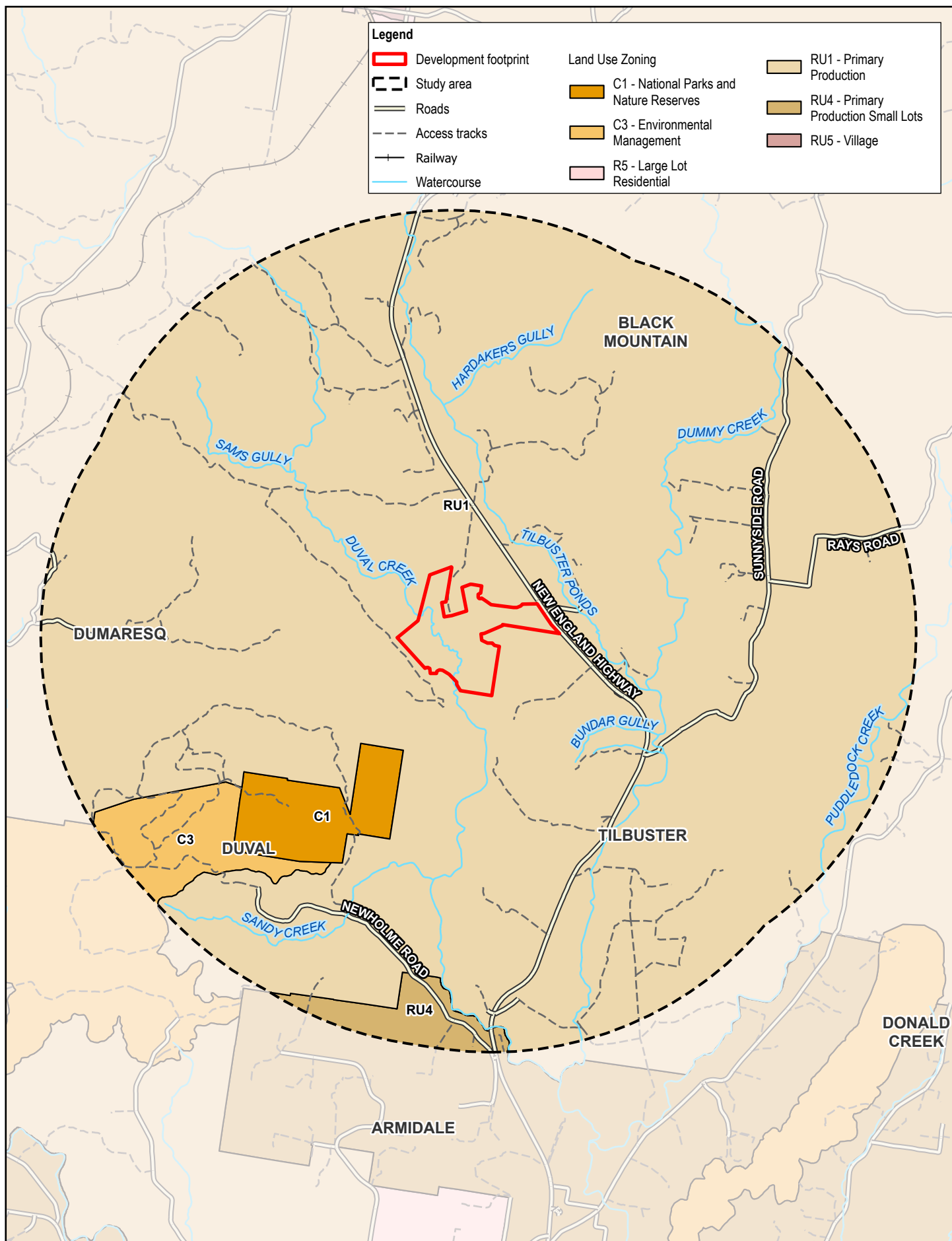
The proposal is located within the Armidale Regional LGA and is therefore subject to relevant planning controls including those in the *Armidale Regional Local Environment Plan 2012* (LEP). Most of the land within the study area is zoned as RU1 (Primary Production), including the proposal site, refer to Figure 4.1. The Duval Nature Reserve south-west of the proposal site is zoned as C1 (National Parks and Nature Reserve) and C3 (Environmental Management), and an area of RU4 (Primary Production Small Lots) is located at the southern extent of the study area.

The objectives of each zone relevant to the LVIA are outlined in Table 4.1.

Table 4.1 Key land zone objectives

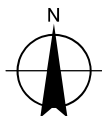
Land zones	Key objectives relevant to LVIA
RU1 Primary Production	To encourage diversity in primary industry enterprises and systems appropriate for the area. To minimise the fragmentation and alienation of resource lands. To minimise conflict between land uses within this zone and land uses within adjoining zones.
RU4 Primary Production Small Lots	To encourage and promote diversity and employment opportunities in relation to primary industry enterprises; particularly those that require smaller lots or that are more intensive in nature. To minimise conflict between land uses within this zone and land uses within adjoining zones.

Land zones	Key objectives relevant to LVIA
C1 National Parks and Nature Reserve	To enable the management and appropriate use of land that is reserved under the <i>National Parks and Wildlife Act 1974</i> or that is acquired under Part 11 of that Act. To identify land that is to be reserved under the <i>National Parks and Wildlife Act 1974</i> and to protect the environmental significance of that land.
C3 Environmental Management	To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values. To provide for a limited range of development that does not have an adverse effect on those values.



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56



Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Land zoning

FIGURE 4-1

5. Existing landscape and visual environment

5.1 Regional and local context

The proposal is located within the Armidale Regional LGA, approximately 15 km north of the Armidale city centre, in the New England/North West region of NSW, refer to Figure 1.1. The New England region is known for its natural landscapes including waterfalls, gorges and open plains. Other major towns in the region include Glen Innes, Tamworth, Moree, Inverell, Narrabri and Tenterfield. The A15 New England Highway runs north to south through the town of Armidale and adjacent to the proposal site, and the B78 Waterfall Way runs east to west, connecting Armidale to the A1 Pacific Highway on the NSW's east coast.

The proposal would be located within the rural suburb of Black Mountain, with the suburbs of Dumaresq to the west and Duval to the south-west. The proposal site also borders the suburb of Tilbuster to the south. The A15 New England Highway traverses the study area and connects with the eastern boundary of the proposal site just north of the Tilbuster suburb boundary. Other roads within the study area include Sunnyside Road and Rays Road to the east, and Newholme Road to the south. The Duval Nature Reserve is located south-west of the proposal, within surrounding bushland located to the west, east and north. A network of drainage paths and tributaries also exist within the study area, including Tilbuster Ponds adjacent to the A15 New England Highway to the east, and Duval Creek which traverses the proposal site. The proposal site is located immediately south-east of the approved Stage 1 project site.

5.2 Existing environment

The following section provides a summary of the existing landscape and visual environment of the study area including a baseline context study to establish the existing landscape of the area and its sensitivity. The review is based on desktop analysis, site visit field work and mapping of GIS data to identify the existing local landscape factors within the study area.

The landscape baseline context analysis includes:

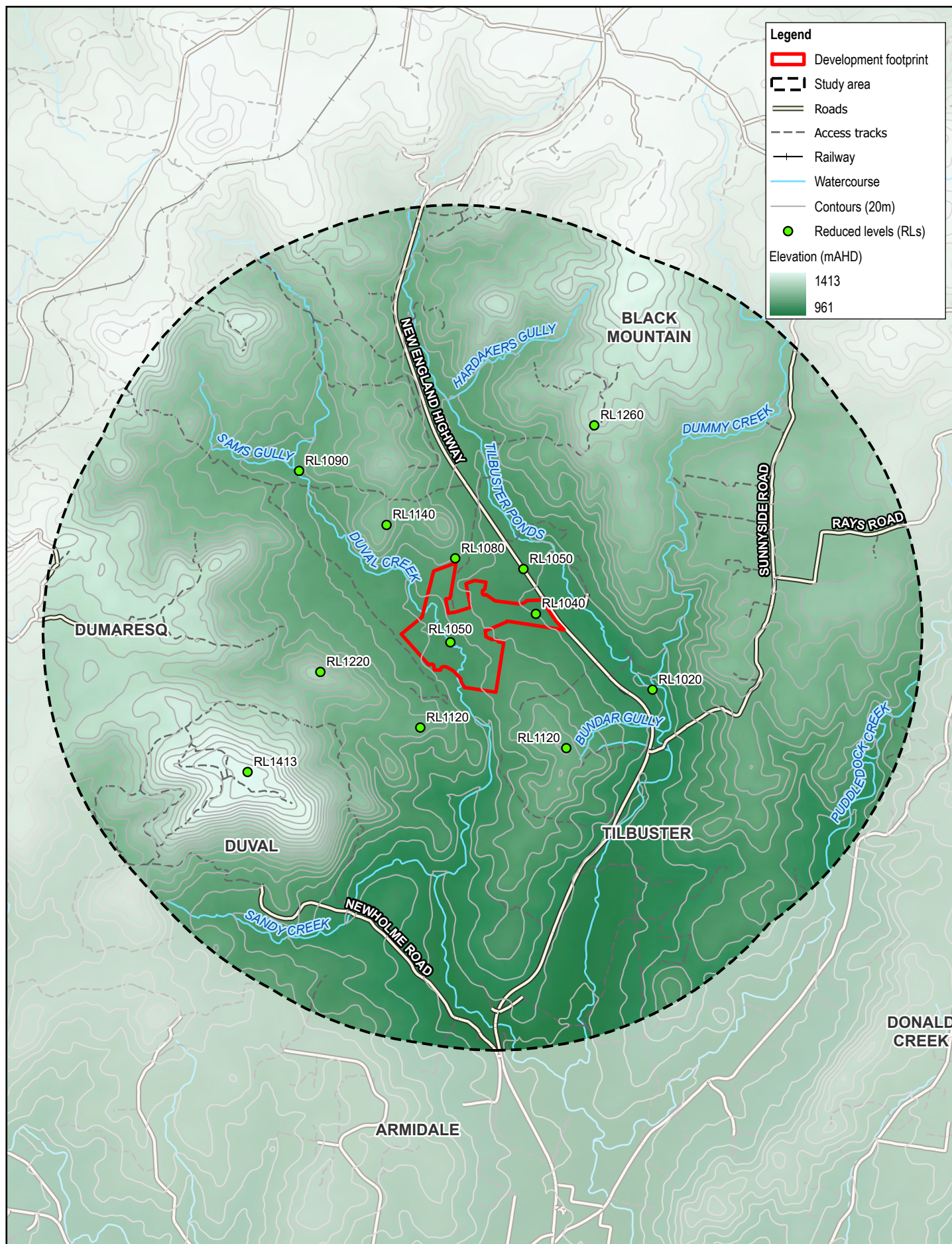
- Topography and hydrology
- Vegetation communities
- Land use and built form
- Heritage and Indigenous cultural values
- Landscape character

5.2.1 Topography and hydrology

The topography within the study area predominately comprises flat and gently undulating rural terrain around the proposal site and along the A15 New England Highway to the east and north, refer to Figure 5.1. The land slopes up sharply to the west of the proposal site towards the Duval Nature Reserve and surrounding bushland. The land slopes up more gradually to the north of the proposal and to the east of the A15 New England Highway Reduced levels (RL) 1,050 m and Tilbuster Ponds, forming vegetated slopes and distinct ridgelines which are visible from the proposal site.

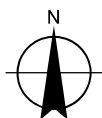
RLs range from the highest peak in the Duval Nature Reserve (RL 1,413 m) to the lowest point at the confluence of Tilbuster Ponds and Dummy Creek (RL1020m). The lowest RLs are generally associated with natural drainage paths and waterbodies within the study area including Tilbuster Ponds and Duval Creek (RL 1,050 m), while the highest RLs are associated with the hilly, vegetated terrain to the east and west of the proposal site.

The steep terrain would likely screen views of the proposal to visual receivers to the west and north-west while elevated residential dwellings to the east and north-east may have views to the proposal. Motorist views of the proposal from the A15 New England Highway would be likely due to the open, flat land on which the proposal sits.



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56



Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Topography

FIGURE 5-1

5.2.2 Vegetation communities

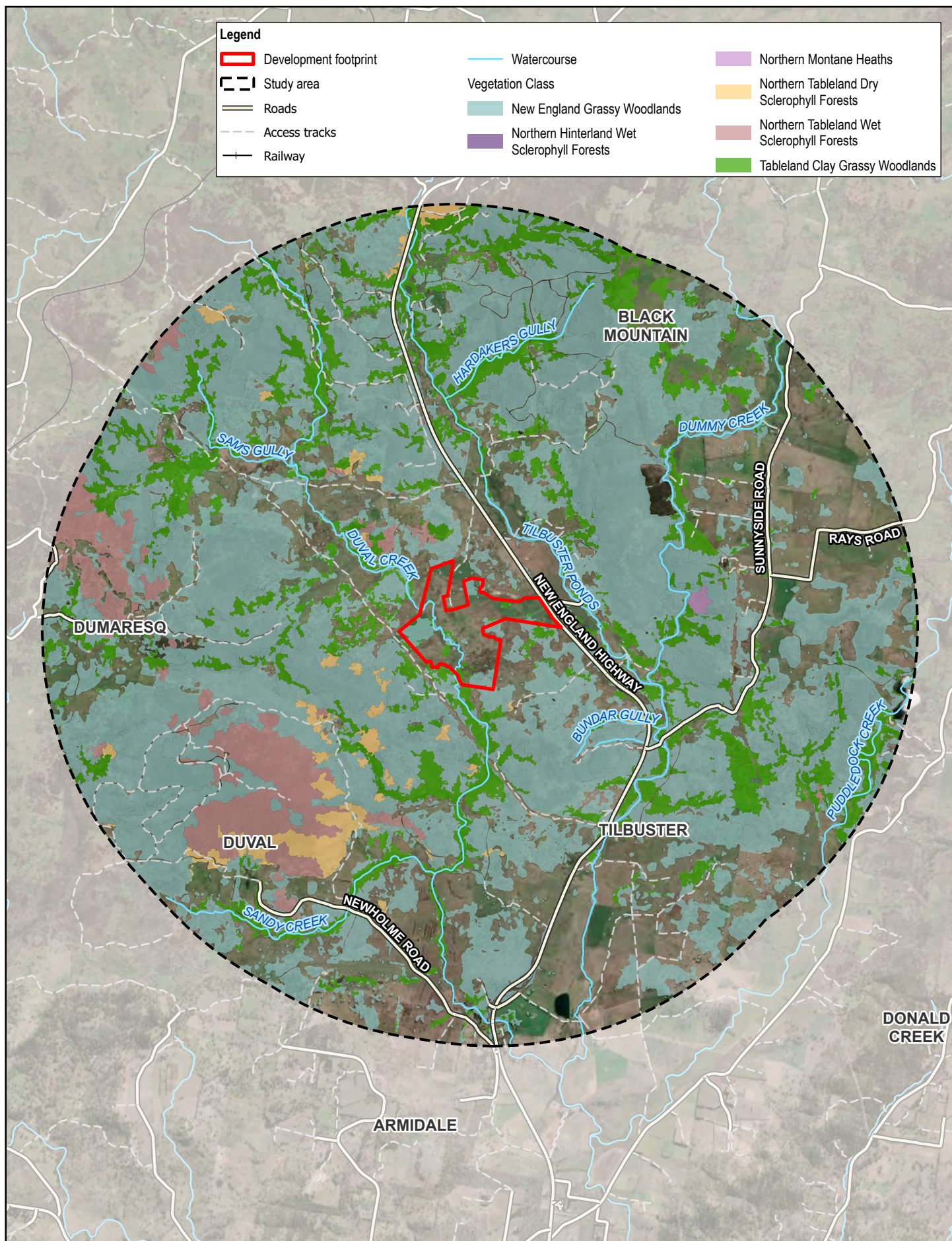
The study area consists of highly modified, cleared land for rural cropping and grazing, with sparse, remnant trees within paddocks and along drainage paths and creek lines. Densely vegetated slopes are located to the north, east and west of the proposal site. Both native and exotic plants are associated with residential gardens, generally immediately adjacent to dwellings.

Figure 5.2 and Table 5.1 outlines the most prominent vegetation classes within the study area and where they are located in relation to the proposal.

Table 5.1 **Vegetation classes**

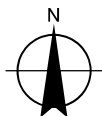
Plant community type (PCT)	Description	Location
New England Grassy Woodlands	Open eucalypt woodland reaching up to 25 m tall on the deepest, most fertile soils. Grassy groundcover with erect, generally sparse shrubs. Canopy is dominated by eucalypt species, as well as <i>Angophora floribunda</i> (rough-barked apple).	The New England Grassy Woodlands is the most prominent vegetation class in the study area, covering most of the land surrounding the proposal site. Small patches of the vegetation class exist on the mostly cleared proposal site.
Northern Tableland Dry Sclerophyll Forests	Low open dry eucalypt forest and woodland reaching up to 20 m tall with a prominent sclerophyll shrub stratum and sparse groundcover. Dominant tree species include eucalypt species as well as <i>Callitris endlicheri</i> (black cypress pine).	Generally associated with the Duval Nature Reserve. Small patches of Northern Tableland Dry Sclerophyll Forests are located just west of the proposal site and at the far north extents of the study area.
Northern Tableland Wet Sclerophyll Forests	Tall eucalypt forest reaching 30-40 m in height with an open subcanopy of non-rainforest trees, scattered understorey of shrubs and a dense groundcover of grasses and herbs. Canopy is dominated by eucalypt species.	Predominately associated with Duval Nature Reserve. Areas of Northern Tableland Wet Sclerophyll Forests are located just north of the proposal and at the western extent of the study area.
Tableland Clay Grassy Woodlands	Open eucalypt forest and woodland reaching up to 15-30 m tall, with a sparse shrub stratum and dense and relatively diverse groundcover. Canopy is dominated by eucalypt species and groundcovers are dominated by tussock grasses and herbs.	Scattered patches of Tableland Clay Grassy Woodlands across the study area, often associated with drainage paths and creek lines.

The proposal is located within the New England Tableland Bioregion as identified in the NSW National Parks and Wildlife Service (NPWS) Bioregions of NSW. This bioregion lies within the temperate to cool temperate climate zone of NSW and is characterised by a stepped plateau of hills and plains on Permian sedimentary rocks, intrusive granites and Tertiary basalts.



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56



Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Vegetation communities

FIGURE 5-2

5.2.3 Land use and built form

The study area predominately comprises primary production land uses including grazing native vegetation and grazing pastures, refer to Figure 5.3. The proposal site comprises pasture grazing land. Other major land uses within the study area include cropping east of the A15 New England Highway, nature conservation associated with Duval Nature Reserve to the west, and a pocket of plantation forests adjacent to Dummy Creek to the east. Residential and farm infrastructure uses are scattered throughout the study area, predominately located north, south and east of the proposal site.

Built structures within the study area mostly include one and two-storey residential dwellings on large lot properties with associated rural infrastructure including sheds, barns and other storage facilities.

Transport and communication land uses are generally associated with important road infrastructure including the A15 New England Highway, providing an important north-south motorist route between Armidale to the south and Glenn Innes to the north.

5.2.4 Heritage and Indigenous cultural values

Indigenous heritage

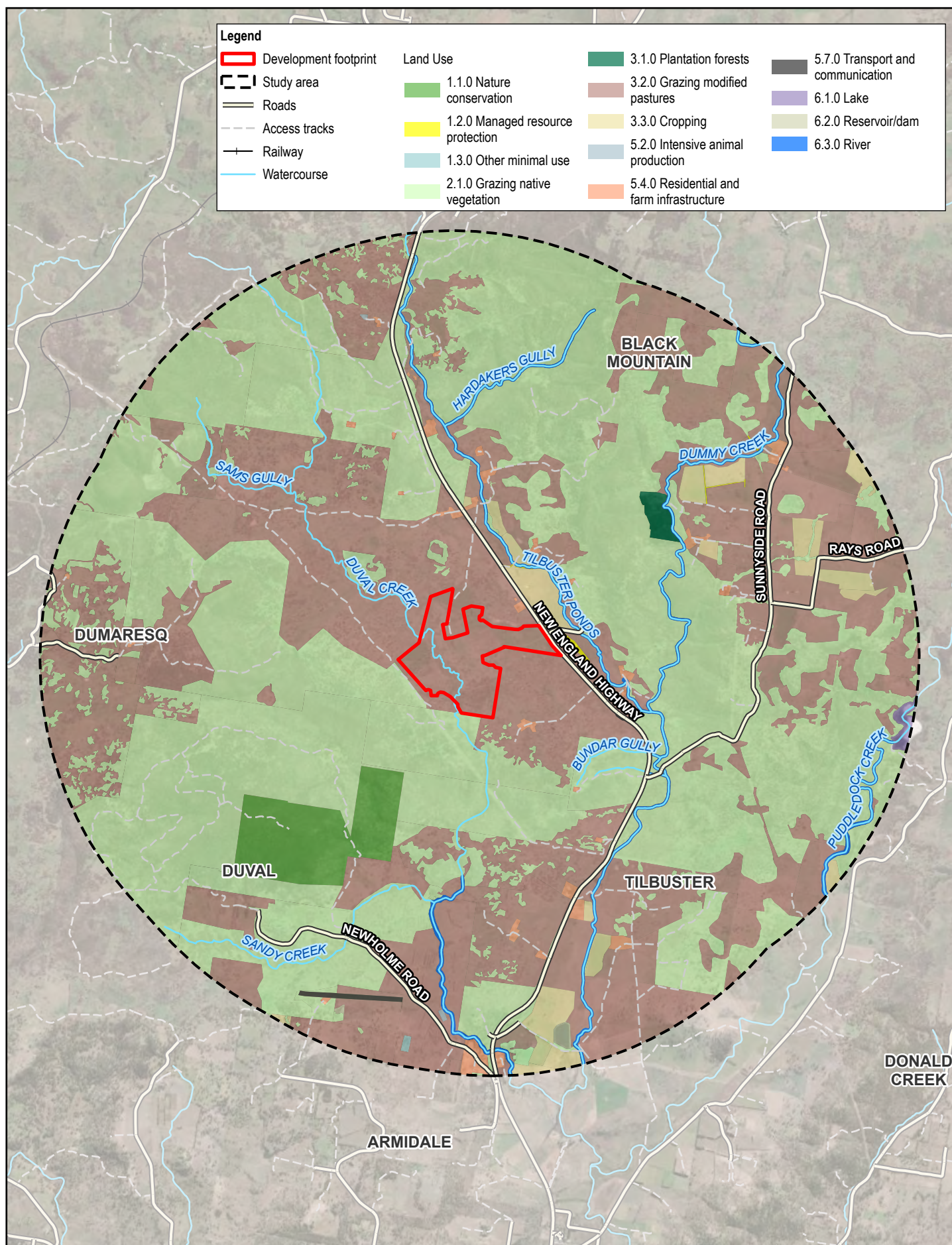
A number of Indigenous heritage items have been identified within the study area, refer to Figure 5.4. There are no Indigenous heritage items located within the development footprint, however, many items are located in close proximity to the proposal. Large clusters of heritage items are located immediately north and north-west of the proposal. The remaining Indigenous heritage items are scattered to the south and south-east. The Indigenous cultural values associated with the heritage items should be considered and preserved where possible.

Non-indigenous heritage

The following are two local heritage items identified within the study area which are listed in the Armidale Regional LEP, refer to Figure 5.4:

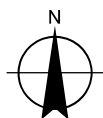
- Listing I191 (Homestead, “Newholme”) - regionally significant building located at the western end of Newholme Road in the south-west of the study area.
- Listing I242 (Pinch Flat) - heritage listed property located at 12150 New England Highway, Black Mountain, north of the proposal site.

Local heritage item #I191 is located about five kilometres from the proposal site and sits south-west of the steep terrain associated with Duval Nature Reserve. This existing topography would likely screen views of the proposal from this heritage listed building. Local heritage item #I242 is located within proximity of the proposal and could have views of the proposal, hence is considered in the detailed visual impact assessment.



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56



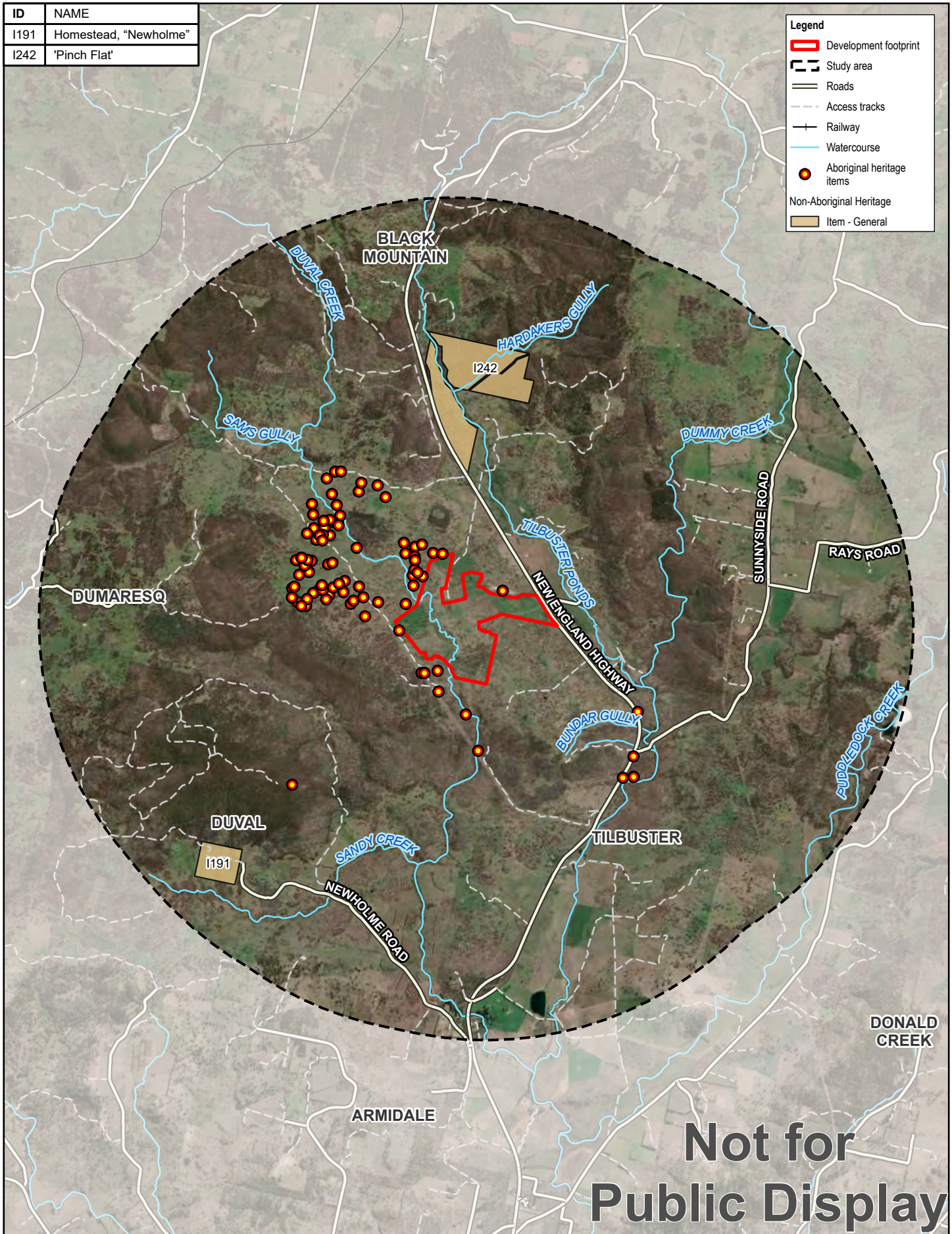
Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

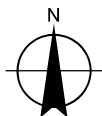
Land use

FIGURE 5-3

ID	NAME
I191	Homestead, "Newholme"
I242	'Pinch Flat'



Paper Size ISO A4
 0 0.5 1 1.5 2
 Kilometres
 Map Projection: Transverse Mercator
 Horizontal Datum: GDA2020
 Grid: GDA2020 MGA Zone 55



Enerparc Australia Pty Ltd
 Tilbuster 2 Solar Farm
 Landscape Character and Visual Impact Assessment

Project No. 12636761
 Revision No. 0
 Date 23/10/2024

Heritage

FIGURE 5-4

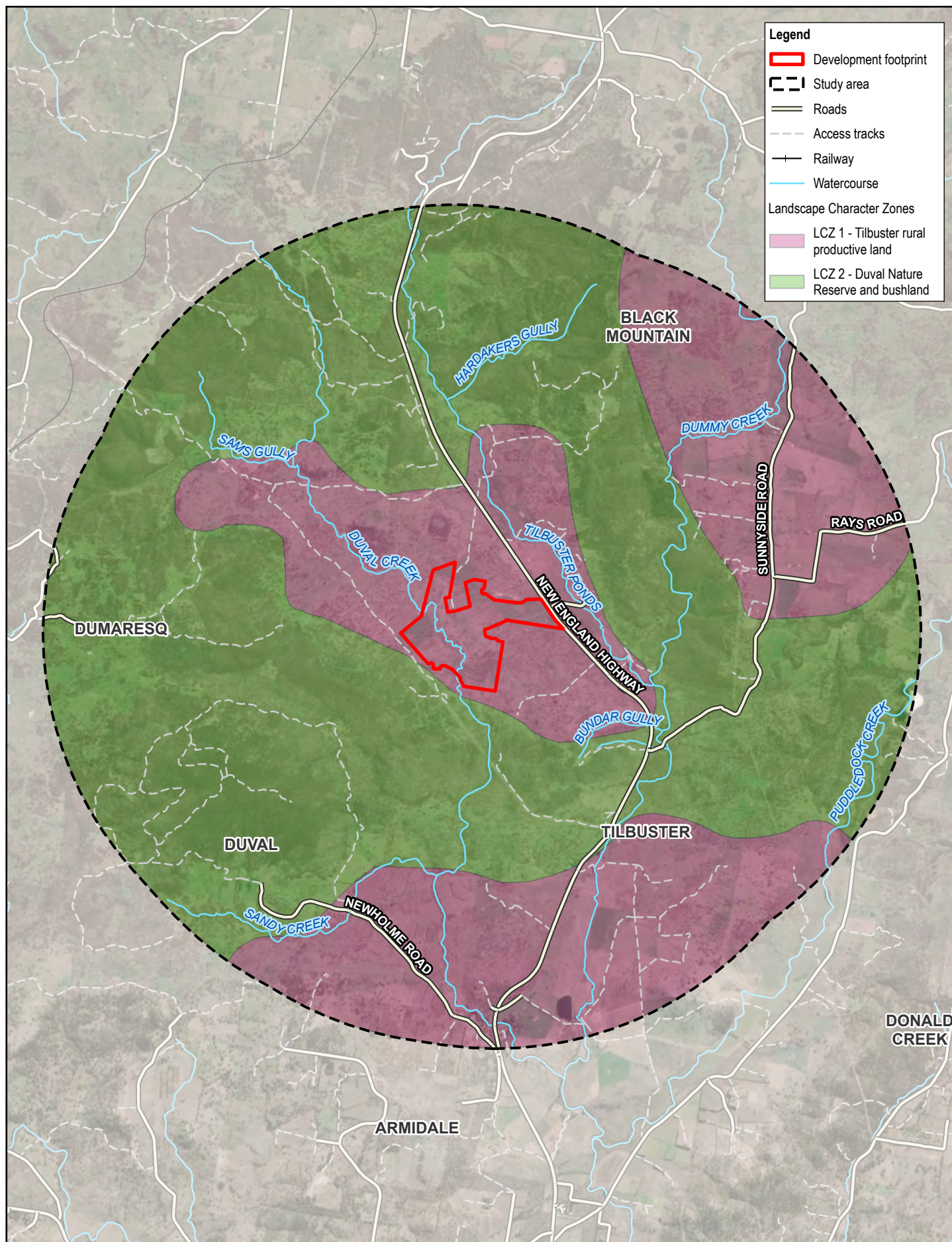
5.2.5 Landscape character

Landscape character relates to the built, natural, cultural and community aspects that make a place unique. A LCZ can be defined as “*an area of landscape with similar properties or strongly defined spatial qualities, distinct from areas immediately nearby*” (Transport for NSW, 2023). LCZs are designated by landscape characteristics that can easily be described by common physical landscape features.

Two distinct LCZs were identified in the study area based on the built, natural and cultural features of the landscape identified in the analysis of the existing environment, refer Figure 5.5.

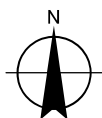
The two identified LCZs in the study area include:

- **LCZ 1** – Tilbuster rural productive land.
- **LCZ 2** – Duval Nature Reserve and bushland.



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56



Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Landscape character zones

FIGURE 5-5

LCZ1 – Tilbuster rural productive land

LCZ1 makes up the largest portion of the study area and comprises rural living and agricultural land uses, refer to Figure 5.5. It is characterised by a generally flat and gently undulating rural landscape with scattered residential dwellings and paddocks for grazing and cropping. The key characteristics of LCZ1 are outlined in Table 5.2 and shown in Figure 5.6 to Figure 5.9.

Table 5.2 LCZ1 key characteristics

Landform	Gently undulating and moderately sloping terrain. Relatively open with views across cleared paddocks of hills beyond.
Vegetation	Areas of hedgerow vegetation is occasionally present of varying heights. Tree vegetation is typically located along property boundaries, adjacent to roads and along waterways such as Duval Creek and Tilbuster Ponds.
Waterways/reserves	Tributary network of drainage lines including creeks and farm dams.
Land use	Productive farming paddocks generally cleared for agricultural uses including grazing, cropping and livestock rearing.
Infrastructure/Built form	Built form includes rural dwellings, farm buildings and associated sheds and ancillary infrastructure. Rural dwellings are typically one to two-storeys with timber post and rail or wire boundary fencing. Road network comprises of both arterial roads such as the New England Highway and unsealed access roads private driveways to properties. Existing overhead powerlines are located intermittently throughout the LCZ.



Figure 5.6 Typical aerial view (source: Nearmaps)



Figure 5.7 Typical ancillary buildings and infrastructure



Figure 5.8 Typical cleared, flat rural land

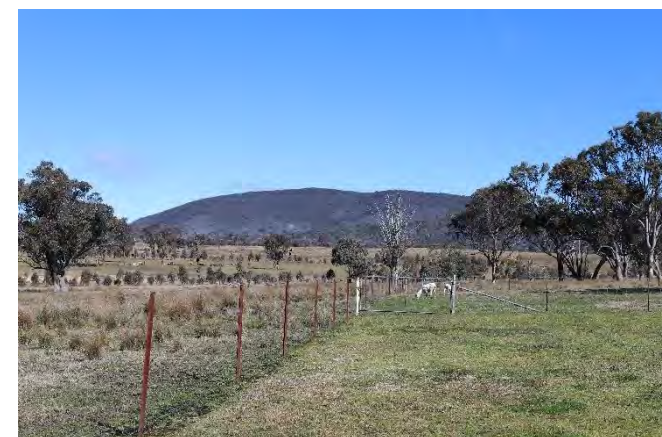


Figure 5.9 Typical rural property with associated fencing

LCZ2 – Duval Nature Reserve and bushland

LCZ2 comprises sloping, densely vegetated terrain to the north, east and west of the proposal. Vegetation becomes more sparse south of the proposal site. LCZ2 is generally associated with Duval Nature Reserve to the west and other connected areas of bushland, refer to Figure 5.5. The key characteristics of LCZ2 are outlined in Table 5.3 and shown in Figure 5.10 to Figure 5.13.

Table 5.3 LCZ2 key characteristics

Landform	Sloping, hilly terrain. Elevated views from slopes and ridgelines towards surrounding pasture land.
Vegetation	Remnant, dense bushland on hilly terrain, interspersed with patches of cleared land for agricultural uses and residential dwellings.
Waterways/reserves	Tributary network of drainage lines including farm dams and creeks generally located in valleys between slopes.
Land use	Cleared corridors on ridgelines for access roads, transmission lines and walking tracks.
Infrastructure/Built form	Built form includes rural dwellings, farm buildings and associated sheds and ancillary infrastructure. Rural dwellings are typically one to two-storeys with timber post and rail or wire boundary fencing. Built forms are sparse within the LCZ, generally located in small clearings, enclosed by the bushland. Road network comprises predominately unsealed access roads and private driveways to limited residential dwellings and properties setback from the New England Highway.



Figure 5.10 *Typical aerial view (Nearmaps)*



Figure 5.11 *Typical bushland on sloping terrain*



Figure 5.12 *Typical unsealed access road within bushland*



Figure 5.13 *Typical bushland*

6. Landscape character assessment

6.1 LCZ1 - Tilbuster rural productive land

Table 6.1 describes the anticipated changes and provides an assessment of the landscape character impacts based on sensitivity and magnitude to determine an overall landscape character impact rating for LCZ1.

Table 6.1 LCZ1 landscape character impact assessment

Anticipated change to landscape character	The proposal would predominately occur within LCZ1 on cleared productive land and would introduce new built form into the rural landscape. The key elements include solar panels, internal access roads and other associated infrastructure.
Sensitivity	Low LCZ1 has been highly modified from its natural state with clear human modifications including widespread clearance of native vegetation and the presence of roads, dwellings and ancillary agricultural buildings. LCZ1 is considered to have some capacity to absorb the type of change envisaged by the solar energy development due to the modified landscape. The landscape elements that contribute to LCZ1's quality would remain generally unchanged.
Magnitude	Moderate The proposal would likely cause a discernible change to the character of LCZ1 due to the addition of large-scale solar infrastructure within a mostly rural, agricultural area. The change would be partially out of scale with the landscape character, and at odds with the local landform pattern. Views of the proposal are likely to be quite open due to the relatively flat terrain and cleared vegetation. The proposal would occupy a relatively small portion of the LCZ.
Landscape character impact	Moderate-Low

6.2 LCZ2 - Duval Nature Reserve and bushland

Table 6.2 describes the anticipated changes and provides an assessment of the landscape character impacts based on sensitivity and magnitude to determine an overall landscape character impact rating for LCZ2.

Table 6.2 LCZ2 landscape character impact assessment

Anticipated change to landscape character	There are no anticipated changes to LCZ2 as the proposal is not located within LCZ. The western extent of the proposal site is located directly adjacent to part of LCZ2 associated with Duval Nature Reserve. There may be indirect impacts on the bushland due to close proximity to the proposal, however these would likely be minimal.
Sensitivity	High High landscape value is associated with Duval Nature Reserve and surrounding bushland to the north, east and west of the proposal. LCZ2 provides important vegetation coverage and ecological values in a predominately cleared, modified landscape. The landscape elements that contribute to LCZ2's quality would remain generally unchanged. LCZ2 has been somewhat modified from its natural state with evidence of human modifications including some vegetation clearing for driveways, walking tracks and residential properties.

Magnitude	Low The proposal is unlikely to change the character of LCZ2 as it does not directly interact with the LCZ. Views of the proposal from within the LCZ are likely to be limited to close range where screening from existing vegetation and topography is absent.
Landscape character impact	Moderate

7. Preliminary visual impact assessment

7.1 Sensitive receivers

Private and public receivers were identified within a 4 km radius of the proposal using a combination of desktop analysis and site visits. Visual receivers were identified using the following parameters from the Technical Supplement:

- *‘identify all viewpoints from public roads and rail lines within 2.5 km of the proposed development’.*
- *‘identify other public and private viewpoints within 4 km of the proposed development’.*

Refer to Figure 7.1 for receiver locations. The reference numbers for receivers are based on the following:

- ‘R’ receivers: private (residential) receivers.
- ‘P’ receivers: public receivers.

A total of 23 receivers were included in the preliminary analysis, including 21 private receivers and two public receivers. The public receivers are representative of the major roads located within 2.5 km of the proposal. These public viewpoints were measured from the closest point of each road to the proposal, to indicate the ‘worst-case’ scenario of visual impacts on public receivers.

7.2 Zone of theoretical visibility

A ZTV analysis (refer to Figure 7.1) was undertaken for the proposal, using parameters outlined in Section 2.6.1 of this LVIA. The ZTV reveals a patchwork of visibility spanning across the extent of study area, in response to the varying topography.

Findings from the ZTV include:

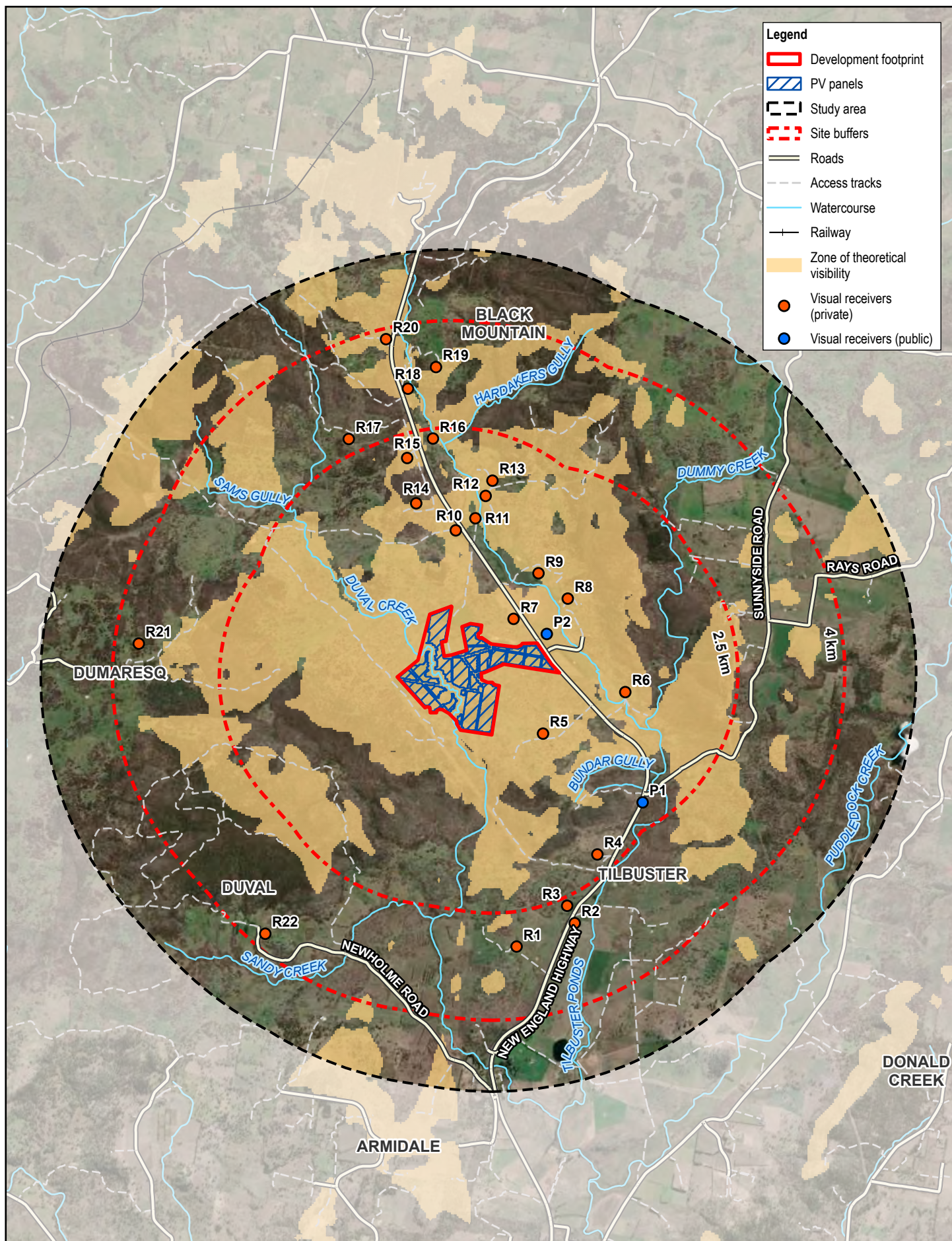
- Land immediately around the proposal site in all directions would likely have views towards the proposal due to the relatively flat terrain around the proposal site.
- Visual receivers to the south-east and west are unlikely to have views of the proposal due to the steep, forested terrain associated with Duval Nature Reserve separating the receivers from the proposal site.
- Most visual receivers to the north and east of the proposal could have potential views of the solar farm due to the predominately flat, agricultural land in this area.

It is noted that the ZTV analysis is based only on topographical conditions and does not consider other screening factors, including vegetation and other structures.

7.3 Preliminary visual impact assessment

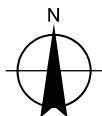
A preliminary visual assessment was undertaken including plotting of the visual receivers using the preliminary visual assessment tool taken from the Technical Supplement (Figure 7.2) to determine the viewpoints that require further assessment.

The relative height difference between each viewpoint and the proposal was calculated using the lowest (1,038 m AHD) and highest (1080 m AHD) points of the proposal. The elevation of the proposal includes an offset of 4 m above ground level to accommodate for the maximum height of the solar panels across the site.



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56



Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Zone of theoretical visibility

FIGURE 7-1

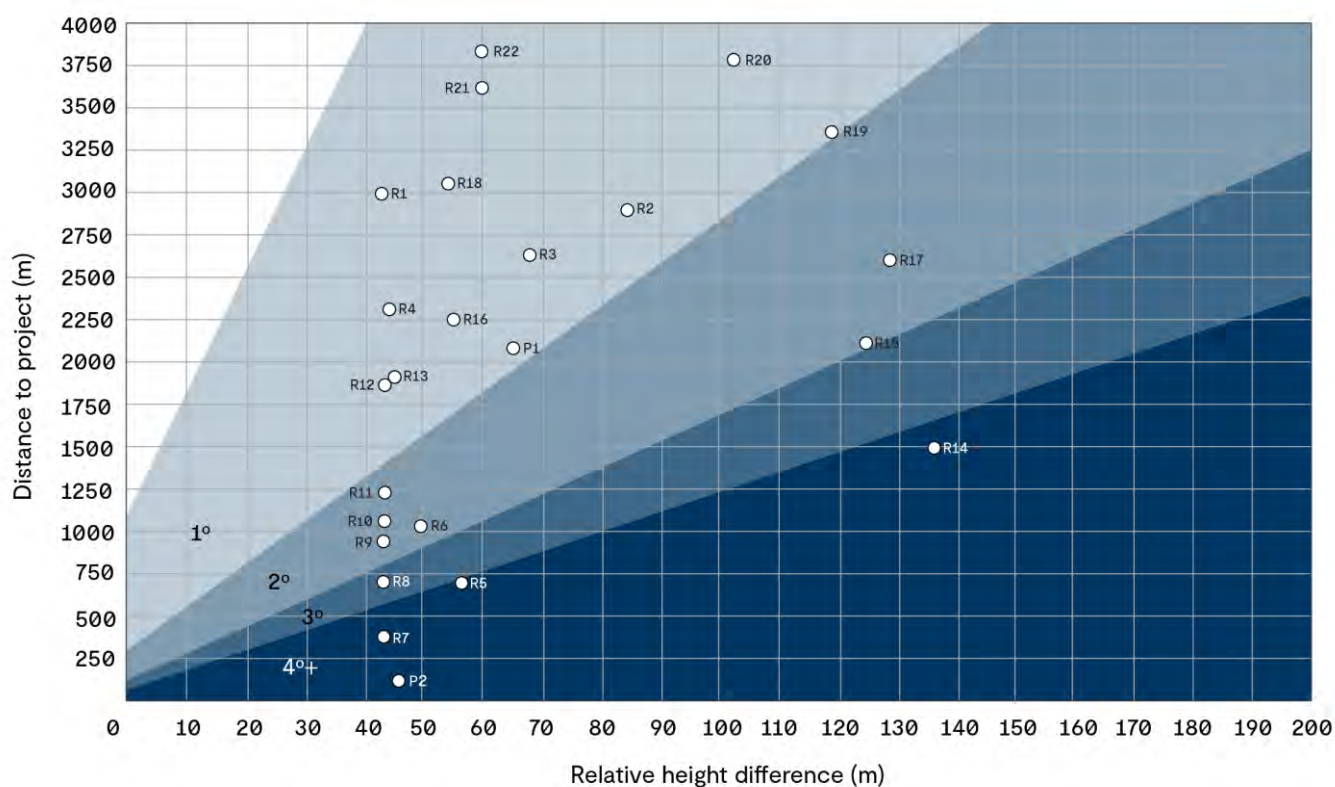


Figure 7.2 Preliminary assessment tool

Table 7.1 contains the preliminary visual assessment results. Viewpoints outside of the ZTV do not require a detailed visual assessment.

Table 7.1 Preliminary visual assessment results

Receiver	Distance to Proposal (m)	Elevation (mAHD)	Relative height difference (m)	Horizontal field of view (degrees)	Horizontal field of view (category)	Sector (prelim tool DPE)	Assessment	Within ZTV?	Assessment required?
P1	2094	1015	65	38	31-40°	1°	No assessment required	No	No
P2	167	1034	46	122	71-130°	4°+	Assessment required	Yes	Yes
R1	2990	1043	42	33	31-40°	1°	No assessment required	No	No
R2	2874	996	84	33	31-40°	1°	No assessment required	No	No
R3	2635	1012	68	35	31-40°	1°	No assessment required	No	No
R4	2275	1037	43	40	31-40°	1°	No assessment required	No	No
R5	707	1094	56	106	71-130°	4°+	Assessment required	Yes	Yes
R6	1030	1030	50	47	41-50°	2°	Assessment required for all viewpoints except road/rail	Yes	Yes
R7	273	1046	42	148	130°+	4°+	Assessment required	Yes	Yes
R8	738	1046	42	80	71-130°	3°	Assessment required	Yes	Yes
R9	947	1052	42	81	71-130°	2°	Assessment required	Yes	Yes
R10	1031	1070	42	58	41-50°	2°	Assessment required for all viewpoints except road/rail	Yes	Yes

Receiver	Distance to Proposal (m)	Elevation (mAHD)	Relative height difference (m)	Horizontal field of view (degrees)	Horizontal field of view (category)	Sector (prelim tool DPE)	Assessment	Within ZTV?	Assessment required?
R11	1246	1060	42	54	41-50°	2°	Assessment required for all viewpoints except road/rail	Yes	Yes
R12	1838	1065	42	44	41-50°	1°	No assessment required	Yes	No
R13	1860	1082	44	45	41-50°	1°	No assessment required	Yes	No
R14	1497	1174	136	46	41-50°	4°+	Assessment required	Yes	Yes
R15	2300	1162	124	38	31-40°	2°	Assessment required for all viewpoints except road/rail	Yes	Yes
R16	2250	1093	55	38	31-40°	1°	No assessment required	No	No
R17	2678	1167	129	31	31-40°	2°	Assessment required for all viewpoints except road/rail	No	No
R18	3080	1092	54	30	21-30°	1°	No assessment required	Yes	No
R19	3328	1157	119	29	21-30°	1°	No assessment required	Yes	No
R20	3790	1140	102	25	21-30°	1°	No assessment required	Yes	No
R21	3614	1286	248	21	21-30°	1°	No assessment required	No	No
R22	3808	1098	60	22	21-30°	1°	No assessment required	No	No

8. Detailed visual impact assessment

Based on the preliminary visual assessment and community consultation, a total of 14 visual receivers were considered and assessed during the site inspection. Ten of these were identified as requiring further assessment based on the preliminary visual impact assessment. The remaining four (R12, R13, R17, R18) were considered during fieldwork based on community and sensitivity concerns, with R17 being identified as a local heritage listed property.

During the site inspection, some visual receivers were identified as having no line of sight to the proposal, and hence have not been included in the detailed visual impact assessment. Table 8.1 identifies the visual receivers that do not require detailed assessment.

Table 8.1 Visual receivers not requiring a detailed viewpoint assessment

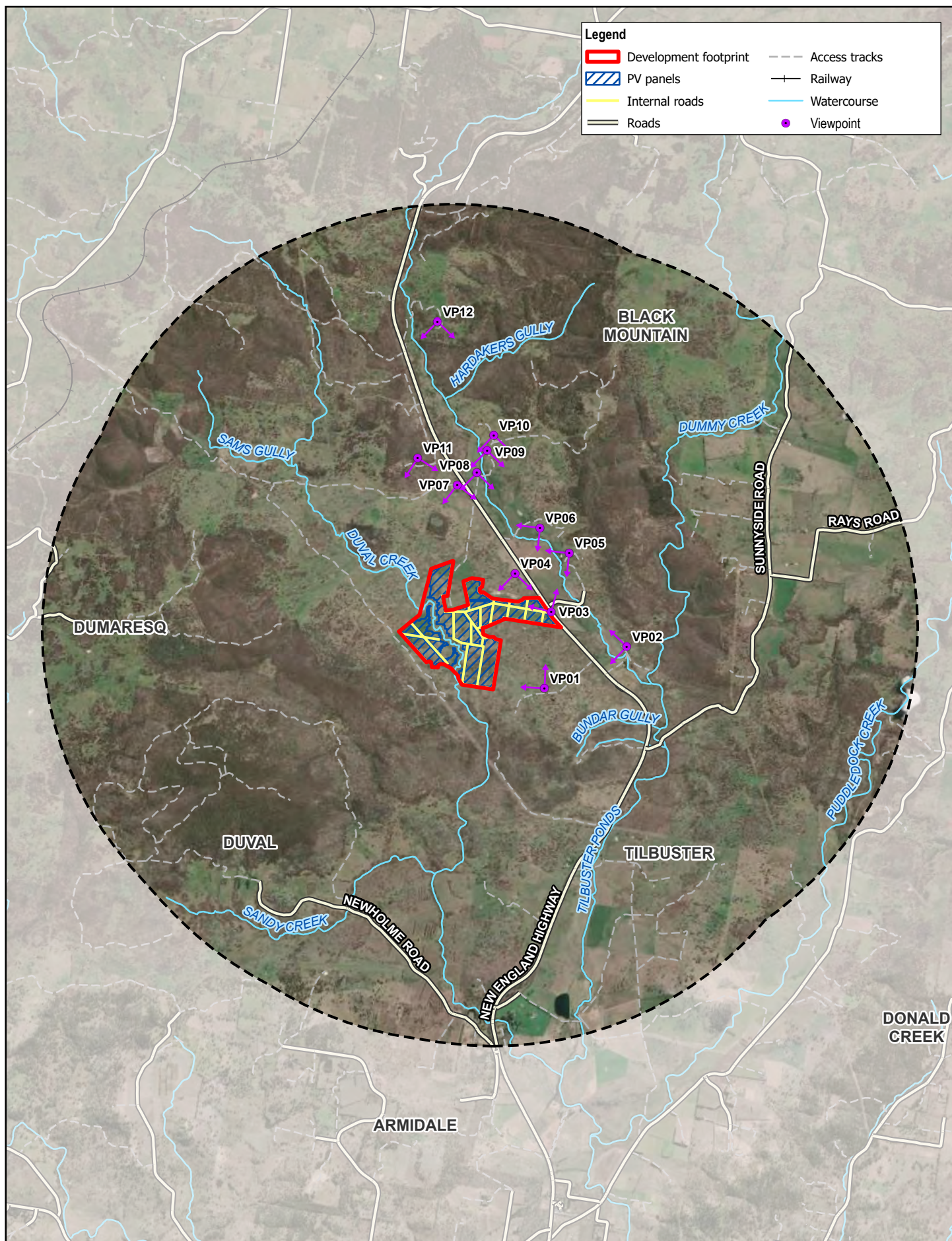
Visual receiver	Location/address	Photo	Justification
R15 (Caringle)	12175 New England Hwy, Black Mountain NSW 2365		View south from the back of the residential dwelling. The land immediately south of the residential dwelling at this location slopes up sharply. This steep slope as well as existing vegetation along the ridgeline obscures views of the proposal from the dwelling.
R16 (Pinch Flat)	12150 New England Hwy, Black Mountain NSW 2365		View south-west from the front of the residential dwelling. The land immediately south-west of the residential dwelling at this location slopes up towards the New England Highway. The topography and existing vegetation along the property boundary obscures views of the proposal from the dwelling.

A total of 12 viewpoints are included in the detailed visual impact assessment, representing the remaining 12 visual receivers accessed during the site inspection. These visual receivers may have a line of sight to the proposal and are summarised in Table 8.2 and shown in Figure 8.1.

The wireframe models, photomontages and magnitude grid tools for each viewpoint are provided in Appendix A.

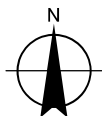
Table 8.2 *Visual receivers requiring a detailed viewpoint assessment*

Viewpoint no.	Viewpoint name	Visual receiver represented	Location / Address
VP01	Snake Gully	R5	11853 New England Highway, Tilbuster, NSW, 2350
VP02	Taits Gully	R6	11768 New England Highway, Tilbuster, NSW, 2350
VP03	New England Highway	P2	New England Highway, Tilbuster, NSW, 2350
VP04	Varuna	R7	11947 New England Highway, Black Mountain, NSW, 2365
VP05	Hillwood	R8	11924 New England Hwy, Black Mountain NSW 2350
VP06	Tilthorpe	R9	11966 New England Hwy, Black Mountain NSW 2365
VP07	Annaleey	R10	12029 New England Hwy, Black Mountain NSW 2365
VP08	Tilbuster North	R11	12024 New England Hwy, Black Mountain NSW 2365
VP09	Ravenswood (south)	R12	12008 New England Hwy, Black Mountain NSW 2365
VP10	Ravenswood (north)	R13	12008 New England Hwy, Black Mountain NSW 2365
VP11	Minmai	R14	12173 New England Hwy, Black Mountain NSW 2365
VP12	Uralba	R19	12250 New England Hwy, Black Mountain NSW 2365



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56



Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Landscape Character and Visual Impact Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Viewpoints

FIGURE 8-1

8.1 VP01 – Snake Gully



Figure 8.2 Baseline panoramic photograph – VP01

Table 8.3 VP01 viewpoint summary and assessment

Represented visual receivers	R5
Distance to proposal	550 m
Viewpoint type	Residential dwelling (secondary view)
View location and direction	Coordinates: 30°23'48"S 151°40'43"E VP01 represents the view from the residential dwelling at 11853 New England Highway, Tilbuster (Snake Gully). This private property could not be accessed, hence the panorama (Figure 8.1) was taken from the southern edge of the proposal site, approximately 1.1 km north of the dwelling.
Description of existing view	VP01 comprises generally open views over a cleared rural landscape. The foreground consists of post and wire rural fencing and a cattle grid along an unsealed, dirt road that slopes up gently to the west and slopes down slightly to the east. Remnant trees are scattered throughout the paddocks, somewhat filtering views across the cleared land. Densely vegetated hills form a distinct ridgeline extending east to west in the background of the view.
Anticipated change to view	Construction Earthworks, construction stockpiling and relatively minor tree and vegetation clearing would be visible to the north. Operation New solar array, security fencing and internal access tracks would be visible across the open rural land to the north.
Viewpoint sensitivity	Moderate – VP01 represents a primary view from a residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Moderate – Large expanse of extensively cleared, flat and gently undulating pastoral land with long distance views of hilly, vegetated terrain with distinct ridgelines. – Dispersed yet evident presence of human settlement including highly modified landscapes and agricultural fencing and infrastructure.
Overall visual sensitivity	Moderate
Occupied cells (magnitude)	17
Magnitude rating	Moderate
Overall visual impact rating	Moderate

8.2 VP02 – Tait's Gully



Figure 8.3 Baseline panoramic photograph – VP02

Table 8.4 VP02 viewpoint summary and assessment

Represented visual receivers	R6
Distance to proposal	950 m
Viewpoint type	Residential dwelling (secondary view)
View location and direction	Coordinates: 30°23'28"S 151°41'35"E View west from the front of the residential dwelling at 11768 New England Highway, Tilbuster (Tait's Gully). VP02 represents secondary views for residential visual receivers within the residential dwelling set back approximately 550 m north-east of the New England Highway.
Description of existing view	VP02 comprises generally open views over a predominately cleared rural landscape, sloping down to the west down to a creek line. Remnant trees are scattered throughout the pastoral land, somewhat filtering views across the cleared land. Densely vegetated hills form a distinct ridgeline in the distance of the view. Infrastructure includes rural fencing and a timber power pole and associated overhead power lines.
Anticipated change to view	Construction Partial views of solar array construction process may be possible through existing vegetation. Trucks and construction vehicles may be visible along the A15 New England Highway. Operation Partial views of the solar array may be possible through gaps in existing vegetation to the north-west.
Viewpoint sensitivity	Low – Secondary view from front of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Moderate – Large expanse of extensively cleared, flat and gently undulating pastoral land with long distance views of hilly, vegetated terrain. – Dispersed yet evident presence of human settlement including highly modified landscapes and agricultural fencing and infrastructure.
Overall visual sensitivity	Low
Occupied cells (magnitude)	3
Magnitude rating	Very Low
Overall visual impact rating	Very Low

8.3 VP03 – New England Highway



Figure 8.4 Baseline panoramic photograph – VP03

Table 8.5 VP03 viewpoint summary and assessment

Represented visual receivers	P2
Distance to proposal	20 m
Viewpoint type	Public motorist view
View location and direction	Coordinates: 30°23'08"S 151°40'53"E View north from western verge of the A15 New England Highway. VP03 represents public, motorist views from the highway.
Description of existing view	VP03 consists of the dual carriageway A15 New England Highway sloping up to the north. Sparse trees and vegetation border line the eastern verge of the highway, filtering views to the north-east. Predominately cleared verges and flat, open rural land is located on both sides of the highway to the east and west, bounded by post and wire or timber rural fencing. An unsealed, dirt access road leads onto the project site to the west. Densely vegetated hills form a distinct ridgeline in the distance of the view.
Anticipated change to view	Construction Earthworks, construction stockpiling and relatively minor tree and vegetation clearing may be visible from the road. Operation New solar array, security fencing and internal access tracks would be visible across the open rural land to the west.
Viewpoint sensitivity	Very Low – Motorist views from sealed dual carriageway A15 New England Highway. – Motorists generally have short viewing times.
Scenic quality	Low – Large expanse of extensively cleared, flat and gently undulating pastoral land with long distance views of hilly, vegetated terrain with distinct ridgelines. – Dominant presence of human settlement including highly modified landscapes, sealed highway and agricultural fencing and infrastructure.
Overall visual sensitivity	Very Low
Occupied cells (magnitude)	25
Magnitude rating	High
Overall visual impact rating	Low

8.4 VP04 – Varuna



Figure 8.5 Baseline panoramic photograph – VP04

Table 8.6 VP04 viewpoint summary and assessment

Represented visual receivers	R7
Distance to proposal	200 m
Viewpoint type	Residential dwelling (primary view)
View location and direction	Coordinates: 30°22'56"S 151°40'41"E View south from the back of the residential dwelling at 11947 New England Highway, Black Mountain (Varuna). VP04 represents views for visual receivers within the residential dwelling.
Description of existing view	VP04 comprises generally open views over a predominately flat, cleared rural landscape which slopes up to the south into more densely vegetated hills which form a distinctive ridgeline south of the cleared pastoral land. Remnant trees are scattered throughout the pastoral land, somewhat filtering views to the south. Infrastructure includes rural post and wire fencing along the property boundary.
Anticipated change to view	Construction Earthworks, construction stockpiling and relatively minor tree and vegetation clearing may be visible from the road. Operation New solar array, security fencing and internal access tracks would be visible across the open rural land to the south.
Viewpoint sensitivity	Moderate – Primary view from back of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Moderate – Large expanse of extensively cleared, flat and gently undulating pastoral land with long distance views of hilly, vegetated terrain. – Dispersed yet evident presence of human settlement including highly modified landscapes and agricultural fencing and infrastructure.
Overall visual sensitivity	Moderate
Occupied cells (magnitude)	29
Magnitude rating	High
Overall visual impact rating	Moderate

8.5 VP05 – Hillwood



Figure 8.6 Baseline panoramic photograph – VP05

Table 8.7 VP05 viewpoint summary and assessment

Represented visual receivers	R8
Distance to proposal	700 m
Viewpoint type	Residential dwelling (primary view)
View location and direction	Coordinates: 30°22'40"S 151°41'04"E View south-west from the front balcony of the residential dwelling at 11924 New England Highway, Black Mountain (Hillwood). VP04 represents primary views for visual receivers within the residential dwelling, set back approximately 600 m east from the A15 New England Highway.
Description of existing view	VP05 comprises generally open views over a cleared rural landscape which slopes down to the west towards an artificial dam, then slopes back up gradually to meet the A15 New England Highway. Timber posts and fencing associated with the dwelling and balcony structure are visible in the foreground. Existing scattered trees and vegetation filter and frame views to the west towards densely vegetated hills forming a distinctive ridgeline in the distance.
Anticipated change to view	Construction Partial views of solar array construction process may be possible through existing vegetation. Trucks and construction vehicles may be visible along the A15 New England Highway. Operation Partial views of solar array may be visible between existing, distant vegetation to the south-west.
Viewpoint sensitivity	Moderate – Primary view from front balcony of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Moderate – Large expanse of extensively cleared, flat and gently undulating pastoral land with long distance views of hilly, vegetated terrain. – Dispersed yet evident presence of human settlement including highly modified landscapes and agricultural fencing and infrastructure.
Overall visual sensitivity	Moderate
Occupied cells (magnitude)	10
Magnitude rating	Low
Overall visual impact rating	Low

8.6 VP06 – Tilthorpe



Figure 8.7 Baseline panoramic photograph – VP06

Table 8.8 VP06 viewpoint summary and assessment

Represented visual receivers	R9
Distance to proposal	1000 m
Viewpoint type	Residential dwelling (primary view)
View location and direction	Coordinates: 30°22'30"S 151°40'46"E View south-west from the front of the residential dwelling at 11966 New England Highway, Black Mountain (Tilthorpe). VP06 represents primary views for visual receivers within the residential dwelling set back approximately 500 m east of the A15 New England Highway.
Description of existing view	VP06 comprises generally open views over a predominately flat, cleared rural landscape which slopes down from the viewpoint location to an artificial dam. The land then up gradually to the south-west into more densely vegetated pastoral land and steep hills in the distance. Infrastructure includes an agricultural ancillary shed, a timber power pole and associated overhead powerlines.
Anticipated change to view	Construction Partial views of solar array construction process may be possible through existing vegetation. Trucks and construction vehicles may be visible along the A15 New England Highway. Operation Partial views of solar array may be visible between existing, distant vegetation to the south-west.
Viewpoint sensitivity	Moderate – Primary view from front balcony of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Low – Large expanse of flat and gently undulating terrain. – Extensively cleared paddock and pastoral land for grazing. – Dispersed yet evident presence of human settlement including highly modified landscapes and agricultural fencing and infrastructure.
Overall visual sensitivity	Moderate
Occupied cells (magnitude)	8
Magnitude rating	Low
Overall visual impact rating	Low

8.7 VP07 – Annaleey



Figure 8.8 Baseline panoramic photograph – VP07

Table 8.9 VP07 viewpoint summary and assessment

Represented visual receivers	R10
Distance to proposal	1000 m
Viewpoint type	Residential dwelling (secondary view)
View location and direction	Coordinates: 30°22'14"S 151°40'08"E View south-west from the side of the residential dwelling at 12029 New England Highway, Black Mountain (Annaleey). VP06 represents primary views for visual receivers within the residential dwelling.
Description of existing view	VP07 comprises views over a predominately cleared rural landscape. The view is partially enclosed by existing vegetation along the metal, rural fence line in the foreground. Other infrastructure within the view includes a water tank and timber power poles and associated powerlines extending to the south across the cleared paddocks.
Anticipated change to view	Construction No anticipated change to view as the proposal site and construction works would be obscured by existing topography and vegetation. Operation No anticipated change to view as the proposal site would be obscured by existing topography and vegetation.
Viewpoint sensitivity	Low – Secondary view from side of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Low – Large expanse of flat and gently undulating terrain. – Extensively cleared paddock and pastoral land for grazing. – Dispersed yet evident presence of human settlement including highly modified landscapes and agricultural fencing and infrastructure.
Overall visual sensitivity	Low
Occupied cells (magnitude)	0
Magnitude rating	Very Low
Overall visual impact rating	Very Low

8.8 VP08 – Tilbuster North



Figure 8.9 Baseline panoramic photograph – VP08

Table 8.10 VP08 viewpoint summary and assessment

Represented visual receivers	R11
Distance to proposal	1250 m
Viewpoint type	Residential dwelling (primary view)
View location and direction	Coordinates: 30°22'10"S 151°40'15"E View south from the front of the residential dwelling at 12024 New England Highway, Black Mountain (Tilbuster North). VP08 represents primary views for visual receivers within the residential dwelling set back approximately 1,300 m east of the A15 New England Highway.
Description of existing view	VP08 comprises views over a predominately cleared rural landscape. The view is partially obscured by existing vegetation in the foreground. The land slopes up gradually to the west and down to the east, and densely vegetated slopes are visible in the distance to the south-east. Infrastructure in the foreground of the view includes rural post and wire fencing and gates, a timber power pole and associated overhead powerlines.
Anticipated change to view	Construction No anticipated change to view as the proposal site and construction works would likely be obscured by existing topography and vegetation. Operation No anticipated change to view as the proposal site would likely be obscured by existing topography and vegetation.
Viewpoint sensitivity	Moderate – Primary view from front of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Low – Large expanse of flat and gently undulating terrain. – Extensively cleared paddock and pastoral land for grazing. – Dispersed yet evident presence of human settlement including highly modified landscapes and agricultural fencing and infrastructure.
Overall visual sensitivity	Moderate
Occupied cells (magnitude)	1
Magnitude rating	Very Low
Overall visual impact rating	Low

8.9 VP09 – Ravenswood (south)



Figure 8.10 Baseline panoramic photograph – VP09

Table 8.11 VP09 viewpoint summary and assessment

Represented visual receivers	R12
Distance to proposal	1600 m
Viewpoint type	Residential dwelling (primary view)
View location and direction	Coordinates: 30°21'58"S 151°40'21"E There are two residential dwellings on the rural residential property 12008 New England Highway, Black Mountain (Ravenswood). VP09 is the more southern of the two dwellings, located approximately 470 m east of the A15 New England Highway. VP09 represents the view south from the back balcony of the southern residential dwelling.
Description of existing view	VP09 comprises views over a rural backyard with views south screened by existing vegetation and rural infrastructure and equipment in the foreground of the view, including raised vegetable gardens, water tanks, Colourbond storage structures and timber power poles with overhead powerlines extending to the south. The land slopes up steeply to the south beyond the property boundary towards vegetated hills beyond.
Anticipated change to view	Construction Minimal or no changes to view as the proposal site and construction works would be mostly obscured by existing topography and vegetation. Operation Minimal or no anticipated change to view as the proposal site would likely be obscured by existing topography and vegetation. Partial view of northern extent of solar array may be possible through existing vegetation.
Viewpoint sensitivity	Moderate – Primary view from front of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Low – Generally flat and gently undulating terrain. – Dominant presence of human settlement including highly modified landscapes, overhead powerlines and agricultural fencing and infrastructure.
Overall visual sensitivity	Moderate
Occupied cells (magnitude)	2
Magnitude rating	Very Low
Overall visual impact rating	Low

8.10 VP10 – Ravenswood (north)



Figure 8.11 Baseline panoramic photograph – VP10

Table 8.12 VP10 viewpoint summary and assessment

Represented visual receivers	R13
Distance to proposal	2000 m
Viewpoint type	Residential dwelling (primary view)
View location and direction	Coordinates: 30°21'45"S 151°40'19"E There are two residential dwellings on the rural residential property 12008 New England Highway, Black Mountain (Ravenswood). VP10 is the more northern of the two dwellings, located approximately 620 m east of the A15 New England Highway at a higher elevation than the other house. VP10 represents the view south from the front of the northern residential dwelling.
Description of existing view	VP10 comprises open views over a partially cleared rural landscape that slopes down steeply from east to west towards a cleared valley to the south-west, then back up towards higher vegetated areas of rural land. Densely vegetated hills are visible in the distance to the south-west. Rural ancillary buildings are visible to the south.
Anticipated change to view	Construction Partial views of solar array construction process may be possible through existing vegetation. Trucks and construction vehicles may be visible to the west along the A15 New England Highway. Operation Partial views of the northern extent of solar array may be possible through gaps in existing vegetation.
Viewpoint sensitivity	Moderate – Primary view from front of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Moderate – Large expanse of partially cleared, sloping pastoral land with filtered long distance views of hilly, vegetated terrain. – Dispersed yet evident presence of human settlement including highly modified landscapes and agricultural ancillary buildings.
Overall visual sensitivity	Moderate
Occupied cells (magnitude)	3
Magnitude rating	Very Low
Overall visual impact rating	Low

8.11 VP11 – Minmai

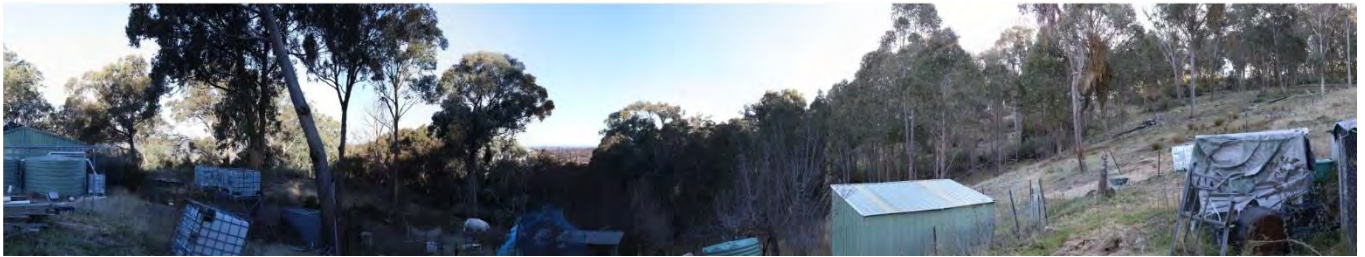


Figure 8.12 Baseline panoramic photograph – VP11

Table 8.13 VP11 viewpoint summary and assessment

Represented visual receivers	R14
Distance to proposal	1500 m
Viewpoint type	Residential dwelling (secondary view)
View location and direction	Coordinates: 30°22'03"S 151°39'38"E View south-east from the side of the residential dwelling at 12173 New England Highway, Black Mountain (Minmai). VP11 represents secondary views for visual receivers within the residential dwelling, set back approximately 600 m west from the A15 New England Highway.
Description of existing view	VP11 comprises cleared, grassed land with agricultural infrastructure and equipment in the foreground including water tanks and storage containers, post and wire fencing and other farming materials. Densely vegetated land slopes up to the south-west and slopes down sharply to the south beyond the property boundary. Some distant views of bushland are partially visible above existing trees to the south.
Anticipated change to view	Construction No anticipated change to view as the proposal site and construction works would be obscured by existing topography and foreground vegetation. Operation No anticipated change to view as the proposal site would be obscured by existing topography and foreground vegetation.
Viewpoint sensitivity	Low – Secondary view from side of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	Low – Dense bushland just south of property boundary obscures most views to the south – Dispersed yet evident presence of human settlement including modified landscapes and agricultural fencing and infrastructure.
Overall visual sensitivity	Low
Occupied cells (magnitude)	7
Magnitude rating	Low
Overall visual impact rating	Low

8.12 VP12 – Uralba



Figure 8.13 Baseline panoramic photograph – VP12

Table 8.14 VP12 viewpoint summary and assessment

Represented visual receivers	R19
Distance to proposal	3300 m
Viewpoint type	Residential dwelling (primary view)
View location and direction	Coordinates: 30°21'01"S 151°39'57"E View south from the balcony of the residential dwelling at 12250 New England Highway, Black Mountain (Uralba). VP12 represents primary views for visual receivers within the residential dwelling, set back approximately 500 m east from the A15 New England Highway.
Description of existing view	VP12 comprises a modified, residential, turfed yard in the foreground, with associated rural infrastructure including post and wire fencing, a hills hoist clothesline and water tanks to the east. The land slopes down sharply into a vegetated valley. Dense, natural bushland extends continuously to the south where vegetated slopes and distinct ridgelines are visible to the south-west. An area of cleared rural land is visible in the distance to the south.
Anticipated change to view	Construction Partial, long distance views of solar array construction process may be possible to the south but would likely be obscured by existing vegetation. Operation Partial, long distance views of the northern extent of solar array may be possible to the south-west but would likely be obscured by existing vegetation.
Viewpoint sensitivity	Moderate – Primary view from front balcony of residential dwelling zoned as RU1 (Primary Production). – Private, residential visual receivers with generally long viewing periods towards the proposal.
Scenic quality	High – Dense natural bushland covering sloping terrain. Vegetated hills in the distance forming distinct ridgelines and landform patterns in the distance. – Minimal evidence of human production and presence beyond the cleared, grassed area in the foreground.
Overall visual sensitivity	High
Occupied cells (magnitude)	3
Magnitude rating	Very Low
Overall visual impact rating	Low

9. Cumulative impacts

Cumulative impacts are defined in the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPE 2022) as the ‘result of incremental, sustained and combined effects of human action,’ caused by the ‘compounding effects of a single project or multiple projects in an area, and by the accumulation of effects from past, current and future activities as they arise’. The following section considers the combined impacts on landscape character and visual amenity, caused by the proposal in the context of other nearby existing and future projects.

Cumulative impact assessments have a range of dimensions to consider:

- Impact of the proposal when combined with impacts from all other existing developments and the existing landscape character of the area.
- Impact of the proposal in the context of potential for other future infrastructure developments on a local and regional scale.
- Impact of developments that are ancillary to or associated with the proposal including substation upgrades and associated infrastructure.

Cumulative impacts should also be assessed with regard to potential visual impacts when viewed sequentially. If the proposal is viewed in succession as a visual receiver moves through the landscape, such as motorists travelling along tourist routes like the A15 New England Highway, this may impact the overall perception of the landscape character. While the receiver is only seeing one development at a time, if each successive strip of road is visually dominated by a different development, this may cause cumulative visual impacts. A desktop search of the Major Projects portal revealed a number of other major projects within the vicinity of the proposal for consideration of cumulative impacts. Table 9.1 summarises these projects.

Table 9.1 *Major projects in the vicinity of the proposal for consideration of cumulative visual impacts*

Application number	Project name	Project description	Location	Status	Project Stage
SSD-9619	Tilbuster Solar Farm (the approved Stage 1 Project)	The development of a 150 MW solar farm, energy storage facility and associated infrastructure.	Immediately adjacent to the north-west of the proposal site	Approved	Construction expected to commence 2025
SSD-7931	Metz Solar Farm	Development of a 100 MW solar farm and associated infrastructure.	Approximately 24 km southeast of the proposal site	Approved	Complete and operational
SSD-10346	Oxley Solar Farm	Development of a 215 MW solar farm with up to 50 MW of battery energy storage and associated infrastructure.	Approximately 25 km southeast of the proposal site	Approved	Construction expected between 2023 and 2025
SSD-9255	New England Solar Farm	Development of a 720 MW solar farm with energy storage and associated infrastructure.	Approximately 29 km south southwest of the proposal site	Approved	Stage 1 completed in 2023. Stage 2 (320 MW) and a 200 MW/two hour battery will start construction in 2024

Application number	Project name	Project description	Location	Status	Project Stage
SSD-70753725	Deeargee Solar	320 MW Solar Farm, ancillary infrastructure, and a battery energy storage system (BESS) with a capacity of either 1400 MW/2800 MWh OR 700 MW/2800 MWh.	Approximately 35 km south of the proposal site	Prepare EIS	Yet to commence
SSD-65058714	Armidale East BESS	Development of a 500 MW/1000 MWh battery energy storage facility with associated infrastructure.	Approximately 16 km southeast of the proposal site	Prepare EIS	Yet to commence
SSD-49505734	Eathorpe BESS	Development of a 100 MW/200 MWh battery energy storage system with associated infrastructure and connection works.	Approximately 16 km southeast of the proposal site	Prepare EIS	Yet to commence
SSD-10476	Rangoon Wind Farm	Development of a 130 MW wind farm with energy storage and associated infrastructure.	Approximately 45 km north of the proposal site	Prepare EIS	Yet to commence
SSI-12422997	Oven Mountain Pumped Hydro Energy Storage	Development of a 900 MW pumped hydro energy storage and generation project, grid connection and ancillary infrastructure.	Approximately 60 km southeast of the proposal site	Review submissions	Yet to commence

As summarised above, there are a number of similar renewable energy projects that have been recently constructed or are likely to commence construction in the near future within proximity to the proposal. The proposal would adjoin land that will also be developed for the purposes of Stage 1 of the Tilbuster Solar Farm. The LVIA prepared for Stage 1 allocated low overall visual impact ratings for all assessed sensitive receivers and viewpoints. VP01 in this LVIA was identified in the Stage 1 EIS as being the only visual receiver with potential adverse visual impacts. However, it was still assigned a low visual impact rating as it is located at a significant distance from that project. Hence, adverse cumulative visual impacts associated with these two adjacent developments are unlikely, as none of the assessed viewpoints are combined with moderate or high visual impact ratings from the Stage 1 LVIA.

The other projects in Table 9.1 are generally located at a distance from the proposal, with many of them located close to the township of Armidale to the south. The combination of all of these large-scale renewable energy developments within the Armidale region may have potential cumulative impacts on the predominately rural landscape character of the area.

10. Glint and glare

The following section summarises the results of the *Glint and Glare Assessment* (GHD 2024), which is provided in full in Appendix B.

The *Glint and Glare Assessment* assessed impacts from a number of private observation points (OP) as well as from the New England Highway. A total of five OPs were identified as having potential glare impacts from the proposal and these were further assessed and given a glare impact rating, as summarised in Table 10.1.

The glare impact rating is based on the total hours of glare exposure per annum. For all of the observation points, the majority of this glare is green glare, which has a low potential for after-image. Also, as noted in the table, existing vegetation is likely to reduce the glare impact for OP 6 and OP 8.

All glare for the observation points occurs around 5:00 – 6:00 pm, which is around sunset time, when glare from the sun will likely be more of a nuisance than glare resulting from the proposal. Green glare has a lower after image than the sun. Therefore, although the glare impact is rated as moderate and high by the guidelines, the impact at the residential dwellings is unlikely to cause any visual inconvenience.

The glare impact on the New England Highway only occurs during two months of the year; March and September, also at sunset, therefore it is unlikely that drivers would be significantly inconvenienced.

Mitigation measures, including vegetation screening, to further reduce glare impacts are discussed in Section 11.

Table 10.1 *Glint and glare assessment summary*

Receptor type	Receptor	Green glare per annum (hours/year)	Yellow glare per annum (hours/year)	Total glare per annum (hours/year)	Comments	Glare impact
Routes	New England Hwy	1.9	9.5	11.4	Glare is possible.	Measures should be taken to eliminate the occurrence of glare.
Observation points	OP 6	25.5	0.0	25.5	Receives under 30 hours but over 10 hours of glare per annum, for less than 30mins a day. Local vegetation likely to block some of the impacts.	Moderate impact – explore mitigation measures to reduce impacts as far as practicable.
	OP 7	52.5	27.9	80.4	Receives over 30 hours of glare per annum, but for less than 30mins per day.	High impact – glare should be avoided; explore mitigation measures.
	OP 8	71.0	2.3	73.3	Receives over 30 hours of glare per annum, but for less than 30 mins per day. Local vegetation likely to block some of the impacts.	High impact – glare should be avoided; explore mitigation measures.

Receptor type	Receptor	Green glare per annum (hours/year)	Yellow glare per annum (hours/year)	Total glare per annum (hours/year)	Comments	Glare impact
	OP 9	11.6	0.0	11.6	Receives under 30 hours but over 10 hours of glare per annum, for less than 30 mins a day.	Moderate impact – explore mitigation measures to reduce impacts as far as practicable..

11. Mitigation measures

The following sections provide recommended mitigation measures that respond to issues arising in the landscape character and visual impacts identified within this LVIA that have potential to adversely impact on:

- Existing landscape character.
- Views to the proposal from nearby sensitive visual receivers.

11.1 Performance objectives

There are several visual performance objectives for each viewpoint based on the assigned overall visual impact rating in this report, refer to Table 11.1. Ten viewpoints are assessed as having a low or very low overall visual impact and two viewpoints (VP01 and VP04) are assessed as having a moderate overall visual impact and require mitigation. None of the viewpoints were assessed as having a high visual impact.

Table 11.1 Visual performance objectives (adapted from the Technical Supplement)

High visual impact	This level of impact should be avoided unless the applicant can justify that: – All reasonable efforts have been made to avoid the impact and alternative proposal designs are not feasible or would be unlikely to materially reduce the impact. – All reasonable mitigation options have been considered. – The proposed mitigation measures would effectively mitigate the impact and would not result in a significant obstruction of views. – The proposal site is strategically important because of its location. – The proposal is in the public interest.
Moderate visual impact	Visual impact mitigation is required in consultation with the affected landowner and should be proportionate to the scale of impact. There is no expectation this mitigation should eliminate the view of the development entirely but must reduce the impact to an acceptable level. Appropriate mitigation options include vegetation screening or proposal landscaping to reduce visual impacts. If the available mitigation options would not be effective in reducing impacts or are unsuitable due to the nature of the impact (e.g. screening would result in the obstruction of views), then proposal redesign and/or impact agreements should be considered.
Low or very low visual impact	No mitigation is required.

11.2 Proposed mitigation measures

The following mitigation measures would be implemented into the proposal design and/or construction and decommissioning to reduce visual impacts with moderate or higher rating to assist mitigating visual and landscape character impacts.

11.2.1 Construction

- Ensure construction equipment, stockpiles, and other visible elements are located away from the key sensitive receiver views. Should any equipment or stockpiles be located in a visually prominent location for any reasonable period of time, incorporate screening measures, such as hoarding and buffer planting, and practices to ensure the site is kept tidy and visibility reduced.
- Implement no-go-zones and tree protection fencing to areas of existing vegetation that are proposed to be retained for the duration of the construction period.

11.2.2 Landscape character

- Planting should respond to the existing character and conditions including topography, landform and natural systems. Use of native vegetation species in patterns that mimic the surrounding conditions and retain as much existing, native vegetation to minimise impacts.
- Minimise changes to landform where possible to maintain the existing terrain profile.
- Replace pasture grass planting, to match existing paddock conditions.

11.2.3 Visual amenity

- Soft visual screening treatment, such as vegetation screening, is preferred over hard infrastructure elements, such as retaining structures and solid walls.
- The colours, materials and finishes used in the design of any site facilities should be compatible with the surrounding visual environment. The use of a natural colour palette to help visually conceal or blend some of the proposal's main visual features into the landscape is recommended. Bright colours and reflective surfaces should be avoided.

11.2.4 Landscape plan

A draft landscape plan has been prepared for the proposal and is provided in Appendix C. The landscape plan outlines proposed landscape plantings and treatments to minimise the visual impacts of the proposal for viewpoints with moderate or higher visual impact ratings.

Proposed landscape treatments include:

- Screen planting in key locations using locally endemic species for identified viewpoints, particularly along the northern extent of the proposal site to mitigate views and glare impacts for VP04/OP 7.
- Intermittent screen planting between the proposal site boundary and the New England Highway to filter views to the proposal and improve visual amenity for motorists.
- Replacement tree planting for tree removal required as part of the development.
- Ground level landscape treatments such as native and pasture grasses in areas where revegetation is required to tie in with the landscape.

Due to the elevated position of the residential dwelling at VP01, vegetation screening around the solar farm is unlikely to have any mitigating effect and has not been included. Vegetation screening on the residential property itself would provide a better screening outcome and should be considered through consultation with the property owner.

11.2.5 Design refinements

Detailed design refinements, in consultation with the design team and solar panel manufacturers, could further reduce glare impacts, such as:

- Considering single-axis tracking (SAT) instead of fixed tilt: SAT maintains perpendicularity between the panels and the sunlight, which can be effective in mitigating glare.
- Adjusting the tilt angle of the panels: keeping a lower angle of incidence can mitigate some occurrences of glare.
- Adjusting the orientation of the panels: orienting the panels slightly west may reduce glare impacts as majority of the sensitive receivers are located to the east of the proposed solar farm.

Further modelling is recommended to test the effectiveness of chosen design refinements during the detailed design of the proposal.

12. Conclusion

The key findings of this assessment are summarised in the following sections.

12.1 Summary of landscape character impacts

The assessment of impacts to landscape character from the proposal deals with how the development would affect the elements that make up the landscape, including the aesthetic and perceptual aspects of the landscape and its distinctive characteristics.

Two (2) LCZs were identified within the study area and assessed in the landscape character assessment. Table 12.1 provides a summary of the impacts. Both LCZs received ratings of moderate or moderate-low due to the moderate sensitivity ratings relating to the rural and natural landscapes.

Table 12.1 Landscape character impact summary

Landscape character zone	Sensitivity	Magnitude	Landscape character impact
LCZ1 - Tilbuster rural productive land	Low	Moderate	Moderate-Low
LCZ2 – Duval Nature Reserve and bushland	High	Low	Moderate

12.2 Visual impact assessment

The assessment of visual impacts involved an understanding of the sensitivity of viewing locations, the likely changes to the views, and an evaluation of the significance of the likely changes. From the preliminary assessment, twelve (12) viewpoints were identified for further assessment.

Table 12.2 provides a summary of the visual impacts ranging from very low to moderate with VP01 and VP04 being the most impacted receivers requiring mitigation. Mitigation strategies have been proposed in a landscape plan with the most effective treatment being foreground screen planting for impacted receivers. Pending the successful implementation of mitigation measures, the overall impact ratings could expect to be lowered.

Table 12.2 Summary of visual impact assessment ratings

Viewpoint	Viewpoint sensitivity	Scenic quality	Overall visual sensitivity	Magnitude	Overall visual impact
VP01	Moderate	Moderate	Moderate	Moderate	Moderate
VP02	Low	Moderate	Low	Very low	Very low
VP03	Very Low	Low	Very low	High	Low
VP04	Moderate	Moderate	Moderate	High	Moderate
VP05	Moderate	Moderate	Moderate	Low	Low
VP06	Moderate	Low	Moderate	Low	Low
VP07	Low	Low	Low	Very low	Very low
VP08	Moderate	Low	Moderate	Very low	Low
VP09	Moderate	Low	Moderate	Very low	Low
VP10	Moderate	Moderate	Moderate	Very low	Low
VP11	Low	Low	Low	Low	Low
VP12	Moderate	High	High	Very low	Low

12.3 Glare impacts

A total of five OPs were identified as having potential glare impacts from the proposal and these were further assessed and given a glare impact rating, as summarised in Table 10.1. The glare impact rating is based on the total hours of glare exposure per annum. For all of the observation points, the majority of this glare is green glare, which has a low potential for after-image. Also, existing vegetation is likely to reduce the glare impact for OP 6 and OP 8.

Furthermore, all glare for the observation points occurs around 5:00 – 6:00pm, which is around sunset time, when glare from the sun will likely be more of a nuisance than glare resulting from the proposal. Green glare has a lower after image than the sun. Therefore, although the glare impact is rated as moderate and high by the guidelines, the impact at the residential dwellings is unlikely to cause any visual inconvenience.

The glare impact on the New England Highway only occurs during two months of the year; March and September, also at sunset, therefore it is unlikely that drivers would be significantly inconvenienced.

Mitigation measures, including vegetation screening are recommended to further reduce glare impacts.

13. References

DDPE. 2022. *Technical Supplement - Landscape and Visual Impact Assessment, Large-Scale Solar Energy Guideline* (the Technical Supplement).

DPE. 2022. *Cumulative Impact Assessment Guidelines for State Significant Projects*.

GHD. 2024. *Glint and Glare Assessment*.

Landscape Institute and Institute of Environmental Management & Assessment. 2013. *Guidelines for Landscape and Visual Impact Assessment, 3rd Edition*.

NGH. 2020. *Environmental Impact Statement – Tilbuster Solar Farm* (October 2020), Project Number: 18-645, Final Version 1.1.

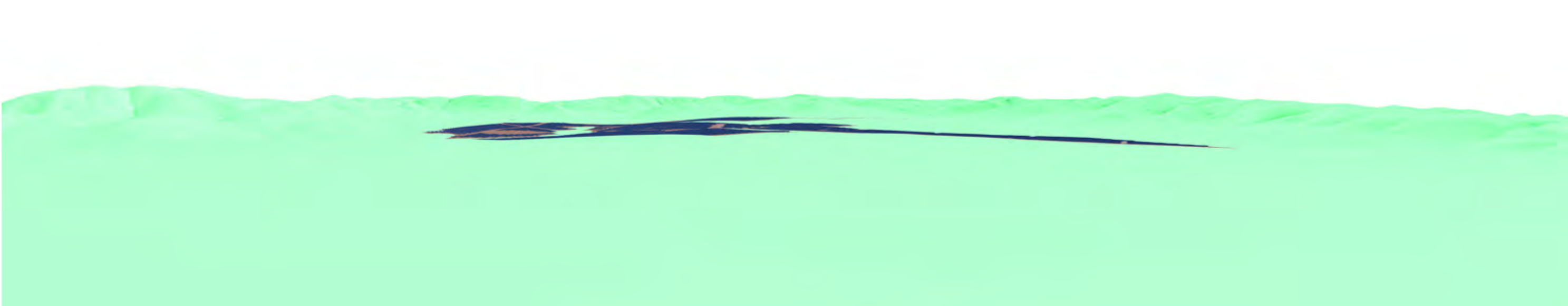
NSW Department of Planning and Environment 2022. *Large-Scale Solar Energy Guideline, NSW Department of Planning and Environment*, August 2022.

Transport for NSW. 2023. *Guideline for landscape character and visual impact assessment - Environmental impact assessment practice note EIA-N04 - Version 2.3*.

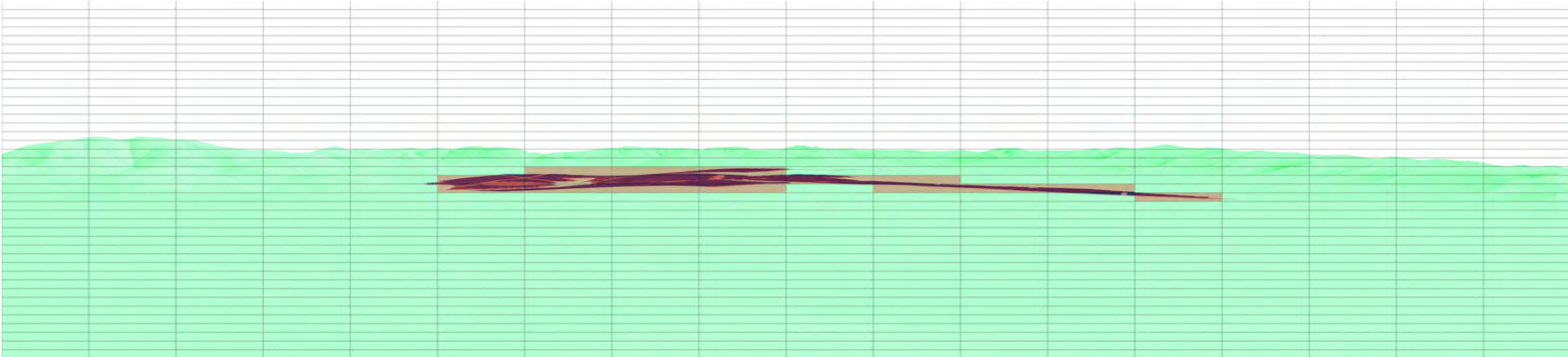
Appendices

Appendix A

Wireframes and photomontages



Proposed wireframe view



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	373112, 6636475
Distance to development	546 m
Viewpoint type	Residential dwelling (secondary view)
Viewpoint elevation	1097 m
View direction	239° - 59°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	N/A
Lens type	50 mm
Photograph time and date	N/A

Viewpoint VP 01
Wireframe viewpoint assessment

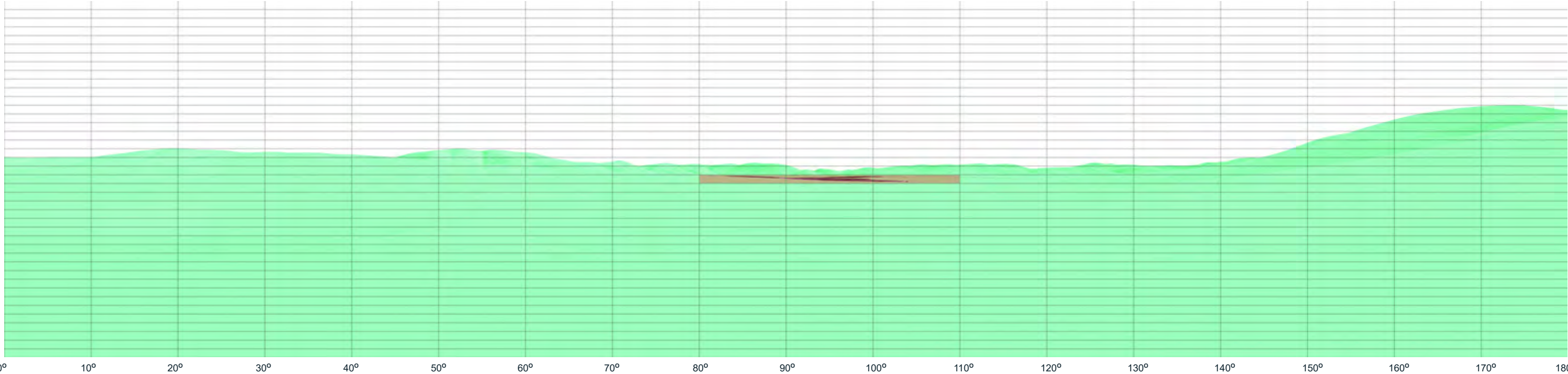
Tilbuster Stage 2 Solar Farm - Enerpac
Australia

Issue v01
Date 17.09.2024





Existing View



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	374444, 6637119
Distance to development	941 m
Viewpoint type	Residential dwelling (secondary view)
Viewpoint elevation	1026 m
View direction	132° - 312°
Horizontal field of view	180°
Camera height	1.7 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1456

Viewpoint VP 02
Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



0° 10° 20° 30° 40° 50° 60° 70° 80° 90° 100° 110° 120° 130° 140° 150° 160° 170° 180°

Proposed View with Magnitude Grid Tool



Coordinates (MGA 55 - 2020)	374444, 6637119
Distance to development	941 m
Viewpoint type	Residential dwelling (secondary view)
Viewpoint elevation	1026 m
View direction	132° - 312°
Horizontal field of view	180°
Camera height	1.7 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1456

Viewpoint VP 02
Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



140° 150° 160° 170° 180°
Inset A



Coordinates (MGA 55 - 2020)	374444, 6637119
Distance to development	941 m
Viewpoint type	Residential dwelling (secondary view)
Viewpoint elevation	1026 m
View direction	132° - 312°
Horizontal field of view	180°
Camera height	1.7 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1456

Viewpoint VP 02
Photomontage viewpoint assessment

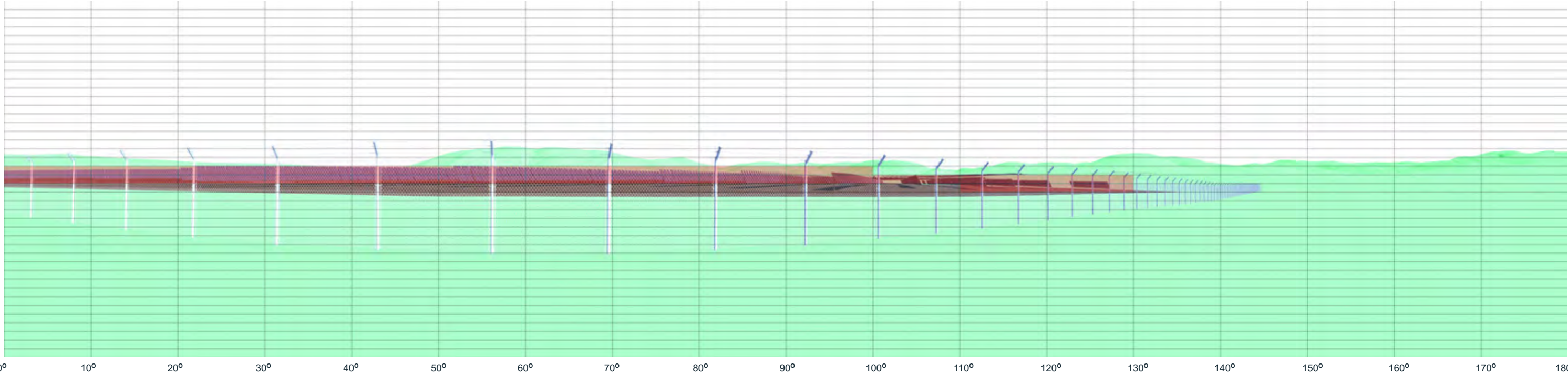
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Existing View



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	373321, 6637752
Distance to development	10 m
Viewpoint type	Public motorist view
Viewpoint elevation	1036 m
View direction	239° - 59°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	29 March 2024, 1043

Viewpoint VP 03
Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



Proposed View with Magnitude Grid Tool



Coordinates (MGA 55 - 2020)	373321, 6637752
Distance to development	10 m
Viewpoint type	Public motorist view
Viewpoint elevation	1036 m
View direction	239° - 59°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	29 March 2024, 1043

Viewpoint VP 03

Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



10°20°30°40°50°

Inset A



Coordinates (MGA 55 - 2020)	373321, 6637752
Distance to development	10 m
Viewpoint type	Public motorist view
Viewpoint elevation	1036 m
View direction	239° - 59°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	29 March 2024, 1043

Viewpoint VP 03
Photomontage viewpoint assessment

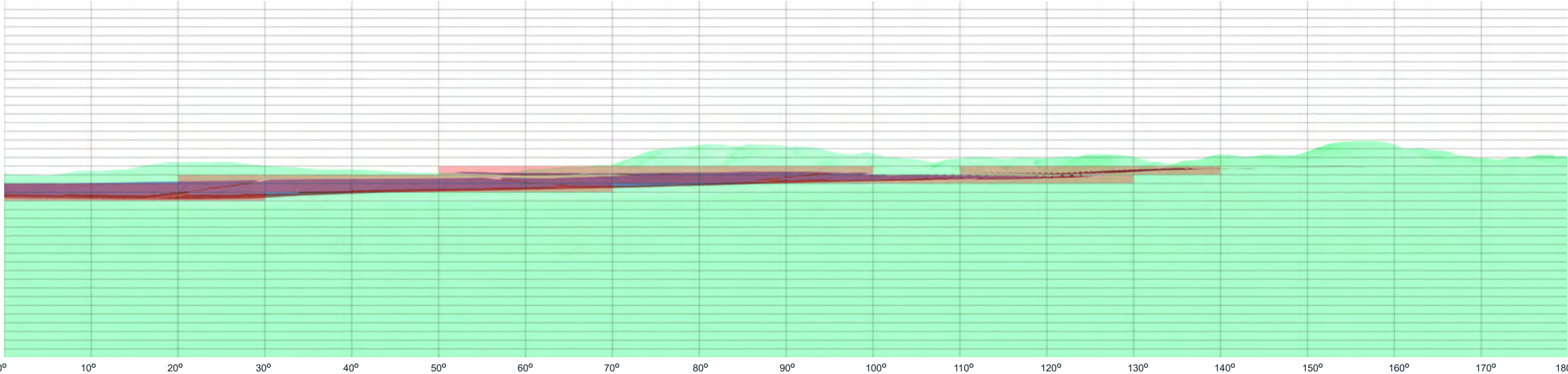
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Existing View



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	372987, 6638092
Distance to development	187 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1045 m
View direction	64° - 244°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1133

Viewpoint VP 04
Photomontage viewpoint assessment

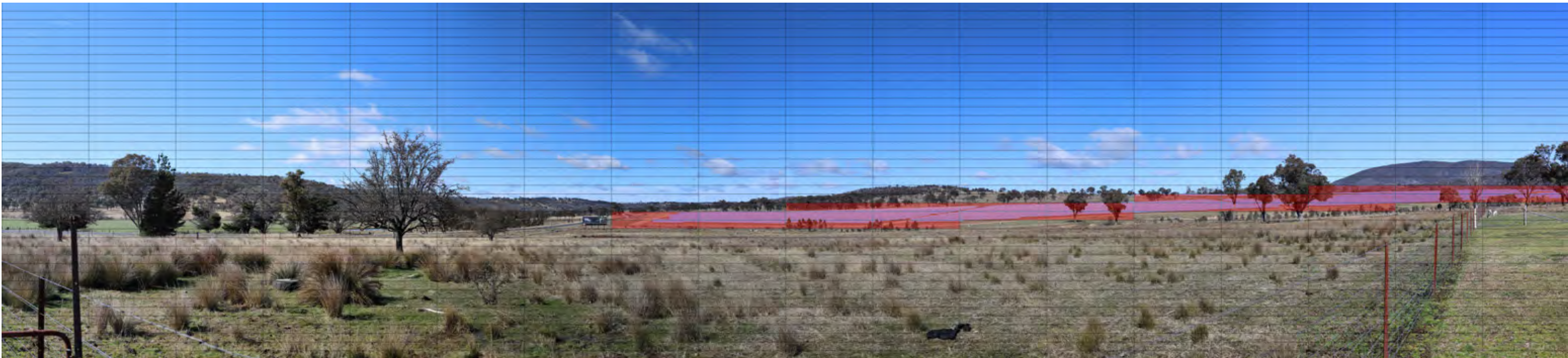
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



0° 10° 20° 30° 40° 50° 60° 70° 80° 90° 100° 110° 120° 130° 140° 150° 160° 170° 180°

Proposed View with Magnitude Grid Tool



Coordinates (MGA 55 - 2020)	372987, 6638092
Distance to development	187 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1045 m
View direction	64° - 244°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1133

Viewpoint VP 04
Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



90°100°110°120°130°

Inset A



Coordinates (MGA 55 - 2020)	372987, 6638092
Distance to development	187 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1045 m
View direction	64° - 244°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1133

Viewpoint VP 04
Photomontage viewpoint assessment

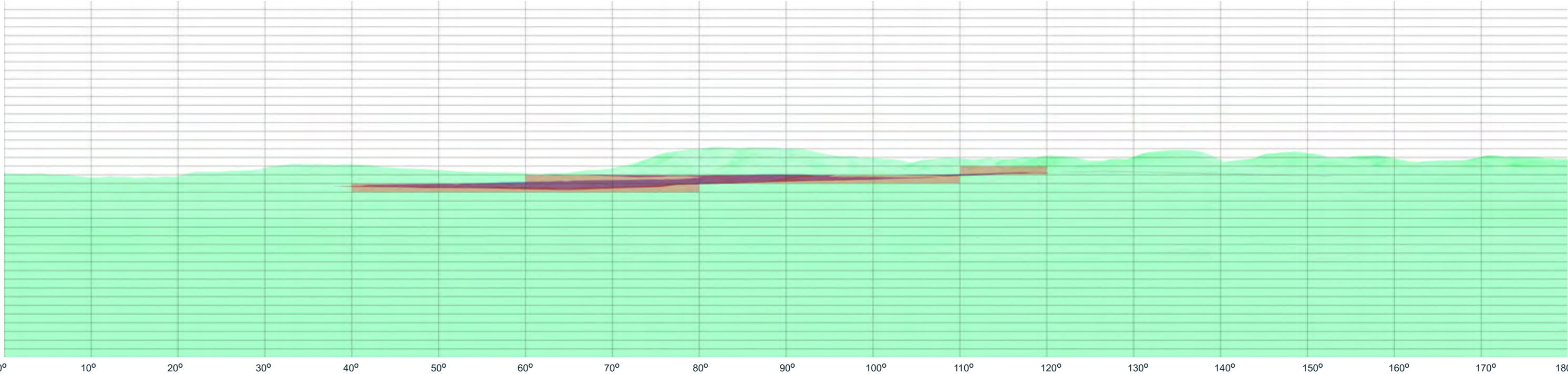
Tilbuster Stage 2 Solar Farm - Enerpac
Australia

Issue v01
Date 17.09.2024





Existing View



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	373603, 6638456
Distance to development	703 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	703 m
View direction	166° - 346°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1159

Viewpoint VP 05
Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



Proposed View with Magnitude Grid Tool



Coordinates (MGA 55 - 2020)	373603, 6638456
Distance to development	703 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	703 m
View direction	166° - 346°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1159

Viewpoint VP 05
Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



50° 60° 70° 80° 90°

Inset A



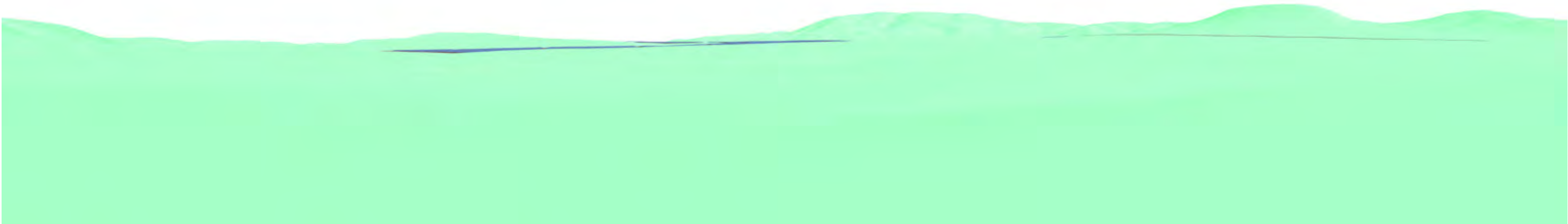
Coordinates (MGA 55 - 2020)	373603, 6638456
Distance to development	703 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	703 m
View direction	166° - 346°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1159

Viewpoint VP 05
Photomontage viewpoint assessment

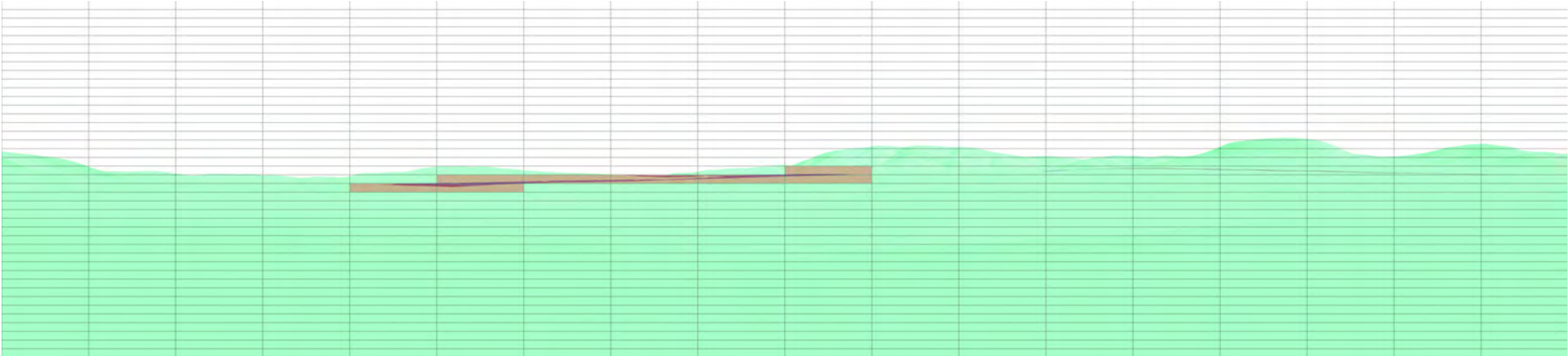
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed wireframe view



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	373130, 6638895
Distance to development	1005 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1050 m
View direction	123° - 303°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	N/A
Lens type	50 mm
Photograph time and date	N/A

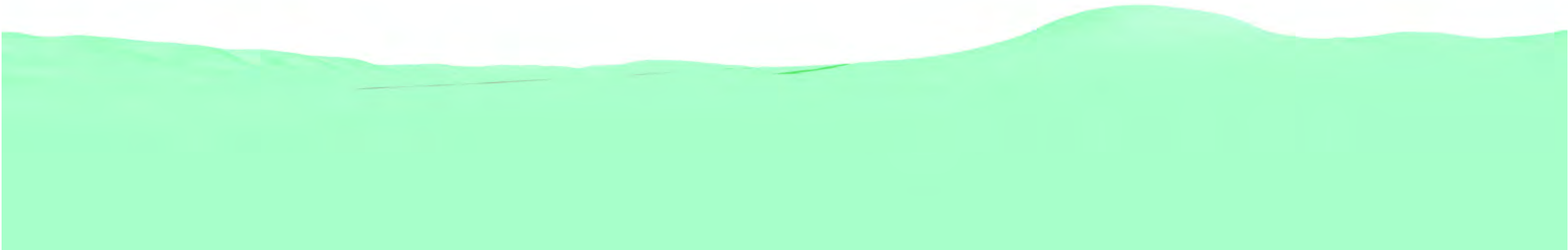
Viewpoint VP 06

Wireframe viewpoint assessment

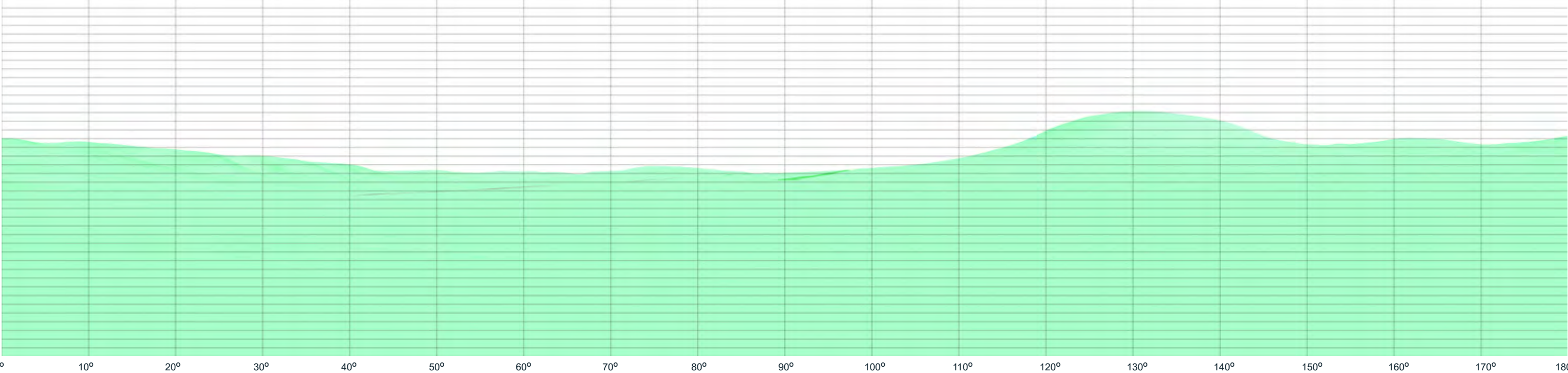
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024

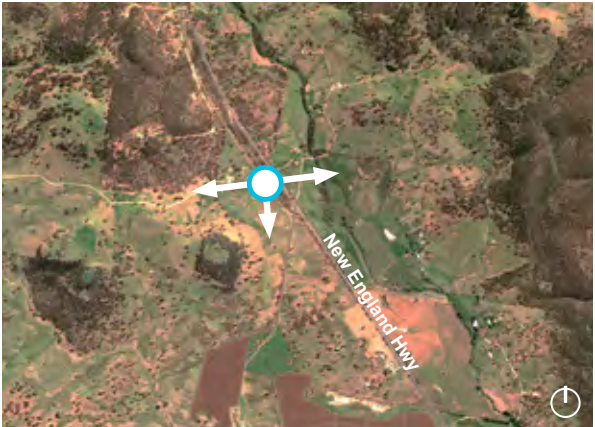




Proposed wireframe view



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	342096, 6639384
Distance to development	1069 m
Viewpoint type	Residential dwelling (secondary view)
Viewpoint elevation	1010 m
View direction	80° - 260°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	N/A
Lens type	50 mm
Photograph time and date	N/A

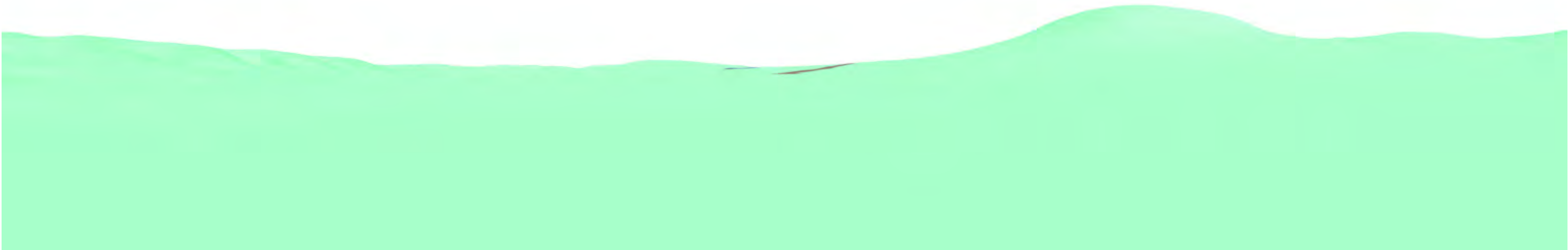
Viewpoint VP 07

Wireframe viewpoint assessment

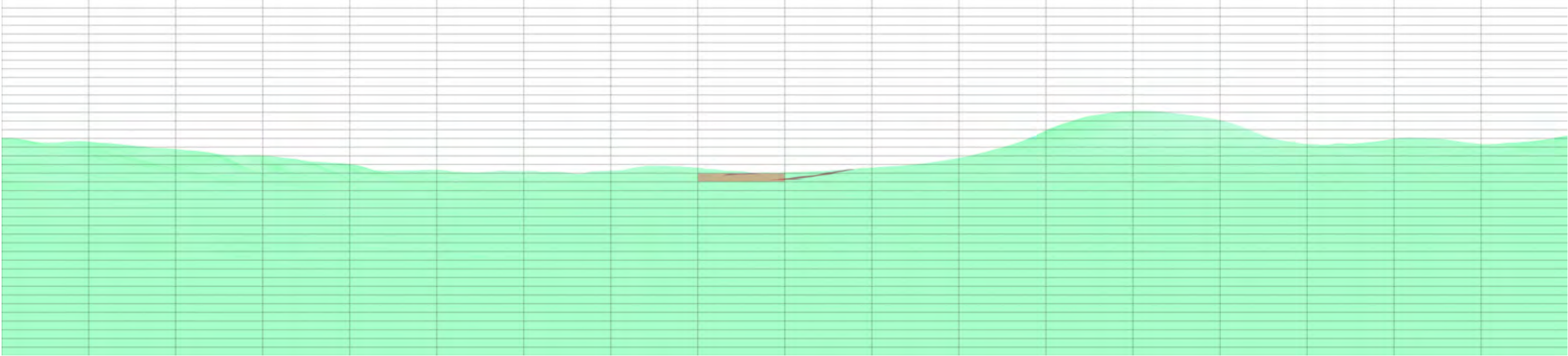
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed wireframe view



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	372293, 6639518
Distance to development	1170 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1062 m
View direction	87° - 267°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	N/A
Lens type	50 mm
Photograph time and date	N/A

Viewpoint VP 08

Wireframe viewpoint assessment

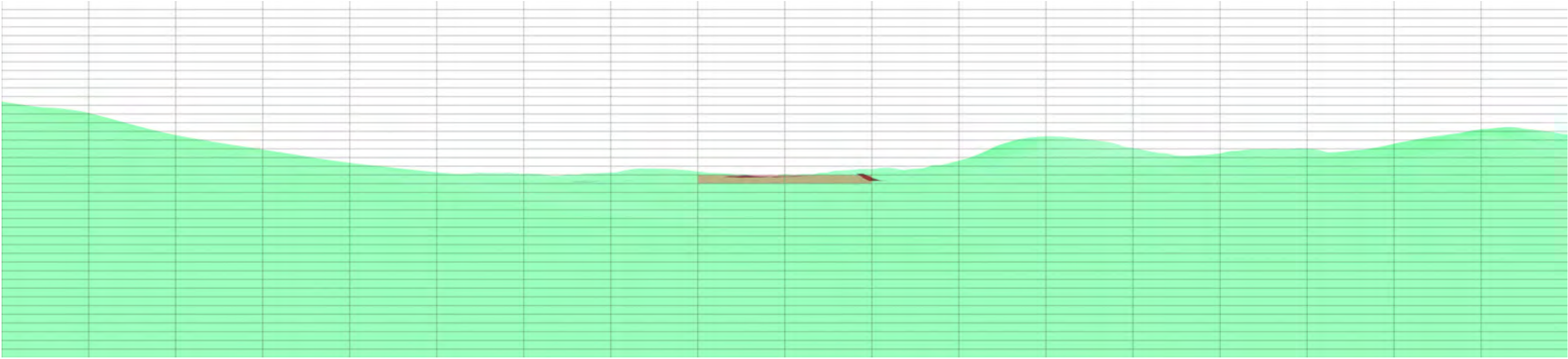
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed wireframe view



Proposed wireframe view with magnitude grid tool



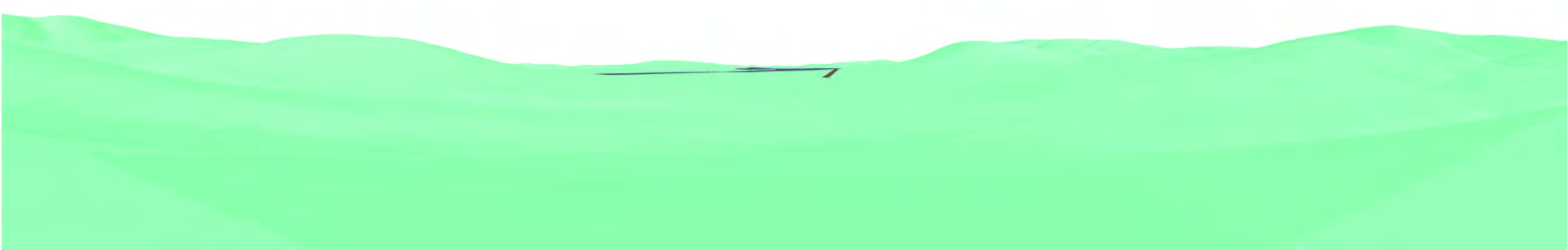
Coordinates (MGA 55 - 2020)	372451, 6639891
Distance to development	1578 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1065 m
View direction	93° - 273°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	N/A
Lens type	50 mm
Photograph time and date	N/A

Viewpoint VP 09
Wireframe viewpoint assessment

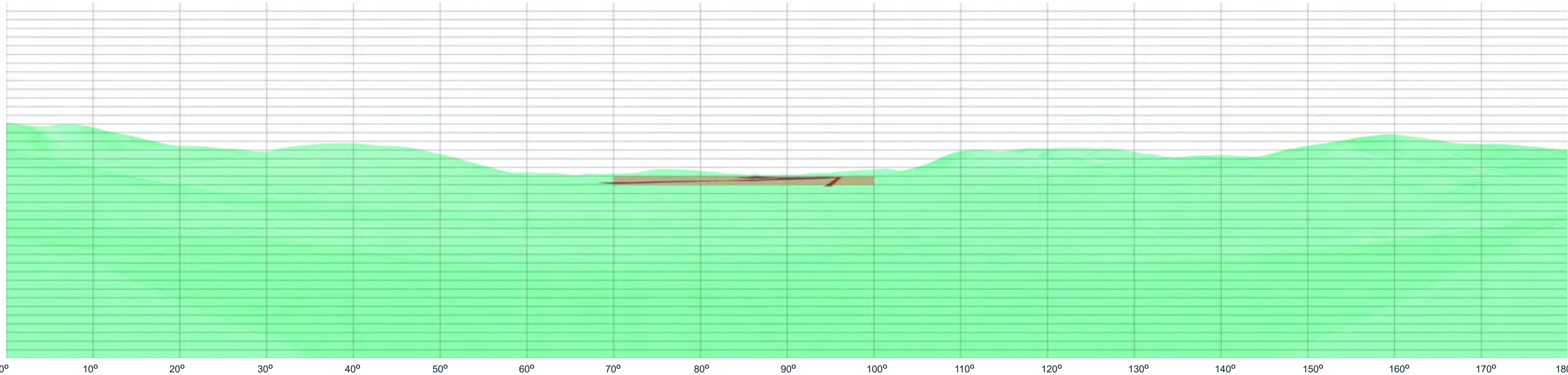
Tilbuster Stage 2 Solar Farm - Enerpac
Australia

Issue v01
Date 17.09.2024





Proposed wireframe view



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	372405, 6640264
Distance to development	1924 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1083 m
View direction	92° - 272°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	N/A
Lens type	50 mm
Photograph time and date	N/A

Viewpoint VP 10
Wireframe viewpoint assessment

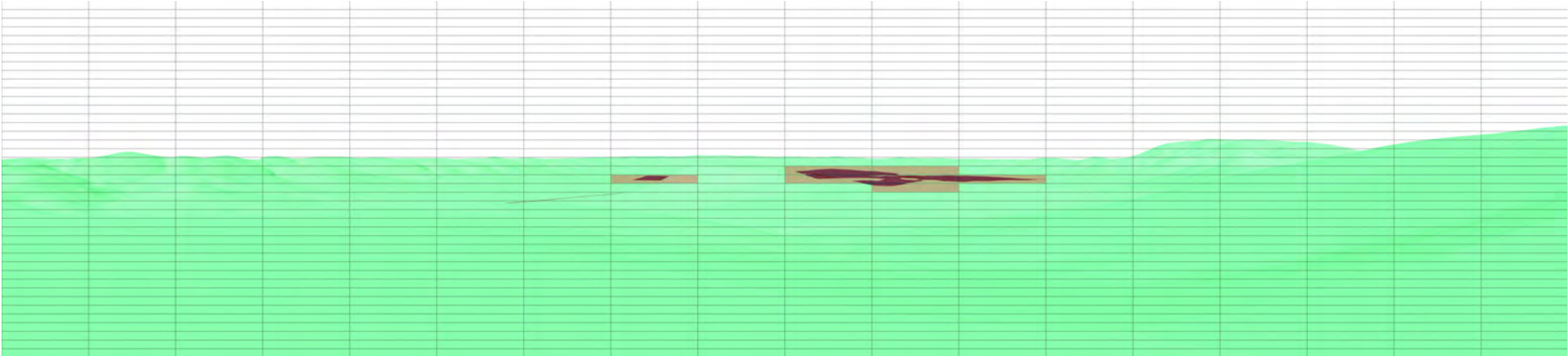
Tilbuster Stage 2 Solar Farm - Enerpac
Australia

Issue v01
Date 17.09.2024





Proposed wireframe view



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	371262, 6639708
Distance to development	1507 m
Viewpoint type	Residential dwelling (secondary view)
Viewpoint elevation	1166 m
View direction	61° - 241°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	N/A
Lens type	50 mm
Photograph time and date	N/A

Viewpoint VP 11

Wireframe viewpoint assessment

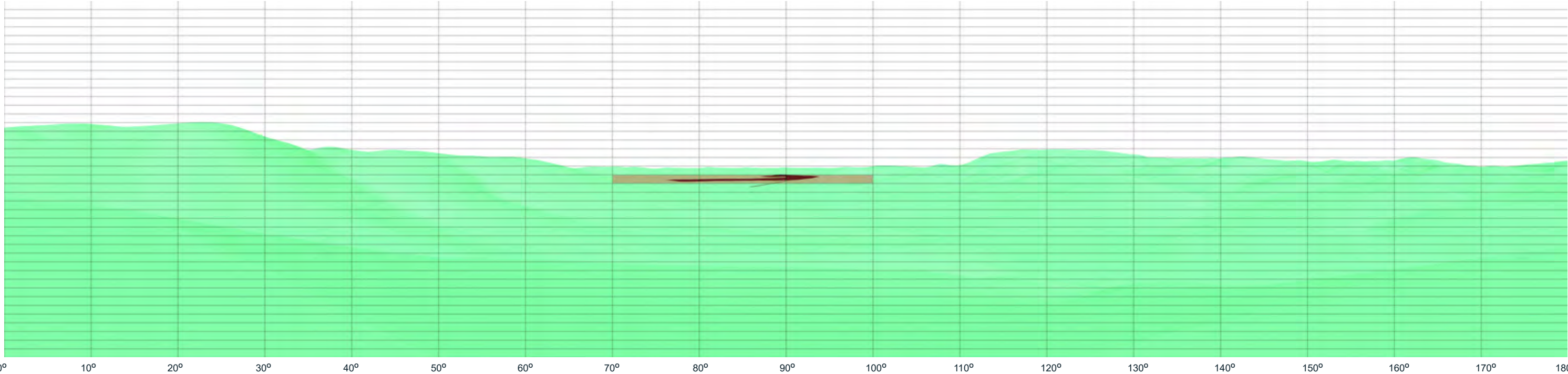
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Existing View



Proposed wireframe view with magnitude grid tool



Coordinates (MGA 55 - 2020)	371768, 6641632
Distance to development	3274 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1166 m
View direction	80° - 170°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1642

Viewpoint VP 12
Photomontage viewpoint assessment

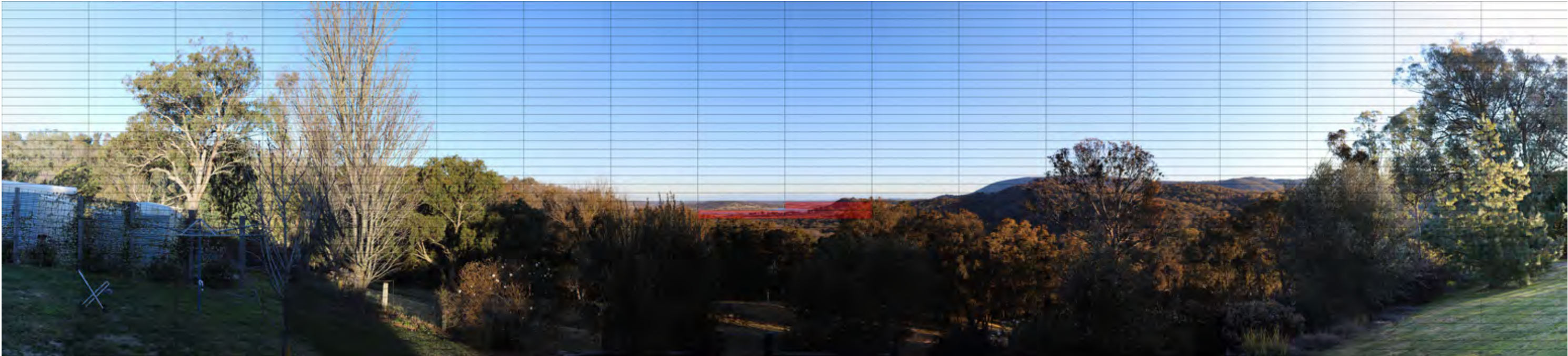
Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



Proposed View with Magnitude Grid Tool



Coordinates (MGA 55 - 2020)	371768, 6641632
Distance to development	3274 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1166 m
View direction	80° - 170°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1642

Viewpoint VP 12
Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024





Proposed View with Design



70° 80° 90° 100° 110°
Inset A



Coordinates (MGA 55 - 2020)	371768, 6641632
Distance to development	3274 m
Viewpoint type	Residential dwelling (primary view)
Viewpoint elevation	1166 m
View direction	80° - 170°
Horizontal field of view	180°
Camera height	1.5 m
Camera type	Cannon 6D
Lens type	50 mm
Photograph time and date	28 March 2024, 1642

Viewpoint VP 12
Photomontage viewpoint assessment

Tilbuster Stage 2 Solar Farm - Enerpac Australia

Issue v01
Date 17.09.2024



Appendix B

Glint and Glare Assessment



Tilbuster 2 Solar Farm

Glint and Glare Assessment

Enerparc Australia Pty Ltd

07 March 2025

→ The Power of Commitment



Project name		Stage 2 Tilbuster Solar Farm					
Document title		Tilbuster 2 Solar Farm Glint and Glare Assessment					
Project number		12636761					
File name		12636761-REP-Tilbuster Solar Farm Glint and Glare Assessment.docx					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	S. Gupta	L. King		S. Murphy		05/11/24
S4	1	S. Gupta	L. King		S. Murphy		07/03/25

GHD Pty Ltd | ABN 39 008 488 373
133 Castlereagh Street, Level 15
Sydney, New South Wales 2000, Australia
T +61 2 9239 7100 | **F** +61 2 9239 7199 | **E** sydmal@ghd.com | **ghd.com**

© GHD 2025
This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Acknowledgement of Country

GHD acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land, water and sky throughout Australia on which we do business. We recognise their strength, diversity, resilience and deep connections to Country. We pay our respects to Elders of the past, present and future, as they hold the memories, knowledges and spirit of Australia. GHD is committed to learning from Aboriginal and Torres Strait Islander peoples in the work we do.



Contents

1.	Introduction	1
1.1	Background	1
1.2	Proposal overview	1
1.3	Purpose of this report	4
1.4	Scope and limitations	4
2.	Glare principles	5
2.1	Angle of incidence and reflection	5
2.2	ForgeSolar software overview	6
2.2.1	Glare ocular impact categories	6
2.2.2	Glare assessment parameters	7
2.2.3	Software limitations	8
2.3	Solar farm configurations	9
2.3.1	Fixed tilt	9
3.	Methodology	11
3.1	Impact assessments	11
3.1.1	Aviation Impact	11
3.1.2	Vehicles (road and rail)	11
3.1.3	Community	11
4.	Site assessment inputs	12
4.1	Solar farm	12
4.2	Transport routes	13
4.3	Community	13
5.	Results analysis	15
5.1	Glare results	15
5.2	Routes	16
5.3	Community observation points	16
5.3.1	OP 6	16
5.3.2	OP 7	18
5.3.3	OP 8	19
5.3.4	OP 9	21
6.	Conclusions and recommendations	23
6.1	Summary of impacts	23
6.2	Mitigations	24
6.2.1	Screening	24
6.2.2	Design considerations	24
7.	References	25

Table index

Table 1.1	Glint and glare SEARs	4
Table 3.1	Appendix C glint and glare assessment requirements (Large-Scale Solar Energy Guidelines)	11
Table 3.2	Impact rating and performance objectives for glare impacts to residential dwellings	11
Table 4.1	Glare assessment parameters	13
Table 4.2	Route receptors	13
Table 4.3	LVIA viewpoints and glare assessment OPs - coordinates, elevation, and height above ground	14
Table 5.1	SGHAT glare classifications	15
Table 5.2	Annual glare impact	15
Table 6.1	Summary of impacts	23

Figure index

Figure 1.1	Regional setting	2
Figure 1.2	Proposal overview	3
Figure 2.1	Angle of incidence and reflection	5
Figure 2.2	Angle of incidence and panel reflectance (Yellowhair, 2015)	5
Figure 2.3	Specular and diffuse reflection	6
Figure 2.4	Ocular impact categories (Ho, 2011)	7
Figure 2.5	Aerial representation of a north facing array	9
Figure 2.6	Cross sectional representation of a north facing array	9
Figure 2.7	Aerial representation of an east-west array	10
Figure 2.8	Cross sectional representation of an east-west array	10
Figure 4.1	Polygons used in the glare assessment	12
Figure 4.2	Proposed view along New England Highway	13
Figure 5.1	Glare impact on New England Highway from east and west block	16
Figure 5.2	Glare impacts on OP 6 from east and west blocks	17
Figure 5.3	Hazard plot of glare impact for OP 6	17
Figure 5.4	Proposed view of the site from OP 6	18
Figure 5.5	Glare impacts on OP 7 from east and west blocks	18
Figure 5.6	Hazard plot of glare impact for OP 7	19
Figure 5.7	Glare impacts on OP 8 from east and west blocks	20
Figure 5.8	Hazard plot of glare impact for OP 8	21
Figure 5.9	Proposed view of the site from OP 8	21
Figure 5.10	Glare impacts on OP 9 from east block	22
Figure 5.11	Hazard plot of glare impact for OP 9	22

Appendices

Appendix A	ForgeSolar report
------------	-------------------

Glossary

Term	Definition
ARC	Anti-reflective coatings
DC	Direct current
DNI	Direct normal irradiance
EIS	Environmental Impact Statement
Enerparc	Enerparc Australia Pty Ltd
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
GHD	GHD Pty Ltd
ha	hectares
i°	Angles of incidence
km	Kilometre
kV	Kilovolt
LVIA	Landscape and Visual Impact Assessment
LGA	Local Government Area
m	Metre
MW	Megawatt
MWh	Megawatt per hour
OP	Observation points
Proposal	The construction, operation and decommissioning of a ground-mounted photovoltaic (PV) solar array, which would generate approximately 140 MW
Proposal site	The site within which the proposal is located, namely Lot 4 DP800611, 11915 New England Highway, Black Mountain NSW 2365
Project	Approved Stage 1 of Tilbuster Solar Farm
PV	Photovoltaics
SEARs	Secretary's Environmental Assessment Requirements
SGHAT	Solar Glare Hazard Analysis Tool
SSD	State Significant Development
SSD	State Significant Development
w/m^2	Watts per square meter

1. Introduction

1.1 Background

Enerparc Australia Pty Ltd (Enerparc) is developing the Tilbuster Solar Farm (State Significant Development (SSD) 9619), which was approved under Section 2.22 and Clause 20 of Schedule 1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 3 March 2022. The Tilbuster Solar Farm (the project) is located approximately 15 kilometres (km) north of Armidale in the Armidale Regional local government area (LGA), refer to Figure 1.1.

The project involves the construction, operation and decommissioning of a new solar farm with a generating capacity of 150 megawatts (MW) and 15 MW/30 megawatt hours (MWh) of battery energy storage. The solar farm will connect to the existing Transgrid 330 kilovolt (kV) transmission line, which traverses the site and connects Dumaresq substation to Armidale substation.

Due to design refinements to suit ecological and heritage constraints identified during the preparation of the Environmental Impact Statement (EIS), the project was approved with a lower MW capacity than originally anticipated. As a result, Enerparc have acquired adjacent land and propose developing Stage 2 of the project to maximise the generation potential of the site (the proposal).

The proposal is located on land adjoining the project and would make use of transmission, storage and construction facilities on that site.

1.2 Proposal overview

The proposal involves the construction, operation and decommissioning of a ground-mounted photovoltaic (PV) solar array, which would generate approximately 140 MW, in addition to the 150 MW generated by the project.

The proposal site is located at Lot 4 DP800611, 11915 New England Highway, Black Mountain NSW 2365. The proposal site has an area of approximately 250 hectares (ha), with the proposed development to be constructed on approximately 140 ha of this land.

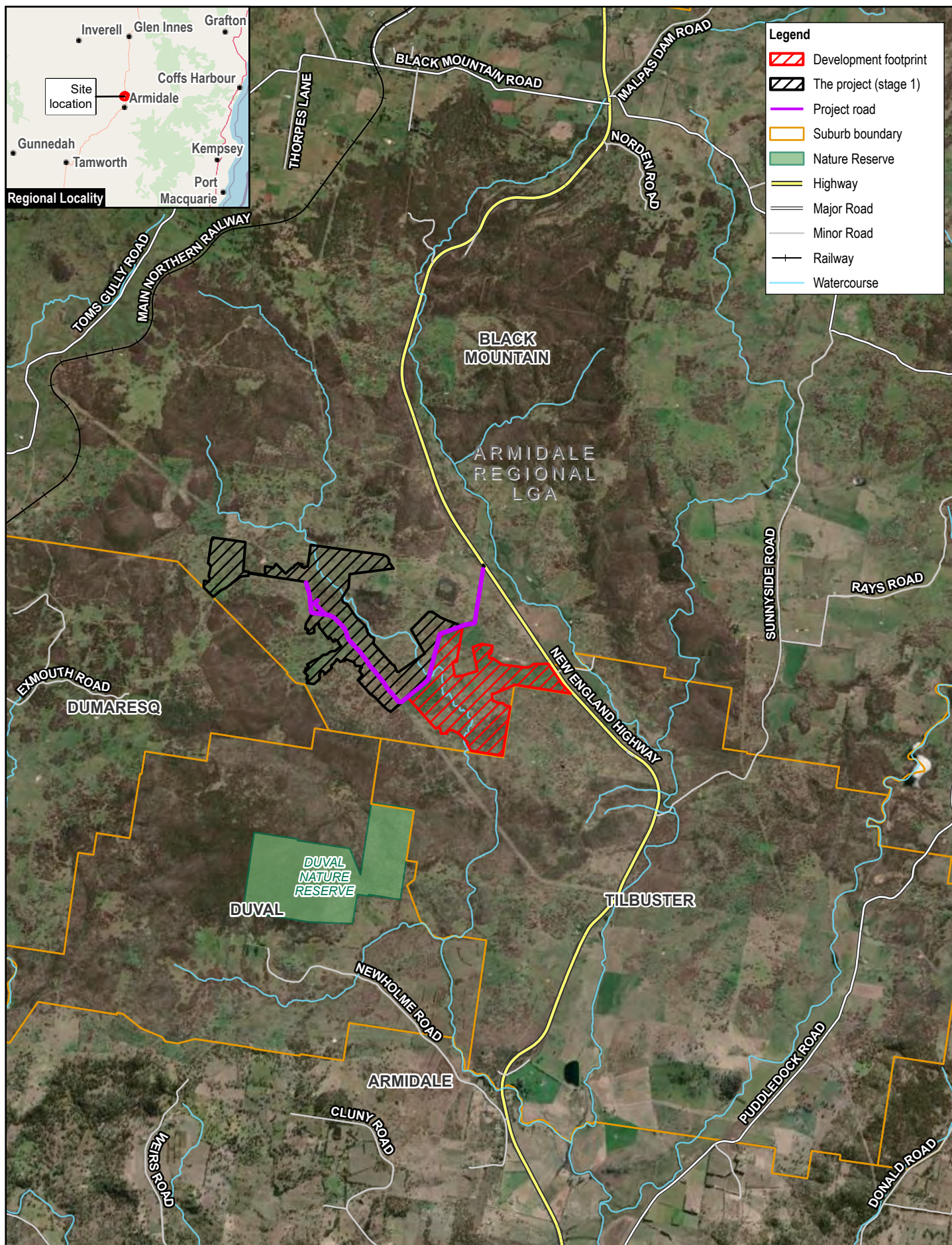
In total, the construction phase of the proposal is expected to take nine months, and the facility is expected to operate for around 30 years or extended pending further approvals. The proposal would be constructed as part of the overall construction of the approved project. This would reduce the construction period for the proposal and minimise impacts on the community.

The primary access point for light and heavy vehicles during construction and operation would be via an existing access off the New England Highway, currently under construction for the project. Temporary construction compounds and laydowns areas would also be located on the project site.

Construction of the proposal is anticipated to take nine months, with work commencing, pending approval, in early 2025. Up to 100 construction workers would be required.

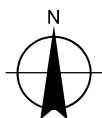
Up to five full time equivalent operations and maintenance staff and service contractors would operate the proposal, as part of the operation of the approved project. Existing transmission and storage infrastructure within the approved project footprint would be used to connect the proposal to the national electricity grid.

Figure 1.2 shows the indicative layout for the proposal, including the location of solar PV panels, associated infrastructure and internal access roads.



Paper Size ISO A4
0 0.5 1 1.5 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

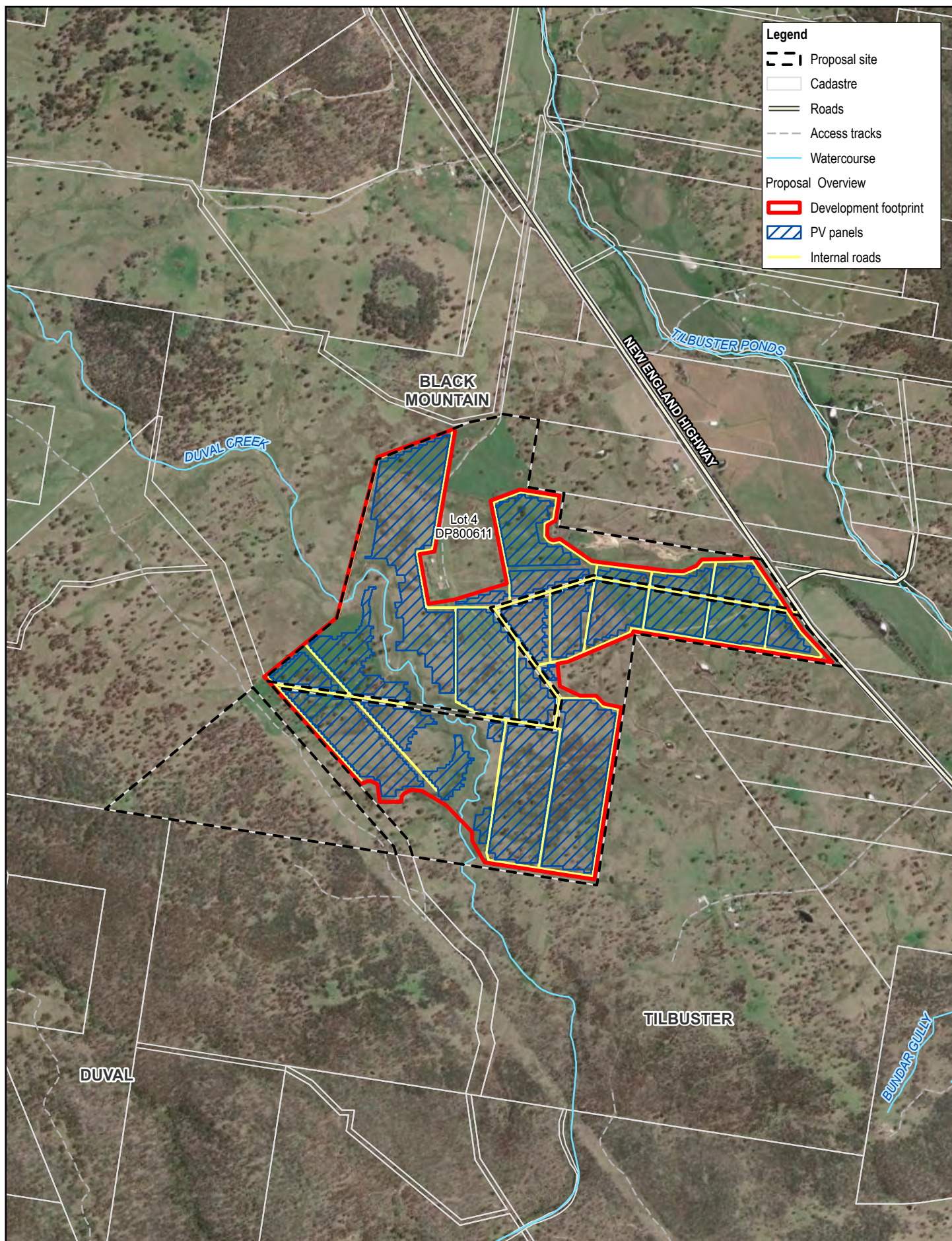


Enerparc Australia Pty Ltd
Tilbuster 2 Solar Farm
Glnt and Glare Assessment

Project No. 12636761
Revision No. 0
Date 23/10/2024

Local context

FIGURE 1.1



1.3 Purpose of this report

The purpose of this report is to complete a glare assessment study in accordance with the Solar Glare Hazard Analysis Tool (SGHAT) technology and the *Large-Scale Solar Energy Guideline* (DPE 2022). The SGHAT technology, licensed from Sandia National Laboratories, is a web-based tool and methodology to evaluate potential glint/glare hazards associated with solar energy installations. The assumptions and parameters used in the glare assessment are described in Section 2.

The report has been prepared to address the Secretary's environmental assessment requirements (SEARs) for the proposal, issued 18 April 2024, as summarised in Table 1.1.

Table 1.1 *Glint and glare SEARs*

Issue	SEARs	Where addressed
Glint and Glare	Provide a glint and glare assessment prepared in accordance with Appendix C of the <i>Large-Scale Solar Energy Guideline</i> 2022	This report

1.4 Scope and limitations

This report has been prepared by GHD for Enerparc Australia Pty Ltd and may only be used and relied on by Enerparc Australia Pty Ltd for the purpose agreed between GHD and Enerparc Australia Pty Ltd as set out in Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Enerparc Australia Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

GHD has prepared this report on the basis of information provided by Enerparc Australia Pty Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Glare principles

2.1 Angle of incidence and reflection

Glare (in the context of solar farms) is caused by the reflection of sunlight by the surface of solar panels. The magnitude of the reflected light is dependent on the surface of the solar panel and the angle at which light hits the solar panel surface. Solar panels are all manufactured with a glass layer to shield the underlying photovoltaic layer from weather-related damage. As glass is very transparent, almost all sunlight, at angles of incidence (i°) close to the surface normal can pass through it. However, at greater angles of incidence, light will be refracted internally ($i^\circ = \text{critical angle}$) or will be reflected ($i^\circ > \text{critical angle}$), see Figure 2.1. At greater angles of incidence, glass can act like a mirror.

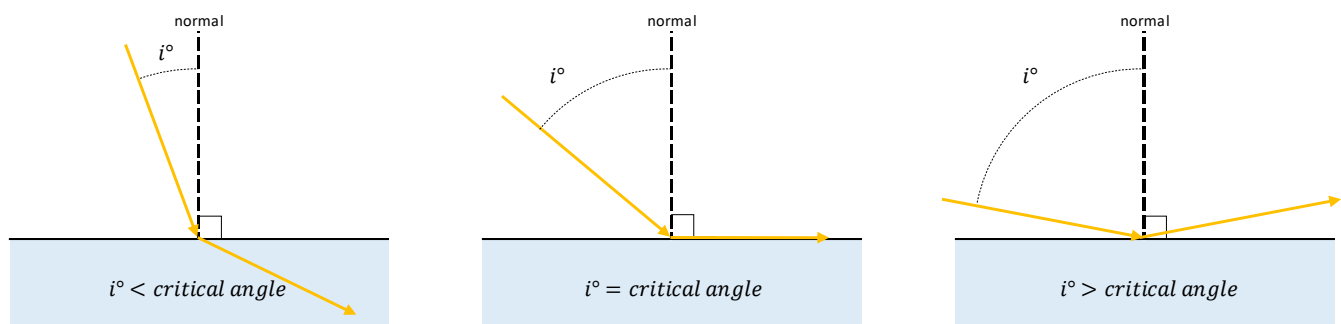


Figure 2.1 Angle of incidence and reflection

Figure 2.2 demonstrates that reflected light is relatively insignificant at low angles of incidence, however increases exponentially as angle of incidence exceeds 60 degrees.

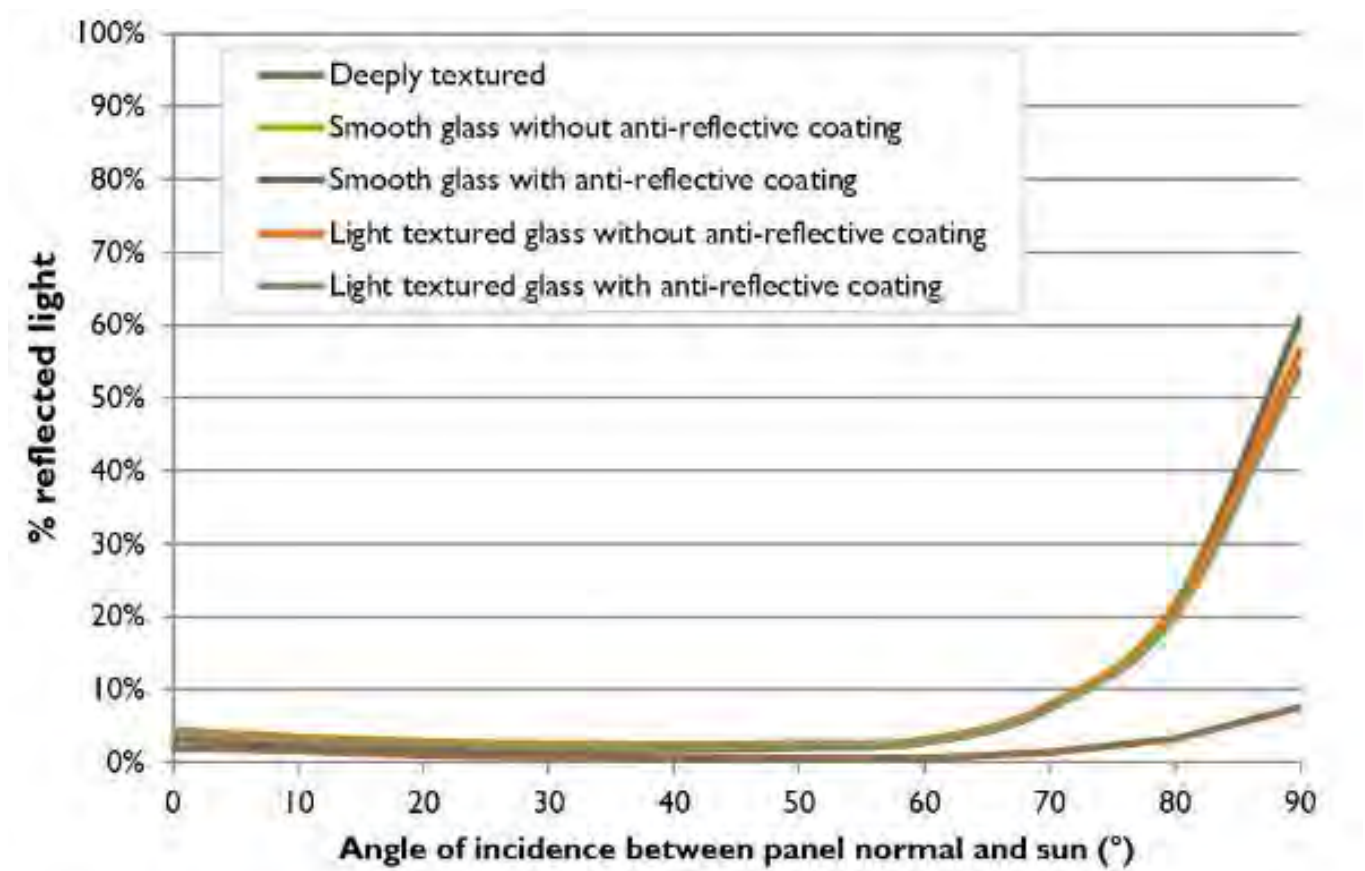


Figure 2.2 Angle of incidence and panel reflectance (Yellowhair, 2015)

Figure 2.2 also shows how reflected light also depends on the surface of solar panels. Clean solar panels with smooth glass create specular reflection, whereas solar panels with textured glass or anti reflective coating, can result in diffuse reflection as shown in Figure 2.3. Specular reflection has a direction symmetrical to the angle of incidence with reference to the panel's normal direction, this results in more intense reflections.

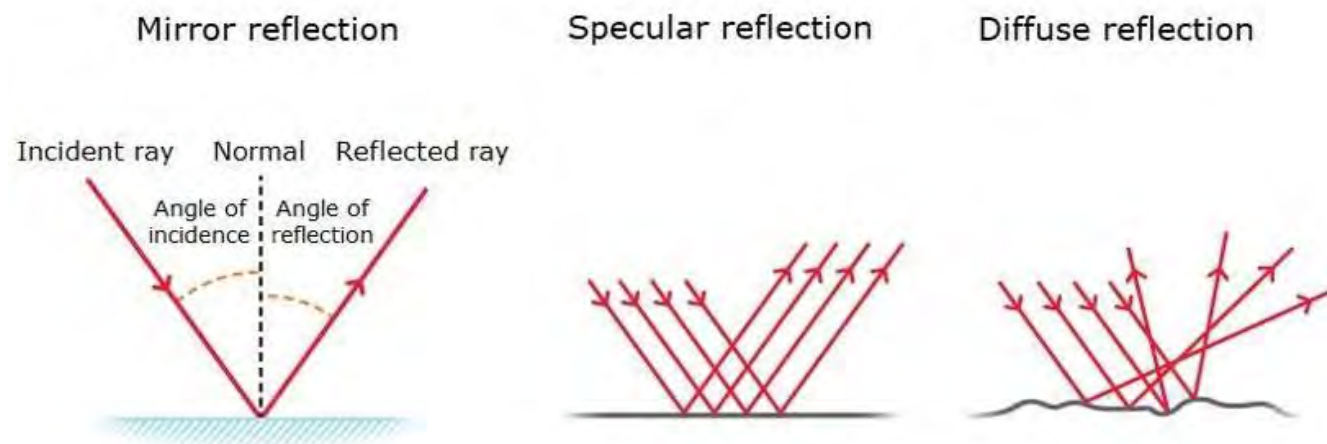


Figure 2.3 Specular and diffuse reflection

Diffuse reflections result from a beam of light being scattered in multiple angles due to a rough surface. Reflections are less intense as they are scattered over a wider range. Such reflections may occur on a solar farm due to any slight roughness of the panel surface type, or by dust and contaminants. Diffuse reflection lowers the intensity of the overall specular reflection and therefore it can be considered to lower the likelihood of hazardous glare.

2.2 ForgeSolar software overview

Licensed from Sandia National Laboratories and provided by ForgeSolar, the SGHAT is an industry standard technical modelling tool. SGHAT can be used to determine the impact of glare on aeroplane pilots and air-traffic controllers, pedestrians, motorists, and train drivers. SGHAT calculates the sun position and sunlight intensity at one minute intervals specific to location data, time of day and time of year to determine the direction and intensity of the glare.

NOTE: There are more sophisticated methods for calculating glare more accurately, however ForgeSolar SGHAT is the only platform specifically for evaluating the impact of hazardous solar glare, reflected by solar panels, on the aviation industry.

2.2.1 Glare ocular impact categories

Ocular impact is a measure of the potential for after-image and damage that may occur to the human eye when exposed to glare. Ocular impact is a function of both the magnitude of the reflected sunlight received by the observer 'retinal irradiance' (W/cm^2) and the size of the glare source perceived by the observer, measured by the subtended angle of the reflected glare (milliradians). The SGHAT identifies glare as either green, yellow, or red glare using Ho's (2011) classification of ocular impact (see Figure 2.4):

- Low potential for after-image, also referred to as green glare.
- Potential for after-image, also referred to as yellow glare.
- Potential for permanent eye damage, also referred to as red glare.

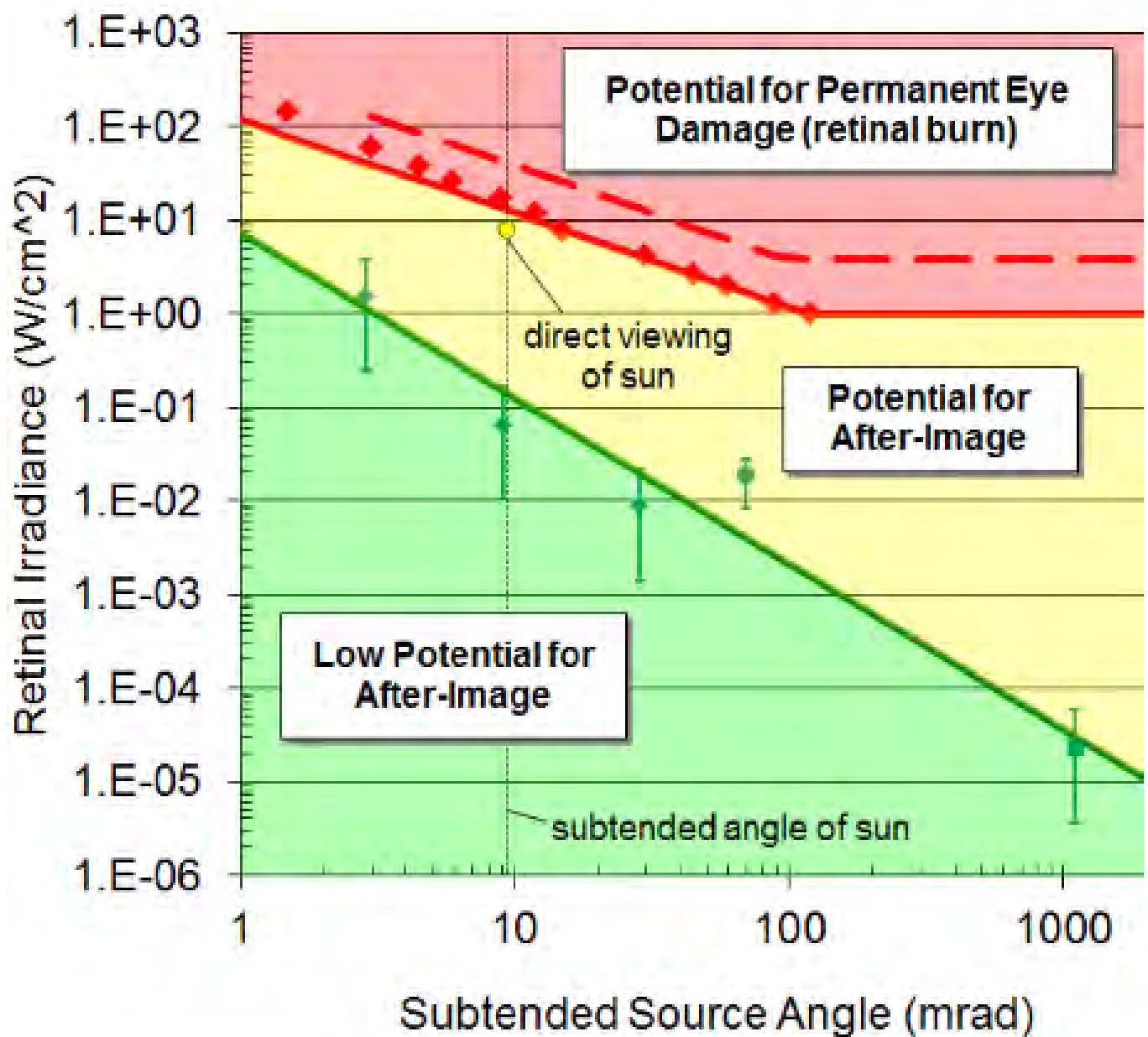


Figure 2.4 Ocular impact categories (Ho, 2011)

2.2.2 Glare assessment parameters

The ForgeSolar SGHAT can account for the following factors:

- The tilt, orientation, and optical properties of the solar panels in the solar farm and the elevation.
- Sun position with respect to, geographic location, elevation, time of year and time of day.
- The location of sensitive receptors (viewers) and their elevation.

ForgeSolar SGHAT uses the following assumptions for evaluation:

- Clear atmospheric conditions are assumed as this will present the strongest/worst case conditions for glare, therefore the effect of clouds and dust will not be included.
- There is no shading by vegetation.
- The Google Earth topography database, which is used to determine elevation specific to location data, is accurate.

Direct normal irradiance

Direct normal irradiance is the measurement of power that a given surface area may absorb when it is exposed to sunlight, measured in watts per square meter (W/m^2). The maximum irradiance occurs at midday when the sun is directly overhead however this irradiance will decrease as the sun angle decreases, as the sunlight passes through more of the atmosphere and less energy will reach the solar panel surface. SGHAT accounts for the variation in sunlight intensity by applying a subtractive function depending on the sun angle.

Solar panel surface

Solar panels aim to maximise the conversion of sunlight energy to electrical energy by, in part, minimising energy loss through reflection of sunlight. Some manufacturers of solar panels provide anti-reflective coatings (ARC) to reduce surface reflectivity. ARC is most effective with small angles of incidence (the angle between panel perpendicular and sun) and is not as effective as angle of incidence increases, demonstrated in Figure 2.1. This is due to greater surface texturing slightly increasing the subtended source angle (glare spot) increasing reflection. The SGHAT can account for ARC.

Bifacial panels also slightly reduce glare. Power can be produced from both sides of a bifacial panels, increasing total energy generation. Bifacial panels allow light to pass through them (they do not have a backing sheet) and be reflected by ground surface. This reflected light is converted to power by solar cells on the back of the panels. Allowing light to pass through the panel slightly reduces the reflectivity, therefore slightly reducing glare (Marsh, 2024). The SGHAT cannot account for bifacial panels.

2.2.3 Software limitations

ForgeSolar SGHAT is limited by the following:

- The algorithm does not rigorously represent the detailed geometry of a system; including features such as gaps between modules, variable height of the photovoltaic (PV) array, and support structures that may impact actual glare results.
- It is only capable of assessing the glare of an array in a single orientation.
- Random number computations are utilised by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result.
- The algorithm assumes that the PV array is aligned with a plane defined by the approximate total heights of the PV vertices.
- The SGHAT cannot account for bifacial panels.
- The algorithm does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc Therefore the assessment is conservative.
- The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
- The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modelling methods.
- Hazard zone boundaries shown in the glare hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- The program does not consider glint (momentary flashes of bright light, often caused by a moving source).

2.3 Solar farm configurations

Glare from a solar farm depends on its configuration. The most common configurations currently used in the industry are single axis tracking and fixed tilt arrays.

2.3.1 Fixed tilt

The proposal would be north facing with a fixed tilt array. The most common orientations for fixed tile arrays currently used in the industry are north and east-west.

North facing

North facing arrays consist of solar panels running in east west 'rows', tilted to an optimal angle to face north. The rows are spaced to minimise panel on panel shading and to allow access for maintenance (see Figure 2.5).

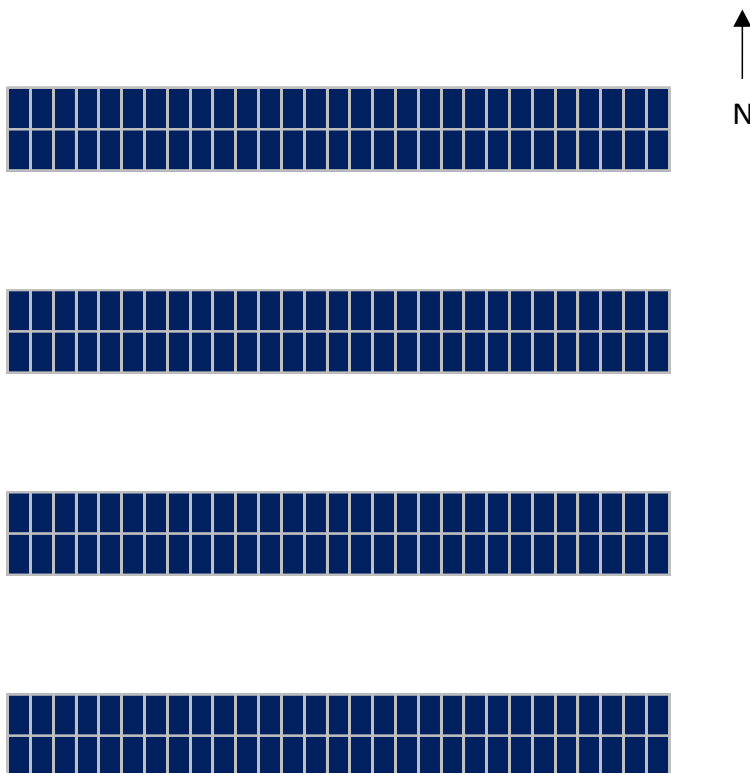


Figure 2.5 Aerial representation of a north facing array

As the solar panels are fixed in position, the angle of incidence varies throughout the day. North facing arrays can result in greater glare to receptors to their north, though eliminate glare to the south (see Figure 2.6).

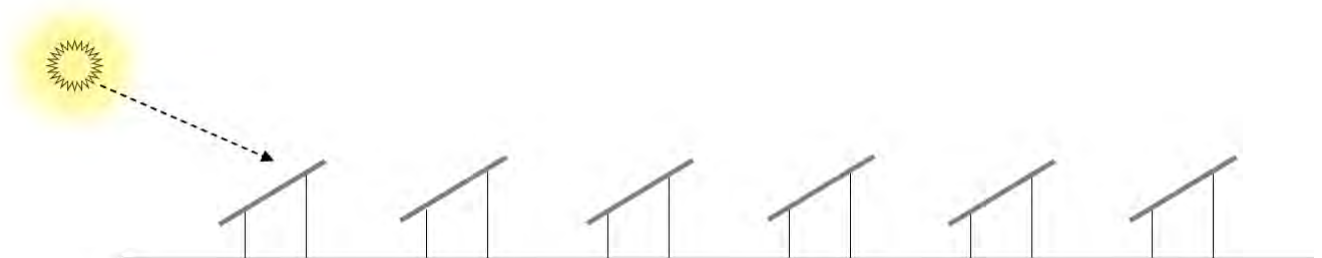


Figure 2.6 Cross sectional representation of a north facing array

East – west array

Some smaller solar farms adopt a low profile, east – west array arrangement (see Figure 2.7). These arrangements allow for a higher energy density per unit area.

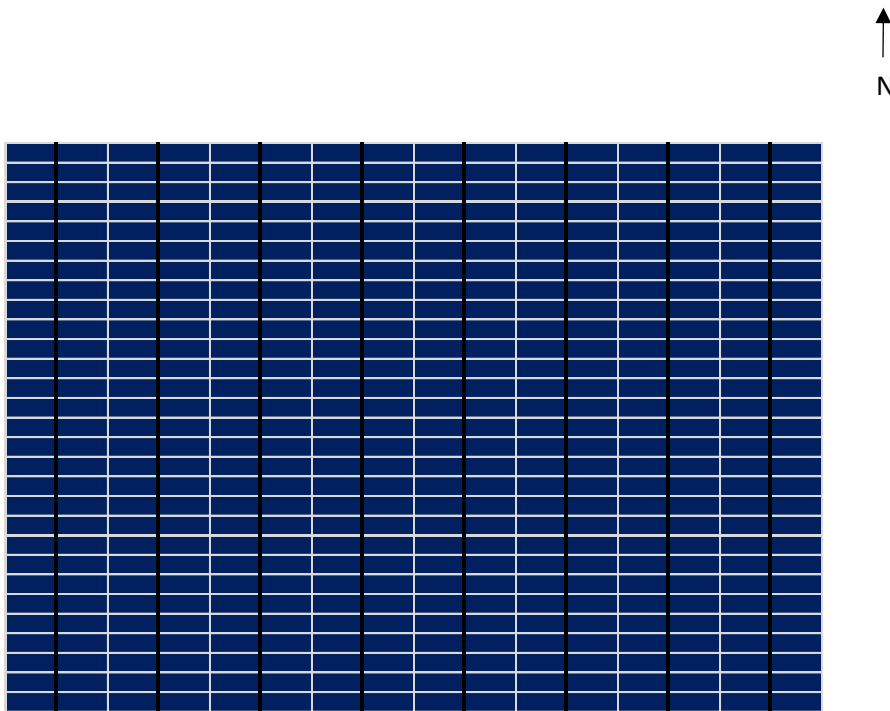


Figure 2.7 Aerial representation of an east-west array

As there are solar panels facing both east and west, there are more occasions where large angle of incidence occurs, increasing glare durations (see Figure 2.8).

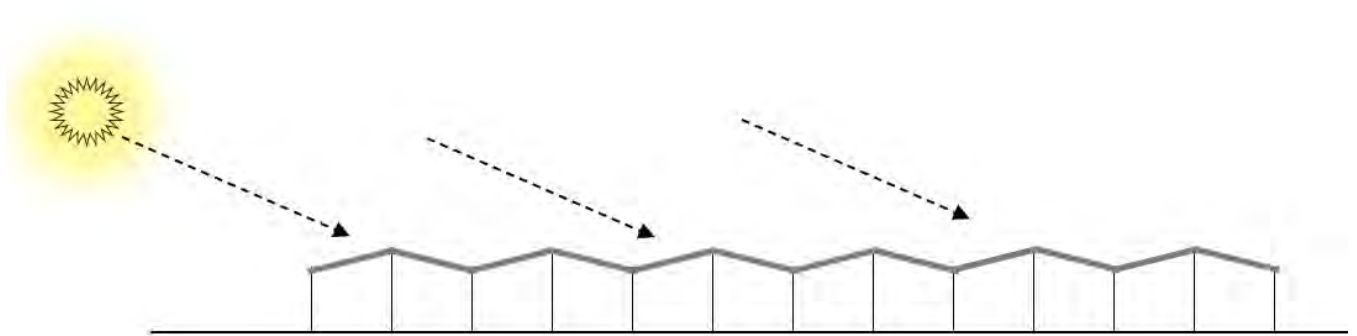


Figure 2.8 Cross sectional representation of an east-west array

3. Methodology

3.1 Impact assessments

There are currently no Australian Standards on the maximum acceptable glare impact. The NSW Department of Planning, Housing and Infrastructure provides some assessment guidelines in their *Large-Scale Solar Energy Guideline* (DPE, 2022). These are summarised in Table 3.1.

Table 3.1 Appendix C glint and glare assessment requirements (*Large-Scale Solar Energy Guidelines*)

Receptors	Scope	Performance objectives
Aviation	All air traffic control towers and take off/ landing approaches to any runway or landing strip within 5 km of the proposed solar array.	Any glint and glare should be avoided unless the aerodrome operator agrees that the impact would not be material.
Road and rail	All roads and rail lines within 1 km of the proposed solar array.	If glare is geometrically possible then measures should be taken to eliminate the occurrence of glare.
Residential receivers	All residential viewpoints within 3 km of the proposed solar array that have a line of sight.	Refer to impact ratings and performance objectives for residential receivers outlined in Table 2 of the Solar Guidelines.

Table 2 of the *Large-Scale Solar Energy Guidelines* (as referenced in the performance objectives for residential receivers in the Table 3.1) outlines the following impact ratings for residential dwellings.

Table 3.2 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

3.1.1 Aviation Impact

There is no airport or airfield within a 5 km radius of the proposed solar array, therefore assessing aviation impact is not required.

3.1.2 Vehicles (road and rail)

The SGHAT route receptor function can assess glare impact for vehicle operators traveling along continuous paths such as roads or railways. For a conservative approach, glare is assessed at a height to represent the viewing perspective from the driver's position in a truck, which is estimated at around 2.5 m above ground. Glare experienced by cars at lower heights is expected to be less due to greater obstructions at lower heights, such as vegetation or fencing along the routes.

The SGHAT's algorithm does not consider obstacles (either man-made or natural) between the observation points and the solar farm that may obstruct observed glare, such as trees, hills, buildings, etc.

The New England Highway is relevant to this assessment but there are no rail routes in proximity to the proposal.

3.1.3 Community

In the SGHAT, a discrete observation point (OP) receptor allows the simulation of an observer at a single, location, defined by a latitude, longitude, elevation, and a height above ground. OP receptors were used to assess the potential glare for a pedestrian, at a height of 1.5 metres (m), in line with the *Large-Scale Solar Energy Guidelines*.

4. Site assessment inputs

4.1 Solar farm

The proposal location and layout are shown in Figure 1.1 and Figure 1.2. The solar array will be located adjacent to the approved Stage 1 of the project. The visual impact assessment for Stage 1 (NGH 2020) rated impacts at all receivers as low. No glint and glare assessment was completed for Stage 1.

The proposal includes a north facing array with a fixed tilt of 20°, configured in 'rows' with sufficient spacing to minimise panel on panel shading and to allow access for maintenance. For the glare assessment, these arrays are modelled as polygons – referred to as the 'east block' and 'west block', as shown in Figure 4.1.

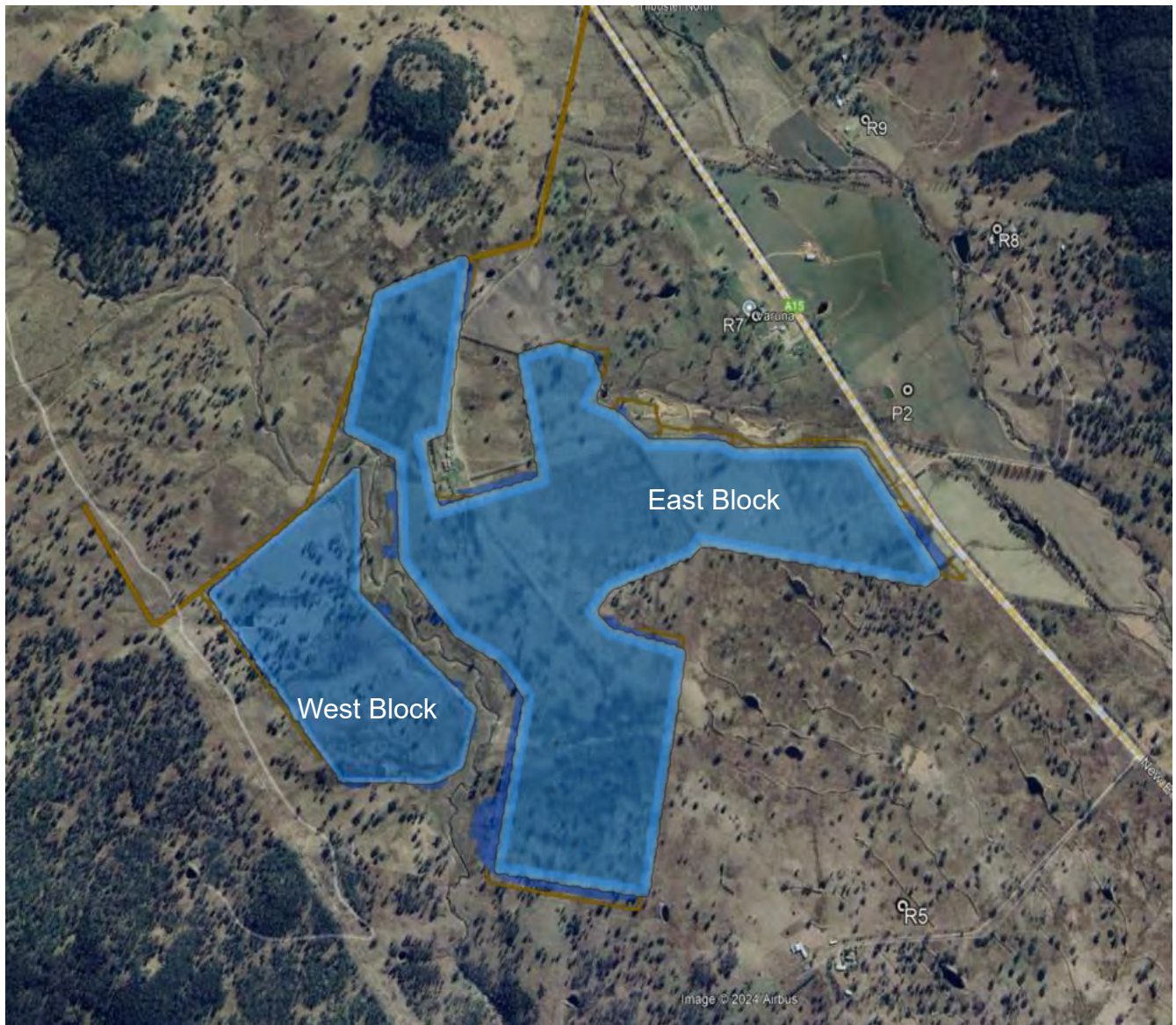


Figure 4.1 Polygons used in the glare assessment

As a conservative estimate, it has been assumed the panels will be mounted at a height of 2 m. Input assumptions are summarised in Table 4.1.

Table 4.1 Glare assessment parameters

Parameter/Information	Value
Solar farm size	140 MW direct current (DC)
Orientation	North
Ground coverage ratio	0.5
Solar panel midpoint height	2 m
Tilt	20°
Solar panel model	Generic
Solar panels surface	Smooth glass with anti-reflective coating

4.2 Transport routes

Glare impacts on transport routes within a 1 km radius were assessed for the proposal. The New England Highway is the only roadway assessed and runs north-south adjacent to the proposal site, see Figure 1.1.

The Google Earth topography database estimates the natural ground elevation of each vertex of the route receptors. The receptors' height above ground was set to 2.5 m for roads to account for the viewing level of truck drivers. It can be assumed cars will receive similar or slightly less glare due to having a lower viewing angle and greater obstructions at lower heights, but this is not accounted for in the model. A viewing angle for truck drivers of 50° was also nominated (Rogers, 2015), permitting the SGHAT to disregard any glare predicted outside of the 100° field of view. Each route and respective assumptions are provided in Table 4.2.

Table 4.2 Route receptors

Name	Type	Vertices elevation (m - ASL)	Vehicle	Receptor height (m)	Observer viewing angle (°)
New England Highway	Route – Road	1,029 – 1,072	Truck	2.5	50

The photomontage for the highway provided in the *Landscape and Visual Impact Assessment (LVIA)* for the proposal (see Figure 4.2) shows that while there is limited vegetation on the highway verge to serve as effective glare obstructions. The proposed solar array is visible in blue on the left side of the montage, behind the fencing.



Figure 4.2 Proposed view along New England Highway

4.3 Community

The LVIA (GHD 2024) prepared for the proposal identified several residential and public viewpoints within 3 km of the site. These are shown in Figure 8.1 of the LVIA and are used in this assessment. Table 4.3 summarised the viewpoints used in the LVIA and corresponding observation points applied to this assessment. Note that viewpoints R19, R20, R21, and R22 in the LVIA have not been included, as they lie outside this assessment's 3 km boundary. The observation points (OPs) assume an average viewing height of a pedestrian is 1.5 m.

Table 4.3 *LVIA viewpoints and glare assessment OPs - coordinates, elevation, and height above ground*

Viewpoint (as per LVIA)	Receiver (as per LVIA)	Receptor (as per this report)	Latitude (°)	Longitude (°)	Elevation (m – ASL)	Height above ground (m)
-	R1	OP1	-30.422987	151.676346	1044.47	1.50
-	R2	OP2	-30.420489	151.685186	996.81	1.50
-	R3	OP3	-30.417529	151.684199	1014.49	1.50
-	R4	OP4	-30.411636	151.688924	1037.54	1.50
VP01	R5	OP5	-30.397127	151.679300	1096.16	1.50
VP02	R6	OP6	-30.391183	151.693199	1028.95	1.50
VP04	R7	OP7	-30.382178	151.678224	1046.65	1.50
VP05	R8	OP8	-30.379126	151.684652	1046.61	1.50
VP06	R9	OP9	-30.375054	151.679716	1051.83	1.50
VP07	R10	OP10	-30.370619	151.668745	1070.48	1.50
VP08	R11	OP11	-30.369273	151.671175	1060.59	1.50
VP09	R12	OP12	-30.366135	151.672731	1064.30	1.50
VP10	R13	OP13	-30.364505	151.674297	1075.58	1.50
VP11	R14	OP14	-30.367542	151.660264	1179.41	1.50
-	R15	OP15	-30.360335	151.659632	1163.57	1.50
-	R16	OP16	-30.358614	151.664824	1084.34	1.50
-	R17	OP17	-30.359039	151.653806	1168.44	1.50
-	R18	OP18	-30.353221	151.662875	1092.06	1.50

5. Results analysis

This section summarises the results of the glare analysis. The glare analysis report exported from ForgeSolar is provided in Appendix A. As per Section 2.2.1, glare impacts are categorised as either green, yellow, or red – see Figure 2.4 – as summarised in Table 5.1.

Table 5.1 SGHAT glare classifications

Classification	Description
Green glare	Low potential for after-image
Yellow glare	Potential for after-image
Red glare	Potential for permanent eye damage (retinal burn)

5.1 Glare results

The SGHAT model did not detect any red glare for the proposal, hence there is no potential for permanent eye damage. The hazard plots generated by ForgeSolar for all analysed arrays show the glare potential has lower intensity than that of the sun. The glare impact results are presented in Table 5.2.

Table 5.2 Annual glare impact

Receptor type	Receptor	Green glare per annum (hours/year)	Yellow glare per annum (hours/year)
Routes	New England Hwy	1.9	9.5
Observation points	OP 1	0.0	0.0
	OP 2	0.0	0.0
	OP 3	0.0	0.0
	OP 4	0.0	0.0
	OP 5	0.0	0.0
	OP 6	25.5	0.0
	OP 7	52.5	27.9
	OP 8	71.0	2.3
	OP 9	11.6	0.0
	OP 10	0.0	0.0
	OP 11	0.0	0.0
	OP 12	0.0	0.0
	OP 13	0.0	0.0
	OP 14	0.0	0.0
	OP 15	0.0	0.0
	OP 16	0.0	0.0
	OP 17	0.0	0.0
	OP 18	0.0	0.0

5.2 Routes

The stretch of the New England Highway adjacent to the proposal site was the only major route considered in this assessment. This section of road is predicted to receive around 10 hours of yellow glare per year, caused by both PV blocks (see Figure 5.1). This is likely due to the fact the highway runs north-south, and that the panels are facing north at a 20° fixed tilt. This impact is only predicted to happen during the months of March and September, for less than 15 minutes per day around sunset time. The intensity of the glare from the solar arrays is predicted to be relatively low compared to glare from the direct sun.



Figure 5.1 Glare impact on New England Highway from east and west block

5.3 Community observation points

Only four of the 18 OPs assessed herein are predicted to be impacted by glare from the proposal – OP 6, OP 7, OP 8, and OP 9, the timings of which align with sunset. Further, OP 6 and OP 9 are only predicted to receive green glare, which is considered to have low potential for an after-image. As per Table 3.2 glare impacts of over 10 minutes a day or 10 hours a year should be mitigated.

5.3.1 OP 6

OP 6 is predicted to receive no yellow glare, and around 26 hours annually of green glare from both PV blocks – as shown in Figure 5.2. These impacts are predicted to occur around 5:00 – 6:00 pm in February – March and September – October for around 15 minutes per day.



Figure 5.2 Glare impacts on OP 6 from east and west blocks

The hazard plot for OP 6, given in Figure 5.3, indicates that all the glare has a low potential for causing after-image and is much less than that from the sun.

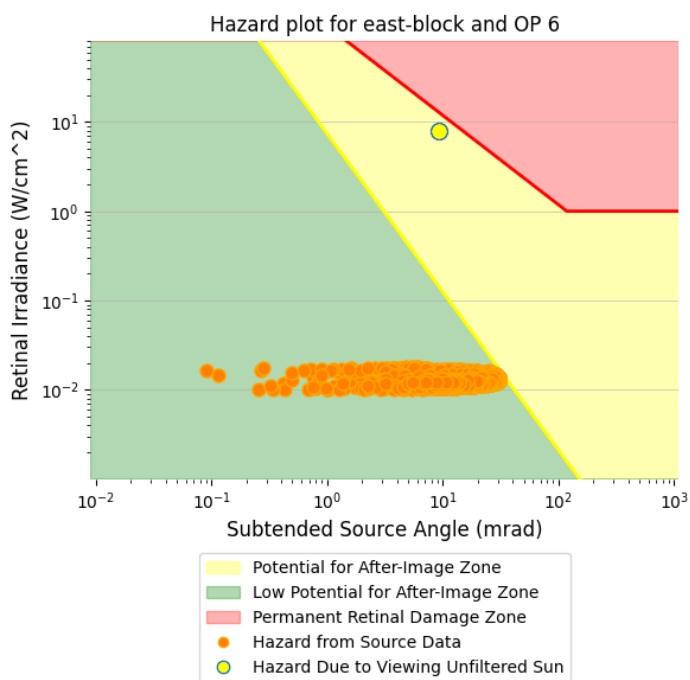


Figure 5.3 Hazard plot of glare impact for OP 6

Furthermore, the LVIA for the proposal (GHD 2024) found reduced visibility of the proposal from OP 6, with vegetation blocking sightlines – see Figure 5.4.



Figure 5.4 Proposed view of the site from OP 6

5.3.2 OP 7

OP 7 is expected to receive around 28 hours of yellow glare annually, and 53 hours of green glare originating from both PV blocks – as demonstrated in Figure 5.5. These impacts are predicted to occur around 5:00 - 6:00 pm from September – April, for around 15 minutes per day.



Figure 5.5 Glare impacts on OP 7 from east and west blocks

The hazard plot for OP 7, given in Figure 5.6, indicates that majority of the glare has a low potential for causing after-image and is much less than that from the sun.

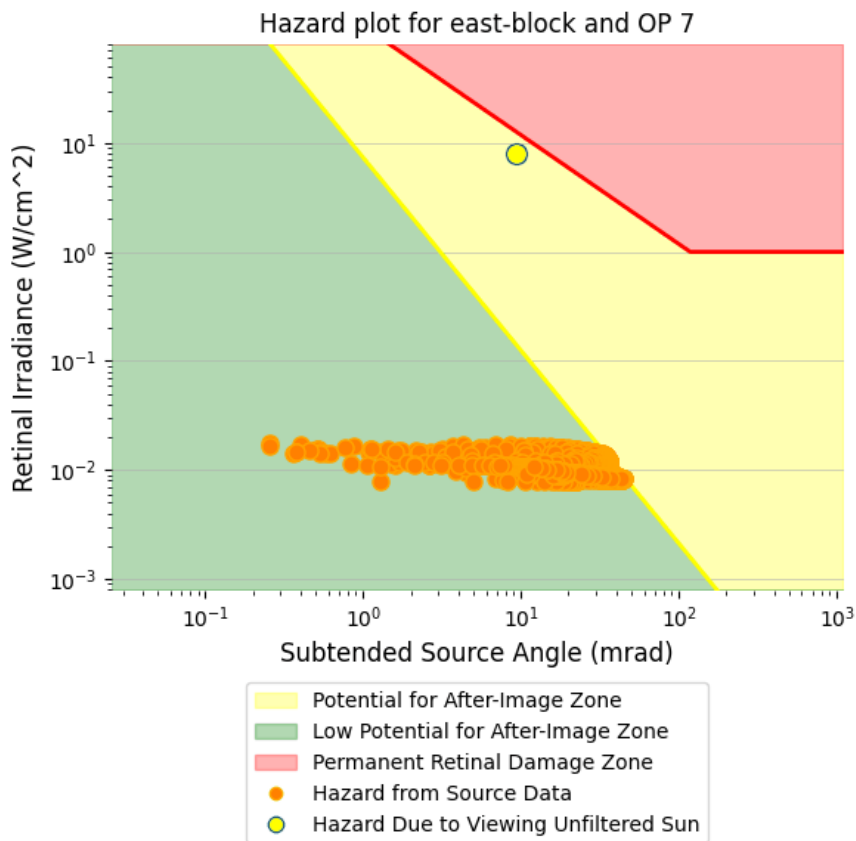


Figure 5.6 Hazard plot of glare impact for OP 7

5.3.3 OP 8

OP 8 is predicted to receive only a small amount of yellow glare from the east block – just over two hours annually, and over 70 hours of green glare from both PV blocks – as demonstrated in Figure 5.7. These impacts are predicted to occur around 5:00 – 6:00 pm from September – April, for around 15 - 20 minutes per day.

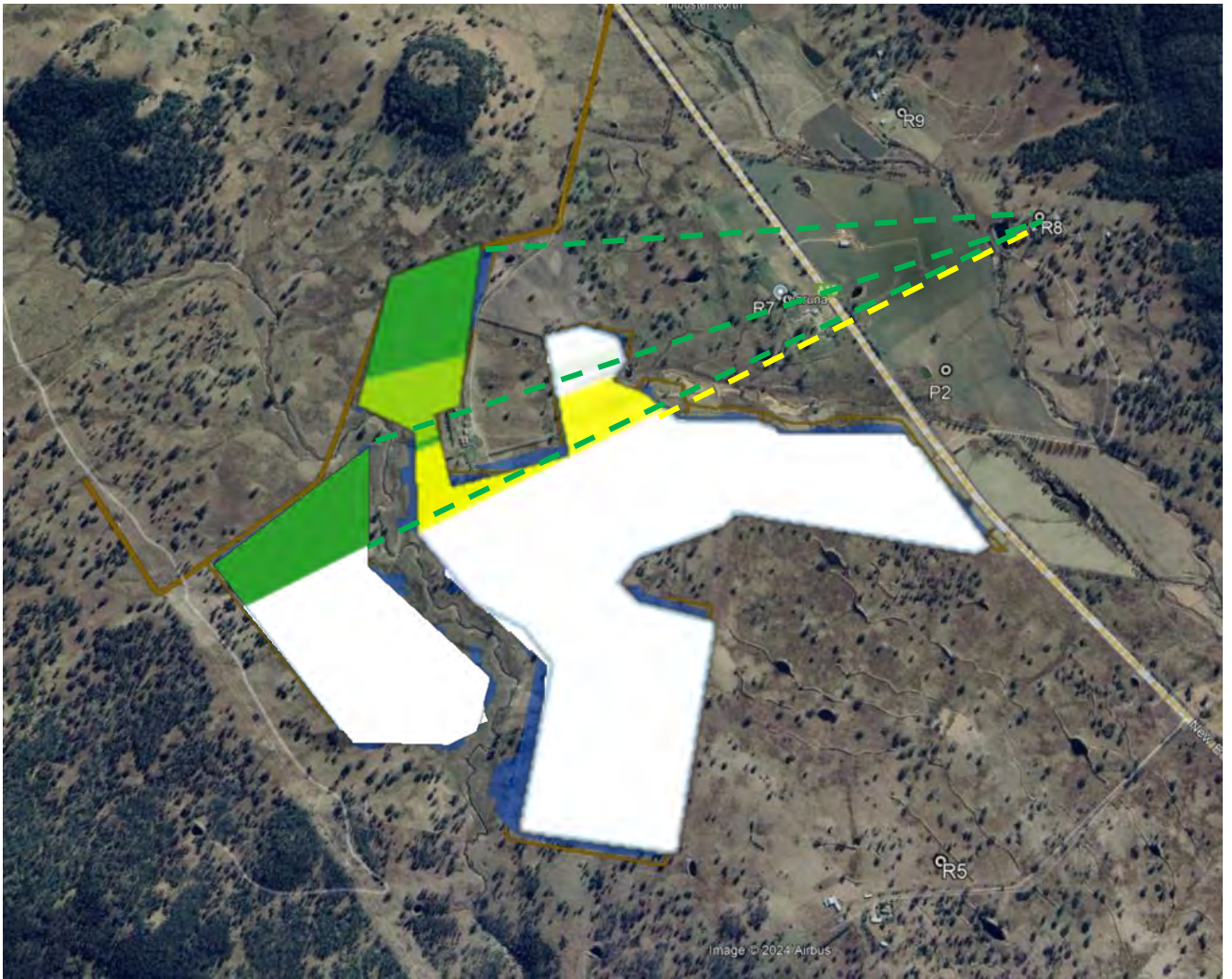


Figure 5.7 *Glare impacts on OP 8 from east and west blocks*

The hazard plot for OP 8, given in Figure 5.8, indicates that majority of the glare has a low potential for causing after-image and is much less than that from the sun.

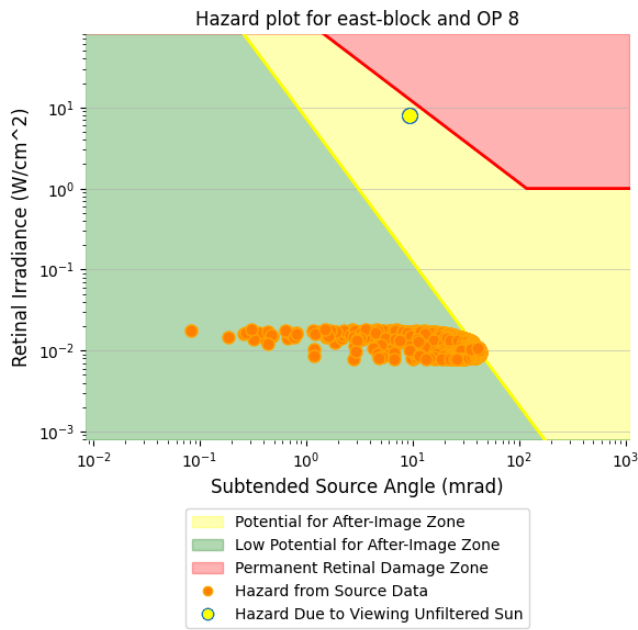


Figure 5.8 Hazard plot of glare impact for OP 8

Furthermore, the LVIA for the proposal (GHD 2024) found reduced visibility of the proposal from OP 8, with vegetation blocking sightlines – see Figure 5.9.



Figure 5.9 Proposed view of the site from OP 8

5.3.4 OP 9

OP 9 is predicted to receive just over 10 hours of green glare only per year, from the east block – as shown in Figure 5.10. These impacts are predicted to occur around 5:00 – 6:00 pm during summer months, for around 15 minutes per day.



Figure 5.10 Glare impacts on OP 9 from east block

The hazard plot for OP 9, given in Figure 5.11, indicates that all glare has a low potential for causing after-image and is much less than that from the sun.

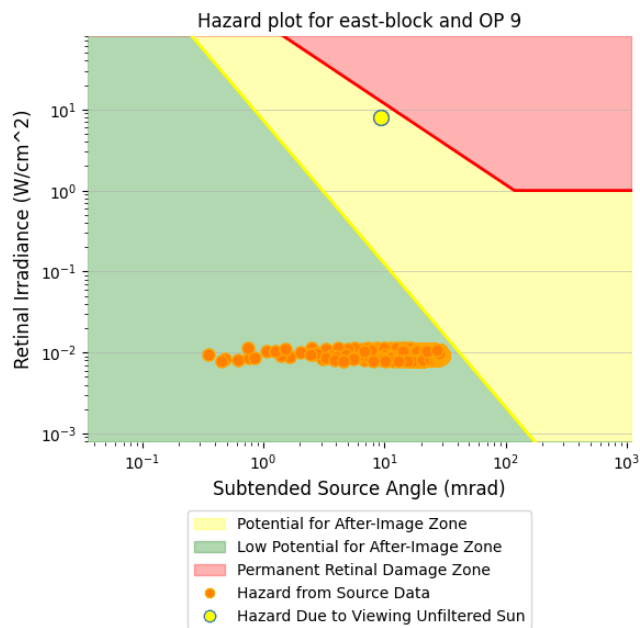


Figure 5.11 Hazard plot of glare impact for OP 9

6. Conclusions and recommendations

6.1 Summary of impacts

The significant glare impacts due to the proposal are summarised in Table 6.1. These are assessed in accordance with the glint and glare requirements of Table 7 in Appendix B of the Large-Scale Solar Energy Guidelines (presented in Table 3.1 in this report).

Table 6.1 Summary of impacts

Receptor type	Receptor	Green glare per annum (hours/year)	Yellow glare per annum (hours/year)	Total glare per annum (hours/year)	Comments	Glare impact
Routes	New England Hwy	1.9	9.5	11.4	Glare is possible.	Measures should be taken to eliminate the occurrence of glare.
Observation points	OP 6	25.5	0.0	25.5	Receives under 30 hours but over 10 hours of glare per annum, for less than 30 mins a day. Local vegetation likely to block some of the impacts.	Moderate impact – explore mitigation measures to reduce impacts as far as practicable.
	OP 7	52.5	27.9	80.4	Receives over 30 hours of glare per annum, but for less than 30 mins per day.	High impact – glare should be avoided; explore mitigation measures.
	OP 8	71.0	2.3	73.3	Receives over 30 hours of glare per annum, but for less than 30 mins per day. Local vegetation likely to block some of the impacts.	High impact – glare should be avoided; explore mitigation measures.
	OP 9	11.6	0.0	11.6	Receives under 30 hours but over 10 hours of glare per annum, for less than 30 mins a day.	Moderate impact – explore mitigation measures to reduce impacts as far as practicable..

The glare impact described in Table 6.1 is based on the total hours of glare exposure per annum. For all of the observation points, the majority of this glare is green glare, which has a low potential for after-image. This is demonstrated in the hazard plots presented in Section 5. Also, as noted in the table, existing vegetation is likely to reduce the glare impact for OP 6 and OP 8.

Furthermore, all glare for the observation points occurs around 5:00 – 6:00 pm, which is around sunset time, when glare from the sun will likely be more of a nuisance than glare resulting from the proposal. Green glare has a lower after image than the sun (see Figure 2.4). Therefore, although the glare impact is rated as moderate and high by the guidelines, the impact at the residential dwellings is unlikely to cause any visual inconvenience.

The glare impact on the New England Highway only occurs during two months of the year; March and September, also at sunset, therefore it is unlikely that drivers would be significantly inconvenienced.

Mitigation measures are provide below to further reduce glare impact.

6.2 Mitigations

6.2.1 Screening

Screening of glare with barriers or vegetation is effective in reducing glare impact for receivers, due to the relatively low viewing heights. Screen planting is recommended along the northern boundary of the site to mitigate views for OP 7 (VP04 in the LVIA) and the New England Highway – see section 11.2 of the LVIA. Preliminary modelling indicates that the glare impact is significantly reduced for OP 7 and OP 8 with vegetative screening.

6.2.2 Design considerations

Detailed design refinements, in consultation with the design team and solar panel manufacturers, could further reduce glare impacts, such as:

- Considering single-axis tracking (SAT) instead of fixed tilt: SAT maintains perpendicularity between the panels and the sunlight, which can be effective in mitigating glare.
- Adjusting the tilt angle of the panels: keeping a lower angle of incidence can mitigate some occurrences of glare.
- Adjusting the orientation of the panels: orienting the panels slightly west may reduce glare impacts as majority of the sensitive receivers are located to the east of the proposed solar farm.

Further modelling is recommended to test the effectiveness of chosen design refinements during the detailed design of the proposal.

7. References

GHD, 2024, Landscape and Visual Impact Assessment.

Ho, C. K., 2011, Observations and Assessments of Glare from Heliostats and Trough Collectors: Helicopter Flyover and Drive-By Sightings, in proceedings of SolarPACES 2011, Granada, Spain, Sept. 20-23.

Marsh, 2024.

NGH (2020), Environmental Impact Statement – Tilbuster Solar Farm (October 2020), Project Number: 18-645, Final Version 1.1.

NSW Department of Planning and Environment (2022). *Large-Scale Solar Energy Guideline, NSW Department of Planning and Environment, August 2022.*

Rogers, J. A., et al. (2015). "Evaluation of Glare as a Hazard for General Aviation Pilots on Final Approach", Federal Aviation Administration.

Yellowhair, J. and C.K. Ho. "Assessment of Photovoltaic Surface Texturing on Transmittance Effects and Glint/Glare Impacts". ASME 2015 9th International Conference on Energy Sustainability collocated with the ASME 2015 Power Conference, the ASME 2015 13th International Conference on Fuel Cell Science, Engineering and Technology, and the ASME 2015 Nuclear Forum. 2015. American Society of Mechanical Engineers.

Appendices

Appendix A

ForgeSolar report

FORGESOLAR GLARE ANALYSIS

Project: **Tilbuster Stage 2 Solar Farm**

Site configuration: **Fixed tilt 3**

Created 18 Sep, 2024

Updated 18 Sep, 2024

Time-step 1 minute

Timezone offset UTC10

Minimum sun altitude 0.0 deg

DNI peaks at 1,000.0 W/m²

Category 10 MW to 100 MW

Site ID 129229.22079

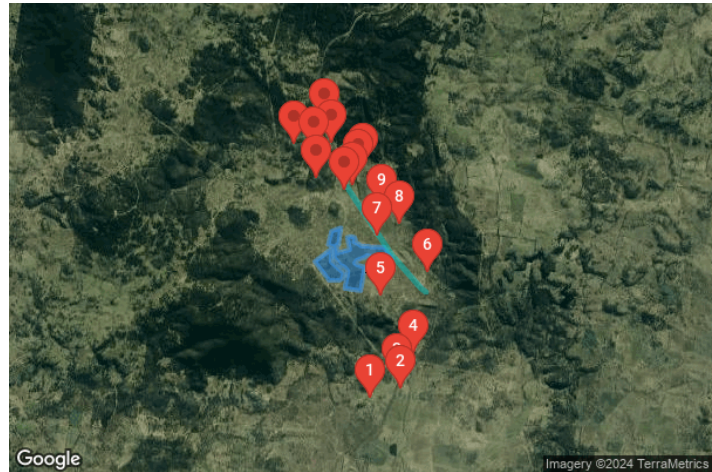
Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

PV analysis methodology V2



Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
East Block	20.0	0.0	5,643	94.0	1,395	23.2	-
West Block	20.0	0.0	4,102	68.4	984	16.4	-

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
New England Hwy	115	1.9	570	9.5
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	1,528	25.5	0	0.0
OP 7	3,147	52.5	1,673	27.9
OP 8	4,262	71.0	136	2.3
OP 9	693	11.6	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0

Component Data

PV Arrays

Name: East Block

Axis tracking: Fixed (no rotation)

Tilt: 20.0°

Orientation: 0.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.384830	151.665547	1059.55	2.00	1061.55
2	-30.384145	151.663852	1058.12	2.00	1060.12
3	-30.380804	151.664817	1074.40	2.00	1076.40
4	-30.379915	151.667564	1074.42	2.00	1076.42
5	-30.384173	151.666866	1066.61	2.00	1068.61
6	-30.384367	151.666115	1063.50	2.00	1065.50
7	-30.386283	151.666652	1062.36	2.00	1064.36
8	-30.385459	151.670160	1060.03	2.00	1062.03
9	-30.382358	151.669452	1058.47	2.00	1060.47
10	-30.382109	151.670579	1057.66	2.00	1059.66
11	-30.382386	151.671609	1054.85	2.00	1056.85
12	-30.382960	151.671855	1053.06	2.00	1055.06
13	-30.383515	151.671469	1053.44	2.00	1055.44
14	-30.383849	151.672467	1050.21	2.00	1052.21
15	-30.384552	151.673475	1047.68	2.00	1049.68
16	-30.384575	151.675761	1042.58	2.00	1044.58
17	-30.384783	151.676372	1041.61	2.00	1043.61
18	-30.384783	151.680235	1034.04	2.00	1036.04
19	-30.387791	151.682724	1037.45	2.00	1039.45
20	-30.387986	151.682348	1038.53	2.00	1040.53
21	-30.386921	151.675117	1048.69	2.00	1050.69
22	-30.387254	151.674827	1051.29	2.00	1053.29
23	-30.388087	151.672231	1060.51	2.00	1062.51
24	-30.388754	151.671609	1060.86	2.00	1062.86
25	-30.389272	151.672209	1061.86	2.00	1063.86
26	-30.389800	151.674538	1060.75	2.00	1062.75
27	-30.395796	151.673379	1063.65	2.00	1065.65
28	-30.395204	151.668701	1049.36	2.00	1051.36
29	-30.390882	151.669667	1056.12	2.00	1058.12
30	-30.389948	151.668819	1054.93	2.00	1056.93
31	-30.389281	151.667371	1054.20	2.00	1056.20
32	-30.387472	151.665665	1052.38	2.00	1054.38

Name: West Block

Axis tracking: Fixed (no rotation)

Tilt: 20.0°

Orientation: 0.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.388458	151.659949	1068.55	2.00	1070.55
2	-30.393187	151.664133	1059.74	2.00	1061.74
3	-30.393187	151.665464	1054.61	2.00	1056.61
4	-30.393224	151.667019	1050.49	2.00	1052.49
5	-30.392863	151.667910	1047.81	2.00	1049.81
6	-30.391401	151.668339	1047.05	2.00	1049.05
7	-30.388476	151.664638	1055.59	2.00	1057.59
8	-30.385376	151.664627	1054.19	2.00	1056.19

Route Receptors

Name: New England Hwy

Path type: Two-way

Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.369524	151.669270	1069.37	2.50	1071.87
2	-30.386776	151.682456	1035.89	2.50	1038.39
3	-30.395202	151.691080	1027.54	2.50	1030.04
4	-30.396151	151.692464	1026.20	2.50	1028.70

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-30.422987	151.676346	1044.47	1.50
OP 2	2	-30.420489	151.685186	996.81	1.50
OP 3	3	-30.417529	151.684199	1014.49	1.50
OP 4	4	-30.411636	151.688924	1037.54	1.50
OP 5	5	-30.397127	151.679300	1096.16	1.50
OP 6	6	-30.391183	151.693199	1028.95	1.50
OP 7	7	-30.382178	151.678224	1046.65	1.50
OP 8	8	-30.379126	151.684652	1046.61	1.50
OP 9	9	-30.375054	151.679716	1051.83	1.50
OP 10	10	-30.370619	151.668745	1070.48	1.50
OP 11	11	-30.369273	151.671175	1060.59	1.50
OP 12	12	-30.366135	151.672731	1064.30	1.50
OP 13	13	-30.364505	151.674297	1075.58	1.50
OP 14	14	-30.367542	151.660264	1179.41	1.50
OP 15	15	-30.360335	151.659632	1163.57	1.50
OP 16	16	-30.358614	151.664824	1084.34	1.50
OP 17	17	-30.359039	151.653806	1168.44	1.50
OP 18	18	-30.353221	151.662875	1092.06	1.50

Glare Analysis Results

Summary of Results Glare with potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
East Block	20.0	0.0	5,643	94.0	1,395	23.2	-
West Block	20.0	0.0	4,102	68.4	984	16.4	-

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

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
New England Hwy	115	1.9	570	9.5
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	1,528	25.5	0	0.0
OP 7	3,147	52.5	1,673	27.9
OP 8	4,262	71.0	136	2.3
OP 9	693	11.6	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0

PV: East Block potential temporary after-image

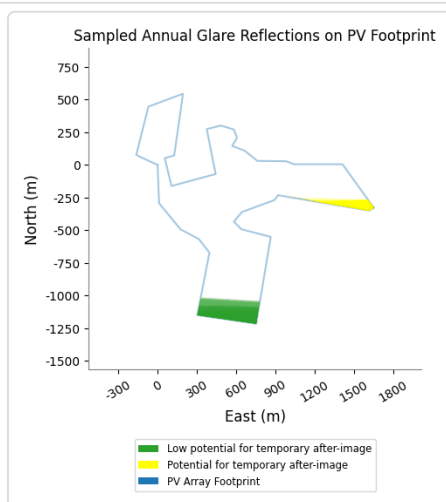
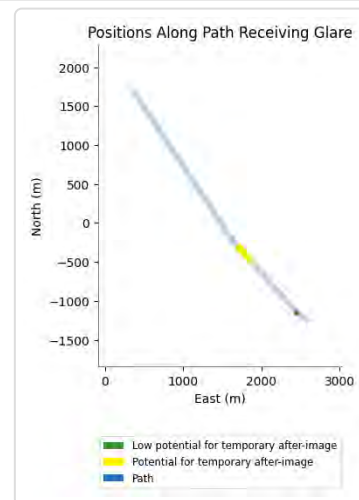
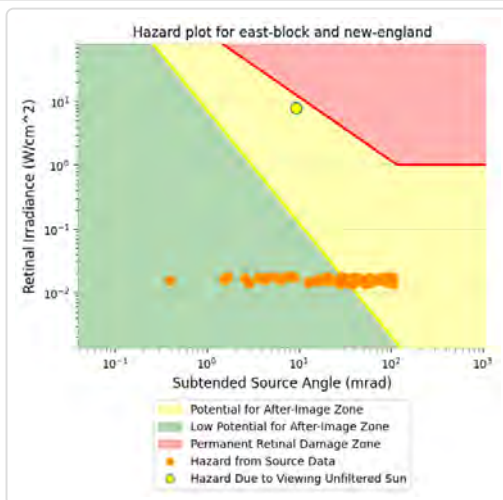
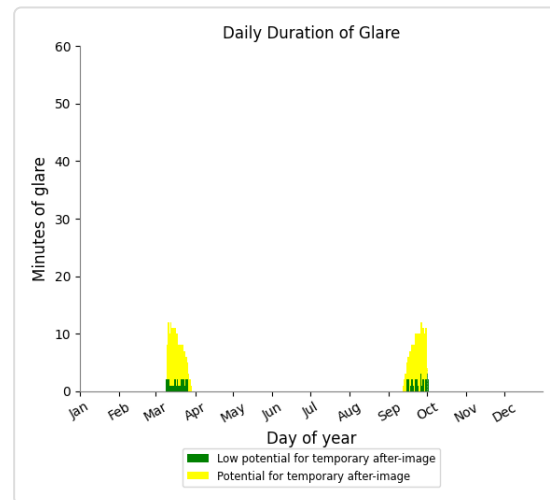
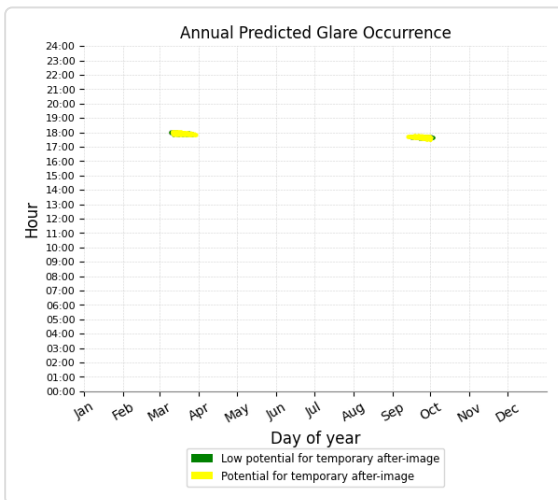
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
New England Hwy	54	0.9	263	4.4
OP 7	1,487	24.8	996	16.6
OP 8	2,441	40.7	136	2.3
OP 6	968	16.1	0	0.0
OP 9	693	11.6	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0

East Block and Route: New England Hwy

Yellow glare: 263 min.

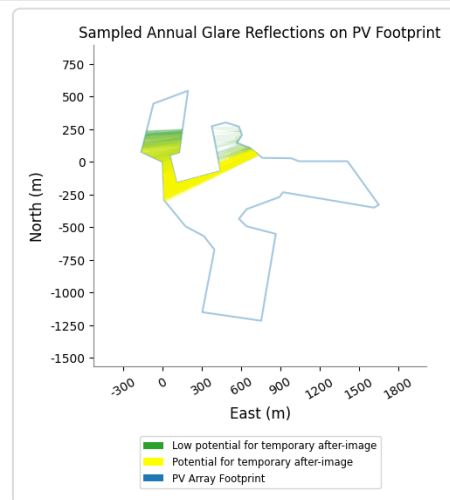
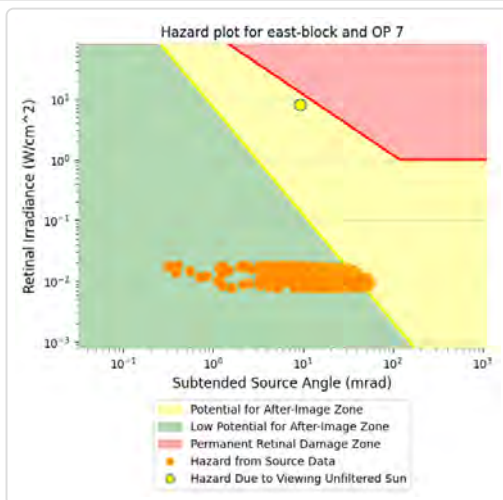
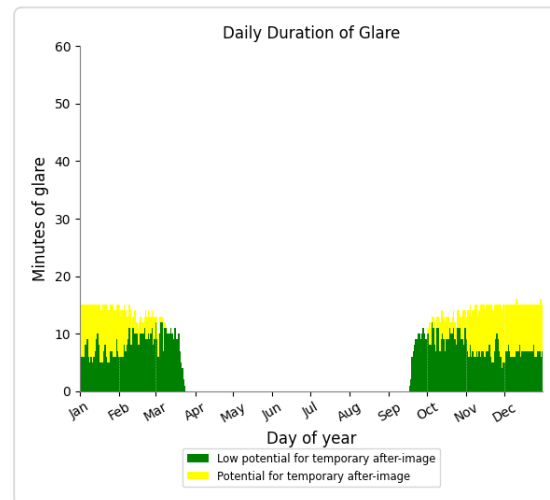
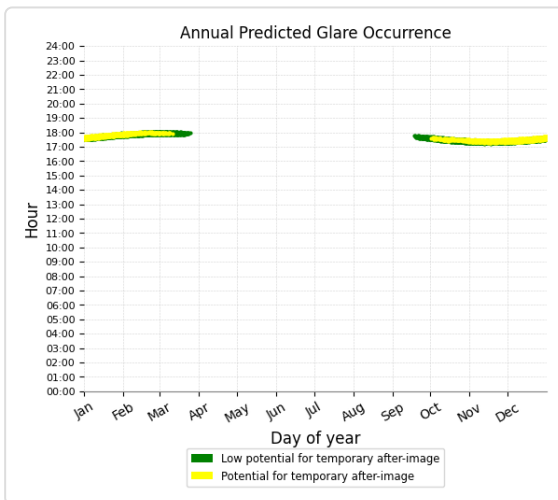
Green glare: 54 min.



East Block and OP 7

Yellow glare: 996 min.

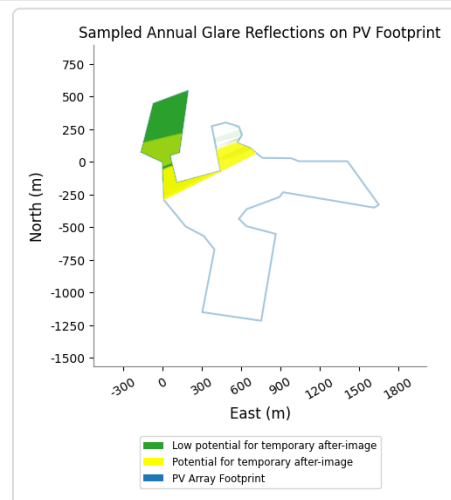
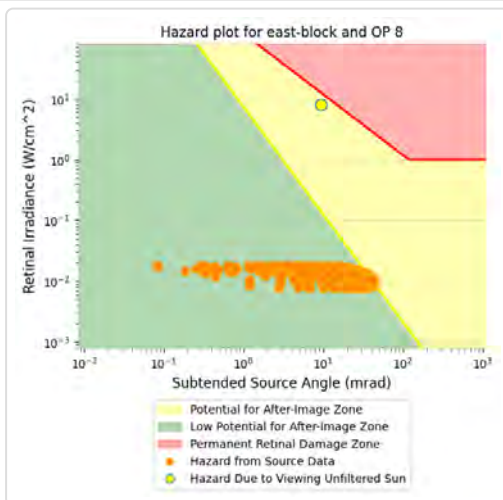
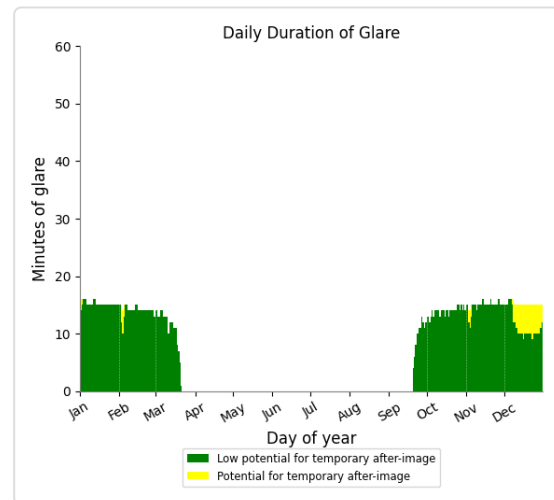
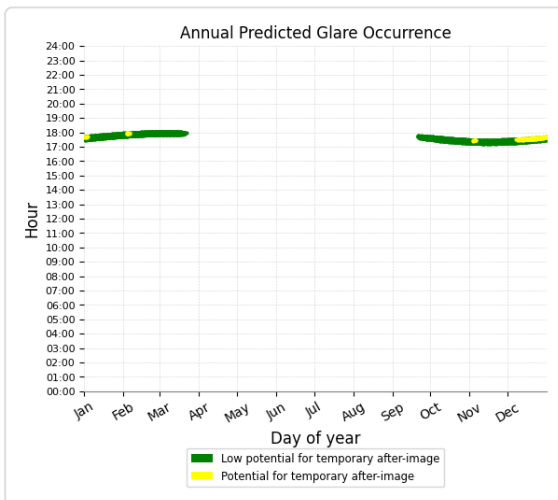
Green glare: 1,487 min.



East Block and OP 8

Yellow glare: 136 min.

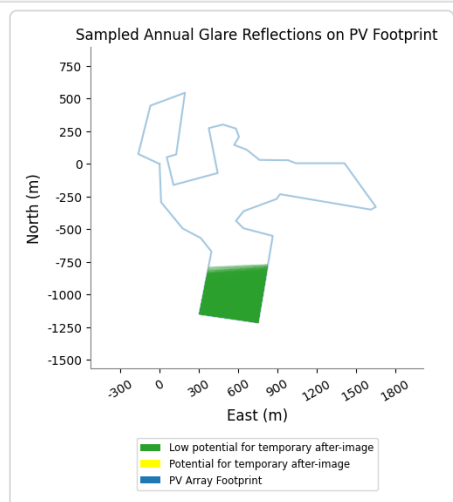
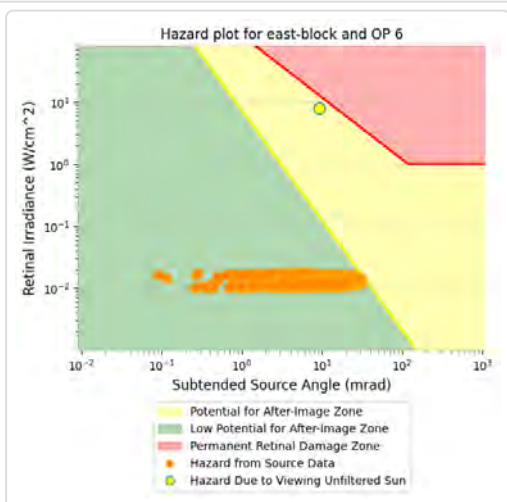
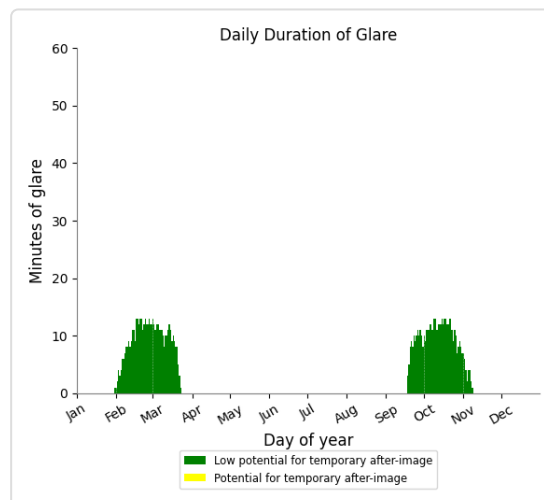
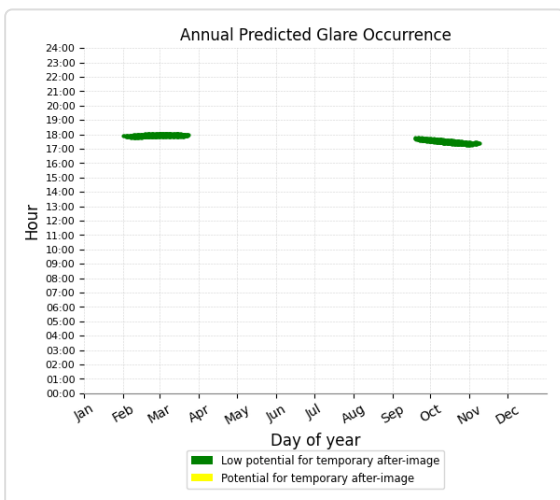
Green glare: 2,441 min.



East Block and OP 6

Yellow glare: none

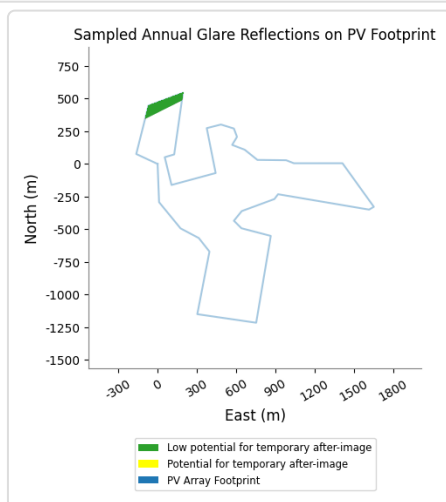
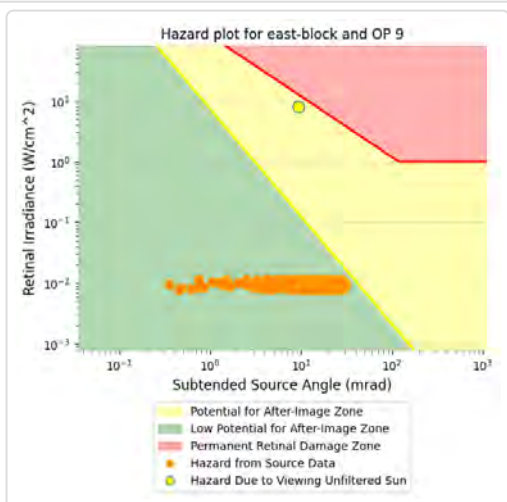
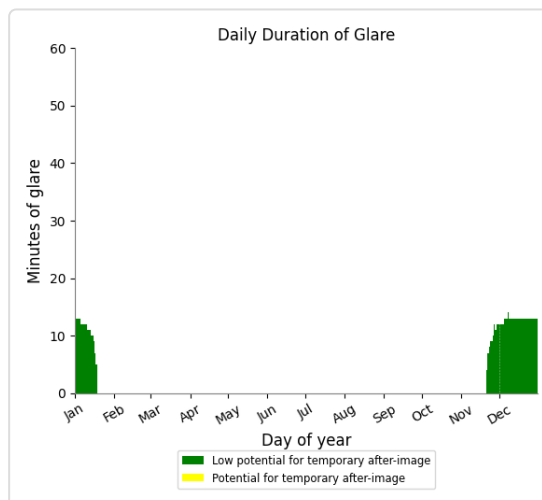
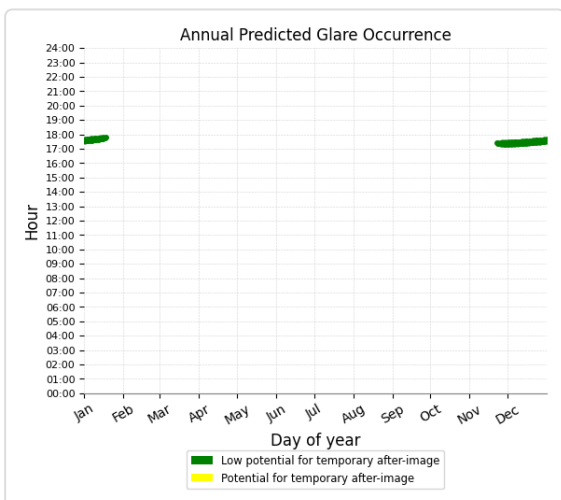
Green glare: 968 min.



East Block and OP 9

Yellow glare: none

Green glare: 693 min.



East Block and OP 1

No glare found

East Block and OP 2

No glare found

East Block and OP 3

No glare found

East Block and OP 4

No glare found

East Block and OP 5

No glare found

East Block and OP 10

No glare found

East Block and OP 11

No glare found

East Block and OP 12

No glare found

East Block and OP 13

No glare found

East Block and OP 14

No glare found

East Block and OP 15

No glare found

East Block and OP 16

No glare found

East Block and OP 17

No glare found

East Block and OP 18

No glare found

PV: West Block potential temporary after-image

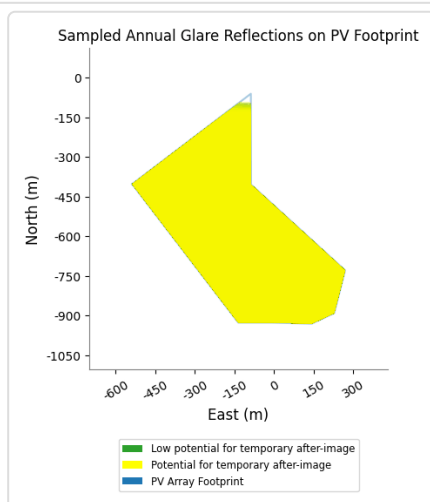
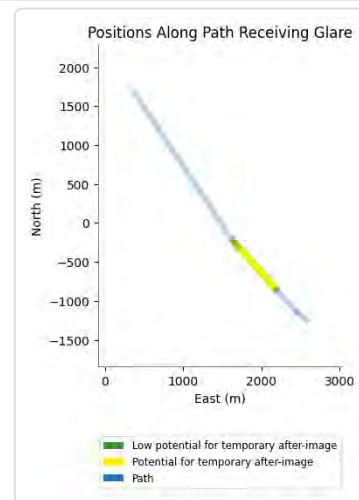
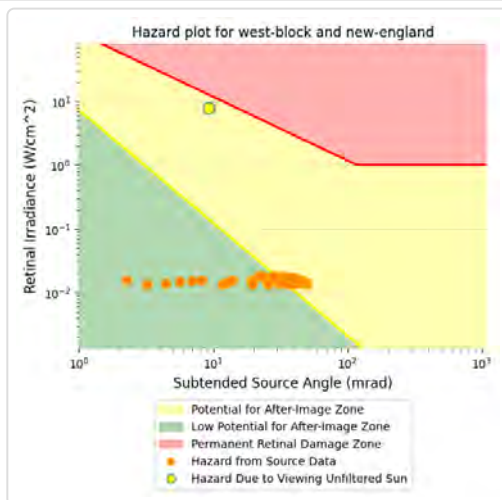
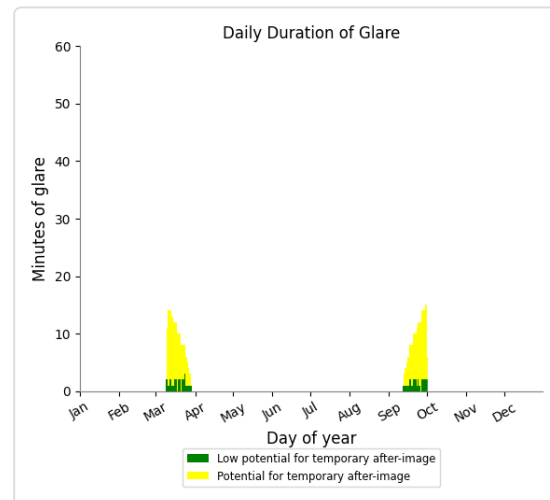
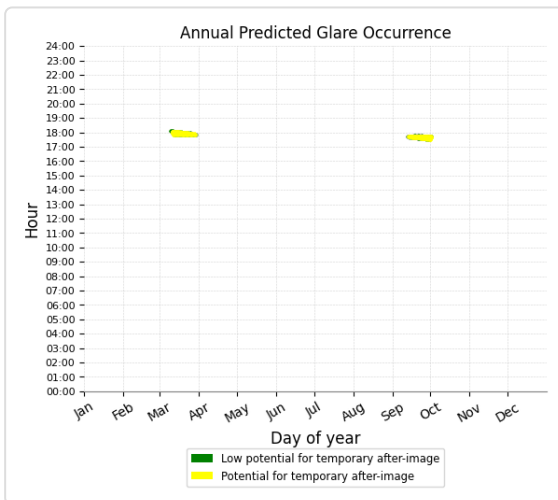
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
New England Hwy	61	1.0	307	5.1
OP 7	1,660	27.7	677	11.3
OP 6	560	9.3	0	0.0
OP 8	1,821	30.4	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0

West Block and Route: New England Hwy

Yellow glare: 307 min.

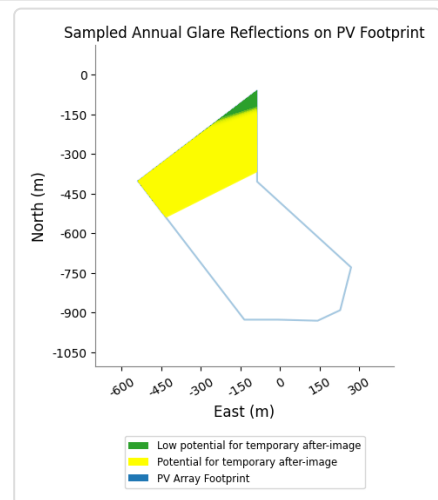
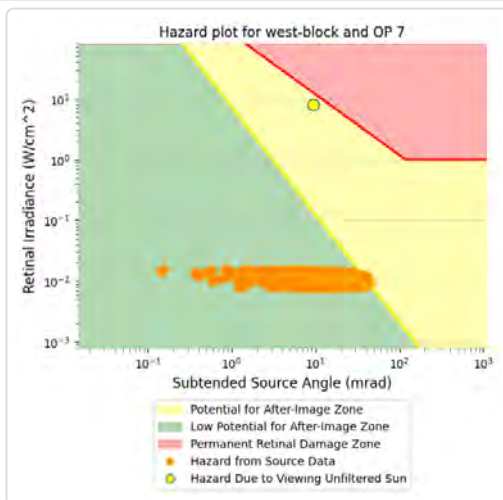
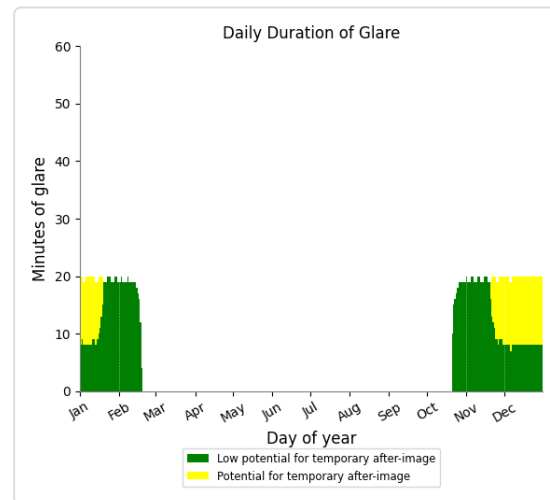
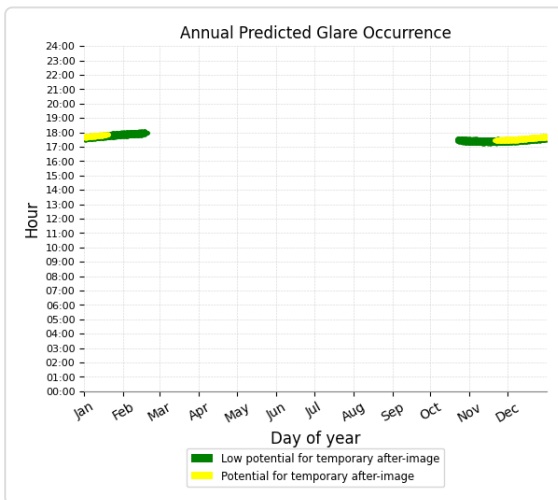
Green glare: 61 min.



West Block and OP 7

Yellow glare: 677 min.

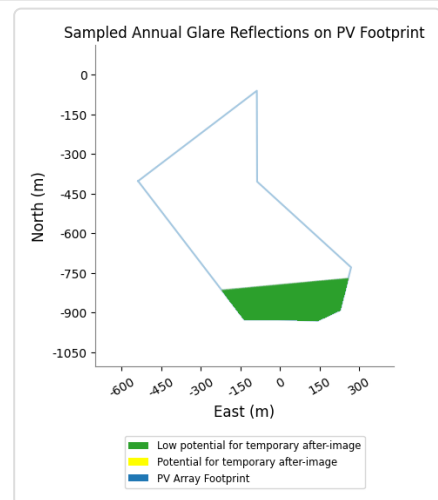
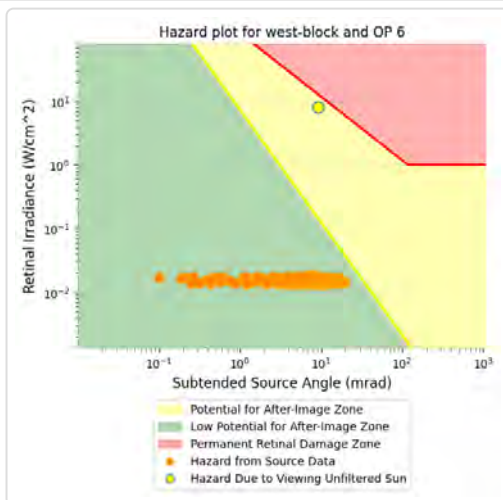
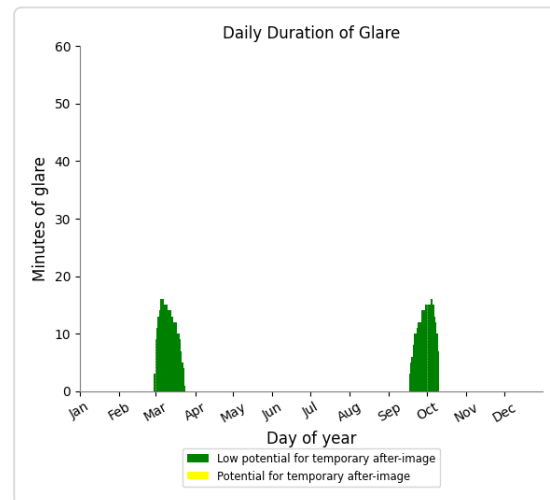
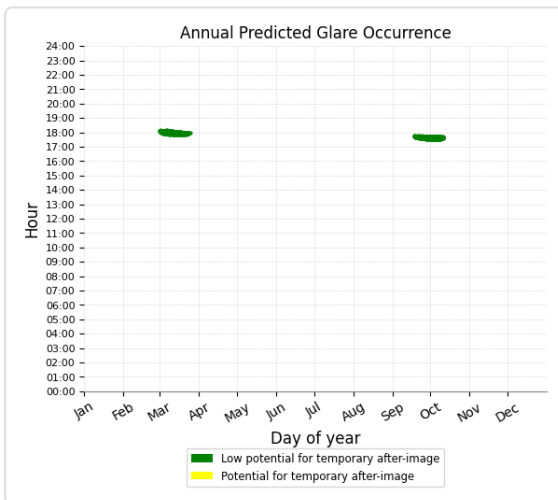
Green glare: 1,660 min.



West Block and OP 6

Yellow glare: none

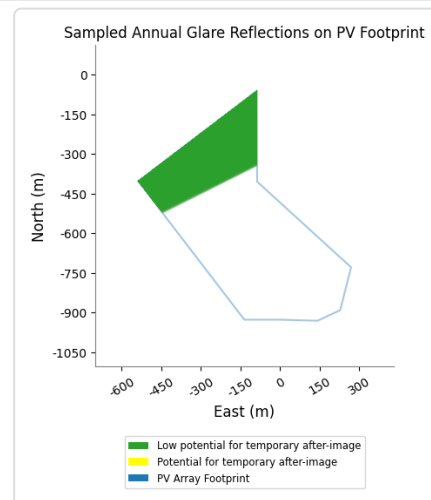
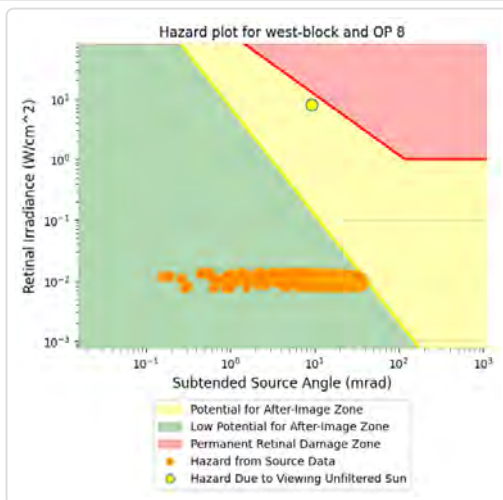
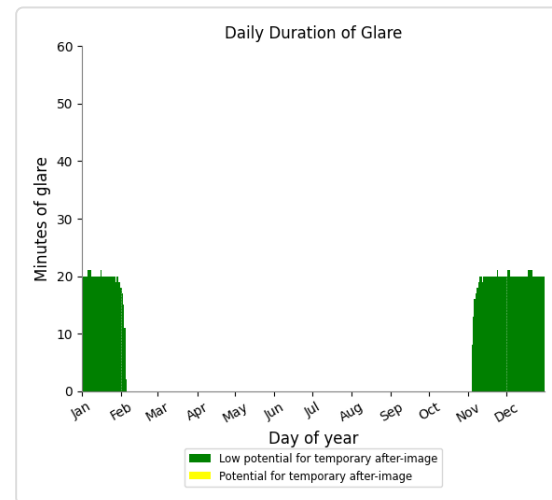
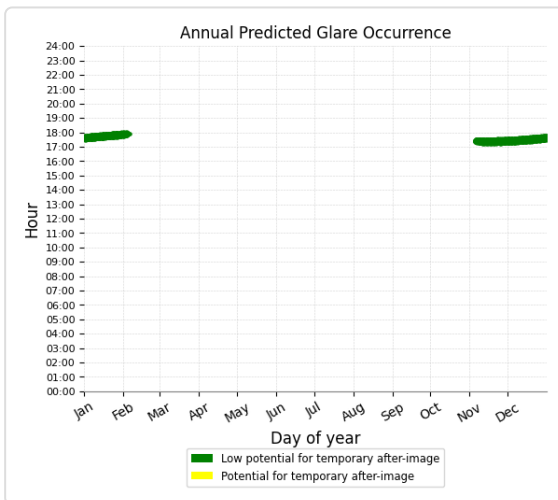
Green glare: 560 min.



West Block and OP 8

Yellow glare: none

Green glare: 1,821 min.



West Block and OP 1

No glare found

West Block and OP 2

No glare found

West Block and OP 3

No glare found

West Block and OP 4

No glare found

West Block and OP 5

No glare found

West Block and OP 9

No glare found

West Block and OP 10

No glare found

West Block and OP 11

No glare found

West Block and OP 12

No glare found

West Block and OP 13

No glare found

West Block and OP 14

No glare found

West Block and OP 15

No glare found

West Block and OP 16

No glare found

West Block and OP 17

No glare found

West Block and OP 18

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

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

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

© Sims Industries d/b/a ForgeSolar, All Rights Reserved.



ghd.com

→ **The Power of Commitment**

Appendix C

Landscape plan

- Legend
- Fenceline

Solar array access tracks

Solar array footprint

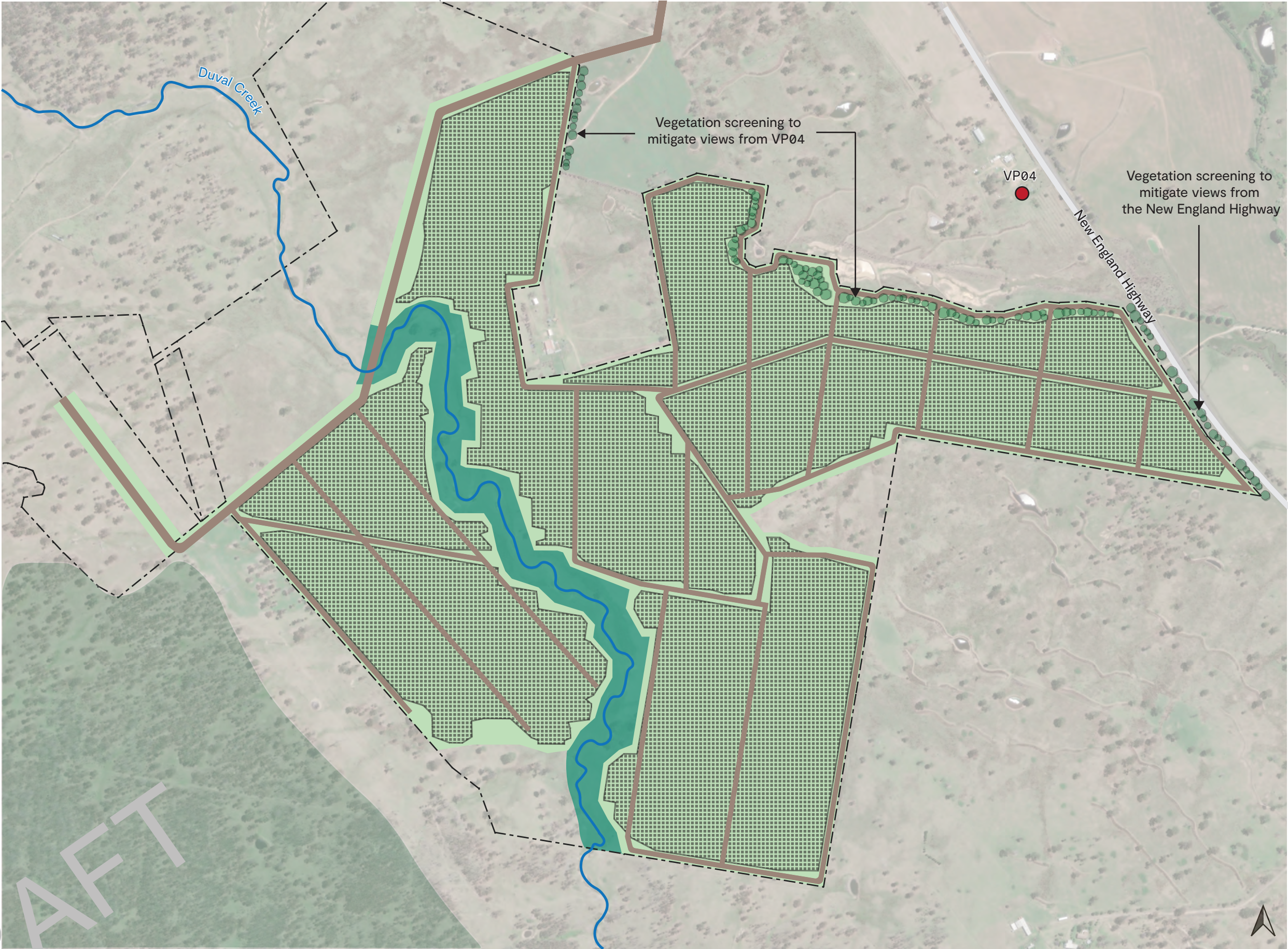
Existing roads

Waterways

Sensitive visual receivers
- Planting

Type 1 - Proposed Revegetation

Type 2 - Native and Pasture Grass Regeneration
-
- Riparian planting





ghd.com/design

→ **The Power of Commitment**