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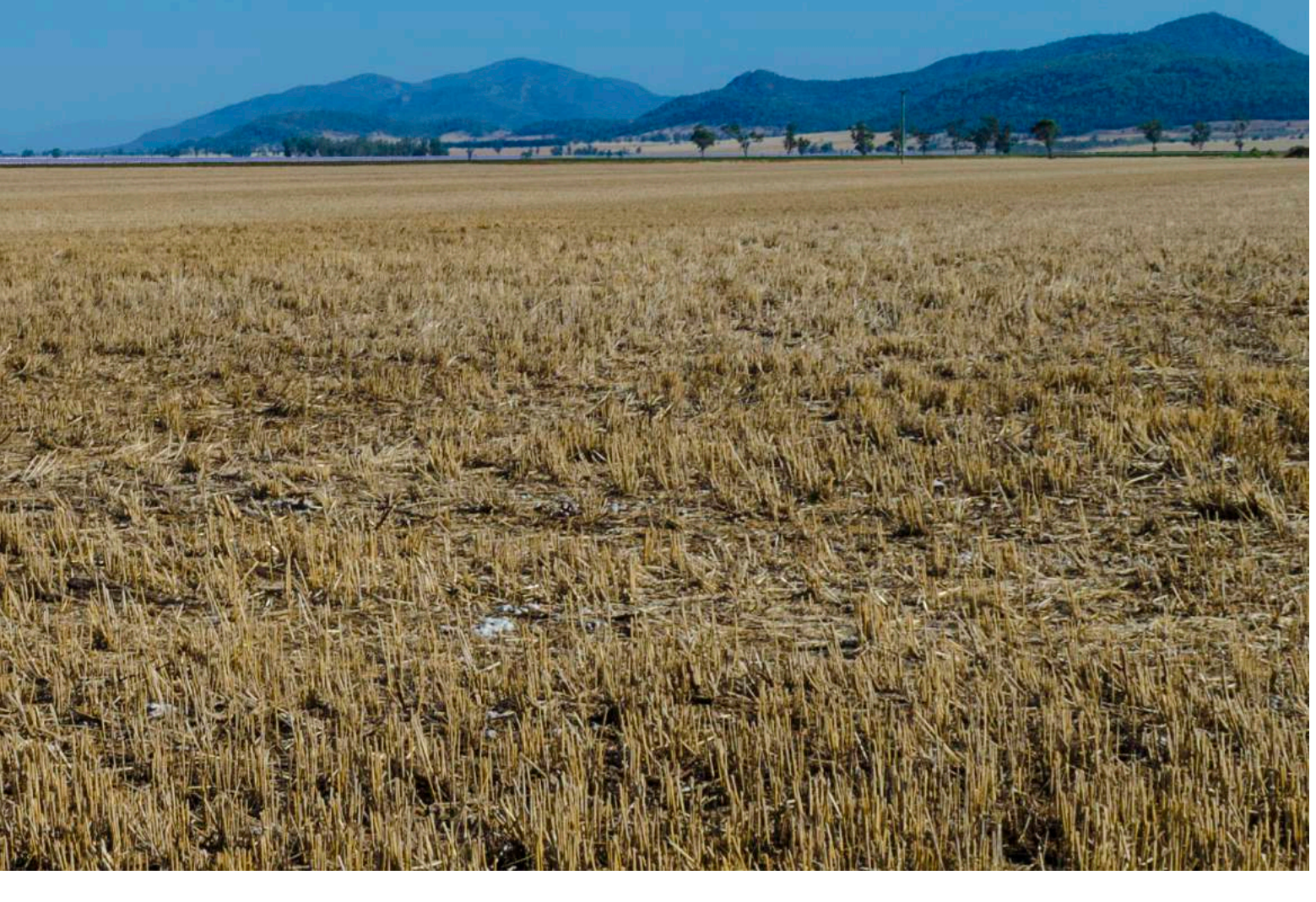
GUNNEDAH SOLAR FARM

VISUAL IMPACT ASSESSMENT

Prepared for Pitt & Sherry - March 2018



PROPOSED GUNNEDAH SOLAR PHOTOVOLTAIC (PV) FARM
VISUAL IMPACT ASSESSMENT

DATE: 28 March 2018
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01	13 December 2017	Draft for review	S. Brodbeck	A. Dodds
02	21 March 2018	Final draft for review	S. Brodbeck	A. Dodds
03	28 March 2018	Final	S. Brodbeck	A. Dodds

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1. Introduction

1.1 Introduction

This report has been prepared to assess visual impacts associated with a proposed 150-megawatt (MW) solar farm (the 'proposal') using photovoltaic (PV) technology at a 763-hectare site (the 'Site') at Gunnedah, NSW (the 'Proposal'). The report has been prepared for the Proponent, Photon Energy, and addresses the Secretary's Environmental Assessment Requirements (SEARs) issued by the Department of Planning and Environment (DPE) regarding 'visual' issues potentially associated with the Proposal.

The relevant SEARs state:

> *Visual – including an assessment of the likely visual impacts of the development (including any glare, reflectivity and night lighting) on surrounding residences, scenic or significant vistas, air traffic and road corridors in the public domain, including a draft landscaping plan for on-site perimeter planting, with evidence it has been developed in consultation with affected landowners.*

The requirements of the SEARs, and the relevant sections of this report where these requirements are met, are identified in **Table 1-1**.

TABLE 1-1: SEARS VISUAL REQUIREMENTS

Visual Requirement	Where addressed in this report
…an assessment of the likely visual impacts of the development…	Whole of report
…(including any glare, reflectivity and night lighting)…	Section 5.0 - Key visual concerns of solar farms, such as glare and reflectivity, are discussed in Section 5.0 and night lighting in Section 4.4.
…surrounding residences, scenic or significant vistas, air traffic and road corridors in the public domain…	Section 6.0 - likely effects to landscape character Section 7.0 - likely effects to surrounding key viewpoints, including public viewpoints from Orange Grove Road and from surrounding rural residences.
…a draft landscaping plan for on-site perimeter planting, with evidence it has been developed in consultation with affected landowners	Section 9.0 – A Concept Landscape Plan (Figure 9-1) has been prepared for on-site perimeter planting.

1.2 Brief project description

An estimated 460,000 PV panels would be installed on a single axis tracker system across the Site. This would consist of groups of east-west facing PV modules tilted at a maximum 60 degree angle from horizontal.

The following works and infrastructure would be required to support the construction and operation of the solar farm:

- Construction of access roads including a main access road from Orange Grove Road
- Installation of electrical infrastructure including:
    - A 132kV Substation including one transformer and associated 132kV switchgear
    - New transmission line (powerlines and poles for a distance of approximately 1km)
    - Inverters
- Ancillary works at Gunnedah Substation and the existing 132kV transmission line adjacent the site
- A maintenance compound and buildings
- Perimeter security fencing
- Landscaping and environmental works.

The operational life of the solar farm is expected to be 25 years at which point the panels are either replaced and operations continue, or removed, and the site is decommissioned and rehabilitated.

A more detailed description of the components most relevant to this assessment is provided in **Section 4.0**.

1.3 Site description

The Proposal would be located adjacent to Orange Grove Road, Orange Grove, NSW 2380 and contained within parts of Lot 1 DP 1202625, Lot 153 DP 754954, Lot 264 DP 754954, Lot 2 DP 801762, Lot 151 DP 754954 and Lot 1 DP 186590 (the "Subject Land"). The Proposal is located within the Gunnedah Local Government Area (LGA) and is approximately 9km north-east from the Gunnedah town centre. The location is shown in **Figure 1-1**.

A description of the Site is provided in **Section 3.0.**

1.4 Report format

The principal tasks of the assessment process are set-out in the report's format:

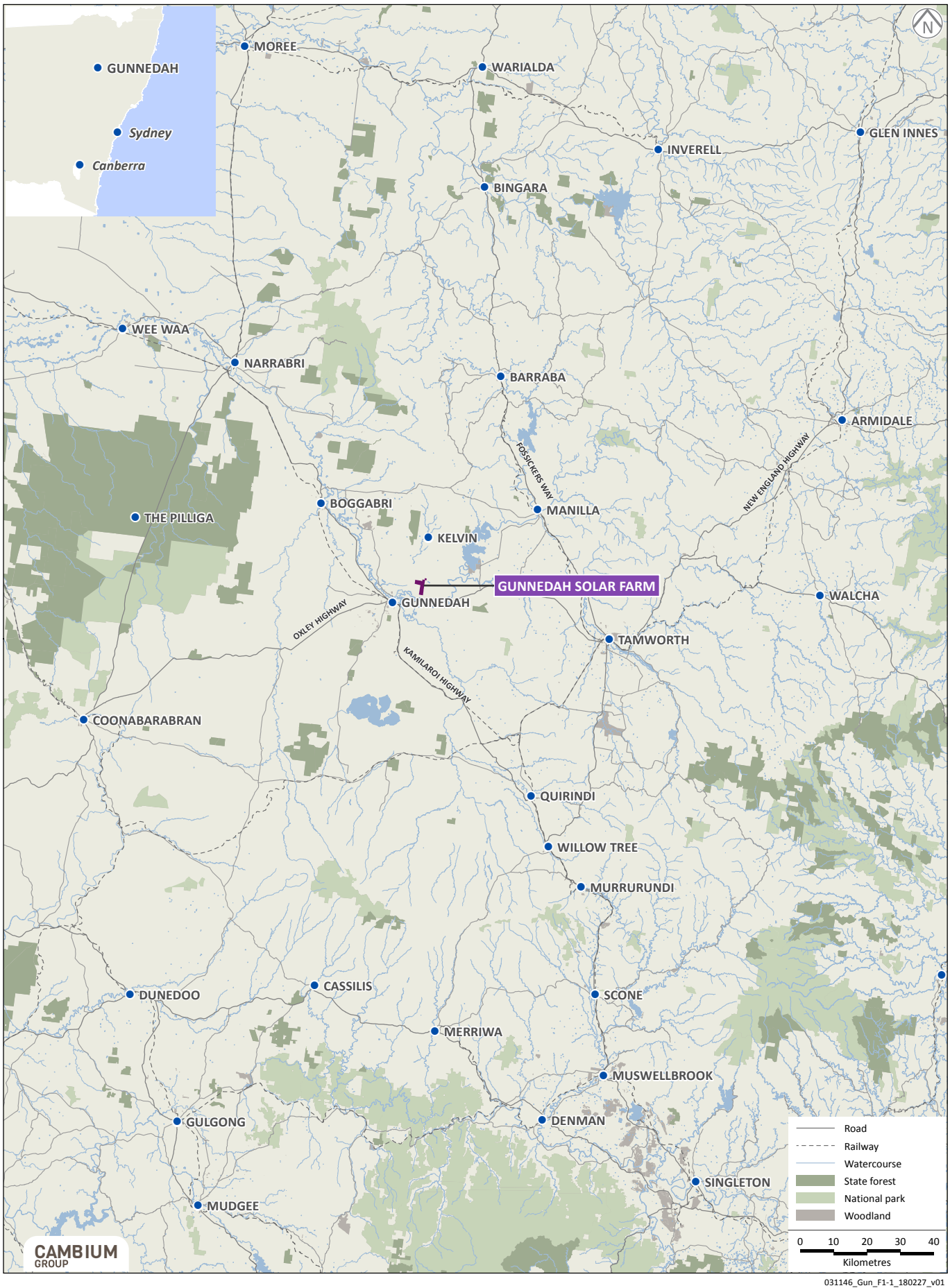
- Outline the methodology for the assessment **(Section 2.0)**
- Establish baseline conditions and describe the context of the site **(Section 3.0)**
- Describe the main visual changes associated with the Proposal **(Section 4.0)**
- Discuss key visual concerns of solar farms **(Section 5.0)**

- Assess the likely effects to landscape character **(Section 6.0**)
- Assess the likely affects to surrounding key viewpoints **(Section 7.0)**
- Present and describe photomontages **(Section 8.0)**
- Present mitigation measures, including a Concept Landscape Plan **(Section 9.0)**
- Discuss cumulative impacts **(Section 10.0)**
- Conclusion **(Section 11.0)**.

FIGURE 1-1

Site location

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT



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2. Assessment methodology

The assessment methodology has been based on the relevant state government guideline (i.e. the *Draft Large Scale Solar Energy Guideline*), professional experience with other large-scale infrastructure projects, and visual assessment guidelines used by government authorities in Australia and internationally.

2.1 Methodology Framework

The *Draft Large Scale Solar Energy Guideline* (New South Wales (NSW) Department of Planning (DPE), 2017) provides the community, industry, applicants and regulators with guidance on the planning framework for the assessment and approval of large scale solar energy development proposals under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), which are classified as 'State significant development' (SSD).

This Guideline identifies the key planning and strategic considerations relevant to solar energy SSD in NSW. It aims to assist in the site selection and design of proposals and it will be used by the DPE to assist in the assessment of relevant development applications. It is intended as a general guideline only.

Under that Guideline visual impact considerations are most relevant under the section on 'site selection', where it states that:

> *'sites with characteristics that may assist in minimising localised impacts such as:*
>
> - *land that does not contain native vegetation or has previously been cleared and utilised for industrial - type purposes (brown - field sites) in rural settings,*
> - *unobtrusive sites with flat, low - lying topography, and*
> - *sites with potential to be screened, such as those that can be readily vegetated along boundaries, to reduce visual impacts'.*

Additionally, under the heading of 'Site Constraints' (where this heading is further defined as meaning that '*while the following types of land or sites are not precluded from large-scale solar energy development, they do indicate areas of constraint that should be identified as part of the constraints mapping*'), the following relevant component is identified:

> *'sites with high visibility, such as those on prominent or high ground positions, or sites which are located in a valley with residences with elevated views looking toward the site'* (NB: a footnote further defines this to mean: '*high visibility or prominence is of particular concern if the solar infrastructure at the site would be juxtaposed against significant scenic, historic or cultural landscape'*.)

Under 'Key Assessment Issues' the Guideline refers to the consideration of visual impacts as follows:

Visual impacts: the acceptability of impacts on landscape character and values, the amenity of landholders and communities, and the adequacy of the measures which are proposed to avoid, reduce or otherwise manage these impacts.

The visual impact of solar energy development will depend on the scale and type infrastructure, the prominence and topography of the site relative to the surrounding environment, and any proposed measures to screen or otherwise reduce visibility of the site. Solar thermal projects may have greater offsite visibility due to the presence of tower infrastructure. Greater off - site visibility of the site will increase the chances of impacts such as glint, glare, reductions in visual amenity, and detraction from the surrounding landscape character including natural, scenic, historic or cultural landscapes. There may also be road safety impacts from glint and glare.

The relevant parts of the Guidelines were addressed as part of the site selection process, the more detailed assessment of potential visual impacts presented in this report, and proposed mitigation measures. The conclusion sets-out the application of these draft guidelines where most relevant (refer **Section 11.0** and **Table 11-1**).

2.2 Applied methodology

The applied methodology used in this report has been based on professional experience with other large-scale infrastructure projects, and visual assessment guidelines used by government authorities in Australia and internationally, including:

- *'Environmental Impact Assessment Guidance Note – Guidelines for Landscape Character and Visual Impact Assessment',* 2013, NSW Roads and Maritime Services
- *'Visual Landscape Planning in Western Australia', 2007,* Western Australian Planning Commission
- the United Kingdom's widely used '*Guidelines for Landscape and Visual Impact Assessment,'* 2013, the Landscape Institute and Institute of Environmental Management and Assessment.
- *'Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands', 2013,* United States Department of the Interior.

The below guideline on reviewing visual assessments has also informed the methodology:

- '*Guide to Evaluating Visual Impact Assessments for Renewable Energy Projects'*, 2014, Sullivan and Meyer, for United States Department of the Interior.

The methodology has been tailored to address the particular visual impacts of establishing this type and scale of infrastructure in this location.

2.3 Potential visibility

An initial step in the assessment was to identify potentially-sensitive viewing locations such as residences, and publicly accessible areas such as towns and local roads. Potentially-sensitive viewing locations were verified via aerial mapping and during a detailed site inspection (26-27 October 2017). During the site visit we were given access to a number of the closest private properties which also aided the assessment.

The assessed viewpoints are identified in **Section 7.0**.

Viewpoints were then selected for photomontage images. Where possible, the locations selected have the 'worst case' (most prominent) view of the Proposal, however, viewpoints have also been selected that are representative of views from a variety of locations. A second round of site visits were undertaken in early January 2018, specifically to take photographs for the photomontages contained in this report, visiting a number of properties where residents had raised visual concerns

2.4 Assessment Criteria

Two main types of visual impacts are assessed in this report:

1. Effect on the landscape character – the overall impact of a project on an area's character and sense of place.
2. Effect on key viewpoints – the day to day visual effects of a project on people's views.

The level of impact to landscape character and viewpoints is based on the combination of two criteria – 'sensitivity' and 'magnitude of change', defined by Roads and Maritime (2013) as:

- Sensitivity - The sensitivity of a landscape character zone or view and its capacity to absorb change. In the case of visual impact this also relates to the type of viewer and number of viewers.
- Magnitude - The measurement of the scale, form and character of a development proposal when compared to the existing condition. In the case of visual assessment this also relates to how far the proposal is from the viewer.

Public vs Private viewpoints

Visual perceptions of renewable energy equipment dominate public acceptability but differ between visitors and residents*.

When assessing private viewpoints, such as residences, the closer the proximity and clearer the potential view, generally the greater sensitivity to change, and therefore the higher potential for visual impact. However, although a high impact may be experienced by an individual residence, or group of residences, the overall level of impact needs to take into account the number of residents affected, plus how significant that impact may be in terms of the wider community.

* Apostol, D. 2017. *The Renewable Energy Landscape.* Routledge, 20160819. (Apostol 108)

For the purposes of this assessment, the specific criteria used to determine sensitivity and magnitude of change (both for landscape character and visual impact to viewpoints) are listed in **Table 2-2** and **Table 2-3**. These criteria have been defined for this Proposal and take into account the particular characteristics of the solar farm Proposal, such as its low height.

Sensitivity criteria

Understanding the characteristics of those who would likely view the Proposal is important because it is the human response to visible changes in a landscape that determines whether the changes represent an improvement in scenic attractiveness (a positive visual impact) or a decrease in scenic attractiveness (a negative visual impact)[1].

The following sensitivity criteria have been considered in this assessment[2]:

- The type of viewer that sees from a particular viewpoint (private or public, stationary or moving and their engagement in the view) (Refer also side bar "public vs private viewpoints")
- Viewer distance from the Proposal (clarity is reduced as distance increases)[3]
- Numbers of people viewing from the viewpoint
- Expected duration of views
- Particular sensitivities of the viewers

These criteria have been used as a guide to determine high, moderate, low or negligible sensitivity rankings, as shown in **Table 2-1**.

[1] Sullivan, R. and M Meyer. 2014. p22

[2] Adapted from:

- Apostol, D. 2017. *The Renewable Energy Landscape*; Sullivan, R. and M Meyer. 2014. p43; and
- United States Department of the Interior. 2013. *Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands.*

[3] Regions with sunnier skies and dryer air will, on average, experience higher levels of visual contrast and longer visibility distances for renewable energy facilities than will regions with less sunny skies and higher humidity levels. United States Department of the Interior. 2013

TABLE 2-1: SENSITIVITY RANKING CRITERIA

Sensitivity	Criteria (general guide only, some or all may apply)
High	▪ Landscape or cultural heritage of high to very high conservation value ▪ Landscape with characteristics that are highly sensitive and highly affected by large-scale development ▪ Public views with a high to very high number of users and/or in close proximity ▪ Private views in close proximity (generally less than 1km) with mostly unimpeded views
Moderate	▪ Landscape or cultural heritage of moderate conservation value ▪ Landscape with characteristics moderately affected by large-scale development ▪ Public views with a moderate to high number of viewers and/or viewers are in close or moderate proximity (generally less than 2.5km away) ▪ Private views in moderate proximity (generally 1-2.5km) with some views, or a further distance (2.5-5km) with mostly unimpeded views
Low	▪ Some landscape or cultural heritage conservation value but of lower visual value ▪ Landscape characteristics not greatly affected by large-scale development ▪ Public views for a small number of users and/or viewers more distant (generally over 2.5km away) ▪ Private views in more distant proximity (generally over 2.5km) with some unimpeded views
Negligible	▪ Landscape has no or very little cultural heritage, conservation or visual value ▪ Characteristics relatively unaffected by large-scale development ▪ Very few people can view ▪ Viewers are a long distance from site (generally over 5km or less with no obvious views) ▪ Private views generally not affected.

Magnitude of change criteria

The following magnitude criteria have been considered when determining magnitude of change:

- The characteristics of the proposal (its size, scale relative to other objects in view)
- Visual prominence (how dominant, or the focal point of the view is the proposal)
- Viewer position in relation to the proposal (elevation and angle of viewpoint, relationship to sun angle)

- Extent (proportion of the proposal that would be seen)
- Compatibility with surrounding landscape (the contrasts of the proposal in scale, colour and character (either existing or planned) and effect on the scenic quality of the scene.
- Whether the change would be temporary or permanent.

These criteria have been used as a guide to determine high, moderate, low or negligible magnitude taking into account the general visual features of the proposal, as shown in **Table 2-2**.

TABLE 2-2 MAGNITUDE OF CHANGE RANKING CRITERIA

Magnitude	Criteria (general guide only, some or all may apply)
High	▪ Significant scale (bulk and height) and extent of area affected ▪ Permanent and irreversible change ▪ The site has a high visual prominence (is a key feature of the view) ▪ The viewer position in relation to the proposal is substantially elevated and mostly from a northern, eastern or western location ▪ The viewer sees a large proportion of the facility (typically more than half (50%) ▪ The proposal forms a significant and immediately apparent part of the scene, and one that significantly contrasts in scale and character (either existing or planned) and is severely detrimental to the quality of the scene.
Moderate	▪ Moderate scale (bulk and height) and extent of area affected ▪ The site is visually prominent (a recognisable feature of the view) ▪ The viewer position in relation to the proposal is slightly elevated ▪ The viewer sees a moderate proportion of the facility (typically a quarter to a half (25-50%)) ▪ Temporary, or if permanent, effects which may reduce over time ▪ The proposal becomes a noticeably dominant feature of the scene, and one that contrasts in scale and character (either existing or planned), possibly reducing the quality of the scene.
Low	▪ Small in scale (bulk and height) and extent of area affected ▪ Temporary, or if permanent, visual effects able to be reduced substantially over time ▪ The site is less visually prominent ▪ The viewer position is usually to the south of the facility

Magnitude	Criteria (general guide only, some or all may apply)
	▪ The viewer sees a small portion of the facility (typically less than a quarter (25%) and/or from a further distance) ▪ The proposal forms a visible and recognisable new element within the overall scene, yet one that is relatively compatible with the surrounding character (either existing or planned) and would not generally reduce the quality of the scene.
Negligible	▪ The proposal constitutes only a minor component of the wider view, which might be missed by the casual observer or receptor. Awareness of the proposal would not have a marked effect on the overall quality of the scene.

Level of impact

By combining sensitivity and magnitude of change, an approximate level of impact to either landscape character or visual impact to viewpoints is ascertained, as shown in **Table 2-3** (as adapted from Roads and Maritime, 2013). The range of overall impact level (to both the landscape character and visual impact to surrounding viewpoints) can be either beneficial or adverse, with six possible rankings: high, high–moderate, moderate, moderate-low, low, and negligible.

TABLE 2-3: LEVEL OF IMPACT

Matrix of relationship between sensitivity and magnitude					
	Magnitude				
Sensitivity		HIGH	MODERATE	LOW	NEGLIGIBLE
	HIGH	High	Moderate-high	Moderate	Negligible
	MODERATE	Moderate-high	Moderate	Low-moderate	Negligible
	LOW	Moderate	Low -moderate	Low	Negligible
	NEGLIGIBLE	Negligible	Negligible	Negligible	Negligible

3. Site context and description

This section of the report describes the Site and its surroundings. It identifies any important visual resource areas (including sensitive scenic, historic, or cultural resources) and important natural landscape elements.

3.1 Site context

The Proposal Site is located in the Gunnedah LGA. It has good road access from the Oxley Highway which is 1.9km south of the Site and the Kamilaroi Highway, 6.8km to the south-west of the Site. Additionally, Gunnedah has a small airport located approximately 8km west of the Site.

The environment around the Site is dominated by cleared agricultural land which is the dominant industry in the region. There are also several large mines in the region with the nearest the RocGlen Mine 17km to the north-west of the Site. The Shire of Gunnedah is situated within the North West Slopes region of NSW, adjacent the Liverpool Plains. It is a fertile agricultural region, with the majority of the shire devoted to farming. The area is a significant producer of cotton, coal, beef, lamb, pork, cereal and oilseed grains, and Gunnedah claims the title "Koala Capital of World".

Gunnedah has a population of just over 12,500[4] and is located some 80km east of the next nearest large town of Tamworth. It is a rural area that is typical of the undulating, agricultural, broadacre farming areas within the North West Slopes region.

The town of Gunnedah and the surrounding area is focussed along the Namoi River and its wide floodplain. Local topography is generally comprised of the flat Namoi floodplain, with some gentle flanking rises and slopes. There are also several highpoints in the area such as the Bindea Hills, which rise beside Gunnedah and include Porcupine Hill which dominates the landscape, and the Kelvin Hills to the north-west. The popular recreational facility of Keepit Dam is situated some 40km to the north-east.

The Namoi River is located approximately 900m south of the Site and is surrounded by scattered stands of native vegetation.

The Site context is shown on **Figure 3-1**, and a site features map is included as **Figure 3-2**. Photographs of the typical landscape character as **Figures 3-3** and **3-4**.

[4] Australian Bureau of Statistics, 2016, the Shire of Gunnedah

FIGURE 3-1: SITE VISUAL CONTEXT

FIGURE 3-1

Site visual context

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FIGURE 3-2

Existing site features

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT

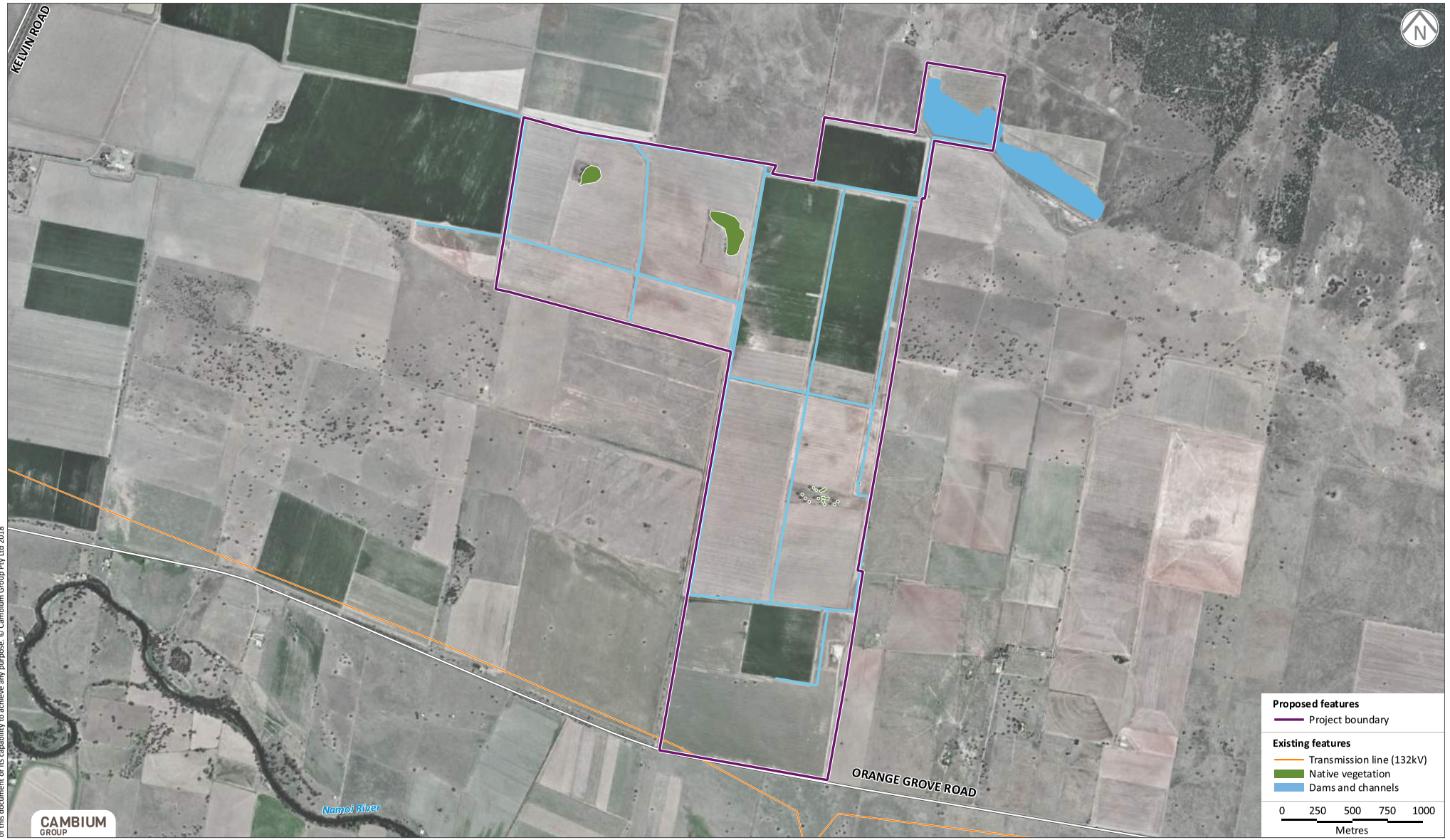

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FIGURE 3-3: TYPICAL RURAL LANDSCAPE AROUND GUNNEDAH – OPEN PADDOCKS, SCATTERED TREES, FARM STRUCTURES

FIGURE 3-4: TYPICAL LANDSCAPE CHARACTER AROUND GUNNEDAH - PATCHWORK OF COLOURS AND PADDOCKS (TAKEN FROM AN ELEVATED LOCATION ALONG TUDGEY ROAD TO THE NORTH)

3.2 The Site

The Proposal would be contained within part of Lot 1 DP 186590 Lot 1 DP 1202625, Lot 153 DP 754954, Lot 264 DP 754954, Lot 2 DP 801762, Lot 151 DP 754954 (the 'Subject Land').

The proposed development footprint is anticipated to cover only a part of the area detailed above (i.e. 'the Site'). The Site is not located in close proximity to urban or dense residential areas, and comprises a series of barb-wire fenced paddocks which have been largely cleared for agricultural purposes (specifically cropping: irrigated cotton, wheat and chickpea). The Subject Land surrounding the Site currently contains a number of built structures (refer **Figure 3-4**) including agricultural sheds, a temporary residential dwelling and a permanent residential dwelling which is currently under construction.

The Site has been identified as flood prone land (*Gunnedah Local Environmental Plan (LEP) 2012*). Surface hydrology, landform and soils have been heavily modified by the paddock development and irrigation works.

There are no natural waterways within the Site and waterways on the Subject Land surrounding the Site are limited to a large dam contained in the north-eastern corner of Lot 1 DP 1202625 which has an area of approximately 6.05 hectares. At the time of the site inspection this dam was dry (October 2017). Irrigation channels are present throughout the Site to facilitate water movement for cropping from five irrigation bores and the storage dam using pumps.

FIGURE 3-5: VIEWS ACROSS SITE SHOWING SILOS AND FARM BUILDINGS IN DISTANCE

There is an existing TransGrid easement which runs along Orange Grove Road at the southern boundary of the Site (refer **Figure 3-5**). This easement contains

existing Transgrid 132kV powerlines on wooden pole structures connecting to the Gunnedah substation approximately 2.3km to the south of the Site.

FIGURE 3-6:EXISTING TRANMISSION LINES ON THE SITE

A site features map is included as **Figure 3-2**.

3.2.1 Heritage

There were no heritage places or items that have been identified at the Site.

3.2.2 Vegetation

There are several clusters of native vegetation located in the Site. The largest two clusters are in Lot 1 DP 186590 and are roughly 1.51 hectares and 2.96 hectares in area, respectively. Other vegetation on-site includes:

- a row of native trees along the boundary of the Site and Orange Grove Road
- a row of native trees along the western boundary of Lot 151 DP 754954 and Lot 2 DP801762.
- a sparse group of trees located in Lot 153 DP 754954.
- other isolated trees scattered throughout the Site.

A detailed Biodiversity Assessment has been prepared as part of the EIS which provides further details on existing vegetation and biodiversity.

The development footprint would avoid the majority of vegetation present on the site where possible, including the two largest clusters which would be protected and avoided. A smaller cluster in Lot 53 DP754954 would be removed, as would isolated trees within the layout area.

3.2.3 Landform

The Site has an almost flat landform given its location on of the Namoi floodplain. Landform rises to a low forested range just to the north-east of the Site where there are a number of houses in elevated locations.

3.3 Planning and regulatory requirements

3.3.1 Land zoning

The Subject Land is located within the Gunnedah LGA and is subject to the *Gunnedah Local Environment Plan 2012* (Gunnedah LEP 2012), under which it is zoned as Primary Production (RU1).

According to the Preliminary Environmental Assessment (PEA) (Pitt & Sherry, 2017), the Proposal is generally compliant with the objectives of this zone. There are no specific provisions relating to scenic quality concerns.

3.3.2 Future development

Plans for further solar PV installations in the area are being considered, with known potential facilities being Ironbark Energy Solar Farm and Orange Grove Sun Farm.

The cumulative impact of the potential development is further considered at **Section 10.0**.

4. Description of the Proposal

This section presents information about the Proposal, describes the visual characteristics of the solar PV farm and the main sources of potential visual change associated with the Proposal.

A more detailed description of the Proposal is provided in the EIS.

4.1 Overview

The proposed Gunnedah Solar Farm would involve the installation of solar farm with a capacity of 150MW that would supply electricity to the national electricity grid. An estimated 460,000 PV panels would be installed on a single axis tracker system across the Site.

The following works and infrastructure would be required to support the construction and operation of the solar farm:

- Construction of access roads including a main access road from Orange Grove Road
- Installation of electrical infrastructure including:
    - A 132kV Substation including one transformer and associated 132kV switchgear
    - New transmission line (powerlines and poles for a distance of approximately 1km)
    - Inverters
- Ancillary works at Gunnedah Substation and the existing 132kV transmission line adjacent the site
- A maintenance compound and buildings
- Landscaping and environmental works
- Perimeter security fencing
- Two maintenance storage containers.

Further details have been provided below for indicative key infrastructure components most relevant to this assessment, however, the final supplier for all components would be confirmed during the construction contract Request for Proposal (RFP).

4.2 Main components relevant to visual impact assessment

Solar components

The Proposal would comprise PV panels using a single axis tracking system, facing east-west and tilted at a maximum 60 degree angle from horizontal, along the north-south axis. The PV modules (2m x 1m) would consist of 72 high efficiency monocrystalline cells with glass and aluminium frames. The modules would be arranged in strings and connected to inverters located adjacent to

PV arrays. The PV arrays would be fitted with an earthing and lightning protection system connected to the main earth link.

The solar modules would consist of a mounting system, PV solar panels and cabling. The overall maximum height of the PV panels would be 3.0m high, with these set on steel mounting structures with steel posts as foundations. Piles would be driven or screwed in to the ground using pile drivers. During the piling installation, work would be undertaken to avoid disturbing the existing ground cover to minimise ground disturbance and limit the potential for erosion.

Figure 4-1 and **Figure 4-3** provide an indication of what the proposed solar modules would look like. An indicative layout of the solar farm is shown in **Figure 4-2**. **Figure 5-1** (Section 5.0) illustrates how the panels change at various time of the day and 'track' the sun.

FIGURE 4-1: EXAMPLE OF TRACKER (PV) SOLAR PV PANELS

Inverter stations

Inverter Stations collect electricity from an area of panels (approximately 10,000 panels) and the energy is conveyed to the substation (refer Figure 4-4). There would be 30 to 45 inverter stations across the Site, which be of one of the following options:

- 26 x 4.92 MW Ingeteam CON40 inverters (Dimensions: 12.2m long x 2.4m wide x 2.9m high) - 3 inverters housed in a 40' container.
- 40 x 3.20 MW Ingeteam CON20 inverters (Dimensions: 6.1m long x 2.4m wide x 2.6m high) - 2 inverters housed in a 20'container.

The inverter stations would be installed on concrete foundations, elevated approximately 1.2m above the ground due to potential flooding.

FIGURE 4-2

Site layout

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT

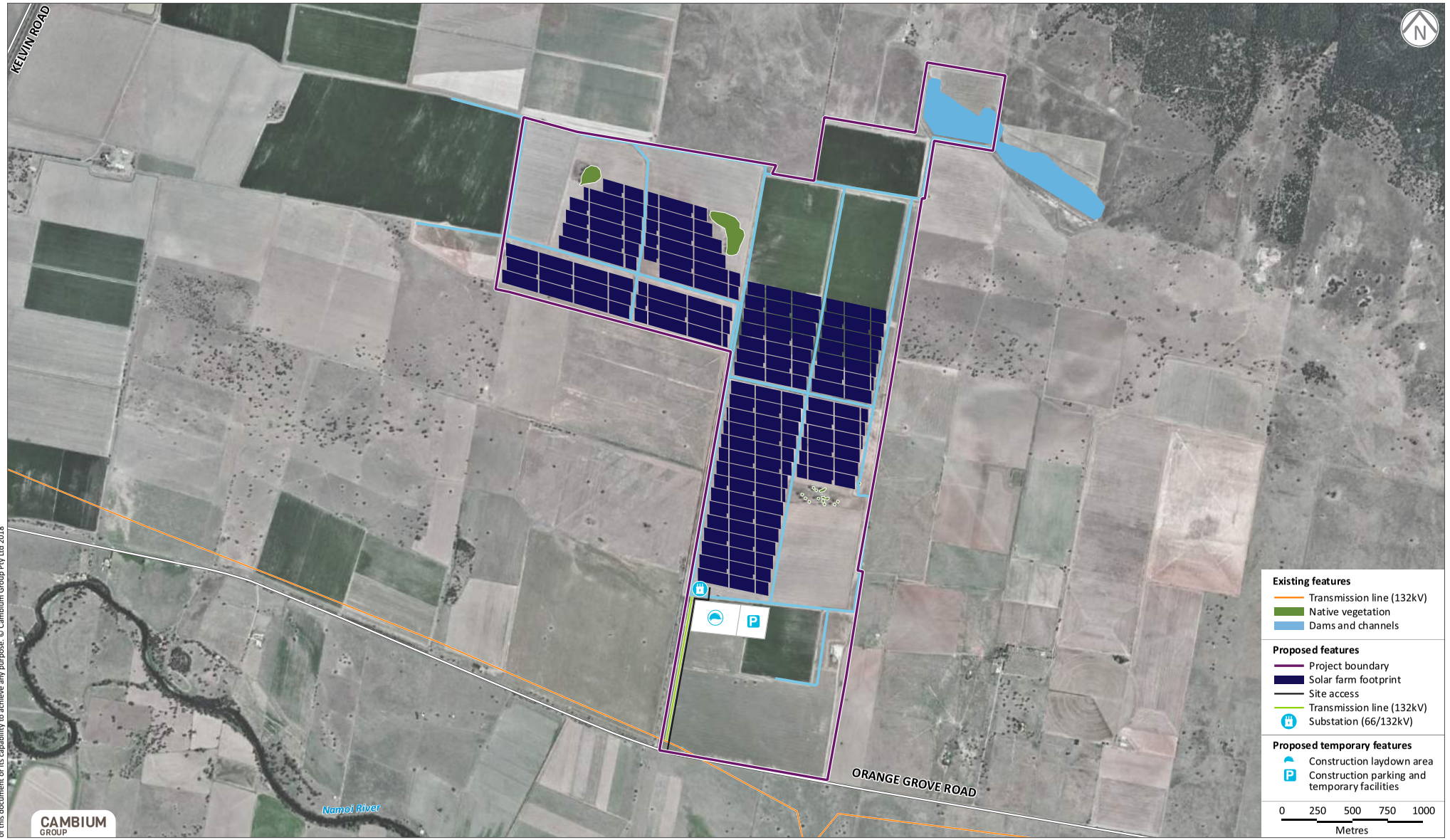

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FIGURE 4-3: EXAMPLE OF GROUND-MOUNTING ARRANGEMENTS

FIGURE 4-4: EXAMPLE OF INVERTER STATION

Substation

A new 132kV substation would be established on Site in the south-west corner of Lot 264 DP754954 (refer **Figure 4-2**).

The substation footprint is approximately 60m x 80m and set back approximately 1.2km from Orange Grove Road. The substation switchyard would include a transformer, 33kV switchgear building and auxiliary services building. New overhead transmission lines would connect the existing 132 kV transmission line located near Orange Grove Road to the substation. An example of a similar substation can be seen in **Figure 4-5**.

The new substation would include (subject to detailed design):

- 1 x 132kV 140MVA transformer
- 33kV switchgear building
- Auxiliary services building

- Elevated busbar
- A lightning protection system
- Circuit breakers
- Disconnectors
- Current transformers
- Voltage transformers
- Diesel Generator
- Communications pole with microwave dish and antennas.

A chain link fence with upper barbed strands approximately 3m high would be installed around the substation to maintain security of the site and ensure safety for the public and the ongoing agricultural activities surrounding the substation. The substation would have a 20m asset protection zone (APZ) in accordance with TransGrid design and safety standards.

The substation would be constructed on a concrete pad, approximately 60m x 80m, and the concrete pad will be elevated off ground level to mitigate risks of flood waters affecting safe and reliable operation of the substation. Consistent with existing TransGrid substation designs, gravel will be placed around the substation equipment.

The Proposal would require connection to electrical infrastructure within an existing TransGrid easement which is located to the south of the Site along Orange Grove Road. This enables the energy generated from the project to be transmitted via TransGrid's existing transmission network, ultimately making the electricity available to the National Electricity Market (NEM).

The connection will be made via new 132kV overhead transmission lines using towers or poles for a distance of approximately 1km. This connection is subject to TransGrid detailed design however it is expected that six towers or poles, distanced approximately 150m-200m apart would be erected to suspend conductors from the substation to the existing 132kV transmission line.

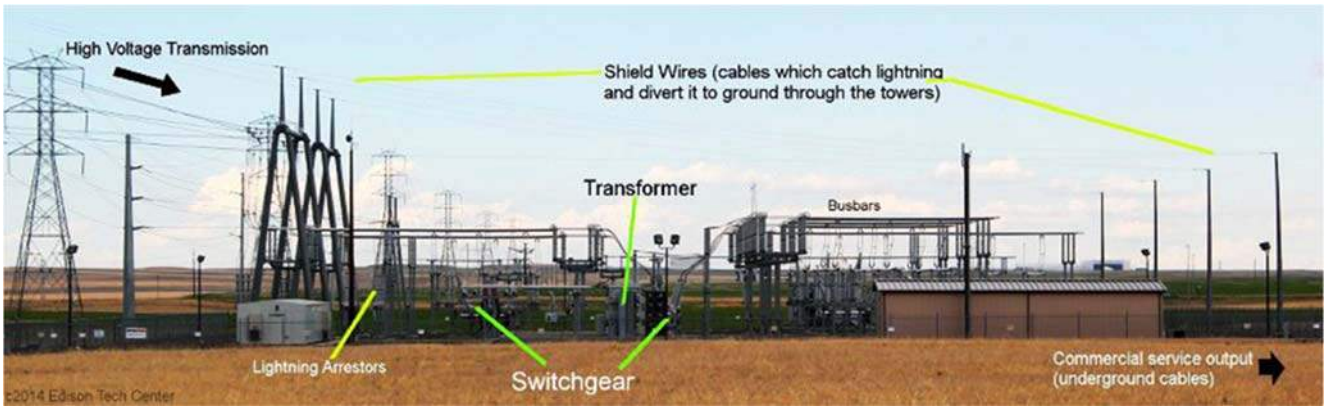


FIGURE 4-5: EXAMPLE OF A SIMILAR SUBSTATION TO THAT PROPOSED

TransGrid infrastructure works

The following works would be undertaken within the existing TransGrid easement and as upgrade/retrofitting of existing infrastructure including:

- Approximately 1km of existing TransGrid transmission line between structures 315 and 310 will be restrung with higher rated conductors.
- Installation of a high capacity fibre is also required to ensure that necessary communication and protection systems are in place for safe and reliable operation of the solar farm and TransGrid's continued operation of its high voltage transmission network. The installation of this fibre would occur by means of retrofitting approximately 1.6km of optical ground wire (OPGW) onto TransGrid's existing transmission line back to the Gunnedah Substation. Installation of the OPGW would replace the existing overhead earth wire on the transmission line with a fibre that is visually consistent with the existing transmission line arrangement.
- The works required to undertake this would occur wholly within the existing transmission line easement and readily occur as part of general maintenance and upgrade works undertaken by TransGrid across its network. No detailed environmental assessment has been undertaken of the works in the TransGrid easement however TransGrid have advised it will not result in any change to existing land use and has limited potential for environmental impacts due to the existing disturbed nature of the easement and temporary nature of the works.

Access roads

The current access road to the Site is an unnamed, unsealed road off Orange Grove Road near the western boundary of the Site in the south-west corner of Lot 151 DP754954. This access road would be utilised as the main access road following upgrade of the intersection with Orange Grove Road.

Existing road seal on Orange Grove Road would need to be extended to the proposed main access road. The upgrade would be the same as the existing sealed portion of the road. The first 30 metres of the main access road within the Site would be sealed to provide for truck access.

4.3 Construction and Commissioning

The construction phase of the Proposal is expected to take nine to twelve months, and that approximately 150 construction personnel would be required on Site during the peak construction period.

It is anticipated that the solar farm would be constructed in 1ha stages – with up to 10 stages in construction at any one time. No construction works are proposed to occur at night. Standard construction hours would be adopted.

Site establishment

A temporary construction compound would be installed along the eastern boundary of the Site. The location of the construction compound is shown on **Figure 4-1**. Access to the construction compound would be via a temporary access road off Orange Grove Road.

During construction, the traffic volume is expected to be up to 40 heavy vehicles (mostly B-double trucks), and 50 light commercial vehicles per day.

Initial site establishment works would include:

- formation of a stabilised, temporary construction access
- materials laydown area
- construction offices (one 12m x 3m site office, four 12 x 3m break rooms)
- parking area (for approximately 80 vehicles)
- staff amenities
- fencing.

Vegetation clearance

Vegetation to be retained would be protected. A buffer of 40m is proposed between infrastructure and any waterway and the majority of existing vegetation on Site would be avoided.

Minor vegetation clearing is proposed. Vegetation clearance would be targeted to grasses, shrubs and isolated trees located at proposed trenching areas, and where steel post installation is proposed.

Earthworks

While extensive earthworks are not proposed, some land forming (including localised cut and fill areas) may be undertaken to achieve more consistent gradients beneath the PV modules.

Delivery

Most of the infrastructure for the solar farm would be pre- fabricated off-site, delivered and then assembled on-site. Trucks would transport the modular equipment to Site via Orange Grove Road.

4.4 Operation

The operational phase of the Proposal is anticipated to commence in the first quarter of 2019. Once operational, activities would include daily operations and maintenance.

A small area would be maintained for parking of utility vehicles during operation of the solar farm. Two 40' shipping containers for storage of maintenance equipment would be permanently situated within the Site on the compound areas used during construction.

There would be no permanent night lighting installed on the Site, apart from possibly emergency lighting for the substation. Minimal operational plant and equipment would be required.

4.5 Decommissioning

The solar farm would have an operational timeline of 25 years and as such in 2044 the infrastructure would be reviewed and either:

- Updated - the plant would be updated for continued use; or
- Decommissioned - the plant would be permanently removed.

Should the decision be made to remove the plant, then the Site would be returned as close as possible to its existing condition and would be decommissioned as per standard solar plant isolation and disconnection procedures.

It is understood that the substation would remain in place to service the locality subject to review of viability by TransGrid. The main isolation switch would provide a disconnection point and would be used to de-energise the site.

5. Potential visual concerns

A review by others of studies of social-cultural attitudes and renewable energy acceptance, based on surveys from 13 countries, concluded that 'the singularly most important concern about renewable energy is visual intrusion'[5].

This section of the report briefly discusses, and seeks to address, some of the potential visual concerns that the community may have in relation to PV solar farms. The impact assessment presented in **Sections 6.0** and **7.0** takes account of any concerns where relevant.

5.1 Scale

Large scale solar facilities can occupy very large land areas, have regular, strong geometry, and can be visible for long distances. One study found that large PV solar facilities are not uncommonly visible at a distance of 16km[6]. Yet it is notable that, when viewed from long distances, the facilities may not be recognisable as solar facilities.

Figure 5-1 provides a visual comparison of the height of PV panels compared to other familiar elements, illustrating the overall low profile of the Proposal.

Although large in area, such solar facilities have visual advantages in that they are generally low to the ground, have low visual contrast, and can appear as shadows from a distance [7]. Depending on the project layout and contrast, in some cases they may appear to be like natural features, while in other cases, they may lack sufficient visual detail to be identified positively as solar facilities[8].

5.2 Glint and glare

Glint is generally defined as a momentary flash of light whilst glare is a longer and for some time continuous source of light reflection.

In desert areas, glare has been observed from parabolic trough facilities and solar array facilities[9]. However, the Proposal does not use these technologies. The solar PV modules proposed to be installed at Gunnedah are different to concentrated thermal solar power which uses mirrors to reflect the sun to one point concentrating the sunlight.

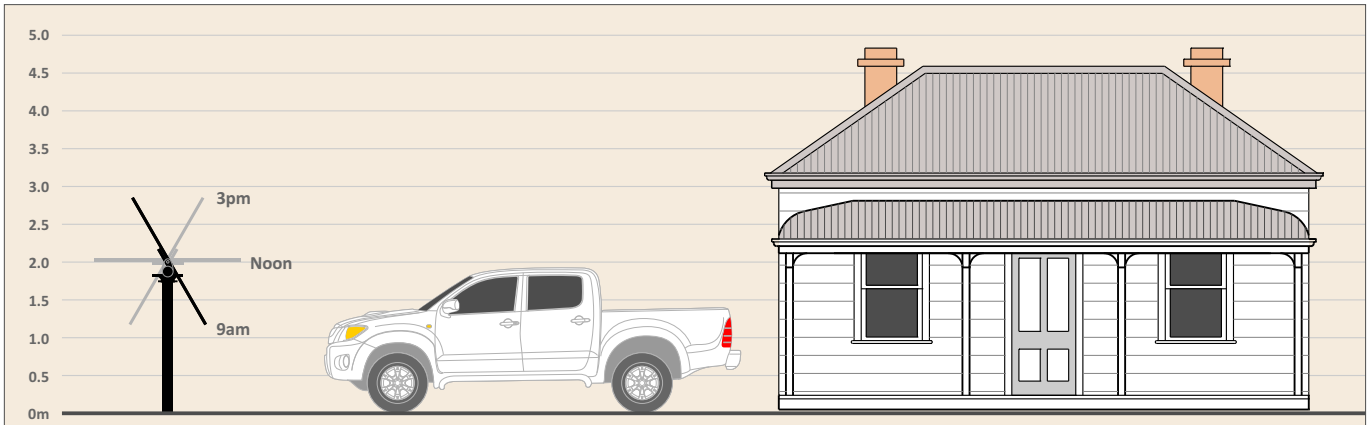
The *NSW Department of Industry Solar Farm Fact Sheet* (2016) states: 'Solar farms are not considered to be reflective. Photovoltaic panels are designed to reflect as little light as possible (generally around 2% of the light received) to maximise their efficiency, absorb sunlight and convert it to electricity. Minimising the light reflected from solar panels is a goal of panel design,

[5] Apostol, Dean (2017) *The Renewable Energy Landscape*. Routledge. (Apostle 121)
[6] Sullivan, R. et.al. (2012). *Visual impacts of utility-scale solar energy facilities on southwestern desert landscapes.*
[7] Sullivan et al. (2012). *p14*
[8] Apostol, Dean. (2017) (Apostle 21)
[9] Sullivan et al. (2012). *p16*

FIGURE 5-1

Photovoltaic panel height comparison

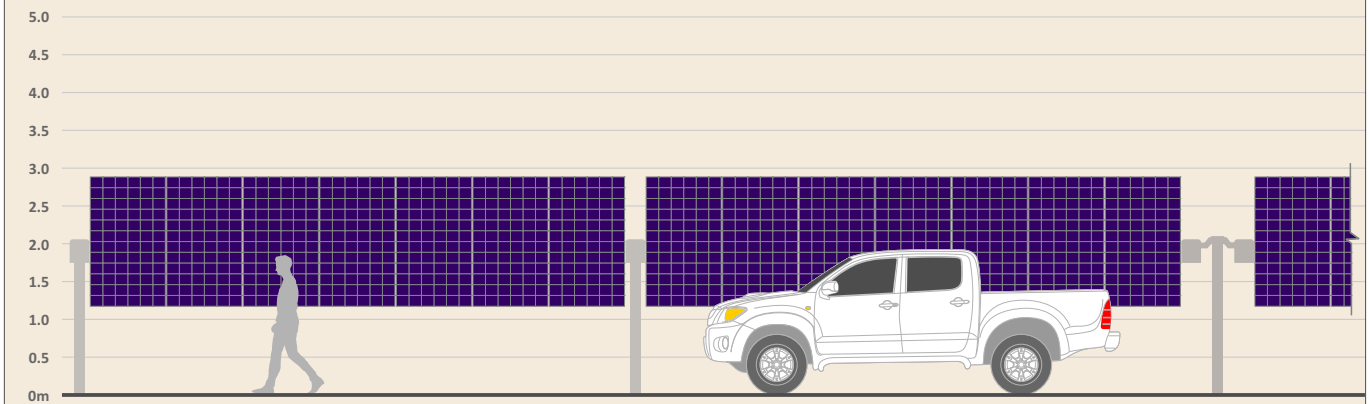
GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT



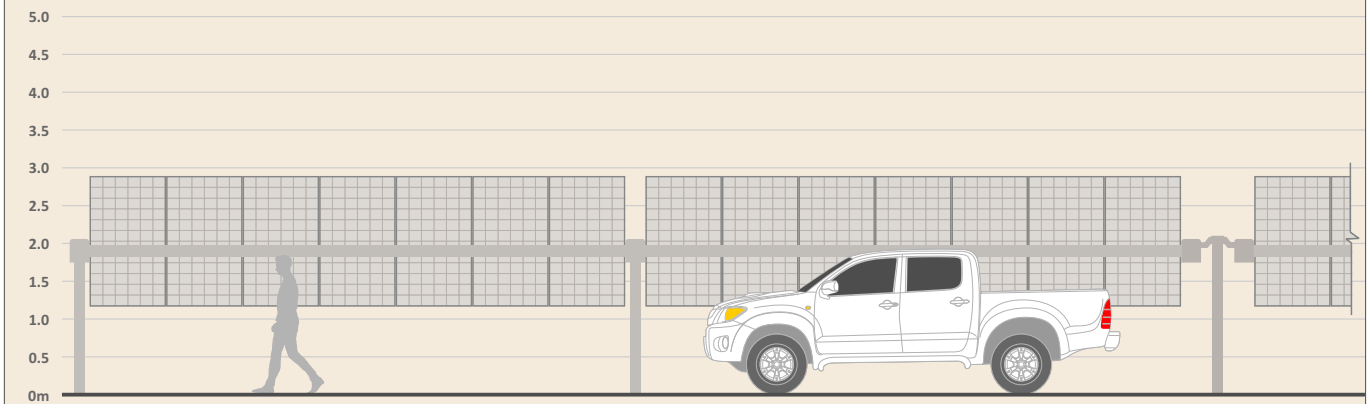
NORTH/SOUTH ELEVATION

DUAL CAB UTE

FARM COTTAGE



EAST ELEVATION (9am)



WEST ELEVATION (9am)

PHOTOVOLTAIC SOLAR PANEL (TRACKING)

CAMBIUM GROUP

manufacture and installation. The glare from panels is significantly less than that from bodies of water.'

A comprehensive study of the potential for glint and glare was undertaken for Sapphire Solar Farm (Page Power, 2017). Sapphire Solar Farm is proposed to be located near Glenn Innes and would comprise 'tracking panels'.

That study reviewed a substantial amount of available literature and found that:

- *Glint and glare effects can only ever occur when the weather is clear and sunny*
- *The reflections produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel*
- *In the scenario where a solar reflection is possible towards a road user or resident in a surrounding dwelling, the individual will also be looking in the general direction of the Sun. This means the Sun and solar reflection will be visible simultaneously. The Sun is a significantly brighter source of light.*
- *Lastly, at any one location, only a particular area of solar panels will produce a solar reflection towards it.*

The study concluded:

- *'the overall expected impact upon road users with respect to safety is classified as Low (at worst) where the reflecting solar panels are visible*[10]
- *And that for residents, 'The solar reflections would last for up to 20 minutes per day for up to 6 months from windows with a clear view of the reflecting solar panels... In all cases, a clear view of the reflecting solar panels at the particular time of day when a solar reflection was geometrically possible would be required. In addition, the weather would also have to be clear and sunny...the resulting impact significance is Low to Moderate. If screening removes the solar panels from view, No Impact will be possible.*
- *If mitigation were to be requested, the most appropriate form would be the installation of screening in the form of vegetation.*

Therefore, based on available information, and in-line with the *NSW Department of Industry Solar Farm Fact Sheet*, glint and glare are unlikely to be an issue for surrounding residents or road users.

5.3 Light refraction

A 'mirage' effect — glittering or shimmering — can be sometimes observed at PV facilities. The effect is similar to the shimmering seen over a bitumen road on a hot day which can make the road surface appear as though it is wet, rippling or reflective (refer to **Figure 5-2**).

[10] Pager Power, 2017, p3

FIGURE 5-2: 'MIRAGE EFFECT' ON ROAD ON A HOT DAY

The effect occurs because the surface of the road (or surface of the PV panels) is hotter than the air around it. In the case of PV panels, heat from the panel surface warms the air above it, distorting (refracting) light waves. The air wobbles and makes the colour above the panels (or road) appear brighter and bluer[11].

The 'mirage' effect is not bright enough to cause discomfort. It is likely to be only observed during certain times of day and from certain viewing positions. **Figure 5-3** shows the effect (although difficult to see) from an elevated position (approximately 45m higher), north-east of, and 2.75km from, Royalla Solar Farm, in the Australian Capital Territory (ACT). A further image of the Royalla Solar Farm is provided at **Figure 5-4**.

It is to be noted that the Royalla Solar Farm is not a directly comparable visual example as it comprised of fixed-angle panels and located on a site with a greater slope than the generally flat terrain of the Proposal.

5.4 Geometric patterns

Viewer position in relation to the patterning of the PV modules also affects the appearance of the facility. An image showing viewer position in relation to the rows of PV modules is shown at **Figure 5-5**. Viewer position determines which side of the facility is in view, and therefore which angle of surface is seen with respect to the viewer.

[11] Adapted from:
- The Naked Scientists, 01/06/2008, https://www.thenakedscientists.com/forum/index.php?topic=14849.0
Physics, 26 May 2011, https://physics.stackexchange.com/questions/10464/why-does-the-road-look-like-its-wet-on-hot-days

FIGURE 5-3: PHOTOGRAPH OF ROYALLA SOLAR FARM NEAR CANBERRA

FIGURE 5-4: ROYALLA SOLAR FARM SHOWING COLOUR CHANGE THAT CAN OCCUR WHEN VIEWED FROM THE FRONT

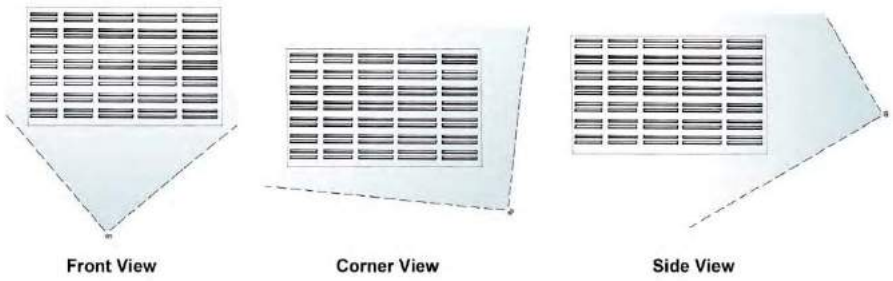


FIGURE 5-5: VIEWER POSITION AFFECTS APPEARANCE OF SOLAR (PV) FARM (CREDIT: ARGONNE NATIONAL LABORATORY IN SULLIVAN & MEYER, 2014)

From some viewer positions it may be possible to see down the straight lines of the solar modules. When driving past PV modules in rows perpendicular to the road, the rapid change in viewer position would result in abrupt changes in angle and pattern of the panels. The colour of the panels would appear to change rapidly from black (when viewing the rear of the panels) to various shades from blue to white (when viewing the face of the panels). The visual change – the lightening in appearance as the vehicle passes the facility[12] - would only be seen if looking directly down the rows when travelling past at speed, and would be momentary[13].

Colour change in relation to viewer position is shown in the image at **Figure 5-4** (taken 200m from the nearest panels at Royalla Solar Farm, ACT). When viewing the face of the panels, the panels appear lighter in colour – with shades of blue to white. Looking at the rear of the panels, the panels appear black as they cast shadow.

The Royalla Solar Farm, however, is comprised of fixed-angle panels permanently facing the same direction, yet is useful in providing an example of a solar farm with low height PV panels. The proposed solar farm at Gunnedah would comprise tracking panels which slowly move throughout the day, changing their angle and direction.

It is noteworthy too, that the Solar PV modules proposed to be installed at Gunnedah would not be mounted perpendicular to any public roads, which means the phenomenon of travellers noticing rapid colour change when moving at speed past the solar farm would not be possible.

5.5 Aviation

Aviation warning lights are required for towers and other tall structures which may be a hazard to aircraft. Normally these would be red flashing lights. As the proposed solar panels are low-profile, aviation warning lights are not required. The solar panels also do not need to be painted white (such as would be required for wind turbines) as an aide to aerial navigation safety. There would be no colour contrast from the solar panels as a result of aviation safety requirements.

There is no movement (visible to the naked eye) that would be associated with the solar farm infrastructure, and therefore, motion would not be an obstruction to aviation. The Proposal would not include solar towers or other

[12] Sullivan, R (2012) p22
[13] Sullivan, R et.al. (2012) p22

structures that would contrast with dark night skies. The Proposal would not include mirrors or lenses or other reflective surfaces.

It is understood that the Civil Aviation Safety Authority (CASA) has generally advised that large scale solar farms, such as that proposed, are very unlikely to be a hazard to aircraft operations (in terms of glint and glare) unless they are very close to and aligned to an airport's approach or take off paths. The Proposal does not fall into that category.

5.6 Movement

Fixed solar panels are permanently oriented toward one aspect (north). Moving Tracking PV solar panels, however, slowly follow the daily transverse of the sun in a 180 degree turn from the north-east in the morning, to the north-west by the afternoon. There is a wider range of potential viewpoints which may face moving panels during the day, however, their exposure to the face of the panels would be shorter in duration. Although 'tracking' solar panels change their orientation during the day, the movement is usually very slow and not apparent in short-duration views[14].

5.7 Skylining

Skylining occurs when structures are placed on ridgelines, summits, or other locations where they would be silhouetted against the sky. The eye is naturally drawn to prominent landscape features and high points15. Examples of skylining can be seen with power poles, telecommunications towers and wind turbines that are installed on ridges in rural landscapes.

The solar panels to be installed for the Proposal are low-profile – generally a maximum of 3m above ground level. Therefore, skylining is less likely to be an issue unless the panels are located on prominent, exposed, high points, which drawn the attention of the viewer.

There are no high, prominent ridges within the proposed footprint of the solar farm at Gunnedah.

5.8 Ancillary structures

PV solar farms require a high number of inverters and ancillary structures to be installed in association with the panel. An inverter, at 2.9m high x 2.4m wide x 12.2m long, is slightly taller than individual panels at full tilt, and wider than individual rows (strings or arrays) of panels.

The colour of such ancillary PV solar farm structures may contrast against the background landscape of the solar fam and could have the effect of drawing attention to the multiple structures laid out in a grid pattern across the farm.

The colour of ancillary structures is therefore important. Inverters and other facility components that are colour-treated two to three shades darker than the background landscape colour, better match the surroundings and

[14] Sullivan, R. and M Meyer. 2014.p50
[15] United States Department of the Interior. 2013. *Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands*. BMP 6.2.12

decrease their visibility and contrast. White is generally the most conspicuous colour. Lighter colours should be avoided.

To determine the appropriate colour, colours should be tested on-site for visual compatibility and minimal contrast. Several colours should be trialled and tested from key viewing points to determine which colour best reduces visibility.

An example of white coloured inverters and other solar farm buildings is shown at **Figure 5-6** and an example of colour-treated inverters at Williamsdale at **Figure 5-7**. These images show that the use of more recessive colours lowers visual contrast and potential visual impact.

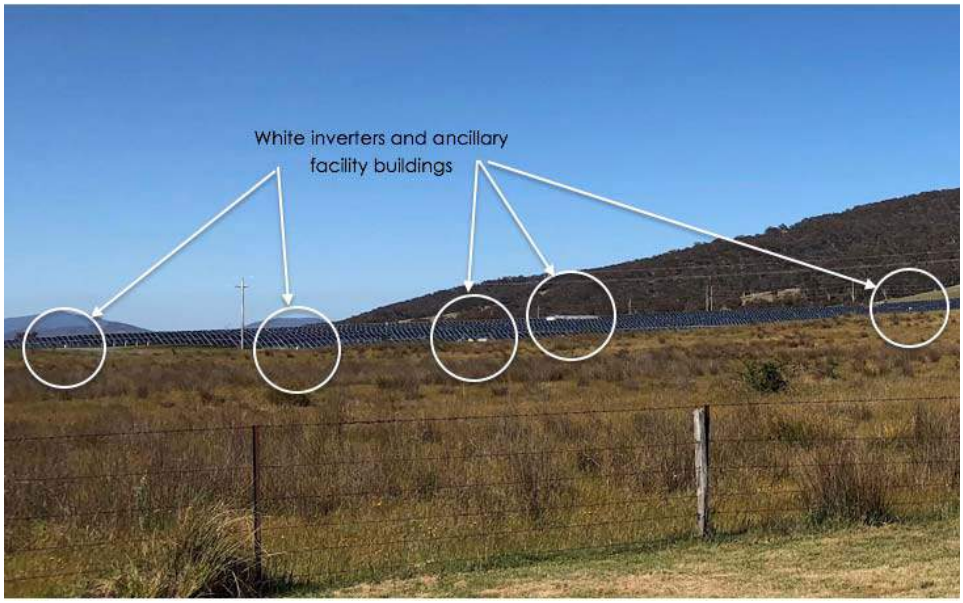


FIGURE 5-6: ROYALLA SOLAR FARM SHOWING THE CONTRAST OF WHITE ANCILLARY STRUCTURES

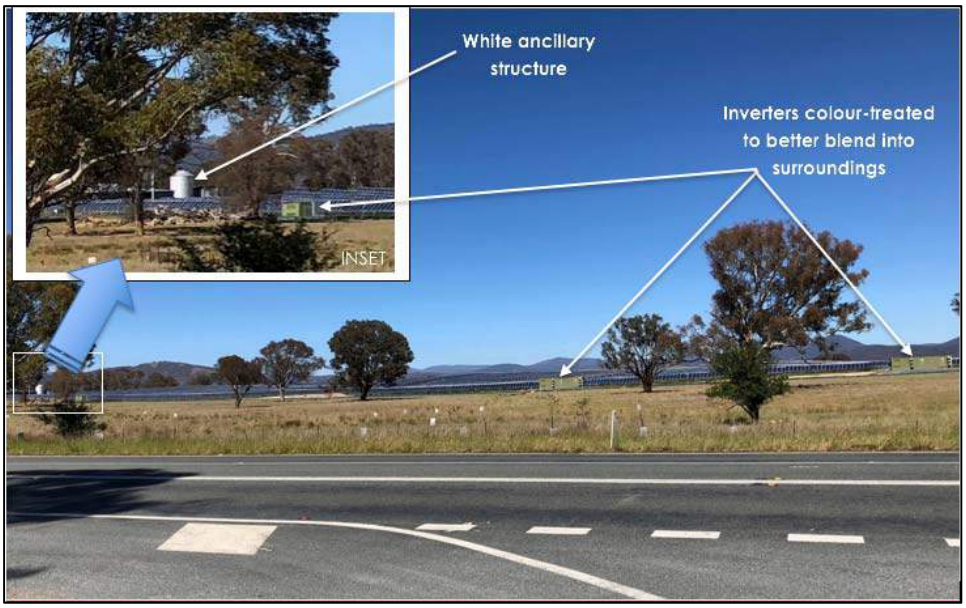


FIGURE 5-7: WILLIAMSDALE SOLAR FARM SHOWING COLOUR-TREATED INVERTERS

6. Impact to landscape character

The landscape character of the vicinity has been described at **Section 3-1**. This section of the report describes the changes in visual quality and character of the landscape caused by the Proposal. As noted in **Section 2.0**, the assessment of impact is based on the combination of two criteria: sensitivity and magnitude of change.

6.1 Sensitivity

The landscape character of Gunnedah and its environs is typical of the surrounding North West Slope Region. The landscape occasionally includes industrial-type elements, such as silos and sheds, and the land surface is often divided into grids and rows via fences, trees, and cropping patterns. However, the installation of a large-scale solar PV farm within the rural setting of Gunnedah would introduce a new, significantly large, human-made element into this agricultural landscape.

The colour contrast of the solar panels may be more evident in warmer months during wheat growing and harvesting. The dark colour of, and shadows cast by, the solar panels would contrast against the light, bright colour of the crops. The local landscape of broadacre paddocks, however, also creates a patchwork of geometrical patterns and background colours that can also serve to reduce the visual contrast of a solar (PV) farm in this the landscape.

The large silos present across this rural landscape, including those situated on the Subject Land on which the Proposal would be located, are also significantly taller than the proposed infrastructure. Nevertheless, it is acknowledged that the Proposal would be much larger in scale given the extent of land covered.

There are no local sources of large-scale artificial lights such as would be associated with an industrial premises or commercial facility operating at night. Farm sheds and associated farming infrastructure are made of sheet metal, concrete or timber. Some existing surfaces, particular roofs, are highly reflective. Power lines and tall transmission lines cross the paddocks and run along the local road. They generally appear as dark vertical lines via their steel or timber pole construction.

Using the criteria listed in **Table 2.1**, the overall landscape character is rated as having a **moderate** sensitivity:

- The landscape does not have particular high scenic significance yet is an attractive, rural landscape common throughout the North West NSW agricultural area
- The patterning of the area is dominated by geometrical patterns and a patchwork of colours ranging from the black soils, green pasture to golden crops

- The surrounding area is sparsely populated with there being a small number of permanent residential viewers and the nearest road, Orange Grove Road, providing only local access.

6.2 Magnitude of change

Construction

A key construction impact would be the number of trucks accessing the Site to deliver equipment and smaller worker's vehicles accessing the Site to install the facility. Orange Grove Road would be affected by the number and frequency of transport movements.

The construction footprint would affect a large area. During construction, machinery and equipment would be seen over different parts of the Site, however, considering the prevalence of farm infrastructure and machinery this change would be relatively compatible.

Using the criteria listed in **Table 2.2**, the magnitude of change to landscape character during construction is rated as **low**. There would be:

- Large extent of area affected
- The closest public views would be from Orange Grove Road, with these not elevated and at least 1km away, and from the local Tudgey Road, which is in places slightly elevated and almost 2km away (note that **Section 7.0** assesses the potential effects to both public viewpoints in detail)
- There are relatively few residential viewpoints, with the only elevated ones being along Tudgey Road to the north, and 1.8km away (note that **Section 7.0** assesses the potential effects to private viewpoints in detail)
- The additional visual changes associated with the construction machinery, truck movements and a site compound would be of a short timeframe and temporary.

Operation

Once construction is completed, the solar PV panels and the substation would be visible from Orange Grove Road, the unsealed Tudgey Road to the north and some surrounding private properties (refer **Section 7.2** for a detailed assessment and **Figure 7-1**(Section 7.0) for viewpoint locations).

The PV panels would occupy a large area of land within the surrounding landscape. However, due to the low height of the PV panels and the flat terrain, the solar farm would not be a large visual feature unless the viewer was elevated. There are very few places where an elevated view would be possible, and therefore the change to the landscape character would not be easily perceived when viewing the landscape as a whole.

The inverters are no higher than the panels, however, are wider and longer. Colour-treating the inverters, as well as other structures on the Site as proposed in the mitigation measures (refer **Section 9.0**), would reduce their visibility.

The substation, which would be the tallest element at approximately 25-30m high (some pole structures), is located at the furthest point away from the only

location from where elevated views are possible (that being along Tudgey Road and the properties accessed from it, with the nearest viewpoint over 4km away).

Using the criteria listed in **Table 2.2**, the magnitude of change to landscape character during operation is rated as **moderate**:

- The Site is on flat terrain and not visually prominent
- The proposed PV panels and most Site elements are low-profile
- There are no public viewpoints within 1km (the nearest is Tudgey Road almost 2km away and Orange Grove Road is approximately 1km away) and no elevated viewpoints frequented by many viewers, and therefore it would not become the dominant feature of the scene in general (note that **Section 7.0** assesses the potential effects to public viewpoints in detail)
- There are relatively few residential viewpoints, with the only elevated ones being along Tudgey Road to the north, and at least 1.8km away (note that **Section 7.0** assesses the potential effects to private viewpoints in detail)
- Its scale and colour would produce some contrast, however, it is not substantially incompatible with the geometric patterning and colour of the prevalent landscape, and is generally of low height (including PV panels, inverters and inverter stations)
- The substation is relatively small in scale and height and located some 1km from the nearest public viewpoint (Orange Grove Road) and more than 800m from the nearest resident.

6.3 Level of Impact to landscape character

Construction

The moderate sensitivity ranking, combined with the low magnitude of change during construction, leads to an overall low-moderate level of impact.

Operation

The moderate sensitivity ranking, combined with the moderate magnitude of change post-construction, leads to an overall moderate level of impact.

7. Impact to viewpoints

This section of the report assesses the potential effects of the changes on the viewer experience.

7.1 Identification of viewpoints

Approximately twenty-four (24) potential viewing points were initially investigated during the site inspection (26-27 October 2017), with identification (ID) numbers allocated to identify each viewpoint.

Access to four of the closest private properties[16] was possible during the site inspection. For the remaining properties, visibility was determined from the closest public access to each viewpoint and desktop analysis of aerial and topographic mapping. Subsequent access to a number of other private properties was given during a second site visit early in January 2018.

7.2 Assessment of viewpoints

Private and public viewpoints within approximately 5km proximity of the Proposal have been individually assessed, with the majority from private residences. In addition, any highpoints from where more distant views may be possible were also considered, such as lookouts and the airport.

7.2.1 Public viewpoints

The closest potential public viewpoint is the Porcupine Hill lookout in the main town of Gunnedah some 8.5km away. The Proposal is not located in the part of the landscape where the main views from the lookout are orientated, and there are unlikely to be any easily discernible views of the Proposal from this viewpoint, and therefore there would be a low or negligible visual impact.

The only other public viewpoints with potential views of the Proposal are from two local roads: Orange Grove Road, some 1km to the south: and the unsealed Tudgey Road some 2km to the north. The sensitivity of views from Orange Grove Road (identified in **Figure 7-1** as VP Orange Grove Road), is considered low, with the nearest part of the solar PV farm, including the substation, some 1km away. The predicted magnitude of visual change would be at most moderate, due to: the flat terrain between the road and the substation for the most part; the separation distance; that the panels would be seen from the rear and/or side view; and the mostly low height (including of the substation for the most part). Therefore, the visual impact to viewpoints from Orange Grove Road has been assessed as low-moderate.

Due to the unsealed Tudgey Road only been used by local property owners, it has not been assessed in detail, as views are sufficiently covered by the assessment of impacts to private properties in the vicinity. Overall The sensitivity of views from Tudgey Road (identified in **Figure 7-1**) is considered low, with the nearest part of the solar PV farm more than 2km away, and the substation more than 4.5km away. The predicted magnitude of visual change

[16] ID numbers 1, 2, 7 and 9, Figure 7-1

would be moderate at most, with therefore the overall the impact level to public viewpoints from Tudgey Road assessed as being low - moderate.

There would also be views possible of the Proposal from aircraft using Gunnedah Airport, which is situated some 8km to the south-west. It is likely that many airborne viewers would find the solar (PV) farm interesting to look at, yet others may feel it reduces the quality of the landscape character. Nevertheless, it is put forth that the overall visual impact would be low.

7.2.2 Private viewpoints

Table 7-1 provides a detailed assessment of potential visual impacts from surrounding private viewpoints, with those viewpoints and the predicted visual impact level identified in **Figure 7-1**.

Table 7.1 firstly assesses the likely visual impact level to each viewpoint based on the visual situation immediately following construction, that is as a base case where there is no landscape screening. Where impact levels are of a level that of moderate-high or higher (yet NB that no 'high' levels were identified), then mitigation in the form of landscape screening has been considered, and if determined to be feasible, the impact level to the viewpoint has been re-assessed (refer to last two columns of the table).

In the subsequent section (**Section 8.0**), photomontages (simulated images) have been provided which illustrate some of the more affected viewpoints and the potential for landscape screening to reduce visual impact levels. Landscape screening then forms part of the mitigation measures described in **Section 9.0**, where it is also illustrated on the Concept Landscape Plan (refer **Figure 9-1**).

FIGURE 7-1

Predicted visual impact levels for identified viewpoints and photomontage locations

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT

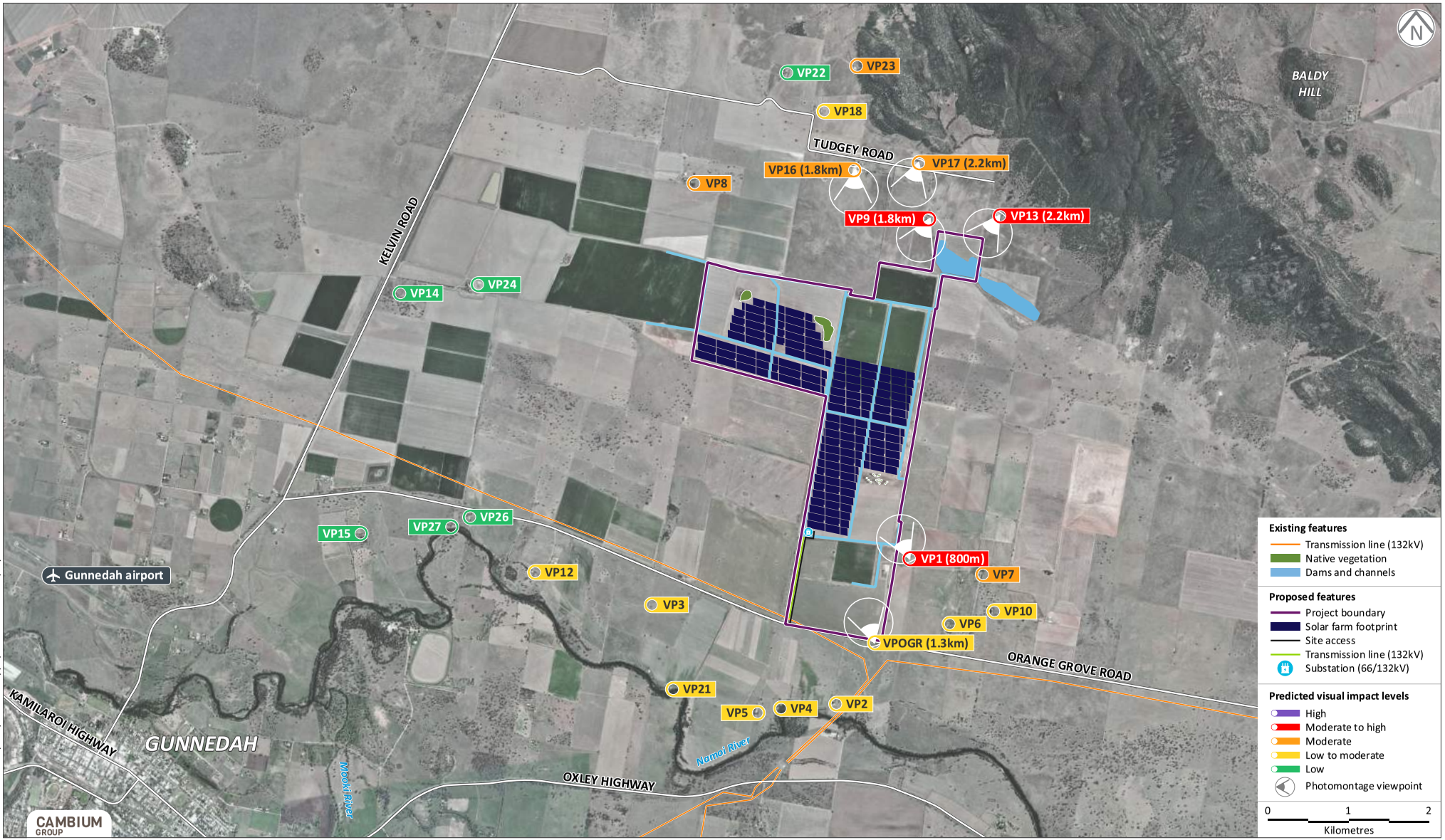


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TABLE 7-1: ASSESSED PRIVATE VIEWPOINTS (ALL HOUSES) AND PREDICTED VISUAL IMPACT LEVELS

VIEWPOINTS	Analysis (on base case of no landscape screening)	Distance to nearest view of panels	Distance to substation	Position in relation to panels	Sensitivity (criteria in table 2.1)	Magnitude of change (criteria in table 2.2)	Impact level (criteria in table 2.3)	Could landscape screening reduce impact?	Revised impact level where relevant**
VP1* – 767 Orange Grove Road, Gunnedah	In close proximity to panels The viewpoint is a private home with mostly unimpeded views. Slightly higher (several metres) in elevation so some views would extend over the broader solar farm Substation more than 1km away	800m	1.25km	East, front (morning) & rear view(after noon)	High	Moderate	Moderate -high-	Yes	Moderate
VP2 – 726 Orange Grove Road, Gunnedah	In moderate proximity to panels The view is from a private home, with closer views from front of property Trees around home would likely partially screen views Due to low elevation, coupled with rear view of panels, would mean panels difficult to discern from house Substation 2km away	2km	2km	South, side view	Moderate	Low	Low - moderate		
VP3 – 476 Orange Grove Road, Gunnedah	In moderate proximity to panels The view is from a private home, with closer views from front of property and some intervening trees Due to low elevation, coupled with rear view of panels, it would mean panels difficult to discern from house Substation 2km away	2km	2km	South-west, side/rear view	Moderate	Low	Low - moderate		

VIEWPOINTS	Analysis (on base case of no landscape screening)	Distance to nearest view of panels	Distance to substation	Position in relation to panels	Sensitivity (criteria in table 2.1)	Magnitude of change (criteria in table 2.2)	Impact level (criteria in table 2.3)	Could landscape screening reduce impact?	Revised impact level where relevant**
VP4 – 640 Orange Grove Road, Gunnedah	In moderate proximity to panels The view is from a private home, with closer views from front of property Trees around home would partially screen views Due to low elevation, coupled with side view of panels, it would mean panels likely difficult to discern from house Substation over 2km away	2.1km	2.1km	South, side view	Moderate	Low	Low-moderate		
VP5 – 640 Orange Grove Road, Gunnedah	In moderate proximity to panels The view is from a private home, with closer views from front of property Trees around home would partially screen views Due to low elevation, coupled with side view of panels, it would mean panels difficult to discern from house Substation over 2km away	2.2km	2.2km	South, side view	Moderate	Low	Low-moderate		
VP6 – 851 Orange Grove Road, Gunnedah	In moderate proximity to panels The viewpoint is a private home with mostly unimpeded views Due to low elevation, coupled with generally a side/rear view of panels, it would mean panels difficult to discern from house Substation over 2km away	1.7km	2km	East, front (morning) & rear view(after noon)	Moderate	Low	Low - moderate		

VIEWPOINTS	Analysis (on base case of no landscape screening)	Distance to nearest view of panels	Distance to substation	Position in relation to panels	Sensitivity (criteria in table 2.1)	Magnitude of change (criteria in table 2.2)	Impact level (criteria in table 2.3)	Could landscape screening reduce impact?	Revised impact level where relevant**
VP7 – 875 Orange Grove Road, Gunnedah	In moderate proximity to panels The viewpoint is a private home with mostly unimpeded views Due to low elevation only outer edge of panels (front in the morning)would be visible Substation over 2km away	1.5km	2.1km	East, front (morning) & rear view(after-noon)	Moderate	Moderate	Moderate		
VP8 – 254 Tudgey Road, Kelvin	In moderate proximity to panels The viewpoint is a private home with mostly unimpeded views Slightly higher in elevation so some views over broader solar farm with front of some panels seen in afternoon, and mostly rear of panels in morning	1.55km	4.5km	North – front (after-noon) & rear (morning)	Moderate	Moderate	Moderate		
VP9* – 616 Tudgey Road, Kelvin	In moderate proximity to panels The viewpoint is a private home with mostly unimpeded views (new house under construction) House location approximately 15m higher in elevation than solar farm so would therefore have elevated views and see a portion of front face of panels at different times of the day At times could see a 'mirage' or 'shimmering' effect	1.8km	4km	North – generally a side view, with front face of some panels seen at different times	High (due to elevation)	Moderate	Moderate - high	Yes	Moderate

VIEWPOINTS	Analysis (on base case of no landscape screening)	Distance to nearest view of panels	Distance to substation	Position in relation to panels	Sensitivity (criteria in table 2.1)	Magnitude of change (criteria in table 2.2)	Impact level (criteria in table 2.3)	Could landscape screening reduce impact?	Revised impact level where relevant**
VP10 – 897 Orange Grove Road, Gunnedah	In moderate proximity to panels The viewpoint is a private home with mostly unimpeded views Due to low elevation only outer edge of panels (front in the morning) and substation would be visible Substation over 2km away	2.0km	2.4km	East, front (morning) & rear view(after-noon)	Moderate	Low	Low-moderate		
VP13* – 691 Tudgey Road, Kelvin	In moderate proximity to panels The viewpoint is a private home with mostly unimpeded views House approximately 30m higher in elevation than solar farm so would therefore have elevated views and see a large portion of front of panels mostly in morning At times could see a 'mirage' or 'shimmering' effect in mostly in morning	2.2km	4.5km	North – slightly front view (morning) & generally rear view (afternoon)	High	Moderate	Moderate-high	Yes	Moderate
VP14 – 554 Kelvin Road, Gunnedah	The viewpoint is a private home with some intervening trees Due to low elevation only outer edge of front of panels (in afternoon) would be visible yet at some distance	2.7km	5km	West, side view	Low	Low	Low		
VP15 – 88 Orange Grove Road, Gunnedah	The viewpoint is a private home surrounded by some trees Due to low elevation only outer edge of panels (front in afternoon) and substation would be visible (yet barely discernible if at all)	5.3km	5.3km	West, side view	Low	Low	Low		

VIEWPOINTS	Analysis (on base case of no landscape screening)	Distance to nearest view of panels	Distance to substation	Position in relation to panels	Sensitivity (criteria in table 2.1)	Magnitude of change (criteria in table 2.2)	Impact level (criteria in table 2.3)	Could landscape screening reduce impact?	Revised impact level where relevant**
VP16* – 526 Tudgey Road, Kelvin	In moderate proximity to panels The viewpoint is a private home with mostly unimpeded views House approximately 8m higher in elevation than solar farm so would therefore have slightly elevated views and see a moderate portion of front of panels (mostly in afternoon) At times could see a 'mirage' or 'shimmering' effect, yet only narrow band seen	2.1km	4.5km	North – generally a side view, slight view of front in afternoon	Moderate	Moderate	Moderate	Yes	Moderate or lower
VP17* – 516 Tudgey Road, Kelvin	In moderate proximity to panels The viewpoint is a private home with mostly unimpeded views House approximately 25m higher in elevation than solar farm so would therefore have elevated views and see a large portion of mostly side of panels all day	2.4km	4.5km	North – generally a side view	Moderate	Moderate	Moderate	Yes	Moderate or lower
VP18 – 413 Tudgey Road, Kelvin	The viewpoint is a private home with mostly unimpeded views House approximately 10m higher in elevation than solar farm so would therefore have elevated views and see a moderate portion of front of panels (mostly in afternoon) At times could see a 'mirage, or 'shimmering' effect Distant views towards substation	2.6km	5km	North – generally a side view, slight view of front in afternoon	Moderate	Low	Low-moderate		

VIEWPOINTS	Analysis (on base case of no landscape screening)	Distance to nearest view of panels	Distance to substation	Position in relation to panels	Sensitivity (criteria in table 2.1)	Magnitude of change (criteria in table 2.2)	Impact level (criteria in table 2.3)	Could landscape screening reduce impact?	Revised impact level where relevant**
VP21 – 538 Orange Grove Road, Gunnedah	The view is from a private home, with closer views from front of property Trees around home would partially screen views Due to low elevation the Proposal would be difficult to discern from the house	2.4km	2.4km	South, rear view	Moderate	Low	Low - moderate		
VP22 – 351 Tudgey Road, Kelvin	The viewpoint is a private home with mostly unimpeded views House approximately 15m higher in elevation than solar farm so would therefore have elevated views and see a moderate portion of front of panels (in afternoon) yet due to position only over a narrow band At times could see a 'mirage' or 'shimmering' effect	3km	5.5km	North - west, rear view (morning), slight view of front in afternoon	Low	Low	Low		
VP23 – 415 Tudgey Road, Kelvin	The viewpoint is a private home with mostly unimpeded views House approximately 50m higher in elevation than solar farm so would therefore have elevated views and see a moderate portion of front of panels (in afternoon) yet due to position only over a narrow band At times may see a 'mirage' 'shimmering' effect	3.3km	5.7km	North – generally a side view, slight view of front in afternoon	Low (due to elevation)	Moderate (due to elevation)	Moderate		
VP24 – 632 Kelvin Road, Gunnedah	The viewpoint is a private home surrounded by some trees Due to low elevation, distance and trees there would be a low chance of discernible views.	3.3km	5.4km	West, rear in morning, front on afternoon	Low	Low	Low		

VIEWPOINTS	Analysis (on base case of no landscape screening)	Distance to nearest view of panels	Distance to substation	Position in relation to panels	Sensitivity (criteria in table 2.1)	Magnitude of change (criteria in table 2.2)	Impact level (criteria in table 2.3)	Could landscape screening reduce impact?	Revised impact level where relevant**
VP26 – 242 Orange Grove Road, Gunnedah	The viewpoint is a private home surrounded by some trees Due to low elevation only outer edge of panels and substation would be visible (yet barely discernible)	4.1km	4.1km	West, rear in morning, front in afternoon	Low	Low	Low		
VP27 – 224 Orange Grove Road, Gunnedah	The viewpoint is a private home surrounded by some trees Due to low elevation only outer edge of panels and substation would be visible (yet barely discernible)	3.9km	3.9km	West, rear in morning, front in afternoon	Low	Low	Low		

*Photomontages provided of VP in Section 8.0 **Impact levels only revised where initial impact level moderate to high or higher

8. Photomontages

Photomontages (simulated images) have been prepared for VP1, VP9, VP16, VP17 and VPOGR (Orange Grove Road) (refer **Figure 8-1**). Some photomontage locations were explicitly selected due to the potential visual impact level (such as VP1, VP9 and VP13), whilst others (such as VP16 and VP17) were prompted by concerns raised by landholders, and VPOGR was selected due to the potential for views from this public road.

For each viewpoint the following images are provided:

- Existing view from VP (viewpoint) toward Proposal
- Analytical image of potential visibility of Proposal from VP
- Photomontage of likely view from VP toward Proposal post-construction
- Photomontage of likely view from VP toward Proposal with landscape screening five (5) years following construction. Note it has been assumed that a height of some 5-7m of dense vegetation would be achievable in that timeframe. More detail is provided in **Section 9-1**.

In some locations the photographs are not taken from right at the residence, yet the images are generally representative of the views that would be seen. It is acknowledged that it is not feasible to illustrate all views. By necessity the photomontages represent a momentary point in time, and for consistency illustrate the position of the panels at approximately 9.00am, which would be a 'worst case' scenario for the most-affected residents (i.e. those to the east and north), as the panels would be partially facing in their direction.

The following discusses the general outcomes illustrated by the photomontages for each viewpoint (refer **Figures 8-2 to 8-25,** consolidated at the end of this section).

8.1 Viewpoint (VP) 1 photomontages

VP1 is the closest residence to the Proposal, located some 800m away. The house is slightly higher (several metres) in elevation so without landscape screening there would be some views over the Proposal. The rear and side view of the panels would be evident. The assessed visual impact level, without landscape screening, was assessed at moderate-high.

The photomontages illustrate the potential effectiveness of landscape screening, and on that basis, the visual impact level with landscape screening has been revised down to moderate.

FIGURE 8-1

Photomontage locations

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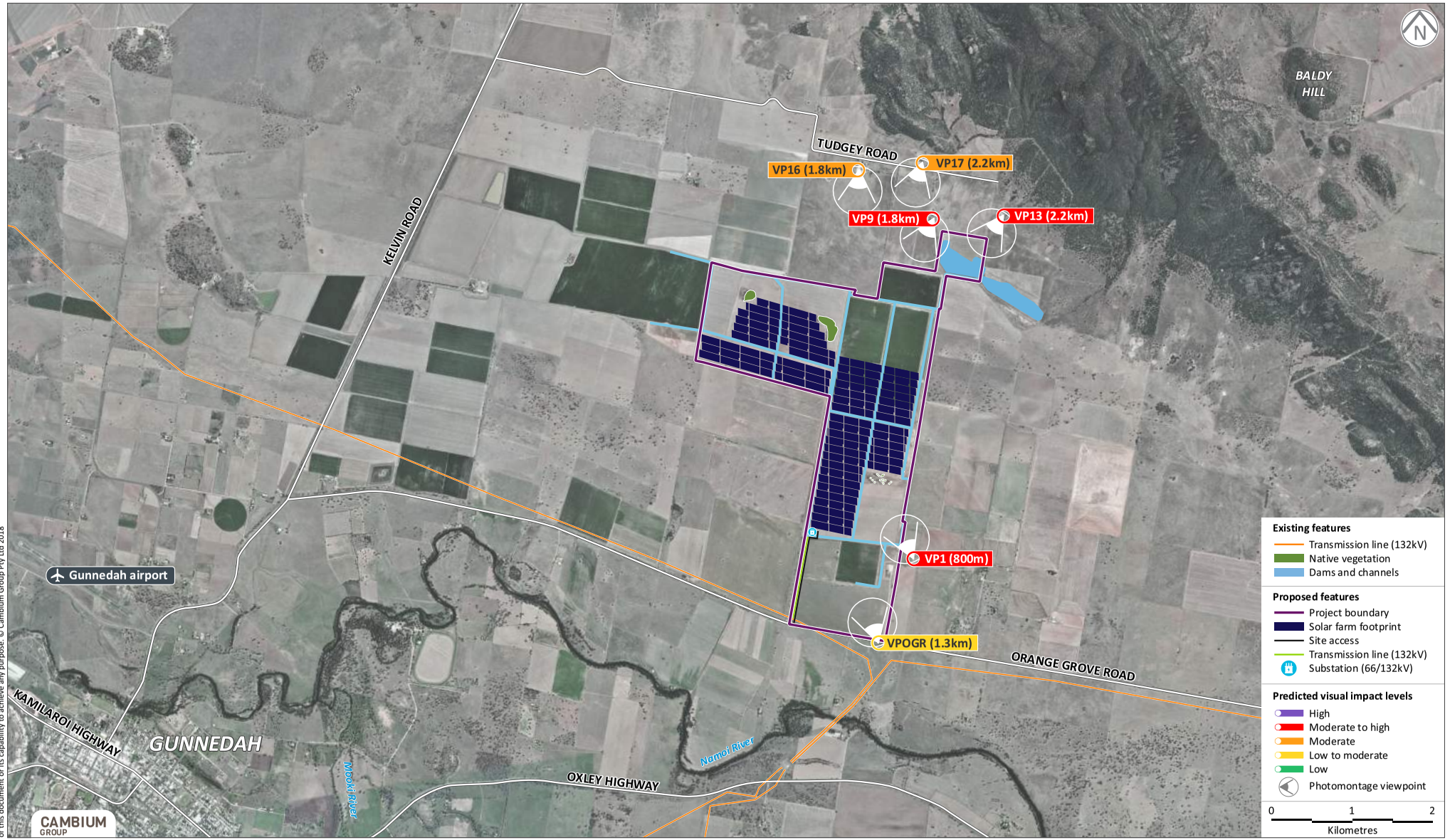

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8.2 Viewpoint (VP) 9 photomontages

The residence of VP9 is in moderate proximity to panels, located some 1.8km away. The house is approximately 15m higher in elevation than the Proposal and so there would be elevated views of a large portion of the front of the solar panels. As the panels turn, a portion of the front face of panels would be seen at different times of the day (refer **Figure 5-4** (Section 5.0) for an image of Royalla Solar Farm which shows a similar effect where some panels are seen from the front, and some from the rear in shade).

At times a 'mirage' or 'shimmering' effect could be evident mostly in the morning. The assessed visual impact level, without landscape screening, was assessed at moderate-high.

It is noteworthy that the photomontages show part of the panel area as being of a white or silver colour. That is due to the slight elevation of this viewpoint, which means that the top silver rim of a many individual panels can be seen as the panels extend into the distance.

The photomontages illustrate the potential effectiveness of landscape screening along the northern boundary of the Site, whilst still permitting the residents to see broad views across the wider rural landscape. Even if trees obtain a likely mature height of 15-20m these distant views would still be possible. On that basis, the visual impact level with landscape screening has been revised down to moderate.

8.3 Viewpoint (VP) 13 photomontages

The residence of VP13 is in moderate proximity to panels, located some 2.2km away. The house is approximately 15m higher in elevation than the Proposal and so there would be elevated views of a large portion and so there would be elevated views of a large portion of the solar panels, with an overall width of approximately 2.75km seen. As the panels turn, a portion of the front face of panels would be seen, mostly in the morning (refer **Figure 5-4** (Section 5.0) for an image of Royalla Solar Farm which shows a similar effect where some panels are seen from the front, and some from the rear in shade). At times a 'mirage' or 'shimmering' effect could be evident mostly in the morning.

The assessed visual impact level, without landscape screening, was assessed at moderate-high.

It is noteworthy that the photomontages show part of the panel area as being of a 'white' or 'silver' colour. That is due to the slight elevation of this viewpoint, which means that the top silver rim of a many individual panels can be seen as the panels extend into the distance.

The photomontages illustrate the potential effectiveness of landscape screening along the northern boundary of the Proposal, whilst still permitting the residents to see broad views across the wider rural landscape. On that basis, the visual impact level with landscape screening has been revised down to moderate.

8.4 Viewpoints (VP) 16 photomontages

The residence of VP16 is in moderate proximity to the panels yet only slightly elevated, being approximately 8m higher. From the house a large portion of the panels would be seen, yet the depth of view would be narrow (i.e. the panels would appear as a thin band). As the panels turn, part of the front face of the panels would be seen, mostly in the afternoon (refer **Figure 5-4** (Section 5.0) for an image of Royalla Solar Farm which shows a similar effect where some panels are seen from the front, and some from the rear in shade). Due to the narrowness of the portion seen, any potential 'mirage' or 'shimmering 'effect would be unlikely. The assessed visual impact level, without landscape screening, was assessed at moderate.

The photomontages illustrate the potential effectiveness of existing trees along the northern boundary of the Proposal, and that the additional proposed landscape screening would be effective in further reducing views. On that basis, the visual impact level with landscape screening has been revised down to moderate or less.

8.5 Viewpoints (VP) 17 photomontages

The residences of VP17 is in moderate proximity to the panels and substantially higher, being elevated by approximately 25m. As the panels turn, a large portion of mostly the side of the panels would be seen all day. There would be a low potential for a 'mirage' or 'shimmering' effect. The assessed visual impact level, without landscape screening, was assessed at moderate.

The photomontages illustrate the potential effectiveness of existing trees along the northern boundary of the Proposal, and that the additional proposed landscape screening would be effective in further reducing views. On that basis, the visual impact level with landscape screening has been revised down to moderate or less.

8.6 Viewpoints (VP) OGR (Orange Grove Road) photomontages

VPOGR is the representative of the closest public location from where the Proposal could be seen, with that being approximately 1km away, including the substation. The visual impact to viewpoints from Orange Grove Road was assessed as low-moderate as described in **Section 7.2.2**, largely due to: the flat terrain between the road and the substation; the separation distance; that the panels would be seen from the rear and/or side view; and the mostly low height of the substation. That assessment is supported by the photomontage images and hence no landscape screening has been recommended in association with this viewpoint.

FIGURE 8-2

Viewpoint 1 - Existing view

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FIGURE 8-3

VP1 - Analytical view of likely visibility of Proposal

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FIGURE 8-4

VP1 – Photomontage of likely view of Proposal post construction

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FIGURE 8-5

VP1 – Photomontage of likely view of Proposal with landscape screening 5 years after construction

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FIGURE 8-6

VP9 – Existing view

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FIGURE 8-7

VP9 - Analytical view of likely visibility of Proposal

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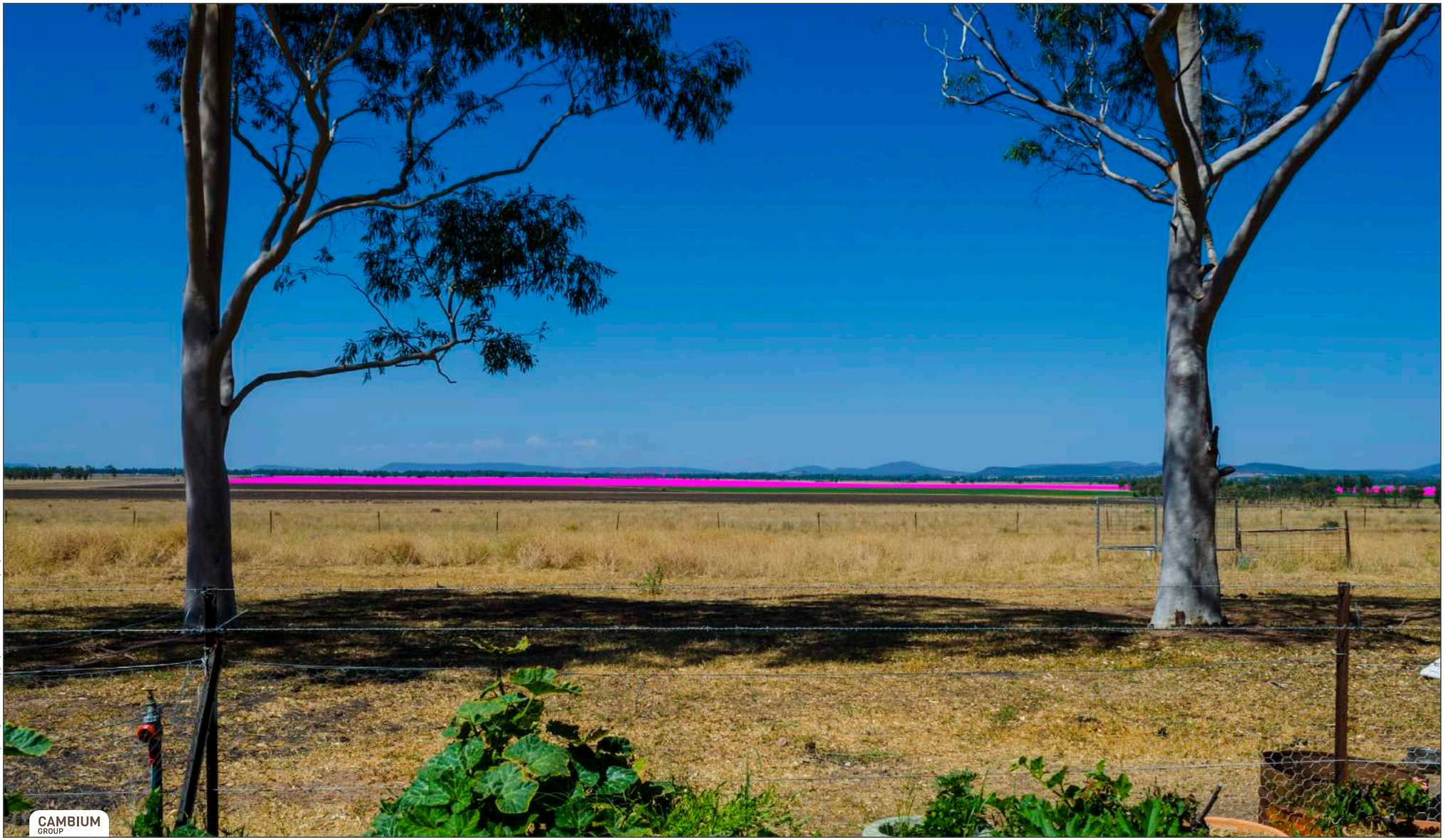

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FIGURE 8-8

VP9 – Photomontage of likely view of Proposal post construction

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FIGURE 8-9

VP9 – Photomontage of likely view of Proposal with landscape screening 5 years after construction

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FIGURE 8-10

VP13 – Existing view

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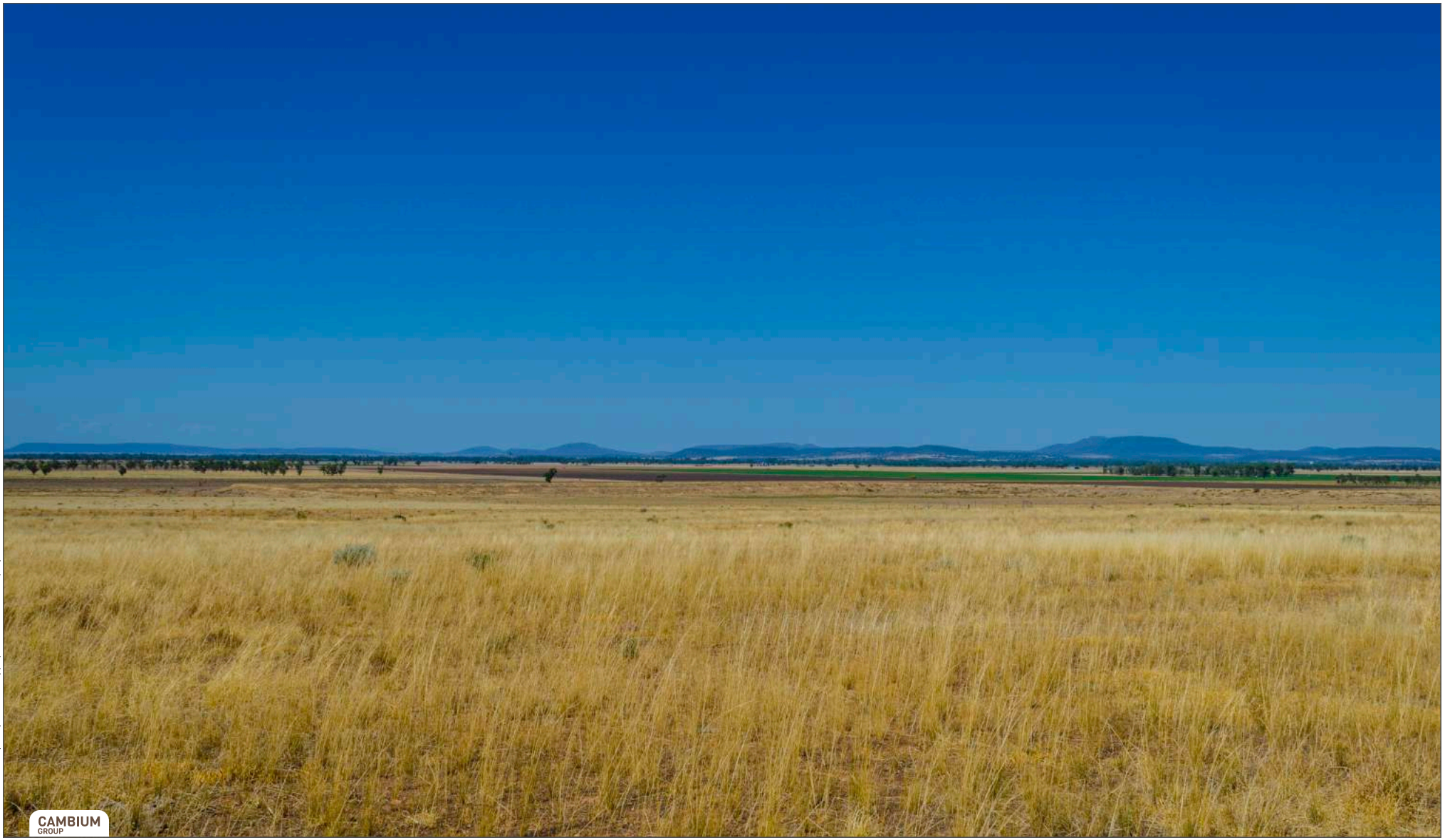

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FIGURE 8-11

VP13 - Analytical view of likely visibility of Proposal

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT

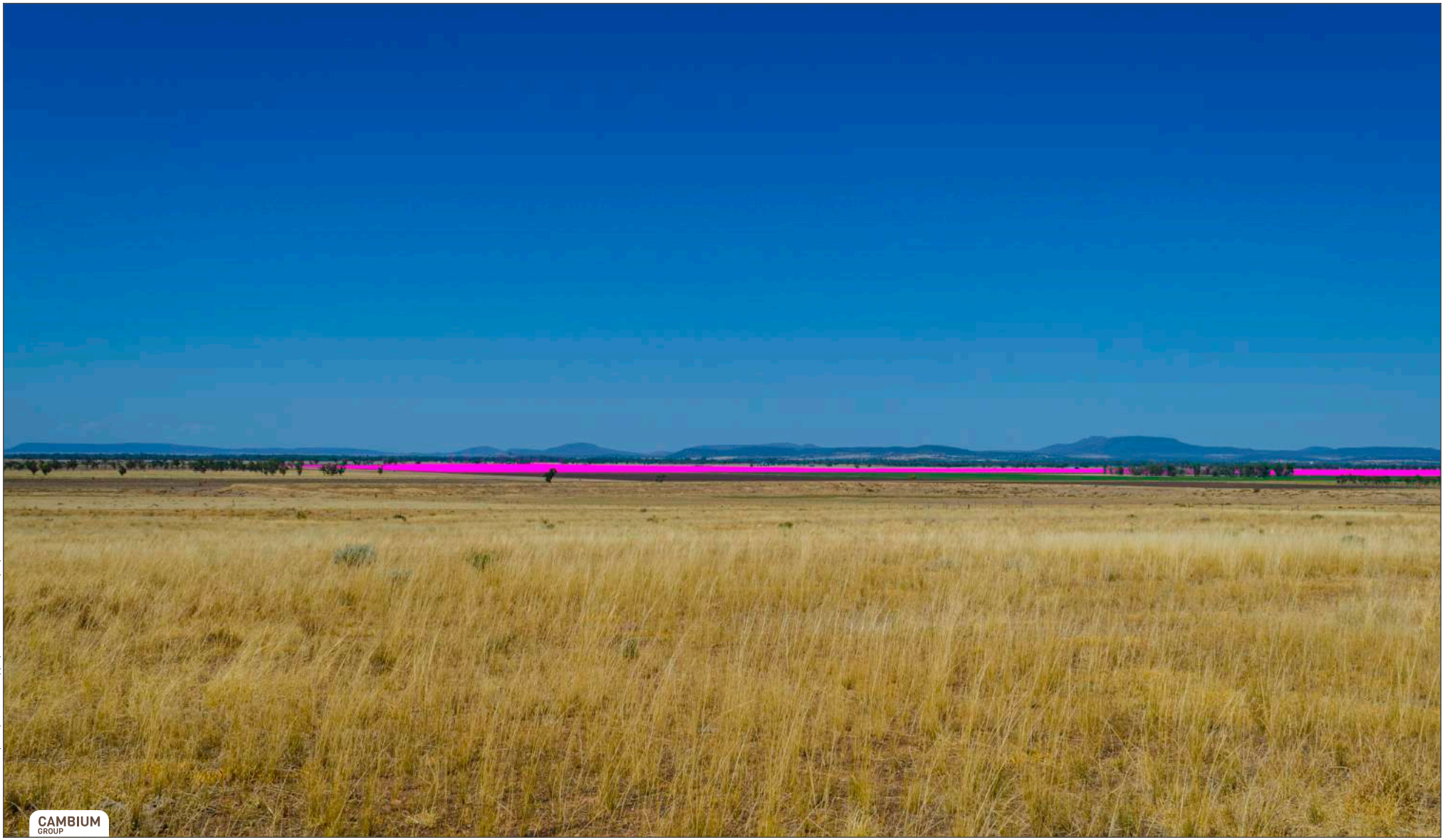

FIGURE 8-12

VP13 – Photomontage of likely view of Proposal post construction

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT

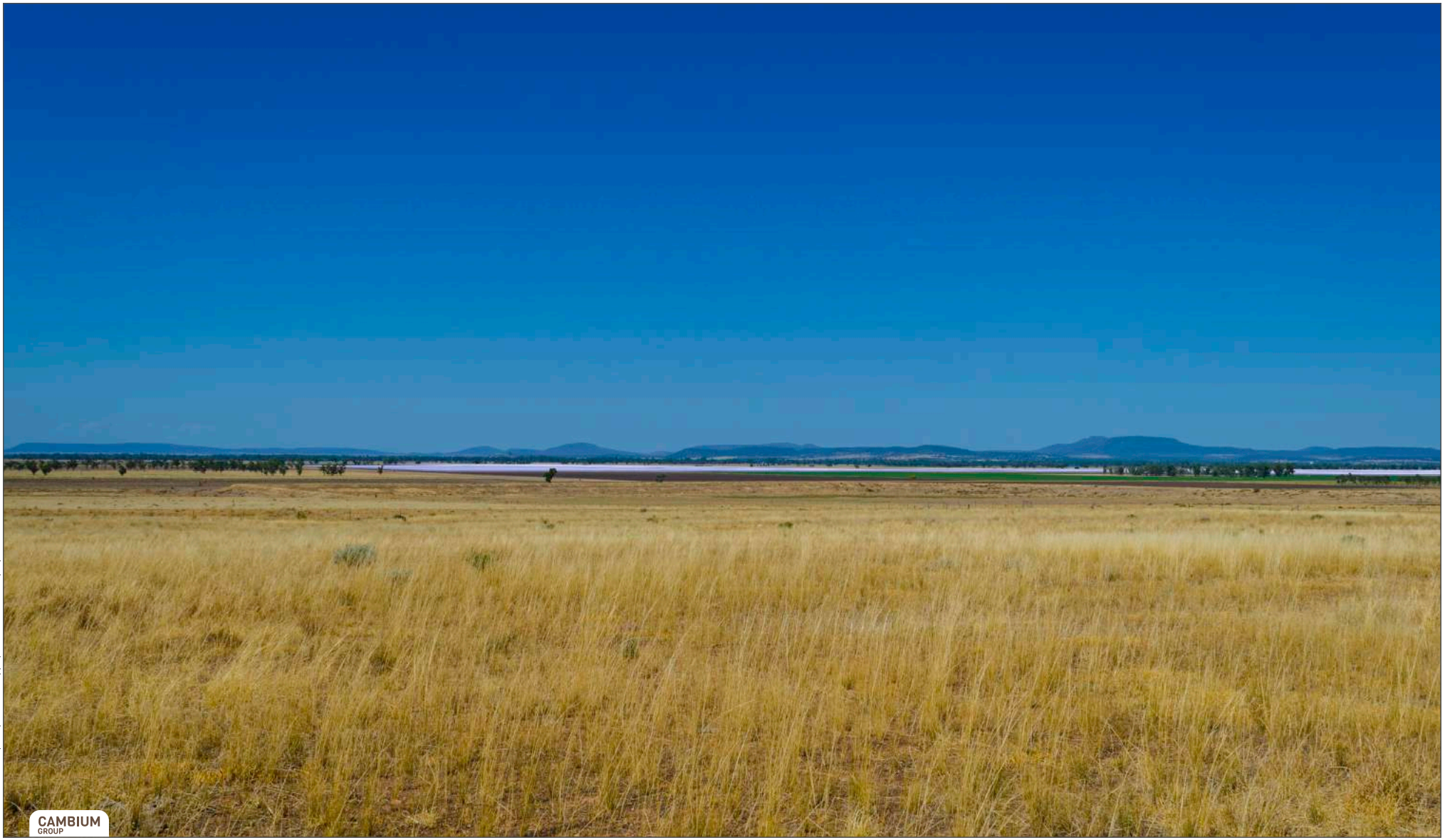

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FIGURE 8-13

VP13 – Photomontage of likely view of Proposal with landscape screening 5 years after construction

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT

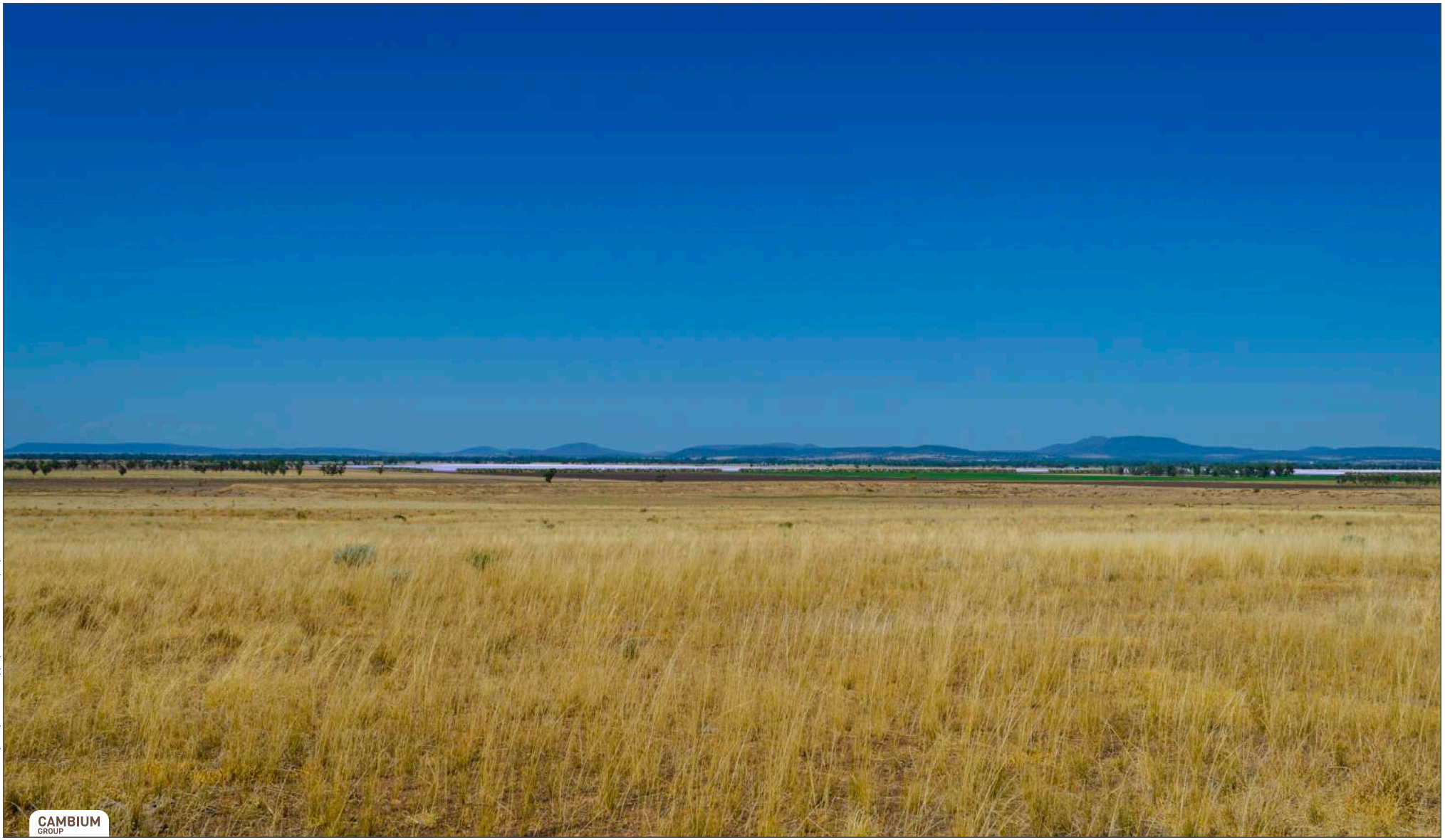

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FIGURE 8-14

VP16 – Existing view

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FIGURE 8-15

VP16 - Analytical view of likely visibility of Proposal

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FIGURE 8-16

VP16 – Photomontage of likely view of Proposal post construction

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FIGURE 8-17

VP16 – Photomontage of likely view of Proposal with landscape screening 5 years after construction

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FIGURE 8-18

VP17 – Existing view

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FIGURE 8-19

VP17 - Analytical view of likely visibility of Proposal

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FIGURE 8-20

VP17 – Photomontage of likely view of Proposal post construction

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FIGURE 8-21

VP17 – Photomontage of likely view of Proposal with landscape screening 5 years after construction

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FIGURE 8-22

VP OGR (Orange Grove Road) – Existing view

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FIGURE 8-23

VP OGR (Orange Grove Road) - Analytical view of likely visibility of Proposal

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FIGURE 8-24

VP OGR (Orange Grove Road) – Photomontage of likely view of Proposal post construction

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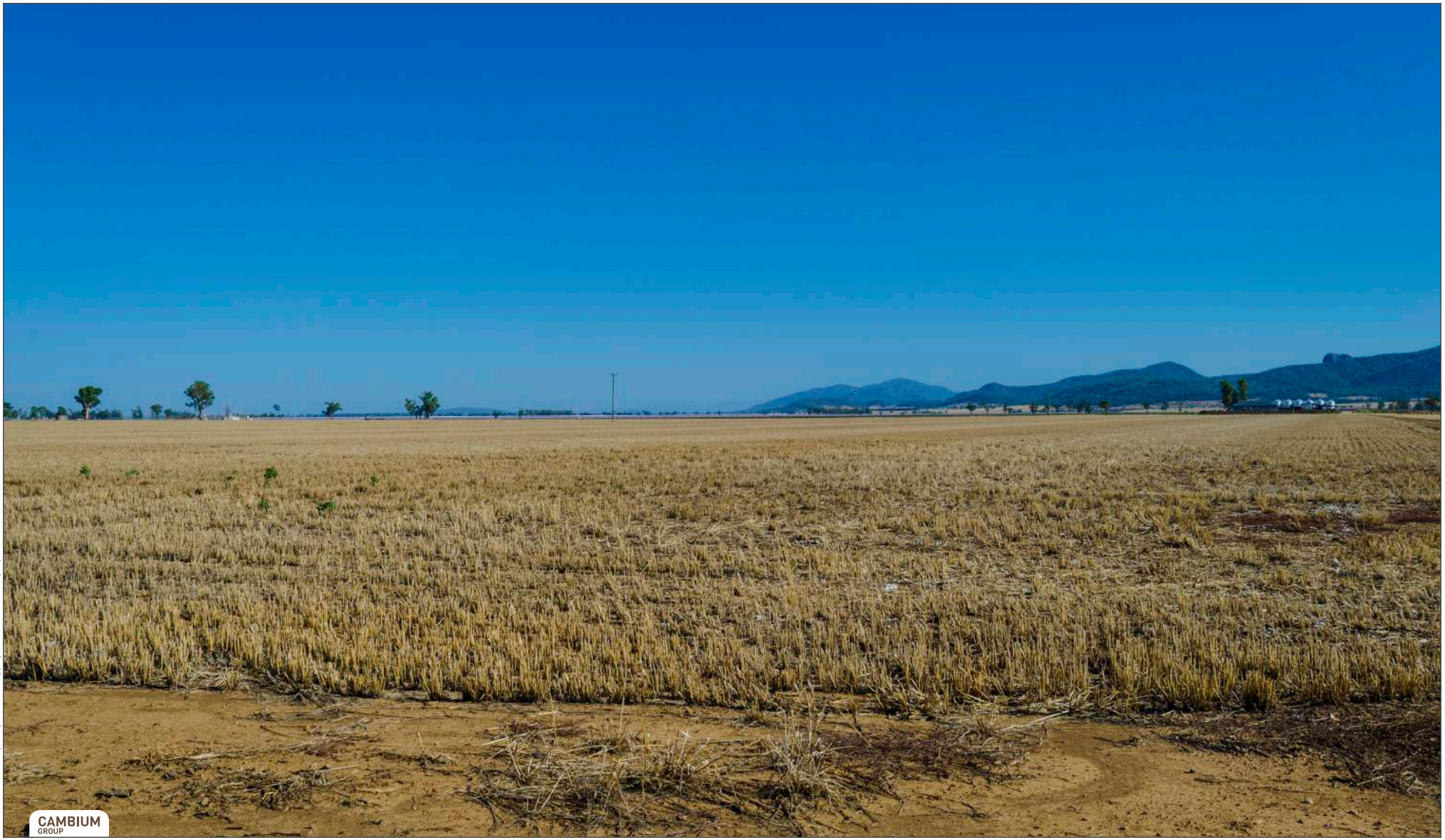

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FIGURE 8-25

VP OGR (Orange Grove Road) – Photomontage of likely view of Proposal with landscape screening 5 years after construction

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT

9. Mitigation

This section specifies mitigation measures to avoid, reduce, or compensate for potential landscape character and visual impacts of the Proposal.

9.1 Best practice

Visual impact mitigation for solar PV farms includes a range of measures that could be undertaken to avoid, reduce or compensate for potential impacts. The following is a list of best practices applicable to PV solar facilities when considering potential mitigation options[17]:

1. Minimise impact through use of design features (refer also to 'vegetation screening' in sidebar at **Section 9-3**)
2. Minimise and repair ground disturbance
3. Site facilities away from most prominent land features (locate in less prominent locations and away from focal points)
4. Avoid night sky impacts
5. Site facilities in already disturbed landscapes or clearings
6. Increase distance to reduce visual dominance
7. Use site-specific location and topographic features to reduce visibility
8. Use colour to reduce contrast
9. Monitor visual issues.

9.2 Existing measures and proposed mitigation

The Proposal already features a number of elements that serve to mitigate potential landscape character and visual impacts to key viewpoints. **Table 9-1** lists the best practices, the positive features of the Proposal, and additional mitigation measures which are recommended to further reduce landscape character and visual impacts.

Landscape screening implications

The nature of solar farms means that it is desirable to maximise the exposure of sunlight to the PV panels. That means that screen planting close to the northern, eastern and western sides of the solar farm is usually not preferred as such screening can shade the panels during part of the day, with that effect obviously most pronounced when trees are on the northern side and during winter months. Recommended mitigation measures have taken that into account and where possible generally avoided any landscape screening where shading would result, unless it is determined that such landscape screening would have substantial benefits in terms of reducing visual impacts.

[17] Adapted from Apostol, D. 2017 (180)

Any proposed landscape screening also needs to consider the implications of any bushfire restrictions which could affect the suitability of different types of plant species, screening locations and planting densities. For the Proposal, a 20m wide APZ has been adopted, which based on a maximum height of 20m for established and new tree screening, that would be sufficient to not cause shading.

A Concept Landscape Plan has been provided (refer **Figure 9-1**) which identifies strategic locations for landscape screening to reduce any visual impacts.

9.3 Discussion of specific mitigation options for the most-affected viewpoints

The Concept Landscape Plan (refer **Figure 9-1**) identifies areas recommended for landscape screen planting to specifically address the potential impact to residents at the most-affected three properties, that being those with a predicted moderate - high impact level: VP 1 (house to east) and VP 9 and VP13 (elevated houses to north) (refer **Table 8-2**). It is to be noted that discussions were also held with the residents of VP-16 and VP-17, both of which were identified as having a moderate impact rating? yet were held as those residents had expressed concern in regard to visual impacts. Photomontages were prepared to illustrate potential impacts and mitigation for all of those properties, as described previously in **Section 8.0**.

The predicted result of landscape screening after a period of approximately five years, which assumes a conservative growth height of 5 -7m, shows that landscape screening would screen a large proportion of the solar farm from those viewpoints, and would importantly reduce the predicted level from VP1, VP9 and VP13 from moderate-high to moderate. There would also be a reduced impact to other properties to the north as a result of proposed landscape screening.

Vegetation Screening

Vegetation, typically trees, may screen views fully or partially, especially close to the viewpoint*. But in many cases, vegetation is not tall enough to screen views of large-scale infrastructure. Such infrastructure extends over a wide area of land, and, particularly if viewpoints are elevated, vegetation is not sufficient to block or even reduce views. However, in some instances, where elevation is favourable, it would be possible to plant trees of adequate height and density, within a wide planting area, to minimise or even eliminate some views.

* United States Department of the Interior. 2013. *Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands.* Bureau of Land Management.

FIGURE 9-1

Concept landscape plan

GUNNEDAH SOLAR FARM - VISUAL IMPACT ASSESSMENT

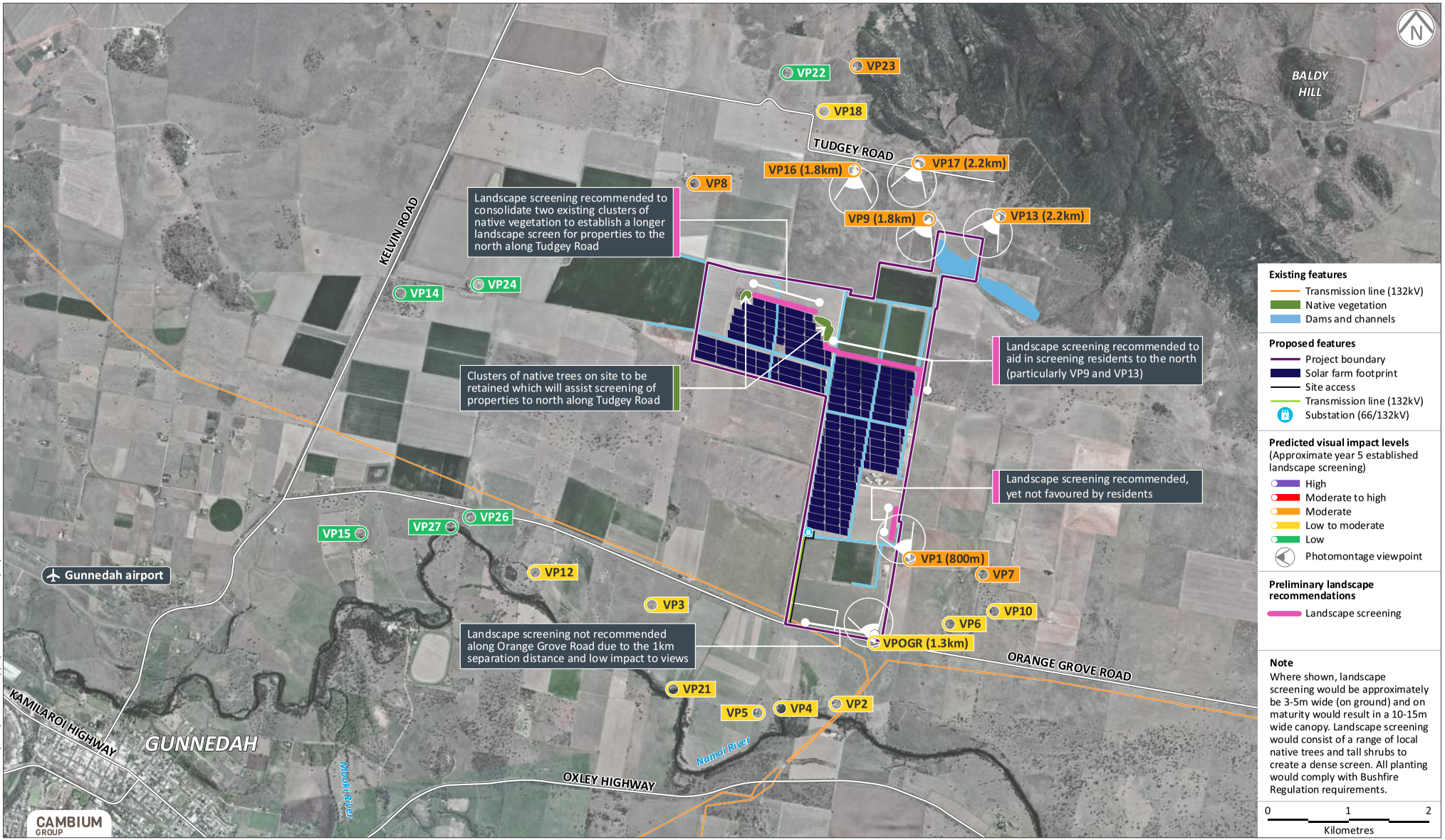

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TABLE 9-1: GENERAL MITIGATION MEASURES OF THE PROPOSAL

Best-practice	Existing positive measures within the Proposal	Additional measures recommended
1. Minimise impact through use of siting and design features	- The proposed solar farm has been located in a rural area with a small local population, and limited visual exposure due to the dominant flat terrain - There are only a few elevated viewpoints to the Site - The Site is located along a local road generally only accessed by residents and visitors to local properties - The panels are not perpendicular to the road (avoiding dynamic visual changes in panel angles for the viewer when driving past at speed) - the solar farm has a low profile with panels a maximum height of 3m - The surface of the panels would be non-reflective - A Concept Landscape Plan has been prepared (refer to **Figure9-1**) to provide screening where likely to reduce visibility. - The Proposal would avoid waterways and existing vegetation. - A buffer of 40m would be provided between infrastructure and any natural waterway - A 10m buffer would be provided from the Site boundaries.	Prior to construction: - Use Concept Landscape Plan to discuss landscape screening with surrounding relevant residents, particularly if on their property. Refine and detail planting Proposal in a Detailed Landscape Plan. - Check vegetative screening plans with local authorities to reduce potential for fire risk by introducing an additional fuel source. Construction: - Group ancillary facility structures where possible to minimise sprawl. - Stabilise new access tracks formed within the Site required for operations, but do not seal with bitumen or other dark coating - Locate the construction compound and storage areas away from Orange Grove Road. Operation: - Do not install commercial messages, or large-scale signage. Signage required at the Site should be of sufficient size to be readable at driver height within short range (0-20m) and contain only information sufficient for basic facility and company identification, for safety, navigation, and delivery purposes. - Keep Site tidy and neat, remove weeds, and undertake necessary repairs

Best-practice	Existing positive measures within the Proposal	Additional measures recommended
2. Minimise and repair ground disturbance	- The Proposal is located within an area already mostly cleared of trees - The Proposal would require minimum cut and fill - Trenches for cabling would be backfilled as soon as possible - Installation of the panels are on pile driven mounts, foundations are not required.	Construction: - Minimise grading across the Site and undertake the minimum levelling necessary to install panel supports - Rehabilitate exposed ground surfaces as soon as possible - Implement dust and wind erosion controls to avoid visual issues associated with dust. E.g.: water cart on site; avoid ground disturbance on high wind days; water exposed surfaces; cover stockpiles - Implement erosion and sediment controls to avoid visual issues associated with erosion and water pollution.
3. Site facilities away from most prominent land features (locate in less prominent locations and away from focal points)	- There are no prominent features on the Site.	
4. Avoid night sky impacts	- The Proposal would not be operated at night. Lighting is not anticipated to be required unless in emergency situations.	Operations: - Undertake maintenance activities (such as cleaning the panels and other routine tasks) during daylight hours - Use amber lighting if lights are required, rather than bluish-white lighting
5. Site facilities in already disturbed landscapes or clearings	- The panels and ancillary infrastructure would be located in already cleared areas.	Construction:

Best-practice	Existing positive measures within the Proposal	Additional measures recommended
	- Minimal Tree clearing is required (no more than 20 trees)	- Retain existing grass cover beneath solar panels and supports if possible to do so safely, and not interfering with facility management Decommissioning: Development of a remediation plan to include: - recontour, cultivate, seed, and stabilise the majority of disturbed surfaces with pasture grass species following the removal of infrastructure - re-establish any previously removed native vegetation with appropriate, similar species.
6. Increase distance to reduce visual dominance	The nearest part of the solar farm is set-back approximately 1km from Orange Grove Road, and 820m from the nearest resident to the east (VP1). During consultation with residents the set-back to residents to the north, where some elevated views would be possible was increased by over 600m (to the nearest elevated resident VP9) to further reduce potential visual impact, giving an overall separation of some 1.8km.	
7. Use site-specific location and topographic features to reduce visibility	Retaining and protecting the majority of the limited vegetation on Site is a mitigation feature of the Proposal.	Construction: - Protect the existing vegetation to be retained. Install temporary fencing around vegetation and demarcate as a no-go zone. No storage or equipment, stockpiling or disturbance is to occur within the zone.

Best-practice	Existing positive measures within the Proposal	Additional measures recommended
8. Use colour to reduce contrast	PV panels treated with a non-reflective finish	Construction: - Treat the support structures of PV panels and ancillary structures such as inverters with a non-reflective finish - Paint or colour-treat facility components to better match the surroundings and decreasing their visibility and contrast (particularly inverters and inverter stations). Choose a colour two to three shades darker than the background colour. Dark grey is generally considered a good colour for ancillary infrastructure. Do not paint components white unless there is a safety or functional requirement to do so. White is generally the most conspicuous colour. Lighter colours should be avoided. - Specify substation to have a low-reflectivity, neutral colour finish. Insulators at substations should be non-reflective and non-refractive. Choose a colour for the substation surfaces two to three shades darker than the background colour. As the substation is located near a line of trees, a deep green or dark grey may be suitable. Operation: - Keep non-reflective finishes and colour-treated coatings in good repair. Reapply if surface is subject to fading or flaking.
9. Monitor visual impact 10.		Operation: - At least twice within the first year contact the nearest residents to the facility to determine if visual issues are being experienced

Best-practice	Existing positive measures within the Proposal	Additional measures recommended
		- Monitor performance of screen planting areas six-monthly for first three years then annually. Replant as necessary if plants die, and supplement planting with alternative species if plants are not adapting to the Site. Ensure density and growth is satisfactory to achieve screening effect, re-assess after first three years and consider alternatives if unsuccessful result achieved. - Record complaints of visual issues - Discuss possible remedies for visual issues with the resident or complainant - Take meaningful action to remedy visual issues. For example: o introduce additional planting to screen views, o colour treat ancillary site infrastructure, or o install fabric-covered screening fences to reduce views from particular viewpoints

10. Cumulative impacts

Cumulative visual effects occur as we move through the landscape. The combined effects from the Proposal with other past, present, and likely future projects or activities.

It is understood that other solar PV farms are proposed at:

- Ironbark Energy Solar Farm – 27 megawatt solar farm with 90,000 PV panels. The farm will be located approximately 4.5km west of the Gunnedah town centre.
- Orange Grove Sun Farm - a large-scale solar photovoltaic (PV) generation facility and associated infrastructure with estimated installed capacity in the order of 110 MW, generated by approximately 330,000 PV solar panels. This Site is immediately to the east of the Proposal.

The following conclusions are made in terms of potential cumulative visual impact:

- Due to the location of the proposed Ironbark Energy Solar Farm it would be unlikely to be seen by the same residents as would see either the Proposal or the Orange Grove Solar Farm.
- It is understood that it is planned that both the Proposal and the Orange Grove Solar Farm would not be given approval, therefore there would be no cumulative visual impact for the nearest residents.
- Should the Proposal and the Ironbark Energy Solar Farm both be realised, it would be possible to see both within the same day, or the same journey, as the sites are within approximately 10km of each other.

It is possible that the location of two large solar farms around the town of Gunnedah may increase the landscape character and visual impacts for some transient viewers, such as those travelling around the area and residents living within it. The cumulative visual impact is suggested to be a slightly increased overall impact than any one solar farm.

11. Conclusion

11.1 NSW State Government's draft Large Scale Solar Energy Guideline

The *NSW State Government's draft Large Scale Solar Energy Guideline* lists the key visual factors to be taken into account when considering the likely impact of solar energy developments. The key visual factors from the Guideline, together with the findings from this assessment, have been presented in **Table 11-1.**

Note that the guideline is quite detailed, so for the purposes of this conclusion, **Table 11-1** concentrates on the key aspects. This report provides a detailed assessment of all potential visual impact concerns.

TABLE 11-1: APPLICATION OF DRAFT LARGE SCALE ENERGY GUIDELINE

Relevant component of Guideline	Visual consideration from Guideline that may assist in minimising localised impacts:	Finding from this assessment
Site characteristics	▪ land that does not contain native vegetation or has previously been cleared and utilised for industrial – type purposes (brown field sites) in rural settings	▪ The proposed Site is mostly cleared, within a rural setting and has been used for agricultural purposes. The majority of the limited existing native vegetation would remain on site as part of the Proposal.
	▪ Unobtrusive sites with flat, low-lying topography	▪ The proposed Site has a flat landform and is low-lying. There are relatively few outside locations where there would be elevated views. Such views are from a small number of slightly elevated rural residences to the north.
	▪ Sites with potential to be screened, such as those that can be readily vegetated along boundaries, to reduce visual impacts	▪ Potential to be screened – there is potential to screen views from the limited number of rural properties to the north that have some slightly elevated views. A draft Concept Landscape Plan has been prepared in consultation with residents.

Site constraints	▪ sites with high visibility, such as those on prominent or high ground positions ('high visibility or prominence is of particular concern if the solar infrastructure at the site would be juxtaposed against significant scenic, historic or cultural landscape'), or sites which are located in a valley with residences with elevated views looking toward the site	▪ The Site has a relatively low visibility with the only elevated views possible from a small number of rural properties to the north (i.e. along Tudgey Road). The only publically-accessible location for slightly elevated views is from the local Tudgey Road. ▪ It is acknowledged that the Proposal would introduce a large -scale built element into this rural landscape, yet its low height, and colour and form are generally compatible with the dominant geometric patterns in this farmed area and views can be substantially screened from nearby viewpoints. ▪ The Site and its surrounds is a typical rural landscape type within this region and has not been identified as being a significant scenic, historic or cultural landscape.
Key assessment issues	The visual impact of solar energy development will depend on: ▪ the scale and type of infrastructure,	▪ The proposed infrastructure although being large in the extent of area covered is low-profile, with a maximum height about ground level of 3m
	▪ the prominence and topography of the site relative to the surrounding environment,	▪ The proposed Site has a flat landform and is not prominent relative to the surrounding environment.
	▪ and any proposed measures to screen or otherwise reduce visibility of the site.	▪ A draft Concept Landscape Plan has been prepared which proposes screening along the northern and eastern edges of the solar panels which would effectively screen the nearest properties with potential views, including those to the north and east. ▪ Further mitigation measures have been proposed, such as colour treating ancillary facilities, as set out in **Table 8.1**.

11.2 Summary of overall level of landscape character and visual impact

The assessment results of Impact to landscape character finds there would be a moderate impact.

The assessment results of visual impact to 22 potentially-affected private viewpoints finds that there are:

- No viewpoints with a high impact
- 3 viewpoints with a moderate – high impact (note that after five years, with the recommended landscape screening, it has been predicted that this impact level could fall to moderate for all three of these properties)
- 5 viewpoints with a moderate impact
- 8 viewpoints with a low – moderate impact

- 6 viewpoints with a low impact.

The assessment results of visual impact to public viewpoints finds that there would be:

- A low-moderate impact to views from Orange Grove Road
- A low-moderate impact to views from Tudgey Road
- A low impact to views from the Porcupine Hill lookout.

11.3 Cumulative impact

Two solar farms are currently proposed in the vicinity of the Proposal - Ironbark Energy Solar Farm (west of the Gunnedah town centre) and Orange Grove Sun Farm (on next door property).

It is possible that the location of two large solar farms around the town of Gunnedah may increase the landscape character and visual impacts for some transient viewers, such as those travelling around the area and living within it. The cumulative visual impact is suggested to be slightly increased should two solar farms be realised, yet it is understood that Proposal and the Orange Grove Sun Farm will not both receive approval.

11.4 Conclusion

This assessment concludes that the proposed Gunnedah Site is appropriate for the proposed solar development. The Site is within a rural setting, is generally cleared of native vegetation, is not visually prominent, and has relatively few sensitive receptors viewing the Site.

Importantly, the Proposal incorporates a number of key measures that limit potential visual impacts. In particular:

- the proposed PV solar panels are low-profile and non-reflective
- the Site has a relatively low visibility with the only elevated views possible from a small number of rural properties to the north (i.e. along Tudgey Road)
- the only publically-accessible location for slightly elevated views is from the local Tudgey Road.

Overall the Proposal would represent a moderate and acceptable level of change to the landscape character of the Site and its surrounds and an acceptable impact to private and public viewpoints. Initial impacts to close viewpoints would initially be higher, however, are predicted to reduce over time as proposed planting increases in height and is able to adequately screen the Site.

12. References

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