STATEMENT OF ENVIRONMENTAL EFFECTS

Proposed Electricity Generating Works
190 Rodhams Road, Uranquinty

June 2021

Project Number: 19-890





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ACRONYMS AND ABBREVIATIONS

AHIMS	Aboriginal heritage information management system
BayWa	BayWa r.e. Projects Australia (the proponent)
BOM	Australian Bureau of Meteorology
Cwth	Commonwealth
DA	Development Application
DEE	(Cwth) Department of the Environment and Energy
DPIE	(NSW) Department of Planning, Industry and Environment
EEC	Endangered ecological community – as defined under relevant law applying to the proposal
EIA	Environmental impact assessment
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Cwth)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
ESD	Ecologically Sustainable Development
ha	hectares
ISEPP	*State Environmental Planning Policy (Infrastructure) 2007* (NSW)
km	kilometres
LEP	Local Environment Plan
m	Metres
MW	megawatt
NSW	New South Wales
PV	photovoltaic
SEE	Statement of Environmental Effects
SEPP	State Environmental Planning Policy (NSW)
WWCC	Wagga Wagga City Council

1. INTRODUCTION

1.1. OVERVIEW

This Statement of Environmental Effects (SEE) has been prepared to support a Development Application (DA) seeking Wagga Wagga City Council's consideration of proposed electricity generating works (a solar farm) at 190 Rodhams Road, Uranquinty.

BayWa r.e. Projects Australia (BayWa), the applicant and proponent, proposes the construction of a photovoltaic solar farm at Uranquinty. The subject land comprises agricultural land with a history of clearing for cropping. It is currently used for cropping and sheep grazing. The proposed development site would comprise an area of approximately 42 hectares, located in the north-eastern portion of the subject land.

The proposed solar farm would include the installation of solar photovoltaic (PV) cells with a capacity of 17 MW_p DC (and a maximum export capacity into the Essential Energy network of approximately 12 MW AC) on a ground-mounted tracking system of pole driven steel posts. The proposed development would connect to the existing 22kV line along the Olympic Highway, via a new switching station. The proposed works would involve ground surface disturbances, changes to existing land use and the local visual environment.

The design of the proposed development was developed and finalised in conjunction with environmental assessments and constraints analysis, to ensure potential impacts were avoided and minimised wherever possible. The development design has been informed by engineering advice. The scale of the proposed development has been influenced by:

- Property boundaries.
- Demand for new renewable electricity generation to meet generation targets.
- Commercial investment and viability considerations.
- Electricity grid capacity.

The scale of the proposed solar farm successfully responds to the constraints and opportunities onsite. Importantly, the proposed development would benefit network reliability and security by distributing generation closer to local consumption centres. The subject proposal would generate enough power each year to service around 7,500 households.

1.2. APPLICANT AND LAND OWNERSHIP

The Applicant for the development is BayWa r.e. Projects Australia (BayWa). The registered proprietor of the land is Myree McGrath.

1.3. THIS REPORT

This Statement of Environmental Effects (SEE) has been prepared by NGH on behalf of the proponent, BayWa.

This report has been informed by information and mapping prepared by external consultants. Please note for clarification, the lots (in their entirety) containing the proposed development are referred to as the ***subject land***.

The area of land subject to the proposed development footprint may be referred to as either the ***proposal area*** or the ***development site*** **on** mapping and discussion contained in this report.

This SEE:

- Describes the proposed works, the development site, and the wider locality.
- Describes the planning context and statutory approval requirements.
- Identifies and assesses the significance of impacts on environmental values.
- Provides mitigation measures to avoid, minimise or mitigate identified impacts.

This report shall be read in conjunction with the accompanying plans and documentation as listed in Table 1-1.

Table 1-1 Accompanying Plans and Documentation

Appendix	*Reference*	*Description*	*Prepared by*
A	BWre-AU-SAN-002-GAL (rev 4)	Development Plan Set	BayWa r.e. Projects Australia Pty Ltd
B	19-890 Final	Aboriginal Cultural Heritage Assessment	NGH
C	19-890 Final	Biodiversity Assessment report	NGH
D	19-890 Final	Bushfire Assessment report	NGH
E		Noise Assessment	NGH
F	Final December 2020	Traffic Impact Assessment	Peter Meredith Consulting
G	February 2019	Hydrology assessment report	BayWa r.e. Projects Australia Pty Ltd
H	March 2021	Preliminary Runoff Assessment	Xeros Piccolo
I	April 2021	Glint and Glare Study	Pager Power

1.4. BACKGROUND

Development consent for the proposed development is sought under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The proposal is funded by the proponent and the calculated Capital Investment value (CIV) is approximately $19 million. According to Schedule 7 of the State Environmental Planning Policy (State and Regional Development) 2011, the proposal would be defined as private infrastructure development. The proposal has a CIV exceeding $5 million, and not exceeding $30 million and is therefore considered Regionally Significant Development.

The proposal is not deemed to be a Designated Development pursuant to Schedule 3 of the *Environmental Planning and Assessment Regulation 2000*, given the expected output would not exceed 30MW, as set out under Clause 18(1)(c) of Schedule 3 of the Regulation, and does not trigger other matters listed.

The development application would be assessed by Wagga Wagga City Council, whilst the determining authority is the Southern Regional Planning Panel.

1.5. SUBJECT LAND AND LOCALITY

The village of Uranquinty is located approximately 1.5 km to the south of the subject site.

This development application relates to land described as 190 Rodhams Road, Uranquinty. The proposed solar farm would be located on land legally identified as Lots 118, 129 and 149 DP 754567. The land is situated on the north-western side of the Olympic Highway. The land is bounded by Rodhams Road (unformed) to the north and Churches Plain Road to the west.

The proposed development would not involve access directly to the highway. The development site would be accessed directly from Churches Plain Road, via a new internal access road south of the existing planted tree line. Part of the access road would traverse Lot 55 DP 754567.

The subject land is shown in Figure 1-1 and Figure 1-2 on the following pages.

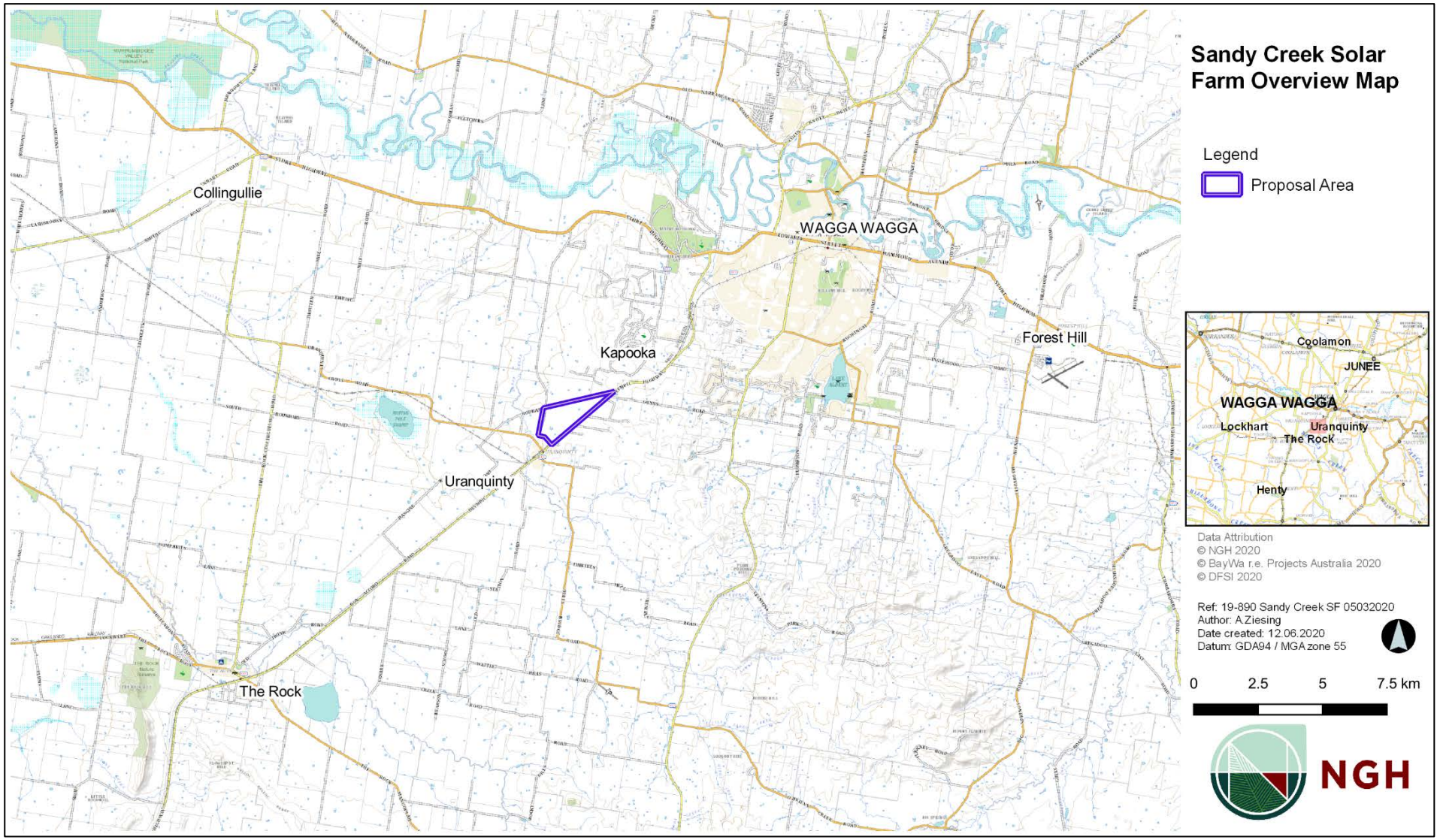


Figure 1-1 Site locality of the subject land (Source: NGH, 2020)

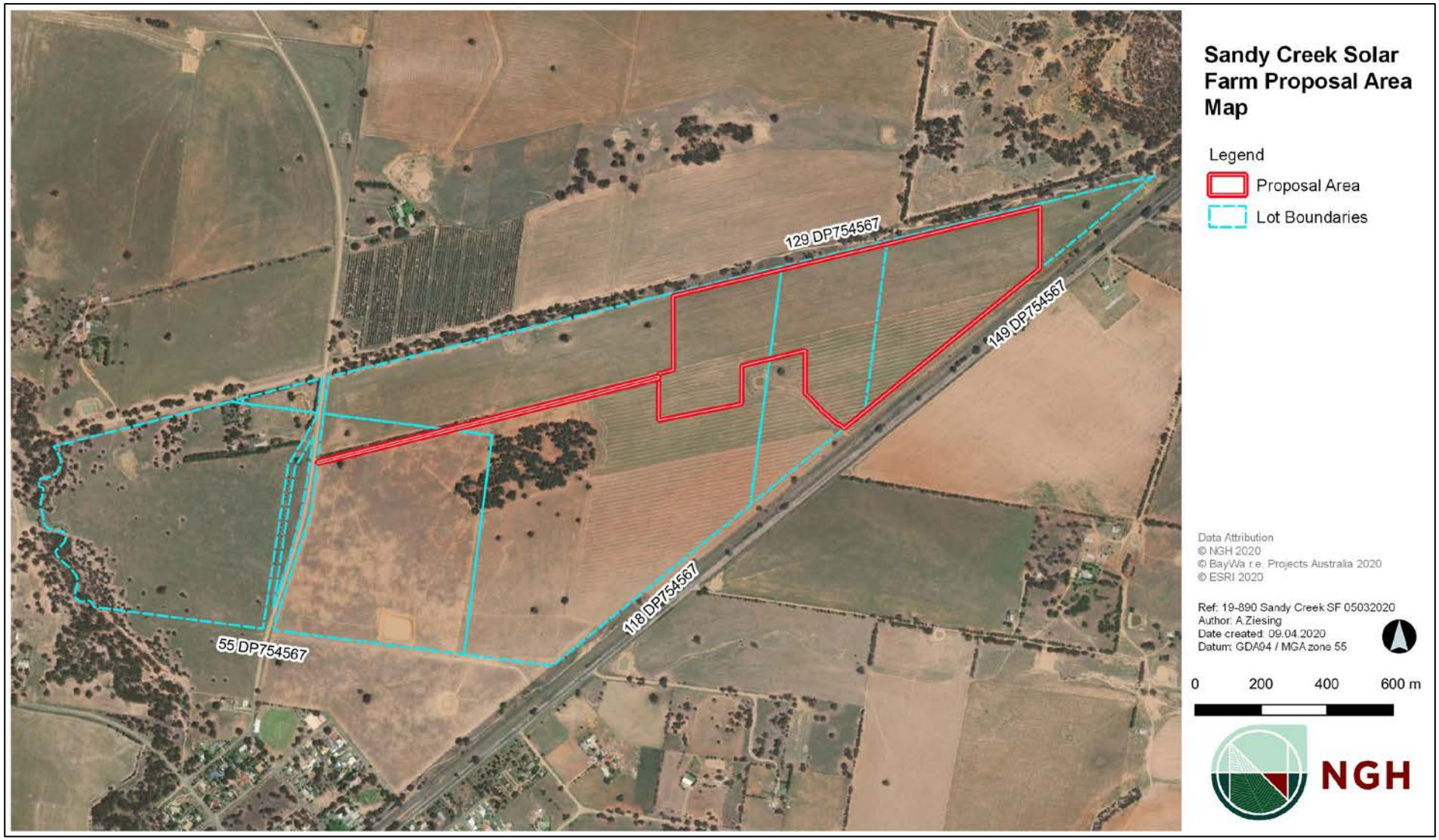


Figure 1-2 Subject land (lot boundaries) and proposal area (footprint) (Source: NGH, 2020)

2. THE DEVELOPMENT PROPOSAL

2.1. GENERAL OVERVIEW

The construction of a solar farm is proposed 2km north of Uranquinty, in the Wagga Wagga Local Government Area (LGA). The proposed site is within cleared rural farmland, with no sensitive environmental features. The proposed solar farm would consist of 17 MW_p DC of solar panels and export approximately 12 MW AC into the National Electricity Market (NEM) grid via grid connection infrastructure to be located adjacent to the Olympic Highway, on the eastern side of the development site.

2.2. PROPOSAL SUMMARY

The key features of the proposed development are summarised in Table 2-1. Note that component specifications are subject to detailed design and final product selection.

Table 2-1 Summary of the key features of the proposal

Proposal element	Description
Proposal	Sandy Creek Solar Farm.
Capacity	17 MWp DC / 12 MW AC Note: the capacity is based on products and technology available at the time of the proposal but may change through the life of the solar farm as advances in technology occur.
Development site	Approximately 42 hectares solar farm infrastructure area.
Solar array	Approximately 40,000 solar panels mounted in rows on tracker tables and approximately 5,000 array posts. Four containerised power stations (containing SMA SC-4400-UP Medium Voltage Power Stations or similar) within the solar array.
Grid connection infrastructure	Connection to an existing 22 kV powerline along the Olympic Highway via a proposed switching station on the eastern side of the development site. Grid connection assets, to be gifted to Essential Energy, would be subject to a Part 5 assessment and would be undertaken with the approval of the electricity authority, do not form part of this DA. All other assets that require approval as part of this DA have been identified in this SEE and the development plans provided at Appendix A.
Site compound	Approximately 800sqm containing control facilities, storage, temporary site office and amenities.
Access tracks	Internal access tracks constructed of engineered fill topped with crushed stone pavement would be used to access the solar farm infrastructure for maintenance, as per the accompanying concept site plan.
Perimeter fencing, lighting, and CCTV	Standard wire mesh fencing installed around the site perimeter would be approximately 2m high. Infra-red security technology and CCTV cameras

Proposal element	Description
	may be installed on posts around the perimeter fence and on the main access track.
Construction hours	Standard daytime construction hours would be 7.00am to 6.00pm Monday to Friday and 8.00 am to 1.00 pm on Saturdays. Construction would not occur on Sundays.
Construction timing	Approximately 9 months.
Workforce	Construction – approximately 40 workers at peak construction. Operation – 1 operation/maintenance contractor, stationed off-site.
Operation period	Up to 50 years.
Decommissioning	The site would be returned to its pre-works state. All above ground infrastructure would be removed to a depth of 1000mm (exceptions apply, see Section 2.6). The site would be rehabilitated in consultation with the landowner, consistent with future land use requirements.
Capital investment value	Calculated at approximately $19 million. A quantity surveyor's report has been provided for Council's reference.

2.3. PROPOSED INFRASTRUCTURE

2.3.1. Solar arrays

Approximately 40,000 solar panels would be installed across the development site. The panel size would be approximately 2.1m x 1.1m. An example of the preferred panel is the JA Solar Half-Cell Module JAM72S20.

The panels would be mounted in portrait orientation (one or two solar panels in portrait orientation, dependent on final detailed design) on single axis north-south tracker tables. Array rows would be spaced between 5 and 16 metres, determined through final detailed design and selection of the panel and tracker system arrangement. The maximum height of the panels and trackers would be approximately 2.5 metres where one panel is mounted in portrait orientation, or up to 4 metres if two solar panels are mounted in portrait orientation.

The solar array trackers would be supported by steel posts, with a typical footing depth of 1-3m, as determined by the geotechnical characteristics of the soil. Examples of a tracking systems being considered are NEXTracker single axis tracking systems. Indicative solar panel and tracker arrangements are shown in Figure 2-1 (a) and (b).

No land reshaping is required in the array areas due to the selection of a relatively level development site through constraints assessment. The steel posts would be mounted in the natural soil profile, retaining existing grass cover as much as possible. This results in maximum erosion protection during construction and operation and continued agricultural capability of the land under the array.



(a)



(b)

Figure 2-1 Single axis tracking systems considered for the project include (a) the NEXTracker NX Horizon and (b) the NEXTracker NX Gemini tracking systems (Source: BayWa, 2020)

2.3.2. Inverters and transformers

Four containerised medium voltage power stations would be installed. Each would contain one inverter, a transformer, and a switchgear. The power stations would be approximately 6.5 metres long, 2.5 metres wide and 3 metres high. The power stations would be installed on a cast concrete slab or pier blocks. A model being considered for use in this project is shown in the figure below.



Figure 2-2 Inverter station being considered for the project (Source: BayWa, 2020)

2.3.3. Perimeter fencing and security CCTV

The proposed perimeter fencing would comprise an industry standard wire mesh style securing fencing, approximately 2 metres in height. The fence would have a gap of approximately 200mm at the base to allow wildlife to pass through the site, while excluding stock and people.

CCTV cameras may be installed to the perimeter security fencing. In which case, signage noting the surveillance may be placed at 30 metre intervals around the fence line. All other signs associated with the development would be small-scale information and safety signage.

2.3.4. Distribution line connection and cabling

The proposed solar farm would connect to an existing overhead 22 kV powerline via a switching station within the site, proposed to be located near the eastern boundary (Olympic Highway). A Right of Carriageway (ROC) and easement for electricity is required to be established on the property title, benefiting Essential Energy, for access/maintenance purposes. This would extend from the driveway access point to the switching station to provide legal access. The detailed design and construction of the grid connection infrastructure would be undertaken by an accredited electrical service provider. Some of this infrastructure would be gifted to Essential Energy as is required. The infrastructure to be gifted would be subject to a separate Part 5 assessment and undertaken with the approval of/on behalf of the electricity authority.

The grid connection arrangement would be finalised in the detailed design stage. The grid connection works for infrastructure to be owned by the proponent would generally include installation of a 22kV switchboard, auxiliary transformers and backup battery power supply, communications and protection equipment and new power poles.

Some cabling within the development site would be located along tracks/trays attached to the panel posts or supported by the solar panel frames and tracking system frame with cable ties. Other major cables would be underground and located along access tracks wherever practicable.

Underground cable trenches would be constructed in accordance with the relevant Australian Standard. Cables would be protected in accordance with AS 3000.

2.3.5. Site access

The existing access point from Churches Plain Road is proposed to be utilised for all phases of the project. No access is proposed to the Olympic Highway or Rodhams Road.

2.3.6. Meteorological stations

Meteorological stations monitoring site conditions such as solar irradiance, ambient temperature, solar panel temperature, wind speed, rainfall, flood level, humidity, soiling etc. would be located at multiple locations on the solar farm site. Some of these sensors would be used by the tracking system to detect site conditions outside of design operating conditions and trigger defensive action. Some of these measurements would also be used to track the performance of the solar farm.

2.4. CONSTRUCTION

The construction phase is expected to last approximately 9 months. The main construction activities would include:

- Site establishment and construction of temporary facilities (fencing, ground preparation, construction of the internal track system, upgrade of existing access points/intersections, preliminary civil works, and drainage).
- Installation of steel post and framing system for the solar panels.
- Installation of underground cabling.
- Installation of power and inverter stations.
- Installation of PV panels.
- Removal of temporary construction facilities and rehabilitation of disturbed areas.

2.4.1. Site preparation and earthworks

Soils within the proposed development site have been disturbed by historic agricultural activities. Ground disturbance associated with the development would be limited to:

- The installation of the steel posts supporting the solar panels, cable trenches up to 1.5m deep,
- Construction of internal access tracks and access points and associated drainage,
- Ground preparation for substations and site buildings
- The construction of perimeter security fencing, lighting and, potentially, infra-red technology and CCTV.

Minimal weed presence was detected during the biodiversity survey; however, weed treatment would be undertaken where required prior to the commencement of earthworks to reduce the potential for spread of these species within the site.

2.4.2. Temporary construction facilities

Temporary facilities established at the site during the construction phase would include:

- Material laydown areas.
- Construction site offices, generator and skip bins with wind shield and lid.
- Car and bus parking areas for construction workers.

- Staff amenities (kitchen and toilet/s).
- CCTV at construction compound.

The proposed hardstand in the construction compound would comprise compacted stone / gravel to provide a clean, firm, level, and free draining surface suitable for cabins and heavy traffic. Temporary staff amenities would be designed to accommodate the proposed maximum number of workers simultaneously at the site at the peak of the construction period.

2.4.3. Materials and resources

Materials

Construction materials would be sourced locally wherever possible. Gravel would be imported to surface the access road and internal service track network and hardstand. Sand may be required for the bedding of underground cables, depending on ground conditions. Concrete would be required for the switching station equipment, inverter, and transformer foundations.

Approximately 2,500 kilolitres of water would be required during construction, mostly for dust suppression, but also for cleaning, concreting, on-site amenities, establishing and maintaining landscaping. Water would be sourced from town water supplies or would be trucked in and stored in temporary tanks.

Additional water would be stored for fire-fighting purposes in a pre-fabricated non-combustible storage tank (neutral colour) of no less than 20,000 litres, in accordance with *Planning for Bush Fire Protection* (PBP) 2019 and the accompanying Bushfire Assessment.

Indicative machinery/plant types and numbers, potentially in use at any one time across the site, are provided in

Table 2-2.

Table 2-2 Estimated machinery and equipment

Plant description	*Estimated number of items*
Pile driving rig	3
Crane	1
Padfoot roller	3
Wheeled loader	0
Dump truck	2
30t excavator	2
Water truck	1
Bobcat tracked	3
Telehandler forklift	1
Scraper for topsoil stripping	1
Grader (access track construction)	1
Smooth drum roller (access track construction)	1
15t excavators for shallow trenches	2

Waste

The management of waste during the construction phase would observe the objectives of the *Waste Avoidance and Resource Recovery Act 2001* and would be addressed in a Construction Management Plan submitted to Council prior to the commencement of works.

Construction wastes would include:

- Packaging materials.
- Excess building materials, scrap metal and cabling materials.
- Masonry products, including concrete wash.
- Excavation of topsoils and vegetation clearing.
- Bio wastes facilities, hired from portable WC providers.

Waste produced during construction would be disposed of at an appropriately licensed waste facility. Green waste, from vegetation clearing, would be mulched for use in rehabilitation at the site, or removed from the site.

In accordance with the POEO Act and associated waste classification guidelines, most waste would be classified as building and demolition waste within the class general solid waste (non-putrescibles). Based on the proponent's experience with other existing solar farms, approximately 80 percent of site waste is recyclable.

Ancillary facilities in the site compound would produce sanitary wastes classified as general solid waste (putrescibles) in accordance with the POEO Act. Toilet hire and maintenance services would be employed to remove sanitary wastes on a regular basis.

2.4.4. Personnel and work hours

At the peak construction period, the solar farm is expected to require approximately 40 workers. Construction activities would be undertaken during standard construction hours (7.00 am to 6.00 pm Monday to Friday and 7.00 am to 1.00 pm on Saturdays).

Construction activities would be restricted to the hours indicated above, construction required outside of these hours would only be undertaken with prior approval from relevant authorities and in accordance with the project's Construction Management Plan, or in the event of emergency circumstances i.e. to make work safe.

It is anticipated that most workers would be locals, or if non-local, would use existing accommodation within the local area.

2.5. OPERATION

2.5.1. Operation activities

Following commissioning, the solar farm would commence the generation of electricity and exporting to the electricity grid.

The proposed solar farm would be monitored remotely from an off-site location and contractors would visit the site on an as-needed basis. Operational activities would include:

- Routine visual inspections, general maintenance and cleaning operations of the solar arrays, grid connection equipment and other infrastructure as required.
- Vegetation establishment and management, potentially involving managed grazing to control grass growth beneath the panels. Groundcover vegetation would be maintained over the site to minimise

erosion, dust, and weeds (subject to climatic conditions). Groundcover would be monitored and remediation (such as reseeding or soil protection) undertaken as required.

- Site security response (24hr) should this be required.
- Site operational response (24hr) should this be required.
- Replacement of equipment, cabling, communications, and monitoring infrastructure as required.
- Maintenance of landscaping and screening plantings, as required.
- Pest plant and animal management and control, as required.

2.5.2. Transport and access

Staff attending the site during the operation phase would primarily use light vehicles (4x4). Traffic associated with the operation and maintenance of the solar farm would use the routes specified for the construction phase.

2.5.3. Materials and resources

As outlined above, a tank would be installed at the site to store water for bushfire protection and other non-potable water uses, with a minimum of 20,000 litres dedicated to bush firefighting.

Potable water would be provided for staff using imported supplies or via town water supply.

During operation, non-potable water may be required for establishing and maintaining landscaping and to support grazing animals. Regular panel cleaning is typically not necessary. If required, panel cleaning water would be sourced from a commercial supplier and delivered by tanker to the site. Solar panel cleaning typically requires no more than 1.5 litres per solar panel. This is not expected to occur at a frequency of more than once per year. Therefore, up to 60,000 litres per year of water may be needed for solar panels in years in which they need to be cleaned.

As outlined above, most operational phase waste would be classified as building and demolition waste and approximately 80 percent of site waste can be recycled. Water closet hire and maintenance services would be employed to remove sanitary wastes on a regular basis.

2.5.4. Personnel and work hours

The proposed solar farm would be monitored remotely from an off-site location and staff would visit the site on an as-needed basis. Staff would not be permanently stationed at the proposed facility, given the extensive electronic monitoring that would be in place.

Most of the infrastructure maintenance would be conducted by staff on a rotational basis with activities scheduled consistently throughout the year. Any required maintenance or other site management activities would be undertaken during standard working hours.

There would be some occasions, such as during a major plant shut down, that may require additional maintenance staff on site. Bar emergencies or major asset inspection or maintenance programs, night works or work on Sundays or public holidays would not be required.

The solar panels and tracker units would operate during daylight hours and this would comprise an extended period during the daylight-savings.

2.5.5. Lighting

There would be no permanently illuminated night lighting installed.

2.5.6. Refurbishment and upgrading

The solar farm operator may replace or upgrade solar panels or other infrastructure within the existing development site during the projected 50-year life of the solar farm. Should upgrade works be proposed to extend beyond the existing impact site or alter the nature or scale of environmental impacts, the proponent would consult Council regarding the need for further assessment/approval.

The proponent would also consult Council regarding the need for further assessment and approval to continue the operation of the solar farm beyond the 50-year timeframe, should this be proposed.

2.6. DECOMMISSIONING AND REHABILITATION

At the time of decommissioning, the site would be returned to its pre-developed state. All above ground infrastructure including the solar arrays, inverter stations and operations buildings would be removed. Cabling would be removed to a depth of 1,000 millimetres so that future cultivation would not be affected.

All areas of soil disturbance would be rehabilitated during decommissioning, consistent with land use requirements. Traffic required for decommissioning would be similar in type but of shorter duration than that required for the construction phase.

Waste during decommissioning would be handled in line with the objectives of the relevant legislation, policies, and strategies. Wherever possible and practicable, all materials removed would be sorted for re-use or recycling including solar panels and mounting system and metals from posts, cabling, and fencing. Buildings and major electrical equipment would be removed for resale or reuse. Items that cannot be recycled or reused, would be disposed of at relevant licensed waste facilities as required.

A Decommissioning Plan would be prepared and submitted to Council for approval prior to operation of the proposed solar farm. The Plan would include an indicative decommissioning phase timeline and waste management processes. It is estimated the decommissioning phase would extend for a period of approximately 6 months.

2.7. JUSTIFICATION FOR THE PROJECT

2.7.1. Strategic need

Riverina Murray Regional Plan 2036

The Sandy Creek solar farm would contribute to the realisation of the vision for the Riverina Murray, specifically:

- *A thriving renewable energy industry is generating reliable energy for the Riverina Murray and the nation* (NSW Gov. 2017).

The proposal is consistent with the current goals and actions for renewable energy generation of the Riverina Murray Regional Plan 2036 and diversification of the economy, specifically:

- *Goal 1: A growing and diverse economy:*
    - *Direction 11: Promote the diversification of energy supplies through renewable energy generation.*
        - *The region has significant potential for renewable energy industries, with vast open spaces*

Although the area of Wagga Wagga was specifically identified as having potential for wind-generated energy, the open spaces and level nature of the topography of the site also lends itself to large-scale solar power generation and is supported by action 11.3 of Direction 11 (listed below).

- *11.1 Encourage renewable energy projects by identifying locations with renewable energy potential and ready access to connect with the electricity network.*
- *11.2 Promote best practice community engagement and maximise community benefits from all utility-scale renewable energy projects.*
- *11.3 Promote appropriate smaller-scale renewable energy projects using bioenergy, solar, wind, small-scale hydro, geothermal or other innovative* storage technologies.

The Sandy Creek solar farm would contribute to achieving actions 11.1 and 11.2 given the site has renewable energy potential with ready access to the grid. Community engagement has been an important part of the projects consultation process to best understand local community views and values (refer to Table 2-3 for consultation results and actions). The project would result in benefits to the community listed in section 2.7.2 below.

Wagga Wagga Special Activation Precinct

Special Activation Precincts (SAP) are an initiative of the NSW Government to develop economic growth-driving precincts focussing on the strengths of a local area. The Wagga Wagga SAP is focussed around the existing Bomen precinct, with the intention to establish an industrial enterprise area that is sustainable, encourages circular economies and includes environmental and heritage protection.

One of the principles for Wagga Wagga SAP Master Plan is the opportunity for the precinct to operate from 100 percent renewable energy. The establishment of the Sandy Creek Solar Farm could contribute to the realisation of this goal, through the sustainable generation of electricity near to this proposed major consumption centre. Renewable energy is also required for the production/generation of green hydrogen, which is a desired industry in the Bomen SAP.

Climate change mitigation

Human activity is resulting in the release of large amounts of greenhouse gases (GHGs) which trap the sun's heat in our atmosphere and alters the balance of the earth's climate. This threat is acknowledged by scientists and politicians around the world, as illustrated by the 2015 United Nations Paris Agreement on Climate Change (DEE 2017).

Electricity generation is the largest individual contributor of greenhouse gas emissions in Australia, representing 35 percent of emissions (DEE 2018). The transition to low carbon renewable energy sources is critical to enable Australia to meet its United Nations Paris Agreement commitments.

In terms of renewable energy technologies, solar projects have the capacity to provide faster results in reducing greenhouse gas emissions than other options because of shorter potential construction and commissioning times (CER 2017). Rapidly improving technology in this sector is also seeing the improved performance of solar energy projects.

National renewable energy targets

Renewable energy currently contributes to 21 percent of total electricity generation in Australia (0.8 percent of which is generated by large-scale solar PV), and represents the lowest-cost type of new energy generation that can be constructed (CEC, 2019). According to the Clean Energy Council, as of May 2020, there are currently 95 projects that are in construction (or due to start construction soon) in Australia. This is based on projects that have reached financial close and are not yet commissioned.

These projects would deliver over $19.5 billion in capital costs, 11,231 MW of new renewable energy capacity and create 13,849 direct jobs (CEC, 2020).

The Sandy Creek Solar Farm proposal would support long term and stable energy policies such as the Renewable Energy Target (RET). Additionally, large-scale solar farm proposals such as this provide an alternative power generation source resulting in the potential to benefit the Australian community by reducing average household electricity bills and power disruptions.

Specific to Australia's commitments, the Sandy Creek Solar Farm proposal would provide the following benefits:

- Reduced greenhouse gas emissions, contributing to meeting our international climate commitments.
- Aid the transition towards cleaner electricity generation.
- Direct contribution to help in meeting the RET.

NSW goals and policies

The proposal is consistent with the current goals and targets for renewable energy generation in NSW. These include:

- Goal 22 of the **NSW 2021: A plan to Make NSW Number One** (NSW Government 2011):
    - *Contribute to the national renewable energy target [i.e. 20 percent renewable energy supply] by promoting energy security through a more diverse energy mix, reducing coal dependence, increasing energy efficiency and moving to lower emission energy sources.*
- Contributing to the three goals of the **NSW Renewable Energy Action Plan** (NSW Government, 2013):
    - *Attract renewable energy investment and projects.*
    - *Build community support for renewable energy.*
    - *Attract and grow expertise in renewable energy.*
- The **Electricity Infrastructure Roadmap**, building on the 2019 NSW Electricity Strategy and the 2018 NSW Transmission Infrastructure Strategy, is a plan to transition the electricity sector to cheaper, cleaner and more reliable. The roadmap aims to:
    - *achieve the target of zero net emissions by 2050.*
    - *attract up to $32 billion in private investment for regional energy infrastructure by 2030;*
    - *support an estimated 9,000 jobs, mostly in regional NSW.*

A legally binding and universal agreement on climate was reached at the 2015 Paris Climate Conference, with the aim of keeping global warming below 2°C, by reducing greenhouse gas emissions. Australia has committed to reducing greenhouse gas emissions by aiming for the following targets:

- 5 percent below 2000 levels by 2020.
- 26 to 28 percent below 2005 levels by 2030.
- Net zero emissions in the second half of this century.

The proposed Sandy Creek Solar Farm would contribute to Australia's effort in helping meet these targets.

Finkel Report

The 2017 Independent Review into the Future Security of the National Electricity Market (Finkel Report) is a report commissioned by the Australian Government to support the establishment of a framework for the development of the Australian energy sector. It recommends the use of a Clean Energy Target (CET) scheme to stimulate renewable energy production throughout the National Electricity Market (NEM) and would likely replace the present Federal MRET scheme due to expire in 2020.

The report modelled the outcomes required to achieve the trajectory committed to by the Australian Government by 2030 and determined that renewable energy would constitute approximately 42 percent of the NEM. With the current projection that renewable energy would make up 23.5 percent by 2020, the proposed development would contribute to closing the gap to the 2030 target.

Electricity reliability and security

While most of Australia's electricity is currently provided by coal-fired power stations, as many as three-quarters of these plants are operating beyond their original design life (DIS 2015). Nine coal-fired power stations have closed since 2011-2012, representing around 3,600 MW of installed capacity (AER 2015 in Commonwealth of Australia 2016). NSW's 1,680 MW Liddell Power Station is also slated for closure in 2022.

The Commonwealth RET scheme is supporting the transition to renewable energy sources, principally solar and wind. The National Energy Market grid is long and linear, with much less network meshing than many international systems. Geographic and technological diversity in the network can improve security and smooth out the impacts of variability (Finkel et al. 2017).

The Australian Energy Market Operator (AEMO 2018) forecasts that grid-supplied electricity consumption would remain flat for the next 20 years, despite projected 30 percent growth in population. Although not required to meet a projected increase in demand, the proposed development would benefit network reliability and security by providing embedded electricity generation closer to local consumption centres and diversifying the mix of energy sources.

2.7.2. Socio-economic benefits

Broad benefits

Broad benefits that would be associated with the proposed development include:

- Reduced GHG emissions, assisting the transition towards cleaner electricity generation.
- Provision of a renewable energy supply that would assist the Australian and NSW Governments to reach Australia's energy and carbon mitigation goals.
- Embed electricity generation supply into the Australian grid, closer to identified consumption centres.
- Diversification of land use and economic activity in regional NSW.

Specifically, the proposal would:

- Generate approximately 32,000 MWh of renewable electricity per year.
- Supply enough power each year to service around 7,500 households (assuming average household consumption of 4,215 kWh per year).
- Save around 10,000 tonnes of carbon dioxide (CO2) per year (assuming generation would otherwise use brown coal with a carbon factor of 0.33372 tonnes per MWh (DEE 2017)). A solar farm that displaces 10,000 tonnes of CO2 per annum is the equivalent of taking almost 4,400 cars off the road each year (based on an average car in NSW travelling 14,000 km per year with CO_2 emissions of 162 g/km (DIT, 2011)).

Local benefits

The proposal would provide a local supply of renewable energy direct to the grid, as outlined above.

The proposal would support 40 direct jobs over the peak construction period, and 1 full-time equivalent position during operation.

The employment benefits extend through the local supply chains to fuel supply, vehicle servicing, uniform suppliers, hotels/motels, B&B's, cafés, pubs, catering and cleaning companies, tradespersons, tool and equipment suppliers and many other businesses. Data from solar farm projects at Nyngan and Broken Hill indicate that local goods and services accounted for approximately 56 percent of the project's procurement spend (First Solar 2014).

Benefits for the landowner

Diversification of land use for the farmer. The solar farm provides a potential protection against adverse farming conditions (i.e. climate change). Farming (livestock grazing) around the solar farm and within, where possible, would continue during the construction and operation of the solar farm and post decommissioning.

Electricity prices

Household electricity bills increased 61 percent between 2008-09 and 2012-13, due mainly to network expenditure (ABS 2016 in Commonwealth of Australia 2016). Australian households would pay $510 million more for power in 2020 without renewable growth through the RET and up to $1.4 billion more per year beyond 2020 (Roam Consulting 2014). Renewables increase diversity and competition in the wholesale energy market – and as in any market, more competition means lower prices.

To the extent that competition amongst retailers is limited, and to the extent that the RET creates greater contestability through the creation of economically sustainable new entrant retailers, there would be further downward pressure on the retail margins (Sinclair Knight Merz 2013).

2.8. CONSULTATION

Table 2-3 below provides a summary of the consultation that has been undertaken for the Sandy Creek Solar Farm prior to lodgement of the Development Application.

Table 2-3 Consultation summary table

Method	*Result/Proposed action*
Meeting with WWCC Planning staff	Method: Council was notified of the proposal in late February 2020. A meeting was held with Council's Senior Town Planner. This consultation comprised of the presentation of the proposal, discussion of early background research, constraints assessment results, application, and assessment process. Feedback: Consideration of visual impacts, access other than to the highway, biodiversity matters and the like. Action: Continue with constraints assessment and relevant assessments to support a development application. Further discussions with Council's Senior Town Planner have occurred as the investigations and DA preparation has progressed.
Uranquinty Progress Association	Method: Phone call to Christine Steward, Secretary of the Uranquinty Progress Association in early March, followed by provision of project information by email, an offer to attend the next Association meeting to provide a presentation and respond to any questions and outlined opportunities to provide feedback. Due to the Covid-19 public health orders that were issued shortly thereafter, it is understood that meetings have not taken place, nor has the proponent been able to attend.

Method	*Result/Proposed action*
	Detail and Feedback: On 12 March 2020, the Uranquinty Progress Association responded with several questions about the proposal. The proponent provided a written response on 12 March 2020. On 6 April, the Uranquinty Progress Association responded with two further questions about the proposal. The proponent provided a written response on 6 April 2020. Action: Keep the community updated and involved as the proposal progresses towards submission of the Development Application.
Website	https://sandycreeksolarfarm.com.au/ A project website was established to inform the community of the proposal, to host further information about the project as it becomes available and outline opportunities to provide feedback.
Neighbour consultation	Method: Phone calls and email correspondence. Due to the Covid-19 public health orders, site meetings and an open day have not been able to be hosted. 'Claremont', Lot 117 and Lot 119 DP754567 at 144 Churches Plain Road, Uranquinty (Mackinnon) – immediately north of proposal site. Land is rated to AD and HP Mackinnon. The proponent was able to contact the manager of the property, L. Mackinnon (grandson of AD and HP Mackinnon). No issues were raised at this time by Mr Mackinnon. The proponent forwarded via email details of the proposal and outlined opportunities to provide feedback. 'Connorton', Lot 146 DP754567 at 6318 Olympic Highway, Uranquinty – immediately south/south-east of proposal site. Land is rated to TP and KJ Harris, recently transferred from father B. Harris. The proponent was able to contact B. Harris who would continue to reside in the primary dwelling on the property for several years. No issues were raised at this time by Mr B. Harris. The proponent forwarded via email details of the proposal and outlined opportunities to provide feedback. Wagga Model Aero Club, Lot 1 DP1068577, at 6318 Olympic Highway, Uranquinty – immediately east of proposal site. Land is rated to TP and KJ Harris, recently transferred from father B. Harris as above. It is understood the club lease land from the Harris family. The proponent was able to contact the Secretary of the club, Mr. I. Dobly. No issues were raised at this time by the Secretary. The club flies model aircraft to the east, north and south of their clubhouse and runway facilities, but does not cross the Olympic Highway. It is understood club typically operates on a Sunday. The proponent forwarded, via email, details of the proposal and outlined opportunities to provide feedback. Blamey Barracks, Kapooka – immediately north/north-east of the proposal site. The proponent forwarded details of the proposal and outlined opportunities to provide feedback via registered post in a letter addressed to The Commandant.

3. ENVIRONMENTAL ANALYSIS

3.1. SITE ANALYSIS

The scale of the proposed development has been influenced by:

- Demand for new renewable electricity generation to meet generation targets
- Commercial investment and viability considerations
- Electricity grid capacity
- Site accessibility
- Environmental constraints on the subject land
- Property boundaries.

The proposed scale of the solar farm responds to site constraints and opportunities. The design was developed in conjunction with the environmental assessment provided in this SEE to avoid or minimise potential impacts, where possible.

3.1.1. Site description

The subject land comprises Lots 55, 118, 129 and 149 of DP 754567, with an area of approximately 206 hectares. As indicated previously in this report, the proposed development site would comprise an area of approximately 42 hectares, located in the north-eastern portion of the subject land.

The subject land is located approximately 10km from the city of Wagga Wagga and is on the northern side of the rural village of Uranquinty in the south west. The land is within the Wagga Wagga LGA.

3.1.2. Existing land use

The subject land is currently used for agricultural purposes (cattle grazing and small-scale cropping) and has been extensively cleared to facilitate farming activities (Figure 3-1). Similar agricultural practices and residential occupation occur on adjacent properties within the RU1 Primary Production zone.

There is an existing residence (referred to as an associated receptor) on the subject land, being part of Lot 55 DP754567. However, the residence is located on the western side of Churches Plain Road (Figure 3-2).

Non-associated receptors (rural dwellings and dwellings in the village of Uranquinty) surrounding the proposed Sandy Creek Solar Farm are mapped in Figure 3-21. The visual impact of the proposed development on nearby receptors is considered in Section 3.12 of this report.



Figure 3-1 View of the proposal area from Churches Plain Road (Source: NGH, 2020)



Figure 3-2 View of associated receptor on Lot 55 DP754567 from Churches Plain Road (Source: NGH, 2020)

3.1.3. Character and landscape

The development site is located within a rural landscape approximately 1.5km of the village of Uranquinty (land zoned RU5). The proposed access road to the solar farm would be located on Churches Plain Rd (Figure 3-3), approximately 800m north of the village edge.

The surrounding land contains medium-sized properties running small-scale grazing and other agricultural operations, each typically having a rural dwelling. The residential properties in Uranquinty are located either side of the highway in a small village setting, with a cluster of local shops and a pub, a community hall, and a public school. Uranquinty township has a population of 770, with a further 139 people living in the surrounding locality according to the 2016 ABS census (ABS, 2016a, 2016b).

The Uranquinty power station is located approximately 2.8km west of the subject site. The Wagga Model Aero Club is located on the opposite side of the Olympic Highway. The Kapooka Army Base adjoins the northern side of Rodhams Road. The proposed solar farm would be sited greater than 400m from any buildings associated with the army base. The proposal site is approximately 2km from the main cluster of buildings on the Base.



Figure 3-3 View of Churches Plain Road looking south from the proposed access point (Source: NGH, 2020)



Figure 3-4 View of Uranquinty oval from Churches Plain Road looking south east (Source: NGH, 2020)



Figure 3-5 View of Yarragundry Street (haulage route) looking north-west (Source: NGH, 2020)

Geology and topography

The proposal area is located within the Inland Slopes of the NSW South Western Slopes IBRA biogeographic region. The South Western Slopes IBRA Bioregion comprises foothills and ranges west of the Great Dividing Range. The wide variety of rock types are affected by topographic and rainfall gradients that decrease toward the west (State of New South Wales (Department of Planning, Industry and Environment) 2016a).

The Inland Slopes subregion is characterised by steep, hilly and undulating ranges, and granite basins, with occasional basalt caps, confined river valleys with terrace remnants (State of New South Wales (Department of Planning, Industry and Environment) 2016b).

The development site gently slopes east to west towards Churches Plain Road. The average site elevation is approximately 220m AHD, with a low of approximately 212m AHD falling to the west. The north eastern corner of the site has an elevation of approximately 230m AHD. The rural village of Uranquinty is between 225m to 200m AHD. The subject land is relatively level with the Uranquinty village. Consistent with the 'Large-scale solar energy guideline' (DPE 2018), the development proposal is not sited in an elevated area, nor within a valley where it would be highly visible within the surrounding landscape.

The surrounding topography can be described as relatively flat to gently undulating, with stands of woodland, or dotted with paddock trees, especially surrounding the township of Uranquinty. Most of the subject land is comprised of cropped pasture within relatively flat open paddocks, with one patch of woodland and a few paddock trees.

3.2. POST-EUROPEAN HERITAGE

The subject land is not located within a heritage conservation area and does not contain items of Environmental Heritage pursuant to Schedule 5 of the Wagga Wagga Local Environmental Plan (WWLEP) 2010.

Several Items of Environmental Heritage are located within the village of Uranquinty. The closest Item being the 'Uranquinty Cemetery', listed as Item I286 in Schedule 5 of the WWLEP. The item is described on the State Heritage Register as a large, semi-isolated plot with representations of families from the late 19th and 20th centuries interred there. The cemetery is divided into denominations and well maintained (Figure 3-6).

The railway line, located on a raised earth embankment, and intervening vegetation, provides a visual screen between the cemetery and the Sandy Creek site (Figure 3-7). It is considered the proposed development would have no impact on the significance of the heritage item. Accordingly, no further post-European heritage assessment or reporting is considered necessary.



Figure 3-6 View of Uranquinty Cemetery - Item of Environmental Heritage (Source: NGH, 2020)



Figure 3-7 View from Uranquinty Cemetery towards the proposed solar farm. The mid-distance vegetation is roadside vegetation along the Olympic Highway, with the proposed solar farm located beyond this (Source: NGH, 2020)

3.3. ABORIGINAL CULTURAL HERITAGE

3.3.1. Existing conditions

An assessment of Aboriginal Cultural Heritage was conducted by NGH to identify the potential impacts of the proposal on Aboriginal sites and places in the vicinity of the proposed development site.

A qualified archaeologist from NGH conducted an initial site inspection of the subject land in March 2020. Four isolated artefacts (Sandy Creek SF AFT1 to Sandy Creek SF AFT4), one artefact scatter (Sandy Creek SF AFT5), and an area of potential archaeological deposit (PAD) were identified at that time.

A search of the AHIMS database of an area approximately ~10 km by ~10 km centred on the proposed development site was undertaken and found 118 Aboriginal sites recorded within the wider search area and no declared Aboriginal Places. Figure 3-8 indicates the location of the AHIMS sites in relation to the proposed development site.

An Aboriginal Cultural Heritage Assessment (ACHA) has been prepared in support of the proposed development and is included as Appendix B to this report. A summary of the results is included below.

3.3.2. Potential impacts

A total of 16 stone artefact sites were identified during the assessment, 13 of which are situated within the proposed development site. These sites include one artefact scatter (Sandy Creek SF AFT 2) and 12 isolated artefacts (Sandy Creek SF AFT 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16) (Figure 3-9). Two scarred trees (Sandy Creek SF ST 1 and 2) lie within the subject land but outside of the proposed development site and would not be impacted.

The impact to the sites with stone artefacts is likely to be most extensive where earthworks occur, such as the installation of panels and trenching, which may involve the removal, breakage, or displacement of artefacts. This is considered a direct impact on the sites and the Aboriginal objects by the development in its present form. The assessment considered that whilst the artefacts would be disturbed, there are likely to be a number of similar sites in the local area and therefore the impact to the overall local archaeological record is considered to be low. The stone artefacts have little research value apart from what has already been gained from the information obtained during the present assessment.

An Aboriginal Heritage Impact Permit (AHIP) is required to be obtained, to permit disturbance of the 13 Aboriginal archaeological sites that lie within the development site. The proposed development is therefore considered Integrated Development under the EP&A Act and referral of the DA to Heritage NSW is required.

3.3.3. Recommendations

As such, the following safeguards and mitigation measures are recommended:

1. A minimum 5 m buffer must be observed around the boundary extent of all artefact sites prior to the achievement of the below recommendations.
2. The scarred tree sites (Sandy Creek SF ST 1 and Sandy Creek SF ST 2) should be avoided by the proposed solar farm, including a 10 m buffer zone, to prevent inadvertent impacts to the crown and root systems.
3. The proponent applies to Heritage NSW within the Department of Premier and Cabinet (DPC) and receives an Aboriginal Heritage Impact Permit (AHIP) to allow harm to the 13 Aboriginal archaeological sites that will be impacted within the proposed solar farm area. The AHIP should be sought for the entire Sandy Creek Solar Farm proposal area.

4. Should the proponent seek to apply for an AHIP, this report must accompany the application, as outlined in the Heritage NSW document: Applying for an Aboriginal Heritage Impact Permit: Guide for Applicants.

5. Once an AHIP has been issued the 13 impacted sites within the development footprint, as approved by the AHIP, must be salvaged prior to the proposed work commencing and moved to a safe area within the property that will not be subject to any ground disturbance.

6. The collection and relocation of the artefacts should be undertaken by an archaeologist with representatives from the registered Aboriginal parties and be consistent with Requirement 26 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales*. A site impact card will be submitted for each site salvaged and a new site card will need to be completed once the artefacts are buried to record their new location on the AHIMS database.

7. No salvage excavation of the PAD 1 area is required due to the low-density of subsurface finds, degree of previous disturbance and erosion.

8. If any items suspected of being Aboriginal in origin are discovered during the proposed construction, all work in the immediate vicinity must stop and Heritage NSW notified. The find will need to be assessed and if found to be an Aboriginal object further investigation will be required.

9. In the unlikely event that human remains are discovered during the development works, all work must cease in the immediate vicinity. Heritage NSW and the local police should be notified. Further assessment would be undertaken to determine if the remains were Aboriginal or non-Aboriginal. Should the remain be identified to be Aboriginal in origin, Heritage NSW would advise the proponent and/or archaeologist on the appropriate Aboriginal parties to contact.

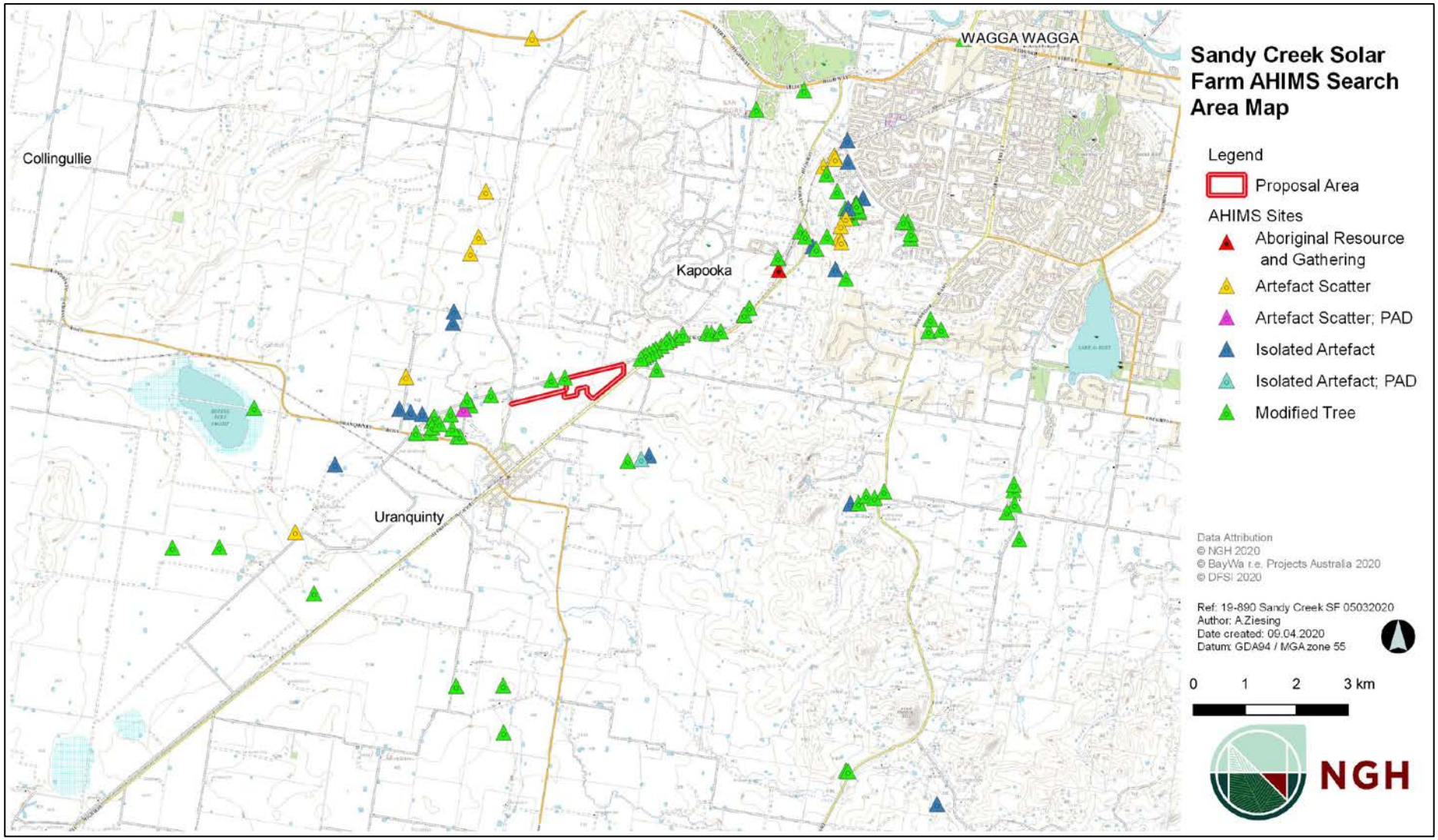


Figure 3-8 AHIMS Sites in the 10km search area (Source: NGH, 2020)

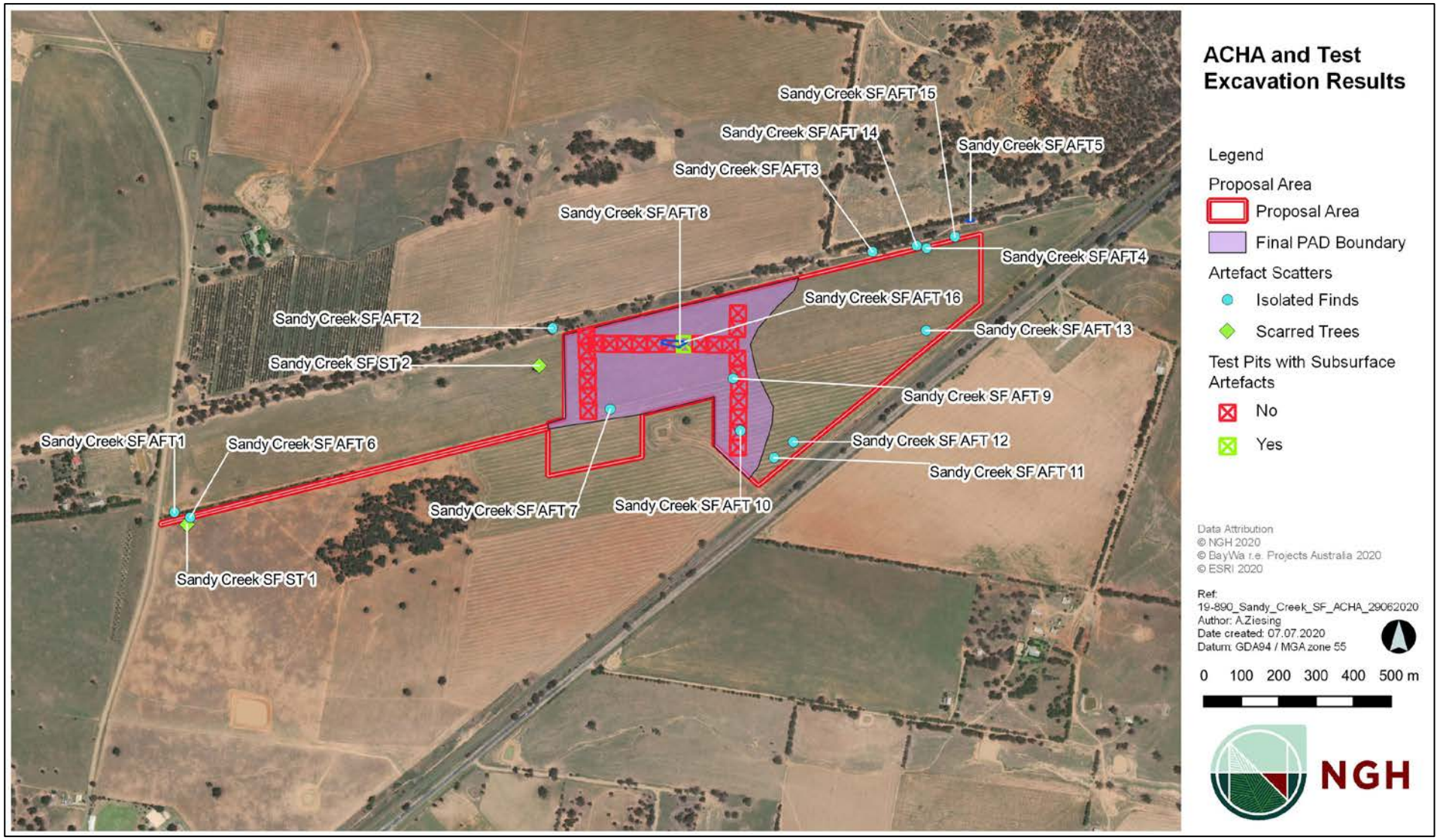


Figure 3-9 ACHA results including artefacts and scarred trees (Source: NGH, 2020)

3.4. LAND USE AND RESOURCES

3.4.1. Existing conditions

Land and soil capability

Land capability is the inherent physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air, and water resources (OEH 2012). The NSW land and soil capability assessment scheme (OEH 2012) describes and maps eight land and soil capability classes. The classification is based on various biophysical features of the land and soil, as well as its susceptibility to a range of hazards.

The development site land mapped as Capability Class 3 (high capability land) (refer to Figure 3-10).

Class 3 land is described as having slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation (OEH, 2012).

The OEH land and soil capability assessment scheme guidelines (OEH 2012) states that limitations of the land can be managed:

The land can be subject to sheet, rill and gully erosion as well as wind erosion and soil structure decline. However, these limitations can be controlled by land management practices that are readily available and easily implemented, such as conservation tillage and conservation farming practices. These practices include retaining stubble, reducing tillage, sowing with minimum disturbance and rotating pastures.

Refer to section 3.11 for details of the Soil and Water Management Plan, which includes provisions for sediment and erosion controls for the Sandy Creek Solar Farm and section 3.5 for recommendations about improvement and maintenance of ground cover vegetation.

Biophysical Strategic Agricultural Land

The NSW Government has mapped Biophysical Strategic Agricultural Land (BSAL) across the state. This is land which features the best quality soil and water resources and can sustain high levels of productivity. BSAL has a rare combination of natural resources highly suitable for agriculture, with the best quality landforms, soil, and water resources, inherently fertile and generally lacking significant biophysical constraints (NSW Government 2013a).

BSAL land includes areas of Wagga Wagga, specifically following land along the Murrumbidgee River. The proposal site is not mapped as BSAL land (refer to Figure 3-11).

Important Agricultural Land

A Guideline for Identifying Important Agricultural Lands in NSW (DPI 2017) defines IAL as ‘existing or future location of local or regionally important agricultural industries or resources as mapped that is consistent with the NSW DPI Guideline to Identifying Important Agricultural Lands in NSW’. The IAL mapping methodology involves overlays of current land use, biophysical resources, socioeconomic information, and agricultural industries. The methodology is intended to be used at the LGA, sub-region and region scales, rather than property scale.

A draft of the State-wide map and the regional profiles are noted as proposed for completion by August 2020 (DPI 2020). The map and profile were not available at the time of writing this report, as such cannot be considered in this SEE.

Land use

The subject land has been used for canola cropping and grazing. It has been extensively cleared and consists mainly of exotic-dominated pasture with scattered paddock trees. It is currently stocked with cattle. Similar agricultural practices occur on adjacent properties along Rodhams Rd and the Olympic Highway.

The predominant land uses surrounding the site are cropping and grazing (refer to the land use map at Figure 3-12. There is also a high land use of residential land (urban land) due to the proximity to Wagga Wagga and surrounding villages.

The land is located within the Riverina Local Land Services (LLS) area (LLS 2020). Land use in the area is described as:

> *mainly agricultural with dry land grazing and cereal based cropping accounting for over 80% of land use. Irrigation farming in the region covers over 5% of the area.*

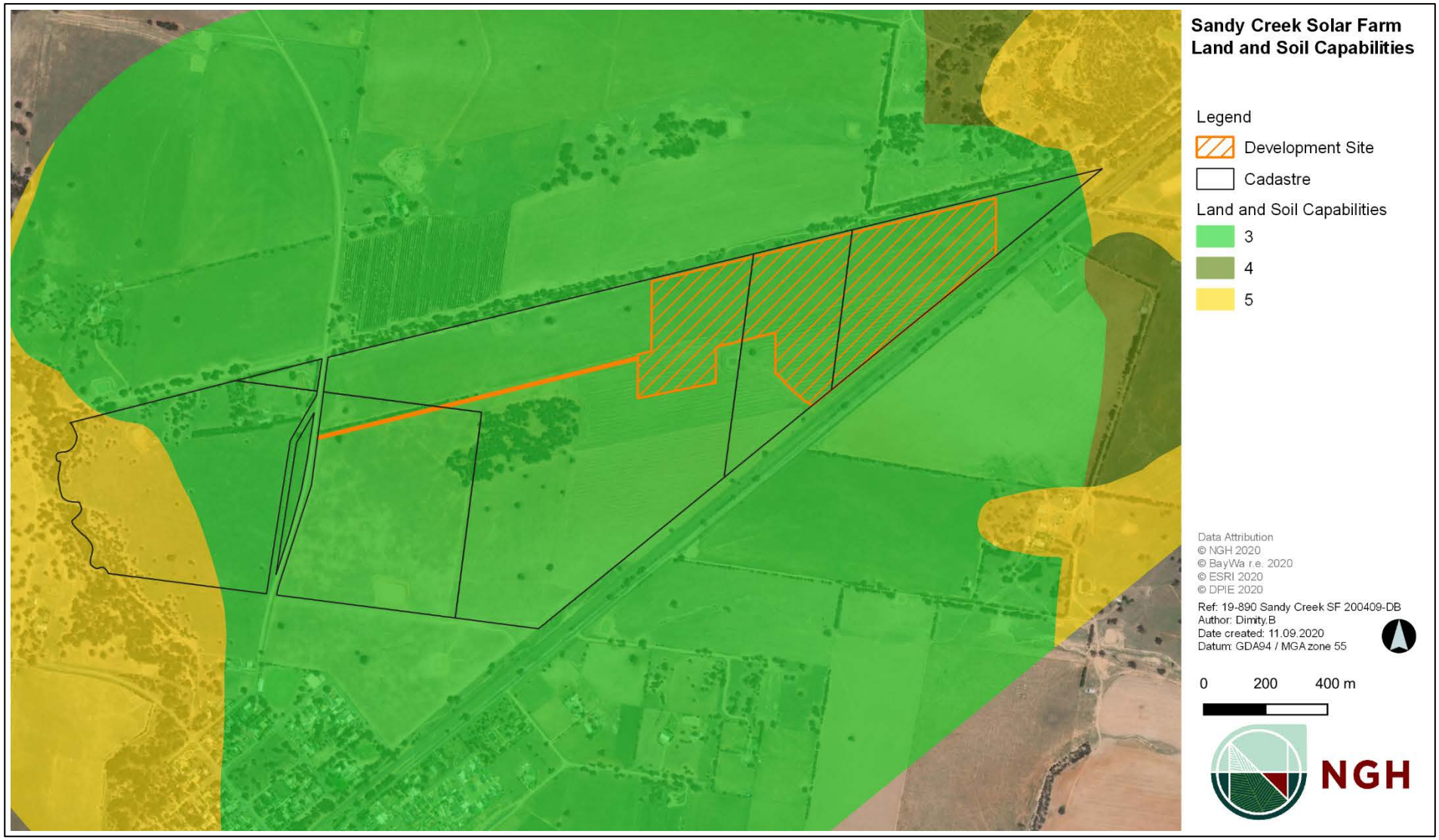


Figure 3-10 Land capability map 1986 (Source: NGH, 2020)

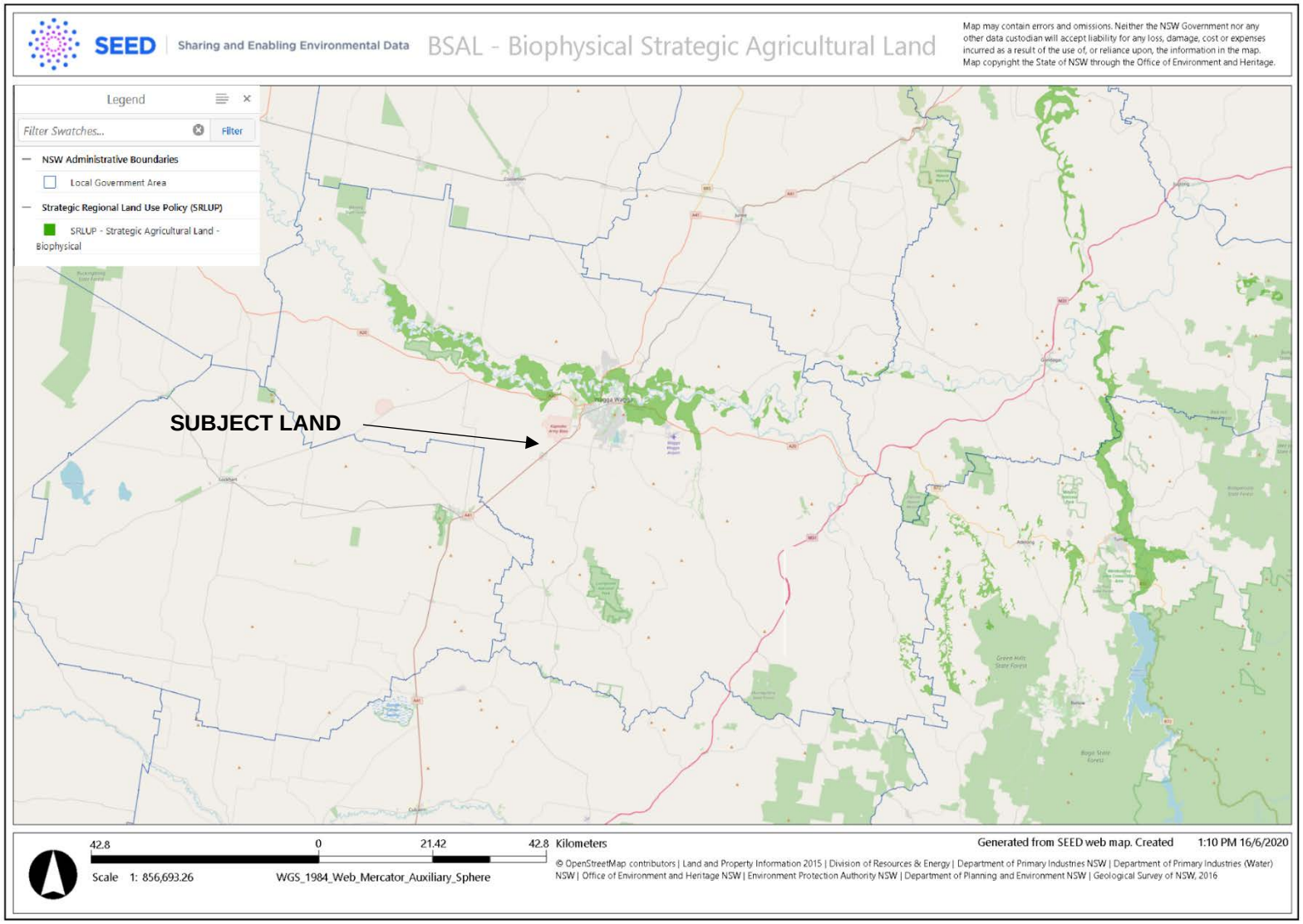


Figure 3-11 BSAL in the wider locality (Source: SEED, 2020)

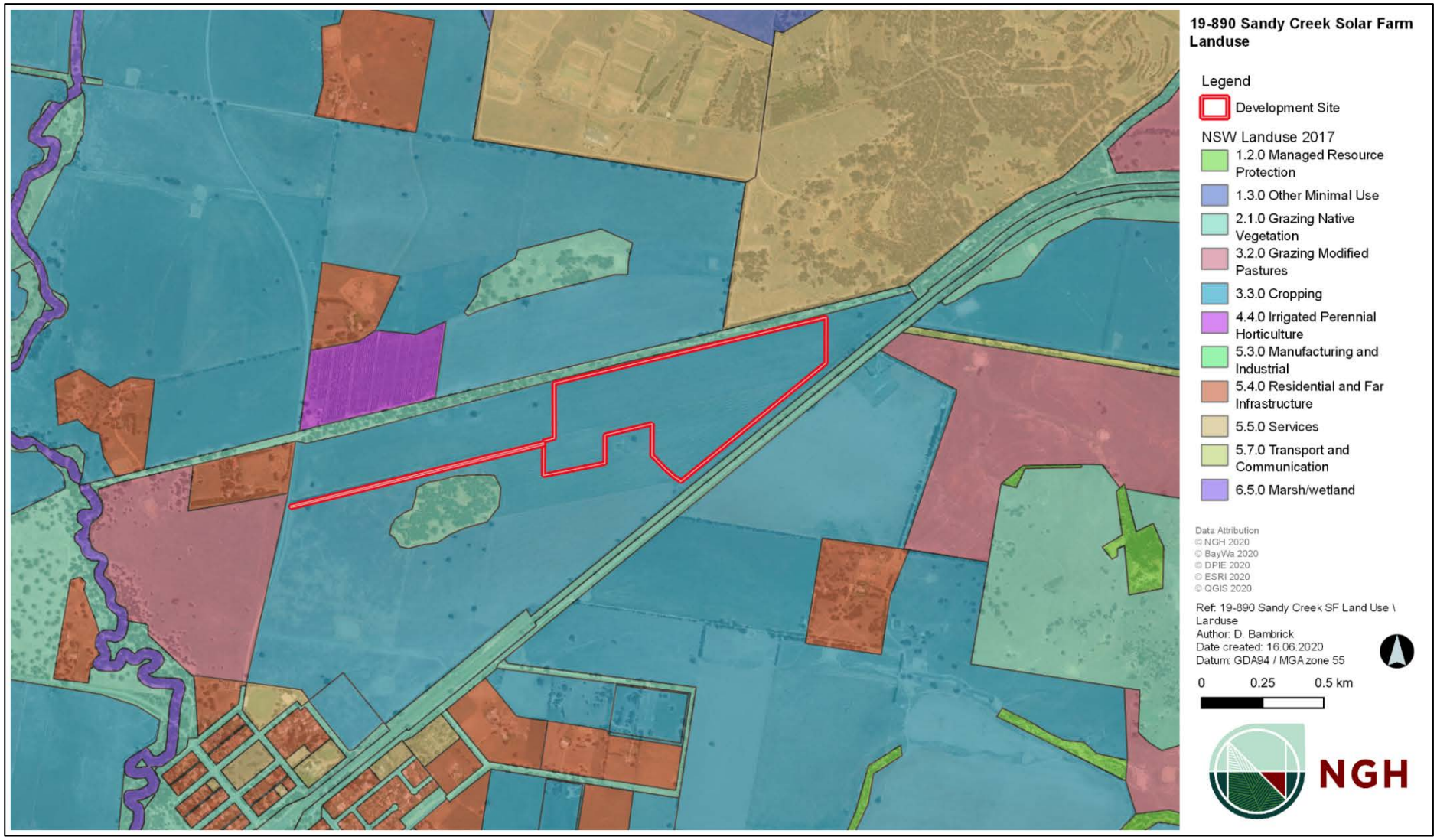


Figure 3-12 NSW Landuse 2017 (Source: NGH, 2020)

3.4.2. Potential impacts and recommendations

Land capability, BSAL and IAL

The proposed development is not expected to adversely affect any of the biophysical factors or hazards which determine land and soil capability. During any broad area or trench excavations at the site, topsoil would be removed, stockpiled separately, and replaced to restore the original soil profile. Following construction, the perennial grass cover would be re-established to protect soils and landscape function. Some soil nutrients may run down over time with the cessation of any pasture fertiliser regime. Soil impacts and mitigation measures are addressed in Section 3.11.

During the operation of the solar farm, soils would be protected, and perennial grass cover would be maintained. Some agricultural production would continue from grazing at the site. The proposal would not permanently change any of the biophysical or socio-economic factors at the site that contribute to BSAL or IAL status. All risks to agricultural land use values (including weeds, soil degradation, pollutants) can be adequately managed and are covered by specific mitigation measures in this SEE.

Land use impacts

Primefact 1063 Infrastructure proposals on rural land (DPI 2013) provides the following guidelines to minimise impacts on agricultural resources and enterprises (summarised):

- Proposals should be clearly justified in a regional context and merits and community benefits identified.
- Agricultural resource lands should be identified and avoided.
- Land use conflicts be minimised.
- Landholders should be effectively consulted during planning, construction and rehabilitation works and the expectations of local communities should be managed.
- Development proposals should identify suitable mitigatory/remediation responses for all likely agricultural impacts.

This SEE has strategically justified the proposal and identified community benefits (refer Section 2.7.2). The proposal would result in reduced agricultural production for the life over the solar farm but would not affect long term capability or use options. Mitigation measures have been incorporated into the design and the proposed operation and management of the development to avoid impacts to long term land capability and land use potential.

The potential sustainable agriculture impacts identified in the Primefact are addressed below in relation to the current proposal.

Resource loss and fragmentation

There are no known mining leases in the vicinity of the subject land. Further, the proposed development is of a nature that would not prevent resource exploitation on surrounding sites or the wider locality. Should valuable resources be present on the subject land, the proposed development would also not compromise the condition of the site such that future resource exploitation would be affected.

It is considered that the impacts of the proposed development are broadly compatible with productive agricultural activities in the surrounding area. The proposal would not impinge on the right to farm on adjacent and nearby properties in the area.

Farming operations and livestock

Grazing may be undertaken amongst the solar panel array, for management of groundcover; thus, the proposed development and traditional primary production have affinity and compatibility. Following decommissioning, the property would be returned to the original agricultural potential (refer below).

Best practice waste and wastewater management, and chemical handling would be applied to prevent potential soil and water pollution (refer to Section 3.11). Construction noise and traffic would be managed to minimise impacts to landholders surrounding the site and located along the access route (refer to Section 3.9). Impacts on soils, erosion and water quality are assessed in Section 3.11 and impacts on local air quality are assessed in Section 3.10. These assessments conclude that the proposal would not be likely to adversely affect land uses or activities on neighbouring properties or elsewhere in the locality, subject to identified mitigation measures.

As indicated above, it is considered that the impacts of the proposed development are broadly compatible with productive agricultural activities in the surrounding area. The proposal would not impinge on the right to farm or the undertaking of routine farm management on adjacent and nearby properties in the area.

The remainder of the subject land (outside of the development site) would also continue to be utilised for livestock grazing.

Weed, biosecurity and bushfire risks

High biosecurity standards would be applied during the construction period, including pre-works weed treatment and maintaining high levels of weed and disease hygiene for construction vehicles, machinery, and materials. Weeds would be monitored and controlled as part of the continuing management of the solar farm site, in line with the recommended protocols in the Biodiversity Assessment.

Risks related to bushfire are assessed in Section 3.6 of this SEE report. The assessment concluded that the proposal would not be likely to introduce significant bushfire risk and any risk would be managed in accordance with the relevant principles of 'Planning for Bushfire Protection'.

Site rehabilitation

At the time of decommissioning, the site would be returned to its pre-developed state. All above ground infrastructure including the solar arrays, inverters and buildings would be removed. Cabling would be removed to a depth of 1,000 millimetres so that cultivation would not be affected. All areas of soil disturbance during decommissioning would be rehabilitated consistent with land use requirements.

A decommissioning plan or strategy would be prepared and submitted to Council for approval prior to operation of the proposed solar farm. The Plan would specifically address the need to return the site to a pre-developed state and fit for agriculture.

LUCRA assessment

The DPI Land Use Conflict Risk Assessment (LUCRA) system is intended to identify and assess the potential for land use conflict between neighbouring land uses (DPI 2011).

The Primefact 1134 Land Use Conflict Risk Assessment Guide (DPI 2011) identifies common issues that can lead to land use conflict. The issues and their reference in this report are identified below:

Rural amenity issues

- Impacts to air quality – refer Section 3.10.
- Noise interfering with the use and enjoyment of neighbouring land – refer Section 3.9.
- Visual amenity – refer Section 3.12.
- Glint, glare, and reflectivity – refer to Section 3.13.
- Traffic (construction and operation) – refer to Section 3.14.

Environmental protection issues

- Soil erosion and water pollution – refer Section 3.11.
- Clearing of native vegetation – refer Section 3.5.

Direct impacts

- Changes to stormwater flows or water availability – refer Section 3.11.
- Management of pest animals and weeds – refer to Section 3.5.

Collectively, the assessments conclude that impact risks to surrounding properties are not likely to be significant, and are manageable using continuing consultation and notification, best practice works methods and identified mitigation measures.

Resource impacts

Construction materials would be sourced locally wherever possible. Gravel would be imported to surface the access road and internal service track network and hardstand. Sand may be required for the bedding of underground cables, depending on ground conditions. Concrete would be required for the switching station equipment, inverter, and transformer foundations. The availability of these resources is not subject to notable decline or limitation in the region.

Any requirement for potable water would be limited and would not place pressure on local drinking water supplies.

Materials used in the fabrication and construction of the solar farm infrastructure would include precast masonry products, steel, aluminium, copper and other metals, glass, plastics and fuels and lubricants. These are common industrial and construction materials. Silicon and silver are the major raw materials for crystalline silicon PV; resource availability is not limiting for these materials (Solar Power Europe 2017a). Most components would be reused or recycled when infrastructure is replaced or decommissioned in accordance with EPA requirements as outlined in Section 2.6.

In view of the nature of the resources, the limited quantities required and the opportunities for recycling, the proposal is unlikely to place significant pressure on the availability of local or regional resources.

There are no known mining leases in the vicinity of the subject land. Additionally, the proposed development is of a nature that would not prevent resource exploitation on surrounding sites or the wider locality. Should valuable resources be present on the subject land, the proposed development would also not compromise the condition of the site such that future resource exploitation would be affected.

3.5. BIODIVERSITY CONSIDERATIONS

A Biodiversity Assessment was prepared by NGH in support of the proposed development and discusses the potential impacts of the proposal on threatened species, populations, or ecological communities in the vicinity of the development site. The report is summarised below and included in full at Appendix C of this report.

3.5.1. Existing conditions

The subject land and surrounding Rodhams Road corridor and Churches Plain Road roadside were initially surveyed in March 2020. Sixty-five flora species were detected within the proposal area in total comprised of 34 exotic and 31 native species. Five bird species, one mammal (European Rabbit, *Oryctolagus cuniculus*) and one reptile (Goanna, Varanus sp.) were observed during field surveys. The Superb Parrot (*Polytelis swainsonii*) was observed from the Rodhams Road corridor.

No fauna habitat was identified within the development site, though is located within and adjacent to the subject land. The main habitat types identified were Box-Gum Woodland native vegetation (PCT 267), hollow bearing trees and planted vegetation.



Figure 3-13 Site view of the southern side of the property, showing historically cropped paddocks (Source: NGH, 2020)



Figure 3-14 Site view of the northern side of the property, showing historically cropped paddocks (sheep were grazing this area) (Source: NGH, 2020)



Figure 3-15 Site view of the western access track, showing planted native vegetation (Source: NGH, 2020)

Land comprised by the development site was considered to be Category 1-exempt land, as defined under the LLS Act (Part 5A Division 2 Section 60H), being:

- Land legally cleared at or since 1st Jan 1990 (Woody vegetation only).
- Significantly disturbed or modified since 1990 (Non-woody vegetation).
- Low Conservation Grasslands.
- Land containing only low conservation groundcover (not being grasslands).
- Native vegetation identified as regrowth in a Property Vegetation Plan (PVP) under the repealed *Native Vegetation Act 2003.*
- Land biodiversity certified under the BC Act.

An assessment was prepared to evaluate the land categorisation for the proposal area. This is included in the accompanying Biodiversity Assessment.

3.5.2. Potential impacts

The proposed development would involve the removal of approximately 42 hectares of non-native vegetation including exotic pastures and crops. The development site has been refined to avoid all existing trees. Direct impacts to native vegetation have been avoided by the proposed development; however, the disturbance of groundcovers would constitute the removal of potential foraging habitat for fauna.

No threatened flora species, one threatened ecological community (TEC) and one threatened fauna species was observed during the site survey. The results of background searches identified 24 flora species, 4 Endangered Ecological Communities (EECs), 71 fauna species and 1 endangered population with the potential to occur within the locality. Assessments of Significance were conducted for certain species, either observed or considered likely to occur based on habitat or records, under the BC Act and EPBC Act to determine if the impacts are likely to be significant. The assessments concluded that there is unlikely to be a significant impact to these species, given that:

- The amounts of habitat to be removed or disturbed by the proposal is relatively small in the local context.
- No fragmentation or isolation of habitat would occur.
- No substantial contribution to any key threatening process would be expected.
- Mitigation measures would be implemented to prevent disruptions to the life cycle or harm to individual animals of these species.
- The proposal would not interfere with the recovery of these species.

3.5.3. Recommendations

Through siting and design, the proposed development would avoid notable impacts on threatened species, populations, or ecological communities in the vicinity of the site. Minor mitigation measures are incorporated into the Biodiversity Assessment to manage the priority weed identified on the development site and prevent the introduction of other weeds, unexpected species find protocols and protection of nearby native vegetation.

The proposed development would not exceed the relevant thresholds under the BC Act. The site is not located in an Area of Outstanding Biodiversity Value (AOBV). The development would not have a significant effect on threatened species according to the test under Section 7.3 of the Act, nor would the Biodiversity Offset Scheme (BOS) thresholds be exceeded. No further biodiversity assessment is required.



Figure 3-16 Mapped Plant Community Type (PCT) and proposed extent of direct impacts (Source: NGH, 2020)

3.6. BUSHFIRE

A Bushfire Assessment report was prepared by an accredited bushfire consultant in support of the proposed development. The report is summarised below and provided in full at Appendix D.

3.6.1. Existing conditions

A portion of the subject land is mapped as bushfire prone land on the Wagga Wagga City Council (WWCC) Bush Fire Prone Land (BFPL) map. The subject land comprises bushfire prone land, and is in close proximity to Category 1 (red) vegetation, as identified in Figure 3-17 below.



Figure 3-17 Bushfire prone land near the development site (NSW Planning Portal, 2019)

Areas of vegetation in relation to the subject land are identified below:

Hazard vegetation - located north-east of and within the centre of the subject land is identified as Western Slope Grassy Woodland. An isolated area of woodland vegetation also exists within the subject land, south west of the development site. In accordance with Keith (2004), the vegetation would be assessed as Woodland for assessment under PBP. Furthermore, due to the regional and agricultural context of the subject land, Grassland vegetation is present in all other areas surrounding the subject land.

Non hazard vegetation – categorised as managed land, is present in isolated areas, typically due to the construction of access roads and railway infrastructure. Furthermore, a proposed landscape buffer (proposed to be 5m in width) is identified around part of the proposed site perimeter (namely along the southern and eastern edge). If this vegetation is provided in a single formation (i.e. a windbreak), it would be considered low-threat vegetation in accordance with A.1.10 of PBP and is therefore excluded from this assessment.

An FFDI of 80 applies to the Eastern Riverina region, as set out in the NSW RFS' NSW Local Government Areas FDI (2017).

Vegetation and slope are indicated in the Bushfire Site Plan (Figure 3-18).

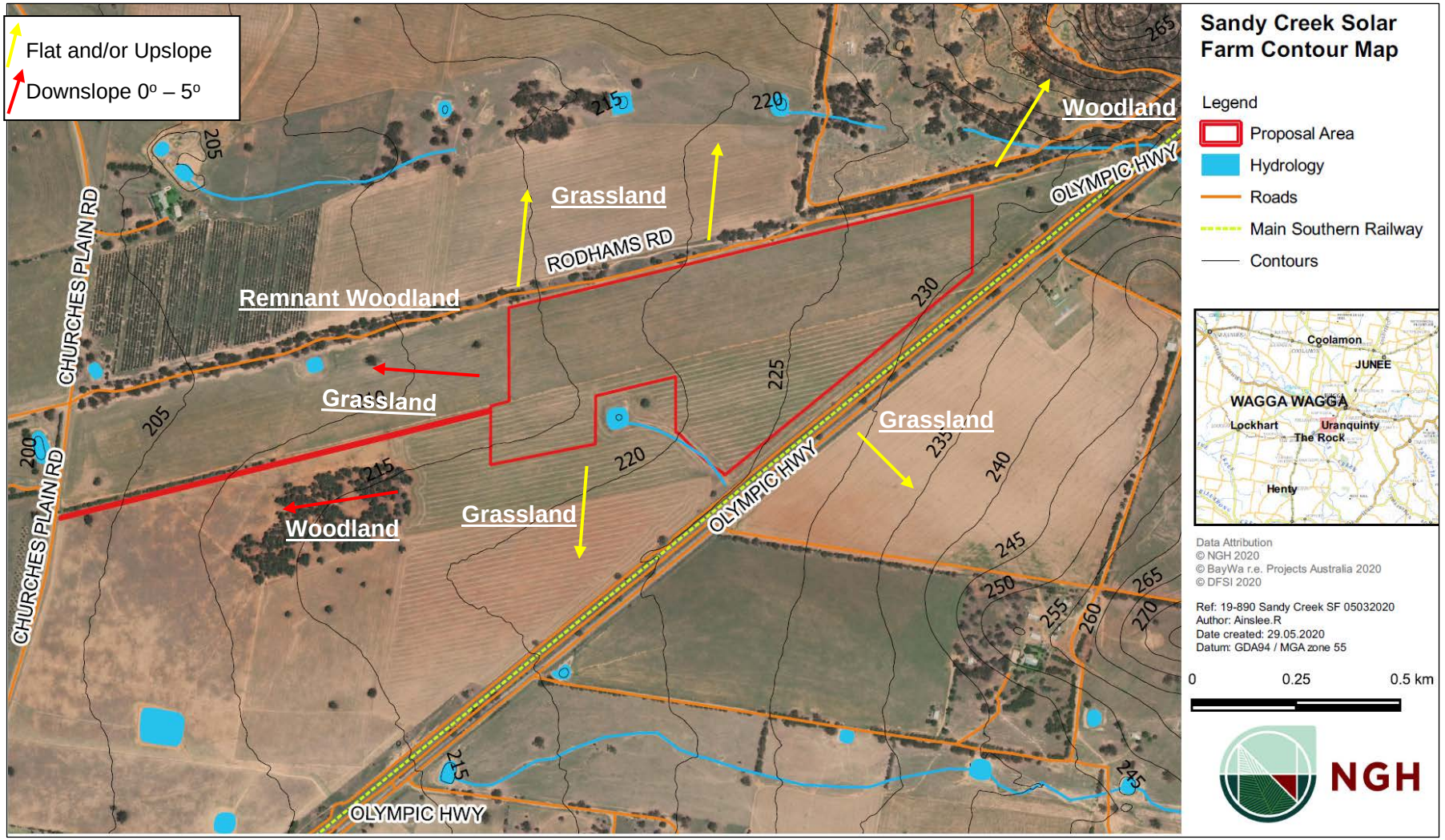


Figure 3-18 Bushfire site plan (Source: NGH, 2020)

The appropriate classes of vegetation, slope and achievable setbacks are identified in Table 3-1 below.

Table 3-1 Determination of achievable Asset Protection Zones for the proposed development.

Direction	*Vegetation*	*Slope*	*Minimum Setback required to conform to Solar Farm APZ specifications*	*Achieved setback (APZ) for proposed development*
North	Grassland	Upslope	10m	10m
North East	Woodland	Upslope	10m	10m
East	Grassland[1]	Upslope	10m	10m
South	Grassland	Flat	10m	10m
South West	Woodland[2]	Downslope 0º – 5º	10m	10m
West	Grassland	Downslope 0º – 5º	10m	10m

3.6.2. Recommendations

The proposed development has been assessed against the appropriate provisions of PBP Chapter 8 specifications, specific to solar farm development sites. The proposed development can conform to the specifications outlined in Section 8.3.5 of PBP.

The following recommendations were made by NGH's accredited bushfire consultant to adequately manage bushfire risk in regard to the proposal, in conjunction with approval conditions from the relevant statutory authorities. These would be implemented as required during the construction and operation of the proposed solar farm.

The proposed development would incorporate the following mandatory bushfire protection measures into its design and operational plans.

Asset Protection Zones

With reference to Section 8.3.5 of PBP a minimum 10m wide area adjacent the proposed solar array footprint (as identified in Appendix A), in addition to an area provided around ancillary buildings, shall be managed in perpetuity as an APZ to Inner Protection Area standards, in accordance with Table 7.4a & Appendix 4 of PBP, refer to the summary provided the bushfire Assessment report in Appendix D.

Landscaping

Future landscaping shall be in accordance with Appendix 4 of PBP, to ensure APZ specifications are not compromised.

Emergency Management

A Bush Fire Emergency Management and Operations Plan would outline appropriate management and maintenance of bushfire protection measures, for the life of the development. This plan should be developed in consultation with local NSW RFS or Fire & Rescue NSW.

In addition to the mandatory measures identified above, bushfire protection measures identified below were recommended to improve property protection measures and to ensure suitable access is provided for emergency services, in addition to facilitating the egress of the construction and/or operational workforce.

Access

Property access and internal access arrangements should comply with the design specifications of Table 7.4a of PBP, to ensure access to the site is suitable for emergency response vehicles.

Water and Utilities (Electricity and Gas)

Water supply requirements shall comply with Table 7.4a of PBP.

A water supply no less than 20,000L (stored in a non-combustible storage tank), shall be provided to improve property protection measures and/or to act as a static water supply for emergency services.

Electricity and Gas where provided within the defendable space, shall comply with Table 7.4a of PBP, where practicable.

Construction Standards

Construction standards prescribed under AS 3959 do not apply to ancillary buildings within the proposal. Notwithstanding this, it is recommended that essential equipment be housed, or stored, so not to contribute to spreading fire to nearby vegetation.

3.7. FLOOD AND OVERLAND FLOW

The subject land is not mapped as subject to riverine flooding and is not considered to be within the Flood Planning Area (FPA) according to the Wagga Wagga Local Environmental Plan 2010 provisions. A flood impact assessment is not considered to be required.

A Hydrology Assessment (BayWa 2019) was prepared by the proponent, to consider the potential overland flow flood risk posed by Sandy Creek and its tributaries. A Preliminary Runoff Assessment (Xeros Piccolo, 2021) was prepared to consider the post-development effects on outlet flood magnitude and volume. A summary of both assessments is provided below, and the full reports provided at Appendix G and H.

3.7.1. Existing conditions

A flood study of Sandy Creek was commissioned by Wagga Wagga City Council in 2015. The study has modelled and mapped the extent of a 1 percent AEP flood of Sandy Creek. It indicates the 1 percent AEP event impacts southern and western parts of the subject land but would not affect the development site.

Following the significant flood event in October 2010, a review on the towns and villages was prepared for NSW State Emergency Service in 2012. The flooding behaviour was mapped, the floodwater mainly travelled along the north-west direction and down Olympic Highway. Having an elevation difference between Uranquinty (200mAHD) and the proposed development site (230m AHD), the risk of flood at the project site is considered low.

The development site is in a region that experiences flooding through runoff accumulation. Water is expected to travel overland towards areas of lower elevation, along creek lines, and flow is likely to be greatly attenuated where the land is vegetated. In times of high flood, the floodwaters can pool and persist for long periods on flat land, however due to the proximity of Sandy Creek, and the steepness of the land sloping down towards the creek, overland flow is likely to dissipate away from the project site.

Churches Plain Road, particularly where the Uranquinty levee crosses the road, is subject to some minor flooding of up to 300 mm approximately. This should not pose a risk to the movement of vehicles.

3.7.2. Potential Impacts

The proposed solar farm (in its entirety), including the solar array and supporting infrastructure, would be located on land that is above the 100yr ARI flood level and is not likely to be impacted by localised flooding or overland flow impacts.

Due to the higher elevation of the development site relative to the surrounding watercourses, and the slope of the site, neither overbank flooding of the Murrumbidgee River or Sandy Creek, nor runoff accumulation pose a significant risk to the development on site.

The preliminary runoff assessment prepared by Xeros Piccolo indicates that post-development flows for the 1% AEP storm event can be limited using a small stormwater detention system so as not to exceed the pre-development flows. The system would comprise a combined basin volume of up to 1,100 cubic metres and indicative locations, subject to detailed drainage design, are shown on the accompanying plans. However, this detention would also severely restrict downstream stormwater flows for smaller, more frequent events such as the 10% AEP storm event. Council may wish to consider whether detention is required for this setting.

3.7.3. Recommendations

The following recommendations are proposed to mitigate and manage overland flow impacts, and would be considered in the design and construction of the facility:

- Ensure groundcovers are re-established post-construction to manage any areas of disturbance.
- Where engineered surfaces are constructed, the edges would be tapered to allow for runoff to disperse to the surrounding land and follow natural flow paths. Refer also to typical details provided.
- Final designs and calculations would be provided prior to the commencement of works to ensure stormwater runoff would be managed to Council's satisfaction.

3.8. CONSIDERATION OF OTHER HAZARDS

3.8.1. Land slip

The subject land does is not located within a mine subsidence district, nor is it on land mapped as landslide risk land. There is no evidence of historical landslips or similar issues.

3.8.2. Acid sulfate soils

A review of NSW acid sulfate soils hazard mapping confirmed that the subject land has low and extremely low probability of occurrence and is not considered at risk (ASRIS 2013).

3.8.3. Land contamination

A search of the NSW EPA contaminated land public record of notices (NSW EPA 2020a) identified 4 records within Wagga Wagga LGA. No records are located within or near Uranquinty, with the closest being the former gasworks at 54 Chaston Street, Wagga Wagga, 8.4km to the north of the subject land.

A search of the list of NSW contaminated sites notified to the EPA (NSW EPA 2020b) returned one site near Uranquinty, being the former Caltex depot Kapooka, located at 6876 Olympic Highway, 3.4km to the north of the subject land.

It is considered these sites are well separated from the development site and would therefore not impact the proposed development by way of contaminated land.

The subject land has been utilised for agricultural activities, specifically cropping. Agricultural activities are listed as a potentially contaminating land use activity according to Table 1 of the Managing Land Contamination

Planning Guidelines. There may be a risk that contamination associated with small-scale cropping is present on the site. Refer also to the provisions of SEPP No.55 – Remediation of Land addressed in Section 4.2.6.

3.8.4. Electromagnetic fields

Background

Electromagnetic fields (EMFs) consist of electric and magnetic fields and are produced whenever electricity is used. Fields of different frequencies interact with the body in different ways. EMF field sources to which people may be exposed are predominantly in three frequency ranges. The Extremely Low Frequency (ELF) range of 0-300 Hz incorporates the 50 and 60 Hz frequencies of the electric power supply and of electric and magnetic fields generated by transmission lines and other electrical devices and infrastructure (Repacholi, 2003).

While it is accepted that short-term exposure to very high levels of electromagnetic fields can be harmful to health, the International EMF Project, established by the World Health Organisation, has thus far concluded that there are no substantive health consequences from exposure to ELF electric fields at the low levels generally encountered by the public (World Health Organization, 2007), such as those that would be produced by electricity generation in connection with the proposed development. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA, 2015) advises that 'the scientific evidence does not establish that exposure to ELF EMF found near power lines is a hazard to human health'.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) published Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300GHz) in 1998, updated 2020. The objective was to establish guidelines for limiting EMF exposure that would provide protection against known adverse health effects. ICNIRP recommends limiting exposure to these fields so that the threshold at which the external electric and magnetic field causes adverse effects inside the body is never reached.

The exposure limits, called basic restrictions, are related to the threshold showing adverse effects, with an additional safety factor. The exposure limits outside the body are called reference levels. These are derived using worst-case exposure assumptions, such that, remaining below the reference levels (in the air) implies that the basic restrictions would also be met (in the body) (ICNIRP 2020).

Research into electric and magnetic fields undertaken at utility scale photovoltaic installations in California by Chang and Jennings (1994), indicated that magnetic fields were significantly less for solar arrays than for household applications. Chang and Jennings (1994) found magnetic fields from solar arrays were not distinguishable from background levels at the site boundary, suggesting the health risk of EMFs from solar arrays is minimal.

Potential impacts

The assessment focuses on the potential for health impacts. The EMFs emitted by the solar farm would not be likely to interfere with local mobile phone, radio, or television reception. These devices operate at a much higher frequency than the AC electrical equipment that would be used at the solar farms, and any EMFs produced would dissipate rapidly with distance from the source.

Potential for EMF impacts occurs only during the operational phase of the solar farm when electrical infrastructure generating EMFs. In relation to potential occupational exposure for solar farm personnel, the electromagnetic fields would vary in different locations at the site. The proposal includes the following components that could generate EMFs:

- 4 x SMA SC-4400-UP medium voltage power stations and inverters or equivalent.
- the solar array (operating at a voltage of up to 1.5kV DC).

Typical and maximum EMF levels for these types of infrastructure are discussed below. As noted above, strength attenuates with distance from the infrastructure.

The closest non-associated non rural use (non-residential – model aeroplane club) is approximately 150 metres south east of the subject land, the closest residential receptor is 800m to the south-west. The solar farm would be fenced, with no public access. During the operation phase, the solar farm would require one offsite contractor to attend the site on occasion.

Overhead powerlines

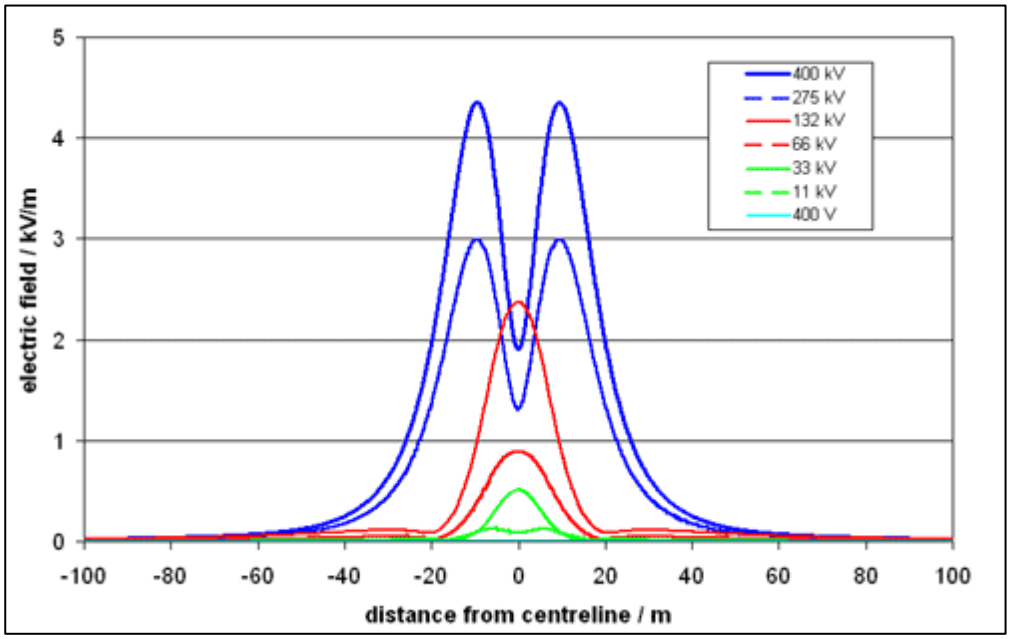


Figure 3-19 Typical electric fields from overhead powerlines (Source: EMFs.info 2017)

Figure 3-19 and Figure 3-20 and Table 3-2 show a range of magnetic field levels measured by the ARPANSA around powerlines and substations. The recommended 200µT and 1000µT limits are not exceeded, even if directly underneath the powerline. Only a short overhead powerline connection is proposed, to connect to the solar farm to the existing 22kV powerline along the Olympic Highway.

Table 3-2 Typical magnetic fields near overhead powerlines and substations

Source	*Location of measurement*	*Range of measurement*	
		(mG)	**(µT)1**
HV Transmission line	Directly underneath	10 - 200	1 - 20
HV Transmission line	At edge of easement	2 - 50	0.2 - 5
Substation	At substation fence	1 - 8	0.1 – 0.8

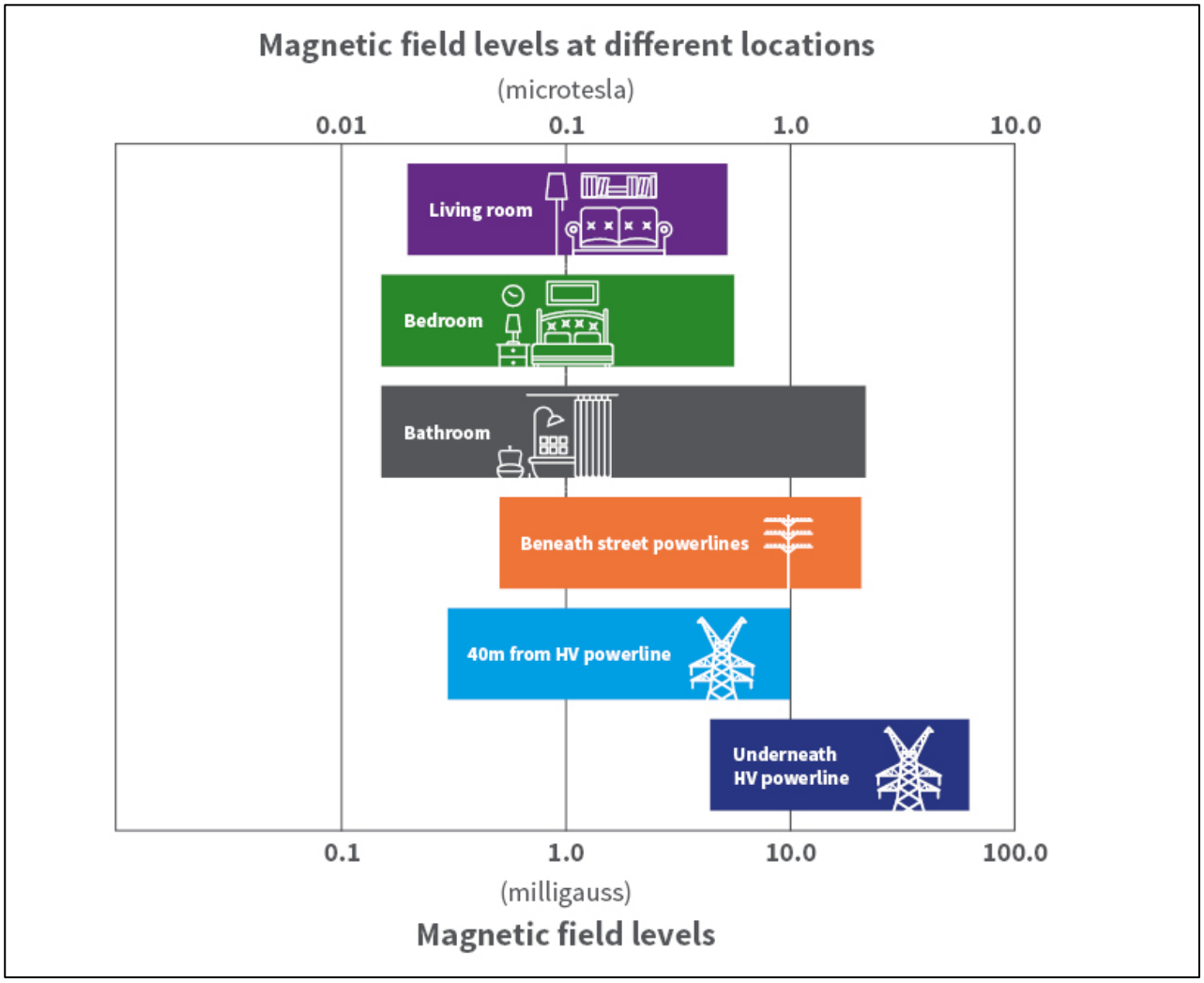


Figure 3-20 Magnetic field levels at different locations (Source: ARPANSA 2015)

[1] Converted from mG where 1 mG = 0.1 µT.

Underground cabling

The proposed development would require the installation of underground cables (of varying voltages up to 22 kV) within the solar array External electric fields from underground cables are attenuated by the soil.

National Grid (EMFs.info 2020) provides typical magnetic field data for a single 11kV and 33kV underground cables at 0.5m depth (as 22kV data is not available, 11kV and 33kV are used as best- and worst-case scenario information). As illustrated in the table below, the magnetic fields generated by underground cabling would be considerably less than the recommended limits of 200 µT and 1000 µT.

Table 3-3 Magnetic field levels from underground 11kV cabling (National Grid, n.d.)

Magnetic Field (µT) at distance from centreline			
0 m	5 m	10 m	20 m
0.75	0.22	0.11	0.06

Table 3-4 Magnetic field levels from underground 33kV cabling (National Grid, n.d.)

Magnetic Field (µT) at distance from centreline			
0 m	5 m	10 m	20 m
1.00	0.29	0.15	0.07

Inverters and transformers

Based on the current design, four inverters would be installed on site. Each inverter would have a total output of up to 5 MVA (AC). The inverter would typically have an AC power frequency range between 47 and 63 Hz and fall into the Extremely Low Frequency (ELF) range of 0-300 Hz. Within this range, EMFs are not considered to be hazardous to human health.

Additionally, the inverter would be containerised and located within the fenced solar farm site with no public access. It would produce power only during the daytime, reducing the total time that EMFs are generated by the infrastructure.

Solar array

The solar farm would require installation of DC cables between the solar panels and the inverters. This wiring may be above ground or underground and would typically conduct less than 500A and 1500V. The potential for electromagnetic interference as a result of the aboveground and underground cable is considered to be negligible.

3.8.5. Hazardous materials

SEPP 33 Hazardous and Offensive Development requires a Preliminary Hazard Assessment (PHA) to be prepared for potentially hazardous or offensive development. The SEPP 33 guideline (DOP 2011) assist in determining whether a development is considered to be potentially hazardous or offensive.

Appendix 3 of the guideline lists industries that may fall within SEPP 33; the guidelines do not include solar farms. Appendix 2 of the guidelines provides a risk screening procedure and a checklist to identify potentially

hazardous or offensive development in instances where the applicability of SEPP 33 is not immediately apparent. The SEPP 33 screening procedure is broadly based on the quantity of dangerous goods stored or transported, the frequency of transportation movements and, in some cases, the distance of the materials from the site boundary.

The dangerous goods that would require transportation and storage, if required during construction or operation of the proposed solar farm, are addressed in the table below.

Table 3-5 Dangerous goods and SEPP 33 thresholds relevant to the proposal

Hazardous material	***Storage threshold***	***Transport threshold***		***Storage arrangements***	***Exceeds thresholds?***
		Movements	*Quantities*		
Class 2.1 Flammable gases					
LPG	10 tonnes or 16m^3 (above ground)	>500 cumulative >30/week	2-5 tonnes	Up to 45kg cylinders beside control building, at least 20 metres from boundary.	No
Class 6.1 Toxic substances (PG II, III)					
Pesticides (herbicides)	2.5 tonnes	All	1-3 tonnes	Secure store at least 20 metres from boundary.	No

In terms of the class, transportation and storage of dangerous goods, the proposal would not exceed SEPP 33 thresholds and would not require the preparation of a PHA. SEPP 33 indicates that the proposed development would not be considered potentially hazardous.

The proposed development is not considered to meet the definition of potentially offensive development according to the SEPP 33 provisions. The proposed development would result in vehicle and machinery exhaust emissions during the construction phase, as in any construction project. The emissions occur outside, in a rural locality, and would be readily dispersed. Noise impacts would also largely be confined to standard working hours during the construction phase and would not be hazardous to employees or neighbouring residents. Water pollution risks are assessed as low, subject to identified mitigation measures, with the re-establishment and maintenance of groundcover across the sites (refer Section 3.11). These factors indicate that the proposal would not be considered potentially offensive development.

3.9. NOISE

3.9.1. Approach and Existing Environment

A qualitative and quantitate noise impact assessment has been prepared to assess the potential impacts of the proposed development on sensitive receivers during construction and operational phases.

Sensitive Receivers

Residential and non-residential sensitive receivers within 1km of the development site were identified from aerial photography, topographic maps and an inspection of the development site and surrounding publicly accessible areas. These receivers are shown in Figure 3-21.

The subject land is located in a rural setting, which is typified by a sparse settlement pattern and low background noise levels (EPA 2017). Surrounding land zones include:

- RU1 Primary Production.
- RU5 Village.
- SP2 Infrastructure (Defence).
- SP2 Infrastructure – Uranquinty cemetery, Waste disposal facility, sewage treatment plant and electricity generating works.

Residential receivers

The Uranquinty village is located 1 km southwest of the development site. Forty-seven residential receivers were identified within 1km of the development site. Nine of those receivers are residential properties associated with agricultural production, the remaining 38 are urban residential properties in the village of Uranquinty.

The closest receiver is an associated receiver, residing on land subject to the proposed development and consents to the proposal. The dwelling is located approximately 260m west of the internal access road and 1.2km from the development site. The closest non-associated receiver is located approximately 650m north of the proposed access road and the closest receiver to the development site is approximately 800m southwest. A caravan park on the edge of Uranquinty township is located approximately 1.2km southwest of the development site.

Non-residential receivers

Public services within Uranquinty and within the 1km buffer include Uranquinty Public School, Uranquinty cemetery and Uranquinty sportsground/playground, tennis courts and soccer field. The waste disposal facility, sewage treatment plant and electricity generating works are outside the 1km buffer of the development site.

Defence land (Blamey Barracks) is adjacent to the north east boundary of the development site.

The following typical background noise levels, referred to as Rating Background Levels (RBL) for rural settings have been derived from Table 2.3 of the NSW EPA Noise Policy for Industry (NPI):

Rural Residential RU1		Suburban Residential RU5	
• Daytime RBL	<40 dB(A)	• Daytime RBL	<45 dB(A)
• Evening RBL	<35 dB(A)	• Evening RBL	<40 dB(A)
• Night RBL	<30 dB(A).	• Night RBL	<35 dB(A).

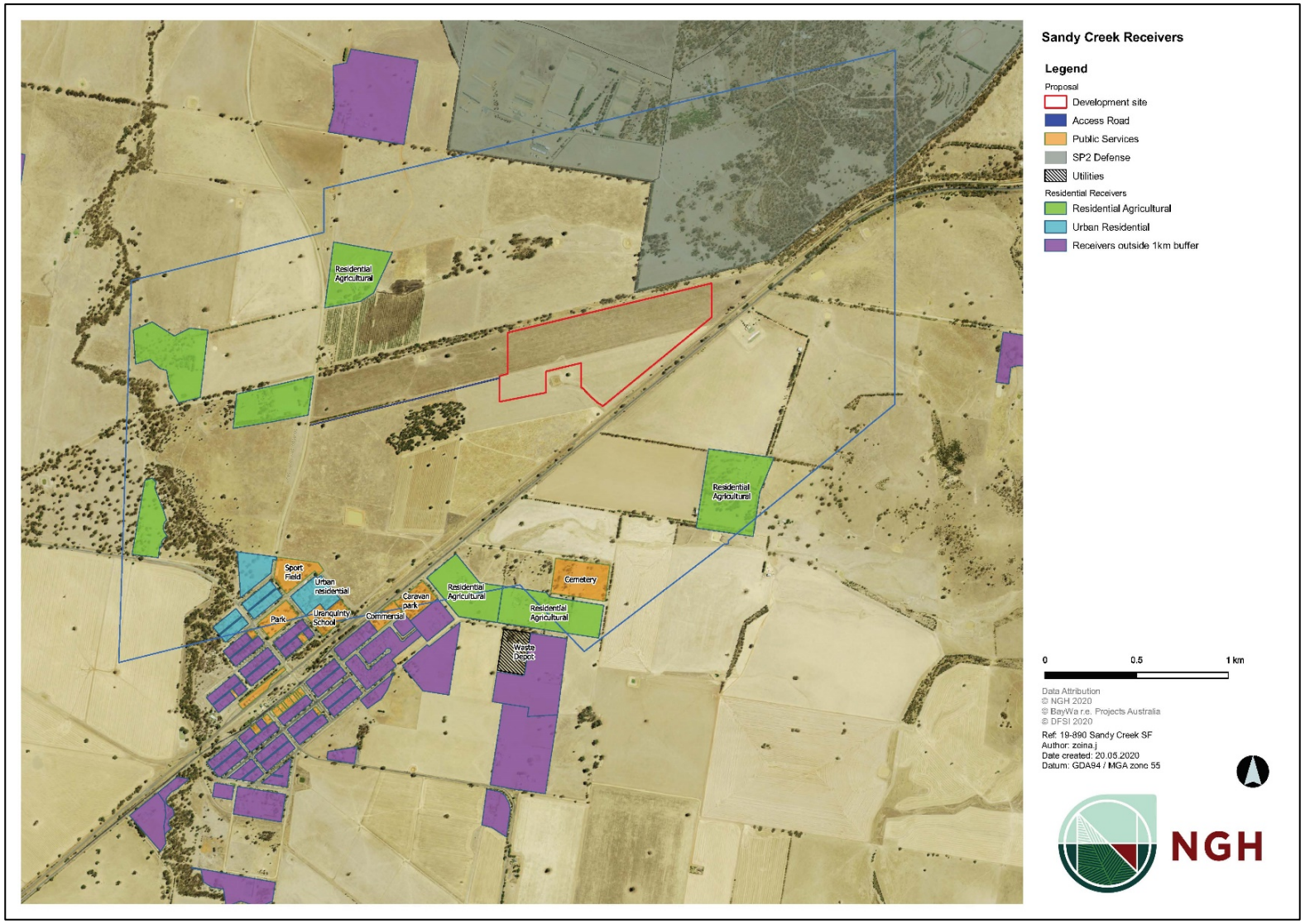


Figure 3-21 Sensitive receivers within 1km of the development site (Source: NGH, 2020)

Construction assessment approach

The quantitative construction noise assessment has been conducted in accordance with the *Interim Construction Noise Guidelines* (NSW and Department of Environment and Climate Change (NSW) 2009) (ICNG) and *Construction Noise and Vibration Guideline* (Roads and Maritime Services (NSW) 2016).

The ICNG was developed by the Department of Environment & Climate Change (now Department of Planning, Industry and Environment (DPIE)) and contains detailed procedures for the assessment and management of construction noise impacts. The ICNG is a non-mandatory guideline that is usually referred to by local councils and other NSW government entities when construction /demolition works require development approval.

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) for sensitive receivers based on the existing background noise in the area. The NMLs are not mandatory limits, however, where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

The ICNG approach for determining NMLs at residential receivers is shown in Table 3-6 below.

Table 3-6 ICNG NMLs for residential receivers

Time of Day	***NML*** $L_{Aeq(15minute)}$	***How to Apply***
Standard Construction Hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	RBL + 10 dB	• The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practises to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly Noise Affected 75 dBA	• The Highly Noise Affected (HNA) level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, considering: o Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences. o If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Standard Construction Hours	RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1: The RBL is the Rating Background Level and the ICNG refers to the calculation procedures in the NSW Industrial Noise Policy (INP). The INP has been superseded by the NSW EPA Noise Policy for Industry (NPfI).

A number of non-residential land uses have been identified in the study area and some of these 'other sensitive' uses are considered sensitive to potential noise impacts. The ICNG NMLs for 'other sensitive' receivers are shown in Table 3-7 below.

Table 3-7 ICNG NMLs for other sensitive receivers

Land Use	Noise Management Level $L_{Aeq(15minute)}$ (Applied when the property is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dBA[1]
Hospital wards and operating theatres	Internal noise level 45 dBA[1]
Places of Worship	Internal noise level 45 dBA[1]
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion)	External noise level 60 dBA
Community centres	Refer to the recommended 'maximum' internal levels in AS 2107 for specific uses
Commercial	External noise level 70 dBA
Industrial premises	External noise level 75 dBA

Note 1: The criteria is specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that all schools and places of worship have openable windows and external noise levels are 10 dB higher than the corresponding internal level, which is representative of windows being partially open to provide ventilation. Hospital wards are assumed to have fixed windows with 20 dB higher external levels.

Works are recommended to be completed during Standard Construction Hours where possible. More stringent requirements are placed on works that are required to be completed outside of Standard Construction Hours (i.e. during the evening or night-time) which reflects the greater sensitivity of communities to noise impacts during these periods

The ICNG recommend standard hours for construction activity as detailed in Table 3-8.

Table 3-8 ICNG recommended construction hours

Work Type	Recommended standard hours of work
Normal construction	Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays

Based on the above and the RBL determined from the NPfI, construction noise monitoring levels are then derived. To ensure a conservative assessment for noise impacts, the RBL for RU1 has been used.

Table 3-9 Construction noise monitoring goals

Receiver	*Day*	*Day (OOHW)*	*Evening*	*Night*
Noise Management Level (NML)	50	45	40	35

The Roads and Maritime Services Noise Estimator was used to estimate the noise emissions from the proposed work. The parameters used to estimate noise emissions from the proposal were:

- Noise area category of RU1 was selected to represent the rating background level (RBL) of the proposal site. The Olympic Highway had a traffic count of 4,178 average daily vehicles in 2010 and is therefore considered to be a moderately trafficked rural road with few other noise emitters in the vicinity.
- Receivers were considered to have a line of sight to the proposal.
- The subject land was considered rural.

A distanced based (scenario) estimation was used, based on the predefined scenario of 'Construction compound site establishment' (119 dB(A) sound power level (SWL)). This construction scenario is based on the use of plant and equipment, largely similar to the equipment of this proposal (refer to Section 2.4.3).

Operation assessment approach

Noise impact for operation has been assessed against the NSW Noise Policy for Industry (NPI) (EPA 2017). The assessment has two components.

- Intrusive noise levels.
- Amenity noise levels.

The process is summarised below:

1. Determine the project noise trigger levels for a development.
   - these are the benchmark levels above which noise management measures are required to be considered.
   - the benchmarks are derived by considering two factors: shorter-term intrusiveness due to changes in the noise environment and maintaining the noise amenity of an area.
2. Predicting or measuring the noise levels produced by the proposed development.
3. Comparing the predicted or measured noise level with the project noise trigger level (step 1) and assessing the need for noise mitigation and management measures.
4. Considering the residual noise impacts.
5. Setting statutory compliance levels that reflect the best achievable and agreed noise limits for the proposed development.
6. Monitoring and reporting environmental noise levels from the proposed development.

Trigger Noise levels for operational noise consider various circumstances that result in certain impacts. Intrusiveness noise levels are a guide of the intrusive noise from a project to be expected above the RBL. Project amenity noise levels describe the cumulative levels associated with a single project. The aim is to limit cumulative noise impacts from industry and maintain amenity for particular land uses.

Intrusiveness level

According to the NPI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the LAeq,15min descriptor) does not exceed the background noise level measured in the absence of the source by more than 5dB(A). The project intrusiveness noise level, which is only applicable to residential receivers, is provided in Table 3-10.

Table 3-10 NSW Noise Policy for Industry intrusiveness goals.

Time of day	*RBL dB(A) L_{A90}*	*Intrusive noise = RBL + allowance*	*Minimum Project intrusiveness noise levels (L_{Aeq},15min dB(A))*
Day	40	= RBL + 5	45
Evening	35	= RBL + 5	40
Night	30	= RBL + 5	35

Amenity level and recommended amenity noise level

The NPI outlines recommended amenity noise levels to maintain the amenity for an area. The recommended amenity noise level represents an objective for total industrial noise at a receiver location, the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

The project amenity noise levels for proposed new industrial noise sources is calculated by the recommended amenity noise level minus 5 dB(A); refer Table 3-11.

Table 3-11 Amenity noise levels for residential receivers in a rural setting (EPA 2017)

Period	*Recommended level L_{Aeq} dB(A)*	*Project level L_{Aeq} dB(A)*
Day (7am-6pm)	50	45
Evening (6pm-10pm)	45	40
Night (10pm-7am)	40	35

The NPI states that increases of 2 dB(A) or less do not require assessment. Further, the trigger level is not intended under the NPI methodology to be a limit, but rather, to provide guidance of a threshold where the affected receptor may experience an adverse impact and mitigation measures should be considered.

3.9.2. Potential Impacts

Construction

Construction works would be restricted to daytime, standard work hours. The construction of the proposed solar farm would occur over a 9-month period, although noise-producing activities and sources would be intermittent and related to the construction phases. Noise-generating components would come from different locations across the 42-hectare construction site depending on the construction phase, rather than a stationary source throughout the 9-month construction period.

Based on the results of the noise estimator tool, construction noise impacts from the proposal would impact sensitive receivers within 360 metres of the development site. One associated residential receiver is located within the 360 metres affected distance. Other sensitive receivers, which are minimum 800m from the development site, are unlikely to be affected, as they would be exposed to noise levels below 55 dB(A).

One non-residential receiver, SP2 Defence, is located adjacent to the north boundary of the development site, however no buildings or built structures are located within the 360m affected distance.

No receivers would be Highly Noise Affected, or experience Moderately to Highly intrusive noise levels. The level of impact is shown in Table 3-12 and Figure 3-22.

Any exceedances of NMLs at receivers are expected to be short-term. Noise sources would move progressively around the construction footprint during the construction phase. Installation of solar array posts by pile driving, would be the noisiest component of construction and would not be continuous for the 9-month construction period.

Table 3-12 Noise impact assessment

Noise impact level	*Noise impact interpretation*	*Distance affected from proposal area*
Affected/Clearly Audible	LAeq(15minute)[1] 5 to 20 dB(A) above background noise levels. Noise would be audible but unlikely to materially affect receivers.	360 metres
Moderately intrusive	LAeq(15minute)[1] 20 to 30 dB(A) above background noise levels. Noise is expected to cause minor impacts to receivers.	170 metres
Highly intrusive	LAeq(15minute)[1] >30 dB(A) above background noise levels. Noise is expected to cause moderate impacts to receivers. Noise at this level may disturb people sleeping during the day such as shift workers.	65 metres
Highly noise affected	LAeq(15minute)[1] 75 dB(A) or greater (Highly affected). Noise is expected to cause major impacts to receivers. Conversation may be difficult at this sound level. Noise at this level may disturb people sleeping during the day such as shift workers.	35 metres

As outlined above, where the prescribed NMLs are predicted to be exceeded, the proponent would be required to implement all feasible and reasonable work practices, as defined in the Interim Construction Noise Guideline (DECC 2009), to minimise noise impacts.

Possible noise control methods from AS 2436-2010 (R2016) Guide to noise and vibration control on construction, demolition and maintenance sites are summarised in Table 3-13.

The noisiest construction process is pile driving where rigs install solar array posts. Alternatively, posts may be installed using a boring technique, which would produce much less noise and reduce the range of potential noise impact.

A Construction Noise and Vibration Management Plan (CNVMP) would be developed and provided to the Council prior to the issue of the construction certificate. The CNVMP would provide mitigation measures for potential sensitive receivers. Sensitive receivers would be notified of the construction activities that would likely be audible.

Table 3-13 Possible noise control methods outlined in AS 2436

Noise control method	*Practical examples*	*Typical noise reduction possible in practice*	*Maximum noise reduction possible in practice*
Distance	Doubling of distance between source and receiver.	6	6
Screening	Acoustics barriers such as earth mounds, temporary or permanent noise barriers.	5 to 10	15
Acoustic enclosures	Engine casing lagged with insulation and plywood.	15 to 25	50
Engine Silencing	Residential class mufflers.	5 to 10	20

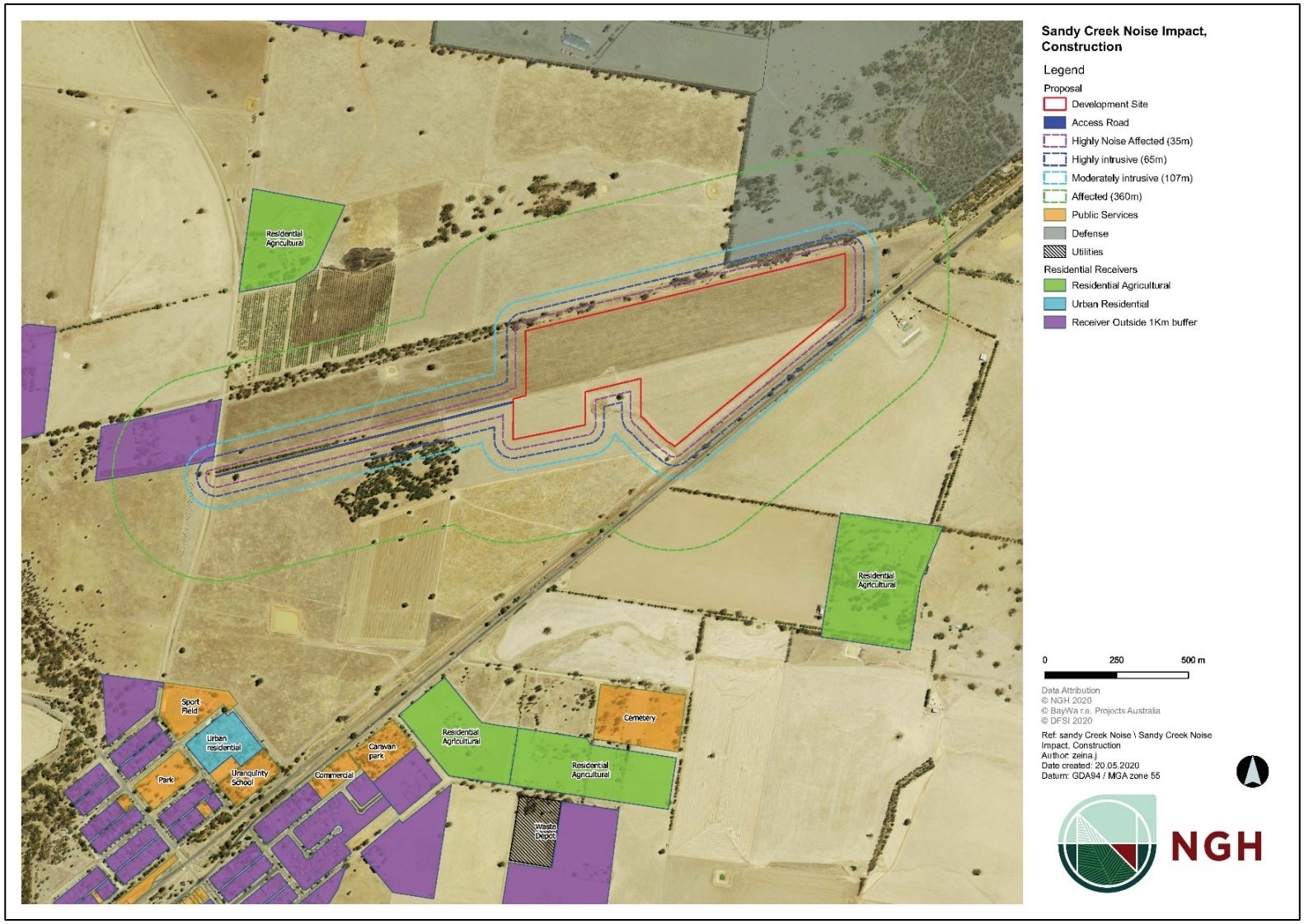


Figure 3-22 Noise impact areas during construction (Source: NGH, 2020)

Operation

The proposed solar farm would operate solar panels installed on motorised single-axis trackers. As such, the tracking motors are a potential source of mechanical noise. The noise generated by the motors would only occur for several seconds each time the panels move tracking points (typically every 20-30 minutes). Additionally, the tracking only operates during daylight hours when the electricity can be generated. This predominantly aligns with daytime hours only (7am to 6pm as defined by the NPI); however, the tracking motors may operate slightly later during daylight saving time.

Minimal additional noise (typically 2dB(A)) would be produced from the trackers. This would result with levels below the project amenity and intrusive noise levels as described in section 3.9.1. Therefore, the cumulative project amenity noise level is unlikely to have an impact on any sensitive receivers.

Four containerised or skid mounted medium voltage power stations would be installed, which would also produce some noise. Each would contain one inverter, a transformer, and a switchgear. These would be located within the solar array. The indicative noise level would be 42dB(A) at 200 metres from the inverter. Given that the closest sensitive receiver is approximately 800 metres away from the development footprint, the operation of the inverters would not affect any sensitive receivers due to the attenuation of noise over several hundred metres.

Typical operating noise levels for solar farm infrastructure are provided in Table 3-14. Based on this table, indicative noise levels within 200 metres of the source would be a maximum of 42 dB(A), this noise level is below the amenity and intrusive noise levels described in section 3.9.1. Furthermore, the closest sensitive receiver is approximately 800 metres from the development site, as such it is unlikely that any sensitive receiver would be impacted by noise during the operation of the solar farm. Figure 3-23 shows the operating noise impact area.

Table 3-14 Operation noise from solar farm equipment

Plant description	*L_{Aeq} Sound Power Levels, dB(A) re. 1pW*	*Indicative noise level at 200m (dB(A))*
Tracker motor single	78 (each)	32
Tracker motor (x10 units)	88	42
Medium voltage power station	88 (each)	42
Light vehicle	88 (each)	42

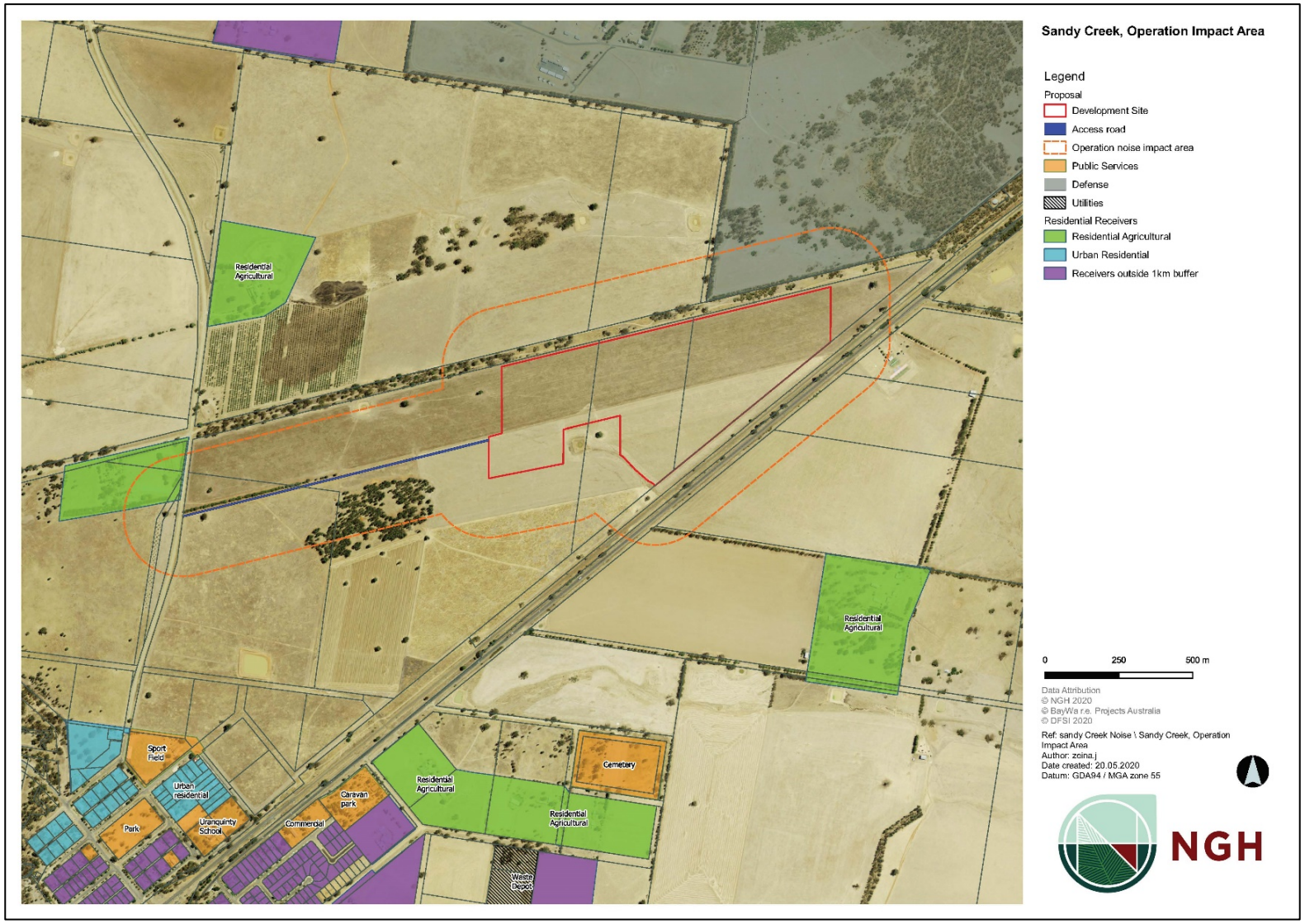


Figure 3-23 Noise impact area during operation (Source: NGH, 2020)

To ensure that the operation of the solar farm follows best practice, it is recommended that the operator develops a noise management procedure to manage any potential noise complaints that may arise from operation activities. Each complaint would need to be investigated and appropriate noise mitigation measures put in place to avoid future occurrences, where the noise in question is in excess of allowable limits.

In the event of a complaint, attended noise monitoring may be required to identify the noise level at the sensitive receiver location. A noise specialist would be engaged to conduct the monitoring and assess the level of impact at the receiver location. Managed measures would be developed in accordance with the specialist recommendations.

Road traffic noise

Noise from potential increases in traffic on the surrounding road network due to construction and operational activities is considered under the NSW Road Noise Policy (RNP) (DECCW 2011). The RNP provides traffic noise criteria based on the road category and type of project or land use; refer Table 3-15.

Based on functionality, Olympic Highway would be categorised as a Freeway/arterial/ sub-arterial road. Churches Plain Road would be categorised as a local road according to the RNP.

Table 3-15 RNP Road Traffic Noise Criteria dB(A)

Road category	***Type of project/land use***	***Assessment criteria dB(A) (external)***	
		Day 7am – 10pm	***Night 10pm – 7am***
Freeway/arterial /sub-arterial road.	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	LAeq (15 hour) 60 (external)	LAeq (9 hour) 55 (external
Local Road	Existing residences affected by additional traffic on existing local roads generated by land use developments	LAeq, (1 hour) 55 (external)	LAeq, (1 hour) 55 (external)

The traffic associated with the construction and operation of the proposal would be limited to daytime hours. Accordingly, 60 dB(A) is the relevant project road noise criteria.

The additional traffic generated by the proposed development would be unlikely to exceed the project road traffic noise criteria. As indicated in the accompanying traffic assessment, most vehicles accessing the site during the construction phase would not be heavy vehicles. It is considered to have an acceptable impact on receptors along the access/haulage route.

Operation phase traffic would be occasional and largely restricted to light vehicles. Increases to local road noise are not anticipated.

Vibration

The potential for vibration impact in terms of human comfort, cosmetic damage and structural damage were assessed with reference to *NSW Department of Environment and Conservation Assessing Vibration: a technical guideline* (DECC 2006) and the *Construction Noise and Vibration Guideline* (CNVG) (RMS 2016).

Vibration generating activities would occur only during the construction phase of the project. The construction activities that would produce vibration at the site include the use of vibrating padfoot rollers and array post boring or pile driving. Safe buffer distances to comply with human comfort, cosmetic damage and structural damage criteria sourced from the CNVG (RMS 2016) are presented in Table 3-16.

The closest residential receiver is located approximately 800 metres from the development footprint. The works would not impinge on the recommended buffer distances in the CNVG and are not likely to result in significant vibration impacts in terms of cosmetic damage or human comfort.

Table 3-16 Safe buffer distances for vibration impacts for relevant equipment from RMS (2016)

Plant	*Description*	*Cosmetic damage (BS 7385)*	*Human response (OH&E guideline)*
Vibratory Roller	<50 kN (typically 1-2 tonnes)	5 m	15 m to 20 m
	<100 kN (typically 2-4 tonnes)	6 m	20 m
	<200 kN (typically 4-6 tonnes)	12 m	40 m
	<300 kN (typically 7-13 tonnes)	15 m	100 m
	>300 kN (typically 13-18 tonnes)	20 m	100 m
	>300 kN (> 18 tonnes)	25 m	100 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	4 m

The minimum distances are quoted for both “cosmetic” damage (refer to BS 7385 and DIN 4150) and human comfort (Department of Environment and Conservation, 2006) are based on empirical data which suggests that where works are further from receivers than the quoted minimum distances then impacts are not considered likely.

Where works are within the minimum working distances and considered likely to exceed the cosmetic damage objectives, construction works should not proceed unless:

- A different construction method with lower source vibration levels is used, where feasible.
- Attended vibration measurements are undertaken at the start of the works to determine the risk of exceeding of the vibration objectives.

The minimum working distances are indicative and would vary depending on the particular item of equipment and local geotechnical conditions.

3.10. AIR QUALITY AND MICROCLIMATE

3.10.1. Air quality

The development site is located within a rural zone with rural residential settlement density, with the village of Uranquinty located approximately 1.5 kilometres to the south west. Air quality in the study area is typical of the surrounding rural region. In general, air quality is high. However, raised dust during the drier months contributes to sporadic reductions in air quality. During autumn, the level of particulate matter in the air increases due to

the burning of agricultural residues and soil cultivation for cropping. In winter, the burning of wood in solid fuel fires contributes to elevated levels of particulate matter in the atmosphere.

Air quality would be affected during the construction phase by vehicle and machinery exhaust emissions, although the emissions would be readily dispersed and any impacts to residents or workers at the site are expected to be transient and minor.

Construction and decommissioning traffic accessing the site would not produce dust on Yarragundry Street or Baker Street as they are sealed roads, however Churches Plain Road is unsealed and may generate dust. Additionally, temporary, and permanent internal site tracks may generate dust. Dust has the potential to cause nuisance for neighbouring residents and affect water supplies and pasture. Dust can also adversely affect the natural terrestrial and aquatic ecosystems which occur at the site. Internal access tracks would be surfaced with compacted basecourse to reduce the potential for dust generation. Additionally, the condition of internal tracks and movement areas would be monitored regularly, and a water cart utilised as required for dust suppression.

During the operation phase, soils at the site would be stable and vegetated with perennial grass cover. Dust generation would be closely managed as it would be harmful to the effectiveness of the solar array to generate electricity and cause nuisance to surrounding receptors and ecosystems. Unlike fossil fuel power generation, solar farms have very low air emissions of air pollutants during the operation phase.

Subject to mitigation measures, any dust or other air quality impacts are likely to be minor, temporary, and highly localised.

3.10.2. Microclimate

Several studies have shown that photovoltaic (PV) panels convert incident solar radiation into heat, and this can alter the airflow and temperature profiles within and adjacent to the panels. This is referred to as the Photovoltaic Heat Island (PVHI) Effect.

Whether such changes may subsequently affect the thermal environment of near-by populations of humans and other species have been questioned (Fthenakis & Yu, 2013). To date there are limited empirical studies on the potential for a heat island effect in utility scale solar plants. Published papers relevant to this issue include:

- Armstrong A, Ostle N and Whitaker J, Solar park microclimate and vegetation management effects on grassland carbon cycling, 2016 (Armstrong, Ostle, & Whitaker, 2016).
- Barron-Gafford, GA, Minor, RL, Allen, NA, Cronin, AD, Brooks, AE & Pavao-Zuckerman, MA 2016, 'The photovoltaic heat island effect: Larger solar power plants increase local temperatures' Scientific Reports, vol 6, 35070. DOI: 10.1038/srep35070 (Barron-Gafford, et al., 2016).
- Fthenakis, V.,& Yu, Y., 2013, Analysis of the potential for a heat island effect in large solar farms, Photovoltaic Specialists Conference (PVSC), 2013 IEEE 39th (Fthenakis & Yu, 2013).
- Yang L, Gao X, Lv F, Hui X, Ma L, and Hou X, Study on the local climatic effects of large photovoltaic solar farms in desert areas Solar Energy 144, 244–253, 2017 (Yang, et al., 2017).

The issue has also been subject to recent consideration by a Victorian Planning Panel for solar farms proposed in Greater Shepparton for solar farms proposed by Neoen and X-Elio. This is detailed in the Panel Report for the Greater Shepparton Solar Energy Facility Planning Permit Application 2017-162, 2017-274, 2017-301 and 2017-344 (Planning Panel Report, 2018). Neoen, in preparation of a response to key issues raised in objecting submissions, commissioned a Statement of Evidence by Greg Barron-Gafford from the Research Group Biography, Ecosystem Science (University of Arizona) (Barron-Gafford G. , 2018).

Studies completed indicate conflicting results, which may reflect site and project design differences. Some studies suggest that PV systems can cause a cooling effect on the local environment, depending on the efficiency and placement of the PV panels while others demonstrate a warming effect (Barron-Gafford, et al.,

2016). Other studies conclude that whilst air temperatures may increase within the solar plant itself, they rapidly decrease to the ambient temperature beyond the perimeter of the solar plant (Fthenakis & Yu, 2013).

Armstrong et al (2016) focussed on microclimate and ecosystem processes directly under the panels. They found:

- PV arrays caused seasonal and diurnal variation in air and soil microclimate. These varied between summer (cooling of up to 5.20c) and winter (cooling up to 1.70c).
- Drying occurred under the PV arrays compared with gap and control areas.
- Differences in the above ground plant biomass and species diversity, with both lower under the PV array.
- Photosynthesis and net ecosystem exchange in spring and winter were also lower under the PV array.

Yang et al (2017) looked at air and soil temperature within a solar farm and at a control site without PV. This found that at a height of 2m in the two sites studied the daytime temperature was essentially the same during winter, while during the other seasons the daytime air temperature in the PV array is higher than that in the control without PV, with the maximum difference appearing in summer. At a height of 2m, the night-time air temperatures during the four seasons in the solar farm are higher than the control outside of the PV array. It also found that the annual range of soil temperatures at depths of 5–180 cm in the solar farm was larger than that in the region without PV. The soil temperature at different depths during winter at the solar farm was clearly lower than that in the region without PV, indicating that the PV farm is a cooling system.

Fthenakis and Yu (2013) undertook an analysis of the potential for large solar plants to generate a PVHI effect and increase air temperature within the solar plant area. The study found at the centre of the solar plant the annual average air temperature at a height of 2.5m increased by up to 1.90C. However, this increase in temperature dissipated at a height of 5m. Additionally, the solar plant completely cooled overnight, so the effect was limited in duration.

Barron-Gafford (2018) in his Statement of Evidence (SoE) to the Victorian Planning Panel included results on the radius of the measured heat effects. This identified that the PVHI effect was indistinguishable from air temperatures over native vegetation when measured at a distance of 30 m from the edge of the PV array (Figure 3 13). In his SoE he states that ‘this pattern held true for both daytime and night-time conditions. Because the PV panels themselves trap the energy from diffuse sunlight that was able to reach the ground underneath them, air temperatures remain elevated within a PV array. As you leave this “overstorey” of PV panels, energy is able to radiate back towards the atmosphere, as it does in a natural setting, and the PVHI quickly dissipates’.

In conclusion of the Victorian Planning Panel Report (Planning Panel Report, 2018), the panel accepted that solar arrays would affect air and soil temperatures within the solar array perimeter, and that in relation to outside of the solar array perimeter a heat island effect is unlikely to occur. It identified that any temperature increase within the solar array would be marginal and recommended a 30-metre setback from any neighbouring property.

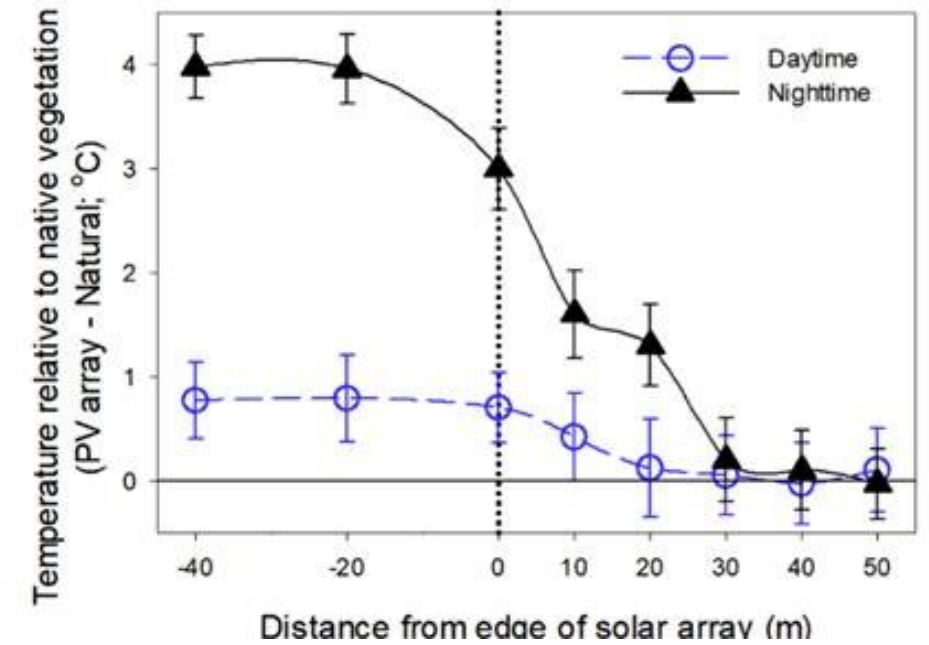


Figure 3-24 Measures of air temperature within and outside of the PV array (Source:- Barron-Gafford 2018)

The research indicates a small potential effect on climate within the solar array. Negligible impacts on adjacent properties and agricultural activities such as plant growth and health of cattle would occur. It is also unlikely that the heat would be carried offsite by the wind. Where sensitive land use occurs adjacent to solar panels, consideration to maintaining a 30 m buffer could be made.

The proposed development adheres to the Victorian Planning Panel Report recommendation, being a minimum of 250 metres from the solar array to the nearest neighbouring property.

3.11. STORMWATER, WATER QUALITY, SEDIMENT AND EROSION CONTROL

A Hydrology Assessment (provided at Appendix G) was prepared by the proponent to consider the potential for adverse stormwater impacts associated with the proposed development. A Preliminary Runoff Assessment (provided at Appendix H) was prepared to consider the post-development effects on outlet flood magnitude and volume. Findings from the reports are incorporated where relevant into the below assessment.

3.11.1. Existing conditions

The subject land is located within the Murrumbidgee River Catchment, about 8km south from the Murrumbidgee River. No named creeks, streams, or waterways, ephemeral or otherwise, run through the subject land. The closest named creek is Sandy Creek, a tributary of the Murrumbidgee River. Sandy Creek is located to the west of the subject land and borders the western boundary of Uranquinty village. One drainage line feeds into a farm dam located in the south-east of the development footprint.

No areas within the development footprint are mapped as having potential to contain Groundwater Dependent Ecosystems (GDEs). Refer to the Bureau of Meteorology's GDE Atlas provided at Figure 3 14. One area to the west within the subject land is mapped as having potential to contain low potential GDEs and would be avoided. Some areas of low potential occur outside of the subject land immediately to the north east and north west and would also be avoided.

Potential for impacts and risks for the Sandy Creek Solar Farm due to floodwaters are considered in above in Section 3.7 of this report.

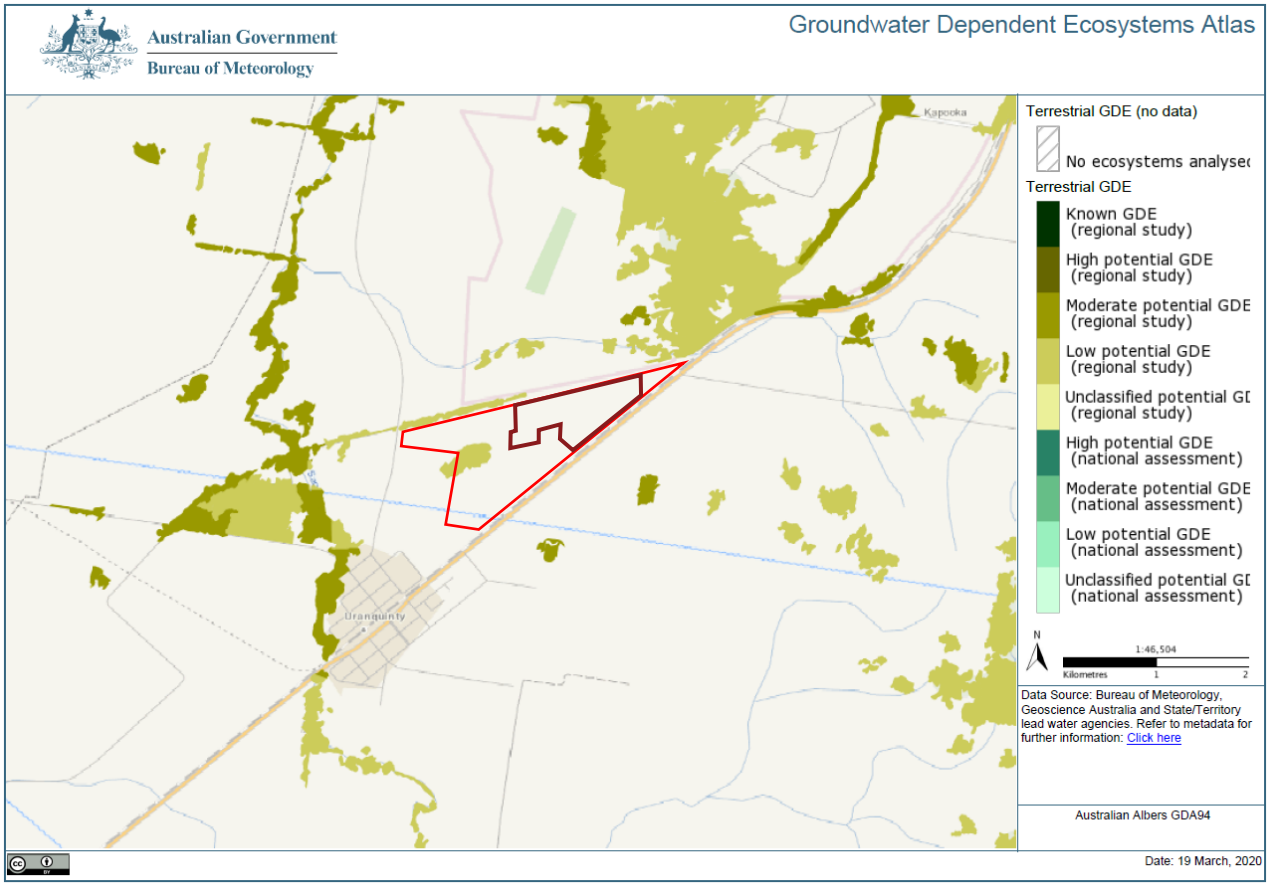


Figure 3-25 Terrestrial Groundwater Dependent Ecosystems in the locality of the development site, with approximate location of development site marked in red (Source: BOM, 2020)

3.11.2. Potential impacts

Drainage and stormwater management

The works are not located within watercourses and as such a Controlled Activity Approval (CAA) for works on Waterfront Land, as defined, is not required from NRAR. The development is not considered to be integrated development.

The proposal would not have a notable effect on existing stormwater runoff or infiltration patterns in the locality. The preliminary runoff assessment prepared by Xeros Piccolo indicates that post-development flows for the 1% AEP storm event can be limited using a small stormwater detention system so as not to exceed the pre-development flows. However, this detention would also severely restrict downstream stormwater flows for smaller, more frequent events such as the 10% AEP storm event. Council may wish to consider whether detention is required for this setting.

The subject land is within a rural environment and as such open channels and onsite stormwater detention basin are proposed for stormwater management and are considered suitable for the environment. If deemed required, the detention system would comprise a combined basin volume of up to 1,100 cubic metres and indicative locations, subject to detailed drainage design, are shown on the accompanying plans.

Water quality

Soils would be exposed during earthworks for the internal track system, underground cabling, site buildings, works compounds and hardstand areas. Sediment and dissolved nutrients transported into local watercourses could pose a risk to channel morphology, flow patterns and water quality.

The construction phase would also entail potential chemical pollution risks such as, hydrocarbon spills; wash and spillage from any on-site concreting for building and equipment foundations; pesticide storage and use for pest plant and animal control. Contamination and spill risks would be managed using on-site contractor protocols and in line with best practice.

The refilling of any required chemicals would take place on hardstand areas only and any issue immediately contained and attended to. All machinery on-site would contain dry and wet spill kits to manage hydrocarbon and other pollutant spills. Machinery would be checked regularly to ensure there is no oil, fuel or other liquids leaking from the machinery.

During the operation phase, it is not likely that fuels or chemicals would need to be stored on-site. These would more likely be brought to site as needed with a contractor and would not remain on-site. Panel washing/cleaning is not a common occurrence; however, if needed, no detergents or other chemicals would be used for washing.

All effluent waste during both construction and operation would be managed by way of hired transportable WC facilities. These would be managed by an external contractor and disposed off-site at a licensed facility. The structures are entirely self-contained and pose a low risk of malfunction and contamination.

Based on the analyses and engineering design, it is not anticipated that any significant issues would be encountered in respect of water quality. An area for an OSD basin has been dedicated in the development footprint, with the size to be determined based on detailed engineering calculations and design at CC stage. The proposed OSD basin would ensure flow rates post development would not exceed pre-development rates as per Council's requirements and that water quality objectives are achieved.

Subject to the implementation of standard safeguards, water quality risks are considered manageable and there are considered to be no significant impacts to waterways, riparian areas, or groundwater dependent ecosystems.

3.12. VISUAL AMENITY

This Visual Impact Assessment (VIA) was undertaken to accompany the Statement of Environmental Effects (SEE) for the proposed Sandy Creek Solar Farm. It provides a full assessment of the visual impacts associated with the proposal, including:

- Landscape character and scenic vistas.
- Stakeholder values regarding visual amenity.
- Potential impacts on representative viewpoints.
- Addressing government agency requirements.
- Addressing community concerns.

The VIA includes a strategy to address identified impacts, including onsite vegetation screening, general design measures and a process to verify the actual visual impacts of the proposal. This improves the reliability of the measures and provides a trigger to undertake additional mitigation if required.

3.12.1. Approach

The VIA was completed in the following stages:

1. Background investigations and mapping, including identifying Land Character Units (LCUs), defining where infrastructure may be visible in the landscape, and identifying key viewpoints such as major travel routes, potential residences, and built-up areas.
2. Field survey including reconnaissance, ground truthing and photography, and understand the likely sensitivity of LCUs within the landscape.
3. Consultation, including understanding community values and documenting community perception.
4. Impact assessment, describing the potential impact on visual amenity during construction and operation of the proposal.
5. Mitigation measures including a 5m vegetation screening along the southern boundary of the development site outside of the security fence.

The impact assessment methodology used in this VIA for operational impacts is based on the *Bureau of Land Management (BLM) Visual Resource Management System*, developed by the BLM, US Department of the Interior (n.d.). The BLM developed a systematic process to analyse the visual impact of proposed developments. The basic philosophy states that the degree to which a development affects the visual landscape depends on the visual contrast imposed by the project. Key steps undertaken to assess the visual impact are as follows:

- Define Landscape Management Zones (LMZ) for the representative viewpoints, based on:
  - The scenic quality of the study area's LCU.
  - The expected sensitivity at representative viewpoints.
  - The proximity of each representative viewpoint.
- Evaluate the degree of contrast the solar farm would generate at representative viewpoints in consideration of the management objectives of the relevant LMZ.
- Determine the acceptability of the contrast with the management objectives of the relevant LMZ; this is the resultant visual impact, rated as high, medium, or low.

For the purpose of this VIA, a maximum rotation height of 4 m for the solar array and other ancillary infrastructure was used as the basis for visual impacts from the majority of selected viewpoints. This VIS functions by comparing existing views from selected viewpoints to views of proposal infrastructure without mitigation measures (but with existing obstacles eg. roadside trees and hills). Unmitigated views from viewpoints are then compared with projected views after mitigation measures proposed by BayWa. have been implemented.

Landscape character

LCUs consider topography, vegetation, land use, and other distinct landscape features. They are a way to summarise differences in the receiving environment that may affect the visual impact of the proposed solar farm at different locations.

Four LCUs were identified within Uranquinty and surrounding areas:

- Rural (including agricultural lands and rural dwellings).
- Residential (urban dwellings).
- Industrial (Olympic Highway, major roads, electrical and other built infrastructure, aerodrome).
- Commercial (businesses, village centre).

The scenic quality was rated in each LCU as follows:

- A high scenic quality rating describes areas with outstanding, unusual, or diverse features.

- A moderate scenic quality rating applies to areas with the features and variety normally present in the character type.
- A low scenic quality rating is given to areas lacking pleasant features and variety.

The four LCUs identified are characterised in Table 3-17 in terms of their scenic quality.

Table 3-17 Key features of LCUs within Uranquinty and surrounds

Rural LCU
Rural and agricultural lands within the study area are used predominantly for small land holdings, grazing, rotational cropping, and olive groves, rural dwellings are located within this LCU. The development site is positioned slightly lower in the landscape at approximately 210 m to 220 m above sea level than the surrounds, however surrounding agricultural land use is generally located on land that is relatively flat to undulating. Expansive views within this LCU are generally limited given the undulating relief and screening provided by vegetation. Secondary sealed and unsealed roads include Churches Plain Road, Dunns Road, Taber Street, King Street, Uranquinty Street, Rodhams Road and Gradys Road are the main vantage points from which to view agricultural areas. From the road corridors, agricultural and grazing land can be viewed openly. Patches of native and planted vegetation screen views of agricultural land from roadways. In addition to sections of road, overhead transmission lines are visible that reinforce rectilinear shapes and are common in rural landscapes. Surrounding blocks are made up of residential, small holding, and agricultural land uses, with residences within this landscape being more concentrated towards the Uranquinty townsite to the southwest. The Kapooka Defence Force facility is located approximately 2km northeast of the development site. Residences are commonly associated with some additional vegetation plantings. Other infrastructure includes agricultural sheds, buildings, aeroclub, cemetery and low open fences. **Scenic quality is considered moderate. Built elements are production-related and include linear fences, powerlines, roads, agricultural buildings, and rural homes. Forms are typically uniform, of undulating elevation and linear. This LCU is common and the dominant LCU in the study area. The proposed solar farm is located within this LCU.**
Residential LCU
Residential areas of Uranquinty and surrounds include viewpoints from the road near residents' homes. Much like the Rural LCU, the area is relatively flat to undulating with expansive views generally limited given the undulating relief and screening provided by vegetation. Views of the proposal from the majority of concentrated residential dwellings located within Uranquinty are blocked by neighbouring houses, sloping hillside and remnant vegetation between them and the development site. Residents are broadly and unevenly distributed over the landscape, with properties commonly associated with additional vegetation planting and screening. Seven residential dwellings on small holdings are located surrounding the development site. Several urban residential homes are also located within 1 km from the development site along Uranquinty Street, King Street and Taber Street. **Scenic quality is considered moderate with views from residences varying in colour and form. Larger lot residential homes are heavily screened by mature vegetation plantings while views from urban residences are dominated by views of other houses, fences, and local roads in close proximity to their living space. Built elements include closed and open linear fences, powerlines, roads, patches of remnant and planted vegetation with limited vistas of surrounding agricultural land. This LCU is common in the study area.**
Industrial LCU

Industrial areas within the study area include the Olympic Highway, the rail line which runs parallel to Olympic Highway, powerlines, waste depot, and the aerodrome. Common features in the LCU include the two-way sealed road, road reserve, long passenger and industrial trains, fencing, powerlines, and regular small and large vehicles.

Scenic quality is considered low, with features matching the land use. Some screening is present along Olympic Highway and surrounding residences, providing broken views of surrounding rural land visible through existing vegetation. This LCU is common in the study area, with the development site located approximately 80m north of Olympic Highway.

Commercial LCU

Commercial land and public facilities are shown in Figure 3-26. The majority of these would be sheltered from views of the development site by the undulating topography of the area. Commercial land and public facilities with likely views of the proposal include Uranquinty Cemetery. The development site is not visible from the Uranquinty townsite.

Scenic quality from the aerodrome is considered moderate, given the elevation and the nature of the business. The development site is clearly visible from the aerodrome, though views, glint and glare are not likely to impact aeroclub activities.

The BLM method requires identification of representative viewpoints in the study area. These may be travel routes such as roads, waterways and recreational tracks, residential areas, tourist facilities, houses, and farmland.

Sixteen representative viewpoints were identified using the BLM methodology and within the Zone of Visual Influence (ZVI) and are mapped in Figure 3-26.

The predicted sensitivity of each viewpoint can be determined considering its proximity to the development site and factors such as use, scenic quality and regional significance.

Criteria for proximity (distance from solar farm infrastructure – not access- due to lesser/short term visual impacts) are as follows:

- Foreground 0 – 1 km.
- Middle ground 1 – 2 km.
- Background More than 2 km.

Criteria for scenic quality are as follows:

- High sensitivity:
  - high use routes or areas.
  - routes or areas of national or state significance.
  - areas with high scenic quality.
- Moderate sensitivity:
  - moderate use routes or areas.
  - routes or areas of regional or local significance.
  - areas with moderate scenic quality.
- Low sensitivity:
  - low use routes or areas.
  - routes or areas of low local significance.
  - areas with low scenic quality.

Considering the sensitivity of local viewpoints, the following assessments were made:

- **Rural viewpoints** were assessed as generally having a moderate scenic quality given the surrounding agricultural activities, including views from rural dwellings. Rural views are from rural dwellings and located on moderate to low routes, or areas only accessed by local traffic, i.e. Churches Plain Road, Rodhams Road, Grady's Road. As motorists use local roads, views increase as vehicles approach the development site. View durations are generally prolonged as vehicle speeds on sealed local roads are limited to 50 km/hr speed limits. Rodhams Road is unformed with little evidence of frequent use by local traffic. The expected number of vehicles on local roads is considered low to moderate. Regional and local significance is low, with scenic quality being moderate.
- **Residential viewpoints** were assessed as generally having a moderate to high sensitivity. If there was a view of the solar farm, the view duration could be expected to be high from a residence.
- **Industrial viewpoints** were assessed as having low sensitivity and include Olympic Highway and areas around existing powerlines. Any views from these areas would be fleeting due to vehicle speed, hard to discern and fragmented by existing roadside vegetation. Built structure is more commonly functional than aesthetic in these settings.
- **Commercial viewpoints** from the cemetery and caravan park were assessed as having moderate to high sensitivity given its location in the landscape and nature of operations.

The sensitivity of each viewpoint is provided in Table 3-18.

Table 3-18 Representative viewpoints and assessed proximity, scenic quality and sensitivity

ID	*LCU*	*Distance to site*	*Scenic quality*	*Sensitivity*
1	Industrial	Foreground	Low	Low
2	Rural/Industrial	Foreground	Moderate	Moderate
3	Rural	Foreground	High	Moderate
4	Rural	Foreground	High	Moderate
5	Industrial	Middle ground	Low	Low
6	Residential	Middle ground	Moderate	High
7	Rural	Middle ground	Moderate	Moderate
8	Rural	Foreground	High	Moderate
9	Rural	Foreground	High	Low
10	Rural	Middle ground	Moderate	Moderate
11	Rural	Foreground	Moderate	Moderate
12	Rural	Middle ground	Moderate	Moderate
13	Rural	Foreground	Moderate	Moderate
14	Rural	Middle ground	Moderate	Moderate
15	Rural	Middle ground	Moderate	Moderate
16	Rural	Middle ground	Moderate	Moderate

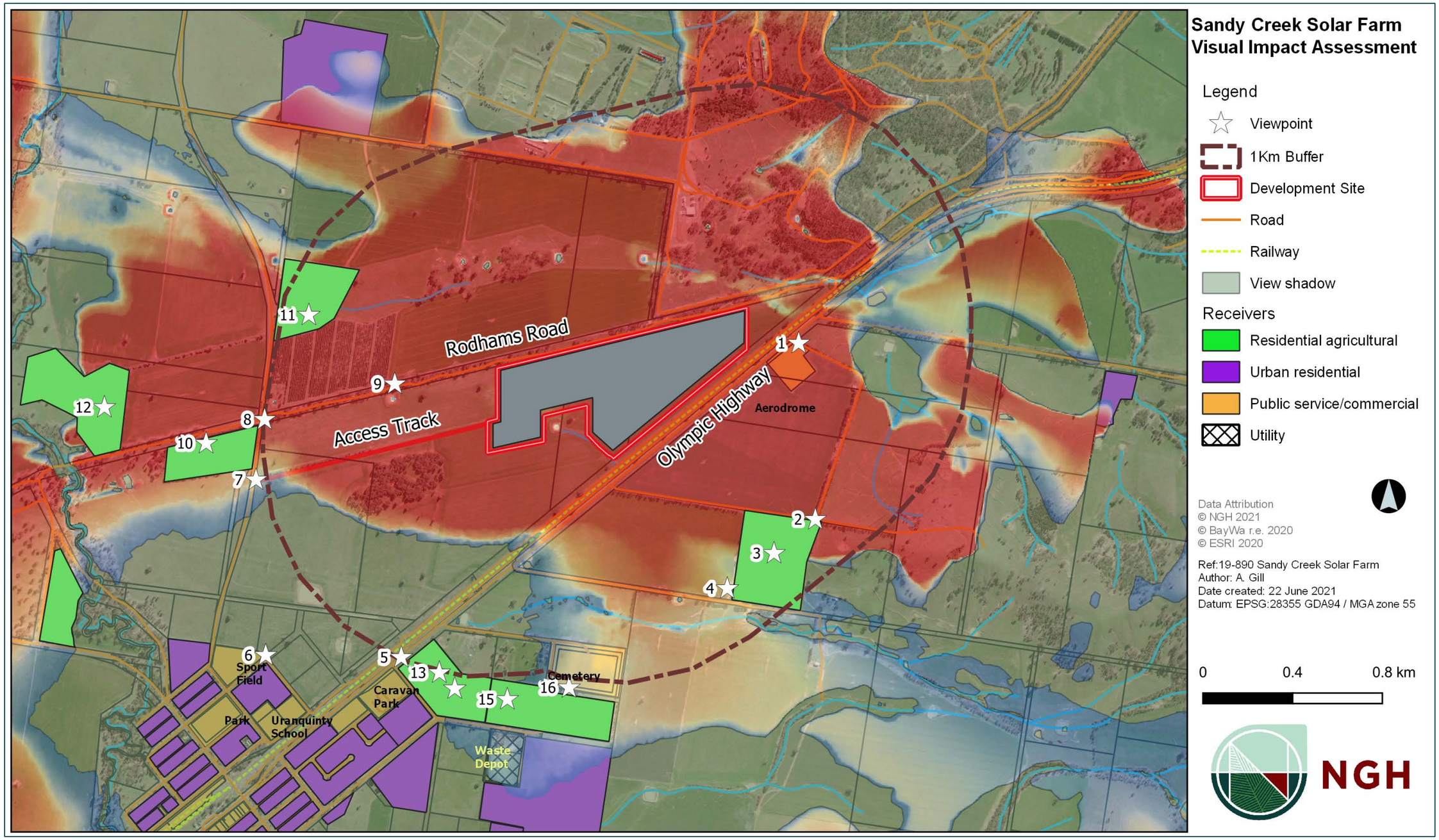


Figure 3-26 Location of Visual Impact Assessment Viewpoints (Source: NGH, 2021)

Definition of landscape management zones

Visual LMZs were assigned to each representative viewpoint. The zones were derived by combining scenic quality (from the LCUs described in Table 3-17), viewer sensitivity and the distance to the proposed solar farm. Combined they produce a three-tiered management hierarchy: A – C, as shown in Table 3-19.

Table 3-19 Visual Landscape Management Zone decision matrix

		Proximity / sensitivity						
Scenic quality		**Foreground High**	**Middle ground High**	**Background High**	**Foreground Moderate**	**Middle ground Moderate**	**Background Moderate**	**Foreground Low**
	High	A	A	A	A	B	B	B
	Moderate	A	B	B	B	B	C	C
	Low	B	B	B	B	C	C	C

Each zone has associated objectives to guide management of visual change and to help evaluate proposed project impacts. These are shown in Table 3-20.

Table 3-20 Visual Landscape Management Zone management objectives

Management priority	***Management objectives***
A	Maximise retention of existing visual amenity. Landscapes are least able to absorb change. Developments may lead to a major change.
B	Maintain existing visual amenity, where possible. Protect dominant visual features. Developments may be allowed to be visually apparent.
C	Less importance for retaining existing visual amenity. Landscapes are able to absorb change. Developments may be allowed to dominate but should reflect existing forms and colours where possible.

3.12.2. Potential impacts

An operational visual impact assessment has been conducted considering:

- The proposed solar farm components.
- The potential for the proposed solar farm to be viewed from representative viewpoints.
- The degree of contrast the proposed solar farm would have within the identified LMZ. LMZs were assigned to viewpoints based on the results of the field work, and the contrast at that viewpoint was evaluated, as described below.
- The potential impact from glare.

Evaluation criteria

The ratings for the degree of contrast created by the proposed solar farm at each viewpoint have the following definitions (U.S. Department of the Interior, n.d.):

- High contrast: the proposal would be dominant within the landscape and generally not overlooked by the observer; the visual change would not be absorbed.
- Medium contrast: the proposed activity would be moderately dominant and noticed; the visual change would be partially absorbed.
- Low contrast: the proposed activity would be seen but would not attract attention; the visual change would be well absorbed.
- Indistinct: contrast would not be seen or would not attract attention; the visual change would be imperceptible.

To determine if the objectives for the VLM zone are met, the contrast rating for the viewpoint is compared with the relevant management objectives to give a visual impact level. The visual impact level is consequently defined as:

- High impact: contrast is greater than what is acceptable.
- Medium impact: contrast is acceptable.
- Low impact: visual contrast is little or not perceived and is acceptable.

For high impact viewpoints, mitigation must be considered.

3.12.3. Evaluation results

Table 3-18 evaluates the expected level of visual impact from the-representative viewpoints and provides the existing views of the development site without any mitigation measures (i.e. vegetative screening or setbacks) and then with proposed mitigation measures. Following changes to the proposal design to reduce visual impacts on nearby residents, no high impact viewpoints were identified.

A total of sixteen viewpoints were selected for assessment, which are generally viewpoints determined to have the greatest potential for visual impact and best represent a range of distances and locations with differing views.

Table 3-21 Visual impact at representative viewpoints with reference to the proposed Sandy Creek Solar Farm

VIEWPOINT 1		
Summary of Viewpoint		Viewpoint Description / Impact
LCU	Industrial	Taken from Olympic Highway outside the aerodrome facing north-west across Olympic Highway towards the proposed solar farm. The viewpoint is representative of the view from the aerodrome and traffic travelling west bound on Olympic Highway. Dominant features include spaced roadside trees, sealed Olympic Highway, grazed paddock, railway line and powerlines. Proposed infrastructure would be noticeable from the aerodrome and by motorists, but existing views are already dominated by transport and utility infrastructure. **No mitigation required, therefore the residual impact remains the same as the inherent visual impact.** 
Scenic quality	Low	
Proximity	Foreground (<1 km)	
Sensitivity	Low	
LMZ objective	C	
Contrast	Low	
Inherent visual impact	LOW	
Residual visual impact	LOW	

<table>
<tr><th colspan="3">VIEWPOINT 2</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural/ Industrial</td><td rowspan="8">Taken from the access track behind the aerodrome towards the residential premises located of agricultural land south-east of the proposal facing northwest over the aerodrome. Viewpoint 2 is representative of the track to the rural dwelling (refer to Viewpoint 3 for the residence). Dominant features include spaced roadside vegetation, grazed and cropped paddocks, vegetated undulating hills, trains, and large and small vehicles using Olympic Highway. Proposed infrastructure would be clearly visible from this elevated position; however, views would be fragmented through existing vegetative screening. Solar farm infrastructure would not be the dominant feature at this viewpoint but would alter the current rural character.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Foreground (<1 km)</td></tr>
<tr><td>Sensitivity</td><td>Low</td></tr>
<tr><td>LMZ Objective</td><td>C</td></tr>
<tr><td>Contrast</td><td>Low</td></tr>
<tr><td>Inherent Visual Impact</td><td>MODERATE</td></tr>
<tr><td>Residual visual impact</td><td>MODERATE</td></tr>
</table>

<table>
<tr><th colspan="3">VIEWPOINT 3</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="8">Taken from a private rural dwelling facing west at an elevated position overlooking the proposed development. Dominant features include garden vegetation surrounding the dwelling with heavily broken views of the development site through the trees. Industrial views of Olympic Highway are hidden by the undulating topography. Proposed infrastructure would be visible from this elevated position; however, views would be fragmented through existing vegetative screening and topography. Due to the elevated position, the additional planted screening proposed may not be effective in further obscuring views from this location. Solar farm infrastructure would not be the dominant feature at this viewpoint but would alter the current rural character, however, the contrast would be similar to treed areas in the background.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic Quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Foreground (<1 km)</td></tr>
<tr><td>Sensitivity</td><td>High</td></tr>
<tr><td>LMZ Objective</td><td>B</td></tr>
<tr><td>Contrast</td><td>Medium</td></tr>
<tr><td>Inherent Visual Impact</td><td>MODERATE</td></tr>
<tr><td>Residual visual impact</td><td>MODERATE</td></tr>
</table>

<table>
<tr><th colspan="3">VIEWPOINT 4</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="8">Taken from a private rural dwelling facing north-west at an elevated position overlooking the development. Dominant features include agricultural land currently used for cropping with remnant roadside vegetation in the background. Industrial views of Olympic Highway and the Kapooka Defence Force base are also visible. Proposed infrastructure would be visible from this elevated position but would not dominate the landscape and blend in with other existing build features. Due to the elevated position, the proposed additional planted screening may not be effective in further obscuring views from this location.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Foreground (<1 km)</td></tr>
<tr><td>Sensitivity</td><td>Moderate</td></tr>
<tr><td>LMZ Objective</td><td>B</td></tr>
<tr><td>Contrast</td><td>Medium</td></tr>
<tr><td>Inherent visual impact</td><td>MODERATE</td></tr>
<tr><td>Residual visual impact</td><td>MODERATE</td></tr>
</table>

<table>
<tr><th colspan="3">VIEWPOINT 5</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Industrial</td><td rowspan="8">Taken from Olympic Highway facing northeast towards the proposed solar farm. Viewpoint 5 is representative of the Uranquinty Caravan Park and the large lot residential dwellings on the southern side of Olympic Highway and along Grady's Road. Dominant features include the sealed Olympic Highway, overhead powerlines, railway line, grazed paddocks, and vegetated undulating hills. Due to the topography of the surrounding area, the proposed infrastructure would not be visible from this viewpoint, therefore the proposal would not increase the industrial character of the view.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic quality</td><td>Low</td></tr>
<tr><td>Proximity</td><td>Middle ground (1-2 km)</td></tr>
<tr><td>Sensitivity</td><td>Moderate</td></tr>
<tr><td>LMZ objective</td><td>C</td></tr>
<tr><td>Contrast</td><td>Low</td></tr>
<tr><td>Inherent visual Impact</td><td>LOW</td></tr>
<tr><td>Residual visual impact</td><td>LOW</td></tr>
</table>

<table>
<tr><th colspan="3">VIEWPOINT 6</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Residential</td><td rowspan="8">Taken from Taber Street / Churches Plain Road facing northeast towards the proposed solar farm. Dominant features include grazed and cropped paddocks, open farm fencing, paddock trees and patches of remnant vegetation and a clear view of transmission lines in the distance. The land is partly cleared and undulating. Due to the undulating topography of the area, proposed infrastructure would not be visible from residential properties on Uranquinty Street, Taber Street or King Street on the eastern edge of the Uranquinty townsite.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Middle ground (1-2 km)</td></tr>
<tr><td>Sensitivity</td><td>High</td></tr>
<tr><td>LMZ objective</td><td>B</td></tr>
<tr><td>Contrast</td><td>Indistinct</td></tr>
<tr><td>Inherent visual impact</td><td>LOW – not visible</td></tr>
<tr><td>Residual visual impact</td><td>LOW</td></tr>
</table>

VIEWPOINT 7		
Summary of Viewpoint		Viewpoint Description / Impact
LCU	Rural	Taken from Churches Plain Road at the proposed access point facing east towards the proposal area. Dominant features include the unsealed Churches Plain Road, existing farm gate and open fencing, grazed paddock, and transmission line. Undulating hills are visible in the background. Remnant vegetation is visible in the middle ground and background. Visibility of the proposed solar farm infrastructure would be screened by existing vegetation and tempered by distance, but visual disturbance from vehicle movements would be observed during the construction period. **No mitigation required, therefore the residual impact remains the same as the inherent visual impact.** 
Scenic Quality	Moderate	
Proximity	Middle ground (1-2 km)	
Sensitivity	Moderate	
LMZ Objective	C	
Contrast	Medium-Low	
Inherent Visual Impact	MODERATE	
Residual visual impact	MODERATE	

<table>
<tr><th colspan="3">VIEWPOINT 8</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="8">Taken from the corner of Churches Plain Road and Rodhams Road facing southeast towards the proposal area. This viewpoint is considered representative of a sensitive receiver at Lot 2 DP754567, the associated receiver at Lot 55 DP754567 (refer to viewpoint 10 below) and users of Churches Plain Road.
Dominant features include the unsealed Churches Plain Road and Rodhams Road, large patches of remnant vegetation and roadside vegetation, grazed paddock, utility signs and farm fencing, causing this viewpoint to be of high scenic quality. The land is partially cleared and slightly undulating so that solar infrastructure would contrast with the existing vista if substantial existing vegetation were not already present. Broken and mid-distance views of infrastructure are likely to be discernible by residents and motorists.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic Quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Middle ground (1-2 km)</td></tr>
<tr><td>Sensitivity</td><td>Moderate</td></tr>
<tr><td>LMZ Objective</td><td>C</td></tr>
<tr><td>Contrast</td><td>Medium</td></tr>
<tr><td>Inherent Visual Impact</td><td>MODERATE</td></tr>
<tr><td>Residual Visual Impact</td><td>MODERATE</td></tr>
</table>

<table>
<tr><th colspan="3">VIEWPOINT 9</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="8">Taken from Rodhams Road facing southeast towards the proposal area. Viewpoint 9 is dominated by mature roadside vegetation and is approximately 300 m from the access track off Churches Plain Road. One rural dwelling is located on an elevated position north of Viewpoint 9 and is screened from the development by olive plantation and screening vegetation surrounding the rural dwelling (Lot 117 DP754567 – refer to viewpoint 11 below). The proposed colour of the infrastructure is also not inconsistent with the existing infrastructure and bare paddocks in this agricultural area. Rodhams Road is well screened from the proposed infrastructure generally and in its current condition is unformed and only trafficable by 4WD vehicles.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic Quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Foreground (<1 km)</td></tr>
<tr><td>Sensitivity</td><td>Low</td></tr>
<tr><td>LMZ Objective</td><td>C</td></tr>
<tr><td>Contrast</td><td>Medium</td></tr>
<tr><td>Inherent Visual Impact</td><td>MODERATE</td></tr>
<tr><td>Residual Visual Impact</td><td>MODERATE</td></tr>
</table>

<table>
<tr><th colspan="3">VIEWPOINT 10</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="8">Taken from the associated dwelling located off Churches Plain Road, facing east towards the solar farm entry and proposal area. Viewpoint 10 (the dwelling) is approximately 1.15 km from the proposed solar farm, off Churches Plain Road. The dwelling (Lot 55 DP754567) is screened from the development by mature vegetation. Dominant features included paddocks, open fence lines and paddock vegetation (treed areas, powerline). The proposed colour of the infrastructure is not inconsistent with the vegetation screening to the north of the dwelling being darker (greens). There are no likely direct views from the dwelling.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic Quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Middle Ground (1-2 km)</td></tr>
<tr><td>Sensitivity</td><td>Moderate</td></tr>
<tr><td>LMZ Objective</td><td>B</td></tr>
<tr><td>Contrast</td><td>Indistinct</td></tr>
<tr><td>Inherent Visual Impact</td><td>LOW– not visible</td></tr>
<tr><td>Residual Visual Impact</td><td>LOW</td></tr>
</table>

<table>
<tr><th colspan="3">VIEWPOINT 11</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="8">Taken from a dwelling off Churches Plain Road, facing southeast towards the proposal area. Viewpoint 11 is approximately 674 m from the access track off Churches Plain Road and approximately 850 m from the solar farm. The dwelling (Lot 117 DP754567) is completely screened from the development by mature vegetation. Dominant features included a tennis court, a small building and transmission lines. The proposed colour of the infrastructure is not inconsistent with the vegetation screening around the dwelling being darker (greens). There are no likely direct views from the dwelling.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic Quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Foreground (<1 km)</td></tr>
<tr><td>Sensitivity</td><td>Moderate</td></tr>
<tr><td>LMZ Objective</td><td>B</td></tr>
<tr><td>Contrast</td><td>Indistinct</td></tr>
<tr><td>Inherent Visual Impact</td><td>LOW – not visible</td></tr>
<tr><td>Residual Visual Impact</td><td>LOW</td></tr>
</table>

VIEWPOINT 12		
Summary of Viewpoint		Viewpoint Description / Impact
LCU	Rural	Taken from a dwelling off Rodham's Road, facing east/southeast towards the proposal area. Viewpoint 12 is approximately 752 m from the access track off Churches Plain Road but is located over 1.7km from the main infrastructure. The dwelling (Lot 2 DP754567) is screened from the development by mature, evergreen vegetation. Dominant features included grazed paddocks, open farm fencing and transmission lines. No other buildings or dwellings were observed within the landscape. The proposed colour of the infrastructure is similar in contrast to the treed areas in this agricultural area seen in the foreground and background in the image below. There are no likely direct views from the dwelling. **No mitigation required, therefore the residual impact remains the same as the inherent visual impact.** 
Scenic Quality	Moderate	
Proximity	Middle (1-2 km)	
Sensitivity	Moderate	
LMZ Objective	B	
Contrast	indistinct	
Inherent Visual Impact	LOW – not visible	
Residual Visual Impact	LOW	

<table>
<tr><th colspan="3">VIEWPOINT 13</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="8">Taken from a dwelling off Grady’s Road, facing north-east towards the proposal area. Viewpoint 13 is approximately 950 m from the main infrastructure. The dwelling (Lot 186 DP754567) is fenced, and views are limited by the fencing. Dominant features included paddock and highway trees, the highway (vehicles) and transmission lines. The proposed colour of the infrastructure is not inconsistent with the existing infrastructure (powerlines) in the middle ground and the treed areas in the background as seen in the image below. The screen planting proposed will further obscure views from this viewpoint.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic Quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Middle Ground (1-2 km)</td></tr>
<tr><td>Sensitivity</td><td>Moderate</td></tr>
<tr><td>LMZ Objective</td><td>B</td></tr>
<tr><td>Contrast</td><td>Medium-Low</td></tr>
<tr><td>Inherent Visual Impact</td><td>MODERATE</td></tr>
<tr><td>Residual Visual Impact</td><td>MODERATE</td></tr>
</table>

VIEWPOINT 14		
Summary of Viewpoint		Viewpoint Description / Impact
LCU	Rural	Taken from a dwelling off Grady's Road, facing north-east towards the proposal area. Viewpoint 14 is approximately 1.1 km from the access track off Churches Plain Road. The dwelling (Lot 1 DP624900) is completely screened from the development. Dominant features included stands of mature vegetation, several buildings and transmission lines. The proposed colour of the infrastructure is not inconsistent with the existing structures (buildings) in the foreground and the treed areas in the background as seen in the image below. The screen planting proposed will further obscure views from this viewpoint. **No mitigation required, therefore the residual impact remains the same as the inherent visual impact.** 
Scenic Quality	Moderate	
Proximity	Middle Ground (1-2 km)	
Sensitivity	Moderate	
LMZ Objective	B	
Contrast	Medium-Low	
Inherent Visual Impact	MODERATE	
Residual Visual Impact	MODERATE	

<table>
<tr><th colspan="3">VIEWPOINT 15</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="8">Taken from a dwelling off Connorton Street, facing north towards the proposal area. Viewpoint 15 is approximately 1.1 km from the proposed solar farm, off Churches Plain Road. The dwelling (Lot 192 DP754567) is mostly screened from the development by mature vegetation, some of which is deciduous. Dominant features included nearby dwellings, open fence lines and transmission lines. The proposed colour of the infrastructure is not inconsistent with the existing structures and infrastructure (fences and powerlines) in the foreground and the treed areas in the foreground, middle ground and background as seen in the image below. The screen planting proposed will further obscure views from this viewpoint.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
  </td></tr>
<tr><td>Scenic Quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Middle Ground (1-2 km)</td></tr>
<tr><td>Sensitivity</td><td>Moderate</td></tr>
<tr><td>LMZ Objective</td><td>B</td></tr>
<tr><td>Contrast</td><td>Medium-Low</td></tr>
<tr><td>Inherent Visual Impact</td><td>MODERATE</td></tr>
<tr><td>Residual Visual Impact</td><td>MODERATE</td></tr>
</table>

<table>
<tr><th colspan="3">VIEWPOINT 16</th></tr>
<tr><td colspan="2">Summary of Viewpoint</td><td>Viewpoint Description / Impact</td></tr>
<tr><td>LCU</td><td>Rural</td><td rowspan="9">Taken from the driveway off Connorton Street, facing north towards the proposal area. Viewpoint 16 is approximately 1 km from the proposed solar farm. The dwelling (Lot 191 DP754567) located just over 1km from the solar farm is partly screened from the development by mature vegetation, some of which is deciduous. Dominant features included paddocks, nearby rural dwellings, open fence lines and the highway. The proposed colour of the infrastructure is not inconsistent with the existing structures and infrastructure (fences and powerlines) in the foreground and the treed areas in the foreground, middle ground and background as seen in the image below. The screen planting proposed will further obscure views from this viewpoint.
No mitigation required, therefore the residual impact remains the same as the inherent visual impact.
 
Note: Photos were taken from the driveway at the boundary of the lot. This provides the best representative photo of the potential impacts from the dwelling without accessing the land. Restrictions on accessing the property and the landowners wishes were considered in the photo location selection. There were limited opportunities to access the site (residents' and NGH staff availability and weather impacts (including rain events and fog impacting quality of photos at certain times of the day)).</td></tr>
<tr><td>Scenic Quality</td><td>Moderate</td></tr>
<tr><td>Proximity</td><td>Middle Ground (1-2 km)</td></tr>
<tr><td>Sensitivity</td><td>Moderate</td></tr>
<tr><td>LMZ Objective</td><td>B</td></tr>
<tr><td>Contrast</td><td>Medium-Low</td></tr>
<tr><td>Inherent Visual Impact</td><td>MODERATE</td></tr>
<tr><td>Residual Visual Impact</td><td>MODERATE</td></tr>
</table>

Results summary

Design inclusions minimise and mitigate visual impacts

The potential for visual impact has been considered from viewpoints around the proposal site. Some sites are likely to have a moderate inherent potential visual impact without mitigation measures, specifically this includes the dwellings at Viewpoints 3, 4, and 13-16. Although mitigation measures are not required for moderate impact viewpoints, the proponent has minimised the potential for visual impacts by including in the design proposed planting of screening vegetation. The screening is proposed along the part of the west, south and south-east border of the development site would likely reduce the visual impacts of the proposal from Viewpoints 3, 4, and 13-16 (see general mitigation measures at section 3.12.4 below).

Even without the design measure it was found that for Viewpoints 3, 4, and 13-16, visual impacts from these locations would generally be minimised by distance, medium/medium-low contrast, existing vegetation and topography.

The landscaping proposed for the site would likely also benefit Viewpoints 1 and 2 to provide screening/filtering of views of the solar infrastructure from the highway and an elevated rural road.

No mitigation required

Viewpoints 7, 8 and 9 are views from lower use roads that are generally level with the site and moving vehicles, reducing the sensitivity and view time. Therefore, there is considered less importance for retaining existing visual amenity. No mitigation was required.

Residences represented by Viewpoints 6, 10, 11 and 12 would be well buffered from views of the proposed infrastructure by topography existing structures and stands of vegetation such that the proposed planted screening would not provide additional benefit due to minimal or no views.

Low impacts are seen for arterial roads, dwellings, and public services where views of the solar farm infrastructure would be difficult to perceive or is not visible. Visual impacts on involved landholders are also considered low.

Low impacts are expected for the majority of the study area and representative viewpoints due to distance to infrastructure, existing vegetative screening, retained on-site vegetation and the overall undulating terrain of the area. No mitigation is required for these locations.

Potential cumulative impacts

Adverse cumulative impacts occur when the infrastructure or activities at the solar farm site exacerbate the negative impacts of other infrastructure or activities occurring nearby. A number of solar farm proposals have been submitted to either Council or DPIE as determining authority, including:

- Bomen Solar Farm – DPIE – Approved.
- Wagga Wagga Solar Farm – Regional Planning Panel – Refused but approved on Court appeal.
- Gregadoo Solar Farm – DPIE – Approved.

Major projects for the Wagga Wagga LGA and their application status are listed below:

- Enirigi Battery Recycling Facility – Bomen – Determination.
- Wagga Wagga Rural Referral Hospital Redevelopment Stage 3 – Determination.
- Wagga Wagga Quarry Project (MOD 1) – Determination.
- SSD 6284 MOD 1 Modification to Water Treatment Plant Upgrade – Determination.
- Teys (formerly Cargill) Beef Abattoir – Multiple Modifications – Determination.

- Riverine Oils and BioEnergy – Multiple Modifications – Determination.
- Wagga Wagga Base Hospital Redevelopment – Determination.
- Uranquinty Gas-Fired Power Station – Multiple Modifications – Determination.
- Wagga Wagga Gasworks Remediation – Determination.
- Wagga Wagga Quarry Project – Determination.
- Hume Highway Duplication – Multiple Bypass Applications – Determination.
- New Public School, Estella – Application.

None of the other solar farm projects or major projects are proposed to be built within 10km of the Sandy Creek Solar Farm. The nearest major project to the proposal is the Uranquinty Gas-fired Power Station. Due to the varying types of development and dispersion of these developments across the Wagga Wagga LGA, noticeable cumulative impacts during either the construction or operation phase of the proposal are not anticipated. Cumulative visual impacts are considered manageable.

3.12.4. Mitigation measures

Design

The design of the solar farm included consideration of landscaping around the periphery of the infrastructure. The landscaping is proposed where the greatest number of people would have potential views of the solar farm.

A 5-metre screening buffer comprising native species would be planted following construction along the southern and eastern boundary of the development site, on the outside of the security fence to break up views of the proposal from residences and vehicles travelling along Churches Plain Road and Olympic Highway.

While fast growing species would be selected for planted screening vegetation, the proponent estimates a period of five years before the benefits of the screening in breaking up views of the proposal are noticeable. Proposed screening vegetation is shown in Figure 3-28 on the following page.

The materials and colour of onsite infrastructure would, where practical, be non-reflective and in keeping with the materials and colouring of existing infrastructure or of a colour that would blend with the landscape. Where practical:

- Buildings would be non-reflective and in eucalypt green, beige, or muted brown.
- Security fencing posts and wire would be non-reflective.
- Avoidance of unnecessary lighting, signage, and logos.
- Retain and protect existing boundary landscaping.

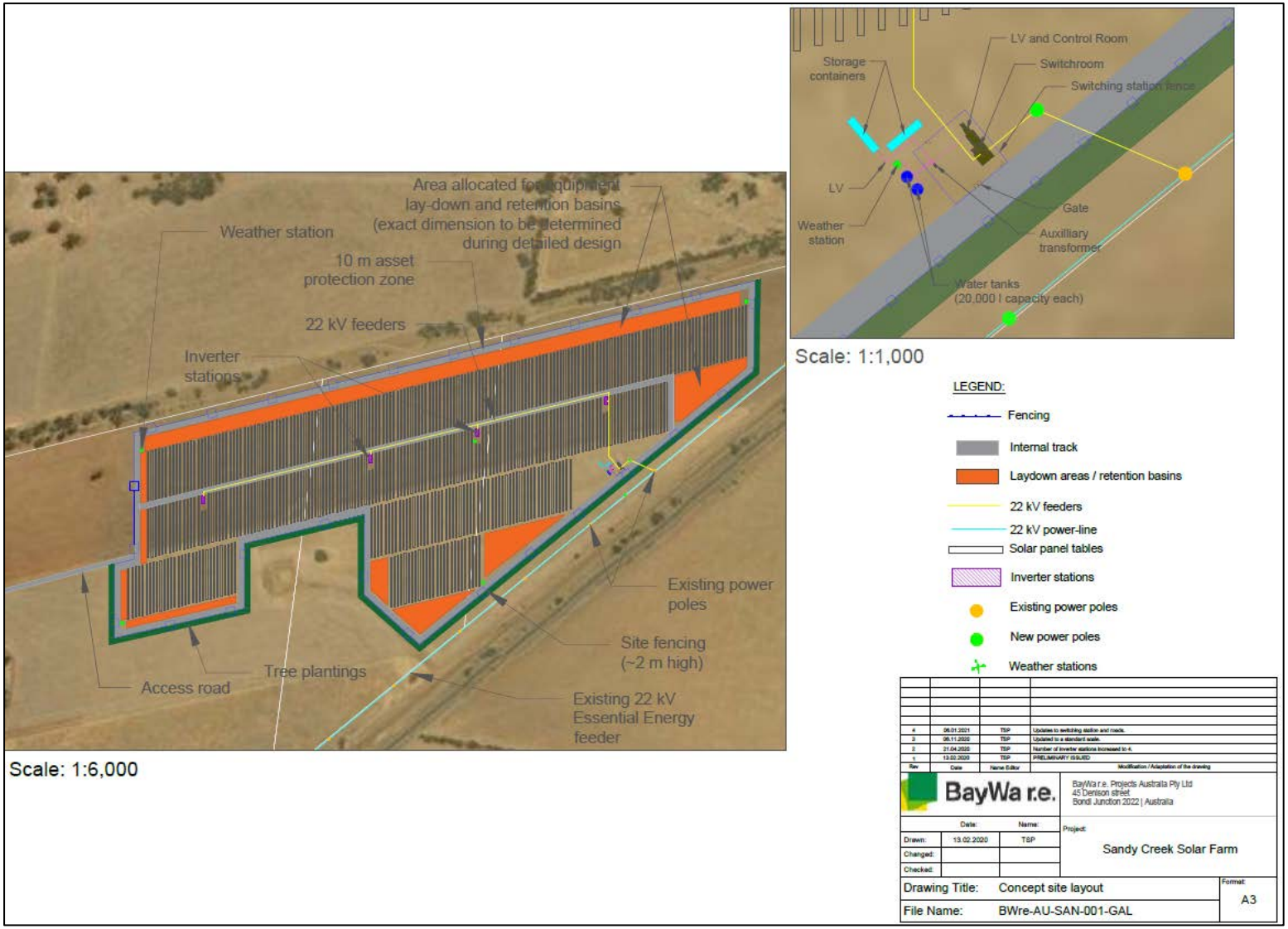


Figure 3-27 Proposed vegetation screening (Source: BayWa, 2020)

Construction

During construction, dust would be controlled in response to visual cues. Areas of soil disturbed by the project would be rehabilitated progressively or immediately post-construction, reducing views of bare soil.

Night lighting

Light spill is light that falls outside the area that is intended to be lit and can contribute to glare and wasted energy. Spill light above the horizontal plane also contributes to artificial skyglow. All light fittings would be located aimed or shielded to avoid spill. Measures to prevent spill include:

- Installing light fittings with an opaque cover and flat glass, mounted horizontally on both axis.
- Mounting lights under part of a building (including awnings, verandah, or roof) so light is blocked above the horizontal plane.
- Design buildings to internalise lights.

Operational light from the proposal must be directed downwards, or inwards towards the work area.

Where floodlights are required, wherever possible use fittings with asymmetric beams that permit horizontal glazing. These are to be kept at or near parallel to the surface being lit, usually the ground and should prevent light spill.

Safeguards and mitigation measures

No viewpoint specific mitigation measures were required due to the low, and moderate inherent visual impact ratings at Viewpoints 1 to 16. The general mitigation measures proposed as part of the design of the solar farm are listed below. It is considered that these measures reasonably address visual impacts of the development.

Table 3-22 Safeguards and mitigation measures for visual impacts

No.	*Safeguards and mitigation measures*	*C*	*O*	*D*
VA1	Screening vegetation would be planted along the boundary of the development footprint as indicated by the site plan: • Plantings would be more than one row deep to break up views of infrastructure including the fencing. • The plant species to be used in the screen would be native and derived from the naturally occurring vegetation community in the area. They should be fast growing and comprise a mixture of trees and shrubs capable of reaching a height of 3 to 4m within 8 years. • Planting would be within 2 months of the completion of construction, so actual views of infrastructure are known or during winter/spring to increase the chance of plant survival. • The screen would be maintained for the operational life of the solar farm. Dead plants would be replaced. Pruning and weeding would be undertaken as required to maintain the screen's visual amenity and effectiveness in breaking up views.		**O**	**D**

No.	Safeguards and mitigation measures	C	O	D
VA2	Prior to the commencement of construction, a detailed landscape plan would be prepared including: • Screening location. • Species type. • Planting density and spacing. • Method for planting. • Descriptive measures that would be implemented to ensure vegetative screening is successful (i.e. irrigation or other watering method). A program to manage, monitor and report on the effectiveness of implemented measures.	**Design stage**		
VA3	The materials and colour of onsite infrastructure would, where practical, be non-reflective and in keeping with the materials and colouring of existing infrastructure or of a colour that would blend with the landscape.	**Design stage**		
VA4	During construction, dust would be controlled in response to visual cues. Areas of soil disturbed by the project would be rehabilitated progressively or immediately post-construction, reducing views of bare soil.	**C**		
VA5	All construction vehicles would enter the development site via the western entrance on Churches Plan Road to minimise impact on residences.	**C**		

C: Construction; O: Operation; D: Decommissioning

3.13. GLINT AND GLARE STUDY

Glint is a quick reflection that occurs when the sun is reflected on a smooth surface. Glare is a longer, sustained reflection. Infrastructure at the site that may cause glint or glare depending on the sun angle, include:

- Steel array mounting - array mounting would be steel.
- Temporary site offices, sheds, medium voltage power stations or inverter stations.
- Perimeter fencing.
- Permanent staff amenities.

PV solar panels are designed to absorb solar energy in order to generate the maximum amount of electricity and to reflect as little sunlight as possible. This results in the PV panels reflecting as little as 2 percent of the light they receive (FAA, 2010). The panels generally have an anti-reflective coating to further reduce the potential for glare and glint. Seen from an elevated position or above, such as from aircraft, they appear dark grey and do not cause a glare or reflectivity hazard.

An assessment of the potential glint and glare impacts of the proposal on nearby receivers has been completed by Pager Power Urban & Renewables (Pager Power). The report is summarised below and provided in full at Appendix I.

3.13.1. Existing conditions

According to the assessment, there is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. However, the significance of a reflection decreases with distance because the

proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases. Terrain and vegetative screening are also more likely to obstruct an observer's view at longer distances. Based on the consultant's technical experience, a 1km buffer from the proposed development site was considered appropriate.

Potential receptors were identified based on mapping and aerial imagery, as indicated in in Table 3-23.

Table 3-23 Receivers considered during the study.

Receiver Type	*Assessment Requirement*
Roads	A 3.15 km section of the Olympic Highway, running adjacent to the south-eastern boundary of the site, was assessed. Thirty-two receptor locations were identified, spaced approximately 100m apart (Figure 7 of the assessment). A height of 1.5 m above ground level was adopted, to represent typical eye level for a road user. Visibility and direction of travel were also considered. For road users, the keys considerations for quantifying impact significance includes: • Whether a reflection is predicted in practice. • The type of road (and associated likely traffic levels/speeds). • The location of the reflecting panels relative to a road user's direction of travel (a reflection directly in front of a driver is more hazardous than a reflection from a location off to one side).
Dwellings	The assessment considered un-associated receivers within 1 km of the proposed development and had a potential view of the panels. Aerial and street view imagery was used to identify dwellings that fit those parameters (Figure 8-10 of the assessment). The results indicated that no further assessment of dwellings was required as they were all appropriately screened from the glint and glare impacts of the development.
Railway Signals	No railway signals were identified within 500 m of the proposed development.
Train Driver Receptors	A 2.05 km section of railway running adjacent to the south-eastern boundary of the site was identified for assessment. Twenty-one receptor locations were identified, spaced approximately 100 m apart (Figure 11 of the assessment). The height of each receptor location was adjusted to 2.75 m above the rail level, so as to be representative of the driver's eye level. For train drivers, the keys considerations for quantifying impact significance includes: • Whether a significant reflection is predicted in practice. • Whether the reflection originates in front of the train driver.

3.13.2. Potential impacts

For roadway receptors, the model indicated that reflections were geometrically possible for 21 of the 32 assessed locations. The potential impact was at worst case considered moderate for these receptors; however, when the road users' primary field of view in both travel directions, rail embankment and the proposed screening buffer was considered, the assessment determined glint and glare impacts should not be possible. No further mitigation was considered required.

The assessment concluded that all dwellings within 1km of the site appeared to be suitably screened and, therefore, no impact was predicted.

For railway users, the model indicated that reflections were geometrically possible for 16 of the 21 assessed locations. The potential impact was at worst case considered moderate for these receptors; however, when the train drivers' primary field of view in both travel directions and the proposed screening buffer was

considered, the assessment determined glint and glare impacts should not be possible. No further mitigation was considered required.

3.13.3. Mitigation measures

The assessment noted that a screening buffer was already proposed as part of the development of the solar farm. The assessment outlined the following additional considerations:

- The height and density of the plantings should be managed such that views of the reflecting panels are sufficiently obstructed from the relevant receptors along the assessed sections of Olympic Highway and the railway line).

3.14. TRAFFIC

An assessment of traffic impacts of the proposal has been completed by Peter Meredith Consulting, the report is summarised below and provided in full at Appendix F.

3.14.1. Existing conditions

Churches Plain Road forms the main access road to the Sandy Creek Solar Farm areas. Churches Plain Road is a formed gravel road running in a north south direction connecting to Baker Street where the surface changes to bitumen and is also the start of the Uranquinty residential area. Churches Plain Road is classified as a local rural road under the management of Wagga Wagga City Council. Churches Plain Road is a designated unladen B-double route. At the site access it accommodates one lane of traffic in each direction and has an unsealed width of approximately 7.0 metres. It has an unposted speed limit of 100km/h in the vicinity of the site.

Baker Street connects to Churches Plain Road (north) and Yarragundry Street (south) and runs in a north South direction. Baker Street connects to Yarragundry Street as a T-junction and is controlled by give-way signs. Baker Street is classified as an urban road under the management of Wagga Wagga City Council and has a posted urban speed limit of 50km/h.

Yarragundry Street connects to the Olympic Highway MR78 and runs in an east west direction where crossing the Great Southern Railway Line and at the town limits becomes Uranquinty Cross Road. In Uranquinty, Yarragundry Street is classified as an urban road under the management of Wagga Wagga City Council and has a posted urban speed limit of 50km/h and is a designated school bus route.

The Olympic Highway MR78 runs in a north and south direction and is a major regional transport corridor and is under the management of the RMS. In Uranquinty, the Olympic Highway is as an urban road and has a posted urban speed limit of 50km/h and is a designated school bus and B-double route.

Traffic volume data for Olympic Highway was obtained from the RMS traffic volume viewer. The closest available data was located 180 m north of Red Hill Road, approximately 6 km north of the development site, where the 2010 data recorded an average of 4,178 vehicles per day (vpd). However, a large proportion of vehicles were considered to use the Olympic Highway between the Sturt Highway and Red Hill Road only. Therefore, the consultant considered that traffic volumes for the Olympic Highway at The Rock (recorded 50 m east of Mangoplah Road) would more closely align with volumes for the Olympic Highway near Uranquinty. 2010 data recorded an average of 3,063 vpd. Expected 2020 traffic volumes were calculated by applying a 1percent growth rate to 2010 data.

3.14.2. Potential impacts

Traffic movements

The duration of construction is expected to be 9 months. There would be an increase in traffic numbers during this period. There would be up to 40 staff on-site at any one time during the peak construction time. Infrastructure would arrive on semi-trailers, or truck and dog trailers. It is anticipated that delivery of the infrastructure and equipment would occur over 30 days on the back of heavy vehicles. A small mobile crane may be required for the offloading of the medium voltage power stations.

The expected traffic movements generated during construction (per month) are summarised in Table 3-23 and Table 3-24.

Table 3-24 Indicative Monthly Construction Traffic Movements - Heavy Vehicles (PMC, 2020)

Material Delivery	**Month**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Modules					14	14	14	14	**56**
Medium Voltage Power Stations		1	1	1	1				**4**
Tracking System		16	16	16	15	15			**78**
Civil Construction Concrete, sand, and gravel	8	8	56	56	56	56	8	7	**255**
Miscellaneous	16	32	40	40	40	40	32	16	**256**
Estimated Total monthly Heavy Vehicle Movements	**24**	**57**	**113**	**113**	**127**	**126**	**54**	**37**	**649**
Average Daily Heavy Vehicle Movements (21 working days/month)	**2**	**2**	**6**	**6**	**6**	**6**	**3**	**2**	

Table 3-25 Indicative Monthly Construction Traffic - Light Vehicles (Workers) (PMC, 2020)

Construction Labour	**Month**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Estimated Total Monthly Light Vehicle Movements	315	315	840	840	840	840	315	315	**4,620**
Average Daily Light Vehicle Movements (21 working days per month)	15	15	40	40	40	40	15	15	

The construction traffic would increase the frequency of large vehicle traffic on Churches Plain Road. The access points onto Churches Plain Road would be constructed to comply with Austroads Guides and Council requirements.

Traffic impacts would largely be confined to standard hours of construction. It is recommended that a Construction Traffic Management Plan be prepared for the gravel section of Churches Plain Road (750m) from the end of the seal at Baker Street and the Solar Farm Access Gate to ensure the gravel pavement is maintained to accommodate construction traffic and other road users. Where possible, goods and services for the solar farm would be sourced locally. Items which cannot be sourced locally would come by road, most likely from Sydney or Melbourne.

Once commissioned, one full time equivalent contractor would support the operations of the solar farm, primarily using a standard light vehicle (4WD). During major outages, several vehicles may be present at any one time. During the operational phase, traffic volumes using Churches Plain Road would not noticeably increase compared to the current average daily traffic volume.

Access Sight Distance Assessment

Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections specifies the Safe Intersection Sight Distance (SISD) as the minimum sight distance which should be provided along the roads at any intersection.

The traffic impact assessment identified the sight distance criteria are satisfied for all roads leading to and from the development site.

3.14.3. Conclusion

In view of the above, the works are not considered likely to result in unacceptable traffic delays or collision risks, provided that the recommendations of the TIA are implemented:

A Construction Traffic Management Plan, based on Austroads and RMS guidelines, would be developed for Churches Plain Road adjacent to the site including the intersection of Churches Plain Road and the Solar Farm Access Gate. The Construction Traffic Management Plan shall be produced in accordance with RMS Traffic Control at Worksites 2018 Version 5 after an appropriate risk assessment has been carried out.

In addition, to comply with Wagga Wagga City Council and RMS standards, the Construction Traffic Management Plan should address the following on Churches Plain Road:

- Dust control with water cart along Churches Plain Road during dry periods.
- Periodic grading and gravel pavement repairs, particularly during wet periods.
- Temporary traffic control arrangements at the intersection of Churches Plain Road and the Solar Farm Access Gate during the peak stages of construction traffic activity and on days when deliveries by oversize vehicles may be required.
- Temporary reduction in speed limit on Churches Plain Road between the end of the existing 50km/h zone and the Solar Farm Access Gate to help reduce damage to the gravel pavement by heavy vehicles.

3.14.4. Off-Street Parking

During the peak of the construction phase, it is expected that up to 40 workers may be supported on the site. There are sufficient areas to accommodate off-street parking on the subject site, with no impacts on Churches Plain Road. A Construction Traffic Management Plan would be developed and include construction phase carparking arrangements.

During operation, one full time equivalent contractor would manage the solar farm, visiting the site as required and primarily using standard light vehicles (4WD). They would primarily require the use of their vehicle to traverse the site using established tracks, rather than parking in a designated area and walking. In all instances, contractor vehicles would be parked well within the bounds of the development site and would pose no concerns.

3.15. PUBLIC UTILITIES

A tank would be installed at the site to store water for bushfire protection and other non-potable water uses, with a minimum of 20,000 litres dedicated to bush firefighting. Potable water would be provided for staff using imported supplies or via town water supply.

All effluent waste during both construction and operation would be managed by way of hired transportable WC facilities. These would be managed by an external contractor and disposed off-site at a licensed facility.

No reticulated stormwater drainage structures are considered required. The subject land is within a rural environment and informal stormwater management would be preferable where this provides a satisfactory outcome. As indicated in Sections 3.7 and 3.11, stormwater runoff can be easily managed.

3.16. KEY CONSIDERATIONS FOR SITE SELECTION

Whilst the development does not meet the thresholds for State Significant Development, the considerations for site selection as detailed within the NSW Large-scale Solar Energy Guideline for State Significant Development (DPE 2018), were evaluated. The key site constraints identified in the Guideline are addressed below.

Table 3-26 Large-scale Solar Energy Guideline considerations

Areas of constraint	*Site justification*
Visibility and topography - 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 towards the site. This is particularly important in the context of significant scenic, historic or cultural landscapes.	Rural and agricultural lands within the study area are used predominantly for small land holdings, grazing, rotational cropping, and olive groves. The development site is positioned slightly lower in the landscape at approximately 210m to 220m above sea level than the surrounds, however surrounding agricultural land use is generally located on land that is relatively flat to undulating. Expansive views are generally limited given the undulating relief and screening provided by vegetation.
Biodiversity - Areas of native vegetation or habitat of threatened species or ecological communities within and adjacent to the site, including native forests, rainforests, woodlands, wetlands, heathlands, shrublands, grasslands and geological features.	The design of the proposal is the result of an iterative process. The design has been adapted progressively as information regarding site constraints has become available. The land has been heavily disturbed from past and current agricultural activities and there are low environmental constraints within the final development site. Given the location, site attributes and the existing disturbance of the land, the proposal would have low impacts on the environment.
Residences - Residential zones or urbanised areas.	The development site is comprised within a small to moderate sized rural holding. The subject land has similar size rural lots (some with dwellings) and bushland to the west, north and east. To the south-west at approximately 1km distance is the rural village of Uranquinty. It is considered the development footprint is appropriately sited away from residential zones and areas and maximises possible separation distances.

Areas of constraint	*Site justification*
Agriculture - Important agricultural lands, including Biophysical Strategic Agricultural Land (BSAL), irrigated cropping land, and land and soil capability classes 1, 2 and 3. Consideration should also be given to any significant fragmentation or displacement of existing agricultural industries and any cumulative impacts of multiple developments.	The proposal is not located on Strategic Agricultural Land or irrigated cropping land. The proposed development is located on land classified as Class 3 capability. The proposal, as mitigated, is not expected to adversely affect the biophysical nature of the land and would eventually be returned to agricultural activity. Refer to Section 3.4 of this report. There are no agricultural industries in the Uranquinty locality. Agricultural activities (extensive agriculture) would continue on the subject land and in the district. There are no identifiable cumulative impacts arising from the proposed development that would adversely impact the community. There are no current major projects in the Uranquinty locality. The proposed development is considered compatible with the nature of land use on surrounding sites and would not introduce conflicts for agricultural uses or residential development within the Uranquinty village.
Natural Hazards – Areas subject to natural hazards, such as flooding and land instability.	The subject land is not mapped as vulnerable land or prone to landslip or unmanageable erosion. A Hydrology Assessment identified the development footprint as not subject to the 100yr ARI overland flow flood event of Sandy Creek, a tributary of the Murrumbidgee River. A Bushfire Assessment found the land would not be at significant bushfire risk. The proposed development can be managed in accordance with standard measures in PBP 2019, as outlined in Section 3.6 of this report.
Resources - Prospective resources developments, including areas covered by exploration licences and mining and petroleum production leases. Solar development applicants should seek advice from the Department of Planning, Division of Resources and Geoscience (GSNSW) about the coverage of resources-related licences.	There are no mining leases or licences within the area (Minview 2020). There are no current operating mines or quarries within the subject land or directly adjacent lands.
Crown Lands – If any part of the project or associated transmission or distribution infrastructure will cross Crown Lands, it may be subject to legislative requirements that restrict access to the land.	The proposed development would not impose on Crown Lands.

4. STATUTORY FRAMEWORK

4.1. COMMONWEALTH LEGISLATION

4.1.1. Environment Protection and Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is administered by the Commonwealth Department of the Environment and Energy (DEE). Under the EPBC Act, if the Minister determines that an action is a 'controlled action' then the action may not be undertaken without prior approval of the Minster.

Assessments of significance based on criteria listed in Significant Impact Guidelines 1.1 issued by the Commonwealth (Commonwealth of Australia 2013) are used to determine whether the proposed action is likely to have a significant impact (i.e. is likely to be considered a 'controlled action').

In the preparation of the Biodiversity Assessment, database searches and site surveys were undertaken to determine the presence and likelihood of impact to threatened species and communities.

The assessments conclude that the proposal is not likely to have a significant impact on threatened species and communities, migratory bird species and marine species listed under the EPBC Act.

4.1.2. Renewable Energy (Electricity) Act 2000

The Renewable Energy (Electricity) Act 2000 (RE Act) aims to:

- Encourage the additional generation of electricity from renewable sources.
- Reduce emissions of greenhouse gases in the electricity sector.
- Ensure that renewable energy sources are ecologically sustainable.

Section 17 of the RE Act defines renewable energy sources eligible under the Commonwealth Government's RET; this includes solar energy.

Certificates for the generation of electricity are issued using eligible renewable energy sources. The proposed development would need to be accredited as a Renewable Energy Generator to create Renewable Energy Certificates.

4.2. STATE LEGISLATION

4.2.1. Environmental Planning and Assessment Act 1979

The proposed development would be assessed under clause 4.2 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This Statement of Environmental Effects report and supporting documentation addresses the matters to be considered under clause 4.15 of the Act.

The proposed development is considered Integrated Development under Division 4.8 of the Act, given that an Aboriginal heritage impact permit is required pursuant to section 90 of the *National Parks and Wildlife Act 1974.*

4.2.2. Biodiversity Conservation Act 2016

Development Applications (DAs) to be assessed under Part 4 of the *Environmental Planning and Assessment Act* must address the relevant requirements of the *Biodiversity Conservation Act 2016*.

The proposed development must be assessed in accordance with the provisions outlined in clause 7.2 of the BC Act, to determine whether the development is likely to significantly affect threatened species. According to clause 7.7(2) of the BC Act, if the proposed development is likely to significantly affect threatened species, the development application is to be accompanied by a biodiversity development assessment report (BDAR). According to this clause, development is considered likely to significantly affect threatened species if:

> *(a) it is likely to significantly affect threatened species or ecological communities, or their habitats, according to the test in section 7.3, (5 part Test) or*
>
> *(b) the development exceeds the biodiversity offsets scheme threshold if the biodiversity offsets scheme applies to the impacts of the development on biodiversity values, or*
>
> *(c) it is carried out in a declared area of outstanding biodiversity value.*

The proposed development would not trigger the BC Act thresholds. Further detailed assessment is not required according to the BC Act.

The accompanying Biodiversity Assessment, prepared by NGH, considers the biodiversity impacts of the proposed development. The proposed development would not significantly affect threatened species or ecological communities, or their habitats.

4.2.3. State Environmental Planning Policy (State and Regional Development) 2011

The proposed development is funded by the proponent and the calculated capital investment value (CIV) is $19 million. According to Schedule 7 of the State Environmental Planning Policy (State and Regional Development) 2011, the proposal would be defined as private infrastructure development. The proposal has a CIV exceeding $5 million, and not exceeding $30 million and is therefore considered Regionally Significant Development.

The development application would be assessed by Wagga Wagga City Council, whilst the determining authority is the Southern Regional Planning Panel.

4.2.4. State Environmental Planning Policy (Infrastructure) 2007

The provisions of the State Environmental Planning Policy (Infrastructure) 2007 are relevant to the proposed development. Under clause 34(1)(b), electricity generating works using solar as the fuel source are permitted with consent on land in a prescribed rural, industrial, or special use zone.

34 Development permitted with consent

> *(1) Development for the purpose of electricity generating works may be carried out by any person with consent on the following land:*
>
> *(a) in the case of electricity generating works comprising a building or place used for the purpose of making or generating electricity using waves, tides or aquatic thermal as the relevant fuel source—on any land,*
>
> *(b) in any other case—any land in a prescribed rural, industrial or special use zone.*

The development site is zoned RU1 Primary Production, which is a prescribed zone for the purposes of clause 34(1)(b) of the ISEPP. According to clause 8 of the ISEPP, the above provisions prevail over any inconsistency in any other planning instruments, including the Wagga Wagga LEP 2010. As such, the proposed development is permitted with consent under the provisions of the ISEPP.

Division 5 Electricity transmission or distribution, Clause 45 Determination of development applications is also of relevance to the proposed development. It is considered to be development that would affect an electricity transmission or distribution network. As such, the application must be referred by Council to the supply authority.

The subject land has frontage to a classified road (Olympic Highway). The provisions of clause 101 are relevant to the proposed development. The objectives of clause 101 are:

> *(a) to ensure that new development does not compromise the effective and ongoing operation and function of classified roads, and*
>
> *(b) to prevent or reduce the potential impact of traffic noise and vehicle emission on development adjacent to classified roads.*

Table 4-1 ISEPP Clause 101 matters

Matters requiring consent authority satisfaction	***Comment***
(a) where practicable and safe, vehicular access to the land is provided by a road other than the classified road, and	The proposed development site would not have direct access to the classified road. The development footprint would be accessed via Churches Plain Road which is a local rural road.
(b) the safety, efficiency and ongoing operation of the classified road will not be adversely affected by the development as a result of: ***(i) the design of the vehicular access to the land, or*** ***(ii) the emission of smoke or dust from the development, or*** ***(iii) the nature, volume or frequency of vehicles using the classified road to gain access to the land, and***	The design of the vehicular access to the land would meet relevant design standards and guidelines, as outlined in the accompanying Traffic Impact Assessment. The proposed development involves no elements that would be likely to cause the emission of smoke from the site. Standard dust controls would be in place during the construction phase to ensure this is managed and mitigated. The nature, volume and frequency of vehicles using the classified road to access the development site is addressed in the accompanying Traffic Impact Assessment. It was concluded that the safety, efficiency, and ongoing operation of the classified road would not be affected.
(c) the development is of a type that is not sensitive to traffic noise or vehicle emissions, or is appropriately located and designed, or includes measures, to ameliorate potential traffic noise or vehicle emissions within the site of the development arising from the adjacent classified road.	The proposed development is electricity generating works with staff generally located offsite and is a development type that is not sensitive to traffic noise or vehicle emissions that might arise from the Olympic Highway.

Refer to section 3.12 for the consideration of visual impacts relating to the Olympic Highway (classified road).

The expected peak traffic movements, as listed in the Traffic Impact Assessment in Appendix F, would not exceed the thresholds outlined in Schedule 3 of the ISEPP. The proposed Sandy Creek Solar Farm is therefore not considered to be a traffic-generating development pursuant to clause 104.

4.2.5. State Environmental Planning Policy No 33—Hazardous and Offensive Development

State Environmental Planning Policy No 33 – Hazardous and Offensive Development requires that consideration be given to the current circulars or guidelines relating to such development as published by the Department of Planning, when determining if the proposal is so classified.

Electricity generating works are not identified as a potentially offensive or potentially hazardous industry in Appendix 3 of the Guidelines. However, this is not conclusive within itself. The potential hazard and offensiveness of the proposed development is discussed in Section 3.8 of this report.

It was concluded that the proposed development does not constitute hazardous or offensive development and does not trigger any further considerations under SEPP 33.

4.2.6. State Environmental Planning Policy No. 55 – Remediation of Land

State Environmental Planning Policy No 55 – Remediation of Land requires the consent authority to take into account whether or not land is contaminated, whether the land is in a suitable state for the proposed development and whether land requires remediation to reach a state that is suitable for that development.

A search of the NSW EPA contaminated land public record of notices (NSW EPA, 2020a) identified 4 records within Wagga Wagga LGA. No records are located within or near Uranquinty, with the closest being the former gasworks at 54 Chaston Street, Wagga Wagga 8.4km to the north of the subject site. A search of the list of NSW contaminated sites notified to the EPA (NSW EPA, 2020b) returned one site near Uranquinty, being the former Caltex depot Kapooka, located at 6876 Olympic Highway, 3.4km to the north of the subject site. It is considered these sites are well separated from the development footprint and would therefore not impact the proposed development by way of contaminated land. A search of the Protection of the Environment Operations Act (POEO Act) register (NSW EPA, 2020c) identified one POEO Licence in Uranquinty, being for the generation of electrical power from gas at Uranquinty Cross Road, 2.7km to the west. It is considered there would be no impact on the proposed development from this licensed development.

The subject land has been utilised for agricultural activities, specifically, livestock grazing and small-scale cropping. Agricultural activities are listed as a potentially contaminating land use activity according to Table 1 of the Managing Land Contamination Planning Guidelines. There may be a risk that contamination associated with small-scale cropping is present on the site. However, no evidence of contamination was observed over the course of field survey. Council's aerial imagery and discussions with the respective landowners indicate that the land has not been used for more intensive forms of agriculture or horticulture, which may present additional land contamination risks.

The proposed development is broadly consistent with the established activity pattern on the subject land, given the low intensity of operations that would occur. The proposed solar farm would be remotely operated for the most part, with staff dispatched as required for certain activities such as malfunction or emergency, or on a scheduled basis for routine site management or infrastructure monitoring and maintenance. A more sensitive land use would not be introduced to the site, as the proposed solar farm would be categorised as an infrastructural activity.

In addition to the low risk of residual agricultural contamination being present, the risk of exposure is considered low based on the proposed staffing arrangements and exclusion of public access from the solar farm.

In consideration of these factors, it is considered that the site is suitable for the proposed purpose.

4.2.7. State Environmental Planning Policy (Koala Habitat Protection) 2019

State Environmental Planning Policy (Koala Habitat Protection) 2019 encourages the conservation and management of areas of natural vegetation that provide habitat for koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline. Koalas are listed under the BC Act as a vulnerable species.

Wagga Wagga LGA is listed as an LGA (Schedule 1) to which this policy may apply. The proposal area is greater than 1 ha, however the land is not mapped on the 'Koala Development Application Area' Map and therefore the Koala Habitat Protection SEPP does not apply (refer to further detail in the Biodiversity assessment at Appendix C).

4.2.8. Roads Act 1993

The Roads Act 1993 (Roads Act) provides for the declaration of RMS and other public authorities as roads authorities for both classified and unclassified roads. Freeways, State Highways and Main Roads ('State Roads') are generally the responsibility of RMS. For State Roads other than Freeways, the local council generally has responsibility for footpaths and road reserves. Councils are roads authorities for less important classified roads and for roads not classified under the Act.

The Roads Act regulates the carrying out of various activities in, on and over public roads. Under section 138, the consent of the appropriate road's authority is required to:

a) Erect a structure or carry out a work in, on or over a public road.
b) Dig up or disturb the surface of a public road.
c) Remove or interfere with a structure, work or tree on a public road.
d) Pump water into a public road from any land adjoining the road.
e) Connect a road (whether public or private) to a classified road.

Proposed treatments at the intersection of Churches Plain Road with the access driveway to the development site are outlined in the accompanying Traffic Management Plan (refer to Appendix F). A permit under section 138 of the Roads Act would be sought from the Council prior to the release of the construction certificate for the proposed road and access upgrades. The development is not Integrated Development under the Roads Act, according to clause 4.48(3) of the EP&A Act.

4.3. Wagga Wagga Local Environmental Plan 2010

The subject land is zoned RU1 Primary Production under the provisions of the Wagga Wagga Local Environmental Plan (LEP) 2010, as indicated in Figure 4-2.

4.3.1. Permissibility of the proposal

The proposed development would be defined as electricity generating works. Under the RU1 Primary Production land use table of the WWLEP 2010, the proposal is permitted with consent in the zone.

The proposal is additionally permitted with consent under clause 34(1)(b) of the Infrastructure SEPP as described in section 4.2.4 above.

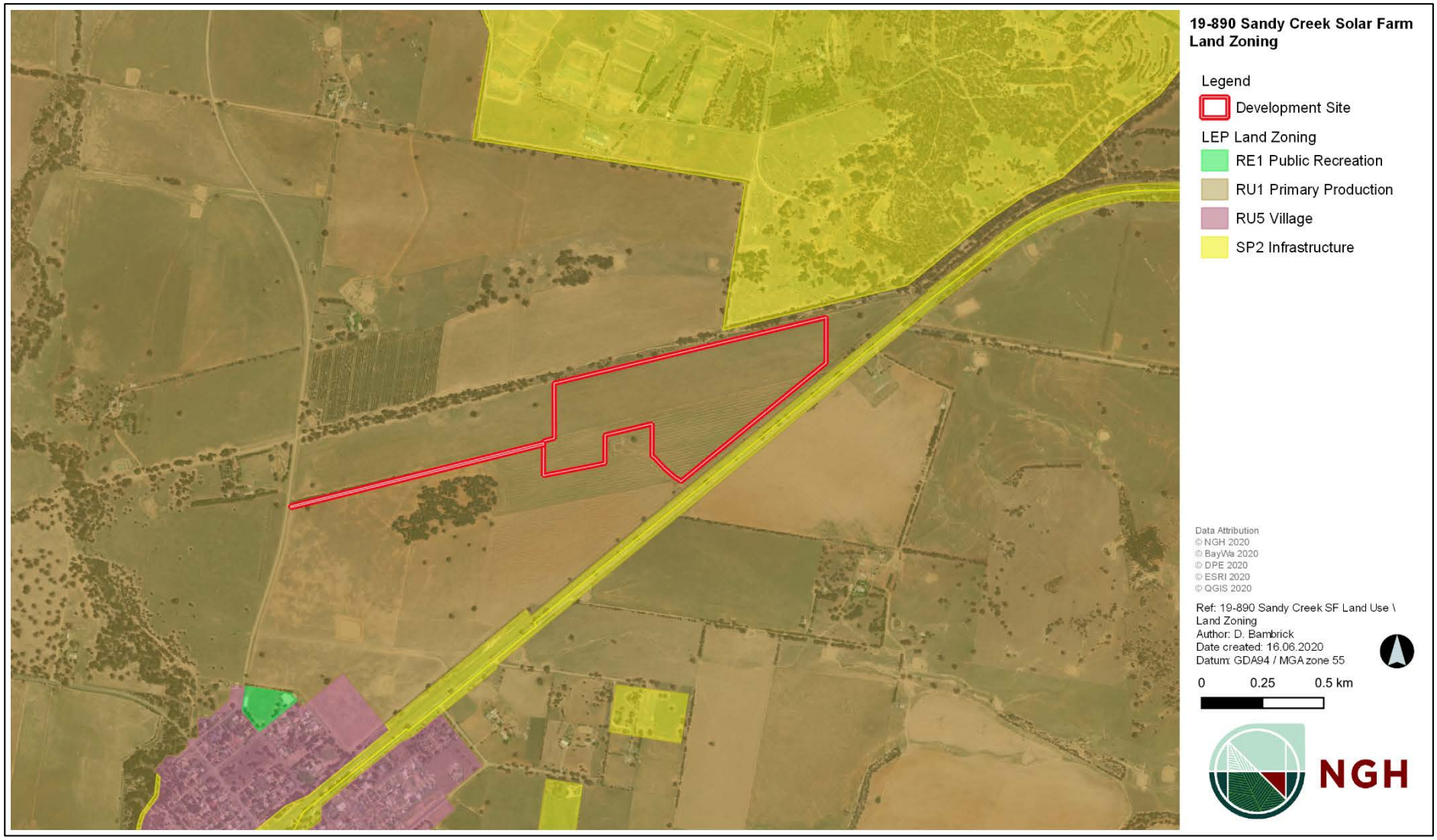


Figure 4-1 WWLEP 2010 Land Zoning (Source: NGH, 2020)

4.3.2. Objectives of the zone

Clause 2.3 of the LEP requires Council to have regard to the objectives for development in a zone when considering a development application. The proposed development would be located within land zoned RU1 Primary Production.

As outlined below, the proposed development is not considered to be averse to the objectives of the RU1 Primary Production zone.

Table 4-2 Wagga Wagga LEP 2010 RU1 Zone Objectives

RU1 Primary Production Zone Objectives	*Comment*
To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.	It is considered that the objective would be achieved. As outlined in Section 3.3.1 of this report, the proposal would not compromise the agricultural capability of the land for future use, nor would the development impinge on the ability to farm adjacent properties. The impacts of the solar farm are considered broadly compatible with agriculture and would not introduce sensitive receivers that would trigger restrictions on farming practices for adjacent properties. The solar farm would allow for some co-location for some types of agriculture, i.e. light grazing. Additionally, the proposal is not expected to have any significant impact on natural resources or affect the access to, or viability of, other natural resources in the locality.
To encourage diversity in primary industry enterprises and systems appropriate for the area.	The proposal would complement grazing and other existing agricultural activities on the subject land and adjacent properties. Following the end of the life of the proposal, the land would be returned to a state suitable for use similar to current grazing activities. As such, the objective would be achieved.
To minimise the fragmentation and alienation of resource lands.	It is considered that the objective would be achieved. The nature of the proposed development would not prevent access or use of resources on surrounding sites or the wider locality.
To minimise conflict between land uses within this zone and land uses within adjoining zones.	Land adjacent to the development site is also zoned RU1. The proposed development is considered to be relatively passive. The impacts of the proposed development are compatible with the continued use of the surrounding area for agriculture. The development also has minimal impact on the residential developments located on the rural properties and within the village of Uranquinty.
To foster strong, sustainable rural community lifestyles.	The ability for diversification of land uses around rural communities fosters job creation and opportunities for the community. The proposal

	objective is to create a sustainable form of energy for the local community and wider NSW community. The proposal is considered to add to the fostering of, not take away from, a strong, sustainable rural community lifestyle for both the rural and village residents of Uranquinty and Wagga Wagga residents.
To maintain the rural landscape character of the land in the long term.	Co-location of farming/agricultural practices on the land surrounding the development footprint and light grazing within the development footprint is expected to continue. Following the proposed solar farm's projected 50-year life span, it is expected that it would be entirely decommissioned, or upgraded where possible. If decommissioned the landscape character would be fully returned to its rural state.
To allow tourist and visitor accommodation only where it is in association with agricultural activities.	The development is not for tourist and visitor accommodation. This objective is not applicable to the proposed solar farm.

4.3.3. Clause 5.10 Heritage Conservation

The subject land is not within a heritage conservation area, does not contain an item of environmental heritage and is not within an Aboriginal place of significance.

Aboriginal cultural heritage items have been identified on site and safeguards and mitigation measures have been recommended. The disturbance of Aboriginal sites is discussed in further detail in Section 3.3 of this report. Refer to Appendix B for the full ACHA report.

4.3.4. Clause 5.11 Bush Fire Hazard Reduction

Part of the subject land is located within a bushfire prone land buffer. The development footprint is not considered to be bushfire prone. No clearing for the purposes of bushfire hazard reduction are proposed.

The proposed development would include measures in line with the recommendations outlined in Section 3.6.5 of this report to ensure that any bush fire hazards are reduced or mitigated.

4.3.5. Clause 7.1A Earthworks

The proposed development would involve earthworks during the construction phase associated with installing the solar array and ancillary infrastructure, as outlined in Section 2.4.1 of this report.

Table 4-3 Clause 7.6 Earthworks matters for consideration

Matters for consideration	*Comment*
the likely disruption of, or any detrimental effect on, drainage patterns and soil stability in the locality,	As outlined in Section 3.11 of this report, the proposed development is not expected to have a notable impact on stormwater runoff or infiltration patterns. The development would maintain and improve where possible the soil stability and water quality of stormwater leaving the site through civil works and erosion and sediment control measures designed

	specifically for the site conditions and through monitoring and maintenance of ground cover vegetation. With standard safeguards implemented, it is considered that soil stability would not be compromised by the proposed development.
the effect of the development on the likely future use or redevelopment of the land,	As outlined in Section 3, the proposed development is not expected to have any permanent impacts on the likely future use or redevelopment of the land.
the quality of the fill or the soil to be excavated, or both,	The proposed development does not require the importation of fill material. Further, any excavated material would be minimal and would be utilised on-site. There is no reason to suspect any concerns with the quality of the excavated material; it currently supports agricultural activity and would remain on-site.
the effect of the development on the existing and likely amenity of adjoining properties,	The proposed development is not expected to have an adverse impact on the existing and likely amenity of adjoining properties. The greatest impacts would be experienced during the construction phase, as outlined in Section 3 of this report. Construction phase impacts would be temporary and only occur during approved construction hours.
the source of any fill material or the destination of any excavated material,	The proposed development does not require the importation of fill material. Further, any excavated material would be minimal and would be utilised on-site.
the likelihood of disturbing relics,	The likelihood of disturbing relics or Aboriginal cultural heritage is discussed in further detail in Section 3.3 of this report.
the proximity to, and potential for adverse impacts on, any waterway, drinking water catchment or environmentally sensitive area,	There are no drinking water catchments or environmentally sensitive areas in proximity to the proposed development site.

4.3.6. Clause 7.3 Biodiversity

The subject land, predominately in the northern portion of the site and along roadsides, is identified on the Terrestrial Biodiversity Map of the WWLEP 2010. The potential for impacts to biodiversity has been considered in section 3.5 of this SEE.

4.3.7. Clause 7.4 Vulnerable land

The subject land, limited to the north east corner of the site, is identified on the Vulnerable Land Map of the WWLEP 2010. The potential for impacts to the land has been considered in section 3.4 of this SEE.

4.4. WAGGA WAGGA DEVELOPMENT CONTROL PLAN 2010

The Wagga Wagga Development Control Plan 2010 (DCP) applies to the subject land. The provisions that are relevant to the proposed development are discussed in the table below.

Table 4-4 Relevant DCP provisions

Development Control Plan Clauses	*Consideration of Clauses*
Section 2 Controls that apply to all development	
Section 3 Environmental Analysis of this SEE forms the site analysis for the proposal. This SEE identifies the opportunities and constraints of the site and features of the surrounding area. The findings of this analysis have been incorporated into the design of the solar farm.	
2.1 Vehicle access and movements	The proposed development would comply with the controls and objectives of section 2.1 of the DCP because: • Access would be from a non-arterial road. • Traffic impacts, haulage routes, access location and required access upgrades is discussed in section 3.14 of this SEE and the full Traffic Impact Assessment report and plans are provided in Appendix F. • The proposed access arrangements would allow for forward movement of vehicles into and out of the site during operation. • Loading and unloading for construction would be located within the set down area as shown on the plans in Appendix A. • The access driveway would be consistent with Australian Standards. • Sight lines for vehicles meet the relevant criteria. This would also provide sufficient sightlines for any pedestrians travelling along the rural road.
2.2 Off-street parking	The proposed development would comply with the controls and objectives of section 2.2 of the DCP because: • The solar farm is not a development type listed within section 2.2 of the DCP as such parking has been determined based on the number and type of vehicles that would be expected to visit the site. • Construction parking would be provided on site within a temporary construction compound and set down area. • Operational parking would be provided within the site adjacent to the temporary site office. Due to the low number of permanent staff during operation (1 FTE) an informal parking area (gravel or hardstand) would be created with space for light vehicles. Parking would be consistent with the relevant Australian standards. • Refer to comments below regarding landscaping to be provided.
2.3 Landscaping	The proposed development would comply with the controls and objectives of section 2.3 of the DCP because:

Development Control Plan Clauses	*Consideration of Clauses*
	Screening vegetation would be planted along the southern boundary of the development footprint (refer to section 3.2.14 for safeguards regarding the proposed landscaping)
2.4 Signage	The proposed development would comply with the controls and objectives of section 2.4 of the DCP because: • Only minor site identification, directional and safety signage would be included and located at the entry to the site and along the site fencing. • The signs would not endanger public safety or cause nuisance or a hazard by reason of its location, construction, or design.
2.5 Safety and security	The proposed development would comply with the controls and objectives of section 2.5 of the DCP because: • Security fencing (constructed of mesh to maintain passive/natural surveillance), lighting and, if required, CCTV and 24hr remote monitoring and alarm would be installed as part of the construction. • The solar farm would not have any public areas, access or facilities and as such no additional measures are considered to be required.
2.6 Erosion and Sediment Control Principles	The proposed development would comply with the controls and objectives of section 2.6 of the DCP because: • There is minimal change to the landform proposed other than for the control and management of stormwater. • The plans and reports that accompany this application including the Hydrology report (BayWa 2019) have been prepared by suitably qualified persons with consideration of applicable legislation. Plans recommended as part of safeguards and mitigation measures within this SEE would be consistent with the DCP objectives and prepared in accordance with relevant codes and standards. • The site would be managed in accordance with the Volume 1 of Managing Urban Stormwater: Soils and Construction (Landcom, 2004) (the "Blue Book").
2.7 Development adjoining open space	Not applicable.
Section 4 Environmental Hazards and Management	
4.1Bushfire	The proposed development would comply with the controls and objectives of section 4.1 of the DCP because: • The proposed development would satisfy the relevant provisions of Planning for Bush Fire Protection 2019 and Australian Standard: 3959 Construction of Buildings in Bush Fire Prone Areas. • A clear separation would be provided between buildings and bushfire hazards in the form of a fuel-reduced Asset Protection Zone (APZ), as is required. • The APZ is to be located wholly within the subject land, as required.

Development Control Plan Clauses	*Consideration of Clauses*
4.2 Flooding	The proposed development is located on flood free land as discussed in section 3.7 of this SEE. A flood assessment is not required for the solar farm.
Section 5	
Natural Resource and Landscape Management	Not applicable. There are no provisions in section 5 relevant to the RU1 zone. All relevant natural resource and landscape management have been addressed in Section 3 of this SEE.
Section 6	
Villages	Not applicable. There are no relevant provisions and the village character statement and town plan do not incorporate the subject land.
Section 8 – Rural development	
8.1 Development in rural areas	The proposed development would comply with the controls and objectives of section 8.1 of the DCP because: • The proposed Sandy Creek Solar Farm is considered to be compatible with the character of the locality in terms of buildings, structures and the nature of operations, as discussed in section 3 of this SEE. • It is considered that adequate buffer areas and setbacks to minimise potential conflicts with adjoining lawful land uses would be provided. Productive (agricultural) land uses would not be impacted during operation. Construction impacts would be carefully managed to minimise impacts. • Landscaping is proposed that would provide screening compatible with the rural setting. Refer to section 3.12.4 for details. • The subject land has access to town services and facilities or would be managed using delivery of goods to the site. • Loading and unloading for construction would be located within the set down area as shown on the plans in Appendix A. • Construction parking would be provided on site within a temporary construction compound and set down area. • Operational parking would be provided within the site adjacent to the temporary site office. • The roads are considered satisfactory. Traffic impacts, haulage routes, access location and required access upgrades is discussed in section 3.14 of this SEE and the full Traffic Impact Assessment report and plans are provided at Appendix F. • Arrangements for storage and disposal of waste have been considered in this SEE, refer to section 2.4.3 and 2.5.3 for discussion about construction and operation waste. All effluent waste during both construction and operation would be managed by way of hired transportable WC facilities. These would be

Development Control Plan Clauses	*Consideration of Clauses*
	managed by an external contractor and disposed off-site at a licensed facility. **Rural buffers and land use conflicts** Not relevant. The proposed development would not contain a dwelling. The associated rural dwelling is located on a separate lot. The solar farm has been designed to provide reasonable buffers from surrounding farms, dwellings, significant vegetation and waterways (refer to commentary in section 3 of this SEE).

4.5. OTHER RELEVANT SECTION 4.15 MATTERS FOR CONSIDERATION

Section 4.15 of the Environmental Planning and Assessment Act 1979 states that in determining a development application, a consent authority is to take into consideration other relevant matters. These matters are listed in the table below.

Table 4-5 Relevant s4.15 matters

Other relevant matters for consideration	
any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority…:	There are no known proposed instruments applicable to the development proposal.
any planning agreement…:	There are no known planning agreements applicable to the development proposal.
the suitability of the site for the development…:	Based on the evidence provided and discussions in this report, the site is considered suitable for the development proposal. The development proposal would have positive social and environmental benefits through the wider contribution to renewable energy targets. The development proposal would avoid adverse environmental impacts, as outlined in Section 3 of this report. The proposed development can support occasional stock grazing and the site can be returned to its pre-development condition.
any submissions…:	The proponent would undertake appropriate public consultation and consider any submissions as a result of public notification.
the public interest…:	The public interest is supported with this application as the proposal is in accordance with the publicly endorsed planning policies and guidelines. The proposed development would not result in any significant adverse impacts and would minimise any changes to amenity for the surrounding community.

Other relevant matters for consideration	
	The proposal would create positive economic impacts through the demand for goods, services and trades during the construction works given the estimated value of $19 million. The proposal is also compatible with social objectives in terms of addressing climate change through renewable energy projects.

4.6. ECOLOGICALLY SUSTAINABLE DEVELOPMENT

Ecologically Sustainable Development (ESD) involves the effective integration of social, economic, and environmental considerations in decision-making processes. In NSW, the concept has been incorporated into legislation including the Environmental Planning and Assessment Act 1979 and Regulation and the Protection of the Environment Administration Act 1991.

Based on the likely costs and benefits of the proposed solar farm, the proposal is considered to comply with the principles of Ecologically Sustainable Development. ESD principles and their relationship to the design, construction and ongoing operations of the proposal are addressed in Table 4 6.

Table 4-6 Assessment of the proposal against the principles of Ecologically Sustainable Development

Assessment against principles of Ecologically Sustainable Development
(a) The precautionary principle—namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by: ***(i) careful evaluation to avoid, wherever practicable, serious, or irreversible damage to the environment, and*** ***(ii) an assessment of the risk-weighted consequences of various options.***
The impacts of the construction of the solar farm at the site are likely to be reasonably predictable and carry low levels of uncertainty and risk. Based on field assessments, the works would be unlikely to result in significant or irreversible environmental damage. The development would have an operational life of around 50 years and can be satisfactorily decommissioned. The precautionary principle has been observed in the assessment of impacts; all potential impacts have been considered and avoided or mitigated wherever possible where a risk is identified.
(b) Inter-generational equity—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.
As outlined in Section 3 of this report, the proposed development is not expected to diminish long term ecological or biological resources or the agricultural productivity and future land use options at the site. At the end of the operating life of the solar farm, the above-ground infrastructure would be removed as outlined in Section 2.6 of this report, to restore land use potential, agricultural productivity and land use options at the site. The proposal would provide a significant environmental benefit by producing sustainable energy, reducing the reliance on fossil fuels which threatens the well-being of current and future generations through climate change.
(c) Conservation of biological diversity and ecological integrity— namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration.
Layout planning and mitigation measures have been adopted to avoid or mitigate any impacts which would affect the long-term viability of populations of all native species at and around the site, particularly threatened species and communities. The design of the proposed development has avoided the removal

Assessment against principles of Ecologically Sustainable Development
of isolated paddock trees and remnant vegetation. These measures include avoiding and protecting natural areas and habitats on the site. It is noted that climate change is a key global threat to many species and communities, and that the proposal would contribute to the abatement of carbon emissions from the electricity sector in Australia.
(d) improved valuation, pricing, and incentive mechanisms— namely, that environmental factors should be included in the valuation of assets and services, such as: ***(i). polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance, or abatement, and*** ***(ii). the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, and*** ***(iii). environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.***
The proposed development would provide for the increased penetration of renewable energy into the energy market. To date the environmental and social costs of electricity generation have not been fully measured or incorporated into wholesale or retail electricity pricing. The long-term external costs of carbon-intensive energy sources in terms of climate change in particular have not been factored into prices. However, photovoltaic solar plants produce approximately 40g CO2eq/kWh, while coal produces approximately 1,000g CO2eq/kWh (NREL 2012). This external cost differential is not reflected in electricity market prices. External costs are similarly not included in calculations of Levelised Cost of Electricity (LCOE) - the discounted lifetime cost of ownership and use of a generation asset expressed in cost per MWh. In terms life cycle energy consumption, the 'energy payback time' for polycrystalline PV modules has been estimated at two years for a solar installation in Southern Europe.

5. CONCLUSION

The proposed development, electricity generating works, would provide an important resource toward addressing Australia's climate change commitments. Specifically, the proposal would generate enough power to service 7,500 homes.

The public interest is supported by the development as it is consistent with endorsed statutory instruments and would provide local social and economic benefits. Benefits to the community are expected to include:

- Employment of 40 staff during construction and 1 FTE employee during operation.
- The construction team would stay locally and benefit the economy during this time resulting in financial benefits to the local area through:
    - Provision of labour:
        - Ground works from site preparation and ongoing maintenance.
        - Civil engineering, installation of infrastructure and ongoing maintenance.
    - Provision of goods and services:
        - Restaurants, hotels, and local businesses.
        - Renting plant and machinery including telehandlers, excavators, trailers, and tractors.
        - Purchasing tools and materials.
        - Transport and logistics.

The proposal was developed in response to a preliminary constraints analysis, to ensure potential impacts are avoided and minimised wherever possible. Key considerations/constraints considered in this SEE and main avoidance/minimisation methods/commitments by the proponent for the proposed solar farm are listed below:

The design has also been informed by the above with specialist assessments completed for biodiversity, Aboriginal cultural heritage, visual/landscape values, bushfire, as well as traffic and access considerations.

The scale of the proposal has been influenced by:

- Demand for new renewable electricity generation to meet generation targets.
- Commercial investment and viability considerations.
- Electricity grid capacity.
- Site accessibility.
- Environmental constraints on the subject land.
- Property boundaries.

It is considered that the proposed development would have an acceptable impact on local amenity. The proposed development would have some localised visual and construction noise impacts on a small number of receivers; however, mitigation measures would result in minimisation of impacts and improve the acceptability of the proposal on these receptors.

This SEE has demonstrated that the proposed development is permissible under the provisions of the ISEPP and is consistent with the provisions of the Wagga Wagga's Local Environmental Plan and Development Control Plan. It is considered that the development site is suited to utility scale solar electricity generation, with adequate capacity in the local electricity network, proximity to a substation and quality solar resources.

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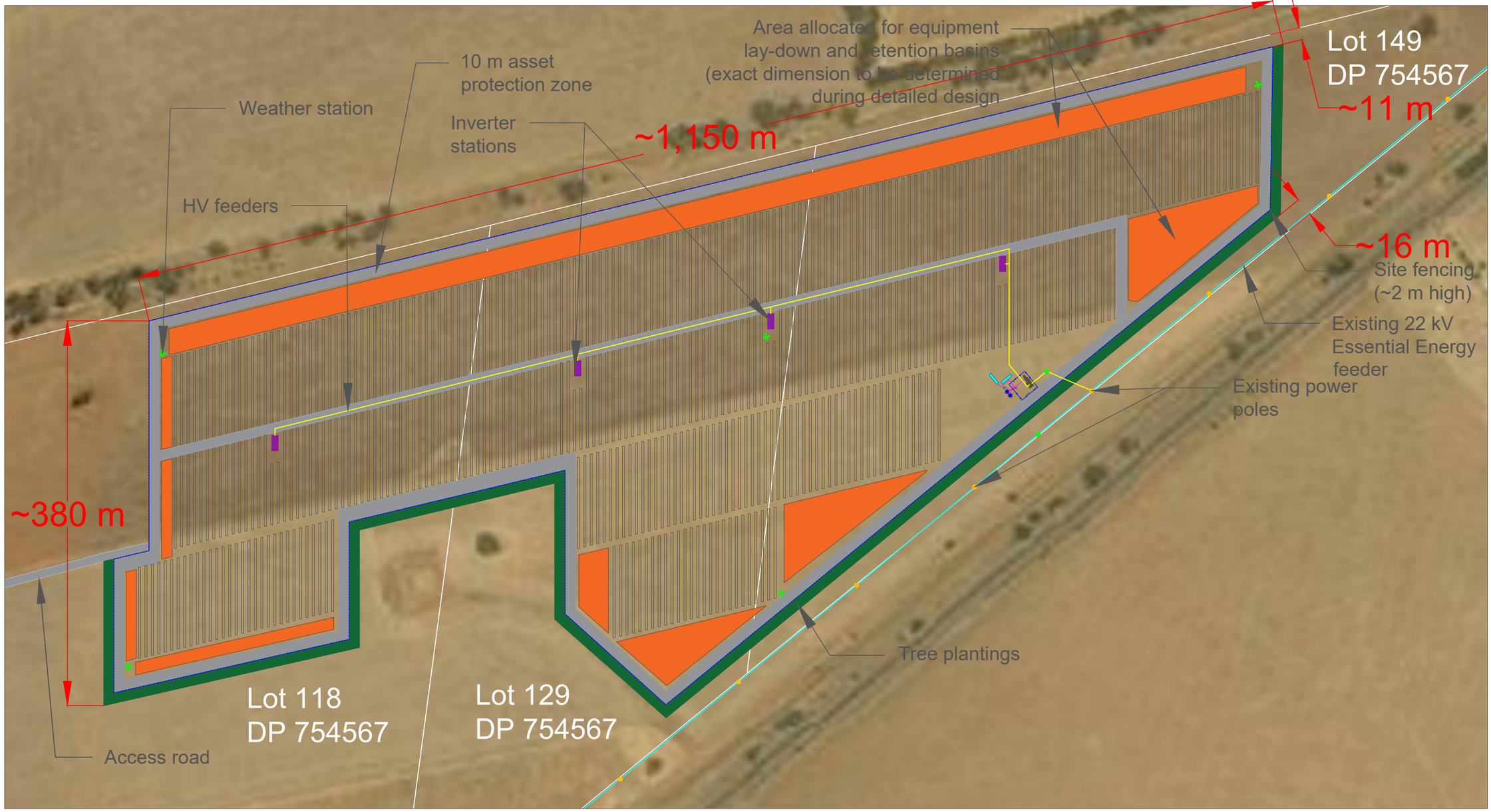
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Scale: 1:4,000

LEGEND:

- Fencing
- Internal track
- 22 kV internal feeders
- 22 kV power-line
- Solar panel tables
- Inverter stations
- Existing power poles
- New power poles
- Weather stations

Rev	Date	Name Editor	Modification / Adaptation of the drawing
4	06.01.2021	TSP	Updates to switching station and roads.
3	06.11.2020	TSP	Updated to a standard scale. Shows setback from boundaries and indicative dimensions.
2	21.04.2020	TSP	Number of inverter stations increased to 4.
1	13.02.2020	TSP	PRELIMINARY ISSUED

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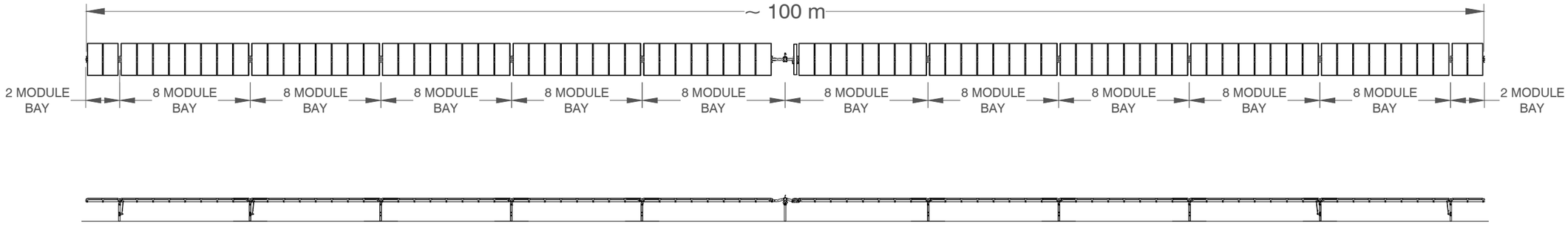
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Project: Sandy Creek Solar Farm

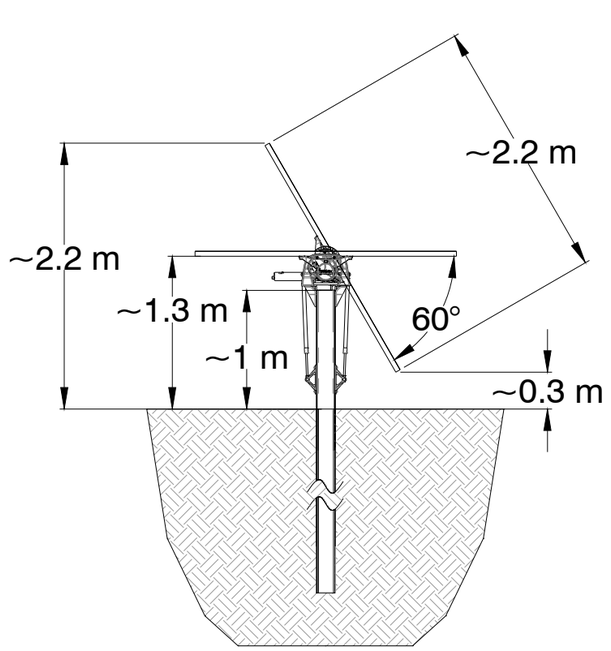
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Format: A3



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Scale: 1:50

Rev	Date	Name Editor	Modification / Adaptation of the drawing
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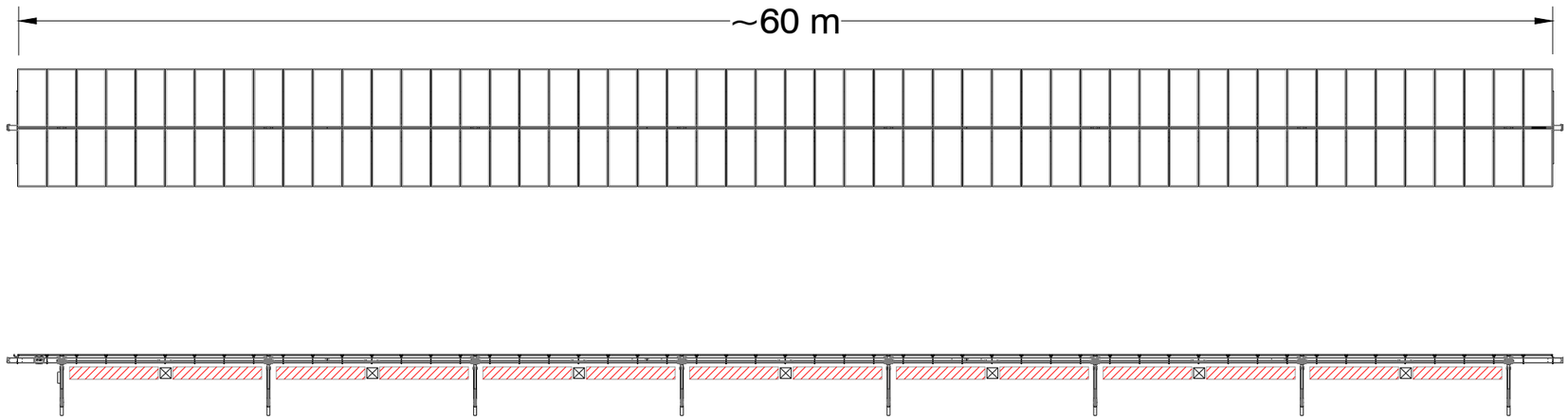
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Sandy Creek Solar Farm
17 MW_p DC / 12 MW AC

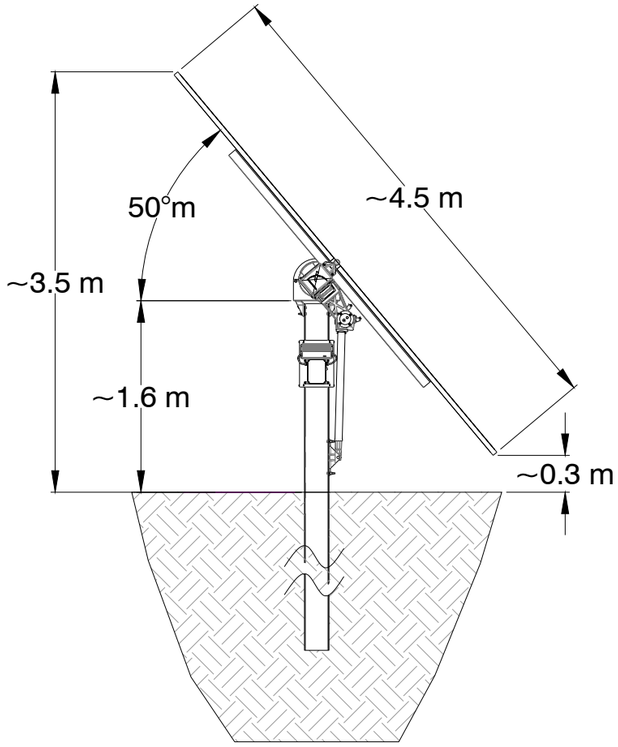
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Format: A3



Scale: 1:200



Scale: 1:50

1	13.11.2020	TSP	Indicative only
Rev	Date	Name Editor	Modification / Adaptation of the drawing

BayWa r.e.

	Date:	Name:
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Project:

Sandy Creek Solar Farm
17 MW_p DC / 12 MW AC

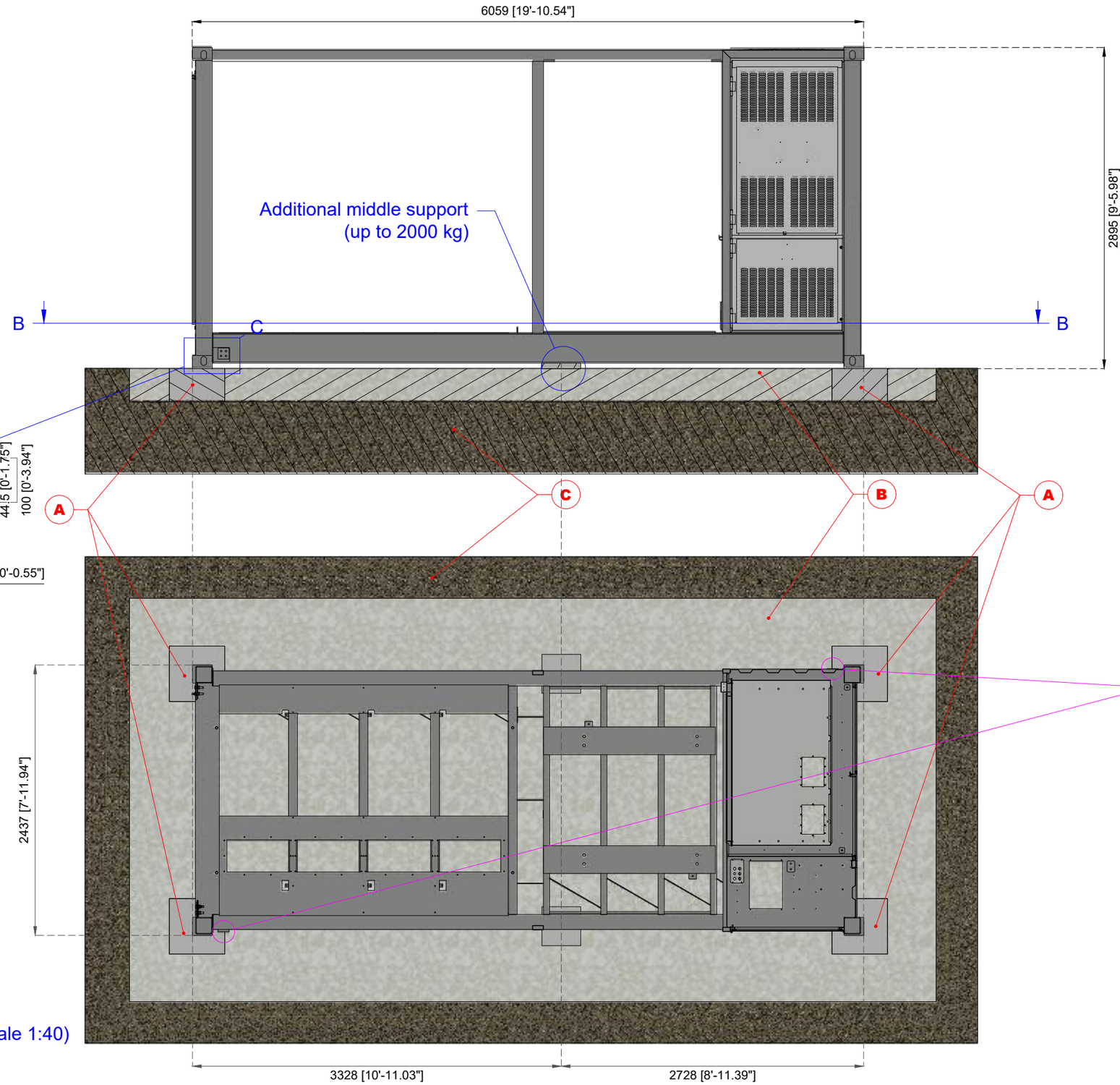
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Format: A3

File Name: BWre-AU-SAN-001-NX

PRINT DATE : 11/11/2020

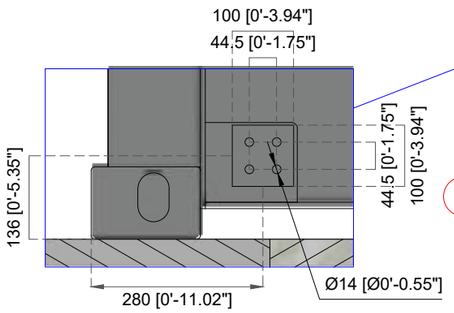
Position	Designation
A	Strip foundation or concrete pilars
B	Pea gravel ground
C	Solid ground, e.g. gravel



Section B-B (scale 1:40)

Maximum weight for each corner block **5000 kg**

Side view



Detail C (scale 1:10)

REV.	DATA / DATE	DESCRIZIONE REVISIONE / REVISION DESCRIPTION	DISEGNATO / DRAWN	CONTROLLATO / CHECKED	APPROVATO / APPROVED
2	09/07/2019	Final version	V. Maiorana	–	M. Melodia
4	27/04/2019	Minor changes about the container frame	G. Drago	–	M. Melodia
3	24/04/2019	New project name	G. Drago	V. Maiorana	M. Melodia
2	19/04/2019	Grounding pads	V. Maiorana	G. Drago	M. Melodia
1	18/04/2019	General changes and additional middle supports	G. Drago	V. Maiorana	M. Melodia

MATERIALE / MATERIAL : –

TRATTAMENTO SUPERF. / SURFACE TREATMENT : –

TRATTAMENTO TERMICO / HEAT TREATMENT : –

DISEGNO DI RIFERIMENTO / DRAWING REFERENCE : GP001143-01 CHIAVETTA s.r.l.

PROGETTO / PROJECT
MVPS20' SKIDTAINER

DISEGNO Nr. / PART No.
MVPS-SK001

SMA

DESCRIZIONE / DESCRIPTION
Foundation for the Skeleton station
Fondazione per la cabina Skeleton

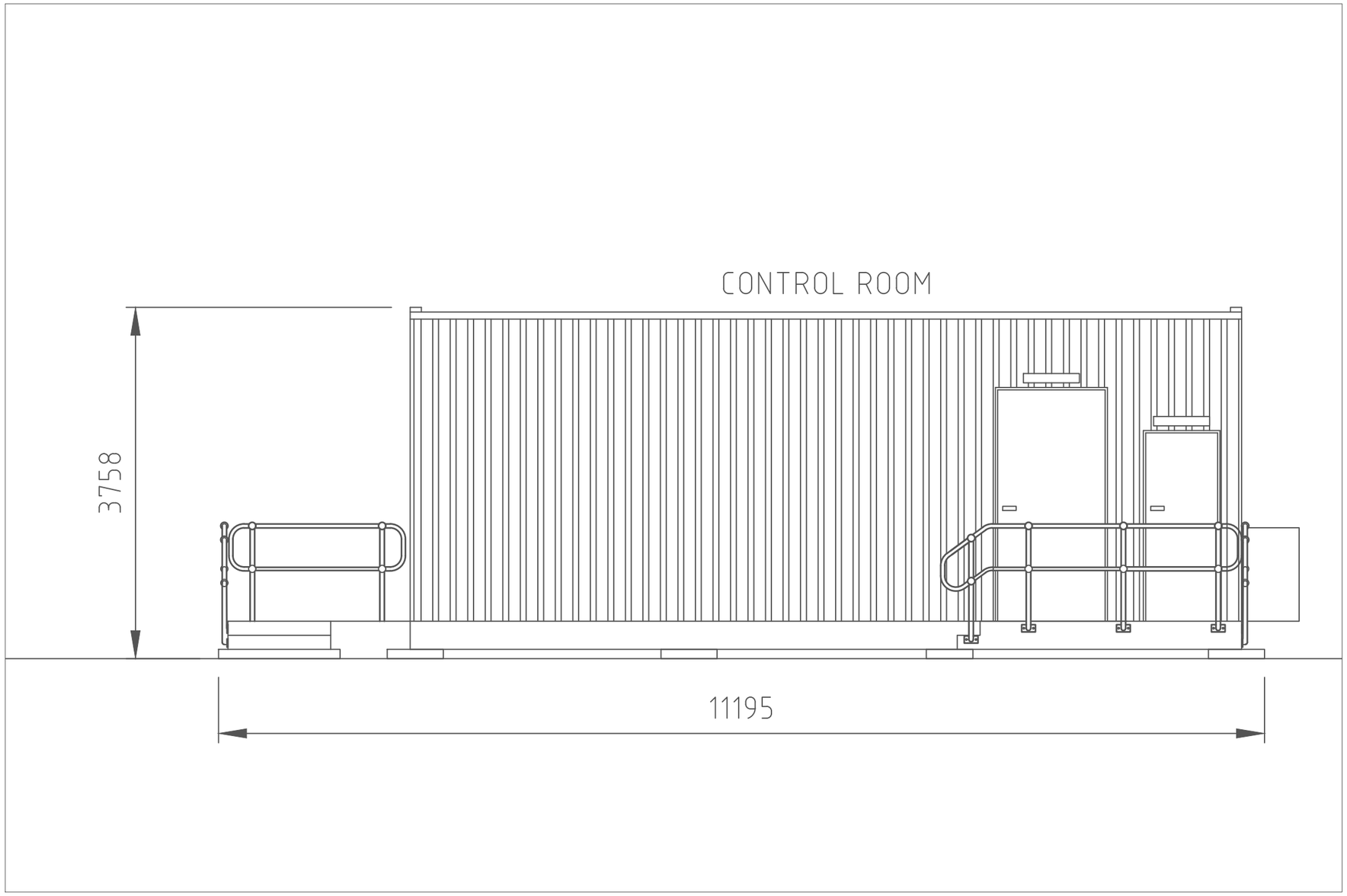
UNITÀ / UNIT
mm [feet – inches]

SCALA / SCALE
1 : 40

TOLERANCES
± 5 mm

FOGLIO / SHEET
1 of 1

Page size : A3 (420 x 297)



Scale: 1:50

All dimensions in millimetres

Rev	Date	Name Editor	Modification / Adaptation of the drawing
1	12.01.2021	TSP	PRELIMINARY ISSUED

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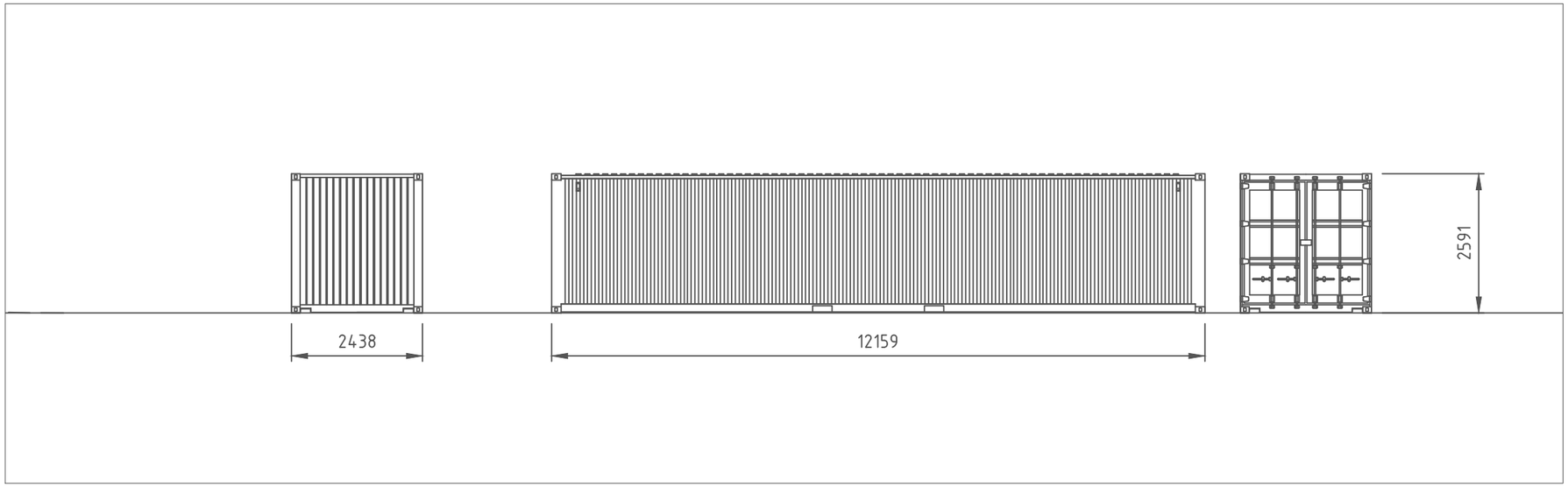
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Project: Sandy Creek Solar Farm

Drawing Title: Indicative Control Room Elevation View

File Name: BWre-AU-SAN-002-GAL

Format: A3



Scale: 1:100

All dimensions in millimetres

1	12.01.2021	TSP	PRELIMINARY ISSUED
Rev	Date	Name Editor	Modification / Adaptation of the drawing

BayWa r.e.

	Date:	Name:	Project:
Drawn:	12.01.2021	TSP	Sandy Creek Solar Farm
Changed:			
Checked:			

Drawing Title:	Indicative Storage Container Elevation View	Format: A3
File Name:	BWre-AU-SAN-002-GAL	

Aboriginal Cultural Heritage Assessment Report Cover Sheet

Report Title	Aboriginal Cultural Heritage Assessment and Subsurface Testing Report: Sandy Creek Solar Farm
Author(s) Name	Amy Ziesing and Matthew Barber
Author(s)' Organisation Name (if applicable)	NGH Pty Ltd
Author(s) contact details	Email: matthew.b@nghconsulting.com.au Phone: 02 6153 6320
Address of Subject Area	• Lot 55, Lot 118, Lot 129 and Lot 149 DP754567. Suburb: Uranquinty State: NSW Postcode: 2652 Title Reference: Local Government Area: Wagga Wagga Other:
Report prepared for	Company Name: BayWa r.e. Projects Australia Pty Ltd Contact Person: Thomas Parel Address: 45 Denison Street, Bondi Junction NSW 2022 Email: Thomas.Parel@baywa-re.com Phone: 0410 228 033
Date of Report	6 October 2020

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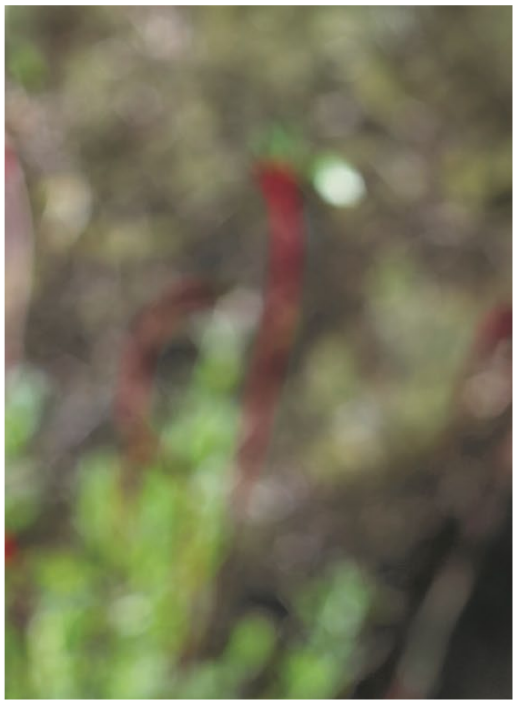
ABORIGINAL CULTURAL HERITAGE ASSESSMENT AND SUBSURFACE TESTING REPORT

Sandy Creek Solar Farm

October 2020

Project Number: 19-890





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ACRONYMS AND ABBREVIATIONS

AASC	Australian Archaeological Survey Consultants
ACHA	Aboriginal Cultural Heritage Assessment
ACHAR	Aboriginal Cultural Heritage Assessment Report
AHIMS	Aboriginal heritage information management system
AHIP	Aboriginal Heritage Impact Permit
BAC	Bundyi Aboriginal Cultural Knowledge Group
BayWa	BayWa R.E. Projects Australia
BCD	Biodiversity and Conservation Division of DPIE (formerly OEH)
Bidya Marra	Bidya Marra Consultancy
BOM	Australian Bureau of Meteorology
CWAHS	Central West Archaeological and Heritage Services
Cwth	Commonwealth
DA	Development Application
DECCW	Refer to OEH
DP&I	(NSW) Department of Planning & Infrastructure (now DPIE)
DPC	(NSW) Department of Premier & Cabinet
DPIE	(NSW) Department of Planning, Industry and Environment
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Cwth)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
ESD	Ecologically Sustainable Development
ha	hectares
Heritage Act	*Heritage Act 1977* (NSW)
Heritage NSW	Heritage NSW of the Department of Premier & Cabinet (formerly BCD)
IBRA	Interim Biogeographic Regionalisation for Australia
km	kilometres
KNC	Kelleher Nightingale Consulting Pty Ltd
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
m	Metres
MW	Megawatt
NGH	NGH Pty Ltd
NOHC	Navin Officer Heritage Consultants
NPW Act	*National Parks And Wildlife Act 1974* (NSW)
NPWS	National Parks & Wildlife Service
NSW	New South Wales
OEH	(NSW) Office of Environment and Heritage (formerly DECCW)

PAD	Potential Archaeological Deposit
PV	Photovoltaic
RAPs	Registered Aboriginal Parties
REF	Review of Environmental Factors
SEE	Statement of Environmental Effects
Warrabinya	Warrabinya Cultural Heritage and Assessment Group

EXECUTIVE SUMMARY

INTRODUCTION

NGH Pty Ltd (NGH) was commissioned by BayWa r.e. Projects Australia (BayWa) to undertake an Aboriginal Cultural Heritage Assessment (ACHA) for a proposed solar farm in Uranquinty, approximately 16 kilometres (km) south west of Wagga Wagga, New South Wales (NSW). The subject land extends for approximately 40 hectares (ha) and comprises portions of Lots 55, 118, 129, 149 DP754567 in the Wagga Wagga Local Government Area (LGA). The proposed solar farm is bounded by Churches Plain Road to the west, Rodhams Road to the north, the Olympic Highway to the east and privately owned pastoral land to the south.

NGH completed an initial site inspection of the proposed solar farm area in March 2020 for a Statement of Environmental Effects (SEE) and identified four isolated artefacts (Sandy Creek SF AFT 1 to Sandy Creek SF AFT 4), one artefact scatter (Sandy Creek SF AFT 5), and an area of potential archaeological deposit (PAD 1). This ACHA covers the entire approximately 40 ha study area and the results of the test excavations of PAD 1, incorporating an area of elevated flat land associated with an ephemeral creekline.

BayWa is seeking to undertake work that may impact Aboriginal heritage objects, as defined under the NSW *National Parks and Wildlife Act* 1974 (NPW Act). To undertake the proposed upgrade work, an application for an Aboriginal Heritage Impact Permit (AHIP) may be required, and the AHIP must be obtained prior to the commencement of works. The ACHA report will accompany the AHIP application, providing Heritage NSW of the Department of Premier & Cabinet (Heritage NSW) with information about the nature, extent and significance of any Aboriginal sites and values.

PROJECT PROPOSAL

The proposal involves the construction of a ground-mounted photovoltaic (PV) solar farm which would generate 17 Megawatt (MW) DC and 12 MW AC capacity of renewable energy. Utility-scale photovoltaic solar farms generally comprise of arrays of solar panels, internal access tracks and electrical cabling, power conversion units, operations buildings, an on-site or off-site substation, powerline connection to the network and possibly an Energy Storage Facility (batteries). These activities require ground disturbance, the use of heavy machinery and laydown areas. Any Aboriginal sites within the disturbance footprint would therefore be subject to harm.

The design of the proposed development is somewhat adaptable and will be refined to avoid adverse impacts where feasible, and to minimise/mitigate environmental and heritage impacts if avoidance is not possible. The design would consider the results of consultation with relevant stakeholders and the outcomes of this assessment.

The proposal is expected to operate for around 50 years, with the construction phase of the proposal is expected to take 9 to 12 months. After the initial operating period, the solar farm would either be decommissioned, removing all above ground infrastructure, and returning the site to its existing land capability, or upgraded with new PV equipment.

ABORIGINAL CONSULTATION

The consultation with Aboriginal stakeholders was undertaken in accordance with clause 60 of the *National Parks and Wildlife Amendment (Aboriginal Objects and Aboriginal Places) Regulation 2019* following the consultation steps outlined in the (ACHCRP) guide provided by OEH (Office of Environment and Heritage, now Heritage NSW).

The full list of consultation steps, including those groups and individuals that were contacted and undertaken and a consultation log is provided in Appendix A.

As a result of this process two groups and two individuals registered their interest in the proposal as listed below.

- Bundyi Aboriginal Cultural Knowledge Group (BAC)- Mark Saddler;
- Bidya Marra Consultancy (Bidya Marra) – James Ingram;
- Warrabinya Cultural Heritage and Assessment Group (Warrabinya)- Dorothy Whyman; and
- Yalmambirra.

No other party registered their interest, including the entities and individuals recommended by Heritage NSW.

The fieldwork was organised, and three of the registered parties were asked to participate in the survey and subsurface testing fieldwork.

No comments were received from the RAPs on the draft ACHA, which was finalised on 6 October 2020.

ARCHAEOLOGICAL CONTEXT

This assessment includes a review of relevant information relating to the landscapes within the proposal area. Included in this background research was a search of the Aboriginal Heritage Information Management System (AHIMS) database. There are no recorded Aboriginal sites within the proposal area. A total of 118 Aboriginal sites and no declared Aboriginal Places are located within the 10 km search area. Nineteen registered sites are located within 1 km of the proposed solar farm. The lack of previously registered sites in the proposal area most likely represents a lack of previous survey within the proposal area and not a lack of Aboriginal cultural material.

One previous investigation has been conducted across the south eastern boundary of the proposal area (Biosis Research Pty Ltd 2006). This archaeological survey for Aboriginal and European heritage sites was completed for the North-South Rail Corridor Albury to Junee Passing Lane Project. The passing lane, known as Passing Lane 16, travelled through Uranquinty and covered an area approximately 140 m wide from the north western side of the Olympic Highway to the south eastern side of the current assessment area. Variations to Passing Lane 16 were also surveyed in subsequent stages of assessment during the same year. No sites of Aboriginal cultural heritage or areas of archaeological potential were identified during the Passing Lane 16 surveys, due to heavy ground disturbance evident in the rail corridor (Biosis 2006, p.49). Potential cultural significance relating to the Wiradjuri Walking Track, to the west of the railway line and north of the overbridge, was noted during the 2006 assessment, but confirmation was not sought as to the extent of significance associated with this public recreation track.

Twenty culturally modified trees have been recorded independently by members of the local Aboriginal community along Rodhams Road on the northern boundary of the current assessment.

Based on previous archaeological investigations in the region and knowledge of Wiradjuri cultural practices and traditional activities, the proposal area will potentially contain additional archaeological sites, especially given that Aboriginal people have lived in the region for tens of thousands of years. This would most likely be in the form of quartz lithic scatters, isolated artefacts and scarred trees where remnant old growth vegetation remains in the form of isolated paddock trees.

SURVEY AND SUBSURFACE TESTING RESULTS

The proposal area comprises land that has had prolonged exposure to pastoral practices, including cropping, ploughing, grazing and native vegetation clearance.

Survey transects were undertaken on foot and traversed the entire proposed solar farm, as well as access points and tracks. Visibility within the proposal area was variable with good visibility in natural exposures, access tracks and fencelines (40-90%) and low visibility in recently cropped areas (0-30%) averaging 40% overall. Between the survey participants, over the course of the field survey, approximately 23 km of transects were walked across the proposal area.

Despite the variable visibility encountered during the survey, two artefact scatters (Sandy Creek SF AFT 1 and Sandy Creek SF AFT 2), 13 isolated finds (Sandy Creek SF AFT 3 to Sandy Creek SF AFT 15) and two scarred trees were recorded (Sandy Creek SF ST 1 and Sandy Creek SF ST 2). This includes the original four isolated finds and one artefact scatter identified in the initial March 2020 site inspection.

An extensive raised landform associated with a nearby ephemeral creek was identified in the initial site inspection as an area of archaeological sensitivity (PAD 1). This area was refined during the survey and subject to a program of test excavations. A total of 26 test pits were manually excavated along three testing transects spaced across the landform in order to gain an understanding of the presence and extent of any intact subsurface cultural deposits. Only one subsurface artefact (Sandy Creek SF AFT 16) was retrieved from Pit 14 (Spit 1: 0-10 cm). The lack of subsurface material was attributed to higher levels of previous disturbance than anticipated during the initial site inspection. Evidence of disturbance was noted in the top 5 cm of the deposit and in many instances the deposit only extended to between 10-15 cm in depth before exposing a red plastic clay similar to that seen in other areas of Wagga Wagga (NGH 2019; NGH 2020). The disbursement of the surface artefacts across the proposal area has likely resulted from ploughing and grazing activities, which has relocated them from their original context.

The results of this survey and subsurface testing support the modelling for the region that there are sites and artefacts present throughout the landscape but these sites are most common on level or gently sloping low elevations which are near ephemeral watercourses or resources. The low density of the artefacts across the proposal area indicates the low-density occupation of the area by Aboriginal people in the past. No direct evidence of longer-term base camps was identified within the proposal area, which is not unusual given the minor nature of the drainage lines and that Sandy Creek is over 800 m west of the proposal area. Aboriginal people in the past likely travelled through this area in a transitory nature to reach the more permanent resources of Sandy Creek, Stringybark Creek (5 km south east) and the Murrumbidgee River (8 km north).

POTENTIAL IMPACTS

The proposal involves the construction of a ground-mounted photovoltaic solar farm which would generate approximately 12 (MW of renewable energy. Utility-scale photovoltaic solar farms generally comprise of arrays of solar panels, internal access tracks and electrical cabling, power conversion units, operations buildings, an on-site or off-site substation, powerline connection to the network and possibly an Energy Storage Facility (batteries). These activities require ground disturbance, the use of heavy machinery and laydown areas. Any Aboriginal sites within the disturbance footprint would therefore be subject to harm.

A total of 16 stone artefact sites were identified during this assessment, 13 of which are situated within the proposed solar farm area. These sites include one artefact scatter (Sandy Creek SF AFT 2) and 12 isolated artefacts (Sandy Creek SF AFT 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16). Two scarred trees (Sandy Creek SF ST 1 and 2) also lie outside of the proposal area.

The impact to the sites with stone artefacts is likely to be most extensive where earthworks occur, such as the installation of panels and trenching, which may involve the removal, breakage or displacement of artefacts. This is considered a direct impact on the sites and the Aboriginal objects by the development in its present form.

While 13 of the 16 stone artefact sites are rated as having total loss of scientific value, it is argued that there are likely to be a number of similar sites in the local area and therefore the impact to the overall local archaeological record is considered to be low. The stone artefacts have little research value apart from what has already been gained from the information obtained during the present assessment.

This information relates more to the presence of the artefacts and in the development of Aboriginal site modelling, which has largely now been realised by the recording. No other values have been identified that would be affected by the development proposal.

RECOMMENDATIONS

It is recommended that:

1. A minimum 5 m buffer must be observed around the boundary extent of all 16 artefact sites prior to the achievement of the below recommendations.
2. The scarred tree sites (Sandy Creek SF ST 1 and Sandy Creek SF ST 2) should be avoided by the proposed solar farm, including a 10 m buffer zone, to prevent inadvertent impacts to the crown and root systems.
3. The proponent applies to Heritage NSW within the Department of Premier & Cabinet and receives an Aboriginal Heritage Impact Permit (AHIP) to allow harm to the 13 Aboriginal archaeological sites that will be impacted within the proposal area. The AHIP should be sought for the entire Sandy Creek Solar Farm proposal area and include salvage collection.
4. Should the proponent seek to apply for an AHIP, this report must accompany the application, as outlined in the document: *Applying for an Aboriginal Heritage Impact Permit: Guide for Applicants*.
5. Once an AHIP has been issued the 13 impacted sites within the development footprint, as approved by the AHIP, must be salvaged prior to the proposed work commencing and moved to a safe area within the property that will not be subject to any ground disturbance. This area will be determined by BayWa prior to the issue of the AHIP.
6. The collection and relocation of the artefacts should be undertaken by an archaeologist with representatives from the registered Aboriginal parties and be consistent with Requirement 26 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales*. A site impact card must be submitted for each site salvaged and a new site card will need to be completed once the artefacts are buried to record their new location on the AHIMS database.
7. No salvage excavation of the PAD 1 area is required due to the low-density of subsurface finds, degree of previous disturbance and erosion.
8. If any items suspected of being Aboriginal in origin are discovered during the proposed construction, all work in the immediate vicinity must stop and Heritage NSW notified. The find will need to be assessed and if found to be an Aboriginal object further investigation will be required.
9. In the unlikely event that human remains are discovered during the development works, all work must cease in the immediate vicinity. Heritage NSW and the local police should be notified. Further assessment would be undertaken to determine if the remains were Aboriginal or non-Aboriginal. Should the remain be identified to be Aboriginal in origin, Heritage NSW would advise the proponent and/or archaeologist on the appropriate Aboriginal parties to contact.

10. Further archaeological assessment would be required if the proposal activity extends beyond the area covered by this assessment. This would include consultation with the registered Aboriginal parties and may include further field survey.

The proponent is reminded that it is an offence under the *National Parks and Wildlife Act* to harm an Aboriginal object without a valid AHIP.

1 INTRODUCTION

NGH Pty Ltd (NGH) was commissioned by BayWa r.e. Projects Australia (BayWa) to undertake an Aboriginal Cultural Heritage Assessment (ACHA) for a proposed solar farm in Uranquinty, approximately 16 kilometres (km) south west of Wagga Wagga, New South Wales (NSW) (Figure 1-1). The subject land extends for approximately 40 hectares (ha) and comprises portions of Lots 55, 118, 129, 149 DP754567 in the Wagga Wagga Local Government Area (LGA) (Figure 1-2). The proposed solar farm is bounded by Churches Plain Road to the west, Rodhams Road to the north, the Olympic Highway to the east and privately owned pastoral land to the south.

NGH completed an initial site inspection of the proposed solar farm area in March 2020 for a Statement of Environmental Effects (SEE) and identified four isolated artefacts (Sandy Creek SF AFT1 to Sandy Creek SF AFT4) and one artefact scatter (Sandy Creek SF AFT5), and an area of potential archaeological deposit (PAD). This methodology covers the entire approximately 40 ha study area and will also include test excavations of the PAD incorporating an area of elevated flat land associated with an ephemeral creekline.

BayWa is seeking to undertake work that may impact Aboriginal heritage objects, as defined under the NSW *National Parks and Wildlife Act* 1974 (NPW Act). To undertake the proposed upgrade work, an application for an Aboriginal Heritage Impact Permit (AHIP) may be required, and the AHIP must be obtained prior to the commencement of works. The ACHA report will accompany the AHIP application, providing Heritage NSW of the Department of Premier & Cabinet (Heritage NSW) with information about the nature, extent and significance of any Aboriginal sites and values.

The proposed solar farm will involve ground disturbance that may impact on known Aboriginal heritage sites and objects located within the proposal area. Aboriginal objects are protected under the NSW *National Parks and Wildlife Act 1974* (NPW Act). The purpose of an ACHA report is to investigate the presence of any Aboriginal sites and to assess the impacts and provide management strategies that may mitigate any impact.



Figure 1-1 Overview Map of the region surrounding the proposed Sandy Creek Solar Farm.



Figure 1-2 Sandy Creek Solar Farm Proposal Area Map.

1.1 DEVELOPMENT CONTEXT

The development of renewable energy projects is one of the most effective ways to achieve the commitments of Australia and a large number of other nations under the Paris Agreement to reduce greenhouse gas emissions. The Sandy Creek Solar Farm would provide the following benefits:

- Reduction in greenhouse gas emissions from energy generation (when compared with fossil fuel generating sources).
- Provision of embedded electricity generation to supply into the Australian grid close to a main consumption centre.
- Provision of social and economic benefits through the provision of direct employment opportunities.

The establishment of the Sandy Creek Solar Farm would therefore have both local, National and International benefits.

The Development Application (DA) for the 17 MW DC/12 MW AC Sandy Creek Solar Farm will be supported by a SEE (NGH 2020).

The current assessment is in line with the recommendations provided for the initial heritage site inspection by NGH in March 2020 that identified the presence of Aboriginal sites and areas of archaeological sensitivity that required further investigation. BayWa are seeking to undertake work that will impact Aboriginal heritage sites as defined under the NSW *National Parks and Wildlife Act 1974*. In order to undertake the proposed development work for the Sandy Creek Solar Farm an AHIP will be required. This ACHA would accompany the AHIP application and would provide Heritage NSW within the Department of Premier and Cabinet (DPC), with information about the nature, extent and significance of any Aboriginal sites and values and assess the impacts and management strategies that may mitigate any impact.

For the purposes of this assessment the proposal area as shown in Figure 1-2 was assessed.

1.2 PROJECT BACKGROUND

NGH completed an initial site inspection of the proposed solar farm area in March 2020 for a SEE and identified four isolated artefacts (Sandy Creek SF AFT1 to Sandy Creek SF AFT4), one artefact scatter (Sandy Creek SF AFT5), and an area of potential archaeological deposit (PAD 1).

This document covers additional heritage assessment of the entire approximately 40 ha study area and also includes the results of the test excavations of PAD 1 incorporating an area of elevated flat land associated with an ephemeral creekline.

1.3 PROJECT PROPOSAL

The proposal involves the construction of a ground-mounted photovoltaic solar farm which would generate 17 MW DC and 12 MW AC capacity of renewable energy. Utility-scale photovoltaic (PV) solar farms generally comprise of arrays of solar panels, internal access tracks and electrical cabling, power conversion units, operations buildings, an on-site or off-site substation, powerline connection to the network and possibly an Energy Storage Facility (batteries). These activities require ground disturbance, the use of heavy machinery and laydown areas. Any Aboriginal sites within the disturbance footprint would therefore be subject to harm.

The design of the proposed development is somewhat adaptable and would be refined to avoid adverse impacts where feasible, and to minimise/mitigate environmental and heritage impacts if avoidance is not

possible. The design would consider the results of consultation with relevant stakeholders and the outcomes of this assessment.

The proposed development footprint is shown above in Figure 1-2. This includes all land likely to be directly impacted by the construction, operation and decommissioning of the proposal, including auxiliary construction facilities (site compound, laydown, stockpiling etc.), access and all considered options. It is important to note that the development footprint is indicative only and will be refined as part of this assessment.

The proposal is expected to operate for around 50 years. The construction phase of the proposal is expected to take 9 to 12 months. After the initial operating period, the solar farm would either be decommissioned, removing all above ground infrastructure and returning the site to its existing land capability, or upgraded with new PV equipment.

1.4 PROJECT PERSONNEL

The assessment was undertaken by NGH archaeologist Amy Ziesing, including research, Aboriginal community consultation, fieldwork, artefact analysis, GIS mapping and report preparation. Claire Rayner also participated in the fieldwork. Matthew Barber reviewed the report.

Consultation with the Aboriginal community was undertaken following the process outlined in the *Aboriginal cultural heritage consultation requirements for proponents 2010.* Two Aboriginal groups and two individuals registered their interest in the proposal.

These registered Aboriginal parties were:

- Bundyi Aboriginal Cultural Knowledge (BAC)- Mark Saddler;
- Bidya Marra Consultancy (Bidya Marra) – James Ingram
- Warrabinya Cultural Heritage and Assessment Group (Warrabinya)- Dorothy Whyman; and
- Yalmambirra.

Representatives who participated in the survey fieldwork were:

- Mark Saddler (Representing BAC),
- Dylan Ingram (representing Bidya Marra) and
- Brett Whyman (Representing Warrabinya).

Further details and an outline of the consultation process is provided in Section 2 and Appendix A.

1.5 REPORT FORMAT

For the purposes of this assessment of the proposed Sandy Creek Solar Farm, we have prepared the report in line with the following:

- Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH 2011);
- *Code of Practice for the Archaeological Investigation of Aboriginal Objects in New South Wales* (OEH 2010a), and
- *Aboriginal cultural heritage consultation requirements for proponents 2010* (ACHCRP) (OEH 2010b) produced by the NSW OEH.

The purpose of this ACHA report is therefore to provide an assessment of the Aboriginal cultural values associated with the study area and to assess the cultural and scientific significance of any Aboriginal heritage sites.

The objectives of the assessment were to:

- Conduct Aboriginal consultation as specified in clause 60 of the *National Parks and Wildlife Regulation 2019*, using the consultation process outlined in the ACHCRP*;*
- Undertake a field survey program of the proposal area to identify and record any Aboriginal heritage objects;
- Undertake a limited program of subsurface test excavations to determine the presence and extent of any potential archaeological deposits;
- Undertake an assessment of the archaeological and cultural values of the proposal area and any Aboriginal sites therein;
- Assess the cultural and scientific significance of any archaeological material, and
- Provide management recommendations for any objects found.

2 ABORIGINAL CONSULTATION PROCESS

The consultation with Aboriginal stakeholders was undertaken in accordance with clause *80C of the National Parks and Wildlife Amendment (Aboriginal Objects and Aboriginal Places) Regulation 2010* following the consultation steps outlined in the ACHCRP guide provided by Heritage NSW (formerly BCD). The guide outlines a four-stage process of consultation as follows:

- Stage 1 – Notification of project proposal and registration of interest.
- Stage 2 – Presentation of information about the proposed project.
- Stage 3 – Gathering information about cultural significance.
- Stage 4 – Review of draft cultural heritage assessment report.

The full list of consultation steps undertaken has been documented in a consultation log, which is provided in Appendix A, along with copies of relevant correspondence with organisations and individuals.

A summary of actions taken in accordance with the ACHCRP guideline is provided below.

Stage 1. Letters outlining the development proposal and the need to carry out an ACHA were sent to the Wagga Wagga LALC and various statutory authorities including Heritage NSW, as identified under the ACHCRP. An advertisement was placed in the local newspaper, the *Daily Advertiser* on 9 April 2020, seeking registrations of interest from Aboriginal people and organisations. A further series of letters were sent to other organisations identified by Heritage NSW in correspondence to NGH. In each instance, the closing date for submission was 14 days from receipt of the letter.

As a result of this process, two Aboriginal groups and two individuals registered their interest in the proposal.

These registered Aboriginal parties were:

- Bundyi Aboriginal Cultural Knowledge (BAC)- Mark Saddler;
- Warrabinya Cultural Heritage and Assessment Group (Warrabinya)- Dorothy Whyman;
- Bidya Marra Consultancy (Bidya Marra) – James Ingram; and
- Yalmambirra.

No other party registered their interest.

Stage 2. On 5 May 2020, an Assessment Methodology document for the project was sent to the four registered Aboriginal parties as listed above. This document provided details of the background to the proposal, a summary of previous archaeological surveys and the proposed heritage assessment and subsurface testing methodology. The document invited comments regarding the proposed methodology and sought any information relating to known Aboriginal cultural significance values associated with the subject area and/or any Aboriginal objects contained therein. A minimum of 28 days was allowed for a response to the document.

No comments were received on the methodology from any of the registered parties and BAC, Bidya Marra and Warrabinya expressed an interest in participating in fieldwork.

Stage 3. The *Assessment Methodology* outlined in Stage 2 included a written request to provide any information that may be relevant to the cultural heritage assessment of the study area. It was noted that sensitive information would be treated as confidential.

At this stage, the fieldwork was organised, and Bundyi Aboriginal Cultural Knowledge, Bidya Marra and Warrabinya were asked to participate in the fieldwork, which was completed from 30 June to 2 July 2020 by two NGH archaeologists with local Aboriginal representatives.

Representatives who participated in the survey and subsurface testing fieldwork were:

- Mark Saddler (Representing BAC);
- Dylan Ingram (Representing Bidya Marra); and
- Dorothy Whyman (Representing Warrabinya).

Stage 4. In August 2020 a draft version of this *Aboriginal Cultural Heritage Assessment Report* for the proposal (this document) was forwarded to the RAPs inviting comment on the results, the significance assessment and the recommendations. A minimum of 28 days was allowed for responses to the document.

2.1.1 Fieldwork feedback

BAC provided a letter to NGH outlining cultural information relating to the Uranquinty region and surrounds during the production of this assessment (Appendix A). Uranquinty means “much water, rain” in Wiradjuri language and the proposed solar farm is located close to a natural wetland. Kapooka or *Gabuga* approximately 2 km north east means “egg” or “brain” and this place is a very special lookout from which you can see *Kengal* (The Rock) and Galore Hill which are important places in Wiradjuri dreaming and song lines. All the areas outlined above are still used by Wiradjuri people as a *murru* (journey/pathway) to special areas, where old people and *wandaang* (spirits) still travel.

BAC requested that no additional traffic be allowed to travel along Rodhams Road to the north to prevent impacts to any known sites in this area. The recovery, documentation, and burial of all artefacts, following a smoking ceremony, identified in the ACHA survey and subsurface testing was also requested. If any employment is to come from the proposed solar farm, BAC requested that local Wiradjuri people have the chance to apply and be employed, as per an Aboriginal employment strategy (Appendix A).

NGH acknowledged receiving the cultural information outlined above and cannot comment further on the request for employment as it lies beyond the scope of this assessment.

2.1.2 Draft ACHA feedback

Community consultation occurred throughout the project. The draft report was provided to each of the RAPs and feedback was sought on the recommendations, the assessment and any other issues that arose.

No comments were received from the RAPs on the draft ACHA, which was finalised on 6 October 2020.

3 BACKGROUND INFORMATION

3.1 REVIEW OF LANDSCAPE CONTEXT

3.1.1 Geology, Topography and Climate

The landscape context assessment is based on a number of classifications that have been made at national and regional level for Australia. The national Interim Biogeographic Regionalisation for Australia (IBRA) system identifies the proposal area as located within the NSW South Western Slopes of south eastern Australia (DE&E 2016).

The NSW South Western Slopes Bioregion is an extensive area of foothills and isolated ranges comprising the lower inland slopes of the Great Dividing Range extending from north of Dunedoo through southern NSW into western Victoria with an area of 8,657,426 hectares. About 8,070,608 hectares or 93.22 per cent of this bioregion occurs in NSW, with the remainder in Victoria. The NSW portion of the bioregion occupies about 10.1 per cent of the state.

The bioregion is bounded by 6 other bioregions: the Riverina and Cobar Peneplain bioregions to the west, Darling Riverine Plains and Brigalow Belt South bioregions to the north, Sydney Basin to the northeast and the South Eastern Highlands Bioregion running along much of the eastern boundary.

Towns located in the bioregion include Wagga Wagga, Mudgee, Cootamundra, Narrandera, Parkes, Gundagai and Young. Griffith lies just outside the western boundary and Crookwell lies just outside the eastern boundary of the bioregion.

The bioregion includes parts of the Murray, Murrumbidgee, Lachlan and Macquarie River catchments.

The geology is comprised of Cambrian to Early Carboniferous sedimentary and volcanic rocks. Granites are common and mostly located in large scale upfolded bodies of rock. Granite landscapes occur either as central basins surrounded by steep hills formed on contact metamorphic rocks, or as high blocky plateau features with rock outcrops and tors.

Hilly landscapes developed on the sedimentary and volcanic rocks are controlled by structural features (bedding and faults) and typically form lines of hills extended along the strike of more resistant rocks such as quartzite. The valleys between ranges are either in granite or generally softer rocks such as shale, phyllite or slate.

The topography recorded for the Uranquinty region consists of a gently undulating alluvial plain landscape which has undergone prolonged exposure to pastoral practices. Multiple large creek systems traverse the area surrounding the proposed solar farm. Any elevated flat land associated with Sandy Creek and a number of unnamed ephemeral drainage lines has potential to contain Aboriginal cultural heritage.

Interim Biogeographic Regionalisation for Australia

The national IBRA system identifies the proposal area as being located in the South Western Slopes Complex (NSS) which is split into two subregions: Upper Slopes (NSS01) and Lower Slopes (NSS02). The proposal area is comprised of the Upper Slopes subregion as outlined in Table 3-1 (DEE 2016).

Inland streams pass across the slopes in confined valleys with terraces and local areas of sedimentation. Soils and vegetation are complex and diverse but typified by texture contrast soils and a variety of eucalypt woodlands.

Table 3-1 South Western Slopes – Upper Slopes (NSS01) subregion after Morgan and Terry (1992).

Bioregion - Subregion	*Geology*	*Landforms*	*Soils*
South Western Slopes - Upper Slopes	Ordovician to Devonian folded and faulted sedimentary sequences with inter-bedded volcanic rocks and large areas of intrusive granites.	Steep, hilly and undulating ranges and granite basins. Occasional basalt caps, confined river valleys with terrace remnants.	Shallow stony soils on steep slopes, texture contrast soils grading from red subsoils on upper slopes to yellow subsoils on lower slopes. Alluvial sands, loams and clays.
South Western Slopes - Lower Slopes	As for the Upper Slopes but with larger areas of Tertiary and Quaternary alluvium.	Undulating and hilly ranges and isolated peaks set in wide valleys at the apices of the Riverina alluvial fans.	Similar to the Upper Slopes but with more extensive red-brown earths on undulating plains and more extensive grey clays on alluvium.

Mitchell Landscapes

The Mitchell landscape (2002) mapping of the proposal area is covered by two landscape types (Figure 3-1). These landscapes are the Wonga Hills and Ranges (Won) and the Brokong Plains (Bro). A description of these landscapes is provided in Table 3-2 below. The Mitchell landscapes provide more specific landform, soil and vegetation profiles for these two landscape areas.

Table 3-2 Description of the Mitchell Landscapes within the proposal area (DECC 2002, p. 91 and 99).

Mitchell Landscape	*Landforms*	*Soils*	*Vegetation*
Wonga Hills and Ranges **Landscape Code: Won** **Ecosystem Meso grouping: NSS Upper Slopes**	Rolling hills, low rises and ridges on Ordovician siltstone, slate, quartzite and phyllite, general elevation 250 to 370m, local relief 50m.	Stony, thin red and brown texture-contrast soils merging to yellow harsh texture-contrast soils on valley floors. High salinity in the subsoil and some brackish flows in small creeks.	Woodlands of; tumbledown red gum (*Eucalyptus dealbata*), red stringybark (*Eucalyptus macrorhyncha*) and grey box (*Eucalyptus microcarpa*) on slopes, yellow box (*Eucalyptus melliodora*), white box (*Eucalyptus albens*) and occasional Blakely's red gum (*Eucalyptus blakelyii*) on flats with kangaroo grass (*Themeda triandra*) and plains grass (*Stipa aristiglumis*).
Brokong Plains **Landscape Code: Bro** **Ecosystem Meso grouping: NSS Lower Slopes**	Quaternary alluvial plains, general elevation 170m, local relief <10m.	Red-brown texture-contrast soils, extensively cleared and cropped.	Extensively cleared grey box (*Eucalyptus microcarpa*), yellow box (*E. melliodora*), Blakely's red gum (*E. blakelyii)* and white cypress pine (Callitris glaucophylla) woodland to open forest. These tree species may exist as isolated old growth paddock trees where they have not been subjected to clearing or as linear stands along road reserves.

Soil Landscapes

Soil mapping has been completed for parts of NSW by the (former) OEH, which identifies two soil landscapes associated with the project area: Becks Lane (bk) and Belfrayden (be) (eSpade v.02). These soil landscapes are described in Table 3-3 and their locations are shown in Figure 3-1.

Table 3-3 Description of the Soil Landscapes within the proposal area (eSpade v.02).

Soil Landscape	*Description*
Becks Lane (bk)	The Becks Lane soil landscape is present across most of the proposed solar farm development. Topsoils comprise dull reddish brown sandy clay loam with high moisture content, many roots, no coarse fragments, overlying a reddish brown light moist clay and a bright brown medium clay subsoil.
Belfrayden (be)	The Belfrayden soil landscape is present within the western half of the access track for the proposed solar farm development. Topsoils are comprised of a dark brown to dark reddish-brown clay loam to loam, overlying a reddish brown to dull orange fine sandy clay loam. Subsoils consist of reddish brown light to medium clays with some mottling.

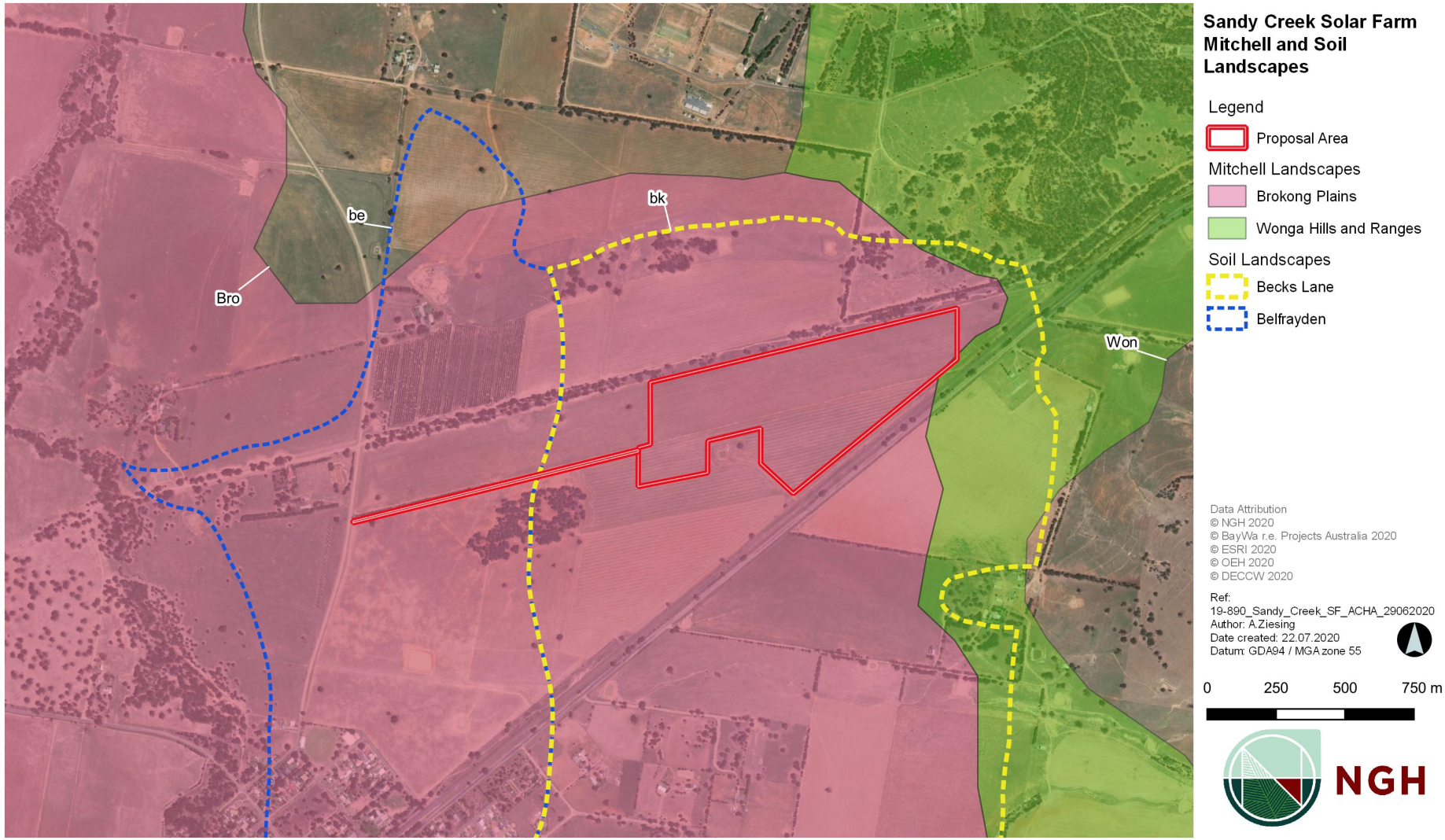


Figure 3-1 Mitchell and Soil Landscapes within the Sandy Creek Solar Farm Proposal Area.

3.1.2 Hydrology

Average annual rainfall is approximately 570 mm, causing moderately moist soils in winter and spring, but dry deposits in summer and early autumn. Run-on is moderate to high across all landforms. Moist soils were noted throughout the subsurface test excavations covered by this assessment.

A series of drainage lines and ephemeral creeklines surround the proposal area, including Sandy Creek (800 m west), a third order drainage line (160 m north) and a modified first order drainage line (along south western boundary). The proposal area is also 4 km north of Coloboralli Creek, 5.6 km north west of Stringybark Creek, and 7.8 km south of the Murrumbidgee River. The proposal area sits outside the southern Murrumbidgee River floodplain boundary. The proposed solar farm area contains an archaeologically sensitive elevated flat landform associated with the unnamed third order drainage line to the north (Figure 3-2).

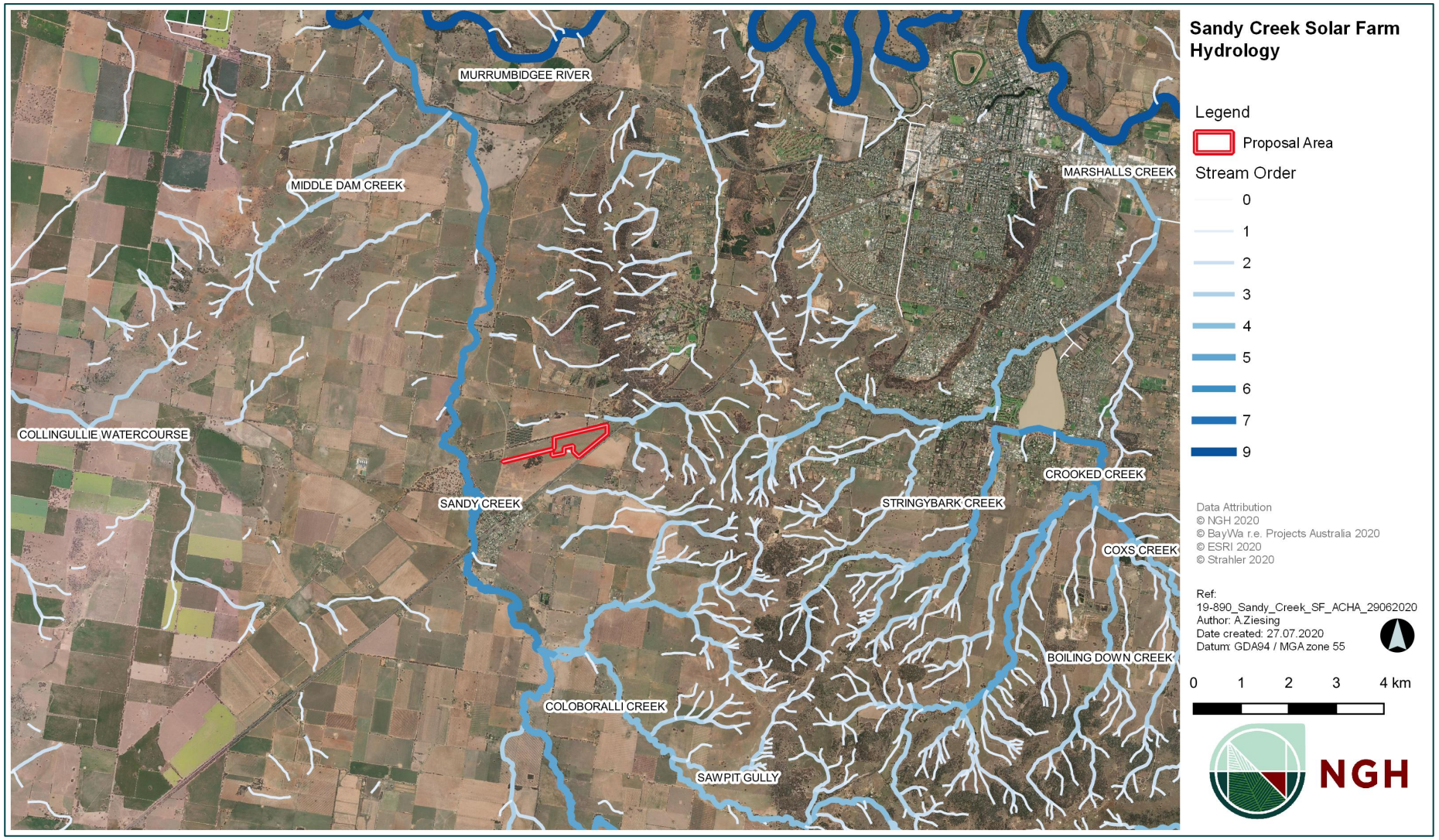


Figure 3-2 Hydrology Map of the Sandy Creek Solar Farm Proposal Area and surrounds, .

3.1.3 Flora and Fauna

The character of the native vegetation depends to a great extent on the underlying soils and topography. Within the proposal area, much of the native vegetation has been cleared for pastoral practices such as grazing and cropping. Isolated native paddock trees remain scattered throughout the proposal site, increasing in density along Rodhams Road to the immediate north of the proposal boundary. A White Cypress Pine (*Callitris columellaris*) plantation is located approximately 50 m south of the proposed access road. A planted treeline of Kurrajong trees (*Brachychiton populneus)* and white cypress pine trees extended along the west to east running access track within the proposal area. All isolated paddock trees in the proposal area were examples of Yellow Box (*Eucalyptus melliodora*) trees.

The extensive clearing of native old growth vegetation was immediately apparent during the fieldwork; and only the isolated paddock trees and the less modified Rodhams Road reserves provide a glimpse into the pre-European landscape woodland habitat. This woodland would not only have provided resources for Aboriginal people in the past, but also habitat for a variety of animals including ground-dwelling and arboreal marsupials such as macropods, possums, gliders, wombats, echidnas; birds; lizards, such as goannas; and snakes. These animals were important to past Aboriginal people as they were valuable as a source of food, as well as being resources for clothing (fur) and implements (bone).

3.1.4 Historic Land Use and Disturbance

The proposal area has been used primarily for cropping and pastoral activities for a prolonged period. Evidence of ploughing was apparent during the test excavations down to a depth of approximately 5 cm.

The lack of trees that has resulted from clearing of the area has also enhanced the erosional processes acting on the soil deposits across the proposed solar farm. Two large farm dams have been constructed approximately 180 m north of the access track and 20 m east of the southern proposal boundary adjoining the first order drainage line that has been modified for the dam construction.

Grading of the access track and firebreaks along the fencelines were noted along the proposal boundaries. The existing transmission line along the eastern boundary has resulted in discrete disturbance for the installation of the associated poles.

Currently cropping only extends across the section of land south of the fenceline, near the farm dam and first-order drainage line. The remainder is now used for sheep grazing.

3.1.5 Landscape Context

Most archaeological surveys are conducted in a situation where there is topographic variation, and this can lead to differences in the assessment of archaeological potential and site modelling for the location of Aboriginal archaeological sites. As already noted, no natural watercourses are present within the proposal site boundary, but the surrounding area contains a number of minor ephemeral drainage lines and is within 1 km of Sandy Creek, a fourth order creekline that runs north to south from the Murrumbidgee River.

Locations in close proximity to a water source, on level or gently sloping elevated landforms tend to have been favoured for occupation by past Aboriginal people in the area. As such, any raised, level well-drained landform associated with these watercourses is most likely to contain evidence of Aboriginal land use.

The different soil and Mitchell landscapes noted above were not readily identifiable within the proposal area and were not used as a means of landscape differentiation. These three landforms are shown in Figure 3-3 and listed below. It should be noted that these landforms extend beyond the proposed development footprint, but only the surveyed areas are differentiated below.

- Elevated Flat;
- Gentle Slopes; and
- Flats.



Figure 3-3 Landform Differentiation in the Proposal Area.

3.2 REVIEW OF ABORIGINAL ARCHAEOLOGICAL CONTEXT

3.2.1 Ethnohistoric Setting

There are several ethnographic recordings of Aboriginal life in the Riverina region from the 1800s that notably focus on the prevalence of Aboriginal people around waterways in the region. It is however important to consider that the Aboriginal people alive at the time of such observations were survivors of serious epidemics of infectious disease such as smallpox, brought by Europeans, that greatly affected the population sizes and distribution of people within the landscape. Consequently, European records may not necessarily reflect pre-contact population distributions and traditional ways of life (Dowling 1997, Littleton and Allen 2007).

The dispossession from traditional lands and acts of violence against the Aboriginal people caused great social upheaval meaning that access to traditional resource gathering and hunting areas, religious life, marriage links and sacred ceremonial sites was disrupted or prevented. Despite this Aboriginal people continued to maintain their connections to sites and the landscape in a variety of ways. The Aboriginal people of the region continue to have a strong connection to their land.

Cultural areas are difficult to define and "must encompass an area in which the inhabitants have cultural ties, that is, closely related ways of life as reflected in shared meanings, social practices and interactions" (Egloff *et al*. 2005, p. :8). Depending on the culture defining criteria chosen - i.e. which cultural traits and the temporal context (historical or contemporary) - the definition of the spatial boundary may vary. In Australia, Aboriginal "marriage networks, ceremonial interaction and language have been central to the constitution of regional cultural groupings" with the distribution of language speakers being the main determinant of groupings larger than a foraging band (Egloff et al. 2005, pp. 8 & 16).

Sandy Creek is within an area identified as part of the Wiradjuri language group. This is an assemblage of many small clans and bands speaking a number of similar dialects (Tindale 1974, MacDonald 1983, Horton 1994).

The Wiradjuri language group was the largest in NSW prior to European settlement. The borders were however, not static, they were most likely fluid, expanding and contracting over time to the movements of smaller family or clan groups. Boundaries ebbed and flowed through contact with neighbours, the seasons and periods of drought and abundance.

It was the small family group that was at the core of Aboriginal society and the basis for their hunting and gathering life. The immediate family camped, sourced food, made shelter and performed daily rituals together. The archaeological manifestations of these activities are likely to be small campsites, characterised by small artefact scatters and hearths across the landscape. Places that were visited more frequently would develop into larger site complexes with higher numbers of artefacts and possibly more diverse archaeological evidence.

These small family units were part of a larger band which comprised several families. They moved within an area defined by their particular religious sites (MacDonald 1983). Such groups might come together on special occasions such as pre-ordained times for ceremonies, rituals or simply if their paths happened to cross. They may also have joined together at certain times of the year at certain places where resources were known to be abundant. The archaeological legacy of these gatherings would be larger sites rather than small family camps. They may include large hearth or oven complexes, contain several grinding implements and a larger range of stone tools and raw materials.

Identification and differentiation of such sites are difficult in the field. A family group and their antecedents and descendants occupying a campsite repeatedly over a long period of time may leave a similar pattern of archaeological signatures as a large group camped over a shorter period.

European settlers started arriving in the district in the 1820s. At this point the Aboriginal population was in decline, due to disease such as smallpox and influenza as well as dispossession from traditional lands and acts of violence against the Aboriginal people.

This meant there was great social upheaval and partial disintegration of the traditional way of life. The dramatic increase in the number of non-indigenous settlers around Wagga Wagga from the 1850s to the 1870s, during the gold rush resulted in the further displacement of the Aboriginal population and acts of violence (Burless 1997). This meant that access to traditional resource gathering and hunting areas, religious life and marriage links and access to sacred ceremonial sites were disrupted or destroyed.

Early settlers and others who wrote about the Wiradjuri people and customs differentiated between the origin of some groups, referring to people as the Lachlan or Murrumbidgee tribes, or the Levels tribe for those between the two major rivers (Woolrych 1890). The extent of the Wiradjuri group means that there were many different environments that were exploited for natural resources and food. Like everywhere in Australia, Wiradjuri people were adept at identifying and utilising resources either on a seasonal basis or all year round.

Terrestrial and arboreal animals such as the possum were noted by many early observers as a prime food source and the skins were made into fine cloaks that evidently were very warm (Evans 1815, Oxley 1820, Mitchell 1839). Kangaroos were also eaten, and their skins made into cloaks as well. A range of reptiles and other mammals were food sources. Fish and mussels would have been prevalent from the rivers and creeks and insects were also a common food type, in particular grubs and ants and ant eggs (Fraser 1892, Pearson 1981). Birds including emus were common as a food source, often being caught in nets made from fibres of various plants such as flax, rushes and kurrajong trees. Bird hunts were also often undertaken as group activities, with emus, ducks and other birds targeted through groups of people flushing them out and driving them into pre-arranged nets (Ramson 1983).

Plant foods were equally as important and mostly consisted of roots and tubers, such as *Typha* or Cumbungi whose tubers were eaten in late summer and the shoots in early spring. Other edible plants from the Wiradjuri region include the Yam Daisy or *Murnong*, eaten in summer and autumn, the Kurrajong seeds and roots, Acacia seeds and other rushes (Gott 1982).

Some of the early settlers and pastoralists, surveyors, explorers, administrators and others observed traditional Aboriginal activities, including ceremonies, burial practices and general way of living, and recorded these in letters, journals and books. These early records of Aboriginal lifestyle and society within the region assist in understanding parts of the traditional Aboriginal way of life, albeit already heavily disrupted at the time of the observations and through the eyes of largely ignorant and uninformed observers.

The early observations also note that some weapons and tools were carried, some made from wood such as spears, spear throwers, clubs, shields, boomerangs, digging sticks, bark vessels and canoes. Other materials were observed in use such as stone axes, shell and stone scrapers and bone needles.

In an archaeological context, few of these items would survive, particularly in an open site context. Anything made from bark and timber and animal skins would decay quickly in an open environment. However, other items, in particular those made of stone would survive where they were made, placed or dropped. Shell material may also survive in an archaeological context. Sources of raw materials, such as the extraction of wood or bark would leave scars on the trees that are archaeologically visible, although few trees of sufficient

age survive in the modern context. Outcropping stone sources also provide clues to their utilisation through flaking, although pebble beds may also provide sources of stone which leave no archaeological trace.

3.3 AHIMS SEARCH

A search of relevant heritage registers for Aboriginal sites and places provides an indication of the presence of previously recorded sites. It is to be noted that a register search is not conclusive, as it reflects only those areas that have been surveyed and that sites recorded are added to the register.

As a starting point the search will indicate whether any sites are known within or adjacent to the investigation area. The Aboriginal Heritage Information Management System (AHIMS) provides a database of Aboriginal heritage sites registered previously. The results of the search are valid for 12 months for the purposes of a heritage assessment.

A search of the AHIMS database of an area approximately ~10 km by ~10 km centred on the proposal area was undertaken on Thursday 9 April 2020 (AHIMS Client Service Number: 496854). The coordinates for the search area were from Lat, Long -35.2468, 147.1648 to Lat, Long -35.1171, 147.3568 with a buffer of 200 m. There were 118 Aboriginal sites recorded within the wider search area and no declared Aboriginal Places. Table 3-4 shows the breakdown of site types and Figure 3-4 and Figure 3-5 show the location of the AHIMS sites in relation to the proposal area.

Table 3-4: Breakdown of previously recorded Aboriginal sites within 10km of the project area.

Site Type	Number
Modified Tree (Carved or Scarred)	83
Artefact (1 or more)	32
Artefact; PAD	2
Aboriginal Resource and Gathering	1
TOTAL	**118**

There is a high proportion (70.3%) of modified trees and artefact sites (27.1%) recorded in the area especially where there are remnant stands of native trees. No registered sites are present within the current assessment area; however, 19 sites are located within 1 km of the proposal area. These sites are listed in Table 3-5 below, including the distance from the proposed solar farm. None of these registered sites will be impacted by the proposed works.

Table 3-5 AHIMS Sites within 1 km of the project area.

Site Name	Site Type	AHIMS ID	Distance to Proposal Area
WW101	Modified Tree	56-1-0089	426 m north west
Kapooka Water Tank ST 1	Modified Tree	56-1-0127	689 m north east
Gabuga Water Tank 1	Modified Tree	56-1-0373	815 m north east
Gabuga Water Tank 3	Modified Tree	56-1-0374	689 m north east
Gabuga Tank 11	Modified Tree	56-1-0382	933 m north east
Gabuga Tank 14	Modified Tree	56-1-0388	652 m north east
Gabuga Tank 15	Modified Tree	56-1-0389	411 m east
Gabuga Tank 16	Modified Tree	56-1-0390	468 m north east
Gabuga Tank 17	Modified Tree	56-1-0391	468 m north east
Gabuga Tank 18	Modified Tree	56-1-0392	353 m east
Rodhams Rd 1	Modified Tree	56-1-0393	267m north
Rodhams Rd 2	Modified Tree	56-1-0430	31 m north west
Dunns road ring tree 1	Modified Tree	56-1-0608	648 m east

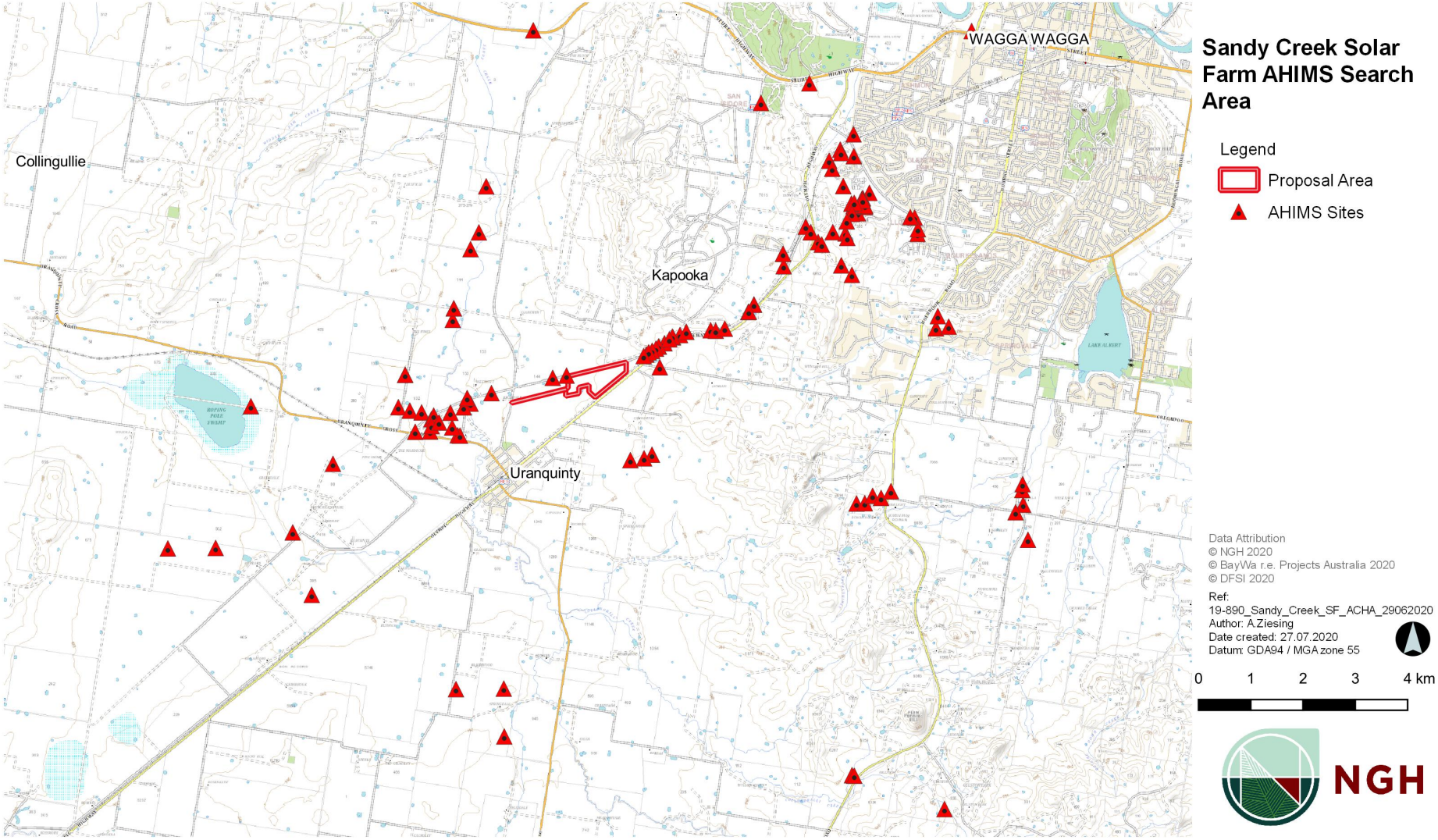


Figure 3-4 AHIMS Sites within a 10 km radius of the Sandy Creek Solar Farm Proposal Area.

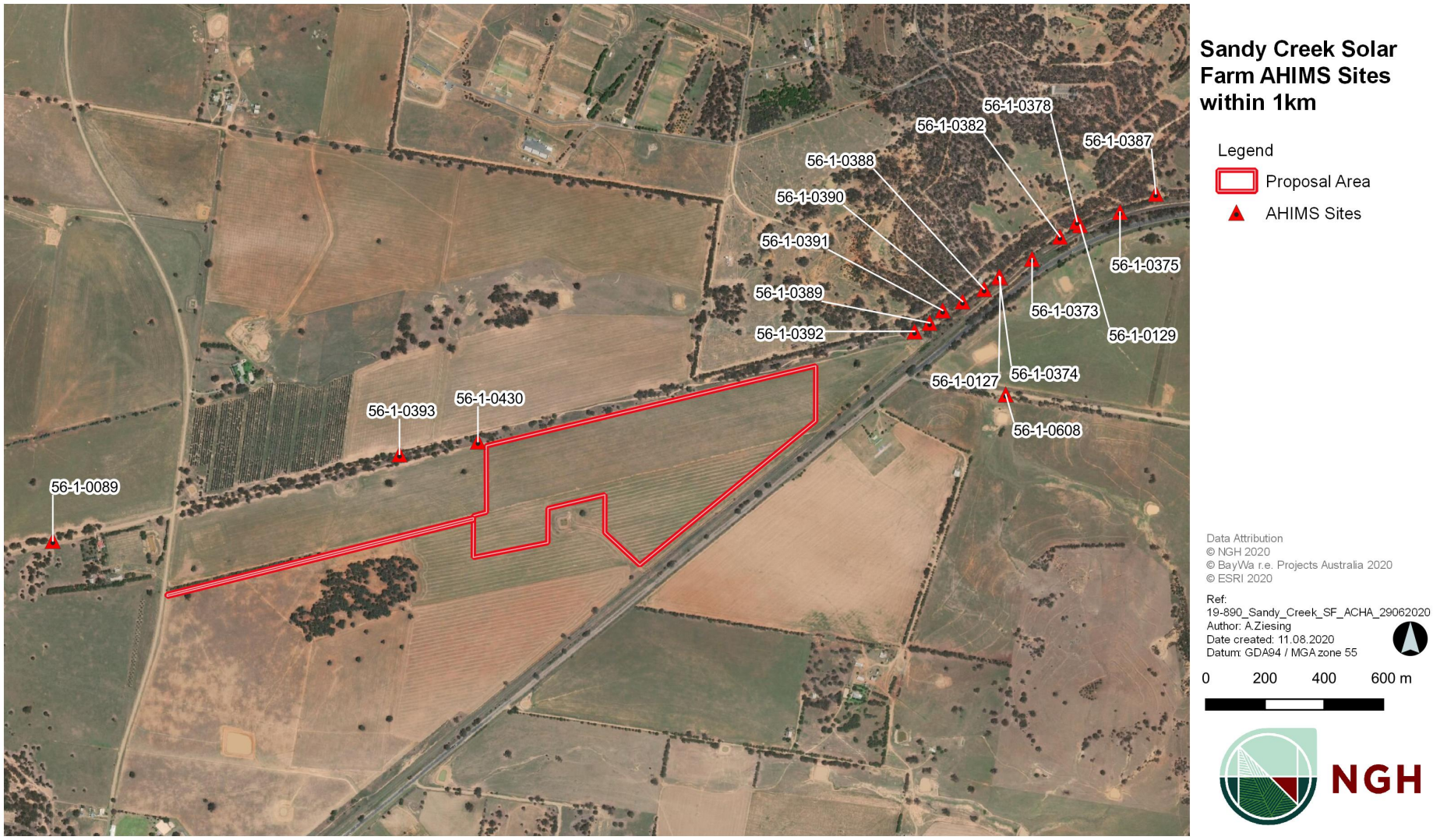


Figure 3-5 AHIMS Sites within proximity of the Sandy Creek Solar Farm Proposal Area.

3.4 REGIONAL ARCHAEOLOGICAL CONTEXT

Aboriginal people have occupied what we now know as the Australian continent for at least 40,000 years and perhaps 60,000 years and beyond (Mulvaney and Kamminga 1999, Hiscock 2007). While no regional synthesis of the archaeology has been completed for the Wagga Wagga region, one archaeological survey has been completed along the south eastern boundary of the proposal area and numerous for the wider Wagga Wagga region, which are detailed below. Section 4.2 below summaries archaeological survey reports that have been completed in the Wagga Wagga area, primarily driven by development and infrastructure requirements. The majority of these studies are within 10 to 20 km from the proposal area and provide a broad overview of archaeology in the region.

Djekic (1978) undertook an archaeological survey for a proposed transmission line from the Wagga Wagga substation to Albury. The route covered approximately 120 km across well-established farming land and passed approximately 9 km north east of the current proposal area. During the survey, six scarred trees were located, four of which were most likely the result of Aboriginal use in the area. Stone artefacts were also recorded on a property just outside Culcairn. The artefacts recorded included a small grinding stone, a hammer stone, a broken pebble and a small round stone of local material that appeared to have been pecked on either side. Djekic concluded that the small number of sites located during the survey was a direct result of over 100 years of environmental modification through the intensive development of agriculture in the region.

Witter (1980) carried out a survey for a gas pipeline between Wagga Wagga and Young. A total of 14 artefact scatters, 21 isolated finds, a possible rock well and a modified tree were recorded. Most of the sites identified by Witter occurred in association with creeks or water courses within a range of landforms including flats, slopes and spurs. Witter recommended the excavation of some of these sites if they were unable to be avoided. One of these sites, artefact scatter BY/4, was salvaged by Kelly (as referenced in Kelleher Nightingale (KNC) 2008:4) later that same year collecting 319 surface artefacts and retrieving 48 subsurface artefacts.

Witter and Hughes (1983) completed several archaeological surveys for Stage 1 of the Murrumburrah to Yass and Murrumburrah to Wagga Wagga transmission lines during which they identified four artefact scatters, 13 isolated artefacts and a possible modified tree. The artefact scatters were large open camp sites with the quartz as the dominate lithology. In 1983, Hiscock also identified 13 isolated artefacts and nine modified trees during another transmission line survey from Wagga Wagga to Darlington Point. During the survey of Stage 2 of the Murrumburrah to Yass Transmission line, Packard and Hughes (1983) identified a further 11 isolated finds, five artefact scatters and two modified trees (as cited in Oz Ark 2012, p.16-17).

Silcox (1987) conducted a series of mechanical test excavations north of the Murrumbidgee River at Gumly Gumly, approximately 10 km east of Wagga Wagga. The testing was based on the results of a previous survey for a water augmentation project. PAD GG1 was proposed for test excavation due to its proximity to a reliable water source, its elevated, well-drained flat surface suitable for camping and the absence of previous ground disturbance activities. A total of 17 test pits were excavated across seven locations and 52 subsurface artefacts were recovered. The assemblage was comprised solely of quartz located in the upper 25 cm of the deposits. A thin layer of mussel shell was also noted in one trench. The results indicated to Silcox that there was a low-density scatter of artefacts across the lower Murrumbidgee floodplain.

L'Oste-Brown (1994) conducted a survey of a proposed optic fibre cable route between East Wagga Wagga, Ladysmith, Big Springs and Book Book, approximately 19 km south east of the current assessment area. The survey concentrated on two areas of high archaeological potential, including Kyeamba Creek and Turkey Flat at the margins of Kyeamba and Turkey Creeks and a saddle between two prominent hills. No archaeological sites were identified.

Australian Archaeological Survey Consultants (AASC) (1995) conducted a study approximately 16 km east of Wagga Wagga and 23 km east of the current assessment area for the proposed upgrade of the Sturt Highway. Most of the survey area had been heavily disturbed by previous highway construction activities. Despite good visibility, no sites were located and AASC concluded this was an accurate reflection of Aboriginal use of steep hill slopes associated with limited water resources.

Dearling and Evans (1997) conducted a cultural resource assessment of the Kapooka Military Area (KMA), approximately 2 km north east of the current assessment area (Dearling and Evans 1997). They recorded 12 artefact scatters and 5 isolated artefacts, containing a total of 92 artefacts in all. The largest site contained 17 artefacts, and all the open scatters were of low density. 97.8% of the artefacts were quartz. Most of the artefacts were associated with drainage lines at the footslopes of the Pomingalarna Ridge which was the main ridge in their study area. This ridge is an outlier of the western slopes.

Central West Archaeological and Heritage Services (CWAHS) (2007) notes that Navin Officer Heritage Consultants (NOHC) identified 65 Aboriginal sites while conducting surveys from 1996 to 1998 for the Wodonga-Wagga Wagga Natural Gas Pipeline, approximately 1.7 km west of the current assessment area. The sites included 39 artefact scatters, 19 isolated artefacts and eight PADs. Based on these survey results, NOHC concluded that artefact scatters are likely to be located in well drained contexts adjacent to water sources.

HLA Envirosciences (1997) completed an assessment for the proposed expansion of an effluent irrigation system at the Bomen Abattoir, approximately 15 km north east of the current assessment area. HLA examined the alignment of a proposed pipeline, holding dam and irrigated paddocks. They located a single isolated silcrete artefact (ISF BOM1), with grinding on one surface, in the upper floodplain area of a paddock devoid of any source material.

NOHC (1998) surveyed a proposed power plant site at Bomen identifying three Aboriginal sites, including the axe manufacturing and quarry site East Bomen 1 (#56-1-0043 / Bomen Axe Quarry) and two isolated finds (Green 2011). The axe quarry is situated on the crest of a ridgeline containing exposures of granite and basalt. The basalt material was utilised for the manufacture of axe blanks, which were most likely carried off-site for final production. Distinct working areas were mapped, with primary flaking areas close to the basalt outcrop and secondary working areas located beyond the outcrops (NOHC map in Green 2011). The site is highly culturally significant to the local Aboriginal community and also of high archaeological significance. The area has now been declared an Aboriginal Place under the *NPW Act* (Green 2011).

NOHC (2002) conducted a survey for the Lloyd Neighbourhood Land Release Area, approximately 5 km north east of the current assessment area. Five Aboriginal sites (LN1 to LN5) were located during the survey, including three artefact scatters, one isolated artefact and one probable culturally modified tree. The sites with artefacts were considered common and representative of those in the region, with areas surrounding these sites deemed unlikely to be associated with *in situ* subsurface deposits. It was recommended that the scarred tree site (LN5) be avoided and that the root and canopy zone of the tree protected. Three PADs were also noted by NOHC including LNPAD1, LNPAD2 and LNPAD3. All PADs were associated with raised landforms associated with ephemeral creek or drainage.

Green (2002) compiled a comprehensive study of Wiradjuri heritage for the Wagga Wagga area. The study focused on Wiradjuri and non-indigenous heritage, oral histories, insight into pre-European Wiradjuri culture, a timeline of Wiradjuri history and highlighted potential tourism, education and employment opportunities. Green also identified several plant and animal resources in the Wagga Wagga area utilised by past and present Wiradjuri people. During the study, Green identified three scarred trees and an artefact scatter at the Bomen and Wollundry Lagoons.

Kelton (2005) (as cited in CWAHS 2007, p.15) conducted a desktop study and brief field assessment of approximately 600 ha within the *Henwood* property, between Coolamon Road the Olympic Highway and Sutherlands Road, Wagga Wagga. This property is approximately 17 km north east of the current assessment area. While the survey visibility of the area was poor, a number of archaeologically sensitive areas and PADs were identified. The PADs were primarily located along the western banks and adjacent terraces of Dukes Creek and its surrounding low hillslopes. Hill crests and ridges were also identified as archaeologically sensitive landforms in the area. These results were similar to the areas of archaeological sensitivity mapped across Wagga Wagga by KNC (2008) and NGH Environmental (2015) in Bomen and Lloyd.

Austral Archaeology (2005) conducted a survey for the proposed Wagga Wagga Rail Bridge Replacement, approximately 12 km north east of the current assessment area. They produced an ACHA and Statement of Heritage Impact (SoHI) for these works, identifying six PADs. Areas of high potential were identified along the Murrumbidgee floodplain. These areas were relatively undisturbed and contained deep soil profiles and high potential for *in situ* subsurface finds. Areas of moderate sensitivity were determined to be north of the Murrumbidgee River on the north-west side of an access track in a relatively flat to undulating floodplain. Areas of low archaeological potential were determined to be south of the Murrumbidgee River on the south-east side of the track, between the riverbank and the fence line.

Kelton (2006) conducted an Aboriginal archaeological heritage assessment for the proposed Lloyd Residential Subdivision. Kelton noted that five of the sites and three PADs previously recorded by NOHC (2002) were within the project area, but that several inconsistencies were present between the AHIMS database, site cards and reported site locations. As a result of these inconsistencies, only one of the five previously recorded sites (LN2) was located during the 2006 survey. Kelton identified a total of eight additional Aboriginal site locations, including two isolated stone artefacts (L-IF-1, L-IF-2) and six scarred tree sites (L-ST-1 to L-ST-6). Four PAD area were also recorded (PAD 4 to 7).

CWAHS (2007) surveyed approximately 40 ha for the proposed extension to the Wagga Quarry on Roach Road, Wagga Wagga, approximately 8 km north of the current assessment area. The quarry is on an alluvial floodplain on the southern side of the Murrumbidgee River and while noted as an archaeologically sensitive area no sites or PADs were identified. The area was extensively disturbed and CWAHS concluded that the flood prone nature of the survey area would have not been ideal for Aboriginal occupation on a regular basis.

KNC (2008) completed an Aboriginal heritage assessment as part of the Wagga Wagga City Council's Local Environmental Study to implement the strategic planning of the Wagga Wagga Spatial Plan 2007. As part of this study, assessments were undertaken for eight sites which were subject to rezoning. These included Lloyd, Bomen, Estella West, Edison Road, Hammond Avenue, Copland Street, Boorooma East and Moorong Street. Predictive modelling for each location was proposed with areas of high archaeological sensitivity being associated with elevated flats near drainage lines and low to moderate sensitivity associated with ridgeline crests, spurline crests, upper/mid and lower slopes. Granite outcroppings were also assessed as having moderate to high archaeological sensitivity. The Murrumbidgee alluvial floodplain was assessed as having low sensitivity, particularly south of the river.

AECOM Australia (2010) conducted the Aboriginal and historic heritage study for Stage 1 of a 61 km pipeline project from Bethungra to Wagga Wagga. The survey methodology was designed to only target archaeologically sensitive landforms, resulting in 18 transects being surveyed. A total of 36 Aboriginal sites (30 artefact scatters and 6 isolated artefacts) were recorded along the proposed pipeline route, including 24 previously unrecorded sites. Most sites identified during the survey were associated with, or in close proximity to an ephemeral water source with over two thirds of sites located within 50 m of a water source.

OzArk (2011) completed an Aboriginal heritage assessment for the Kapooka Bridge Replacement Project, approximately 2 km north east of the current assessment area. One scarred tree and one archaeologically sensitive landform were identified during the survey and it was recommended that both these locations be avoided by the proposed bridge replacement works. The scarred tree was located on a crest and the sensitive landform was described as high ground surrounding an intermittent north-west flowing drainage feature (OzArk 2011: 35).

OzArk (2012) completed an Aboriginal and historic heritage assessment for the proposed upgrade to the Olympic Highway near The Rock, NSW approximately 16 km south west of the current assessment area. The survey assessed a 5 km stretch of road extending into the Lockhart LGA. One potential modified tree (OH The Rock ST-1) was identified along the road corridor and avoidance of this site was recommended. No other sites of Aboriginal cultural heritage were recorded. An area of burnt clay nodules was also noted for avoidance by proposed highway upgrades, but this was not deemed to constitute a hearth site as it was not associated with any artefacts and there was no indication that the nodules were Aboriginal in origin, therefore; no further heritage investigation was recommended.

OzArk (2014) carried out a desktop due diligence assessment for a proposed telecommunications tower as part of the National Broadband Network (NBN) in Bomen, approximately 14 km north east of the current proposal area. The assessment covered the northern portion of Lot 22 DP1085826 approximately 350 m north of East Bomen 1 (Aboriginal Place: Bomen Quarry), on the southern side of East Bomen Road, near the location of low archaeological potential due to the low lying landform and previous disturbance from agricultural and road construction activities. No evidence of basalt quarry or basalt flakes were identified in the study area. No heritage constraints were identified for the NBN study area.

Umwelt (2014) completed excavations of the Wagga Wagga Courthouse in 2013, approximately 10 km north east of the current assessment area. The excavations were completed as part of the courthouse upgrades during which 23 artefacts were recovered from 18 test pits. Following the subsurface testing program, the location was recorded as site Wiradjuri 1 (W1) and consisted of quartz flakes, broken flakes and flaked pieces. During the consultation process, it was noted that the local Aboriginal community associated the sand ridge location with a burial ground, although no human remains where identified during excavations.

NGH Environmental (2015) conducted a due diligence assessment for Stage 1 of the proposed Riverina Intermodal Freight and Logistics (RIFL) Hub at Bomen Park, approximately 14 km north east of the current assessment area. Three isolated artefacts (# 56-1-0432, # 56-1-0433 and # 56-1-0434) were identified within disturbed contexts. They also identified two PADs and areas of archaeological sensitivity that were recommended for subsurface testing to establish the archaeological potential and extent of sites if these areas could not be avoided by the proposed development.

NGH Environmental (2016a) investigated the proposed extension of Brunslea Park estate, approximately 16 km north east of the current assessment area. Nineteen stone artefacts, a single piece of mussel shell, pieces of burnt clay and eight lithic fragments were recovered from 40 test pits, with an additional 17 surface artefacts recorded across the area (Brunslea Park AS7 and Brunslea Park AS8). Most of the subsurface artefacts were recovered from spit 2 (5-15cm) below the surface. Flakes or portions of flakes were the

dominate artefact typology for both the surface and subsurface finds with only a single core recovered. Quartz was the dominant lithology, with one volcanic lithic fragment identified. The sites were concluded to be low density artefact scatters located on low gradient slopes and along the crest of a broad ridgeline.

NGH Environmental (2016b) conducted a due diligence assessment for the Bomen Solar Energy development. A single artefact scatter was recorded (Bomen Solar ISO1), consisting of two quartz flakes. The site was in pastoral land, approximately 90 m from a water source, within an area of high archaeological sensitivity (KNC 2008). The area of archaeological sensitivity was recommended for subsurface testing if it could not be avoided by the proposed development.

NGH Environmental (2018a) completed a due diligence assessment for the proposed replacement of a rising water main in East Wagga Wagga, approximately 12 km north east of the current assessment area. One scarred tree was identified near Marshalls Creek in the course of the site inspection, which was able to be avoided by the Wagga Wagga City Council. No areas of archaeological sensitivity were noted within the proposed works area.

Also, in 2018, NGH Environmental completed an ACHA for the proposed Gregadoo Solar Farm, located 14 km south east of the current assessment area, covering approximately 124 ha (NGH 2018b). Despite the variable visibility encountered during the survey, seven Aboriginal stone artefacts were found across the proposal area. A single possible modified tree was also recorded. Based on the land use history, an appraisal of the landscape, soil, level of disturbance and the results from the field survey it was concluded that there was negligible potential for the presence of intact subsurface deposits with high densities of objects or cultural material within the proposal area.

Access Archaeology & Heritage (2018) completed an ACHA for Stage 1 of the Wagga Wagga Solar Farm at Bomen, approximately 14 km north east of the current assessment area. The ACHA and subsurface investigation undertaken by Access Archaeology and Heritage was in line with the recommendations of the due diligence assessment initially undertaken by NGH in 2016. Two artefact scatters, two isolated finds and two PADs were recorded. The PADs were additional areas of sensitivity that were refined from the 2016 due diligence assessment. The subsurface testing focused on the two PAD areas (WWSF-PAD1 and WWSF-PAD2) and areas of sensitivity associated with an extensive artefact scatter along the creekline (WWSF-1), isolated find (WWSF-3) and a drainage line. A total of 55 test pits were manually excavated across these four areas, with 45 subsurface finds being recovered. Most of the subsurface material was recovered from spit 1 (n=15) or spit 2 (n=22), although small amounts of material were identified in both spit 3 (n=5) and spit 4 (n=3). Quartz was the dominant lithology within the subsurface assemblage, with one fine-grained volcanic artefact recovered. Moderate revisions to the KNC modelling (2008) were proposed based on these results. Higher archaeological sensitivity was identified in association with the higher order water courses and raised, level well-drained ground, with areas of lower sensitivity found further away from this water source. Level terraces, spurs and rises close to low order drainage lines were assigned low to moderate archaeological sensitivity.

NGH (2019a) completed an ACHA survey of the Lloyd Residential Subdivision area in 2018, approximately 5 km north east of the current assessment area. During this survey, four of the previously recorded sites (LN 4, L-ST-5, L-ST-6 and Red Hill Rd West 1) were located. However, five of the previously recorded sites (LN 2, LN 3 and L-IF-2, L-ST- 3, L-ST-4) were unable to be relocated, due to low visibility or no longer being present in the landscape. NGH located and re-assessed all the previously recorded PAD locations. PAD 1, PAD 2 and PAD 7 were modified based on the visual inspection of the area, review of the original site descriptions and the use of 1 m contour spatial data. PAD 4 and PAD 5 were deemed to have low potential for subsurface material and were removed as areas requiring further investigation. NGH was unable to provide any further assessment of PAD 3 beyond the observation that the area is now mostly disturbed. Three additional artefact scatters (Lloyd 528899, Lloyd 529137 and L-AFT-1), one isolated find (L-IF-3), one possible scarred tree (Lloyd

530222), and a new area of potential archaeological deposit (PAD 8) were also recorded. Three cultural tree sites (Lloyd 528729, Lloyd 529096 and Lloyd 529314) were recorded by the Aboriginal representative Mark Saddler.

NGH (2019c) completed a due diligence and subsequent ACHA assessment, including test excavations of five PADs, for the Wagga Wagga Solar Farm South at Bomen, approximately 15 km north east of the current assessment area. A total of four artefact scatters and five isolated artefacts were identified in fenceline and track exposures along a north to south running ridgeline, a gentle slope, flat and spur associated with minor drainage lines and a hill crest. At the completion of the test pitting programme, which included the manual excavation of 49 test pits, a further four subsurface artefact scatters had been identified (NGH 2019b, p.43). Most of the artefacts were manufactured from quartz and one hammerstone from basalt. The results of the investigations were in line with those found in the northern solar farm studies, confirming that low density scatters had low to moderate archaeological sensitivity and that artefact densities increase in areas on the boundary of the northern Murrumbidgee floodplain, especially at the junction of one or more creeks or drainage lines (Access Archaeology 2018, NGH 2019c).

NGH (2020a) completed a subsequent subsurface test excavation program for the proposed Lloyd residential subdivision. Four archaeologically sensitive PADs associated with elevated flats on the east and west banks of an unnamed creekline were tested with a total of 36 test pits at intervals of 10 to 20 m spacing. A total of 118 artefacts were retrieved, predominantly of quartz raw material (n=114, 96.6%). Despite previous disturbance to portions of the deposit, high densities of subsurface finds were identified in PAD 7 (n=84, 71.2%), bordering a quarry that is currently undergoing rehabilitation to facilitate the next stage of proposed subdivision construction. Due to the high number of artefacts retrieved from this area on the eastern bank and elevated flat of the unnamed creekline, additional salvage excavation was recommended following the completion of the quarry stockpile removal and rehabilitation, as the stockpile was encroaching on the boundary of the PAD. Discussions between the landowners, Aboriginal stakeholders and archaeologists concluded that this area would be declared a heritage exclusion zone and no proposed quarry rehabilitation or construction would be permitted in this archaeologically sensitive location.

NGH (2020b) completed an ACHA for the Junior School development of The Riverina Anglican College on Farrer Road, Boorooma approximately 14 km north east of the current assessment area. A total of seven artefacts were identified, representing one artefact scatter and four isolated finds. Three PAD areas were also identified in association with an elevated flat and gentle slope to the west of a first order creekline running south west to north east along the boundary of the proposal area. The proposed development sat along the northern boundary of the Murrumbidgee floodplain. The surface artefacts had been dispersed across the paddocks, due to previous ploughing and grazing of the area, which is currently utilised by the College for agricultural educational purposes. The PADs are being avoided by the proposed development and therefore further heritage investigation is not required.

3.5 PREVIOUS ARCHAEOLOGICAL STUDIES IN URANQUINTY AND THE CURRENT ASSESSMENT AREA

The following are summaries of archaeological investigations that have been completed in nearby Uranquinty and covering the current assessment area.

Williams (1993) (as cited in OzArk 2011, p.22) completed a survey between Albury and Wagga Wagga of a proposed optic fibre cable route provided confirmation that proximity to water was a factor in open site location. Williams recorded one scarred tree and three open sites in close proximity to creek and suggested that sandy water retaining substrates were more likely to contain sites. Williams study passed within 200 m of the current assessment area on the south eastern side of the Olympic Highway.

NOHC (1996) completed an assessment of a natural gas pipeline extending from Wodonga to Wagga Wagga and passing approximately 1.5 km west of the current assessment area. A total of 23 Aboriginal sites, including 17 artefact scatters, nine isolated finds and six scarred trees were identified across the proposed 146 km of pipeline. Eight potential archaeological deposits (PADs) were also identified. The area surveyed in close proximity to the current assessment boundary contained two artefact scatters and one isolated artefact. There was also an elevated bank associated with Sandy Creek that was unable to be surveyed.

Biosis Research Pty Ltd (2006) completed an archaeological survey for Aboriginal and European heritage sites for the North-South Rail Corridor Albury to Junee Passing Lane Project. The passing lane travelled through Uranquinty and covered an area approximately 140 m wide from the north western side of the Olympic Highway to the south eastern side of the current assessment area, known as Passing lane 16. Variations to Passing lane 16 were also surveyed in subsequent stages of assessment in the same year. No sites of Aboriginal cultural heritage or areas of archaeological potential were identified during the Passing lane 16 survey, due to heavy ground disturbance evident in the rail corridor (Biosis 2006, p.49). Potential cultural significance relating to the Wiradjuri Walking Track, to the west of the railway line and north of the overbridge, was noted during this assessment, but confirmation was not sought as to the extent of significance associated with this public recreation track.

3.6 SUMMARY OF ABORIGINAL LAND USE

The results of previous archaeological surveys in the Uranquinty area by show that there are sites and artefacts present throughout the proposal area in sparse low densities.

There appears to be a strong association between the presence of potential resources for Aboriginal use and the presence of archaeological sites. Areas directly associated with water and or elevated ground (such spurs, terraces and flat colluvial and alluvial banks of natural watercourses) appear to have the highest potential for the identification of Aboriginal cultural material. To a lesser extent ridges and crests were also utilised by past Aboriginal people, but these landforms are not present in the current assessment area.

3.7 ARCHAEOLOGICAL SITE LOCATION MODEL

The Aboriginal site modelling for the region to date suggests that there is a strong association between the presence of potential resources for Aboriginal use and the presence of archaeological sites. Areas directly associated with water and or elevated ground appear to have the greatest potential for identification of Aboriginal cultural material. There are exceptions to this however, and relatively low-lying floodplain areas also have potential for the identification of isolated artefacts or campsites.

Based on the results of the previous archaeological investigations in the Uranquinty area, and through extrapolation of sites from the Wagga Wagga area, it is possible to provide the following model of site location in relation to the proposal area. Based on the reviewed reports and the predictive modelling of the region, the key attribute taken into consideration to develop the predictive model was that areas of archaeological sensitivity will occur in association with water sources, including the Murrumbidgee River, creeks and ephemeral drainage lines. Areas of higher archaeological sensitivity are expected in association with the higher order water courses and raised, level well drained ground and areas of lower sensitivity are expected further away from this water source. Level terraces, spurs and rises close to low order drainage lines are expected to have low to moderate archaeological sensitivity, as seen in the current assessment area.

Isolated Artefacts – are present across the entire landscape, in varying densities. As Aboriginal people traversed the entire landscape for thousands of years, such finds can occur anywhere and indicate the presence of isolated activity, dropped or discarded artefacts from hunting or gathering expeditions or the

ephemeral presence of short-term camps. This feature is known to occur as four isolated artefact sites have been identified during previous heritage investigations in the proposal area.

Stone artefact scatters – representing camp sites or flaking and maintenance activity, this site type can occur across the landscape, usually in association with a resource or specific landform such as spurlines or elevated terraces associated with a natural watercourse. Within the general region, artefact scatters tend to be dominated by quartz artefacts as is shown by the 32 previously recorded sites within 10 km of the proposed solar farm.

Artefact scatters are most likely to occur in well-drained elevated, level or gently sloping contexts within riparian zones, flood plains and adjacent to water sources (Access Archaeology 2018, p. 38). Water bodies, such as rivers, ephemeral creeks and drainage lines can also be a focus of Aboriginal occupation. Similar landforms at the junction of creek and drainage lines have been assessed to contain high archaeological sensitivity across the region (Access Archaeology & Heritage 2018, p.38). Given the large number of natural watercourses surrounding the proposal area, there is a high likelihood that low density artefact scatters will occur.

Stone resources – are areas where people used natural stone resources as a source material for flaking. This requires geologically suitable material and outcropping to be accessible. The proposal area does not contain any isolated areas of natural outcropping, therefore this feature is unlikely to occur.

Scarred Trees – these require the presence of mature trees and are likely to be concentrated along major waterways and around swamps areas. There are isolated examples of remnant vegetation within the proposal area; however, extensive historical clearing of tall woodland has occurred. Multiple registered scarred trees have been recorded in along Rodhams Road to the immediate north of the proposal area, suggesting that this feature may occur if trees of a suitable age remain standing.

Hearths/Ovens – are identified by burnt clay used for heat retainers. Some are recorded in the district in association with resource locations. However, they could occur either independently or in association with other Aboriginal cultural features such as artefact scatters. Hearths are generally considered to be limited, one-off use sites, or reused only a few times, and are characterised by smaller concentrations of burnt clay. Ovens are considered to represent larger features, often extending over an extended area and can include other material such as bone. No such sites have been recorded in the area and therefore this site type is considered unlikely to occur.

Mounds- are accumulations of heat retainer ovens that have built up over time. They are typically round or oval in shape and range in length from just a few metres to over 100 m and in height from 0.1 m to 2 m. They are identified by the presence of baked clay heat retainers, which have usually been brought to the location from a nearby source of natural clay such as a lakebed, swamp or drainage line. Mounds are generally found in proximity to wetland areas such as lakes, swamps and creeks, often elevated above these areas by being situated on sandy rises, lunettes, source bordering dunes and palaeochannels. Mounds are likely to contain a range of other archaeological features such as bone, shell, stone artefacts and burials. No such sites have been recorded in the area and therefore this site type is considered unlikely to occur

Burials – are generally found within mound sites, in elevated sandy contexts or in association with rivers and major creeks. The closest major creekline is Sandy Creek, located approximately 800 m west. It is therefore unlikely that burials will occur in the current assessment area.

Shell Middens – are the agglomeration of shell material disposed of after consumption. Such places are found along the edges of significant waterways, swamps and billabongs. As these watercourses do not occur in the proposal area it is unlikely that any midden material will be identified.

In summary, the topography and landscape features within the proposed Sandy Creek Solar Farm area indicate that this area would have been used in a transitory nature by past Aboriginal people moving between more permanent resources, such as Stringybark and Sandy Creek and the Murrumbidgee River. The area will likely contain a low-density archaeological signature in the form of stone artefacts and modified trees on remnant native isolated paddock trees.

3.8 COMMENT ON EXISTING INFORMATION

Within the current assessment area there has only been one previous investigation; however, there have been extensive archaeological investigations in the wider Wagga Wagga region. The information relating to site patterns, their age and geomorphic context is therefore generally quite comprehensive and well understood. The robustness of the AHIMS survey results are therefore considered to be moderate for the present investigation. Despite this, there are likely to be sites that exist that have yet to be identified.

Evidence of erosion activities in the proposal area was noted during the initial site walkover causing disbursement of artefacts through the relatively unmodified landscapes. The modifications to these landscapes result only from vehicle movement along access tracks, fencelines and paddocks, farm dam and transmission line construction and widespread native vegetation clearance. Some modification has also resulted to the first order drainage line that connects to the southern farm dam. The relatively low degree of landform modification suggests that there is a moderate to high probability for *in situ* archaeological deposits to be present where soils are of a suitable depth, particularly within the PAD location recorded during the initial NGH site inspection. The current study is the most comprehensive assessment of the current proposal locality and is considered to present thorough and up to date results for the Uranquinty region.

With regard to the limitations of the information available, archaeologists rely on Aboriginal parties to divulge information about places with cultural or spiritual significance in situations where non-archaeological sites may be threatened by development. During the fieldwork, BAC representative, Mark Saddler, outlined the cultural significance of the area in relation to Sandy Creek, The Rock (*Kengal*), Stringybark Creek and the Murrumbidgee River (*Marrambidya Bila*). Additional cultural information provided by BAC is outline in Section 2.1.1.

4 ARCHAEOLOGICAL INVESTIGATION RESULTS

4.1 SURVEY STRATEGY

The survey strategy was to cover the entirety of the proposed solar farm area. The proposed works will include the installation of PV solar arrays, internal access tracks, fencing, vegetation screening, internal substation/battery storage, inverters.

The strategy therefore was to walk the length of the access track and paddocks in transects with a 20 – 30 m spacing between the five survey participants.

Any mature trees within the proposal area were inspected for evidence of Aboriginal scarring (Long 2005). No rock outcropping was present within the proposal area.

NGH believes that the survey strategy was comprehensive and the most effective way to identify the presence of Aboriginal heritage sites. Discussions were held in the field during the survey between the archaeologists and Aboriginal community representatives to ensure all were satisfied and agreed with the spacing and methodology.

The proposal area was divided into three landforms. The landforms are listed below and shown in Figure 3-3 above.

- Elevated Flat;
- Gentle Slopes and
- Flats.

The survey of the Sandy Creek Solar Farm was undertaken by the team over half a day on 30 June 2020. Over the course of the survey, notes were made about visibility, photos taken, and any possible Aboriginal features identified were inspected, assessed and recorded if deemed to be Aboriginal in origin.

4.2 SURVEY COVERAGE

The Sandy Creek Solar Farm proposal area was characterised by previously graded access tracks, fencelines and cropped, cleared and grazed undulating paddocks. Survey transects were undertaken on foot and traversed the entire proposal area. Visibility within the proposal area was variable however as a whole, the visibility was generally moderate, averaging 30% overall. The effective visibility in more heavily eroded access tracks and exposures was good (80%) to areas of low visibility in grazed previously harvested crops (30%). Between the survey participants, over the course of the field survey, approximately 20 km of transects were walked across the proposal area.

Table 4-1 below shows the calculations of effective survey coverage and Plate 1 to Plate 8 show examples of the transects and landforms within the proposal area.

Allowing for an effective view width of 5 m for each person and given the variability in the ground visibility across the proposal site overall, the survey effectively examined 2.6% of the proposed development footprint. It is considered that the survey of the solar farm proposal area had sufficient and effective survey coverage.

The discovery of a number of Aboriginal sites indicates that the survey technique was effective enough to identify the presence of Aboriginal occupation in the area. Therefore, the results identified are considered a true reflection of the nature of the Aboriginal archaeological record present within the proposal area.



Plate 1. Quartz flake from Sandy Creek SF AFT 12.



Plate 2. View south of the access track into the proposed solar farm. Sandy Creek ST 1 is in the background and Sandy Creek SF AFT 4 is indicated by the range pole.



Plate 3. View west of Sandy Creek SF ST 2 scar close up.



Plate 4. View north towards the unnamed ephemeral creekline in the background showing PAD 1.



Plate 5. View west of exposures along fencelines and location of Sandy Creek SF AFT 14.



Plate 6. View north west of Sandy Creek SF ST 2.



Plate 7. View south of PAD 1 in the background and the location of Sandy Creek SF AFT 13.



Plate 8. Quartz distal fragment from Sandy Creek SF AFT 15.

Table 4-1 Summary of effective survey coverage for the Sandy Creek Solar Farm.

Survey Section/ Topography	*Number of Survey Transects*	*Exposure type*	*Proposal Area ha*	*Surveyed area (length m x width m)*	*Survey Area m^2*	*Visibility*	*Effective coverage (area x visibility) m^2*	*Proposal Area surveyed (ha)*	*Percentage of Proposal area effectively surveyed*	*Survey Archaeological result*
Elevated Flat	4	Bare ground, vehicle tracks, fencelines, cropped paddocks	20	640 x 10 200 x 10	8,400	30% average	2,520	0.252	1.26	1 artefact scatter, 4 isolated finds, 1 scarred tree 1 PAD
Gentle Slopes	4	Bare ground, vehicle tracks, fencelines, cropped paddocks	20	680 x 10 660 x 10	13,400	30% average	4,020	0.402	2.01	1 artefact scatter, 8 isolated finds
Flat	1	Bare ground, vehicle tracks, fencelines	1	1070 x 5	5,350	80% average	4,280	0.428	42.8	2 isolated finds, 1 scarred tree
Total		NA	41	NA	27,150		10,820	1.082	2.6	18 sites 1 PAD

4.3 SURVEY RESULTS

Despite the variable visibility encountered during the ACHA survey nine artefact sites (Sandy Creek SF AFT 6 to Sandy Creek SF AFT 15) and two scarred trees (Sandy Creek SF ST 1 and Sandy Creek SF ST 2) were recorded. These are in addition to the five previously recorded sites (Sandy Creek SF AFT 1 to Sandy Creek SF AFT 5) that were relocated. One subsurface find was also retrieved during the subsurface investigation (Sandy Creek SF AFT 16). This subsurface find will be discussed in further detail below (Section 4.5).

Two scarred trees (Sandy Creek SF ST 1 and Sandy Creek SF ST 2) were also recorded during the survey on Yellow Box trees that are located outside of the proposed development footprint. The PAD area identified in the initial site inspection was re-assessed and it was decided that the area designated for test excavation was adequate (Figure 4-1).

A summary of all the newly identified Aboriginal sites recorded during survey within the Sandy Creek Solar Farm proposal area is provided in Table 4-2. The surface and subsurface artefact data is provided in full in Appendix C with detailed site descriptions provided in Appendix D and test pit excavation data in Appendix E.

Table 4-2 Summary of all cultural and archaeological sites recorded during ACHA and subsurface testing of the Sandy Creek Solar Farm.

AHIMS	Name	Type
56-1-0663	Sandy Creek Solar Farm AFT 1	Artefact Scatter
56-1-0664	Sandy Creek Solar Farm AFT 2	Artefact Scatter
56-1-0665	Sandy Creek Solar Farm AFT 3	Isolated Find
56-1-0666	Sandy Creek Solar Farm AFT 4	Isolated Find
56-1-0649	Sandy Creek Solar Farm AFT 5	Isolated Find
56-1-0650	Sandy Creek Solar Farm AFT 6	Isolated Find
56-10651	Sandy Creek Solar Farm AFT 7	Isolated Find
56-1-0652	Sandy Creek Solar Farm AFT 8	Isolated Find
56-1-0653	Sandy Creek Solar Farm AFT 9	Isolated Find
56-1-0654	Sandy Creek Solar Farm AFT 10	Isolated Find
56-1-0655	Sandy Creek Solar Farm AFT 11	Isolated Find
56-1-0656	Sandy Creek Solar Farm AFT 12	Isolated Find
56-1-0657	Sandy Creek Solar Farm AFT 13	Isolated Find
56-1-0658	Sandy Creek Solar Farm AFT 14	Isolated Find

56-1-0659	Sandy Creek Solar Farm AFT 15	Isolated Find
56-1-0660	Sandy Creek Solar Farm AFT 16	Subsurface Find
56-1-0661	Sandy Creek Solar Farm ST 1	Scarred Tree
56-1-0662	Sandy Creek Solar Farm ST 2	Scarred Tree
N/A	Sandy Creek Solar Farm PAD 1	Potential Archaeological Deposit

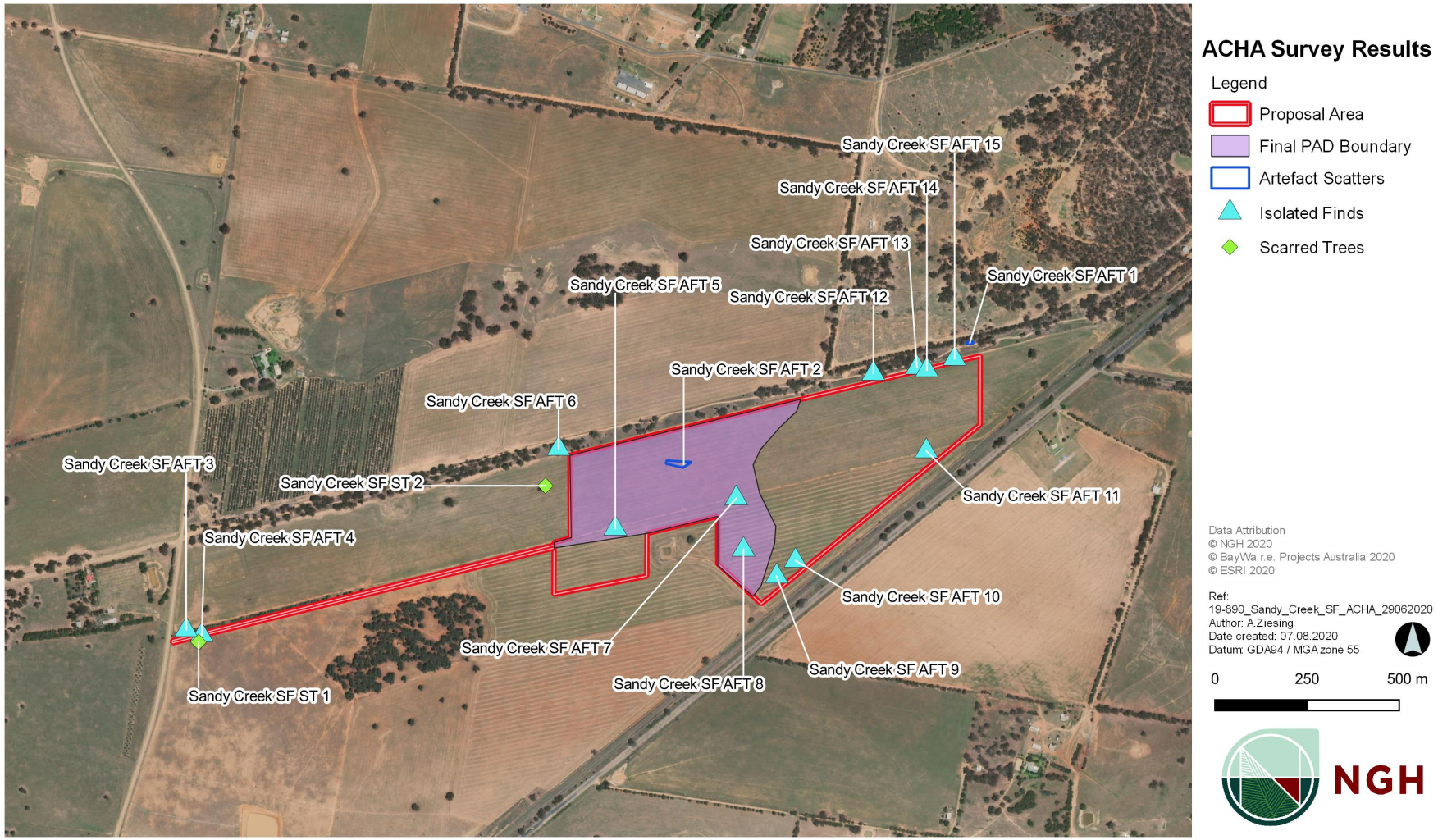


Figure 4-1 Results map from the ACHA survey showing all newly recorded surface sites.

4.4 SUBSURFACE TESTING METHODOLOGY

4.4.1 Aims

Broadly, the aims of the subsurface testing for the proposal were to:

- Identify the presence or absence and character of Aboriginal cultural material through a limited program of subsurface testing in the PAD 1 area, identified during the initial site inspection and re-assessed during the ACHA survey, that will be impacted by the proposed development;
- Consult with the Aboriginal community and identify any areas of Aboriginal cultural value and determine the cultural significance of any sites;
- Develop recommendations for options on how to manage identified Aboriginal heritage subsurface sites if recovered;
- Analyse the characteristics of the stone artefact assemblage; and
- Identify any activity areas or other cultural features present.

4.4.2 Methodology

The testing program was undertaken in accordance with the *Code of Practice for Archaeological Investigations* and included the following methodology.

One PAD area was identified during the initial site inspection in March 2020 and refined during the ACHA survey, that will be impacted by the proposed solar farm. Within this PAD, testing transects were established and NGH used either 10 or 20 m spacing to determine the location of pits along these transects. Initially it was estimated that between 20-30 test pits were required across the testing area, but this was subject to change depending on the density of subsurface artefacts recovered and the depth of deposit encountered, both of which could not be determined prior to the commencement of the fieldwork.

Figure 4-2 below shows the PAD area that was subject to subsurface testing and provides the completed test pit locations. Subsurface testing involved the following elements:

- Hand excavation using shovels and trowels, pits to be 50 cm x 50 cm in area.
- Removal of deposit in 5 cm levels (one test pit per PAD) or ‘spits’ with subsequent test pits at 10 cm spits unless features found requiring a different strategy.
- Placement of excavated deposit in buckets labelled by spit and test square.
- Sieving of deposits (dry sieving was undertaken).
- Removal of residue from sieves, bag and label for analysis.
- Excavated material was analysed in NGH Wagga Wagga office.
- Proceed with excavation until sterile natural clay level or physical limit.
- Photography of excavated sections and the excavation work in progress.
- Scale-drawn records of the stratigraphy/soil profile features and information on Aboriginal objects recovered from each test pit.
- At completion of excavation, test pits were backfilled with sieved material.

4.4.3 Post Fieldwork Analysis

The sieved material was sorted, and any Aboriginal artefacts were recorded with the following characteristics:

- Raw material type and colour.
- Dimensions (percussion length, width, thickness for complete items).
- Technological characteristics (platform surface, platform type and termination type).
- Presence and extent of cortex.
- Presence and extent and type of edge damage (use wear, retouch).
- Comments eg. Production method.
- Analyse the stone artefacts.
- Preparation of a report on the findings and conclusion of the excavation including addressing any research questions (this document).

The recovered archaeological material will be stored at the NGH Wagga Wagga office until a suitable location for burial is found. The storing of the material was discussed with the Aboriginal representative during the fieldwork and all were satisfied with this approach. NGH suggest that the burial location be on the property in an area that will not be impacted by the proposed development. This location should be determined by the NGH archaeologist, Aboriginal stakeholders, landowners and BayWa. A new AHIMS site card will be submitted to ensure the location of the reburied material is identified.

4.5 SUBSURFACE TESTING RESULTS

Test pits were excavated in one archaeologically sensitive location (PAD 1) within the Sandy Creek Solar Farm development footprint (Figure 4-2). The testing location corresponds with an area of elevated flat land associated with an unnamed ephemeral creekline located approximately 150 m north of the proposed development.

A summary of the test pitting results is provided in Table 4-2 below; test pits not specifically listed contained no artefacts. Only one subsurface artefact was recovered from across the three testing transects that were placed across the archaeologically sensitive landform. One additional artefact site, (Sandy Creek SF AFT 16) was recorded based on the location of the subsurface find (Pit 14). A total of 26 test pits were excavated totalling 2.56 m^3 of excavated deposit. Plate 9 to Plate 12 below provide an overview of each testing transect.



Plate 9 View north of PAD 1 testing transect.



Plate 10 View south of PAD 1 testing transect.

	
Plate 11 View west of PAD 1 testing transect.	Plate 12 View south of PAD 1 test pits south of the east to west running fenceline.



Figure 4-2 Test Pit Locations within the Impacted PAD 1..

Table 4-2 Summary of Test Pitting Results for the Sandy Creek Solar Farm Proposal Area.

Associated with Survey Sites	Test Pit Number	Number of Artefacts Identified	New Artefact Site Name
PAD 1 Sandy Creek SF AFT 2	**014**	**1**	**Sandy Creek SF AFT 16**

PAD 1 (Pits 001-026)

PAD 1 was associated with one surface artefact scatter (Sandy Creek SF AFT 2) and three isolated finds (Sandy Creek SF AFT 5, Sandy Creek SF AFT 7 and Sandy Creek SF AFT 8) and is located on an elevated flat area with a gentle slope to the east and north towards an ephemeral third-order unnamed creekline. That this creekline formed part of the broader regions' watershed was further supported by a notable change in the retention of moisture in the soil compared to the surrounding area.

Originally 30 test pits were laid out across the PAD; however, the limited depth of deposit encountered resulted in four of the south western pits not being excavated. A total of 26 test pits were excavated across the area. Only one of these test pits contained a subsurface artefact (Sandy Creek SF AFT 16). The spacing between the test pits was generally 20 m, which would have been reduced to 10 m if a number of subsurface finds had been retrieved. All representatives agreed that this spacing sufficiently tested the landform.

Excavation continued until the deposit was determined to be culturally sterile clay, which occurred between 10 and 30 cm depth in PAD 1, except in Pits 002, 003 and 006 which extended to a depth of 50 cm before reaching a natural clay layer. It is assumed that the increased depth associated with these three pits may have resulted from less ploughing and erosion disturbance at this location. The natural clay was either a yellow brown or bright red plastic clay with no inclusions and a high moisture content was noted throughout the testing areas.

New site cards have been submitted to AHIMS for any newly recorded surface and subsurface sites within the Sandy Creek Solar Farm proposal area (Appendix F).

Impact site cards have been submitted to AHIMS for sites that were subject to test excavations under the Code of Practice.

4.6 DEPOSIT CHARACTERISTICS

The excavation revealed a very similar soil profile across the PAD area, with natural culturally sterile clay generally encountered at 10-17 cm in PAD 1; however, variations to this depth were noted in Test Pits 002, 003 and 006, located on the western north to south running transect. These pits were dug to depth of 50 cm before natural plastic clay was encountered. Generally, the deposit was free from rock inclusions, except in very low-density and occasional finds. The deposit consisted of a reddish-brown topsoil of clayey loam with grass and root inclusions (Table 4-3). Some variation of a silty loam was also noted, overlying a compacted plastic clay of mottled yellow-brown or bright reddish brown.

Evidence of disturbance was noted in the top ~5 cm of deposit in many of the test pits and the lack of deposit prior to exposing natural clay in the majority of test pits suggests that erosion and water wash across the site has been more extensive than anticipated during the initial site inspection. General compaction of the deposit was moderate, and the high moisture content encountered across the whole landform increased the ability to dig but made the sieving of the deposit quite a slow process.

The excavations noted the presence of insects and grass roots throughout the deposits. The impacts of these actions result in the continual movement of soil and subsequently the movement of stone artefacts, a process known as bioturbation. A detailed breakdown on the deposit characteristics in all test pits is provided in Appendix C.

Table 4-3 Stratigraphic Soil Profile.

Stratigraphic Unit	*Depth (cm)*	*Sediment Description*	*Comments*	*Artefacts Present*	
1	0-10	High moisture content red brown to brown silty clayey loam with grass roots.	Topsoil layer is fine to very fine reddish brown to yellowish brown across proposal area. Lots of grass root, gravel and insect burrows in top 10 cm.	1 artefact	
2	10-20	High moisture content loamy clay.	Red brown loamy clay with no inclusions or minimal pebbles and reduced root content.	No artefacts	
3	20-50	Compacted plastic clay	Compacted red brown to yellow brown mottled plastic clay with no inclusions.	No artefacts	

Table 4-4 Comparative results of all test excavation programs to date across the Wagga Wagga region.

Date	Author	Test Excavation Project	Landform	Area Excavated m^2	Subsurface artefacts	Artefact Density per m^2	Raw material	Artefact types	Other	Sites names
1987	Silcox	Gumly Gumly	Floodplain Creek bank	52.4	52	1	All Quartz	37 Flakes 12 Cores 3 Flaked Pieces	Possible heat retaining stones Shell fragments	GG1
2014	Umwelt	Wagga Wagga Courthouse Upgrade	Floodplain Creek bank	5.5	23	4.2	All Quartz	13 Flakes 6 Broken Flakes 4 Flaked Pieces	None	Wiradjuri 1 (W1)
2016	NGH Environmental	Brunslea Park	Crest Upper slope Mid slope Lower slope	10	19	1.9	18 Quartz 1 Volcanic	9 Flakes 7 Flaked Pieces 1 Core 1 Core Fragment 1 Proximal Flake	1x shell fragment Burnt clay 8x lithic fragments 17 quartz surface artefacts	Brunslea AS7 Brunslea AS8
2016	NGH Environmental	Bomen RIFL Hub	Crest Upper slope Mid slope Lower slope	18.2	28	1.5	22 Quartz 4 Quartzite 2 Chert	22 Flakes Flaked Pieces 1 Core	None	Bomen RIFL IF5 Bomen RIFL AS1 Bomen RIFL AS2 Bomen RIFL AS3 Bomen RIFL AS4

Date	Author	Test Excavation Project	Landform	Area Excavated m^2	Subsurface artefacts	Artefact Density per m^2	Raw material	Artefact types	Other	Sites names
			Drainage lines and Creek flats.							
2018	Access Archaeology & Heritage	Stage 1 Wagga Wagga Solar Farm (Bomen)	Crest Upper slope Mid slope Lower slope Drainage lines and Creek flats.	13.75	45	3.3	44 Quartz 1 Fine-grained Volcanic	14 Flakes 13 Flaked Pieces 6 Cores 3 Core Fragments 3 Longitudinally Spilt Flakes 3 Proximal Flakes 1 Medial Flake 1 Distal Flake 1 Backed Artefact	None	WWSF-1 WWSF-3 WWSF-5 WWSF-6
2019	NGH Pty Ltd	Wagga Wagga Solar Farm South (Bomen)	Crest Upper slope Mid slope Lower slope	12.3	34	2.8	All quartz	25 flakes 3 distal flakes 3 proximal flakes 3 flaked pieces	None	Wagga Wagga SF AFT 2 Wagga Wagga SF AFT 5

Date	Author	Test Excavation Project	Landform	Area Excavated m^2	Subsurface artefacts	Artefact Density per m^2	Raw material	Artefact types	Other	Sites names
			Drainage lines and Creek flats.							Wagga Wagga SF AFT 6 Wagga Wagga SF AFT 7 Wagga Wagga SF AFT 8
2020	NGH Pty Ltd	Lloyd Residential Subdivision	Lower slope Drainage lines and Creek flats (all PADs)	8.25	118	14.3	114 quartz 1 basalt 1 chalcedony 1 quartzite 1 silcrete	64 flakes 18 distal flakes 18 proximal flakes 6 cores 6 medial flakes 2 flaked pieces 1 bipolar flake	None	L-AFT-2 L-AFT-3 L-AFT-4 L-AFT-5 L-AFT-6
2020	NGH Pty Ltd	Sandy Creek Solar Farm	Elevated flat near creekline	6.5	1	6.5	1 quartzite	1 flake	None	Sandy Creek SF AFT 16

4.7 ARTEFACT CHARACTERISTICS

This section reports on the artefact characteristics from the limited surface and subsurface stone artefact assemblage recorded during the ACHA survey and the limited subsurface testing program of PAD 1. This section describes the components and nature of the stone artefact assemblage, including the range of raw material represented, the size ranges represented, the visible post depositional impacts and the overall technological categories discarded at the site. Examples of a range of artefacts represented in the assemblage are provided in Plate 13 to Plate 18 below.

4.7.1 Raw Materials

Four raw material types were identified during the artefact analysis of the Sandy Creek assemblage. These include predominantly quartz (n=17, 85%), basalt (n=1, 5%), quartzite (n=1, 5%) and silcrete (n=1, 5%). Both smoky grey (n=3, 15%), white (n=13, 65%) and rose white (n=1, 5%) quartz were present in the assemblage. These results correlate with other sites across Wagga Wagga, where the dominant lithology is quartz for both surface and subsurface assemblages (Table 4-4). Table 4-5 provides a summary of raw material frequency and technological attributes, which are discussed in detail below.

4.7.2 Technological Attributes

In total 20 stone artefacts were recorded during the Sandy Creek Solar Farm survey and subsurface testing program (Appendix B). The assemblage consists of flakes (n=10, 50%), distal flakes (n=3, 15%), proximal flakes (n=2, 10%), cores (n=2, 10%) and flaked pieces (n=2, 10%).

Flakes and broken flakes (distal, proximal and medial) formed the most frequent component of the assemblage (n=15, 75% respectively). The broken nature of much of the assemblage may be the result of previous pastoral disturbances to the ground surface or from shovel damage exhibited during manual excavation (n=5, 25%).

All the assemblage was identified in the tertiary stage of reduction (n=20, 100%), suggesting that the closest stone raw material source might be some distance and artefacts were being exhausted until only small examples remained.

Platforms exhibited flake scars on over half the assemblage (n=12, 60%), with lesser numbers of ridges (n=2, 10%), crushed (n=2, 10%) and faceted platforms (n=1, 5%). Broad platforms (n=11, 55%) were recorded at a slightly higher rate than focal platforms (n=8, 40%). Feather terminations dominated the assemblage (n=18, 90%), with only one example of an axial termination being recorded (n=10, 50%), axial, (n=1, 50%).

The average dimensions of complete flakes were 26.8 x 13.2 x 6.4 cm (LxWxD). The standard deviation of the length of complete flakes is 15.1 cm. Low numbers of cores were recorded (n=2, 10.5%) and the average dimensions of these artefacts were 27.3 x 22 x 17.5 cm (LxWxD) with a standard deviation of 14.7 cm. The low number of cores may be the result of a lower discard rate and fewer raw material resources in the region.

No retouch was identified; however, edge damage was recorded on one find (5.3%).

All results from the survey and subsurface testing are shown in Figure 4-3 below.

Table 4-5 Raw Material Frequency of Subsurface Artefact Assemblage

Assemblage Component	Basalt	Quartz	Quartzite	Silcrete	Total	Percentage
Flake		8	1	1	**10**	**50**
Core		2			**2**	**10**
Distal flake	1	2			**3**	**15**
Proximal Flake		2			**2**	**10**
Flaked piece		2			**2**	**10**
Total	**1**	**17**	**1**	**1**	**20**	**100**
Percentage	**5**	**85**	**5**	**5**	**100**	



Plate 13 White quartz proximal fragment from L-AFT-2.



Plate 14 Quartzite hammerstone fragment from the ground surface of L-AFT-3.



Plate 15 Smoky grey quartz flake from L-AFT-3.



Plate 16 White quartz flake from L-AFT-4.



Plate 17 Smoky grey proximal flake from L-AFT-4.



Plate 18 Brown quartzite flake from Sandy Creek SF AFT 16.

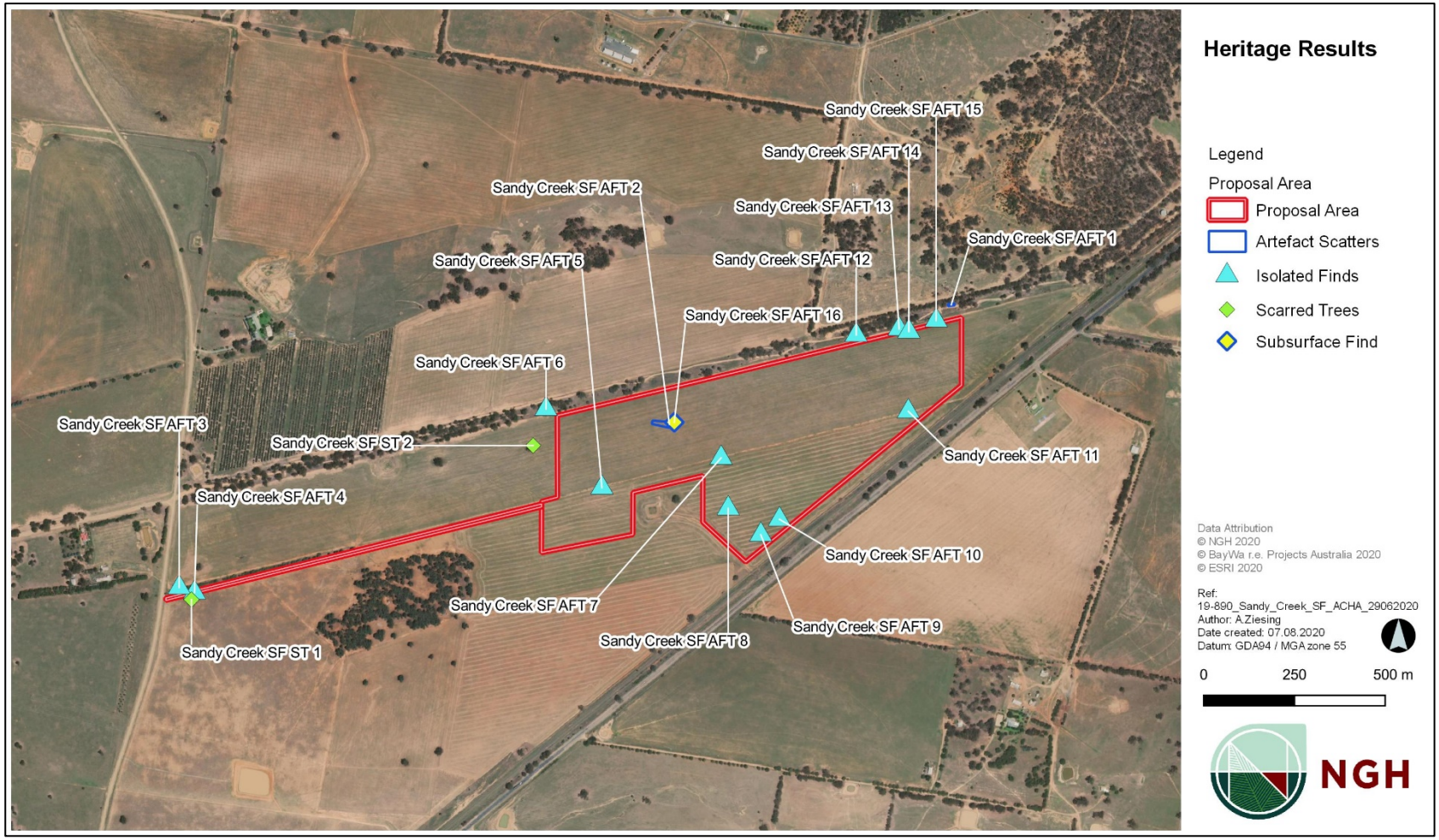


Figure 4-3 Results of the ACHA survey and subsurface testing programs showing all archaeological sites identified across the proposal area.

4.7.3 Summary

The predictions, based on modelling for the proposal area, were that isolated artefacts and artefact scatters consisting predominately of quartz objects were the most likely manifestation of Aboriginal occupation in the proposal area. These sites would most likely be identified on elevated landforms associated with ephemeral creek and drainage lines or to a lesser extent on hill crests and ridges (KNC 2008, p.9). The results indicate that artefact scatters and Aboriginal objects can occur throughout the landscape, even in areas disturbed by farming and quarrying activities. While Aboriginal sites may be expected through all landscapes, there does appear to be a pattern of sites in the general region that relate to the presence of potential resources for Aboriginal use, specifically with reference to natural water sources.

The survey results have confirmed these predictions with 14 isolated finds (including one subsurface find) and two artefact scatters recorded across the proposal area. Two scarred Yellow Box trees were also recorded outside of the proposal area. The sites identified in this assessment are scattered across the proposal area but tend to cluster around elevated landforms in close proximity to an unnamed ephemeral creekline and minor drainage lines or have been dispersed across the wider landscape from prolonged pastoral activities. The area was likely used intermittently over a period of time for camping, hunting and gathering resources, with a focus of longer-term camping on the well-drained elevated banks of the creekline outside of the current assessment area. Based on this assumption, there is every chance that there are similar artefact scatters or isolated artefacts across both the proposal area and comparable landforms in the Wagga Wagga region and these site types, particularly stone objects, could be more prevalent in this area than previously recorded.

The relatively high density of surface artefacts compared to the low density of subsurface finds may be the result of the increased erosion, ploughing disturbance and sheetwash than previously anticipated in the initial site inspection. Low ground surface visibility may have also attributed to the overall low density of the assemblage across the site, with artefacts generally only being identified on the surface in areas of increased visibility such as exposures or access tracks. The degree of ploughing, cropping, harvesting and grazing is apparent across the proposed solar farm area, resulting in a lower density of artefactual finds and the disbursed nature of their locations.

The presence of erosion was confirmed by the lack of deposit encountered during the test excavations of PAD 1, which had been impacted by erosion and ploughing practices.

Overall, the artefact assemblage from the surface and subsurface sites indicates that small groups of Aboriginal people were occupying short-term camps in a transitory nature for short periods of time across the proposal area with a focus along more the more permanent Sandy Creek banks and on slightly elevated areas.

Most of the artefacts, both surface and subsurface, were manufactured from quartz, which is the dominant lithology in the Wagga Wagga region and conforms with data from previous studies (NGH 2020a; NGH 2019; Williams 2018). The presence of cores, flakes, broken flakes and flaked pieces indicates that tool manufacture may have occurred onsite. The low number of cores and the reduced size of much of the assemblage suggest that raw materials were being brought in from elsewhere and being utilised until almost exhausted. This is substantiated by the lack of raw material resources that have been recorded in the immediate Uranquinty region.

It should also be noted that the results of the 2020 NGH survey and subsurface testing program have somewhat increased the number of stone artefact sites recorded in the local area from 32 to 48 with an additional 16 artefact sites recorded during this assessment. The implications for this relate to significance assessments and the related appraisal of site representativeness. We would argue that there are likely to be many hundreds of such artefact sites in the local area, and this is reflected by the number of previously

recorded artefact sites in the area which suggests a lack of previous investigations in the area, rather than an absence of sites.

5 CULTURAL HERITAGE VALUES AND STATEMENT OF SIGNIFICANCE

The assessment of the significance of Aboriginal archaeological sites is currently undertaken largely with reference to criteria outlined in the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in New South Wales* (OEH 2011), which are based on those in the ICOMOS Burra Charter (Marquis-Kyle and Walker 1994). Criteria used for assessment are:

- ***Social or Cultural Value*:** In the context of an Aboriginal heritage assessment, this value refers to the significance placed on a site or place by the local Aboriginal community – either in a contemporary or traditional setting.
- ***Scientific Value*:** Scientific value is the term employed to describe the potential of a site or place to answer research questions. In making an assessment of scientific value, issues such as representativeness, rarity and integrity are addressed. All archaeological places possess a degree of scientific value in that they contribute to understanding the distribution of evidence of past activities of people in the landscape. In the case of flaked stone artefact scatters, larger sites or those with more complex assemblages are more likely to be able to address questions about past economy and technology, giving them greater significance than smaller, less complex sites. Sites with stratified and potentially *in situ* sub-surface deposits, such as those found within rock shelters or depositional open environments, could address questions about the sequence and timing of past Aboriginal activity, and will be more significant than disturbed or deflated sites. Groups or complexes of sites that can be related to each other spatially or through time are generally of higher value than single sites.
- ***Aesthetic Value*:** Aesthetic values include those related to sensory perception and are not commonly identified as a principal value contributing to management priorities for Aboriginal archaeological sites, except for art sites.
- ***Historic Value*:** Historic value refers to a site or place's ability to contribute information on an important historic event, phase or person.
- ***Other Values*:** The Burra Charter makes allowance for the incorporation of other values into an assessment where such values are not covered by those listed above. Such values might include Educational Value.

All sites or places have some degree of value, but of course, some have more than others. In addition, where a site is deemed to be significant, it may be so on different levels or contexts ranging from local to regional to national, or in very rare cases, international. Further, sites may either be assessed individually, or where they occur in association with other sites the value of the complex should be considered.

5.1 SOCIAL OR CULTURAL VALUE

While the true cultural and social value of Aboriginal sites can only be determined by local Aboriginal people, as a general concept, all sites hold cultural value to the local Aboriginal community. An opportunity to identify cultural and social value was provided to the Aboriginal representatives for this proposal through the consultation process which included providing comments on the methodology, participating in fieldwork and draft reporting process.

Feedback about the cultural value of the sites while in the field with representatives was that all sites hold cultural value to the Aboriginal community. It was clear from the conversations held in the field that the community view the stone artefacts as important and would like to see the surface artefacts collected before any development occurs. It was noted during the conversations that there was importance placed on collecting the artefacts and placing them in a safe location to avoid future disturbance.

5.2 SCIENTIFIC (ARCHAEOLOGICAL) VALUE

The research potential of the sites located during this assessment is considered to be low. While the presence of the sites can be used to assist in the development of site modelling for the local landscape, their scientific value for further research is limited.

While the artefacts themselves are intrinsically interesting in terms of their base technical information their current lack of temporal context and the absence of information about local resources makes further conclusions about land use difficult. Their scientific value for further research is also limited due to the disturbed nature of the landscape and the movement of objects by clearing and ploughing activities and lack of association to provide technological analysis.

The findings of this project have substantially increased the number of sites listed in the AHIMS database for the area. In terms of representativeness and rarity however, we would argue that there are likely to be many hundreds of such sites in the local area, the lack of sites in AHIMS is merely an indication that few surveys have been undertaken in the Uranquinty area and therefore they are yet to be found. The nature of Aboriginal occupation in almost any landscape in Australia is that stone artefact sites considerably outnumber any other site type, including scarred trees. This is due to the inorganic nature of stone and the high number of waste flakes produced and left anywhere Aboriginal people traversed and stopped to undertake an activity.

The scarred trees identified in the proposal area have been assessed as having moderate scientific value, due to these sites representing a finite resource that is often removed from the archaeological record due to land clearing practices. As significant native vegetation removal was noted throughout the proposal area, these sites represent a rarer example of Aboriginal cultural modification.

5.3 AESTHETIC VALUE

There is no aesthetic value associated with the archaeological site per se, apart from the presence of Aboriginal artefacts and scarred trees in the pastoral landscape the proposal area.

5.4 HISTORIC VALUE

There are no known historic values associated with the proposal area, the sites identified or links to known people.

5.5 OTHER VALUES

The area may have some educational value (not related to archaeological research) through educational material provided to the public about the Aboriginal occupation and use of the area, although the archaeological material is within private property and there is little for the public to see.

6 PROPOSED ACTIVITY

6.1 HISTORY AND LAND USE

It has been noted above that historically the proposal area has been largely cleared of native vegetation for pastoral development. This has included prolonged cropping, ploughing and grazing of the landscape. Associated fencelines, firebreaks and access tracks have also been installed across the proposal site. The existing transmission line that runs along the eastern survey boundary has also caused discrete disturbance for the installation of the postholes.

The implications for this activity are that the archaeological record was identified on remnant old growth Yellow Box trees that survived as isolated paddock trees. The implication for stone artefacts is that they may have been damaged or moved but they are likely to remain present in the general area they were discarded by Aboriginal people, except in cases where fluvial and erosional activities have significantly distributed artefacts from their original locations.

Despite the impacts, Aboriginal artefacts and cultural material remain in the area, indicating the presence of past Aboriginal people and providing indications of their use of this landscape.

6.2 PROPOSED DEVELOPMENT ACTIVITY

As noted in section 1.3, the proposal involves the construction of a 17 MG DC/12 MW AC solar farm.

The development activity will therefore involve disturbance of the ground during the grading of access tracks, site compound, roads and associated amenities, installation of cabling, PV panels and fencelines.

The final details and timing of the proposed upgrade activity have yet to be finalised, but it is anticipated that upgrades would commence in 2021 or 2022.

6.3 ASSESSMENT OF HARM

As described in this report, 14 isolated finds, two artefact scatters and two scarred trees were located within the assessment area. The assessment of harm also covers the five previously recorded artefact sites identified in the initial site inspection.

Of the 18 newly identified Aboriginal archaeological sites, including 14 isolated artefacts, two artefact scatters and two scarred trees, the following 13 artefact sites are situated within the area of the proposed solar farm and would be directly impacted by the proposed development (see Figure 4-3).

- Sandy Creek SF AFT 2
- Sandy Creek SF AFT 4
- Sandy Creek SF AFT 5
- Sandy Creek SF AFT 7
- Sandy Creek SF AFT 8
- Sandy Creek SF AFT 9
- Sandy Creek SF AFT 10
- Sandy Creek SF AFT 11
- Sandy Creek SF AFT 12
- Sandy Creek SF AFT 13
- Sandy Creek SF AFT 14
- Sandy Creek SF AFT 15
- Sandy Creek SF AFT 16

Three artefact sites (Sandy Creek SF AFT 1, Sandy Creek SF AFT 3 and Sandy Creek SF AFT 6) and two scarred trees (Sandy Creek SF ST 1 and Sandy Creek SF ST 2) will be avoided by the proposed solar farm works. Table 6-1 below details the degree of harm and the consequence of that harm upon the heritage value of each site type resulting from the proposed works. Figure 4-3 also shows the location of the sites and the proposed development footprint.

There is Aboriginal archaeological material present within the assessment area and there are likely to be other artefacts present as well, although in similar low densities. The proposed level of disturbance for the proposed solar farm could impact the stone artefacts recorded during the field survey and others that may be present within other areas of the development footprint.

The impact to these 13 sites is likely to be most extensive where earthworks will occur such as grading, levelling and trenching, which may involve the removal, breakage or displacement of artefacts. This is considered a direct impact on the sites and the Aboriginal objects by the development in its present form.

The assessment of harm overall for the project is therefore assessed as moderate.

Table 6-1. Summary of the degree of harm and the consequence of that harm upon site types

Site Type	Type of Harm	Degree of Harm	Consequence of harm	No. of Sites	% of site type
Artefact Sites	Direct	Complete	Total loss of value	13	81.25
	Nil	Nil	None – avoided by the proposed development	3	18.75
Sub Total				**16**	
Scarred Trees	Nil	Nil	None – avoided by the proposed development	2	100
Sub Total				**2**	
Total				**13**	**72.22**

6.4 IMPACTS TO VALUES

The values potentially impacted by the development are any social and cultural values attributed to the artefacts and the sites by the local Aboriginal community. The extent to which the loss of the sites or parts of the sites would impact on the community is only something the Aboriginal community can articulate.

The impact to scientific values for this development are summarised in Section 5 and detailed in Table 6-2 with the stone artefact sites rated as having low loss of scientific value. While, 13 stone artefact sites are rated as having total loss of scientific value, it is argued that there are likely to be a number of similar sites in the local area and therefore the impact to the overall local archaeological record is considered to be low. Three artefact sites and two scarred trees will be avoided by the proposed development.

The stone artefacts have little research value apart from what has already been gained from the information obtained during the present assessment. This information relates more to the presence of the artefacts and in the development of Aboriginal site modelling, which has largely now been realised by the recording.

The intrinsic values of the artefacts themselves may be affected by the development of the proposal area. Any removal of the artefacts, or their breakage, would reduce the low scientific value they retain.

The proposed solar farm works and the locations of the sites assessed in this report are shown in Figure 6-1. No other values have been identified that would be affected by the development proposal.

Table 6-2. Identified risk to known sites.

AHMIS #	Site name	Site integrity	Scientific significance	Type of harm	Degree of harm	Consequence of harm	Recommendation
56-1-0663	Sandy Creek SF AFT 1	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	None	None	No loss of value – outside of development footprint	5m buffer zone around site to avoid impact
56-1-0664	Sandy Creek SF AFT 2	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0665	Sandy Creek SF AFT 3	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	None	None	No loss of value – outside of development footprint	5m buffer zone around site to avoid impact
56-1-0666	Sandy Creek SF AFT 4	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.

56-1-0649	Sandy Creek SF AFT 5	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0650	Sandy Creek SF AFT 6	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	None	None	No loss of value – outside of development footprint	5m buffer zone around site to avoid impact
56-1-0651	Sandy Creek SF AFT 7	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0652	Sandy Creek SF AFT 8	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0653	Sandy Creek SF AFT 9	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.

56-1-0654	Sandy Creek SF AFT 10	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0655	Sandy Creek SF AFT 11	Good	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0656	Sandy Creek SF AFT 12	Good	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0657	Sandy Creek SF AFT 13	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0658	Sandy Creek SF AFT 14	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.

56-1-0659	Sandy Creek SF AFT 15	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	Direct	Total	Total loss of value	Salvage surface objects prior to development of proposal area.
56-1-0660	Sandy Creek SF AFT 16	Poor – disturbed by erosion, vehicle tracks and fluvial activity.	Low	None – Subsurface Artefact	None	No loss of value – will be buried outside of development footprint	Salvage excavation not required due to low density and previous disturbance to PAD area.
56-1-0661	Sandy Creek SF ST 1	Poor – some rot and branch tear damage.	Moderate	None	None	No loss of value – outside of development footprint	10m buffer zone around site to avoid impact
56-1-0662	Sandy Creek SF ST 2	Poor – some rot and branch tear damage.	Moderate	None	None	No loss of value – outside of development footprint	10m buffer zone around site to avoid impact

7 AVOIDING OR MITIGATING HARM

7.1 CONSIDERATION OF ESD PRINCIPLES

Consideration of the principles of Ecologically Sustainable Development (ESD) and the use of the precautionary principle was undertaken when assessing the harm to the sites and the potential for mitigating impacts to the sites recorded during the survey for the proposed Sandy Creek Solar Farm works. The main consideration was the cumulative effect of the proposed impact to the sites and the wider archaeological record. The precautionary principle in relation to Aboriginal heritage implies that development proposals should be carefully evaluated to identify possible impacts and assess the risk of potential consequences.

In broad terms, the archaeological material located during this investigation is similar to what has been found previously within the region, comprising isolated finds and low-density artefact scatters dominated by quartz lithology. Prior to the completion of this assessment, the most commonly recorded site type in the immediate area was modified tree sites (70.3%). The identification of an additional two scarred trees in an area that has largely been cleared of extensive areas of native vegetation suggests that the dominance of modified tree sites in the record for the local area is an accurate representation of the archaeological record. The findings of this survey are therefore believed to accurately represent the Aboriginal cultural record of land use for the Uranquinty area.

Due to the extensive nature of the previous heritage investigations in the Wagga Wagga region, there is an understanding of the nature, number, extent and content for archaeological sites within the Wagga Wagga LGA. As well as this, it is almost certain that there would be similar site types present within the region. The result of this Aboriginal heritage assessment supports the proposed model of site location and site distribution, whereby objects and sites could be expected to occur across all landscapes and in particular in close proximity to a water source, even in areas of highly disturbed farming activities. The results of this Aboriginal heritage assessment suggest that more sites could be expected to occur in the area than was previously envisaged.

The implications for ESD principles are that in fact more sites are likely to be present in the region than previously thought, which reduces the individual value of the particular sites within the proposal area, as they are likely to be represented elsewhere. It must be recognised that outside of the national park boundaries, large parts of the region have been heavily cleared, farmed and developed through the construction and maintenance of roads and residential structures and therefore other sites are also likely to have been disturbed.

As noted above, the archaeological values of the site within the development footprint, considering the scientific, representative and rarity values assigned to them, was deemed to be low to moderate. In terms of representativeness and rarity the previous number of overall sites in AHIMS for the local area was merely an indication of the surveys that have been undertaken in the immediate areas. It is believed therefore that the proposed impacts to the stone artefact sites through the proposed solar farm development would not adversely affect the broader archaeological record for the local area or the wider Wagga Wagga region.

The principle of inter-generational equity requires the present generation to ensure that the sites and diversity of the archaeological record is maintained or enhanced for the benefit of future generations. We believe that the diversity of the archaeological record is not compromised by the proposed development. Further to this, the number of yet unknown sites in the wider region allow opportunity for identification by future generations.

We estimate, that while the current development proposal will impact some of the stone artefact sites identified, the overall cumulative impact on the archaeological record for the region is likely to be minimal, assuming a

similar density of artefact sites remain across the wider region. Therefore, it is argued that the cumulative impacts of the proposal are not enough to reject outright the development proposal.

7.2 CONSIDERATION OF HARM

Preventing harm to the 16 artefact and two scarred tree sites identified within the proposed Sandy Creek Solar Farm area is technically possible through avoidance by rejecting the development; however; design alterations have already been achieved from the proposed works program in an effort to avoid impact to both scarred tree sites. The scattered nature of the stone artefact sites across the area prevent further exclusions to the development footprint of the proposed solar farm.

Based on the assessment of the sites and in consideration of discussions with the Aboriginal representatives during the field survey, it is not considered necessary to prevent the proposed solar farm, or for total avoidance of the stone artefact sites identified within the current assessment area. The stone artefact sites have been shown to be in highly disturbed contexts with little remaining scientific value. Aboriginal cultural value has been determined by the local Aboriginal community to be generally low enough to not prevent the proposed upgrades from proceeding.

A total of 13 sites with stone artefacts, comprising one artefact scatter and 12 isolated finds, are situated within the area of the proposed development footprint that would be impacted by the proposed works. The most likely cause of harm to these stone artefact sites will therefore be through re-grading, levelling, piling, foundations and trenching works associated with the solar farm.

However, the question remains about possible occurrences of artefacts and cultural material within the balance of the solar farm area. It is possible and considered likely that additional artefacts will be present, most likely in the form of isolated artefacts or small low-density scatters. Without knowing their exact locations, it is difficult to manage the impacts. We do not consider that the risk of such disturbances means the development should be abandoned. The archaeological material identified in the survey, and potentially present in the balance of the development site is not of sufficient value to reject the development proposal.

Mitigation of harm to cultural heritage sites generally involves some level of detailed recording to preserve the information contained within the site. Mitigation can be in the form of minimising harm, through slight changes in the development plan or through direct management measures of the sites and Aboriginal objects.

Complete avoidance has already been achieved for three artefact sites and two scarred trees, therefore, it is argued here that mitigation in the form of further avoidance may not be feasible or warranted within the remainder of the solar farm area. However, any stone artefact sites within the development footprint that cannot be avoided by the proposed works are conducive to salvage as a mitigation strategy as requested by the Aboriginal representatives during the field survey.

As identified above, it is recommended that the impacted sites recorded within the development footprint for the Sandy Creek Solar Farm are salvaged by an archaeologist with representatives of the registered Aboriginal parties prior to the proposed development commencing. The artefacts should be collected and moved to a safe area for burial within the property that will not be subject to any ground disturbance.

8 LEGISLATIVE CONTEXT

Aboriginal heritage is primarily protected under the NPW Act and as subsequently amended in 2019 with the introduction of the *National Parks and Wildlife Amendment (Aboriginal Objects and Places) Regulation 2019*. The aim of the NPW Act includes:

The conservation of objects, places or features (including biological diversity) of cultural value within the landscape, including but not limited to: places, objects and features of significance to Aboriginal people.

An Aboriginal object is defined as:

Any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with the occupation of that area by persons on non-Aboriginal extraction and includes Aboriginal remains.

Part 6 of the NPW Act concerns Aboriginal objects and places and various sections describe the offences, defences and requirements to harm an Aboriginal object or place. The main offences under section 86 of the NPW Act are:

- A person must not harm or desecrate an object that the person knows is an Aboriginal object.
- A person must not harm an Aboriginal object.
- For the purposes of this section, "circumstances of aggravation" are:
    - that the offence was committed in the course of carrying out a commercial activity, or
    - that the offence was the second or subsequent occasion on which the offender was convicted of an offence under this section.
- A person must not harm or desecrate an Aboriginal place.

Under section 87 of the NPW Act, there are specified defences to prosecution including authorisation through an AHIP or through exercising due diligence or compliance through the regulation.

Section 89A of the Act also requires that a person who is aware of an Aboriginal object, must notify the Director-General in a prescribed manner. In effect this section requires the completion of AHIMS site cards for all sites located during heritage surveys.

Section 90 of the NPW Act deal with the issuing of an AHIP, including that the permit may be subject to certain conditions.

The EP&A Act is legislation for the management of development in NSW. It sets up a planning structure that requires developers (individuals or companies) to consider the environmental impacts of new proposals. Under this Act, cultural heritage is considered to be a part of the environment. This Act requires that Aboriginal cultural heritage and the possible impacts to Aboriginal heritage that development may have are formally considered in land-use planning and development approval processes.

The planning approvals pathway for the proposed Sandy Creek Solar Farm project lies under Part 4 of the NSW EP&A Act. A Review of Environmental Factors (REF) is not required to assess the potential environmental impacts for this project. In addition to this, the approvals for impact to Aboriginal heritage remains with Heritage NSW. The remainder of the solar farm is being assessed under DA.

9 RECOMMENDATIONS

The recommendations are based on the following information and considerations:

- Results of the current archaeological survey and subsurface testing program of the area;
- Consideration of results from other local archaeological studies;
- Results of consultation with the registered Aboriginal parties;
- The assessed significance of the sites;
- Appraisal of the proposed development, and
- Legislative context for the development proposal.

It is recommended that:

1. A minimum 5 m buffer must be observed around the boundary extent of all 16 artefact sites prior to the achievement of the below recommendations.
2. The scarred tree sites (Sandy Creek SF ST 1 and Sandy Creek SF ST 2) should be avoided by the proposed solar farm, including a 10 m buffer zone, to prevent inadvertent impacts to the crown and root systems.
3. The proponent applies to Heritage NSW within the Department of Premier & Cabinet and receives an Aboriginal Heritage Impact Permit (AHIP) to allow harm to the 13 Aboriginal archaeological sites that will be impacted within the proposal area. The AHIP should be sought for the entire Sandy Creek Solar Farm proposal area and include salvage collection.
4. Should the proponent seek to apply for an AHIP, this report must accompany the application, as outlined in the document: *Applying for an Aboriginal Heritage Impact Permit: Guide for Applicants*.
5. Once an AHIP has been issued the 13 impacted sites within the development footprint, as approved by the AHIP, must be salvaged prior to the proposed work commencing and moved to a safe area within the property that will not be subject to any ground disturbance. This area will be determined by BayWa prior to the issue of the AHIP.
6. The collection and relocation of the artefacts should be undertaken by an archaeologist with representatives from the registered Aboriginal parties and be consistent with Requirement 26 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales*. A site impact card must be submitted for each site salvaged and a new site card will need to be completed once the artefacts are buried to record their new location on the AHIMS database.
7. No salvage excavation of the PAD 1 area is required due to the low-density of subsurface finds, degree of previous disturbance and erosion.
8. If any items suspected of being Aboriginal in origin are discovered during the proposed construction, all work in the immediate vicinity must stop and Heritage NSW notified. The find will need to be assessed and if found to be an Aboriginal object further investigation will be required.
9. In the unlikely event that human remains are discovered during the development works, all work must cease in the immediate vicinity. Heritage NSW and the local police should be notified. Further assessment would be undertaken to determine if the remains were Aboriginal or non-Aboriginal. Should the remain be identified to be Aboriginal in origin, Heritage NSW would advise the proponent and/or archaeologist on the appropriate Aboriginal parties to contact.
10. Further archaeological assessment would be required if the proposal activity extends beyond the area covered by this assessment. This would include consultation with the registered Aboriginal parties and may include further field survey.

The proponent is reminded that it is an offence under the *National Parks and Wildlife Act* to harm an Aboriginal object without a valid AHIP.

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APPENDIX A ABORIGINAL CONSULTATION

Newspaper advertisement in Daily Advertiser on Thursday 9 April 2020.



32 THE DAILY ADVERTISER **Thursday, April 9, 2020** dailyadvertiser.com.au

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Death Notices

DERRICK
(nee Turner)
Joan

Passed away peacefully at home in the care of her loving family on Sunday, 5th April 2020. Beloved wife of Dudley (dec'd). Treasured sister & sister-inlaw of Peggy & Lionel Lewin (both dec'd), Meg & Dick Derrick (both dec'd) and Betty & Gerald Hughes and Glen Turner (dec'd). Lyle & Joyce Lucas (both dec'd), Gwen & Lance Glasson (both dec'd) and Bill Derrick (dec'd). Dearly loved mother and mother-in-law of Beryl Post, Janice Manson, Ian & Von Derrick, Robyn Kennedy (dec'd) & David Brown, Leanne & Rod Rankin. Loving grandmother of Richard, Karinda (dec'd), Kylie, Daryl, Scott, Troy, Adam, Emma, Amy, Brendan, Derrick, Ashleigh, Jake, Andrew, James, Ashleigh, Mitchell (dec'd), Stephanie, Blake and Maddison. Cherished great-grandmother of her 21.5 great-grandchildren. Aged 89 years. She will be sadly missed by all her family and friends.

A private service to celebrate **Joan Derrick's** life will be held on **Thursday, 9th April 2020, commencing at 2:00pm.**
Family and friends are respectfully invited to watch the celebration of **Joan's** life via livestream at:

www.alanharrismcdonald.com.au

If you would like to be recorded in the family memorial book, simply call our team at Alan Harris McDonald on:
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4pm Thursday 9th April

Wishing all our readers a Safe and Happy Easter

adzuna

Public Notices

Notification for registration of interest for Aboriginal stakeholders

NGH Pty Ltd (NGH) has been contracted by BayWA r.e. Projects Australia (45 Denison St, Bondi Junction, NSW 2022) to undertake an Aboriginal Cultural Heritage Assessment (ACHA), including subsurface testing, for a proposed solar farm involving portions of Lots 55, 118, 129, 149 DP754567 on Churches Plain Road and the Olympic Highway, Uranquinty, NSW.

The project area comprises approximately 40 hectares and is located in proximity to Sandy Creek. The purpose of the consultation with Aboriginal people is to assist the proponent in the preparation of the ACHA and to be involved in consultation as part of possible lodgement of an Aboriginal Heritage Impact Permit application.

In order to fulfil the requirements set out in the OEH *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*, NGH is seeking interested Aboriginal parties who hold cultural knowledge of the assessment area to register their interest in the consultation process for the project and to assist in the determination of cultural significance of any Aboriginal objects or places located therein.

Registrations should be provided in writing to:

NGH Pty Ltd
PO Box 5464
WAGGA WAGGA NSW 2650

Or via email to:

amy.z@nghconsulting.com.au

Closing date for registration is **23rd of April, 2020.**

Those registering an interest will be contacted to discuss the project further. Those who do register are advised that their details will be provided to OEH and the Local Aboriginal Land Council, unless they specifically advise in writing that their details are not to be forwarded.

Public Notices

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Organisation	Contact	Action	Date Sent	Reply Date	Replied by	Response
Heritage NSW (formerly BCD)	Andrew Fisher and South West Branch	letter to OEH via email	08/04/2020	21/04/2020	letter via email	provided list of potential stakeholders, NGH had already contacted all groups except for Robert Carroll from Miyagen Culture & Heritage. Additional letter sent on 21/04/2020.
NTScorp		Letter to NTS Corp via email	08/04/2020			
National Native Title Tribunal		online search	08/04/2020			No determination identified within the proposal area
Office of Registrar Aboriginal Land Rights Act	Elizabeth Loane	Letter to Office of the Registrar via email	08/04/2020		Email	
Wagga Wagga LALC	Lorraine Lyons	Letter sent via email	08/04/2020			
Bundyi Aboriginal Cultural Services	Mark Saddler	Letter sent via email	08/04/2020	08/04/2020	Email	AZ acknowledged registration via email on 09/04/2020

Yalmambirra	Yalmambirra	Letter sent via email	08/04/2020	08/04/2020	Email	AZ acknowledged registration via email on 09/04/2020
Peter Ingram		Letter sent via email	08/04/2020			
Narrandera LALC		Letter sent via email	08/04/2020			
Brungle/Tumut LALC		Letter sent via email	08/04/2020			
Waagan Waagan Project Group		Letter sent via email	08/04/2020			
Wagga Wagga Aboriginal Elders Group			08/04/2020			
Warrabinya Cultural Heritage Assessment Group			08/04/2020	20/04/2020		AZ acknowledge registration during phone call.

Riverina Local Land Services		Letter to LLS via email	08/04/2020			
Wagga Wagga City Council		Letter sent via email	08/04/2020			
Bidya Marra Consultancy	James Ingram		08/04/2020	26/04/2020	Email	AZ acknowledge registration on 27/04/2020
Local Newspapers	Newspaper advertisement	Daily Advertiser	09/04/2020			
Heritage NSW list of potential stakeholders						All groups already contacted excluding Miyagen Culture & Heritage
Miyagen Culture & Heritage	Robert Carroll	Letter sent via email	21/04/2020			

Notification to Heritage NSW of stakeholders	Andrew Fisher and South West Branch	NGH via email	16/06/2020			
Draft Methodology sent						
Bundyi Cultural Services	Mark Saddler	NGH sent methodology via email	05/05/2020	02/06/2020	Email	Mark provided rates and insurances for fieldwork
Yalmambirra		NGH sent methodology via email	05/05/2020	09/05/2020		Add in reconciliation timeline, refer to Wiradjuri or Aboriginal not both and strategically place test pits across whole proposal area. Unable to provide insurances for fieldwork. NGH responded with re-issued draft methodology.
Bidya Marra Consultancy	James Ingram	NGH sent methodology via email	05/05/2020	02/06/2020	Email	James acknowledged receipt of document

Warrabinya	Dot Whyman	NGH sent methodology via email	05/05/2020	04/06/2020		Dorothy provided rates and insurance for the fieldwork.
Heritage NSW informed of potential subsurface testing and provided methodology						
Heritage NSW	Andrew Fisher/John Gilding	Report via email	02/06/2020	15/06/2020	Letter via email	Approved methodology with no changes or comments
Fieldwork						
Bundyi Cultural Services	Mark Saddler	Email	11/06/2020	11/06/2020	Email	Available for fieldwork
Bidya Marra Consultancy	James Ingram	Email	11/06/2020	15/06/2020	Email	Available for fieldwork

Warrabinya	Dot Whyman	Email	11/06/202 and 16/06/2020	18/06/2020	Phone call	Available for fieldwork
Draft V1.0 ACHA updated based on Client comments			31/08/2020			
Draft V1.1 ACHA Report						
Bundyi Cultural Services	Mark Saddler	NGH sent draft report for review and comment via email	01/09/2020			No comments received
Yalmambirra	Yalmambirra	NGH sent draft report for review and comment via email	01/09/2020			No comments received

Warrabinya	Dot Whyman	NGH sent draft report for review and comment via email	01/09/2020			No comments received
Bidya Marra Consultancy	James Ingram	NGH sent draft report for review and comment via email	01/09/2020			No comments received
Final ACHA Sent to RAPs						
Bundyi Cultural Services	Mark Saddler	NGH sent final report for review and comment via email	06/10/2020			
Yalmambirra	Yalmambirra	NGH sent final report for review and comment via email	06/10/2020			
Bidya Marra Consultancy	James Ingram	NGH sent final report for review and comment via email	06/10/2020			
Warrabinya	Dot Whyman	NGH sent final report for review and comment via email	06/10/2020			

Bundyi Culture

Mark Saddler

[redacted]

Att: AMY ZIESING

HERITAGE CONSULTANT/ARCHAEOLOGIST NGH.

Yamma (hello) Amy,

Thanks for requesting some information about the area around and near the proposed Sandy Creek Solar Farm near Uranquinty, NSW.

As a proud Wiradjuri man, I understand the area in and around my tribal lands very well. The name Uranquinty comes from my Wiradjuri language which means "much water, rain"

To the West of the proposed Solar Farm is a great natural wetland. Many of these wetlands are our traditional areas where my mob camped and lived permanently until other people arrived and moved us on. My Wiradjuri people have walked and continue to walk and love this land for over 60,000 years.

The army base to the North of this solar farm area is called "Kapooka" real name is "Gabuga" meaning egg or brain. In the laneway very close to where we surveyed are many special Wiradjuri trees, artifacts and places of significance to my Wiradjuri people. All of these items and places will be protected and remain in place.

Gabuga is a very special lookout area from which you can see "Kengal" (The Rock) and "Galore" both are enormously important to my Wiradjuri dreaming and song lines.

Uranquinty, Sandy Creek, Yarragundry, Kengal, and Gabuga are areas that have and are still used by my Wiradjuri people as a murru (journey/pathway) to special areas. We Wiradjuri do not necessarily have to actually walk these areas on a regular basis, but our old people and their wandaang (spirits) do.

With regards to the access lane to the North of the project area I would request that no extra traffic be allowed to travel this route as we Wiradjuri need to keep traffic away from our places and items.

With regards to the survey and digging work that we carried out recently I would also request that all artifacts are recovered, documented and returned to be placed back on site with a smoking ceremony.

I would also ask that if any employment is to come out of this solar farm project that local Wiradjuri people have the chance to apply and be employed. I would like to have an Aboriginal employment strategy created with the companies that will undertake the work. I would like to see some more test pits dug in the areas where artifacts were found so that I can be assured that we have covered enough of the area to satisfy my feelings of protection of Wiradjuri items.

Solar Farms seem to be getting some traction in my Wiradjuri area, many are happening. However, I will always ensure that my first priority is to protect any and all Wiradjuri items and places that may be endangered by these projects in our areas.

Guwayu (safe travels)

Mark Saddler

Ngurrigilang Wiradjuri Gibirr

(Proud Wiradjuri Man)

9/08/2020

Artwork Mark Saddler "Berrigan" (Emu Bush)

No comments were received on the draft ACHA

APPENDIX B AHIMS SEARCH

Culturally sensitive information withheld

APPENDIX C ARTEFACT DATA

Surface Find #	Site ID	Type	Raw Material	Length	Width	Thickness	Platform surface	Platform type	Termination	Reduction stage	Comments
1	Sandy Creek SF AFT 1	Flake	Quartz	15	16	7	Flake scar	Broad	Feather	Tertiary	
2	Sandy Creek SF AFT 1	Flake	Quartz	5	6	2	Flake scar	Broad	Feather	Tertiary	
3	Sandy Creek SF AFT 2	Core	Quartz	22	14	7	N/A	N/A	N/A	Tertiary	Plough damage, 1 Platform, 2 neg scars
4	Sandy Creek SF AFT 2	Proximal Fragment	Quartz	18	17	6	Flake scar	Broad	N/A	Tertiary	Plough damage
5	Sandy Creek SF AFT 2	Core	Quartz	33	30	28	N/A	N/A	N/A	Tertiary	2 platforms, 4 neg scars
6	Sandy Creek SF AFT 3	Flake	Quartz	12	16	17	Flake scar	Broad	Feather	Tertiary	
7	Sandy Creek SF AFT 4	Flake	Quartz	13	14	8	Flake scar	Broad	Feather	Tertiary	

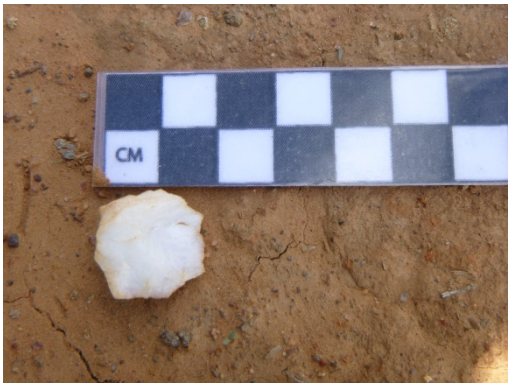
8	Sandy Creek SF AFT 5	Flake	Basalt	8	8	5	Flake scar	Broad	Axial	Tertiary	
9	Sandy Creek SF AFT 6	Flake	Quartz	18	11	8	Crushed	Broad	Feather	Tertiary	Vehicle damage in access track 90% visibility in eroded exposure
10	Sandy Creek SF AFT 7	Distal Fragment	Quartz	8	7	17	N/A	N/A	Feather	Tertiary	Ms moved to fenceline
11	Sandy Creek SF AFT 8	Distal Fragment	Quartz	5	6	4	N/A	N/A	Feather	Tertiary	
12	Sandy Creek SF AFT 9	Flake	Quartz	22	18	12	Crushed	Focal	Feather	Tertiary	Erosion next to fence line
13	Sandy Creek SF AFT 10	Flake	Quartz	59	42	14	Ridge	Focal	Feather	Tertiary	Plough damage
14	Sandy Creek SF AFT 11	Flaked Piece	Quartz	23	21	11	Flake scar	Broad	Feather	Tertiary	
15	Sandy Creek SF AFT 12	Flaked Piece	Quartz	12	13	9	Flake scar	Broad	Feather	Tertiary	Plough damage possible negative scar

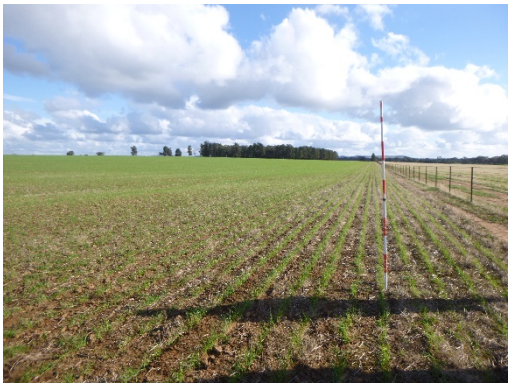
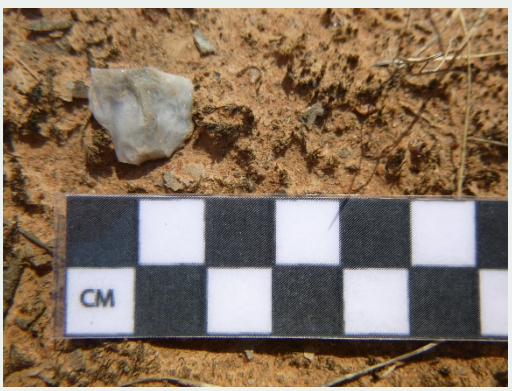
16	Sandy Creek SF AFT 13	Flake	Quartz	8	7	2	Faceted	Broad	Feather	Tertiary	Eroded access track 90% vis
17	Sandy Creek SF AFT 14	Distal Fragment	Quartz	8	14	7	N/A	N/A	Feather	Tertiary	
18	Sandy Creek SF AFT 15	Proximal Fragment	Quartz	12	14	6	Flake scar	Broad	N/A	Tertiary	Access track
19	Sandy Creek SF AFT 16	Flake	Quartzite	11	8	3	Ridge	Focal	Feather	Tertiary	

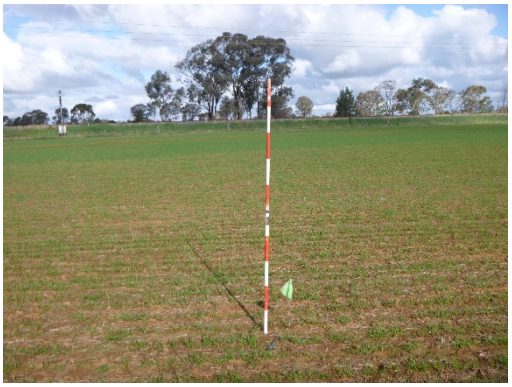
APPENDIX D ARCHAEOLOGICAL SITE DESCRIPTIONS

Archaeological Sites

AHIMS #	Site Name	Comments	Pictures
56-1-0663	Sandy Creek SF AFT 1	The site consisted of at least two quartz flakes. The assemblage was identified along the northern edge of Rodhams Road during the initial site inspection. Ground surface visibility at the site was 90% in the road access track and 10% in the scrub surrounding the site. There is no subsurface potential at this site and vehicle disturbance was identified.	 
56-1-0664	Sandy Creek SF AFT 2	The site consisted of at least three quartz artefacts, two cores and one proximal flake, identified in the initial site inspection and the ACHA survey. The assemblage was identified in an area of moderate archaeological sensitivity (PAD 1) with potential for subsurface deposit along this elevated flat landform. Ground surface visibility at the site was 30%. There is some probability that additional surface artefacts are present in this area.	

			
56-1-0665	Sandy Creek SF AFT 3	The site consisted of at least one quartz flake identified on the northern access track during the initial site inspection. Ground surface visibility was 80%. There is no subsurface potential at this site and vehicle damage from the use of the existing access track was noted.	 
56-1-0666	Sandy Creek SF AFT 4	The site consisted of at least one quartz flake that had been impacted by vehicle damage. The site was identified in the ACHA survey of the southern access track option. The site is approximately 20 m north east of Sandy Creek SF ST 1 but has no subsurface potential. The ground surface visibility was 90%.	

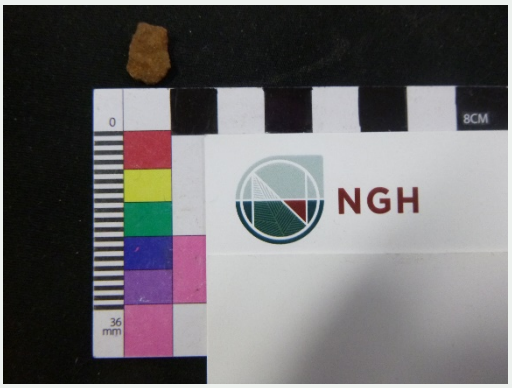
			
56-1-0649	Sandy Creek SF AFT 5	The site consisted of at least one basalt flake. The artefact was identified at the western end of the survey area within PAD 1. This area is in close proximity to a west to east running fenceline. The artefact was placed against the fenceline by a member of the local Aboriginal community to prevent further pastoral impacts. The site has limited subsurface potential, due to erosion and previous disturbance. Ground surface visibility was 40% in the ploughing exposures.	 
56-1-0650	Sandy Creek SF AFT 6	The site consisted of at least one quartz flake. The artefact was identified in the Rodhams Road survey in the initial site inspection. The site does not contain subsurface potential, due to erosion and previous disturbance. Ground surface visibility was 50% in the road reserve exposure.	

			
56-10651	Sandy Creek SF AFT 7	The site consisted of one quartz distal fragment. The artefact was identified near the west to east running fenceline in a ploughed paddock within the PAD 1 testing area. Ground surface visibility is 30% due to low cropping.	 
56-1-0652	Sandy Creek SF AFT 8	The site consisted of one quartz distal fragment. The artefact was identified near the west to east running fenceline in a ploughed paddock within the PAD 1 testing area. Ground surface visibility is 30% due to low cropping.	

			
56-1-0653	Sandy Creek SF AFT 9	The site consisted of at least one quartz flake. The artefact was identified on gently sloping land in a ploughed paddock. The site is approximately 66 m west of Sandy Creek SF AFT 10 and does not contain subsurface potential, due to erosion and previous disturbance. Ground surface visibility was 30% in the access track along the fenceline parallel with the Olympic Highway.	 
56-1-0654	Sandy Creek SF AFT 10	The site consisted of at least one quartz flake. The artefact was identified on gently sloping land in a ploughed paddock. The site is approximately 66 m east of Sandy Creek SF AFT 9 and does not contain subsurface potential, due to erosion and previous disturbance. Ground surface visibility was 30% in the access	

		track along the fenceline parallel with the Olympic Highway.	
56-1-0655	Sandy Creek SF AFT 11	The site consisted of at least one quartz flaked piece. The artefact was identified on gently sloping land in a ploughed paddock along a west to east running fenceline. The site is approximately 220 m south of Sandy Creek SF AFT 15 and does not contain subsurface potential, due to erosion and previous disturbance. Ground surface visibility was 30% in the firebreak along the fenceline.	 
56-1-0656	Sandy Creek SF AFT 12	The site consisted of at least one quartz flaked piece identified along the northern boundary of the proposal area in a fenceline exposure. The artefact was identified on gently sloping land in a ploughed paddock. The site is approximately 120 m west of Sandy Creek SF AFT 13 and does not contain subsurface potential, due to erosion and previous disturbance. Ground surface	

		visibility was 80% in the firebreak along the fenceline.	
56-1-0657	Sandy Creek SF AFT 13	The site consisted of at least one quartz flake identified along the northern boundary of the proposal area in a fenceline exposure. The artefact was identified on gently sloping land in a ploughed paddock. The site is approximately 27 m north west of Sandy Creek SF AFT 12 and does not contain subsurface potential, due to erosion and previous disturbance. Ground surface visibility was 80% in the firebreak along the fenceline.	
56-1-0658	Sandy Creek SF AFT 14	The site consisted of at least one quartz flaked piece identified along the northern boundary of the proposal area in a fenceline exposure. The artefact was identified on gently sloping land in a ploughed paddock. The site is approximately 27 m south east of Sandy Creek SF AFT 13 and does not contain subsurface potential, due to erosion and previous disturbance. Ground surface visibility was 80% in the firebreak along the fenceline.	

56-1-0659	Sandy Creek SF AFT 15	The site consisted of at least one quartz flaked piece identified along the northern boundary of the proposal area in a fenceline exposure. The artefact was identified on gently sloping land in a ploughed paddock. The site is approximately 80 m east of Sandy Creek SF AFT 14 and does not contain subsurface potential, due to erosion and previous disturbance. Ground surface visibility was 80% in the firebreak along the fenceline.	
56-1-0660	Sandy Creek SF AFT 16	The subsurface site consists of one quartzite flake retrieved from Test pit 014 from the top 10 cm of deposit. The site was identified along the west to east running transect of PAD 1. The deposit consisted of a red brown moist silty loam with grass root inclusions.	
56-1-0661	Sandy Creek SF ST 1	This Yellow Box tree with two potential cultural scars was identified to the immediate south of the southern access track option into the solar farm. The first western facing scar measures 68 x 30 x 9 cm (LxWxD) and is located 100 cm from the base of the tree. The second south western facing scar measures 45 x 20 x 4 cm (LxWxD) and is located 57 cm from the base of the tree. Overall, the tree is in good condition, but both oval shaped scars exhibit varying stages of trauma. The tree height is approximately 20 m and the circumference is around 4 m in diameter. Barbed wire was noted around the trunk of the tree.	

			 
56-1-0662	Sandy Creek SF ST 2	This Yellow Box tree was identified to the west of the proposed solar farm area in a ploughed and grazed paddock. The possible south eastern oval shaped cultural scar measure 100 x 16 x 20 cm (LxWxD) and is located 80 cm from the base of the tree. The tree is alive and standing at a height of approximately 25 m and a trunk circumference of 3.7 m in diameter. Some branch tear was noted at other locations on the tree.	

APPENDIX E TEST EXCAVATION PIT DATA

Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
1		1	1-5	Dark brown silty loam little to no inclusions with a uniform soil profile, some rootlets. pH = 6.0	
		2	5-10	Dark brown silty loam little to no inclusions with a uniform soil profile, some rootlets. pH = 6.0	
		3	10-15	Dark brown clayey loam with no inclusions, soft and damp, uniform soil profile. pH = 5.5	
		4	15-20	Dark brown clay with no inclusions, soft and damp, uniform soil profile. pH = 5.5	
2		1	1-10	Dark reddish-brown silty loam with few root inclusions. Moderate moisture content, no gravel or rock inclusions. pH = 5.0	
		2	10-20	Reddish brown silty loam with few root inclusions. Moderate moisture content, no gravel or rock inclusions. pH = 6.0	
		3	20-30	Reddish brown silty loam with few root inclusions, clay content increasing with depth. Moderate moisture content, no gravel or rock inclusions. pH = 7.0	
		4	30-40	Reddish brown silty loam with few root inclusions, clay content increasing with depth. Moderate moisture content, no gravel or rock inclusions. pH = 7.0	
		5	40-50	Becoming yellowish red plastic clay at 43 cm, no inclusions. pH = 7.0	
 Pit 1 Spit 4				 Pit 2 Spit 5	
3		1	0-10	Dark red brown humic silty loam with small rootlet inclusions, very moist, no rock inclusions. pH = 6.0	
		2	10-20	Yellowish red clayey loam with minimal root inclusions, no rocks or gravels. Forming small peds (1-2xm) but friable in sieve. pH = 6.5	

Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
		3	20-30	Yellowish red clayey loam with minimal root inclusions, no rocks or gravels. Forming small peds (1-2xm) but friable in sieve. pH = 6.5	
		4	30-40	Yellowish red clayey loam with minimal root inclusions, no rocks or gravels. Forming small peds (1-2xm) but friable in sieve. Clay content increasing with depth. pH = 6.5	
		5	40-50	Red plastic clay appearing at 48 cm, small light grey clay patch in eastern half of base of spit. No inclusions. pH = 7.0	
4		1	0-10	Dark reddish brown silty loam with no inclusions, except small rootlets and worm burrows. pH = 5.5	
		2	10-20	Dark red silty clay with no inclusions, except small rootlets and worm burrows. pH = 6.0	
		3	20-30	Dark red silty clay with no inclusions, except small rootlets and worm burrows. pH = 6.0	
		4	30-40	Dark red silty clay increasing clay content with depth. pH = 6.0	
 Pit 3 Spit 5				 Pit 4 Spit 4	
5		1	0-10	Reddish brown silty loam minimal small subangular inclusions >1cm gravels and ironstone. Moist and friable deposit. pH = 6.0	
		2	10-20	Reddish brown silty clay loam minimal small subangular inclusions >1cm gravels and ironstone. Moist and friable deposit. pH = 6.0	
		3	20-30	Red silty clay minimal small subangular inclusions >5cm gravels and ironstone. Moist and friable deposit. pH = 7.0	
		4	30-39	Red plastic clay minimal small subangular inclusions >5cm gravels and ironstone. Moist and friable deposit. pH = 7.5	

Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
6		1	0-10	Dark reddish brown silty clay loam with rootlet inclusions, no rocks or gravels. Deposit forming small peds (1-2cm) but friable in sieve. pH = 6.0	
		2	10-20	Dark red brown silty clay loam with rootlet inclusions, no rocks or gravels. Deposit forming small peds (1-2cm) but friable in sieve. Clay content increasing with depth. pH = 6.5	
		3	20-30	Dark red brown silty clay loam with rootlet inclusions, no rocks or gravels. Deposit forming medium peds (1-5cm) but friable in sieve. Clay content increasing with depth. pH = 6.5	
		4	30-40	Yellowish red plastic clay with no inclusions, moderate compaction, still high moisture content. pH = 7.0	
 Pit 5 Spit 4				 Pit 6 Spit 4	
7		1	0-10	Dark reddish brown loam with high clay content and one or two scattered pebbles (1-2cm). pH = 6.5	
		2	10-14	Red plastic clay at 12cm depth with no inclusions, very moist and moderate compaction. pH = 6.5	
8		1	0-10	Dark reddish brown silty loam with some rootlets, very few stone >1cm subangular inclusions. pH = 5.0	
		2	10-14	Dense red plastic clay with no inclusions. pH = 5.0	

Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
 Pit 7 Spit 2				 Pit 8 Spit 2	
9		1	0-10	Dark reddish brown silty clay loam with rootlet inclusions, no rocks or gravels. Deposit forming small peds (1-2cm) but friable in sieve. pH = 6.5	
		2	10-20	Dark reddish brown silty clay loam with rootlet inclusions, no rocks or gravels. Deposit forming small peds (1-2cm) but friable in sieve. Clay content increasing with depth. pH = 7.0	
		3	20-25	Red compact clay at 22 cm with no inclusions. pH = 7.0	
 Pit 9 Spit 3				 Pit 10 Spit 2	
10		1	0-10	Reddish brown clay loam with rootlet inclusions, no rocks or gravels. Deposit forming small peds (1-2cm) but friable in sieve. Red plastic clay appearing at 5-6 cm depth. pH = 6.5	
		2	10-12	Red plastic clay across base of spit by 12cm. pH = 7.0	

Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
 Pit 11 Spit 2				 Pit 12 Spit 2	
11		1	0-10	Dark reddish brown silty clay loam with rootlet inclusions, no rocks or gravels. Deposit forming small peds (1-2cm) but friable in sieve. pH = 5.0	
		2	10-18	Dark reddish brown silty clay with no inclusions. pH = 5.0	
12		1	0-10	Reddish brown clay loam with rootlet inclusions, no rocks or gravels. Deposit forming small peds (1-2cm) but friable in sieve. pH = 6.5	
		2	10-13	Red plastic clay by base of Spit 1 continued excavation until clay across base of spit. pH = 6.5	
 Pit 13 Spit 2				 Pit 14 Spit 1	
13		1	0-10	Dark reddish brown clayey loam with rootlet inclusions, no rocks or gravels. Deposit forming small peds (1-2cm) but friable in sieve. pH = 6.5	
		2	10-17	Red plastic clay at 15cm depth, continued excavation for a further 2 cm. pH = 7.0	
14		1	0-10	Dark reddish brown silty clay loam with gravel inclusions and rootlets. One quartzite flake identified in the sieve. Dense red clay appearing across the base of the spit. pH =	1

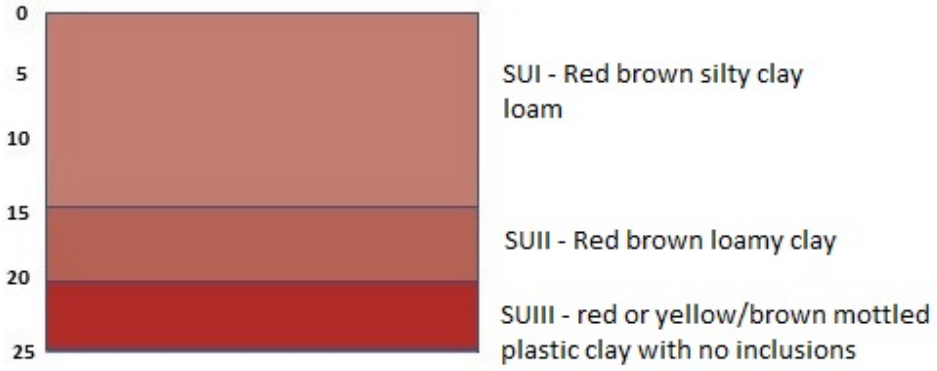
Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
				6.0	
 Pit 15 Spit 2				 Pit 16 Spit 2	
15		1	0-10	Red brown clay loam with roots but no gravel inclusions. Forming small peds (1-2cm) pH = 6.5	
		2	10-12	Red plastic clay at base of spit 1, continued excavation until across base of spit. No inclusions. pH = 7.0	
16		1	0-10	Red brown clay loam with roots but no gravel inclusions. Forming small peds (1-2cm) pH = 6.5	
		2	10-16	Red plastic clay at base of spit 1, continued excavation until across base of spit. No inclusions. pH = 7.0	
 Pit 17 Spit 1				 Pit 18 Spit 2	
17		1	0-10	Dark reddish brown silty clay loam with minimal gravel inclusions, rootlets and high moisture content. pH = 5.0	
18		1	0-10	Red brown clay loam with roots but no gravel inclusions. Forming small peds (1-2cm), but loos friable compaction pH = 6.0	
		2	10-13	Red plastic clay at 11 cm depth, continued excavation until across base of spit. No inclusions. pH = 6.0	

Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
 Pit 19 Spit 2				 Pit 20 Spit 2	
19		1	0-10	Red brown clay loam with roots but no gravel inclusions. Forming small peds (1-2cm) pH = 6.0	
		2	10-16	Red plastic clay at 14 cm depth, continued excavation until across base of spit. No inclusions. pH = 6.0	
20		1	0-10	Dark reddish brown clay loam with roots but no gravel inclusions. Forming small peds (1-2cm) pH = 5.0	
		2	10-13	Dark reddish brown clay loam with roots but no gravel inclusions becoming red clay at 11 cm depth. Forming small peds (1-2cm) pH = 5.0	
 Pit 21 Spit 2				 Pit 22 Spit 2	
21		1	0-10	Dark reddish brown clay loam with roots but no gravel inclusions. Forming small peds (1-2cm) pH = 5.0	
		2	10-15	Reddish brown plastic clay appearing at 12-13cm depth, continued excavation until clay across base of spit. Forming small peds (1-2cm) pH = 6.5	
22		1	0-10	Dark reddish brown clay loam with roots but no gravel inclusions. Forming small peds (1-2cm). Ploughing disturbance noted in top 5 cm. pH = 6.5	

Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
		2	10-17	Red plastic clay appearing at 15cm depth, continued excavation until clay across base of spit. Forming small peds (1-2cm) pH = 7.0	
 Pit 23 Spit 2				 Pit 24 Spit 3	
23		1	0-10	Dark brown clay loam with roots but no gravel inclusions. Forming small peds (1-2cm) pH = 5.5	
		2	10-12	Reddish brown plastic clay appearing at 10-11cm depth, continued excavation until clay across base of spit. Forming small peds (1-2cm) pH = 5.5	
24		1	0-10	Dark reddish brown silty clay loam with roots but no gravel inclusions. Forming small peds (1-2cm) pH = 6.5	
		2	10-20	Becoming reddish yellow clayey sand with no inclusions. Moderate compaction and forming small peds (1-2cm). pH = 7.0	
		3	20-24	Red plastic clay at 22cm depth, no inclusions, continued excavation until clay across base of spit. pH = 7.0	
 Pit 25 Spit 3				 Pit 26 Spit 1	
25		1	0-10	Dark reddish brown silty clay loam with roots but no gravel inclusions. Forming small peds (1-2cm) pH = 6.5	

Pit no	Grid Reference	Spit number	Depth (cm)	Soil Description	Artefacts
		2	10-20	Becoming reddish yellow clayey sand with no inclusions. Moderate compaction and forming small peds (1-2cm). pH = 6.5	
		3	20-25	Red plastic clay at 22cm depth, no inclusions, continued excavation until clay across base of spit. pH = 7.0	
26		1	0-10	Dark brown clayey loam with rootlets and minimal stone inclusions. pH = 7.5	

Sandy Creek Solar Farm - Stratigraphic profile across PAD 1 test pits



APPENDIX F SITE CARDS

Culturally sensitive information withheld

BIODIVERSITY ASSESSMENT

Sandy Creek Solar Farm

August 2020

Project Number: 19-890





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DOCUMENT VERIFICATION

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Project Number:	19-890
Project File Name:	\\WAGGA\Active\Projects\2019\19-890 Sandy Creek Solar Farm\Report\Final\Biodiversity\19-890 Sandy Creek Solar Farm Biodiversity Assessment Final.docx

Revision	Date	Prepared by	Reviewed by	Approved by
Final	26/08/2020	E. Matthews	L Hamilton M. Palmer	E. Budde

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ACRONYMS AND ABBREVIATIONS

AoS	Assessment of Significance
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BOM	Australian Bureau of Meteorology
Cwth	Commonwealth
DPI	NSW Department of Primary Industry
TEC	Threatened ecological community – as defined under relevant law applying to the proposal
EPBC Act	(Cwth) *Environment Protection and Biodiversity Conservation Act 1999*
EP&A Act	(NSW) *Environmental Planning and Assessment Act 1979*
ha	hectares
IBRA	Interim Biogeographic Regionalisation for Australia
km	kilometres
LEP	Local Environment Plan
LGA	Local Government Area
m	Metres
MNES	Matters of National environmental significance under the EPBC Act (*c.f.*)
NSW	New South Wales
OEH (DPIE)	(NSW) Office of Environment and Heritage, formerly Department of Environment, Climate Change and Water
PCT	Plant Community Type
SEPP	State Environmental Planning Policy (NSW)
sp/spp	Species/multiple species
TEC	Threatened Ecological Community
WWCC	Wagga Wagga City Council

1. INTRODUCTION

This Biodiversity Assessment has been prepared to consider the potential biodiversity impacts associated with the proposed development of the Sandy Creek Solar Farm, located approximately 2 km north east of Uranquinty, NSW, and 10 km south west of Wagga Wagga.

Wagga Wagga City Council (WWCC) is the consent authority for the development, under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The proposal is therefore to be assessed under the provisions of the *Biodiversity Conservation Act 2016* (BC Act).

1.1. PURPOSE OF THIS REPORT

NGH was engaged by BayWa r.e. Projects Australia to undertake a Biodiversity Assessment for this proposal. This report assesses the impacts of the proposed development on biodiversity values in the proposal area. The report identifies and describes biodiversity values in terms of vegetation structure, composition, type and condition, and fauna habitats, sightings, and signs.

The potential for, and significance of, impacts to threatened species and communities listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have been evaluated.

The report addresses the flora and fauna assessment requirements of clauses 1.7 and 4.15 of the *Environment Planning and Assessment Act 1979* (EP&A Act) and clause 7.3 of the Wagga Wagga Local Environmental Plan 2010. Where relevant, recommendations are provided to avoid and minimise flora and fauna impacts.

1.2. THE PROPOSAL

1.2.1. Site location and description

The proposed Sandy Creek Solar Farm is located within Lot 55, 118, 129 and 149 DP754567 within the Wagga Wagga Local Government Area (LGA). The works cover an area of approximately 40 hectares (ha), and are bounded by cropping and grazing agricultural land and the township of Uranquinty (Figure 1-1 & Figure 1-2).

The proposal area is located within the Inland Slopes of the NSW South Western Slopes IBRA biogeographic region. The subject site is zoned RU1 Primary Production under the Wagga Wagga Local Environment Plan (LEP 2010). The area has been largely cleared for agricultural purposes. Landuse is primarily cropping, with a small area of grazing native vegetation (Figure 1-3 and Figure 1-4).

1.2.2. Land Category Assessment under the LLS Act

A Land Category Assessment was conducted in accordance with the *Local Land Services Act 2013* (LLS Act) (Appendix E). The land is considered to be Category 1 – Exempt Land and Category 2 – Regulated Land (Figure 1-5).

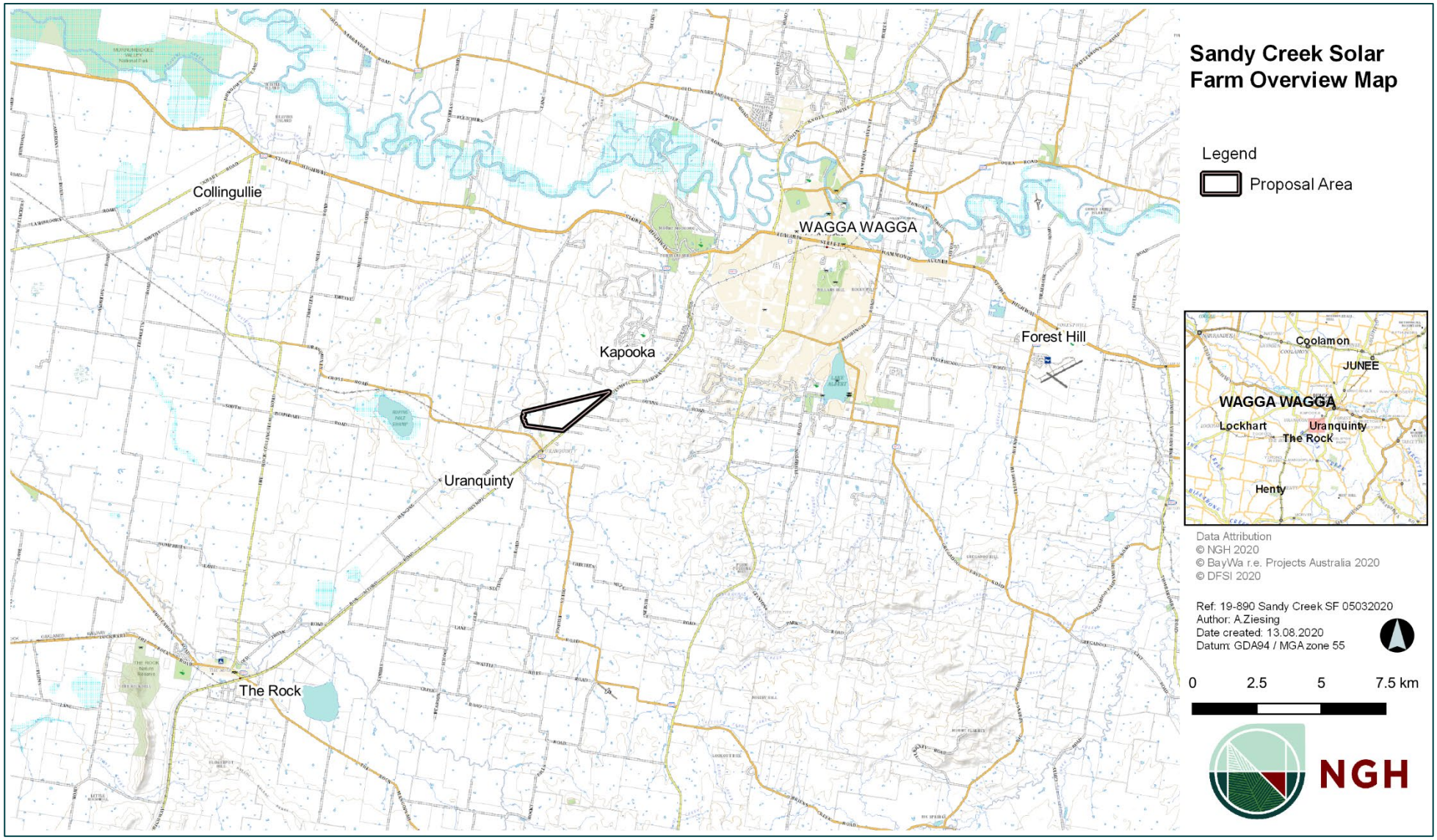


Figure 1-1: Location of proposal area

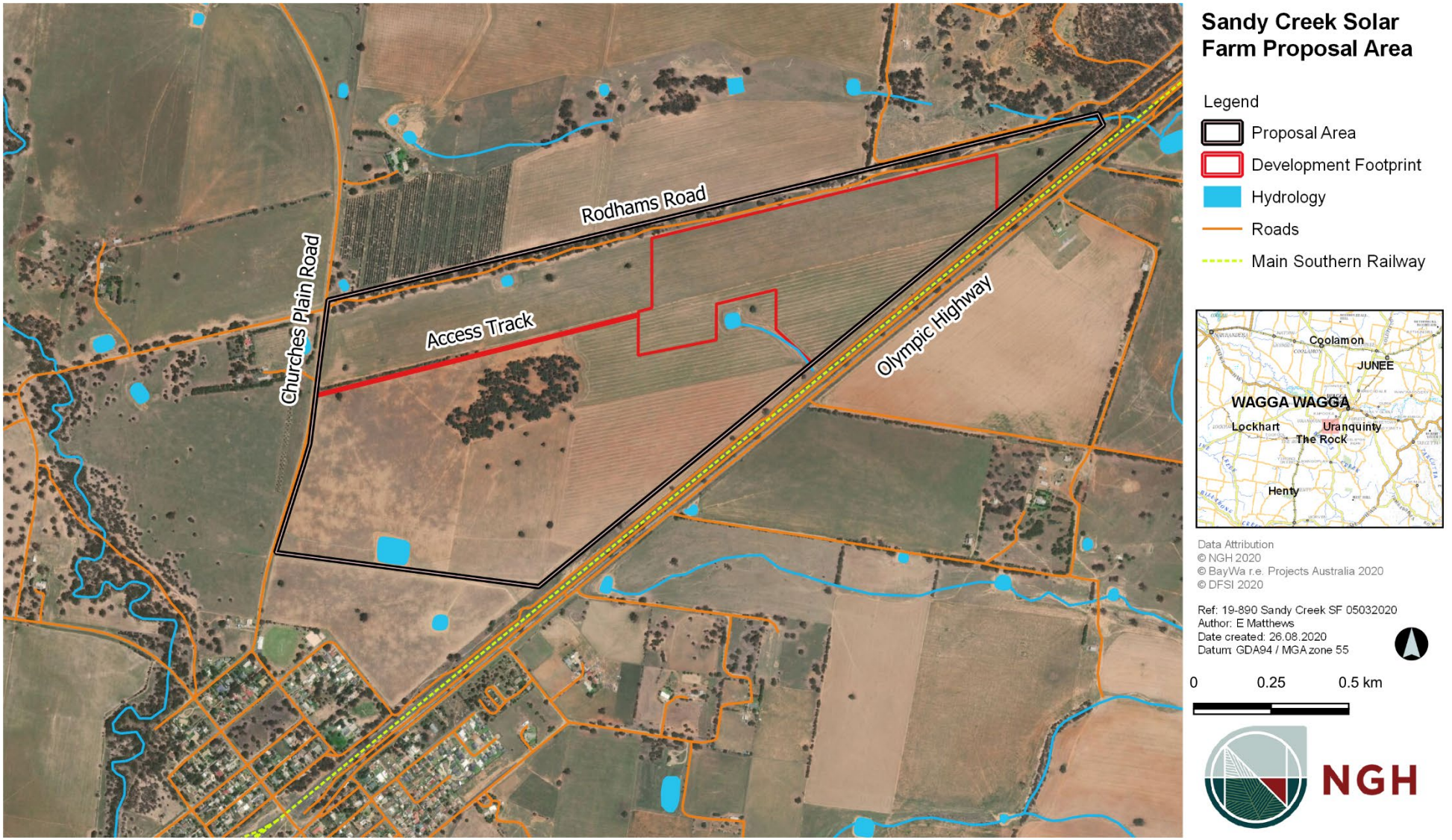


Figure 1-2: Proposal area and development footprint.



Figure 1-3: Relevant land zoning



Figure 1-4 Relevant landuse

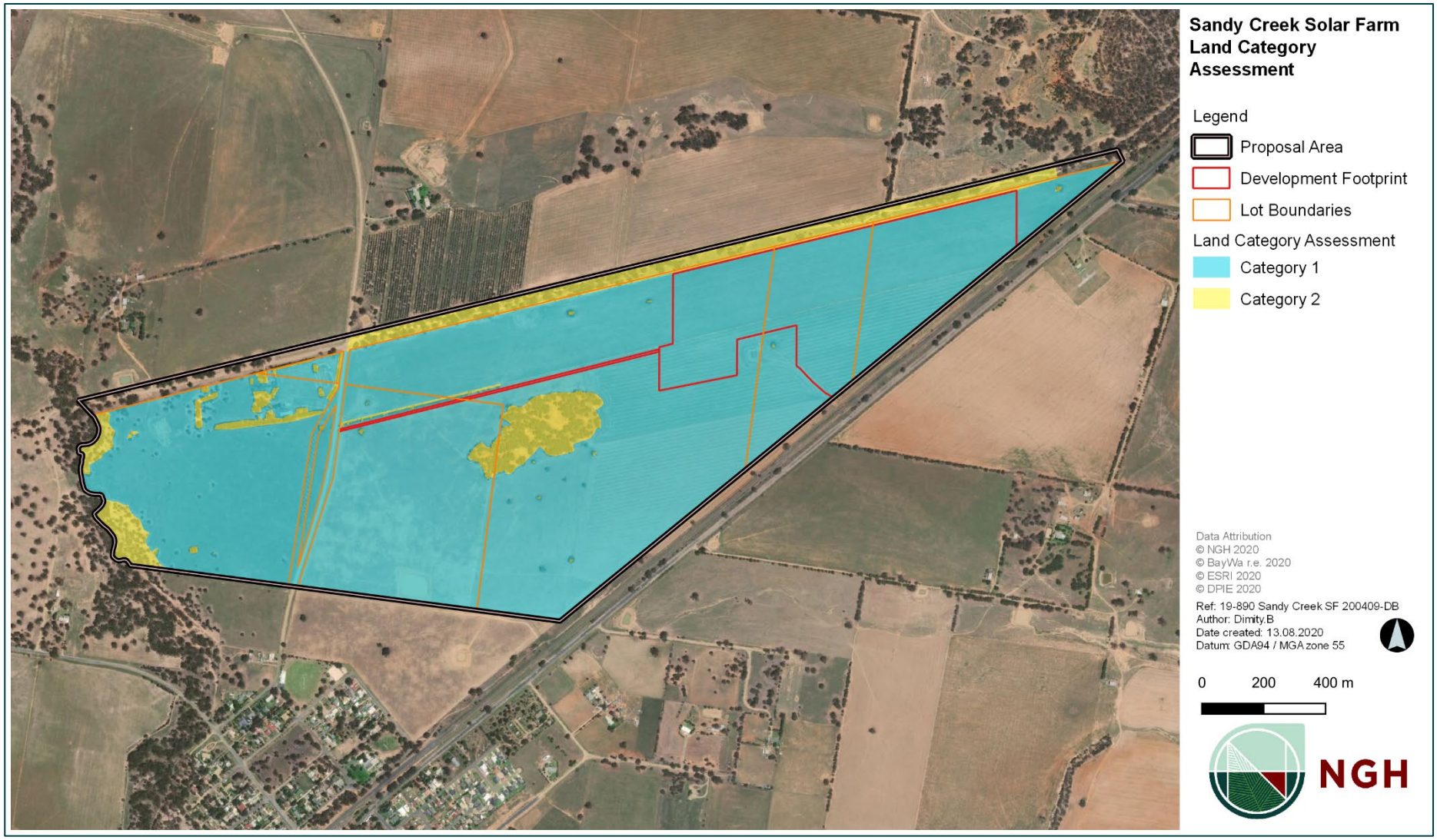


Figure 1-5 Land categorisation



Figure 1-6: Site view of the southern side of the property, showing historically cropped paddocks.



Figure 1-7: Site view of the northern side of the property, showing historically cropped paddocks (sheep were grazing this area).



Figure 1-8: Site view of the western access track, showing planted native vegetation.

1.2.3. Proposal description

The proposed Sandy Creek Solar Farm (Figure 1-2) would comprise the installation of solar panels and their associated infrastructure. The intended capacity of the solar farm is up to 17 MW DC/12 MW AC. The capital investment value of project would be approximately $19 million and comprise a footprint of approximately 40 hectares.

1.3. ERMS USED IN THIS DOCUMENT

The '**proposal area'** is defined as the maximum potential impact of the proposal for which includes access roads to the proposed development from existing roads. The proposal area is the area surveyed for the assessment.

The '**development footprint**' encompasses the total area of land that will be directly impacted by the proposed development.

The '**locality**' encompasses a 10km radius of the proposal area.

2. STATUTORY CONSIDERATIONS

2.1. ENVIRONMENTAL PROTECTION AND BIODIVERSITY CONSERVATION (EPBC) ACT 1999 (CWTH)

The EPBC Act protects nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as matters of national environmental significance. Matters of national environmental significance relevant to biodiversity are:

- Wetlands of international importance
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas

Significance of impacts is determined in accordance with the Significance impact guidelines 1.1 – Matters of National Environmental Significance (DoE 2013). Where a proposal is likely to have a significant impact on a matter of national environmental significance, the proposal is referred to the Commonwealth Environment Minister via the Department of the Environment (DoE). The Minister then determines whether the proposal is a 'controlled action'. If a proposal is declared a controlled action, an assessment of the action is carried out and the Minister makes a decision to approve, approve with conditions, or not approve the proposed action.

This assessment considers the potential for the proposal to impact on matters of national environmental significance relevant to biodiversity.

2.2. ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

The *Environmental Planning and Assessment Act* 1979 (EP&A Act) provides the framework for the assessment of development activities. The proposed development would be considered by the consent authority under clause. 4.2 of this Act, being development that is permitted with consent.

Section 1.7 and Part 4.15 of the EP&A Act requires the consent authority to consider the significance of the impact of the proposal on terrestrial and aquatic threatened species, populations and endangered ecological communities in accordance with the provisions of Part 7 of the Biodiversity Conservation Act 2016).

The potential for, and significance of, impacts to threatened species and communities listed under the NSW BC Act and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have been evaluated in this Biodiversity Assessment. Where relevant, recommendations are provided to avoid and minimise flora and fauna impacts.

2.3. BIODIVERSITY CONSERVATION ACT 2016

In respect of Part 4 developments, the *Biodiversity Conservation Act 2016* (BC Act) establishes a framework to avoid, minimise and offset the impacts of proposed development and land use change on biodiversity. It provides a scientific method for assessing the likely impacts of proposed development on biodiversity values, for calculating measures to offset those impacts and for assessing improvements in biodiversity values. The Act aims to maintain the diversity and quality of ecosystems and to support conservation and threat abatement action to slow the rate of biodiversity loss and conserve threatened species and ecological communities in nature.

The primary requirement under the BC Act, is to determine whether the development is likely to significantly affect threatened species. According to clause 7.7(2) of the BC Act, if the proposed development is likely to significantly affect threatened species, the development application is to be accompanied by a biodiversity

development assessment report (BDAR). According to this clause, development is considered likely to significantly affect threatened species if:

> *(a) it is likely to significantly affect threatened species or ecological communities, or their habitats, according to the test in section 7.3, (5-part Test) or,*
>
> *(b) the development exceeds the biodiversity offsets scheme threshold if the biodiversity offsets scheme applies to the impacts of the development on biodiversity values, or*
>
> *(c) it is carried out in a declared area of outstanding biodiversity value.*

Pursuant to clause 7.4, it is noted that any part of the proposed development that involves clearing on category 1-exempt land (within the meaning of Part 5A of the Local Land Services Act 2013) is to be disregarded for the purposes of determining whether proposed development exceeds the biodiversity offsets threshold (BOS).

The minimum lot size for the subject land is 200 hectares according to the Wagga Wagga LEP 2010. Clearing would be confined to Category 1 – exempt land. Therefore, the BOS threshold would not be exceeded.

2.4. LOCAL LAND SERVICES ACT 2013

Section 6.8(3) of the BC Act determines that the Biodiversity Assessment Method (BAM) is to exclude the assessment of the impacts of clearing of native vegetation on Category 1-exempt land (within the meaning of Part 5A of the *Local Land Services Act 2013* (LLS Act)).

Boundaries mapping Category 1-exempt land on the Native Vegetation Regulatory Mapping are not yet publicly available. During the transitional period, accredited assessors may establish the categorisation of land for the agency head to consider, following the method utilised to develop the Native Vegetation Regulatory Map.

Category 1-exempt land is defined under the LLS Act (Part 5A Division 2 Section 60H) as:

- Land legally cleared at or since 1st Jan 1990 (Woody vegetation only).
- Significantly disturbed or modified since 1990 (Non-woody vegetation)
- Low Conservation Grasslands.
- Land containing only low conservation groundcover (not being grasslands)
- Native vegetation identified as regrowth in a Property Vegetation Plan (PVP) under the repealed *Native Vegetation Act 2003.*
- Land biodiversity certified under the BC Act.

Category 2-regulated land is defined under the LLS Act (Part 5A Division 2 Section 60I) as:

- Land not cleared as at 1st January 1990 or unlawfully cleared after 1st January 1990.
- Native vegetation grown with the assistance of public funds.
- Land that is (or was previously) subject to a Private Native Forestry Plan or Private Native Forestry PVP.
- Grasslands that are neither low nor high conservation grasslands.
- Travelling stock reserves.

An assessment was prepared to evaluate the land categorisation for the proposal area. This is included in Appendix E.

2.5. STATE ENVIRONMENTAL PLANNING POLICY KOALA HABITAT PROTECTION 2019

This policy aims to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline.

Wagga Wagga LGA is listed as an LGA (Schedule 1) to which this policy may apply. The proposal area is greater than 1 ha, however there is no 'Koala Development Application Area' mapped on site (Appendix A.10) and therefore the Koala Habitat Protection SEPP does not apply.

2.6. NSW BIOSECURITY ACT 2015

The Biosecurity Act guides the management of weeds at the regional level throughout NSW. Under the Act, all plants are regulated with a ***general biosecurity duty*** to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant who knows or ought to know of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable. Individual landholders and managers are required under the Act to control priority weeds for their area according to the relevant biosecurity toolset (Table 2-1).

One priority weed was identified at the site. This is discussed further in section 4.3.3: Priority Weeds.

Table 2-1 Biosecurity Act 2015 toolset for weed management (Department of Primary Industry 2016)

Outcome category	*Biosecurity toolset*
Weeds excluded from entering state	Prohibited Matter: Declaration and management of significant weeds not present in NSW or part of NSW.
Weeds to be eradicated	Control Order: Management of weeds that are the targets of approved eradication programs. Although a Control Order is for a five–year period, this can be renewed for longer eradication programs.
Weeds to be effectively managed to reduce spread on regional basis	Biosecurity Zone: Weeds subject to ongoing 'strategic' regional management.
All Weeds	General Biosecurity Duty: Requires any person dealing with biosecurity matter or a carrier of biosecurity matter and who knows or ought to know of the biosecurity risks associated with that activity to take measures to prevent, minimise or eliminate the risk as far as is reasonably practicable. Specific measures to reduce the risk will be detailed in regional weeds plans for priority weeds. Note however, that the General Biosecurity Duty exists for all weeds that present a biosecurity risk.
Other Biosecurity tools	Mandatory Measures Regulation: May require persons to take specific actions with respect to weeds or carriers of weeds. Emergency Order: To respond to a current or imminent biosecurity risk that may have a significant impact. Biosecurity Direction: An enforceable instruction to a person or class of persons to take action to: Prevent, eliminate or minimise a biosecurity risk Prevent, manage or control a biosecurity impact Enforce any instrument under the Act. Biosecurity Undertaking: An authorised officer may accept in writing an undertaking by a person that sets out the measures a person has agreed to implement to remedy a contravention, a likely contravention, or suspected contravention of the Act.

2.7. WAGGA WAGGA LOCAL ENVIRONMENTAL PLAN 2010

The particular aims of the Wagga Wagga LEP 2010 are as follows:

> *(a) to optimise the management and use of resources and ensure that choices and opportunities in relation to those resources remain for future generations,*
>
> *(b) to promote development that is consistent with the principles of ecologically sustainable development and the management of climate change,*
>
> *(c) to promote the sustainability of the natural attributes of Wagga Wagga, avoid or minimise impacts on environmental values and protect environmentally sensitive areas,*
>
> *(d) to co–ordinate development with the provision of public infrastructure and services.*

The provisions under Clause 7.3 Biodiversity under the WWLEP are relevant to the proposal, given a small section of the proposal area is identified on the 'Terrestrial Biodiversity Map' as "Biodiversity" (Appendix A).

> ***7.3 Biodiversity (Wagga Wagga LEP 2010)***
>
> *(1) The objectives of this clause are to protect, maintain or improve the diversity of the native vegetation, including:*
>
> *(a) protecting biological diversity of native flora and fauna, and*
>
> *(b) protecting the ecological processes necessary for their continued existence, and*
>
> *(c) encouraging the recovery of threatened species, communities or populations and their habitats.*
>
> *(2) This clause applies to land identified as "Biodiversity" on the Terrestrial Biodiversity Map "BIO_003"*

This biodiversity assessment will address subclause (3) of the "Biodiversity" clause under the Wagga Wagga LEP 2010. Refer to Section 4.2.4.

3. METHODOLOGY

3.1. BACKGROUND REVIEW

3.1.1. Database searches and literature review

Database searches were undertaken on 18 May 2020 to identify threatened species, populations and ecological communities known to occur, or with potential to occur, within a 10 km radius of the proposal area. The following online search tools were used:

- NSW Bionet Atlas database for species, populations and communities listed under the NSW BC Act and Commonwealth EPBC Act.
- Commonwealth *Protected Matters Search Tool* for threatened species and communities listed under the EPBC Act.
- Office of Environment and Heritage Interim Biogeographic Regionalisation (IBRA) search by region (Inland Slopes) and habitat (Western Slopes Grassy Woodlands) for threatened species and communities listed under the BC Act
- Other background searches undertaken were:
    - NSW Government Biodiversity Values Map and Threshold Tool
    - Australian Government Bureau of Meteorology Ground Water Dependent Ecosystems Atlas
    - Wagga Wagga Local Environmental Plan LEP 2010 Terrestrial Biodiversity Map
    - 2017 Land Use Dataset (Australian Land Use and Management (ALUM) Classification version 7 (Office of Environment and Heritage (OEH), 2017).
    - NSW Woody Vegetation extent and Foliage Projective Cover (FPC) 2011 (OEH, 2015).
    - Sensitive regulated and vulnerable lands on the Native Vegetation Regulatory Map Portal (LLS, 2020).
    - Riverina State Vegetation Mapping (OEH, 2020).
    - 1990 aerial imagery (DSFI, 2020).

3.1.2. Threatened species evaluation

Information was compiled on threatened species, populations, and communities which have potential to be present in the study area from current scientific publications, environmental survey and previous assessment reports. Online databases used include the OEH (DPIE) Threatened Biodiversity Data Collection, particularly the Vegetation Information System (VIS) and threatened species profiles, and the Commonwealth EPBC Act Species Profiles and Threats Database (SPRAT).

The results of the database searches and literature review have been used to evaluate the potential for threatened species, ecological communities and endangered populations to be present in the study area, and to be adversely affected by the works. The threatened species evaluation also considers field survey results in relation to habitat type and quality, and on–site records. The approach is consistent with the NSW Threatened Species Assessment Guidelines (DECC 2007). The threatened species evaluation is included within Appendix B.

3.2. FIELD SURVEYS

The proposal area was surveyed by an ecologist on 10 March 2020 to assess the biodiversity values of the site. The survey was undertaken over a period of a few hours (flora, ecological communities and fauna). Temperatures reached a top of 28.4°C, with a minimum of 11.7°C and no rain.

3.2.1. Flora

Random meanders (Cropper 1993) were used to survey vegetation at the proposal area. These methods provide good coverage in terms of area and microhabitats and maximises opportunities for detecting rare or sparsely distributed species. Species were recorded progressively with abundance recorded within proposal area. Any priority weeds were recorded opportunistically.

Plant Community Types (PCTs) were identified according to the OEH BioNet Vegetation Classification (OEH, 2017). Where relevant, Threatened Ecological Communities (TEC) were confirmed based on the relevant Scientific Committee – final determinations for each TEC. Botanical nomenclature follows Harden (1990–2002) and the PlantNet website, updated with recent changes recognised in Angiosperm Phylogeny Group (2016) and the Australian Plant Census.

3.2.2. Fauna and Habitat

The terrestrial fauna survey was undertaken to record and assess the value of habitats at the site to fauna, particularly threatened species with potential to occur at the site. Fauna sign and key habitat features were recorded, including:

- Hollows and fissures in standing trees and stags.
- Large woody debris and litter.
- Fauna signs such as nests, scratches, glider sap feed marks, scats and latrine sites.
- Food tree species (for gliders and possums, koala).
- Microhabitats such as soaks, rock outcrops and dense understorey.

All trees were individually inspected for trunk or limb hollows and any signs of occupation or use. Any disturbances and active threats to fauna or habitats were also recorded during the survey.

3.3. ASSUMPTIONS AND LIMITATIONS

The flora assessment is based on single–visit random meander survey. It is unlikely that all plant species were detected that may be present at the site due to the time of year the survey was undertaken and only one short site visit being conducted. In particular, some inconspicuous or geophytic species which flower outside the survey period may not have been recorded. However, native grasses and forbs were visible along the roadside vegetation. If these species were present within the proposal area, it is likely they would have also been visible.

No targeted fauna surveys were undertaken. However, in view of the scale and disturbed context of the proposal area, and the assessed low potential for direct impacts to threatened species, the approach is considered adequate and appropriate for the identification and assessment of biodiversity impacts.

4. RESULTS

4.1. GENERAL

The proposal area is situated on the south western side of Wagga Wagga within the NSW South Western Slopes. The terrain is flat as the proposal area has been currently used for farming. The majority of the site is comprised of cropped pasture. Access roads and surrounds contain exotic vegetation.

Sixty-five flora species were detected within the proposal area in total comprised of 34 exotic and 31 native species. Flora species list detailing abundance is within Appendix E.

4.2. BACKGROUND SEARCHES

4.2.1. Threatened Species

The results of the desktop study identified 24 flora species, 4 Endangered Ecological Communities (EECs), 71 fauna species and 1 endangered population with the potential to occur within the locality.

A full list of the threatened species identified through these searches with further description is available in Appendix B.

4.2.2. Biodiversity Values

The proposal area does not fall within an area of high or outstanding biodiversity value listed on the NSW Biodiversity Values Map (Appendix A).

4.2.3. Ground Water Dependent Ecosystems (GDE)

A search of the Australian Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems determined no known aquatic Groundwater Dependent Ecosystems (GDEs) are present within the proposal area (A.5). There are some areas of low potential terrestrial GDEs within the proposal area (A.6).

4.2.4. Wagga Wagga Local Environmental Plan (LEP 2010) Terrestrial Biodiversity

Under Clause 7.3 “Biodiversity” within the Wagga Wagga LEP a section within the proposal area (Statutory Considerations: A.3) has been identified as “Biodiversity”. Under the Wagga Wagga LEP 2010 development consent must not be granted to development on land to which this clause applies unless the consent authority has considered the following matters:

a)	***any potential adverse impact of the proposed development on any of the following:***
(i)	a native vegetation community

The native Plant Community Type PCT 267 (Section: 4.3.2) is present adjacent to the development footprint. This plant community type is consistent with the Endangered Ecological Community ***White Box – Yellow Box – Blakley’s Red Gum Woodland*** (Box-gum Woodland) listed under the NSW BC Act.

Based on the predominantly native understorey and good condition of the woodland, this community is assumed to meet the criteria for the Federally listed Critically Endangered Ecological Community ***White Box – Yellow Box – Blakley’s red Gum Grassy Woodland and Derived Grassland*** listed under the EPBC Act (1999).

PCT 267 are not within the development footprint and therefore will not be affected by the proposal.

(ii) the habitat of any threatened species, population or ecological community

Habitat potentially utilised by some threatened species (Section: 4.1) is present within the proposal area and is likely to be impacted. This is discussed further in section 5: Assessment of impacts. An Assessment of Significance has been undertaken (Appendix C).

(iii) a regionally significant species of plant, animal or habitat,

No regionally significant flora or fauna species were observed during field surveys. Assessments of Significance have been conducted for the species with the potential to occur within the proposal area.

(iv) a habitat corridor

The proposal area was not identified as being part of or connected to a known habitat corridor.

(v) a wetland

No aquatic habitat is present within the development footprint. No aquatic habitat will be impacted by the proposed development.

(vi) the biodiversity values within a reserve, including a road reserve or a stock route

The proposal area includes road reserves. No native vegetation or trees will be impacted.

(b) any proposed measures to be undertaken to ameliorate any such potential adverse impact

Mitigation measures for impacts assessed by this report have been provided (Section 6).

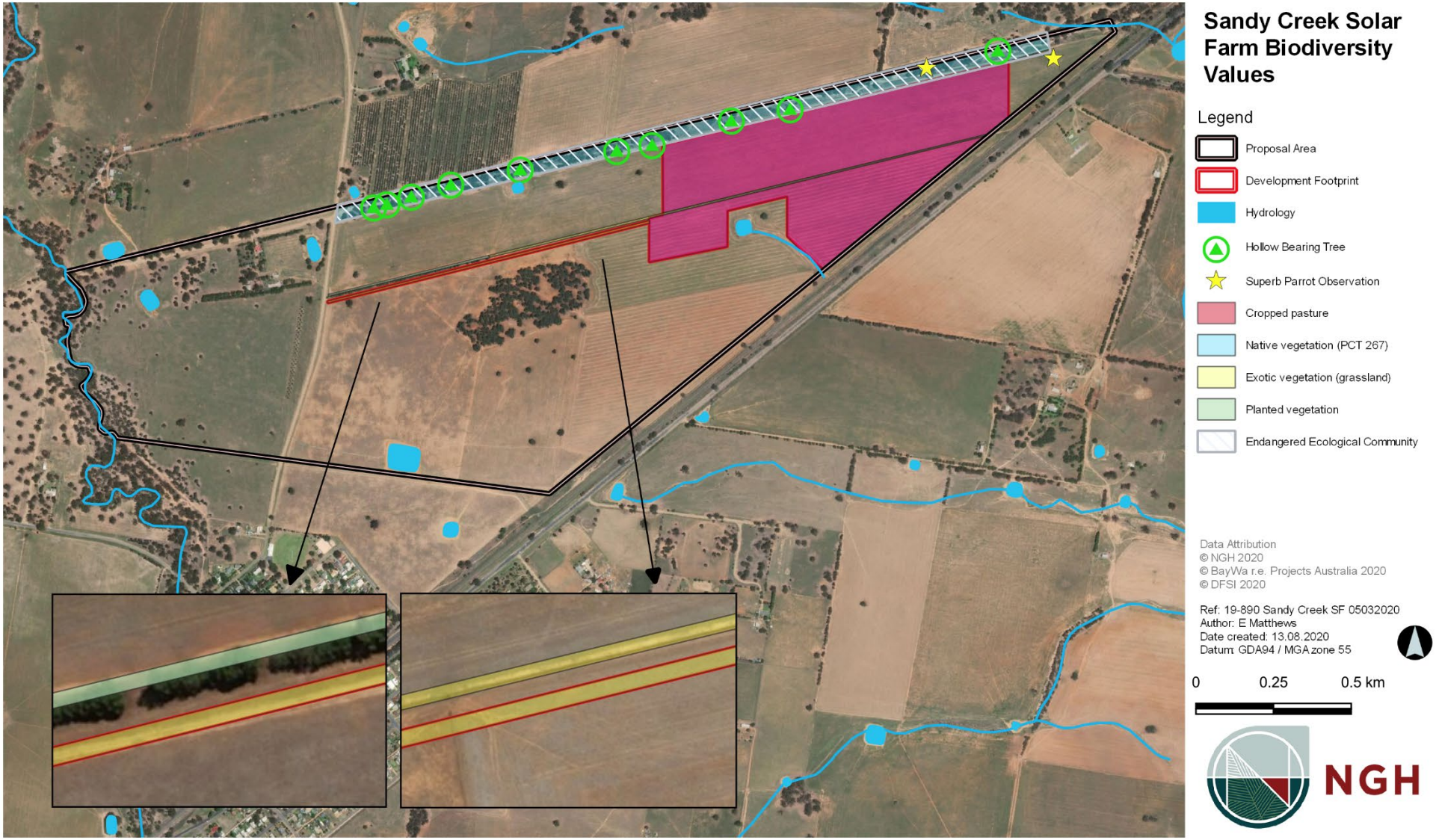


Figure 4-1 Biodiversity values within the proposal area .

4.3. FLORA

4.3.1. Threatened flora

No threatened flora species were identified during the field survey. Three threatened flora species were concluded as having potential to occur within the proposal area (Appendix B):

- Small Scurf-pea (*Cullen parvum*) – BC – E
- Hoary Sunray (*Leucochrysum albicans var. tricolor)* **–** EPBC – E
- A Spear-grass (*Austrostipa wakoolica*) – BC – E, EPBC - E

A full list of flora species recorded within the study area is within Appendix D.

4.3.2. Plant community types

One Plant Community Type (PCT) was identified within the proposal area. PCT 267 White Box – White Cypress Pine – Western Grey Box shrub/grass/forb woodland in the NSW South Western Slopes Bioregion occurs along Rodhams Road (Figure 4.1). This PCT is described within Table 4-1.

This PCT forms part of the TEC; *White Box - Yellow Box – Blakley's Red Gum Woodland* listed as Endangered under the NSW BC Act and Critically Endangered under the EPBC Act (1999).

Table 4-1 The plant community type identified adjacent to the proposal area.

PCT 267 White Box – White Cypress Pine – Western Grey Box shrub/grass/forb woodland in the NSW South Western Slopes Bioregion	
Vegetation Formation	Grassy Woodlands
Vegetation Class	Western Slopes Grassy Woodlands
Description	Tall or mid-high woodland or open woodland with trees to about 15 m high dominated by White Box (*Eucalyptus albens*), White Cypress Pine (*Callitris glaucophylla*) and often Western Grey Box (*Eucalyptus microcarpa*) and rarely Black Cypress Pine (Callitris endlicheri). The shrub layer is sparse containing wattles such as *Acacia decora, Acacia hakeoides, Acacia deanei* subsp. *paucijuga*, *Acacia implexa* and in the south *Acacia pycnantha*. Other shrubs include *Dodonaea viscosa* subsp. c*uneata*, Myoporum montanum, Pittosporum angustifolium, Senna artemisioides, Maireana enchylaenoides and *Maireana microphylla*. The ground cover is mid-dense to very sparse depending on rainfall. It may contain the decumbent shrubs Eremophila debilis. Grass species include *Austrostipa densiflora, Austrostipa bigeniculata, Austrostipa verticillata, Austrodanthonia caespitosa,Themeda australis, Enteropogon acicularis* and *Bothriochloa macra*. Forb species include *Xerochrysum viscosa*, *Dianella revoluta, Dichopogon strictus, Chrysocephalum apiculatum, Hydrocotyle laxiflora, Podolepis jaceoides, Vittadinia cuneata, Wahlenbergia luteola, Einadia hastata, Einadia nutans, Plantago varia* and *Atriplex semibaccata*. The mat-rushes *Lomandra multiflor*a and *Lomandra filiformis* subsp. *coriacea* may be present. Weeds dominate disturbed locations. Occurs on red-brown loamy soils or loamy sandy soils derived from sedimentary or volcanic rocks on hillslopes and hillcrests or parna soils on low rises in undulating low hills landscapes in the mid-western part of the NSW South-western Slopes Bioregion. Contains elements of White Box woodland on the slopes (e.g. ID266), White Cypress Pine woodland (ID70) and Western Grey Box woodlands on the plains (ID76 and ID80). Mostly cleared with remnant stands affected by heavy grazing and weed invasion.

Approximate extent within study area	This vegetation community covers approximately 14.41 ha within the proposal area.
Condition	Good condition. The PCT contained a native dominated overstorey and understorey.
Conservation Status	This plant community type is consistent with the EEC White Box – Yellow Box – Blakley's Red Gum Woodland (Box-gum Woodland) listed under the NSW BC Act. Due to the predominantly native understorey and high condition woodland this community also meets the condition threshold for the Critically Endangered Ecological Community *White Box – Yellow Box – Blakley's red Gum Grassy Woodland and Derived Grassland* listed under the EPBC Act (1999). This is discussed further in Section 5.
Image	

4.3.3. Priority Weeds

One priority weed was detected within the proposal area, African Boxthorn (**Lycium ferocissimum*).

This priority weed has a general biosecurity duty in NSW to prevent, eliminate or minimise any biosecurity risk they may pose (DPI, 2019). This means any person who deals with these plants, has a duty to ensure the risk is prevented, eliminated or minimised so far as is reasonably practicable (DPI, 2019). It also has a prohibition on dealings meaning it must not be imported into the state or sold.

4.3.4. Hollow Bearing Trees

Seven hollow bearing trees and three patches of hollow bearing trees are present within the proposal area. These are all located within the strip of native vegetation along Rodhams Road adjacent to the north of the development footprint (Figure 4-2).

Species included White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*) and Western Grey Box (*Eucalyptus microcarpa*).

Several threatened species with the potential to occur within the proposal area are hollow dependent (Section 4.1: Hollow dependant fauna), making these trees an important resource.



Figure 4-2: Remnant native vegetation (PCT 267) including hollow bearing trees.

4.4. FAUNA

Five bird species, one mammal (European Rabbit, *Oryctolagus cuniculus*) and one reptile (Goanna, *Varanus sp.*) were observed during field surveys. This included one threatened species, Superb Parrot (*Polytelis swainsonii*).

Table 4-2 discusses fauna habitat located adjacent to the development footprint. The main habitat types identified were:

- Box-Gum Woodland native vegetation (PCT 267)
- Hollow bearing trees
- Planted vegetation

Table 4-2 Identified habitats within the study area (adjacent to the proposal area).

Item	*Description*	*Photo*
Box-Gum Woodland native vegetation (PCT 267)	Predominately provides foraging habitat for fauna. Some roosting habitat is also provided. Minimal shrub cover is present. Native understorey provides additional habitat resources.	 Good condition woodland

Hollow bearing trees	Hollow bearing trees including White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*) and Western Grey Box (*Eucalyptus microcarpa*) were observed as containing small to large hollows. Hollows provide nesting and roosting habitat for a range of threatened species.	 Hollow bearing trees
Planted vegetation	Planted vegetation is present along the access track and consists of Kurrajong (*Brachychiton populneus subsp. populneus)*, Western Cypress (*Hesperocyparis spp.)* and White Cypress Pine (*Callitris glaucophylla*). These provide foraging and nesting habitat for fauna species, as well as connectivity between other remnant vegetation.	  Planted vegetation along access track.

4.4.1. Threatened fauna

One threatened fauna species, Superb Parrot *(Polytelis swainsonii*, BC – V, EPBC - V*),* was observed during the field survey. Therefore, an AoS has been completed for it.

The proposal area has been previous disturbed from agricultural activities. Minimal habitat is present within the proposal area. Some foraging, nesting and roosting habitat is present within the vegetation adjacent to the proposal areas, which includes hollow bearing trees. The groundcover is predominantly exotic.

4.5. EPBC MATTERS OF NATIONAL SIGNIFICANCE

The following matters of national significance relevant to biodiversity are considered to apply to the proposal. These matters are assessed further in this report.

4.5.1. Threatened Ecological Communities

Four threatened Ecological Communities were identified to have the potential to occur within the study area by the Protected Matters (EPBC Act) search.

One of these communities, White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box–Gum woodland) is present adjacent to the development footprint.

The EPBC listed Box-Gum Woodland is not considered to occur within the development footprint.

4.5.2. Threatened Species

No EPBC listed flora were identified during the field survey. Two EPBC listed species were determined as having potential to occur within the proposal area:

- Hoary Sunray (*Leucochrysum albicans var. tricolor)* **–** EPBC – E
- A Spear-grass (*Austrostipa wakoolica*) – EPBC - E

The following EPBC listed species was detected during the field survey.

- Superb Parrot *(Polytelis swainsonii)* – EPBC - V

No other EPBC listed species were determined as having potential to occur within the proposal area.

Significance of impact on these species has been discussed further within section 5.1.2

4.5.3. Migratory Species

Migratory species are protected under the EPBC Act. Ten species listed as Migratory under the EPBC Act were determined by the EPBC protected Matters Search Tool as having potential habitat or occurrence within the area. Based on the habitat assessment (Appendix B), no habitat is present that would indicate the likely occurrence of these species. As such, no assessments of significance have been conducted for these species.

5. ASSESSMENT OF IMPACTS

5.1. CONSTRUCTION IMPACTS

5.1.1. Vegetation loss

The proposal involves the removal of approximately 41 ha of non-native vegetation including exotic pastures and crops. This constitutes the removal of potential low-quality foraging habitat for some fauna species.

Direct impacts to native vegetation have been avoided by the proposal. PCT 267 White Box – White Cypress Pine – Western Grey Box shrub/grass/forb woodland in the NSW South Western Slopes Bioregion occurs along Rodhams Road and would be avoided.

The proposal would have a direct impact on vegetation communities and fauna habitat, as a result of habitat removal and temporary disturbance to groundcover, as outlined in Table 5-1.

Table 5-1: Vegetation loss.

Vegetation	Area of Impact of proposal footprint (ha)
Cropped pasture	39.57
Exotic vegetation (grassland)	1.27
Total	**40.83**

5.1.2. Threatened species

There are potential impacts to a range of threatened species (Section 4.2.1) due to impacts on potential habitat including foraging habitat.

Assessments of Significance were conducted for these species under the BC Act and EPBC Act to determine if the impacts are likely to be significant. The assessments concluded that there is unlikely to be a significant impact to these species, given that:

- The amount of habitat to be removed or disturbed by the proposal is relatively small in the local context
- No fragmentation or isolation of habitat would occur
- No substantial contribution to any key threatening process would be expected
- Mitigation measures would be implemented to prevent disruptions to the life cycle or harm to individual animals of these species
- The proposal would not interfere with the recovery of these species.

5.1.3. Priority weeds

The spread of priority weeds may occur during the construction of the proposal. One priority weed was identified during the field survey. This species requires particular treatments in order to mitigate risk of spread. Detailed information on managing this species can be sought from the Noxious and Environmental Weed Control Handbook (DPI 2015).

5.1.4. Key threatening processes

Key threatening processes relevant to the proposed development are listed below (Table 5-2) with a description of how the proposal is expected to impact the process. Thirty-nine Key Threatening Processes are listed by OEH (DPIE) within NSW.

Table 5-2: Key threatening processes and their relevance to the proposed development.

Key Threatening Processes (KTPs)		
BC Act	**EPBC Act**	**Relevance**
Clearing of native vegetation	***Land clearance***	The clearing of native vegetation is considered a major contributor to the loss of biodiversity. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation and off–site impacts such as downstream sedimentation. Only areas classed as 'exotic vegetation (grassland)' and 'cropped pasture' will be cleared as a result of this proposal.
Competition and grazing by feral European Rabbit (Oryctolagus cuniculus)	***Competition and land degradation by European Rabbit***	Disturbance to vegetation and soil may attract this species to the study area. However, as the majority of the study area is highly disturbed pasture it is expected the population numbers of European Rabbit will not increase.
Infection of native plants by Phytophthora cinnamomi	***Dieback caused by the root–rot fungus (Phytophthora cinnamomi)***	The proposal is not considered likely to exacerbate this KTP. No native plants would be impacted by this KTP.
Invasion and establishment of exotic vines and scramblers		No exotic vines or scramblers were observed in the proposal area. The proposal has the potential to contribute to the spread of exotic species in the proposal area through the transfer and introduction of plant material and soil on machinery. Mitigation measures have been recommended to prevent the spread of weeds on site.
Invasion of native plant communities by exotic perennial grasses		Rehabilitation works and regular weed management at the site would help prevent these species from spreading further, and recommendations have been made accordingly.
Loss of hollow–bearing trees		Hollow bearing trees are present in the proposal area but not within the development footprint and therefore will not be impacted. The proposal is not likely to exacerbate this KTP.
Predation by European Red Fox (Vulpes vulpes)	***Predation by European Red Fox***	Disturbance to native fauna and their habitat may attract this species to the study area or modify its current population density. However, as the

Key Threatening Processes (KTPs)		
		majority of the study area is highly disturbed pasture it is expected the population numbers population numbers of European red Fox will not increase.
Predation by Feral Cat (Felis catus)	***Predation by Feral Cat***	Disturbance to native fauna and their habitat may attract this species to the study area or modify its current population density. However, as the majority of the study area is highly disturbed pasture it is not expected the population numbers of Feral Cat will not increase.
Removal of dead wood and dead trees		No large dead standing trees or quantitative amount of dead wood are to be impacted by the proposal.
Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations	***Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species***	The proposal is not considered likely to exacerbate this KTP. The proposal will not increase the risk of this KTP.

5.2. OPERATIONAL IMPACTS

Activity associated with operation of the proposal includes noise, light spill, and foot traffic. As the proposal area is already highly disturbed by a similar level of activity, it is unlikely that these activities would further reduce the value of the site for fauna sensitive to such activities.

These impacts are expected to be very limited geographically to the area surrounding the development footprint. The landscape will be altered through the introduction of panels and security fencing if required. This will have minor impacts including reduction of open foraging area, however given the existing agricultural landuse, impacts from the proposal on fauna are expected to be very minor and limited.

5.3. BIODIVERSITY CONSERVATION ACT THRESHOLDS

A summary of the potential impacts from the proposal against the BC Act thresholds is provided in Table 5-3 below.

Section 6.8(3) of the BC Act determines that the Biodiversity Assessment Method (BAM) is to exclude the assessment of the impacts of clearing of native vegetation on Category 1-exempt land (within the meaning of Part 5A of the *Local Land Services Act 2013* (LLS Act)).

Table 5-3 Impact assessment against the BC Act Thresholds.

Threshold	*Application to the Proposal*	*Threshold Exceeded?*
The development is likely to significantly affect threatened species, populations or ecological communities (clause 7.2(1)(a))	Threatened species are unlikely to be significantly affected (refer to Section 5.1.2).	No
The development exceeds the biodiversity offsets scheme threshold (clause 7.2(1)(b)) Note; there are two potential BOS thresholds, pursuant to clause 7.1(1) of the BC Regulation.		

Minimum lot size associated with the property	***Threshold for clearing of native vegetation***	The minimum lot size for the land is 200 ha according to the WWLEP 2010. Clearing would be confined to Category 1-exempt land. Therefore, the BOS threshold would not be exceeded.	No
40 ha to less than 1000 ha	1 ha or more		
The clearing of native vegetation, or other action prescribed by clause 6.1, on land identified on the Biodiversity Values map;		The land is not identified on the Biodiversity Values map (Appendix A.7).	No
The development is in an area of Outstanding Biodiversity Value (clause 7.2(1)(c))		None occur in the proposal area.	No

The proposal does not trigger the BC Act thresholds. Therefore, no further assessment is required.

5.4. ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT MATTERS

The proposal would not have a significant impact on matters of national environmental significance under the EPBC Act. No referral is recommended in this instance.

6. MITIGATION MEASURES

These safeguards are a tool to assist with minimising the impacts on biodiversity during vegetation removal and maintenance works (Table 6-1).

Table 6-1 Safeguards for Protection of Flora and Fauna.

Impact	*Environmental safeguards*	*Responsibility*	*Timing*
Introduction and spread of priority weeds	• Declared priority weeds should be managed according to the requirements stipulated by the Biosecurity Act, and recommendations made by the local control authority (MLLS) and the Noxious and Environmental Weed Handbook (DPI, 2015), which contains details as to the management of specific noxious weeds. • All weed material containing seed heads, weeds that contain toxins, and weeds that are able to reproduce vegetatively should be disposed of at an appropriate waste management facility or otherwise properly treated to prevent weed growth. • All herbicides should be used in accordance with the requirements on the label. Any person undertaking pesticide (including herbicide) application should be trained to do so and have the proper certificate of completion/ competency or statement of attainment issued by a registered training organisation.	Contractor	Construction Operation Construction Construction
Unexpected threatened species finds	• The site induction should include measures to make employees aware of potential threatened flora and fauna during works and understand the procedures if threatened fauna are detected, this will be recorded as a part of the induction procedure and toolbox talks: o Stop work, o Alert an Ecologist for assessment and possible re–location during works.	Contractor	Construction
Clearing of native vegetation and EEC	• No stockpiling or storage to occur within native vegetation areas. • Additional assessment is required if development footprint is altered to include areas of native vegetation.	Contractor	Construction

7. CONCLUSION

BayWa r.e. Projects Australia proposes to construct a solar farm (electricity generating works) off Churches Plain Road at Uranquinty.

The development footprint is located within Lot 55, 118, 129 and 149 DP754567 and comprises an area of approximately 40 hectares (ha). The area has been largely cleared for agricultural purposes. Land use is primarily cropping, with a small area of grazing native vegetation.

A Land Category Assessment was conducted in accordance with the Local Land Services Act 2013 (LLS Act) and determined the development footprint would be limited to Category 1 – Exempt Land.

The proposal would result in the removal of approximately 41 ha of non-native vegetation including exotic pastures and crops. This constitutes the removal of potential low-quality foraging habitat for some fauna species. Direct impacts to native vegetation have been avoided by the proposal.

Threatened Species

Three threatened flora and one threatened fauna species may potentially occur within the proposal area. Assessments of significance were completed for potential impacts to these species. Due to the limited clearing of habitat required, being the removal of potential low-quality foraging habitat only, as well as the likely avoidance of a contribution to any key threatening processes, a significant impact to threatened species listed under the BC Act and/or EPBC Act is considered unlikely.

Mitigation of Impacts and Offsets

Mitigation and management measures have been recommended in order to minimise impacts to threatened entities, prevent disruptions to the life cycle or harm to individual animals of these species and minimise the contribution of the proposal to key threatening processes.

8. REFERENCES

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APPENDIX A DATABASE SEARCH RESULTS

A.1 BIONET ATLAS SEARCH

Scientific Name	Common Name
Ninox connivens	Barking Owl
Falco subniger	Black Falcon
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)
Grus rubicunda	Brolga
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)
Petrogale penicillata	Brush-tailed Rock-wallaby
Burhinus grallarius	Bush Stone-curlew
Brachyscome muelleroides	Claypan Daisy
Calidris ferruginea	Curlew Sandpiper
Stagonopleura guttata	Diamond Firetail
Artamus cyanopterus cyanopterus	Dusky Woodswallow
Petroica phoenicea	Flame Robin
Pachycephala inornata	Gilbert's Whistler
Calyptorhynchus lathami	Glossy Black-Cockatoo
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)
Pteropus poliocephalus	Grey-headed Flying-fox
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)
Vespadelus baverstocki	Inland Forest Bat
Phascolarctos cinereus	Koala
Miniopterus orianae oceanensis	Large Bent-winged Bat

Hieraaetus morphnoides	Little Eagle
Glossopsitta pusilla	Little Lorikeet
Petroica boodang	Scarlet Robin
Swainsona recta	Small Purple-pea
Myotis macropus	Southern Myotis
Chthonicola sagittata	Speckled Warbler
Circus assimilis	Spotted Harrier
Petaurus norfolcensis	Squirrel Glider
Polytelis swainsonii	Superb Parrot
Lathamus discolor	Swift Parrot
Neophema pulchella	Turquoise Parrot
Daphoenositta chrysoptera	Varied Sittella
Haliaeetus leucogaster	White-bellied Sea-Eagle
Epthianura albifrons	White-fronted Chat
Hirundapus caudacutus	White-throated Needletail
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat

A.2 EPBC PROTECTED MATTERS SEARCH TOOL

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

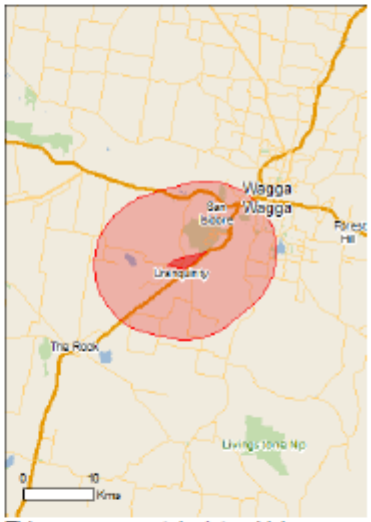
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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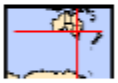
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	26
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	7
Commonwealth Heritage Places:	None
Listed Marine Species:	17
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	29
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Banrock station wetland complex	600 - 700km upstream
Hattah-kulkyne lakes	400 - 500km upstream
Riverland	500 - 600km upstream
The coorong, and lakes alexandrina and albert wetland	600 - 700km upstream

Listed Threatened Ecological Communities		[Resource Information]
For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.		
Name	Status	Type of Presence
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Breeding known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Galaxias rostratus Flathead Galaxias, Beaked Minnow, Flat-headed Galaxias, Flat-headed Jollytail, Flat-headed Minnow [84745]	Critically Endangered	Species or species habitat may occur within area
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat known to occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Frogs		
Crinia sloanei Sloane's Froglet [59151]	Endangered	Species or species habitat may occur within area
Litoria raniformis Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Plants		
Austrostipa wakoolica [66623]	Endangered	Species or species habitat may occur within area
Brachyscome muelleroides Mueller Daisy [15572]	Vulnerable	Species or species habitat may occur within area
Caladenia arenaria Sand-hill Spider-orchid [9275]	Endangered	Species or species habitat may occur within area
Prasophyllum petilum Tarengo Leek Orchid [55144]	Endangered	Species or species habitat may occur within area
Swainsona murrayana Slender Darling-pea, Slender Swainson, Murray Swainson-pea [6765]	Vulnerable	Species or species habitat likely to occur within area
Swainsona recta Small Purple-pea, Mountain Swainson-pea, Small Purple Pea [7580]	Endangered	Species or species habitat may occur within area
Reptiles		

Name	Status	Type of Presence
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Bank of Australia
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Director of War Service Homes
Defence - BLAMEY BARRACKS - KAPOOKA

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-35.170806 147.277242,-35.188555 147.250892,-35.184346 147.227546,-35.179857 147.236215,-35.170806 147.277242,-35.170736 147.277328,-35.170806 147.277242

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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A.3 OEH (DPIE) DATABASE SEARCH RESULTS

Combined geographic and habitat search

Use the form below to submit a search

IBRA Inland Slopes — *Choose an Interim Biogeographic Regionalisation of Australia region or sub-region*

Habitat Type Western Slopes Grassy Woodlands — *Search by habitat type.*

Species Type All species types — *You can search by all species or by a particular species.*

Search

Matching records: 79 **Save to CSV**

Click on column headers to sort

IBRA Subregion	Scientific name	Common name	NSW status	Commonweath status	Occurrence	Vegetation class
Inland Slopes	**Acacia ausfeldii**	**Ausfeld's Wattle**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Ammobium craspedioides**	**Yass Daisy**	Vulnerable	Vulnerable	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Anthochaera phrygia**	**Regent Honeyeater**	Critically Endangered	Critically Endangered	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Aprasia parapulchella**	**Pink-tailed Legless Lizard**	Vulnerable	Vulnerable	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Artamus cyanopterus cyanopterus**	**Dusky Woodswallow**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Austrostipa wakoolica**	**A spear-grass**	Endangered	Endangered	Predicted	**Western Slopes Grassy Woodlands**
Inland Slopes	**Bossiaea fragrans**	***Bossiaea fragrans***	Critically Endangered	Critically Endangered	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Bothriochloa biloba**	**Lobed Bluegrass**	Not listed		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Burhinus grallarius**	**Bush Stone-curlew**	Endangered		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Caladenia concolor**	**Crimson Spider Orchid**	Endangered	Vulnerable	Known	**Western Slopes Grassy Woodlands**

Inland Slopes	**Callocephalon fimbriatum**	**Gang-gang Cockatoo**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Calyptorhynchus lathami**	**Glossy Black-Cockatoo**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Cercartetus nanus**	**Eastern Pygmy-possum**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Chalinolobus dwyeri**	**Large-eared Pied Bat**	Vulnerable	Vulnerable	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Chalinolobus picatus**	**Little Pied Bat**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Chthonicola sagittata**	**Speckled Warbler**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Circus assimilis**	**Spotted Harrier**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Climacteris picumnus victoriae**	**Brown Treecreeper (eastern subspecies)**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Coolac-Tumut Serpentinite Shrubby Woodland in the NSW South Western Slopes and South Eastern Highlands Bioregions**	**Coolac-Tumut Serpentinite Shrubby Woodland in the NSW South Western Slopes and South Eastern Highlands Bioregions**	Endangered Ecological Community		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Crinia sloanei**	**Sloane's Froglet**	Vulnerable	Endangered	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Cullen parvum**	**Small Scurf-pea**	Endangered		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Daphoenositta chrysoptera**	**Varied Sittella**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Dasyurus maculatus**	**Spotted-tailed Quoll**	Vulnerable	Endangered	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Delma impar**	**Striped Legless Lizard**	Vulnerable	Vulnerable	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Dichanthium setosum**	**Bluegrass**	Vulnerable	Vulnerable	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Diuris tricolor**	**Pine Donkey Orchid**	Vulnerable		Known	**Western Slopes Grassy**

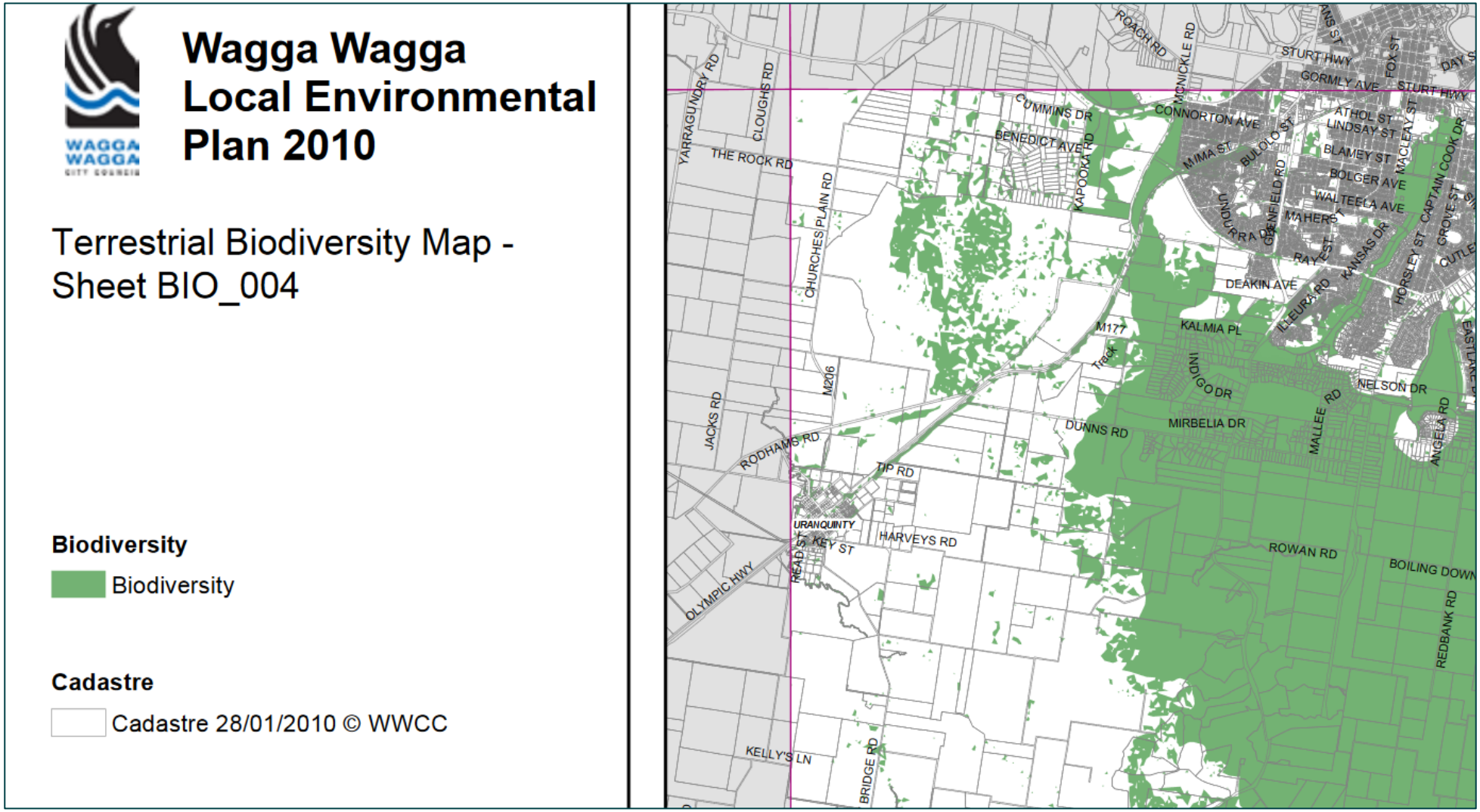
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Inland Slopes	**Eucalyptus cannonii**	**Capertee Stringybark**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Euphrasia arguta**	***Euphrasia arguta***	Critically Endangered	Critically Endangered	Predicted	**Western Slopes Grassy Woodlands**
Inland Slopes	**Falsistrellus tasmaniensis**	**Eastern False Pipistrelle**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions**	**Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions**	Endangered Ecological Community		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Glossopsitta porphyrocephala**	**Purple-crowned Lorikeet**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Glossopsitta pusilla**	**Little Lorikeet**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Goodenia macbarronii**	**Narrow Goodenia**	Not listed		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Grantiella picta**	**Painted Honeyeater**	Vulnerable	Vulnerable	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Grevillea wilkinsonii**	**Tumut Grevillea**	Critically Endangered	Endangered	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Haliaeetus leucogaster**	White-bellied Sea-Eagle	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Hieraaetus morphnoides**	**Little Eagle**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Homoranthus darwinioides**	***Homoranthus darwinioides***	Vulnerable	Vulnerable	Predicted	**Western Slopes Grassy Woodlands**
Inland Slopes	**Hoplocephalus bitorquatus**	**Pale-headed Snake**	Vulnerable		Predicted	**Western Slopes Grassy Woodlands**
Inland Slopes	**Lathamus discolor**	**Swift Parrot**	Endangered	Critically Endangered	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Leucochrysum albicans var. tricolor**	**Hoary Sunray**	Not listed	Endangered	Known	**Western Slopes Grassy Woodlands**

Inland Slopes	Litoria booroolongensis	Booroolong Frog	Endangered	Endangered	Known	Western Slopes Grassy Woodlands
Inland Slopes	Lophochroa leadbeateri	Major Mitchell's Cockatoo	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Lophoictinia isura	Square-tailed Kite	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Miniopterus orianae oceanensis	Large Bent-winged Bat	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Myotis macropus	Southern Myotis	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Neophema pulchella	Turquoise Parrot	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Ninox connivens	Barking Owl	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Ninox strenua	Powerful Owl	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Nyctophilus corbeni	Corben's Long-eared Bat	Vulnerable	Vulnerable	Known	Western Slopes Grassy Woodlands
Inland Slopes	Pachycephala inornata	Gilbert's Whistler	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Petaurus australis	Yellow-bellied Glider	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Petaurus norfolcensis	Squirrel Glider	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Petaurus norfolcensis - endangered population	Squirrel Glider in the Wagga Wagga Local Government Area	Endangered Population		Known	Western Slopes Grassy Woodlands
Inland Slopes	Petrogale penicillata	Brush-tailed Rock-wallaby	Endangered	Vulnerable	Known	Western Slopes Grassy Woodlands
Inland Slopes	Petroica boodang	Scarlet Robin	Vulnerable		Known	Western Slopes

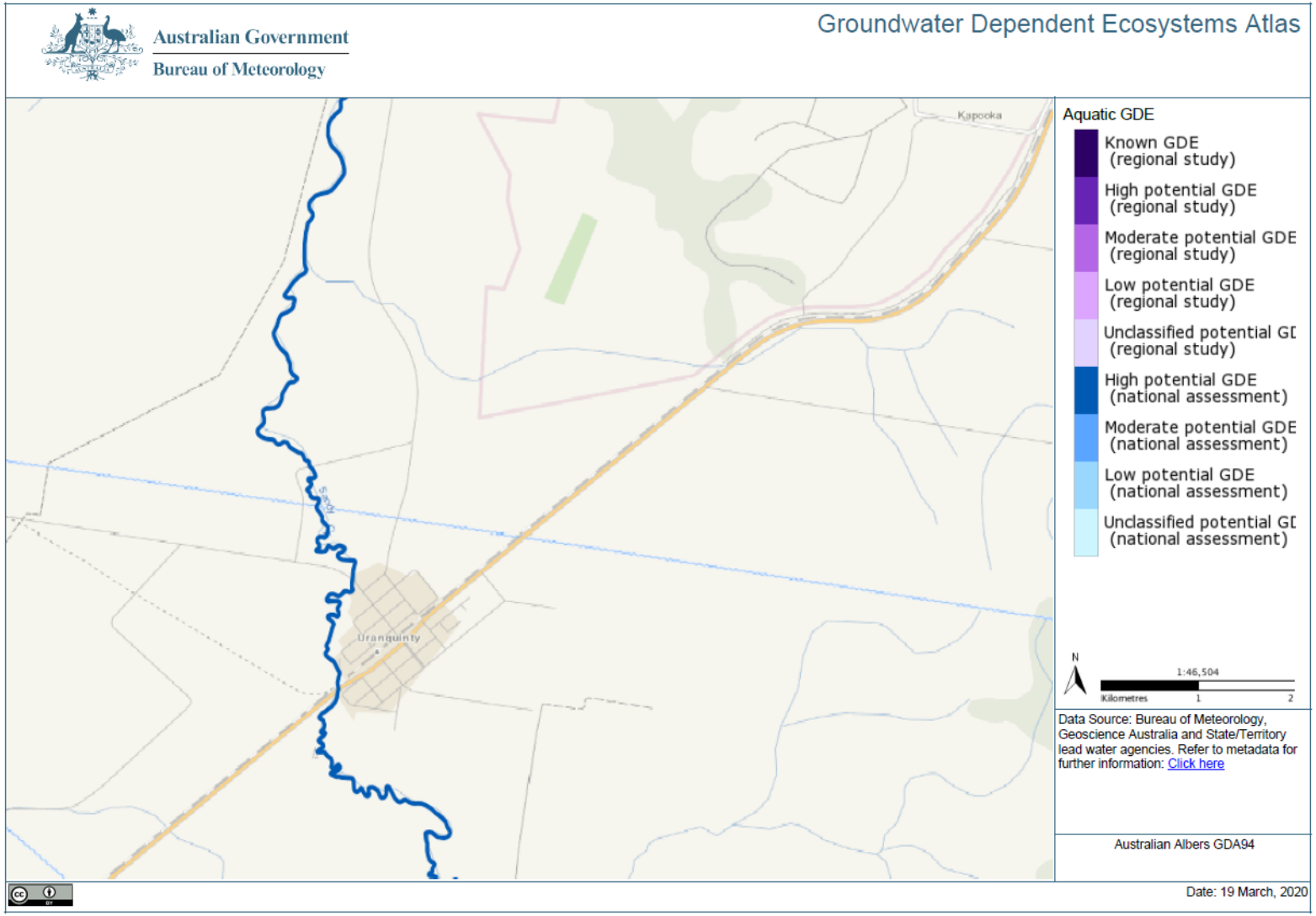
						Grassy Woodlands
Inland Slopes	Petroica phoenicea	Flame Robin	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Phascogale tapoatafa	Brush-tailed Phascogale	Vulnerable		Predicted	Western Slopes Grassy Woodlands
Inland Slopes	Phascolarctos cinereus	Koala	Vulnerable	Vulnerable	Known	Western Slopes Grassy Woodlands
Inland Slopes	Polytelis swainsonii	Superb Parrot	Vulnerable	Vulnerable	Known	Western Slopes Grassy Woodlands
Inland Slopes	Pomaderris queenslandica	Scant Pomaderris	Endangered		Known	Western Slopes Grassy Woodlands
Inland Slopes	Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Prasophyllum petilum	Tarengo Leek Orchid	Endangered	Endangered	Known	Western Slopes Grassy Woodlands
Inland Slopes	Prasophyllum sp. Wybong	*Prasophyllum* sp. Wybong	Not listed	Critically Endangered	Predicted	Western Slopes Grassy Woodlands
Inland Slopes	Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable	Known	Western Slopes Grassy Woodlands
Inland Slopes	Pultenaea humilis	Dwarf Bush-pea	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Senecio garlandii	Woolly Ragwort	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Stagonopleura guttata	Diamond Firetail	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Swainsona recta	Small Purple-pea	Endangered	Endangered	Known	Western Slopes Grassy Woodlands
Inland Slopes	Swainsona sericea	Silky Swainson-pea	Vulnerable		Known	Western Slopes Grassy Woodlands
Inland Slopes	Synemon plana	Golden Sun Moth	Endangered	Critically Endangered	Known	Western Slopes Grassy Woodlands

Inland Slopes	**Tylophora linearis**	***Tylophora linearis***	Vulnerable	Endangered	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Tyto novaehollandiae**	**Masked Owl**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Varanus rosenbergi**	**Rosenberg's Goanna**	Vulnerable		Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**White Box Yellow Box Blakely's Red Gum Woodland**	**White Box Yellow Box Blakely's Red Gum Woodland**	Endangered Ecological Community	Critically Endangered	Known	**Western Slopes Grassy Woodlands**
Inland Slopes	**Zieria obcordata**	**Granite Zieria**	Endangered	Endangered	Known	**Western Slopes Grassy Woodlands**

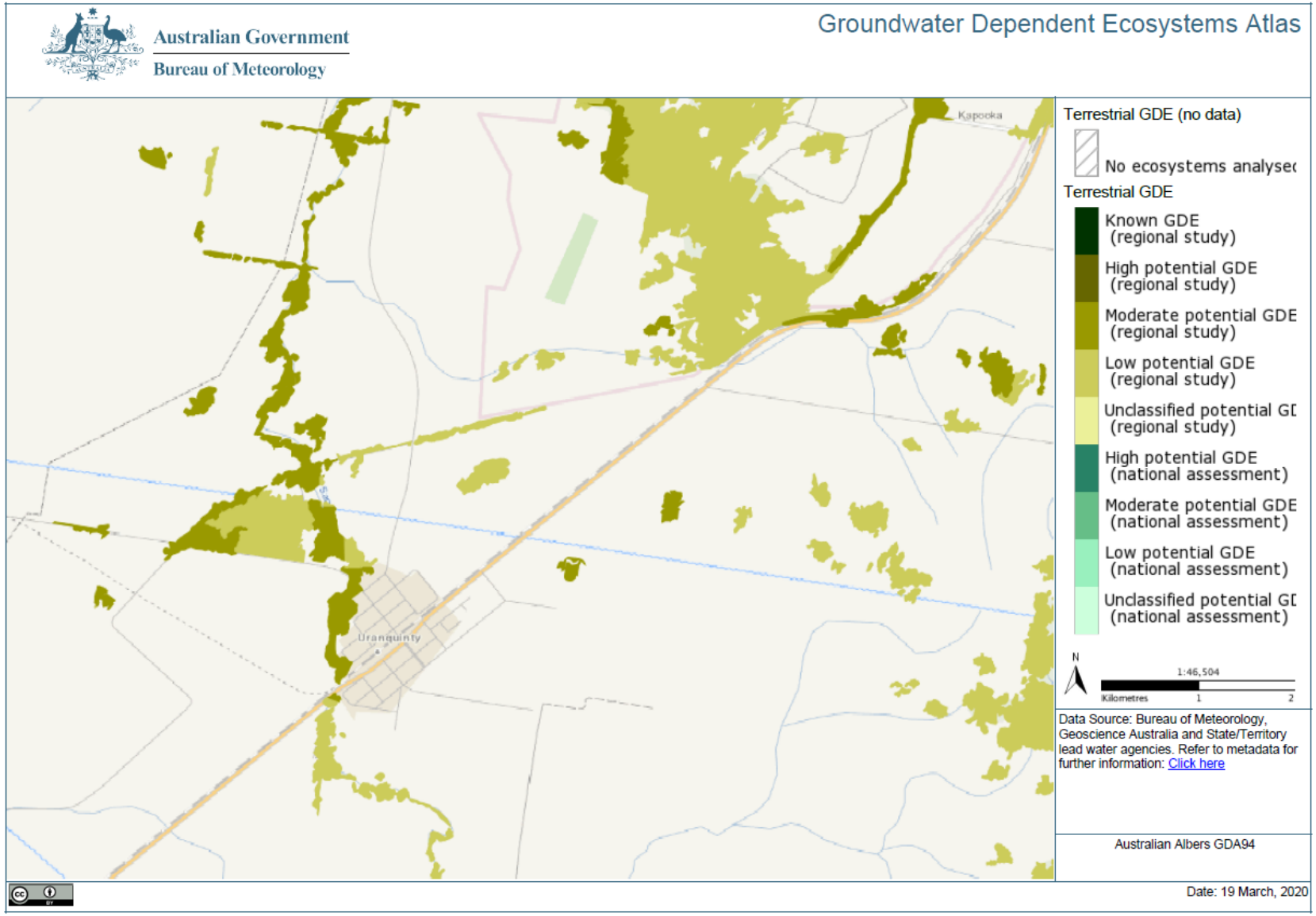
A.4 WAGGA WAGGA LEP 2010 "TERRESTRIAL BIOVERSITY MAP" BIO_004



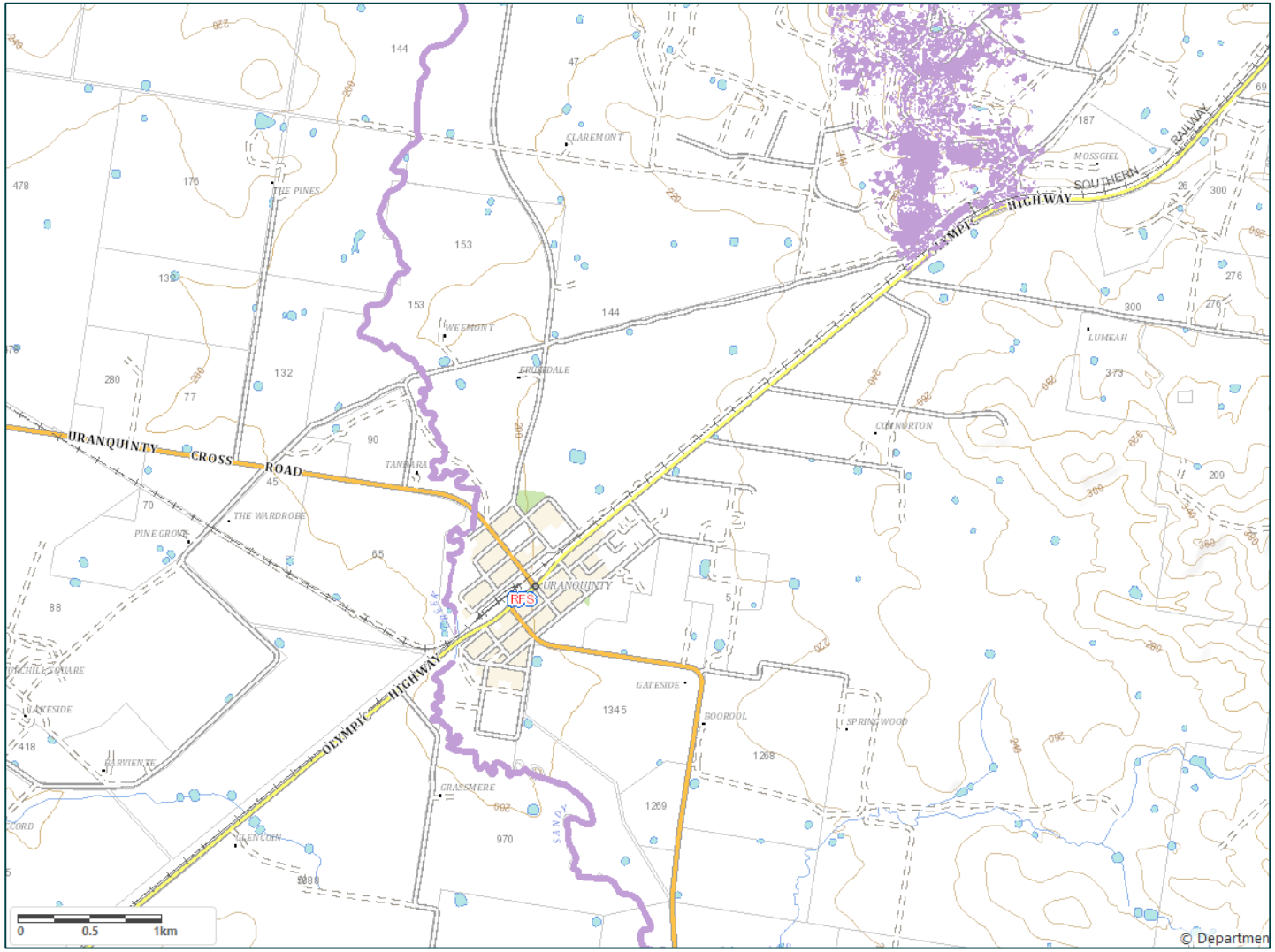
A.5 AQUATIC GROUND WATER DEPENDENT ECOSYSTEM (GDE) ATLAS



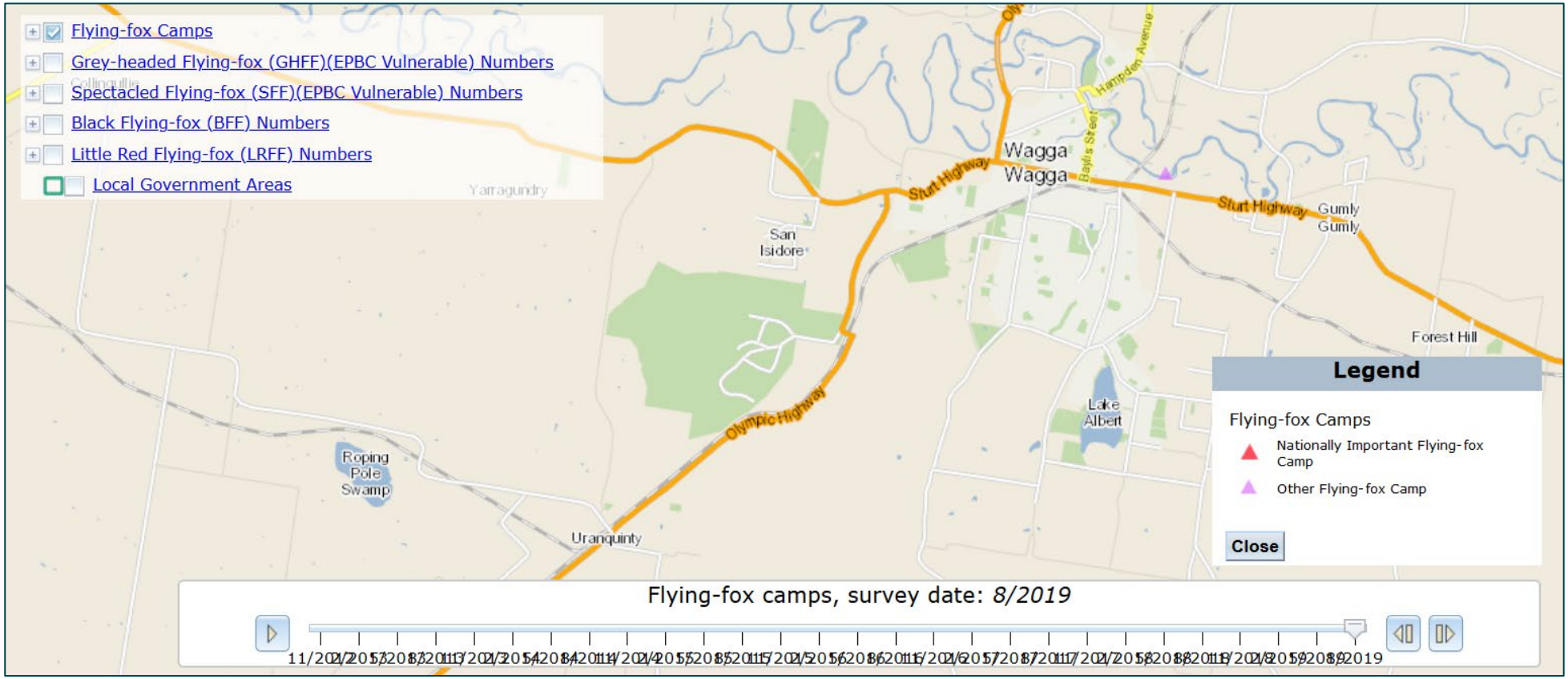
A.6 TERRESTRIAL GROUND WATER DEPENDENT ECOSYSTEM (GDE) ATLAS



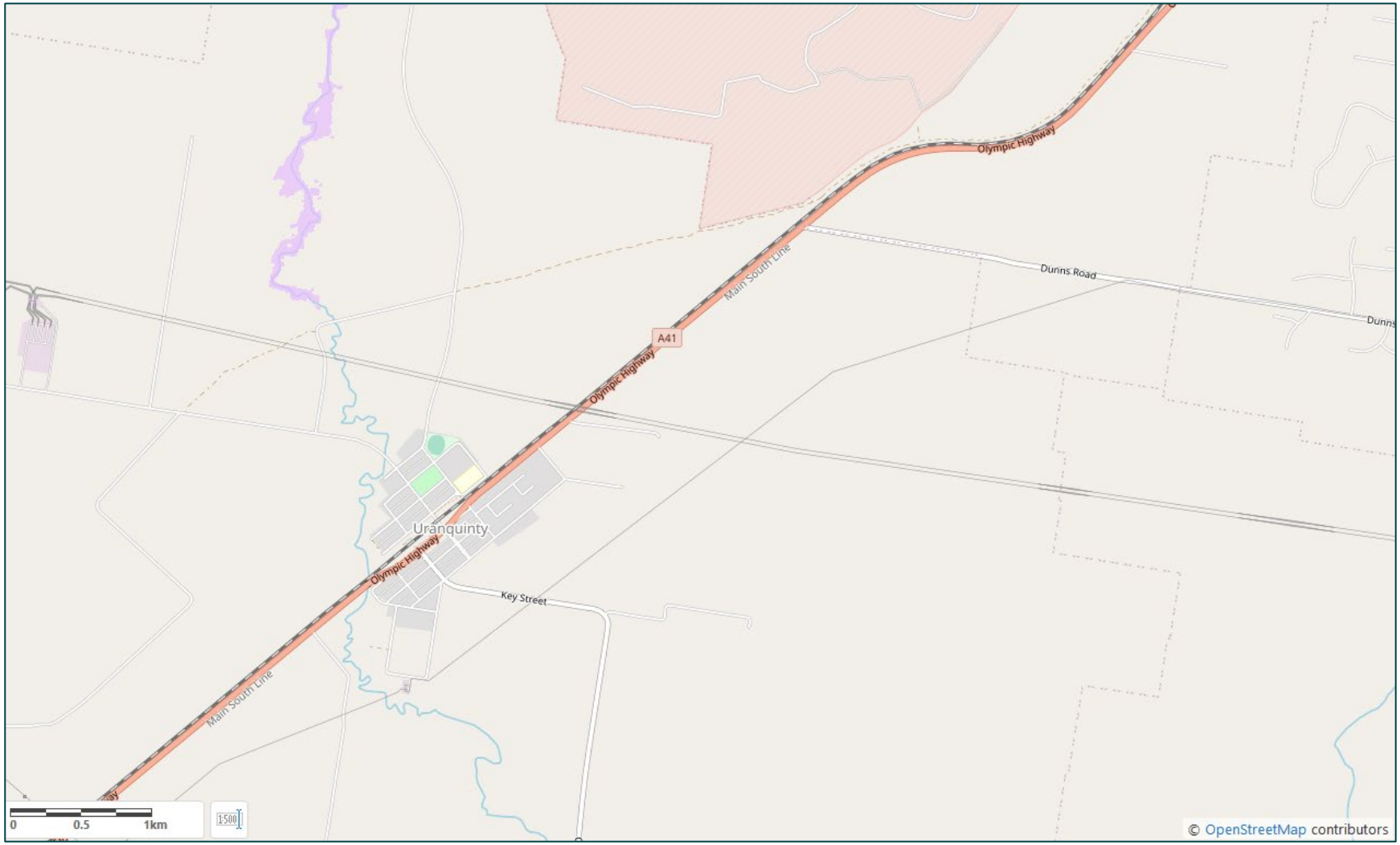
A.7 NSW GOVERNMENT BIODIVERSITY VALUES MAP AND THRESHOLD TOOL, AREAS OF OUTSTANDING BIODIVERSITY VALUE



A.8 GREY HEADED FLYING FOX CAMP WAGGA WAGGA LGA



A.9 KOALA DEVELOPMENT APPLICATION AREA*



* Pink indicates Koala Development Application Map.

APPENDIX B THREATENED SPECIES EVALUATIONS

The tables in this appendix present the habitat evaluation for threatened species, ecological communities and endangered populations listed within 10km of the proposal area in the *NSW BioNet* [1], those identified as potentially occurring in the area according to the Commonwealth EPBC *Protected Matters Search Tool*[2] and those identified in the *Wagga Wagga IBRA Sub–region*[3] *and Western Slopes Grassy Woodlands (OEH habitat and region search).* .

The likelihood of occurrence is based on presence of habitat, proximity of nearest records and mobility of the species (where relevant). The assessment of potential impact is based on the nature of the proposal, the ecology of the species and its likelihood of occurrence. The following classifications are used:

Presence of habitat:

Present: Potential or known habitat is present within the study area

Absent: No potential or known habitat is present within the study area

Likelihood of occurrence

Unlikely: Species known or predicted within the locality but unlikely to occur in the study area

Possible: Species could occur in the study area

Present: Species was recorded during the field investigations

Possible to be impacted

No: The proposal would not impact this species or its habitats. No Assessment of Significance (AoS) is necessary for this species.

Yes: The proposal could impact this species or its habitats. An AOS has been applied to these entities

[1] The *NSW BioNet* is administered by the NSW Office of Environment and Heritage (OEH (DPIE)) and is an online database of fauna and flora records that contains over four million recorded sightings.

[2] This online tool is designed for the public to search for matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is managed by the Commonwealth Department of the Environment, Water, Heritage and the Arts.

[3] This online tool is administered by the NSW Office of Environment and Heritage (OEH (DPIE)) and is designed for the public to search the data base of threated flora and fauna in NSW by geographic region and habitat.

B.1 EVALUATION OF THE LIKELIHOOD AND EXTENT OF IMPACT ON THREATENED FLORA SPECIES

Species	*Description of habitat*[4]	*Presence of habitat*	*Likelihood of occurrence*	*Possible impact?*
Trees				
Ausfeld's Wattle *Acacia ausfeldii* **BC - V**	Acacia ausfeldii is an erect or spreading shrub 2 - 4 m high with branchlets angled or flattened, resinous and smooth. The phyllodes (leaves) are narrowly elliptic to linear-oblong, straight to slightly curved, 2 - 7 cm long, 2 - 5 mm wide, hairless and are dotted with resin glands. Acacia ausfeldii phyllodes have a prominent mid-vein and less pronounced lateral veins, they also have an obtuse apex with a short sharp tip. There is a small gland located near the base of the phyllode and the pulvinus is less than 2 mm long. Two or sometimes 3 flower clusters stemming from the leaf axil and the flower stalks are 4 - 9 mm long, hairy and enclosed by small oval shaped bracts. Flower heads are bright yellow and 6 - 8 mm in diameter. Seed pods are straight or slightly curved and 4 - 9 cm long by 2 - 4 mm wide. Found to the east of Dubbo in the Mudgee-Ulan-Gulgong area of the NSW South Western Slopes bioregion, with some records in the adjoining Brigalow Belt South, South Eastern Highlands and the Sydney Basin bioregions. Populations are recorded from Yarrobil National Park, Goodiman State Conservation Area and there is a 1963 record from Munghorn Gap Nature Reserve. A large population is also known from Tuckland State Forest to the northwest of Gulgong.	**Absent** Incorrect habitat type.	**Unlikely** No records and not observed during site survey.	**No** The proposal would not impact this species or its habitats.

[4] Information sourced from species profiles on NSW OEH (DPIE)'s threatened species database or the Australian Government's Species Profiles and Threats database (SPRAT) unless otherwise stated.

OEH (DPIE) threatened species database: http://www.threatenedspecies.environment.nsw.gov.au/index.aspx
SPRAT: http://www.environment.gov.au/cgi–bin/sprat/public/sprat.pl

Capertee Stringybark *Eucalyptus cannonii* **BC - V**	Usually occurs as a tree 10 – 15 m high with persistent, stringy bark. Leaves are lance-shaped, 9 – 15 cm long and 1. 5– 2.5 cm wide. Buds and bud stems are angular, and fruits are generally greater than 10 mm diameter, often with a distinct rim around the middle. Can be distinguished from E. macrorhyncha, a closely related species that may grow in similar habitat, by the angular buds and usually larger fruit with a medial rim and shorter pedicels. Hybrids between the two species are common in some places where they co-exist. Hybrids may be distinguished in the field on the basis of fruit diameter, lack of prominence of the medial rim and reduced angularity of buds. The Capertee Stringybark is predominantly restricted to the central tablelands and slopes of NSW between the Golden Highway in the north, and the Mitchell Highway in the south. The species' distribution is bounded from east of Bathurst, to Wallerwang near Lithgow, north along the western edge of Wollemi National Park and north-west to Mudgee; isolated occurrences are known from a short way north of Goulburn River National Park between Dunedoo and Merriwa. Within this area the species is often locally frequent.	**Present** Proposal within known distribution.	**Unlikely** No records and not observed during site survey.	**No** The proposal would not impact this species or its habitats.
Shrubs				
Tumut Grevillea *Grevillea wilkinsonii* **BC – CE** **EPBC - E**	The Tumut Grevillea typically grows to a large spreading shrub up to 2.5 m tall and 2 m wide. The plants at Gundagai, however, are essentially prostrate shrubs with a spread of up to 3 m. The leaves are more or less oblong, to 15 cm long by 2 cm wide, with scalloped edges; each scallop is separated by a small sharp tooth. The leaves are green (sometimes bronze on young foliage) and almost hairless on the upper surface; the lower surface has a silky covering of short silvery-grey hairs. The individual flowers are small and distinctive, with pinkish to purple petals and a lilac-pink, green or yellow tipped style. The flowers form toothbrush-like clusters that are usually 3 - 5 cm long. The fruits are woody capsules to 9 mm long; splitting lengthways to release one (rarely two) ovoid dark-brown seed. The seed is 5-6.5 mm long, 2.5-3 mm in diameter and slightly flattened along one side. The Tumut Grevillea has a highly restricted distribution in the NSW South-west Slopes region. Its main occurrence is along a 6 km stretch of the Goobarragandra River approximately 20 km east of Tumut where about 1,000 plants are known. The other occurrence is a small population that straddles the boundary of two private properties at Gundagai where only eight mature plants survive.	**Absent** No riverine vegetation.	**Unlikely** No historical records and lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.

Woolly Ragwort *Senecio garlandii* **BC–V**	Woolly Ragwort occurs on sheltered slopes of rocky outcrops.	**Absent** No rocky outcrops present.	**Unlikely** No historical records and lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Herbs & Forbs				
Claypan Daisy *Brachyscome muelleroides* **BC–V** **EPBC–V**	Recorded primarily in clay soils on Bladder Saltbush and Leafless Bluebush plains, but also in grassland and in Inland Grey Box – Cypress Pine woodland.	**Present** Grey Box and Cypress pine present within proposal area.	**Possible but Unlikely** One record from 8.9 km away, however not observed during site survey and area has been highly disturbed.	**No** The proposal would not impact this species or its habitats.
Zieria obcordata **BC -E** **EPBC - E**	Dense, rounded, perennial shrub to 0.5 m high. Leaves composed of 3 wedge-shaped leaflets, covered with small warts on the upper surface. The tip of the central leaflet is characteristically recurved to give it a notched appearance. Each leaflet 3-8.5 mm long and 1.3-3.7 mm wide, the margins somewhat toothed. Flowers with 4 petals, each 2-2.5 mm long, pale pink rapidly fading to white. Fruit a capsule about 5 mm across, deeply divided into 4 chambers. Occurs at two sites with a geographic range of 105 km. These are in the Wuuluman area near Wellington, comprising of a single subpopulation over 3 sites comprising 209 plants and Crackerjack Rock/Rock Forests area NW of Bathurst, with a subpopulation comprising of 14 sites, totaling to approximately 700 adults plants.	**Absent** Species only known to occur at two sites.	**Unlikely** No historical records and not known to occur in this location.	**No** The proposal would not impact this species or its habitats.
Pomaderris queenslandica Scant Pomaderris **BC - E**	Scant Pomaderris is a medium-sized shrub 2 - 3m tall. The stems are whitish with tiny star-shaped hair clusters. The leaves are oval to narrow elliptical, 2.5 - 7 cm long and 10 - 25 mm wide. They are shiny on the top and woolly underneath. The small creamy yellow flowers appear during spring-summer. Widely scattered but not common in north-east NSW and in Queensland. It is	**Absent** No moist forest present.	**Unlikely** No historical records and lack of suitable habitat.	**No** The proposal would not impact this

	known from several locations on the NSW north coast and a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolata.			species or its habitats.
Homoranthus darwinioides **BC – V** **EPBC - V**	Slender hairless shrub, characterised by its distinctive drooping flower heads, each consisting of two flowers on a stalk. Leaves are linear, cylindrical, 2-5 mm long in some populations, 6-11 mm long in others. Rare in the central tablelands and western slopes of NSW, occurring from Putty to the Dubbo district. It is found west of Muswellbrook between Merriwa and Bylong, and north of Muswellbrook to Goonoo SCA. Grows in in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Landforms the species has been recorded growing on include flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes, and a slight depression on a roadside with loamy sand. Associated species include *Callitris endlicheri, Eucalyptus crebra, E. fibrosa, C. trachyphloia, E. beyeri* subsp. *illaquens, E. dwyeri, E. rossii, Leptospermum divaricatum, Melaleuca uncinata, Calytrix tetragona, Allocasuarina* spp. and *Micromyrtus* spp. Flowers March to December.	**Absent** No gravelly sandy soils or ridgelines.	**Unlikely** No historical records and lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Yass Daisy *Ammobium craspedioides* **BC – V** **EPBC – V**	The Yass Daisy is a rosette-forming perennial. Leaves are spoon-shaped, to 12 cm long and 17 mm wide, hairy on top and white and woolly underneath. The spring flowerheads are hemispherical buttons, to 20 mm wide, and surrounded at the base by papery leaf-like structures (bracts). The solitary flowerheads are borne on unbranched stems to 60 cm tall; the stems are sparsely leafed, and edged with narrow "wings". Rosettes die off after fruiting. Found from near Crookwell on the Southern Tablelands to near Wagga Wagga on the South Western Slopes. Most populations are in the Yass region.	**Present** Box-gum woodland present.	**Possible** Suitable habitat. Species known to tolerate disturbance.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Euphrasia arguta **BC – CE** **EPBCE - CE**	Euphrasia arguta is an erect annual herb ranging in height from 20-35 cm. Collectively, the Euphrasia are commonly known as 'eyebrights'. Its branches are densely covered with stiff hairs and the leaf margins usually have 2-4 pairs of teeth. The flowers vary in colour from white to lilac with yellow, and are borne on flower spikes of 50 to 90 flowers. Plants from the Nundle area have been reported from eucalypt forest with a mixed grass and shrub understorey; here, plants were most dense in an open disturbed area and along the	**Present** Disturbed woodland habitat.	**Possible but Unlikely** Suitable habitat however no records and not observed during site survey.	**No** The proposal would not impact this species or its habitats.

	roadside, indicating the species had regenerated following disturbance. Euphrasia arguta has an annual habit and has been observed to die off over the winter months, with active growth and flowering occurring between January and April.			
Small Purple Pea *Swainsona recta* **BC–E** **EPBC–E**	Small Purple–pea occurs predominantly in grassy woodlands, but sometimes extends into grassy open forest, usually with tree cover including Blakely's Red Gum, Yellow Box, and White Box.	**Present** Box-gum grassy woodland present. Spear grasses also present however low quality exotic dominated.	**Possible** One record from 9 km away. Suitable habitat.	**No** The proposal would not impact this species or its habitats.
Slender Darling–pea *Swainsona murrayana* **EPBC – V** **BC – V**	An ascending to erect perennial forb growing to 25cm high. Occurs from South Australia through south–west Victoria and central NSW to south–east Queensland. Found throughout NSW, it has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree. Found in grassland, herb land, and open Black–box woodland, often in depressions. Has been collected from clay–based soils, ranging from grey, red and brown cracking clays to red–brown earths and loams. Grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with *Maireana* species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated. Plants produce winter–spring growth, flower in spring to early summer and then die back after flowering. They re–shoot readily and often carpet the landscape after good cool–season rains. The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated. It is often associated with low chenopod shrubs (*Maireana sp.*), wallaby–grass (*Austrodanthonia sp.*), and spear grass (*Austrostipa sp.*).	**Absent** Remnant grassy woodlands only present outside development footprint.	**Possible** One record from 9 km away. Suitable habitat.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Bossiaea fragrans **BC – CE**	An erect shrub that grows to 1-2.5m high. The cladodes (stems with foliage leaves reduced or absent) are flattened, glaucous green and range from 8-14mm wide. Leaf scales are present and ranging from 1.5-1.9mm long. The	**Absent** No suitable substrates.	**Unlikely** No historical records and known	**No** The proposal would not impact this

EPBC - CE	flowers, which can be seen from September through to October, are yellow with red markings, except for the keel (the pair of petals beneath the flower) which is dark red. The pods are oblong in shape. Currently only known from the Abercrombie Karst Conservation Reserve, south of Bathurst on the NSW central tablelands. It is highly restricted, with only a small number of known populations.	Associated eucalpyt species not present.	only to occur in specific locations.	species or its habitats.
Silky Swainson–pea *Swainsona sericea* **BC–V**	Silky Swainson–pea has been recorded from the Northern Tablelands to the Southern Tablelands and further inland on the slopes and plains. There is one isolated record from the far north–west of NSW. Its stronghold is on the Monaro. Also found in South Australia, Victoria and Queensland. Found in Natural Temperate Grassland and Snow Gum *Eucalyptus pauciflora* Woodland on the Monaro. Found in Box–Gum Woodland in the Southern Tablelands and South West Slopes.	**Absent** Box-gum woodland only present outside development footprint.	**Unlikely** Suitable habitat however no historic records.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Small Scurf–pea *Cullen parvum* **BC – E**	Found primarily in grassland, River Red Gum Woodland and Box–Gum Woodland. Also found on grazed land and next to drainage lines and watercourses. More easily found in winter or spring because dies back in dry seasons.	**Present** Box-gum woodland and grassland present. Grazed and cropped paddocks.	**Possible** Suitable habitat.	**Yes** AoS completed for this species.
Tylophora linearis *Tylophora linearis* **BC–V** **EPBC – E**	An herbaceous climber with clear latex that grows to about 2 m long. Known from eight localities in the Dubbo area and Mt Crow near Barraba in NSW, and “Myall Park” near Glenmorgan in Queensland. This species is conserved within Goobang National Park, Eura State Forest, Goonoo SF, Pilliga West SF and Coolbaggie Nature Reserve. Grows in dry scrub, open forest and woodlands associated with *Melaleuca uncinata*, *Eucalyptus fibrosa*, *E. sideroxylon*, *E. albens*, *Callitris endlicheri*, *C. glaucophylla*, *Allocasuarina luehmannii*, *Acacia hakeoides*, *A. lineata*, *Myoporum* spp., and *Casuarina* spp. The distribution of this species overlaps with the following EPBC Act–listed threatened ecological communities: Brigalow (*Acacia harpophylla* dominant and co–dominant), and White Box–Yellow Box–Blakely’s Red Gum Grassy Woodland and Derived Native Grassland. Flowers in spring, with	**Absent** Box-gum woodland only present outside development footprint.	**Unlikely** Suitable habitat.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.

	flowers recorded in November or May with fruiting probably 2 to 3 months later.			
Hoary Sunray *Leucochrysum albicans var. tricolor* **EPBC – E**	Endemic to south–eastern Australia, where it is currently known from three geographically separate areas in Tasmania, Victoria and south–eastern NSW and ACT. In NSW it currently occurs on the Southern Tablelands adjacent areas in an area roughly bounded by Albury, Bega and Goulburn, with a few scattered localities know from beyond this region. Can occur within a variety of grassland, woodlands and forests. Generally found on heavy soils. Known to occur within modified habitat (roadsides and semi–urban). Disturbance and bare ground required for germination.	**Present** Box-gum woodland and grassland present. Modified paddocks and disturbance.	**Possible** Suitable habitat.	**Yes** AoS completed for this species.
Grasses				
A spear–grass *Austrostipa wakoolica* **BC–E** **EPBC–E**	A densely–tufted, perennial spear–grass, growing to 1 m tall. Confined to the floodplains of the Murray River tributaries of central–western and south–western NSW, with localities including Manna State Forest, Matong, Lake Tooim, Merran Creek, Tulla, Cunninyeuk and Mairjimmy State Forest. Grows on floodplains of the Murray River tributaries, in open woodland on grey, silty clay or sandy loam soils; habitats include the edges of a lignum swamp with box and mallee; creek banks in grey, silty clay; mallee and lignum sandy–loam flat; open Cypress Pine forest on low sandy range; and a low, rocky rise. Associated species include *Callitris glaucophylla, Eucalyptus microcarpa, E. populnea, Austrostipa eremophila, A. drummondii, Austrodanthonia eriantha* and *Einadia nutans*. Flowers from October to December, mainly in response to rain. Seed dispersal is mainly by wind, rain and flood events; the awn and sharp point of the floret appear to be an adaptation for burying the seed into the soil; grass seed is traditionally believed to be viable for three to five years, so a long–lived seed bank is considered unlikely for this species. Recorded as common in the Mairjimmy State Forest population.	**Present** Other spear grasses observed on site. Box-gum woodland.	**Possible** Suitable habitat.	**Yes** AoS completed for this species.
Bluegrass *Dichanthium setosum* **BC–V** **EPBC – V**	Bluegrass is an upright grass less than 1 m tall. Occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas. Flowering time is mostly in summer. Associated with heavy basaltic	**Absent** No heavy basaltic black soils in proposal area.	**Unlikely** Suitable habitat not present.	**No** The proposal would not impact this

	black soils. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. (Often collected from disturbed open grassy woodlands on the northern tablelands, where the habitat has been variously grazed, nutrient–enriched and water–enriched). It is open to question whether the species tolerates or is promoted by a certain amount of disturbance, or whether this is indicative of the threatening processes behind its depleted habitat. Associated species include *Eucalyptus albens, Eucalyptus melanophloia, Eucalyptus melliodora, Eucalyptus viminalis, Myoporum debile, Aristida ramosa, Themeda triandra, Poa sieberiana, Bothriochloa ambigua, Medicago minima, Leptorhynchos squamatus, Lomandra aff. longifolia, Ajuga australis, Calotis hispidula and Austrodanthonia, Dichopogon, Brachyscome, Vittadinia, Wahlenbergia* and *Psoralea* species. Locally common or found as scattered clumps in populations.			species or its habitats.
Orchids				
Sand–hill Spider–orchid *Caladenia arenaria* **BC–E** **EPBC–E**	*Caladenia arenaria* is found mostly on the south west plains and western south west slopes. The original description is of a plant from Nangus, west of Gundagai (1865) and there is a report of the species from Adelong near Tumut. A record near Cootamundra needs verifying. The Sand–hill Spider Orchid is currently only known to occur in the Riverina between Urana and Narrandera. Occurs in woodland with sandy soil, especially that dominated by White Cypress Pine (*Callitris glaucophylla*).	**Absent** Woodland with white cypress pine present adjacent to the development footprint	**Unlikely** Suitable habitat only exists outside development footprint	**No** Species may be present in woodland areas however these would not be impacted by the proposal
Crimson Spider Orchid *Caladenia concolor* **BC – E** **EPBC - V**	The current NSW Scientific Committee listing incorporates two populations which have each been described as separate species by D.L. Jones. One of these populations comprises a few hundred plants on private property near Bethungra and the other of about 100 plants occurs in Burrinjuck Nature reserve. The other occurrences of the Crimson Spider Orchid in NSW are from the Nail Can Hill Crown Reserve near Albury. The species also occurs at two localities in Victoria near Beechworth and Chiltern. Habitat is regrowth woodland on granite ridge country that has retained a high diversity of plant species, including other orchids.	**Absent** Associated species not present.	**Unlikely** Lack of suitable habitat, no known populations, no historical records.	**No** The proposal would not impact this species or its habitats.

Tarengo Leek Orchid *Prasophyllum petilum* **BC–E** **EPBC–E**	Natural populations are known from a total of five sites in NSW. These areas at Boorowa, Captains Flat, Ilford, Delegate and a newly recognised population c.10 k SE of Muswellbrook. It also occurs at Hall in the Australian Capital Territory. This species has also been recorded at Bowning Cemetery where it was experimentally introduced, though it is not known whether this population has persisted. Grows in grassy woodland in association with River Tussock *Poa labillardieri*, Black Gum *Eucalyptus aggregata* and tea–trees *Leptospermum* spp. at Captains Flat and within the grassy groundseayer dominated by Kangaroo Grass under Box–Gum Woodland.	**Absent** Associated species not present.	**Unlikely** Lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Prasophyllum Wybong **EPBC – CE**	Endemic to NSW. Known populations occur near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell, Tenterfield, Currabubula and the Pilliga area. Occurs within open eucalypt woodland and grassland.	**Absent** Eucalypt woodland only present outside the development footprint	**Unlikely** No known populations or historical records.	**No** The proposal is unlikely to impact this species or its habitats.
Pine Donkey Orchid *Diuris tricolor* **BC–V**	The Pine Donkey Orchid (formerly known as *Diuris sheaffiana*) is a terrestrial species that has a flower stalk 20–40 cm high. It is sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the far north of NSW. Localities include the Condobolin–Nymagee road, Wattamondara towards Cowra, Cooyal, Adelong, Red Hill north of Narrandera, Coolamon, near Darlington Point, Eugowra, Girilambone, Dubbo, Muswellbrook, and several sites west of Wagga Wagga. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats. Associated species include *Callitris glaucophylla, Eucalyptus populnea, Eucalyptus intertexta*, Ironbark and Acacia shrubland. The understorey is often grassy with herbaceous plants such as Bulbine species. Flowers from September to November or generally spring. The species is a tuberous, deciduous terrestrial orchid and the flowers have a pleasant, light sweet scent. It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. Usually recorded as common and locally frequent in populations, however only one or two plants have also been observed at sites. The species has been noted as growing in large colonies.	**Absent** Woodland with white cypress pine only present outside the development footprint	**Unlikely** No suitable habitat.	**Unlikely** Species may be present in woodland areas adjacent to proposal area however these would not be impacted by the proposal

EECs				
Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South–eastern Australia **BC–EEC** **EPBC–CE**	Inland Grey Box Woodland includes those woodlands in which the most characteristic tree species, *Eucalyptus microcarpa* (Inland Grey Box), is often found in association with *E. populnea subsp. bimbil* (Bimble or Poplar Box), *Callitris glaucophylla* (White Cypress Pine), *Brachychiton populneus* (Kurrajong), *Allocasuarina luehmannii* (Bulloak) or *E. melliodora* (Yellow Box), and sometimes with *E. albens* (White Box). Shrubs are typically sparse or absent, although this component can be diverse and may be locally common, especially in drier western portions of the community. A variable ground layer of grass and herbaceous species is present at most sites. At severely disturbed sites the ground layer may be absent. The community generally occurs as an open woodland 15–25m tall but in some locations the overstorey may be absent as a result of past clearing or thinning, leaving only an understorey. Inland Grey Box Woodland occurs predominately within the Riverina and South West Slopes regions of NSW down to the Victorian border. It includes Albury to the east and may extend out west towards Hay. This community also extends across the slopes and plains in Central and Northern NSW up to the Queensland Border. This includes Yetman and Inverell in the North, Molong to the east of the Central Slopes and plains and out towards Nymagee to the west.	**Present**	**Possible**	**Unlikely** Does not occur within proposal area.
White Box–Yellow Box–Blakely's Red Gum Grassy Woodland (and Derived Native Grassland) **BC–EEC** **EPBC–CE**	White Box – Yellow Box – Blakely's Red Gum EEC occurs in areas with moderate to highly fertile soils, on the tablelands and western slopes of NSW from the Queensland border to the Victorian border.	**Present**	**Possible** Box Gum Woodland identified adjacent to proposal area.	**No** Occurs outside proposal area. Unlikely to impact
Coolac – Tumut Serpentinite Shrubby Woodland in the NSW South Western Slopes	Coolac-Tumut Serpentinite Shrubby Woodland consists of an overstorey of drooping sheoak (Allocasuarina verticillata) with the shrubs hickory wattle (Acacia implexa), grasstrees (Xanthorrhoea glauca) and Ricinocarpos bowmanii.The groundlayer is consists of a range of native grasses and herbs,	**Absent**	**Absent**	**No**

and South Eastern Highlands Bioregions **BC - EEC**	often including kangaroo grass (Themeda australis), wiregrasses (Aristida spp.), wallaby grasses (Rytidosperma spp.), Senecio quadridentatus, rock fern (Cheilanthes seiberi) and Carex breviculmis. Scattered trees of white box (Eucalyptus albens) and bundy (Eucalyptus nortonii) can occur. Many sites are degraded and have a poor level of regeneration, no longer supporting the full compliment of species. Serpentinite Shrybby Woodland is restricted to soils derived from serpentinite in the Tumut-Coolac-Gundagai area. The largest occurrence is on the Honeysuckle range to the east of Tumut which extends from Argalong to the Murrumbidgee River. There are other smaller areas near Coolac and Gundagai.			
Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions **BC - EEC**	Tall woodland or open forest dominated by Fuzzy Box *Eucalyptus conica*, often with Grey Box *Eucalyptus microcarpa*, Yellow Box *Eucalyptus melliodora*, or Kurrajong *Brachychiton populneus*. Buloke *Allocasuarina luehmannii* is common in places. Shrubs are generally sparse, and the groundcover moderately dense, although this will vary with season. Alluvial soils of the South West Slopes, Brigalow Belt South and Darling Riverine Plains Bioregions. Mainly in the Dubbo-Narromine-Parkes-Forbes area.	**Absent**	**Absent**	**No**

E TSC = listed as Endangered under Schedule 1 of the NSW *Biodiversity Conservation Act 2016*

E EPBC = listed as Endangered under the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999.*

V TSC = listed as Vulnerable under Schedule 2 of the NSW *Biodiversity Conservation Act 2016.*

V EPBC = listed as Vulnerable under the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999.*

EEC TSC = Endangered Ecological Community listed under Schedule 1 of the NSW *BC Act 1995*

CE EPBC = listed as Critically Endangered under the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999.*

B.2 EVALUATION OF THE LIKELIHOOD AND EXTENT OF IMPACT ON THREATENED FAUNA SPECIES

Species and Status	*Description of habitat*[5]	*Presence of habitat*	*Likelihood of occurrence*	*Potential for impact?*
Aves				
Australian Painted Snipe *Rostratula australis* **BC–E** **EPBC–E**	Feed in shallow water or at waters' edge and on mudflats. Mostly in temporary or infrequently filled freshwater wetlands. Inhabits inland and coastal shallow freshwater wetlands. Occurs in ephemeral and permanent wetlands, particularly with cover of vegetation, including grasses, Lignum and Samphire. Known to use artificial habitats, such as sewage ponds, dams and waterlogged grassland.	**Absent** No shallow water, mudflats or wetlands present.	**Unlikely** Lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Superb Parrot *Polytelis swainsonii* **BC–V** **EPBC–V**	Inhabit Box–Gum, Box–Cypress–pine and Boree Woodlands and River Red Gum Forest. In Riverina nest in hollows of large trees mainly in tall riparian River Red Gum Forest or Woodland. On South West Slopes nest trees in open Box–Gum Woodland or isolated paddock trees.	**Present** Box-gum woodland, cypress pine.	**Present** Numerous records, nearest from 1.2 km away. Two observation during site visit adjacent to the proposal area.	**Yes.** AoS completed for this species.
Malleefowl *Leipoa ocellata* **BC–E**	Inhabit mallee communities, prefers tall, dense, floristically rich mallee in higher rainfall areas. Uses mallee with spinifex understorey, but lower	**Absent**	**Unlikely** Lack of suitable habitat.	**No** The proposal would not impact

[5] Information sourced from species profiles on NSW OEH (DPIE)'s threatened species database or the Australian Government's *Species Profiles and Threats* database (SPRAT) unless otherwise stated.

OEH (DPIE) threatened species database: http://www.threatenedspecies.environment.nsw.gov.au/index.aspx
SPRAT: http://www.environment.gov.au/cgi–bin/sprat/public/sprat.pl

EPBC–V	densities than areas with shrub understorey. Prefers light sandy to sandy loam soils with dense discontinuous canopy and diverse shrub and herb layers.	No mallee communities or spinifex present.		this species or its habitats.
Swift Parrot *Lathamus discolor* **BC–E** **EPBC–CE**	Occur in areas where eucalypts are flowering profusely or with abundant lerp (from sap–sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany, Spotted Gum, Red Bloodwood, Mugga Ironbark, and White Box, and lerp–infested trees Grey Box, Grey Box and Blackbutt.	**Present** Box-gum woodland.	**Possible** Four records, nearest from 2.2 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal
Painted Honeyeater *Grantiella picta* **BC–V** **EPBC–V**	Inhabits Boree/ Weeping Myall, Brigalow and Box–Gum Woodlands and Box–Ironbark Forests. Specialist feeder on fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of genus Amyema.	**Present** Box-gum woodland.	**Possible** Suitable habitat	**No** Species may be present in woodland areas however these are not to be impacted by the proposal
Australasian Bittern *Botaurus poiciloptilus* **BC–E** **EPBC–E**	In NSW, occurs along coast and frequently recorded in Murray–Darling Basin, notably in floodplain wetlands of Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bulrushes (Typha sp.) and spike–rushes (Eleocharis sp.).	**Absent** No wetlands or rushland.	**Unlikely** Lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Regent Honeyeater *Anthochaera phrygia* **BC–CE** **EPBC–CE**	Semi–nomadic, occurs in temperate eucalypt woodlands and open forests. Most records from box–ironbark eucalypt forest associations and wet lowland coastal forests.	**Present** Box-gum woodland.	**Possible** Suitable habitat	**No** Species may be present in woodland areas however these are not to be impacted by the proposal

Dusky Woodswallow *Artamus cyanopterus cyanopterus* **BC–V**	Dusky Woodswallow are widespread in eastern, southern and south western Australia. The species occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region. Most breeding activity occurs on the western slopes of the Great Dividing Range. Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understory of eucalypt saplings, acacias and other shrubs, and groundcover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland. Primarily eats invertebrates, mainly insects, which are captured whilst hovering or sallying above the canopy or over water. Depending on location and local climatic conditions (primarily temperature and rainfall), the Dusky Woodswallow can be resident year–round or migratory. In NSW, after breeding, birds migrate to the north of the state and to southeastern Queensland, while Tasmanian birds migrate to southeastern NSW. Migrants generally depart between March and May, heading south to breed again in spring. There is some evidence of site fidelity for breeding. Nest is an open, cup–shape, made of twigs, grass, fibrous rootlets and occasionally casuarina needles, and may be lined with grass, rootlets or infrequently horsehair, occasionally unlined. Nest sites vary greatly, but generally occur in shrubs or low trees, living or dead, horizontal or upright forks in branches, spouts, hollow stumps or logs, behind loose bark or in a hollow in the top of a wooden fence post.	**Present** Box-gum woodland.	**Possible** Five records, nearest 4.8 km away. Suitable habitat.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Bush Stone–curlew *Burhinus grallarius* **BC–E**	The Bush Stone–curlew is found throughout Australia except for the central southern coast and inland, the far south–east corner, and Tasmania. Only in northern Australia is it still common, however, and in the south–east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feeds on insects and small vertebrates, such as frogs, lizards and snakes. Nests on the ground in a scrape or small bare patch. Two eggs are laid in spring and early summer.	**Present** Open woodland present.	**Possible but Unlikely** Two records, nearest 8.3 km from proposal area. However suitable habitat is low quality and would not be impacted by the proposal.	**No** The proposal would not impact this species or its habitats.

Gang–gang Cockatoo *Callocephalon fimbriatum (Breeding)* **BC–V**	The Gang–gang Cockatoo is distributed from southern Victoria through south– and central–eastern New South Wales. In New South Wales, the Gang–gang Cockatoo is distributed from the south–east coast to the Hunter region, and inland to the Central Tablelands and south–west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier, more open eucalypt forests and woodlands, and often found in urban areas. May also occur in sub–alpine Snow Gum (*Eucalyptus pauciflora)* woodland and occasionally in temperate rainforests. Moves to lower altitudes in winter, preferring more open eucalypt forests and woodlands, particularly in box–ironbark assemblages, or in dry forest in coastal areas. Favours old growth attributes for nesting and roosting.	**Present** Box-gum woodland with hollow bearing trees.	**Possible** Suitable habitat.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Glossy Black–cockatoo *Calyptorhynchus lathami* **BC–V**	Glossy Black–cockatoos inhabit open forest and woodland of the coast and Great Dividing Range where stands of Sheoak occur. Inland populations feed on a wide range of she–oaks. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, and in open woodlands dominated by Belah. They are dependent on large hollow–bearing eucalypts for nesting.	**Present** Box-gum woodland with hollow bearing trees. Sheoak not present.	**Possible but Unlikely** Recorded three times within 10 km of the proposal area. Nearest record from 6.3 km away. Habitat not likely to be preferred as no food tree species present.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Speckled Warbler *Chthonicola sagittata* **BC–V**	Speckled Warblers live in a wide range of eucalypt dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth, and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	**Present** Box-gum woodland	**Possible but Unlikely** One record, 8.5 km from proposal area. Remnant vegetation is not large and undisturbed.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.

Spotted Harrier *Circus assimilis* **BC–V**	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	**Present** Box-gum woodland and agricultural land.	**Possible** Two records, nearest from 9.1 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae* **BC–V**	Brown Treecreepers are found in eucalypt woodlands (including Box–Gum woodland) and dry open forest of the inland slopes and plains west of the Great Dividing Range, mainly in woodlands dominated by Stringybarks or other rough–barked eucalypts, usually with an open grassy understorey and sometimes with one or more shrub species. They are also found in Mallee and River Red Gum forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. They are not usually found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging, and hollows in standing dead or live trees and tree stumps are essential for nesting.	**Present** Box-gum woodland	**Possible but Unlikely** Recorded 11 times within 10km of proposal area. Nearest record from 4.8 km away. Lack of fallen timber and rough barked eucalypts.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Varied Sittella *Daphoenositta chrysoptera* **BC–V**	Varied Sittellas inhabit eucalypt forests and woodlands, especially those containing rough–barked species and mature smooth–barked gums with dead branches, Mallee and Acacia woodland.	**Present** Box-gum woodland	**Possible but Unlikely** Two records, nearest from 7 km away. Lack of mallee and acacia.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Purple–crowned Lorikeet *Glossopsitta porphyrocephala*	Purple–crowned Lorikeets are found in open forests and woodlands, particularly where there are large flowering eucalypts, and in Mallee habitats. They feed primarily on the nectar and pollen of flowering eucalypts, including planted trees in urban areas.	**Present** Box-gum woodland	**Possible but Unlikely** No records within 10km of proposal area.	**No** The proposal would not impact this species or its habitats.

BC–V				
Little Lorikeet *Glossopsitta pusilla* *BC–V*	Little Lorikeets forage primarily in the canopy of open *Eucalyptus* forest and woodland, and finds food in *Angophora, Melaleuca* and other tree species. Riparian habitats are particularly used due to higher soil fertility and resulting greater productivity. Isolated flowering trees in open country, including paddocks, roadside remnants, and urban trees are also used. They typically select nesting hollows in the limbs and trunks of smooth–barked eucalypts, often in riparian areas, which are known to be used repeatedly for decades.	**Present** Box-gum woodland	**Possible but Unlikely** Two records, nearest from 7 km away. No riparian habitat.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
White–bellied Sea–Eagle *Haliaetus leucogaster* **BC–V** **EPBC - M**	White–bellied Sea–Eagles are a common sight in coastal and near coastal areas of Australia. Birds form permanent pairs that inhabit territories throughout the year. Their loud "goose–like" honking call is a familiar sound, particularly during the breeding season. Birds are normally seen perched high in a tree or soaring over waterways and adjacent land. In addition to Australia, the species is found in New Guinea, Indonesia, China, south–east Asia and India. The White–bellied Sea–Eagle feeds mainly off aquatic animals, such as fish, turtles and sea snakes, but it takes birds and mammals as well. It is a skilled hunter and will attack prey up to the size of a swan. Sea–Eagles also feed on carrion (dead prey) such as sheep and fish along the waterline. They harass smaller birds, forcing them to drop any food that they are carrying. Sea–Eagles feed alone, in pairs or in family groups. White–bellied Sea–Eagles build a large stick nest, which is used for many seasons in succession. The nest can be located in a tree up to 30m above the ground but may be also be placed on the ground or on rocks where there are no suitable trees. At the start of the breeding season (May to October), the nest is lined with fresh green leaves and twigs. The female carries out most of the incubation of the two white eggs, but the male performs this duty from time to time.	**Absent** No large open water near sources.	**Unlikely** One record from 5.5 km away, however lack of preferred habitat.	**No** The proposal would not impact this species or its habitats.
Little Eagle *Hieraaetus morphnoides* *BC–V*	The Little Eagle is a medium–sized bird of prey that is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. She oak or acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick	**Present** Box-gum woodland	**Possible** Eight records, nearest from 5.3 km away.	**No** Species may be present in woodland areas however these are

	nest in winter. Lays two or three eggs during spring, and young fledge in early summer. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.			not to be impacted by the proposal.
Major Mitchell's Cockatoo *Lophochroa leadbeateri* **BC–V**	Found across the arid and semi–arid inland, from south–western Queensland south to north–west Victoria, through most of South Australia, north into the south–west Northern Territory and across to the west coast between Shark Bay and about Jurien. In NSW it is found regularly as far east as about Bourke and Griffith, and sporadically further east than that. Inhabits a wide range of treed and treeless inland habitats, always within easy reach of water. Feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines. Normally found in pairs or small groups, though flocks of hundreds may be found where food is abundant. Nesting in tree hollows, occurs throughout the second half of the year; nests are at least 1km apart, with no more than one pair every 30 square kilometres.	**Present** Box-gum woodland	**Possible but Unlikely** No records. Lack of water sources nearby.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Square–tailed Kite *Lophoictinia isura* **BC–V**	The Square–tailed Kite ranges along coastal and subcoastal areas from south–western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north–east and along the major west–flowing river systems. It is a summer breeding migrant to the south–east, including the NSW south coast, arriving in September and leaving by March. Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. In arid north–western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. Appears to occupy large hunting ranges of more than 100km^2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.	**Absent** No timbered watercourses.	**Unlikely** Lack of preferred habitat, no records.	**No** The proposal would not impact this species or its habitats.
Hooded Robin (south–eastern form)	Hooded Robins prefer lightly wooded country, usually open eucalypt woodland, Acacia scrub and Mallee, often in or near clearings or open areas. They require structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs, and a ground layer of moderately tall native grasses.	**Absent**	**Possible but Unlikely** Three records, nearest from 7.4	**No** The proposal would not impact

Melanodryas cucullata cucullate **BC–V**		Box-gum woodland however lack of structural diversity.	km away. Unlikely preferred habitat.	this species or its habitats.
Black–chinned Honeyeater (eastern subspecies) *Melithreptus gularis gularis* **BC–V**	Black–chinned Honeyeaters occupy mostly the upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark, White Box, Grey Box, Yellow Box, Blakely's Red Gum, and Forest Red Gum. They also inhabit open forests of smooth–barked gums, stringybarks, ironbark's, tea trees, and river she–oaks.	**Present** Box-gum woodland.	**Possible but Unlikely** One record from 7.5 km away. Unlikely preferred habitat. No ironbarks.	**No** The proposal would not impact this species or its habitats.
Turquoise Parrot *Neophema pulchella* **BC–V**	Lives on edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December.	**Present** Box-gum woodland with hollow bearing trees.	**Possible** Two records, nearest from 2.1 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Powerful Owl *Ninox stenua* BC – V	In NSW the Powerful Owl lives in forests and woodlands occurring in the coastal, escarpment, tablelands and western slopes environments. Specific habitat requirements include eucalypt forests and woodlands on productive sites on gentle terrain; a mosaic of moist and dry types, with mesic gullies and permanent streams; presence of leafy sub-canopy trees or tall shrubs for roosting; presence of large old trees to provide nest hollows. Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal marsupials. Roosts in groves of dense mid-canopy trees or tall shrubs in sheltered gullies, typically on wide creek flats and at the heads of minor drainage lines, but also adjacent to cliff faces and below dry waterfalls. Species commonly used for roosting include the She-oaks Allocasuarina spp., rainforest species such as Coachwood Ceratopetalum apetalum, Lilly Pilly Acmena smithii and Sassafras Doryphora sassafras, Black Wattle Acacia melanoxylon, Turpentine Syncarpia glomulifera and eucalypts.	**Present** Box-gum woodland with hollow bearing trees.	**Possible** Three records, nearest from 8.9 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.

Barking Owl *Ninox connivens* **BC–V**	Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as *Acacia* and *Casuarina* species, or the dense clumps of canopy leaves in large *Eucalypts*. Feeds on a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding. Lives alone or in pairs. Territories range from 30 to 200 hectares and birds are present all year. Three eggs are laid in nests in hollows of large, old eucalypts including River Red Gum (*Eucalyptus camaldulensis*), White Box (*Eucalyptus albens*), Red Box (*Eucalyptus polyanthemos)* and Blakely's Red Gum (*Eucalyptus blakelyi*). Breeding occurs during late winter and early spring.	**Present** Box-gum woodland with hollow bearing trees.	**Possible but Unlikely** No historical records.	**No** The proposal would not impact this species or its habitats.
Gilbert's Whistler *Pachycephala inornata* **BC–V**	The Gilbert's Whistler is sparsely distributed over much of the arid and semi–arid zone of inland southern Australia, from the western slopes of NSW to the Western Australian wheatbelt. The species was probably once distributed almost continuously across the woodlands and mallee of southern NSW, but this range has been greatly reduced, chiefly by clearance of habitat. The Gilbert's Whistler occurs in a range of habitats within NSW, though the shared feature appears to be a dense shrub layer.	**Absent** Box-gum woodland however lack of dense shrub layer.	**Unlikely** Three records, nearest from 6.8 km away. Lack of suitable habitat on site.	**No** The proposal would not impact this species or its habitats.
Scarlet Robin *Petroica boodang* **BC–V**	The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea–tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude. The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. In autumn and	**Present** Box-gum woodland with open understorey.	**Possible but Unlikely** No historical records.	**No** The proposal would not impact this species or its habitats.

	winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees. Birds forage from low perches, fenceposts or on the ground, from where they pounce on small insects and other invertebrates which are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer. Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season. This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork of tree usually more than 2 metres above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub. Birds usually occur singly or in pairs, occasionally in small family parties; pairs stay together year–round. In autumn and winter, the Scarlet Robin joins mixed flocks of other small insectivorous birds which forage through dry forests and woodlands.			
Flame Robin *Petroica phoenicea* **BC–V**	Flame Robins breed in upland tall moist eucalypt forests and woodlands, often on ridges and slopes, where they prefer clearings or areas with open understoreys. In winter, they migrate to drier and more open habitats in the lowlands, including dry forests, open woodlands, and pastures and native grasslands with or without scattered trees.	**Present** Box-gum woodland with open understorey.	**Possible** Two records, nearest from 7 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Grey–crowned Babbler (eastern subspecies) *Pomatostomus temporalis temporalis* **BC–V**	Grey–crowned Babbler Inhabits open Box–Gum Woodlands on the slopes, and Box–Cypress–pine and open Box Woodlands on alluvial plains. They feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts.	**Present** Box-gum woodland.	**Possible** One record from 1.2 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Diamond Firetail *Stagonopleura guttata* **BC–V**	Diamond Firetails are found in grassy eucalypt woodlands, including Box–Gum woodlands, as well as open forest, Mallee, natural temperate grassland, secondary grassland derived from other communities, and lightly wooded farmland.	**Present** Box-gum woodland.	**Possible** Three records, nearest from 7 km away.	**No** Species may be present in woodland areas

				however these are not to be impacted by the proposal.
Masked Owl *Tyto novaehollandiae* **BC–V**	Extends from the coast where it is most abundant to the western plains. Lives in dry eucalypt forests and woodlands from sea level to 1100m. Habitat for this species is also widespread throughout the dry eucalypt forests of the tablelands, western slopes and the undulating wet–dry forests of the coast. Optimal habitat includes an open understorey and a mosaic of sparse (grassy) and dense (shrubby) groundcover on gentle terrain. Roosts in hollows in live or occasionally dead eucalypts; dense foliage in gullies; and caves. Nest in old hollow eucalypts, live or dead, in a variety of topographic positions, with hollows greater than 40cm wide and greater than 100cm deep. Hollow entrances are at least 3m above ground in trees of at least 90cm diameter at breast height. A specialist predator of terrestrial mammals, particularly native rodents. Home range has been estimated as 400–1000ha according to habitat productivity.	**Present** Box-gum woodland with hollo bearing trees.	**Possible but Unlikely** No historical records.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Black Falcon *Falco subniger* **BC – V**	Widely but sparsely distributed within NSW. Mostly occurs within inland regions. Easley and often confused with Brown Falcon. Highly mobile known to travel hundreds of kilometres. Often found around tree–lined watercourses and in isolated woodlands, mainly in arid and semi–arid areas.	**Absent** No tree lined watercourses.	**Unlikely** Three records, nearest 9.3 km away. However lack of suitable habitat and species highly mobile.	**No** The proposal would not impact this species or its habitats.
White–fronted Chat *Epthianura albifrons* **BC–V**	Damp, open habitat. Includes saltmarsh, coastal dunes, edges of marshland and pastures. Predominately wetland habitat.	**Absent** No damp open habitat or wetlands present.	**Unlikely** Recorded twice, nearest record 5.6 km away. However lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Brolga *Grus rubicunda*	Often feed in dry grassland or ploughed paddocks or desert claypans, but dependent on wetlands, especially shallow swamps. The nest comprises a	**Absent** No wetlands or shallow swamps.	**Unlikely** Two records, nearest from 2 km	**No** The proposal would not impact

BC–V	platform of grasses and sticks, augmented with mud, on an island or in the water.		away. Lack of preferred habitat in proposal area.	this species or its habitats.
Invertebrates				
Synemon plana Golden Sun Moth **BC - E** **EPBC - CE**	The Golden Sun Moth is a medium-sized, day-flying (diurnal) moth. Females have a wing-span of 31 mm; the male's wingspan is 34 mm. The female has a reduced hind-wing and is a very poor flyer. The female's upperside of the fore-wing is dark grey, patterned with paler grey, and the hindwing is bright orange with black spots near the edge. The undersides of both wings is white with small black spots near the edges. The male's upperside of the fore-wing is dark brown, patterned with pale grey, and the hind-wing is bronzy-brown with dark brown patches. The undersides of both wings is pale grey with dark brown spots. Both males and females have clubbed antennae. Functional mouthparts are lacking in both sexes. The immature stages have not been described. The Golden Sun Moth's NSW populations are found in the area between Queanbeyan, Gunning, Young and Tumut. The species' historical distribution extended from Bathurst (central NSW) through the NSW Southern Tablelands, through to central and western Victoria, to Bordertown in eastern South Australia.	**Absent** Spear grasses present., however no wallaby grass observed.	**Unlikely** No historical records and lack of preferred grass species.	**No** The proposal would not impact this species or its habitats.
Fish				
Flathead Galaxias *Galaxias rostratus* **EPBC–CE**	Below 150 m in altitude. Billabongs, lakes, swamps, and rivers, with preference for still or slow–flowing waters.	**Absent** No aquatic habitat.	**Unlikely** No habitat present.	**No** The proposal would not impact this species or its habitats.
Murray Cod *Maccullochella peelii* **EPBC–V**	Lived in wide range of habitats from clear, rocky streams to slow flowing, turbid rivers and billabongs of western plains. Generally found in waters up to 5m deep and in sheltered areas with cover.	**Absent** No aquatic habitat.	**Unlikely** No habitat present.	**No** The proposal would not impact this species or its habitats.

Macquarie Perch *Macquaria australasica* **FM–E** **EPBC–E**	Found in Murray–Darling Basin (particularly upstream reaches) of Lachlan, Murrumbidgee and Murray Rivers, and parts of south–eastern coastal NSW, including Hawkesbury and Shoalhaven.	**Absent** No aquatic habitat.	**Unlikely** No habitat present.	**No** The proposal would not impact this species or its habitats.
Mammals				
Koala *Phascolarctos cinereus* **BC–V** **EPBC–V**	Koalas inhabit a range of temperate, subtropical and tropical eucalypt woodlands and forests where suitable food trees grow, of which there are more than 70 eucalypt species and 30 non–eucalypt species that are particularly abundant on fertile clay soils.	**Present** Box-gum woodland present.	**Unlikely** Four records, nearest from 5.1 km away. No records within the last 10 years. One secondary food tree species observed (Western Grey Box).	**No** Species not likely to be present. Refer to Section 2.4
Corben's Long–eared Bat *Nyctophilus corbeni* **BC–V** **EPBC–V**	Corben's Long–eared Bats inhabit a variety of vegetation types, most commonly Mallee, Bulloke, and Box–dominated communities, but are most common in vegetation which has a distinct canopy and dense understorey. They roost in tree hollows, crevices, and under loose bark.	**Absent** Box-gum woodland with hollow bearing trees.	**Possible** Suitable habitat.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Yellow-bellied Glider *Petaurus australis* **BC – V**	The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south.	**Absent** Box-gum woodland with hollow bearing trees.	**Possible** Suitable habitat.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.

Falsistrellus tasmaniensis Eastern False Pipistrelle **BC - V**	The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	**Absent** Box-gum woodland with hollow bearing trees.	**Possible** Suitable habitat.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Large–eared Pied Bat *Chalinolobus dwyeri* **BC–V**	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle–shaped mud nests of the Fairy Martin (*Hirundo ariel*), frequenting low to mid–elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20–40 females) from November through to January in roof domes in sandstone caves. Found in well–timbered areas containing gullies. This species probably forages for small, flying insects below the forest canopy. Likely to hibernate through the coolest months. It is uncertain whether mating occurs early in winter or in spring.	**Absent** Lack of well-timbered areas with gullies. No suitable roosting habitat.	**Unlikely** Lack of habitat requirements.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Large Bent–winged Bat *Miniopterus orianae oceanensis* *BC*– **V**	Primary roost habitat are caves, also use mines, storm–water tunnels and other man–made structures. Young are also raised within caves. Maternity caves have specific temperature and humidity regimes. Outside of breeding season populations can disperse up to 300m from maternity caves. Breeding colonies can reach numbers up to 150, 000 individuals. Foraging occurs within forests areas above treetops where insects are a primary food source.	**Absent** No caves for roosting habitat.	**Unlikely** 1 record from 5.5 km away however lack of preferred habitat on site.	**No** The proposal would not impact this species or its habitats.
Southern Myotis *Myotis macropus* **BC–V**	Rarely found more than 100 km inland, except along major rivers. Roost in groups close to water in caves, mine shafts, hollow–bearing trees, storm water channels, buildings, dense foliage and under bridges.	**Absent** More than 100 km inland and no adjacent major rivers.	**Unlikely** One record from 4.9 km away however lack of preferred habitat on site.	**No** The proposal would not impact this species or its habitats.

Inland Forest Bat *Vespadelus baverstocki* *BC – V*	Species identification can be difficult; therefore NSW distribution is poorly known. Generally known to occur within areas of less than 400mm of rainfall annually. Within NSW most records are far south west, north from the Murray River to Menindee, and as far east as the Balranald–Ivanhoe Road. Some evidence suggests species may also occur within Mallee. Some records within the Culgoa River. Roosts within tree hollows and abandoned buildings. Know to roost in very small hollows in stunted trees only a few meters tall. Habitat requirements of this species are poorly known, has been recorded in a variety of woodland formations, including mallee, mulga and River Red Gum. Most records are drier woodland habitat near riparian areas. Often inhabited by same areas as Little Forest Bat. Foraging habitat is poorly known.	**Present** Box-gum woodland with hollow bearing trees.	**Possible** One record from 9.6 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Yellow–bellied Sheathtail Bat *Saccolaimus flaviventris* **BC–V**	Yellow–bellied Sheathtail–bats have a broad distribution, foraging in most forested and clear habitats, and roost in tree hollows and buildings, or in mammal burrows in cleared areas.	**Present** Box-gum woodland with hollow bearing trees.	**Possible** One record from 4.6 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Spotted–tailed Quoll *Dasyurus maculatus* **BC–V** **EPBC–E**	Spotted–tailed Quolls have been recorded in a range of habitat types, including open forest, woodland, and inland riparian forest, where they use hollow–bearing trees, fallen logs, small caves, rock outcrops, and rocky cliff faces as den sites. Females occupy home ranges of up to about 750 ha and males up to 3500 ha.	**Absent** No suitable den sites.	**Unlikely** No historical records and lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Grey–headed Flying–fox *Pteropus poliocephalus* **BC–V** **EPBC–V**	Grey–headed Flying–foxes roost and forage in a range of vegetation communities including rainforest, open forest, and closed and open woodland. Roost sites are usually near water, including lakes, rivers, and coastlines.	**Present** Box-gum woodland with hollow bearing trees.	**Possible** Eleven records, nearest from 1.3 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal. No camps are identified within the proposal area on

				the National Flying-fox monitoring viewer.
Eastern Pygmy–possum *Cercartetus nanus* **BC – V**	Rainforest, sclerophyll forest, heath. Woodland and heath appear to be preferred. Feeds largely on banksia, eucalypts and bottlebrush. Shelters (goes into torpor during winter) in tree hollows, rotten stumps, ground holes, abandoned bird nests, or vegetation thickets. Breeds in tree hollows or in spherical nests under tree bark.	**Present** Box-gum woodland with hollow bearing trees. Lack of food tree species.	**Unlikely** No historical records. Habitat unlikely to be preferred.	**No** The proposal would not impact this species or its habitats.
Squirrel Gilder *Petaurus norfolcensis* **BC – V**	Woodland and open forest with eucalypts. Often with midstorey of Acacia and Banksia. Prefers mature old growth box, box–ironbark woodland, River Red Gum forest. Requires hollow bearing tree's, for refuge, resting and breeding. Feeds on Acacia gum, eucalypt sap, nectar, honeydew and mana. Feeds on invertebrates and pollen for protein.	**Present** Box-gum woodland with hollow bearing trees. Lack of food tree species.	**Possible but Unlikely** Numerous records within 10 km, nearest from 800 m away. Habitat unlikely to be preferred.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Brush–tailed Rock–wallaby *Petrogale penicillata* BC–E **EPBC – V**	The range of the Brush–tailed Rock–wallaby extends from south–east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. The species' range is now fragmented, particularly in the south where they are now mostly found as small isolated populations dotted across their former range. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit. Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Throughout their range, Brush–tailed Rock–wallabies feed on a wide variety of grasses and shrubs and have flexible dietary requirements. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15 ha. Live in family groups of 2 – 5 adults and usually one or two juvenile and sub–adult individuals. Dominant males associate and breed with up to four females. Breeding is likely to be continuous, at least in the southern populations, with no apparent seasonal trends in births.	**Absent** No rocky habitat present.	**Unlikely** One record from 3.9 km away. However lack for preferred habitat.	**No** The proposal would not impact this species or its habitats.

Brush–tailed Phascogale *Phascogale tapoatafa* **BC–V**	Brush–tailed Phascogales prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs, or leaf litter. Females have exclusive territories of around 20 – 40 ha, while males have overlapping territories often greater than 100 ha.	**Present** Box-gum woodland and hollow bearing trees.	**Unlikely** No historical records.	**No** The proposal would not impact this species or its habitats
Amphibians				
Growling Grass Frog / Southern Bell Frog *Litoria raniformis* **EPBC – V** **BC – E**	Southern Bell Frogs are only known to exist in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain, and around Lake Victoria. The species is usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps or billabongs along floodplains and river valleys, and where there is no available natural habitat, they may occur in irrigated rice crops.	**Absent** No suitable aquatic habitat.	**Unlikely** No historical records. Lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Sloane's Froglet *Crinia sloanei* **BC – V** **EPBC – E**	Associated with periodically inundated areas in grassland, woodland and disturbed habitats. Floodplains. Known historic distribution within central Victoria and central western NSW as far north as the QLD border. Little is currently known about the species. Eggs are laid on substrate or attachment to submerged vegetation. Within NSW this species is the most infrequently recorded. Species distribution may have some links to box–gum woodland, however this has not been researched. Significant known populations for species recovery are located within Albury, particularly Thurgoona, Corowa and north–east Victoria.	**Absent** No suitable aquatic habitat.	**Unlikely** No historical records. Lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.
Booroolong Frog *Litoria booroolongensis* **BC – E** **EPBC - E**	The Booroolong Frog is a medium sized tree frog, with adults growing to about 5 cm. Their body-colour may be grey, olive or brown with indistinct black markings. The abdomen is white. The skin usually has a slightly warty appearance. The fingers and toes have well developed discs, and the toes are strongly webbed. The Booroolong Frog is restricted to NSW and north-eastern Victoria, predominantly along the western-flowing streams of the Great Dividing Range. It has disappeared from much of the Northern Tablelands, however several populations have recently been recorded in the Namoi catchment. Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses with riffles, cobble banks and other rock structures	**Absent** No suitable aquatic habitat.	**Unlikely** No historical records. Lack of suitable habitat.	**No** The proposal would not impact this species or its habitats.

	within stream margins. Breeding occurs in spring and early summer and tadpoles metamorphose in late summer to early autumn.			
Reptiles				
Pink–tailed Legless Lizard *Aprasia parapulchella* **BC–V** **EPBC–V**	Pink–tailed Legless Lizards inhabit sloping open woodland areas with groundcover dominated by native grasses, typically those which are well–drained with rocky outcrops or scattered, partly–buried rocks.	**Absent** Native grasses not dominant. Lack of rocky outcrops or partly-buried rocks.	**Unlikely** No historical records.	**No** The proposal would not impact this species or its habitats.
Varanus rosenbergi Rosenberg's Goanna **BC - V**	Rosenberg's Goanna occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. There are records from the South West Slopes near Khancoban and Tooma River. Also occurs in South Australia and Western Australia. Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component.	**Absent** No termite mounds observed.	**Unlikely** No historical records.	**No** The proposal would not impact this species or its habitats.
Striped Legless Lizard *Delma impar* **BC–V** **EPBC–V**	Found mainly in Natural Temperate Grassland but has also been captured in grasslands that have a high exotic component. Also found in secondary grassland near Natural Temperate Grassland and occasionally in open Box–Gum Woodland. Habitat is where grassland is dominated by perennial, tussock–forming grasses such as Kangaroo Grass *Themeda australis*, spear–grasses *Austrostipa spp.* and poa tussocks *Poa spp*., and occasionally wallaby grasses *Austrodanthonia spp*. Sometimes present in modified grasslands with a significant content of exotic grasses such as *Phalaris aquatica, Nasella trichotoma* and *Hypocharis radicata*. Sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter.	**Present** Some areas of spear grasses.	**Unlikely** No historical records. Impact areas not dominated by native grasses.	**No** The proposal would not impact this species or its habitats.
Pale Headed Snake	A patchy distribution from north–east Queensland to north–east NSW. In NSW it occurs from the coast to the western side of the Great Divide as far south as	**Present**	**Unlikely**	**No**

Hoplocephalus bitorquatus **BC–V**	Tuggerah. Found mainly in dry eucalypt forests and woodlands, cypress woodland and occasionally in rainforest or moist eucalypt forest. Favours streamside areas, particularly in drier habitats. Shelter during the day between loose bark and tree–trunks, or in hollow trunks and limbs of dead trees. The main prey is tree frogs although lizards and small mammals are also taken.	Box-gum woodland and cypress pine present.	No historical records.	The proposal would not impact this species or its habitats.
Endangered Populations				
Squirrel Glider's in wagga Local Government Area BC – Endangered Population	Woodland and open forest with eucalypts. Often with midstory of Acacia and Banksia. Prefers mature old growth box, box–ironbark woodland, River Red Gum forest. Requires hollow bearing trees, for refuge, resting and breeding. Feeds on Acacia gum, eucalypt sap, nectar, honeydew and mana. Feeds on invertebrates and pollen for protein.	**Present** Box-gum woodland with hollow bearing trees.	**Possible** Numerous records within 10 km, nearest from 800 m away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.
Migratory				
Fork-tailed Swift *Apus pacificus* **EPBC - M**	Almost exclusively aerial. Mostly occur over inland plains, with dry or open habitats, including riparian woodland and tea tree swamps, low scrub, heathland or saltmarsh. Also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand dunes.	**Present** Box-gum woodland.	**Unlikely** No historical records.	**No** The proposal would not impact this species or its habitats.
White-throated Needletail *Hirundapus caudacutus* **EPBC – V** **EPBC - M**	The White–throated Needletail is widespread in eastern and south–eastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. Further south on the mainland, it is widespread in Victoria, though more so on and south of the Great Divide, and there are few records in western Victoria outside the Grampians and the South West. The species occurs in adjacent areas of south–eastern South Australia, where it extends west to the Yorke Peninsula and the Mount Lofty Ranges. It is widespread in Tasmania. In Australia, the White–throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. Although they occur over most types of habitat, they are probably recorded most often	**Present** Box-gum woodland.	**Possible** One record from 8.5 km away.	**No** Species may be present in woodland areas however these are not to be impacted by the proposal.

	above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland. They also commonly occur over heathland, but less often over treeless areas, such as grassland or swamps. When flying above farmland, they are more often recorded above partly cleared pasture, plantations or remnant vegetation at the edge of paddocks. In coastal areas, they are sometimes seen flying over sandy beaches or mudflats and often around coastal cliffs and other areas with prominent updraughts, such as ridges and sand–dunes.			
Yellow Wagtail *Motacilla flava* **EPBC - M**	Variable habitat, but typically flat, open, grassy area near water, which may include grasslands, air strips, pastures, sports fields, and edges of wetlands, rivers, and dams.	**Present** Agricultural land and dam present.	**Unlikely** Low quality habitat, no historical records.	**No** The proposal would not impact this species or its habitats.
Satin Flycatcher *Myiagra cyanoleuca* **EPBC - M**	Found along east coast of Australia from far northern Queensland to Tasmania, including south–eastern South Australia. Also found in New Guinea. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests. Migratory species, moving northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring.	**Absent** Lack of tall forest habitat.	**Unlikely** No historical records.	**No** The proposal would not impact this species or its habitats.
Common Sandpiper *Actitis hypoleucos* **EPBC - M**	Wide range of coastal wetlands and some inland wetlands, with varying salinity, mostly found around muddy margins or rocky shores and rarely on mudflats. Recorded in estuaries and deltas of streams and on banks upstream, around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. Muddy margins often narrow and may be steep. Often associated with mangroves, sometimes areas of mud littered with rocks or snags.	**Absent** No coastal or wetland habitat.	**Unlikely** No historical records. No suitable habitat.	**No** The proposal would not impact this species or its habitats.
Sharp-tailed Sandpiper *Calidris acuminata*	Prefers muddy edges of shallow wetlands, with inundated or emergent sedges, grass, saltmarsh, or other low vegetation. Inland, includes dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline lakes, saltworks and sewage farms, flooded paddocks, sedge lands and other	**Absent** No wetland habitat.	**Unlikely** No historical records. No suitable habitat.	**No** The proposal would not impact this species or its habitats.

EPBC - M	ephemeral wetlands, leaving when dry, and swamps and creeks with mangroves.			
Curlew Sandpiper *Calidris ferruginea* **EPBC – CE** **EPBC - M**	Mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and around non–tidal swamps, lakes and lagoons near coast, and ponds in saltworks and sewage farms. Also recorded inland, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand.	**Absent** No coastal or wetland habitat.	**Unlikely** One record 9.3 km from proposal area. Dam near Proposal area unlikely to support this species.	**No** The proposal would not impact this species or its habitats.
Pectoral Sandpiper *Calidris melanotos* **EPBC - M**	Breeds in high–arctic tundra in Siberia and arctic Alaska and Canada. Small number known to reach Australia and believed to be concentrated in south–eastern Australia. Prefers freshwater mudflats.	**Absent** No freshwater mudflats.	**Unlikely** No historical records. No suitable habitat.	**No** The proposal would not impact this species or its habitats.
Latham's Snipe, *Gallinago hardwickii* **EPBC - M**	Occurs in permanent and ephemeral wetlands up to 2000 m above sea–level. Usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). Can occur in modified or artificial habitats, close to humans or human activity.	**Absent** No permanent wetlands.	**Unlikely** No historical records. No suitable habitat.	**No** The proposal would not impact this species or its habitats.
Eastern Curlew, *Numenius madagascariensis* **EPBC – CE** **EPBC - M**	Sheltered coasts including estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds seagrass.	**Absent** No coastal habitat.	**Unlikely** No historical records. No suitable habitat.	**No** The proposal would not impact this species or its habitats.

APPENDIX C ASSESSMENTS OF SIGNIFICANCE

C.1 BIODIVERSITY CONSERVATION ACT 5 PART TEST

Section 7.3 of the *Biodiversity Conservation Act 2016* specifies five factors to be taken into account in deciding whether a development is likely to significantly affect threatened species, populations or ecological communities, or their habitats, listed at the state level under the Act.

This *Five–part Test* characterises the significance of likely impacts associated with the proposal on the following species:

Flora

- Small Scurf-pea (*Cullen parvum*) – BC – E
- A Spear-grass (*Austrostipa wakoolica*) – BC – E, EPBC - E

Fauna

- Superb Parrot *(Polytelis swainsonii)* – BC – V, EPBC - V

a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Small Scurf-pea and A Spear-grass

Potential habitat for the Small Scurf-pea and Spear-grass exists in the form of open exotic grassland. There are no known populations or historical records of these species within the study area. The proposal will involve clearing/disturbance of an already highly modified habitat. The area of habitat to be impacted is small given the local context. Therefore, the proposal is unlikely to adversely effect the life cycle of these species such that a viable local population of the species is likely to be placed at risk of extinction.

Superb Parrot

The proposal will not involve the removal of any native vegetation and therefore only exotic grassland foraging habitat would be impacted. Tracts of native vegetation adjacent to the proposal area will remain and provide habitat for this species. The proposal area itself is not considered important habitat for this species.

No breeding habitat (hollow bearing trees) will be impacted and therefore the proposal is unlikely to adversely affect the life cycle of these species such that a viable local population of the species is likely to be placed at risk of extinction.

b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- ***a. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***
- ***b. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

Small Scurf-pea and A Spear-grass

Not applicable.

Superb Parrot

Not applicable.

c) In relation to the habitat of a threatened species or ecological community:

i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long–term survival of the species or ecological community in the locality.

Small Scurf-pea and A Spear-grass

I. A small area in comparison to the local context will be disturbed. This includes 40.83 ha of exotic vegetation (cropped pasture and exotic grassland). Native vegetation remnants adjacent to the proposal area will be impacted.

II. No further fragmentation of isolation is expected to occur due to the proposal. Existing fragmentation will not be increased as the proposal area is already disturbed. Mitigation measures will be followed to ensure threatened species are not impacted.

III. The area of habitat to be disturbed/removed is small given the local context. This habitat is not likely to be important for these threatened species, given the previous agricultural disturbance.

Superb Parrot

I. A small area in comparison to the local context will be disturbed. This includes 40.83 ha of exotic vegetation (cropped pasture and exotic grassland). Native vegetation remnants adjacent to the proposal area will be impacted.

II. No further fragmentation of isolation is expected to occur due to the proposal. Existing fragmentation will not be increased as the proposal area is already disturbed. Mitigation measures will be followed to ensure threatened species are not impacted.

III. The area of habitat to be disturbed/removed is small given the local context. This habitat is not likely to be important for these threatened species, given the previous agricultural disturbance.

d) Whether the action proposed is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).

No areas of outstanding biodiversity value occur within or adjacent to the proposal area. There would be no adverse direct or indirect effects on any declared areas of outstanding biodiversity value.

e) Whether the action proposed constitutes or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Key Threatening Processes (KTPs) relevant to the proposal include the following:

I. Clearing of native vegetation

The clearing of native vegetation is considered a major contributor to the loss of biodiversity. In the Scientific Committee's determination, it was found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity.' Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation and off–site impacts such as downstream sedimentation. 40.83 ha of exotic vegetation would be cleared/disturbed as a result of the proposal. This area includes some native species.

The proposal has the potential to increase the impact of this KTP. However, the contribution of this proposal would be relatively minor given the relatively small amount of fragmented habitat to be removed and the area of habitat that would remain in the study area.

II. Invasion and establishment of exotic vines and scramblers

The proposal has the potential to contribute to the spread of exotic species in the proposal area through the transfer and introduction of plant material and soil on machinery. The proposal would be likely to make only a minor contribution to this KTP.

III. Invasion of native plant communities by exotic perennial grasses

Exotic perennial grasses are currently dominant throughout the proposal area. The proposal has the potential to contribute to the introduction or spread of exotic perennial grasses to the study area through the transfer and introduction of plant material and soil on machinery. The proposal would be likely to make only a minor contribution to this KTP.

CONCLUSION

The impacts of the proposal on the assessed threatened species listed under the BC Act are considered to be manageable. A significant threat is considered unlikely based on the following conclusions:

1 The amount of habitat to be removed or disturbed by the proposal is relatively small in an already fragmented area.
2 No further fragmentation of the habitat would occur.
3 No substantial contribution to any key threatening process would be expected.

Mitigation measures listed in Section 6 would be implemented to prevent disruptions to the life cycle or harm to individual animals of these species.

C.2 2 EPBC ACT PRINCIPAL SIGNIFICANT IMPACT ASSESSMENT

C2.1 Vulnerable Species

The *Environment Protection and Biodiversity Conservation Act 1999* specifies factors to be taken into account in deciding whether a development is likely to significantly affect Endangered Ecological Communities, threatened species and migratory species, listed at the Commonwealth level. These assessments characterise the significance of likely impacts associated with the proposal on the following **Vulnerable** species:

- Superb Parrot (*Polytelis swainsonii*) – BC – V, EPBC – V

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

a) Will the action lead to a long–term decrease in the size of an important population of a species?

Superb Parrot (*Polytelis swainsonii*)

The National Recovery Plan for the Superb Parrot, Figure 1, lists Wagga Wagga as an area where breeding is likely to occur. The population within Wagga Wagga may thus be an important population.

Potential foraging habitat for this species occurs adjacent to the proposal area in the form of PCT vegetation, and hollow bearing trees. Two superb parrots were detected during the field survey. There are several records for this species within the Wagga Wagga LGA, with the closest 1.2 km from the proposal area.

The proposal w**ould** not involve the removal of any native vegetation and therefore only exotic grassland foraging habitat would be impacted. Tracts of native vegetation adjacent to the proposal area w**ould** remain and provide habitat for this species. The proposal area itself is not considered important habitat for this species.

The National Recovery Plan for states this species is known to dislike disturbance and has been recorded avoiding hollow use due to human presence. The area has already been heavily disturbed by agricultural activities. The proposal will not lead to a long-term decrease in the size of an important population of this species.

b) Will the action reduce the area of occupancy of an important population of a species?

Superb Parrot (*Polytelis swainsonii*)

The proposal would result in the removal of around 40.83 ha of potential foraging habitat for this species, which exists in the form of exotic vegetation. The proposal area is not located in a known important population of these species. In this context, the removal of a relatively small area of foraging habitat as a result of the proposal is considered unlikely to reduce the area of occupancy of an important population of this species.

c) Will the action fragment an existing important population into two or more populations?

Superb Parrot (*Polytelis swainsonii*)

The proposal would result in the removal of around 40.83 ha of potential habitat for this species, which exists in exists in the form of exotic vegetation. The proposal area is agricultural land and contains no hollow bearing trees. Suitable habitat for this species exists adjacent to the proposal area. Vegetation disturbance is not expected to impact movement of this species between remnant vegetation patches.

The proposal would not impact any hollow bearing tees, which are the preferred breeding criteria for the Superb Parrot. Therefore, it is unlikely to impact on any potential breeding habitat. There is a remnant native vegetation within the locality. The proposal area is not located in a known important population of these species. The proposal would not fragment an existing important population into two or more populations.

d) Will the action adversely affect habitat critical to the survival of a species?

Superb Parrot (*Polytelis swainsonii*)

Critical breeding habitat, (relevant to this report) for this species within the Riverina is Box-gum Woodlands along the Murrumbidgee River, large trees, including River Red Gum (*E. camaldulensis*) with many hollows, typically located an average of 25m from watercourses (Baker-Gabb, 2011).

Box- gum Woodland with large hollow bearing trees is present adjacent to the proposal area. However, it is approximately 8 km from the Murrumbidgee River. This vegetation will not be impacted by the proposal.

e) Will the action disrupt the breeding cycle of an important population?

Superb Parrot (*Polytelis swainsonii*)

The proposal area is agricultural land with no hollow-bearing trees. This Species requires an abundance of hollow bearing trees for nesting as they nest colonially.

The proposal does not meet the breeding criteria for the Superb Parrot. Therefore, the proposal will not disrupt the breeding cycle of this species.

f) Will the action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Superb Parrot (*Polytelis swainsonii*)

The proposal area is agricultural land with no hollow-bearing trees. The habitat within the proposal area is not considered habitat critical to the survival of this species. This species is known to reside within the proposal area.

The proposal area only contains a small amount of potential foraging habitat for this species in the form of a exotic grassland. The removal of 40.83 ha of exotic vegetation from the proposal is unlikely to impact the distribution of this species as it is not near the known roosting colony within Wagga Wagga. The proposal will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

g) Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The proposal has the potential to contribute to the spread of invasive species in the proposal area through the transfer and introduction of plant material and soil on machinery. Mitigation measures have been recommended to prevent the spread of weeds on site. The proposal would therefore be unlikely to result in invasive species that are harmful to these species becoming established in their potential habitat.

h) Will the action introduce disease that may cause the species to decline?

There is a risk that pathogens could be established or spread in the proposal area via machinery during construction. However, with the recommended mitigation measures, the action would be unlikely to introduce any disease which may cause the species to decline.

i) Will the action interfere substantially with the recovery of the species?

Superb Parrot (*Polytelis swainsonii*)

The National Recovery Plan for Superb Parrot lists the following specific objectives:

1. Determine population trends in the Superb Parrot.
2. Increase the level of knowledge of the Superb Parrot's ecological requirements.

3. Develop and implement threat abatement strategies.
4. Increase community involvement in and awareness of the Superb Parrot recovery program.

The proposal would not interfere with any of these objectives.

Conclusion

The impacts of the proposal on the assessed vulnerable species listed under the EPBC Act are considered to be manageable. A significant impact is considered unlikely based on the following conclusions:

1. The amount of habitat to be removed or disturbed by the proposal is relatively small in the context of the greater area of habitat that would remain.
2. No further fragmentation of habitat would occur.
3. No substantial contribution to any key threatening process would be expected.
4. Mitigation measures would be implemented to prevent significant impact to these species.

C2.2 Critically Endangered or Endangered Species

The *Environment Protection and Biodiversity Conservation Act* 1999 specifies factors to be taken into account in deciding whether a development is likely to significantly affect Endangered Ecological Communities, threatened species and migratory species, listed at the Commonwealth level.

The following assessment assesses the significance of the likely impacts associated with the proposal on the **critically endangered** or **endangered** species:

- Hoary Sunray (*Leucochrysum albicans var. tricolor*) – EPBC – E
- A Spear-grass (*Austrostipa wakoolica*) – EPBC – E, BC - E

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

a) Will the action lead to a long-term decrease in the size of a population of a species?

Hoary Sunray and A Spear-grass

Hoary Sunray and Spear-grass were not detected during the site survey, and there are no records within 10 km of the proposal area, however the area is within the known/predicted ranges for these species and suitable habitat is present.

This habitat includes disturbed grassland areas identified as exotic vegetation. Hoary Sunray grows in a variety of habitats, including modified semi-urban areas including bare ground, which is required for germination. Spear-grass habitat is present in the form of exotic grassland. Species associated with Spear-grass are present in the surrounding PCT vegetation areas.

Given the local context, and the presence of more preferred habitat within the remnant native vegetation adjacent to the proposal area, the proposal is not considered an action that would lead to the long-term decrease in the size of an important population for this species.

b) Will the action reduce the area of occupancy of the species?

Hoary Sunray and A Spear-grass

Only a small area of suitable habitat will be disturbed given the local context. There are no records within the proposal area. The proposal is not expected to reduce any potential area of occupancy of these species within the Wagga Wagga LGA.

c) Will the action fragment and existing population into two or more populations?

Hoary Sunray and A Spear-grass

Given this species has not be detected on site, and that the proposal area is not considered or known as critical habitat for these species, the proposed development is not considered an action that would fragment existing populations of Hoary Sunray and A Spear-grass.

d) Will the action adversely affect habitat critical to the survival of a species?

Hoary Sunray and A Spear-grass

No areas of critical habitat for these species are located in or near the proposal area and will not adversely affect any habitat critical for the survival of these species.

The habitat within the proposal area is not likely to be considered critical habitat for his species, as such the proposal will not adversely affect habitat critical to the survival of this species.

e) Will the action disrupt the breeding cycle of a population?

Hoary Sunray and A Spear-grass

As disturbance will be kept within lots subject to previous disturbance from agricultural activities, the proposal is not expected to disrupt the breeding cycle of any potential population of these species.

f) Will the action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Hoary Sunray and A Spear-grass

As disturbance will be kept within lots subject to previous disturbance from agricultural activities, the proposal is not expected to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Mitigation measures have been recommended.

g) Will the action result in invasive species that are harmful to a critically endangered or endangered/vulnerable species becoming established in the endangered / critically endangered /vulnerable species habitat?

Hoary Sunray and A Spear-grass

The proposal has the potential to contribute to the spread of invasive species in the proposal area through the transfer and introduction of plant material and soil on machinery. Mitigation measures have been recommended to prevent the spread of weeds on site. The proposal would therefore be unlikely to result in invasive species that are harmful to these species becoming established in their potential habitat.

h) Will the action introduce disease that may cause the species to decline?

Hoary Sunray and A Spear-grass

There is a risk that pathogens could be established or spread in the proposal area via machinery during construction. However, with the recommended mitigation measures, the action would be unlikely to introduce any disease which may cause the species to decline.

i) Will the action interfere with the recovery of the species?

Hoary Sunray and A Spear-grass

The objectives for The National recovery Plan for the Hoary Sunray *(Leucochrysum albicans var. tricolour)* (2011) are as follows:

- Determine distribution, abundance, and population structure
- Determine habitat requirements
- Ensure that key populations and their habitat are protected, monitored and managed appropriately
- Manage threats to population
- Identify key biological characteristics
- Determine growth rates and viability of populations
- Build community support for conservation

The proposal would not interfere with these objectives.

The Approved Conservation Advice for *Austrostipa wakoolica* (A Spear-grass) (2014) lists the following as priority actions:

- Fence sites where feasible or discourage access of herbivores
- Survey for new populations•Weed control in habitat areas
- Annual monitoring of fenced areas to determine the influence of different grazing animals
- Conduct weed control at 5 selected sites and monitor benefit
- Prevent further loss of extant populations
- Monitor mining proposals in the vicinity and ameliorate potential damage
- Collect seed for NSW Seedbank. Develop collection program in collaboration with Botanic Gardens and Domain Trust - multiple provenances
- Conduct ecological research into specific germination and disturbance requirements and limitations
- Identify two targeted populations (per year over initial three years) and focus recovery actions there, applying adaptive management strategies to determine and ameliorate threats

The proposal would not interfere with these actions.

CONCLUSION

The impacts of the proposal on the assessed critically endangered species listed under the EPBC Act are considered to be manageable. A significant impact is considered unlikely based on the following conclusions:

1. The amount of habitat to be removed or disturbed by the proposal is relatively small in the local context.
2. The proposal area is small, and no fragmentation or isolation of habitat would occur.
3. No interference with the recovery of this species would occur
4. Mitigation measures would be implemented to prevent disruptions to these species.

APPENDIX D SPECIES LISTS

D.1 FAUNA SPECIES RECORDED WITHIN THE STUDY AREA

Scientific Name	*Common Name*
Polytelis swainsonii	Superb Parrot
Cracticus tibicen	Australian Magpie
Platycercus elegans	Crimson Rosella
Corcorax melanorhamphos	White Winged Chough
Manorina melanocephala	Noisy Miner
Oryctolagus cuniculus	European Rabbit
Varanus sp.	Goanna

D.2 FLORA SPECIES RECORDED WITHIN STUDY AREA

*C – Common, U – Uncommon, O – Occasional, * Indicates Exotic Species, ∆ Indicates Priority Weed*

Family	*Exotic*	*Scientific Name*	*Common Name*	*Access Track (West of proposal area)*	*Northern paddock*	*Southern Paddock*	*Rodhams Road (North of Proposal Area)*
TREES							
Myrtaceae		*Eucalyptus albens*	White Box				c
Myrtaceae		*Eucalyptus melliodora*	Yellow Box				c
Malvaceae		*Brachychiton populneus subsp. populneus*	Kurrajong	c			c
Cupressaceae		*Callitris glaucophylla*	White Cypress Pine	c			o
Cupressaceae	*	*Hesperocyparis spp.*	A Western Cypress	c			
Anacardiaceae	*	*Schinus molle var. areira*	Pepper Tree				c
Myrtaceae		*Eucalyptus microcarpa*	Western Grey Box				c
Fabaceae (Mimosoideae)		*Acacia acinacea*	Gold-dust Wattle				o
Asteraceae		*Olearia spp.*	A Olive tree				o
Fabaceae (Mimosoideae)		*Acacia baileyana*	Cootamundra Wattle				o

Rosaceae	*	*Rosa spp.*					o
Fabaceae (Mimosoideae)		*Acacia implexa*	Hickory Wattle	o			
Solanaceae	*Δ	*Lycium ferocissimum*	African Boxthorn				o
FORBS							
Polygonaceae	*	*Polygonum aviculare*	Wireweed	c	c	C	c
Brassicaceae	*	*Lepidium spp.*	A Peppercress	o			c
Malvaceae		*Sida spp. 1*		c	c	c	c
Brassicaceae	*	*Brassica napus*	Canola		c	c	
Malvaceae		*Sida spp. 2*		c	c		c
Asteraceae	*	*Conyza bonariensis*	Flaxleaf Fleabane	c	c	c	
Euphorbiaceae		*Euphorbia drummondii*	Caustic Weed	C	C	O	C
Cucurbitaceae	*	*Citrullus amarus*	Camel Melon	c	c		
Boraginaceae	*	*Echium plantagineum*	Patterson's Curse		o		c
Convolvulaceae		*Dichondra repens*	Kidney Weed	c			
Boraginaceae	*	*Heliotropium europaeum*	Potato Weed	c	c		
Asteraceae	*	*Xanthium spinosum*	Bathurst Burr	c (dead)	c (dead)		o (dead)

Asteraceae		*Vittadinia spp.*	Fuzzweed	c	c		c
Fabaceae (Faboideae)	*	*Trifolium spp.*	A Clover	c			
Brassicaceae	*	*Sisymbrium spp.*		o			
Asteraceae	*	*Sonchus oleraceus*	Common Sowthistle	c	c	c	
Asteraceae	*	*Hypochaeris spp.*	A Catsear	c			
Solanaceae	*	*Solanum spp.*			o		o
Asteraceae	*	*Onopordum acanthium subsp. acanthium*	Scotch Thistle		c (dead)		
Asteraceae	*	*Lactuca serriola*	Prickly Lettuce		c		c
Oxalidaceae		*Oxalis spp.*			c		c
Lamiaceae	*	*Marrubium vulgare*	White Horehound		c		c
Chenopodiaceae		*Salsola australis*					c
Chenopodiaceae		*Einadia nutans subsp. nutans*	Climbing Saltbush				c
Campanulaceae		*Wahlenbergia spp.*	Bluebell				c
Portulacaceae	*	*Portulaca spp.*					o
Convolvulaceae	*	*Convolvulus spp.*	A Bindweed				o
Rosaceae	*	*Sanguisorba minor*	Sheep's Burnet				o

Pteridaceae		*Cheilanthes austrotenuifolia*	Rock Fern				o
Cactaceae	*	*Opuntia spp.*					o
Scrophulariaceae	*	*Verbascum thapsus subsp. thapsus*	Great Mullein				o
GRASSES							
Poaceae		*Cynodon dactylon*	Common Couch	c			c
Poaceae	*	*Hordeum spp.*	A Barley Grass	c			
Poaceae	*	*Lolium spp.*	A Ryegrass		c		c
Poaceae	*	*Bromus hordeaceus*	Soft Brome	o	o		
Poaceae	*	*Avena fatua*	Wild Oats	c			c
Poaceae	*	*Digitaria ciliaris*	Summer Grass	o			
Poaceae		*Chloris truncata*	Windmill Grass	c	c		c
Poaceae		*Rytidosperma spp. 1*			C (common along the fenceline adjacent to Rodhams Road)		c
Poaceae		*Austrostipa spp. 1*		C	c	o	c
Poaceae		*Panicum spp. 1*	Panicum	c	c	c	c

Poaceae		*Panicum spp.2*	Panicum	c	c		c
Poaceae		*Elymus scaber*	Common Wheatgrass				
Poaceae		*Austrostipa spp. 2*		C	c		c
Poaceae		*Rytidosperma spp. 2*			o		c
Poaceae	*	*Paspalum dilatatum*	Paspalum	o			o
Poaceae	*	*Eragrostis cilianensis*	Stinkgrass	c	c		
Poaceae	*	*Vulpia spp.*	Rat's-tail Fescue		o		
Poaceae	*	*Bromus spp.*	A Brome				c
GRAMINOIDS							
Lomandraceae		*Lomandra spp.*	Mat-rush				o
Phormiaceae		*Dianella spp.*					o
ADDITIONAL SPECIES							
Juncaceae		*Juncus spp.*	A Rush				o

APPENDIX E LAND CATEGORY ASSESSMENT

8.1. METHODOLOGY

An initial desktop assessment and literature review of previous studies relating to the proposal area was conducted to determine the ecological constraints and native vegetation communities on site. Assessment of the development site as Category 1 – exempt and Category 2 – regulated land was undertaken using the following data sources:

- 2017 Land Use Dataset (Australian Land Use and Management (ALUM) Classification version 7 (Office of Environment and Heritage (OEH), 2017).
- NSW Woody Vegetation extent and Foliage Projective Cover (FPC) 2011 (OEH, 2015).
- Sensitive regulated and vulnerable lands on the Native Vegetation Regulatory Map Portal (LLS, 2020).
- Riverina State Vegetation Mapping (OEH, 2020).
- 1990 aerial imagery (DSFI, 2020).

8.2. RESULTS

The following table (Table 8) demonstrates how the above mentioned layers were used in determining land category.

Table 2 Summary of data sources and interpretation

Data Sources	***Category 1 – Exempt Land***	***Category 2– Regulated Land***	***Excluded Land***
Current Aerial Imagery Uranquinty Locality	• Clear evidence of cropping. • Clear evidence of significant groundcover modification.	• Woody vegetation present at 1990 demonstrated within woody vegetation extent layer	N/A
1990 aerial imagery	• Clear evidence of cropping and grazing. • Clear evidence of significant groundcover modification.	• Woody vegetation present at 1990 demonstrated within woody vegetation extent layer	N/A
2017 Land Use Dataset	Land use identified as; • Cropping	Land use identified as; • Grazing native vegetation	N/A
NSW Woody vegetation extent	• Areas of woody vegetation regrowth that has occurred post 1990 following previous clearing events	• Woody vegetation present as at 1990 inclusive of paddock trees	N/A
Native Regulatory Map • Sensitive regulated land • Vulnerable regulated land • Excluded land	N/A	No areas identified as vulnerable or sensitive regulated land occur within the development site.	N/A

In summary, the analyses of the above sources identified the following:

- A high proportion of the subject land has previously been used for cropping and is therefore predominately Category 1 exempt land (Figure 8-4).
- Field surveys conducted in March 2020 identified evidence of cropped paddocks and grazing sheep and cattle were present (Figure 8-1, Figure 8-2).
- Another determining feature of constant agricultural use is a lack of woody vegetation regrowth in the majority of areas, as represented in the aerial imagery (both 1990 and current) and field observations (Figure 8-5 and Figure 8-6). The 2011 Woody Vegetation extent does however identify scattered paddock trees in the development site which has been mapped as Category 2 regulated land (Figure 8-4).
- The Native Vegetation Regulatory Map identifies vulnerable and sensitive regulated land; however, no vulnerable and sensitive areas were indicated within the development site (Figure 8-9).

Conclusion

Based on the above data sources, there is evidence to suggest that the subject land has predominantly been under regular cropping and grazing, supported by recent imagery, 1990 aerial imagery, field surveys and 2017 Land Use Mapping data.

Based on our assessment, a draft map of areas considered to be Category 1 – Exempt Land and Category 2 – Regulated Land has been produced (Figure 8-4). The relevant datasets used in the assessment are included in Figures 8-5 to 8-10.



Figure 8-1: Site view of the southern side of the property, showing repeatedly cropped paddocks.



Figure 8-2: Site view of the northern side of the property, showing repeatedly cropped paddocks (sheep were grazing this area).



Figure 8-3: Site view of the western access track, showing planted native vegetation.

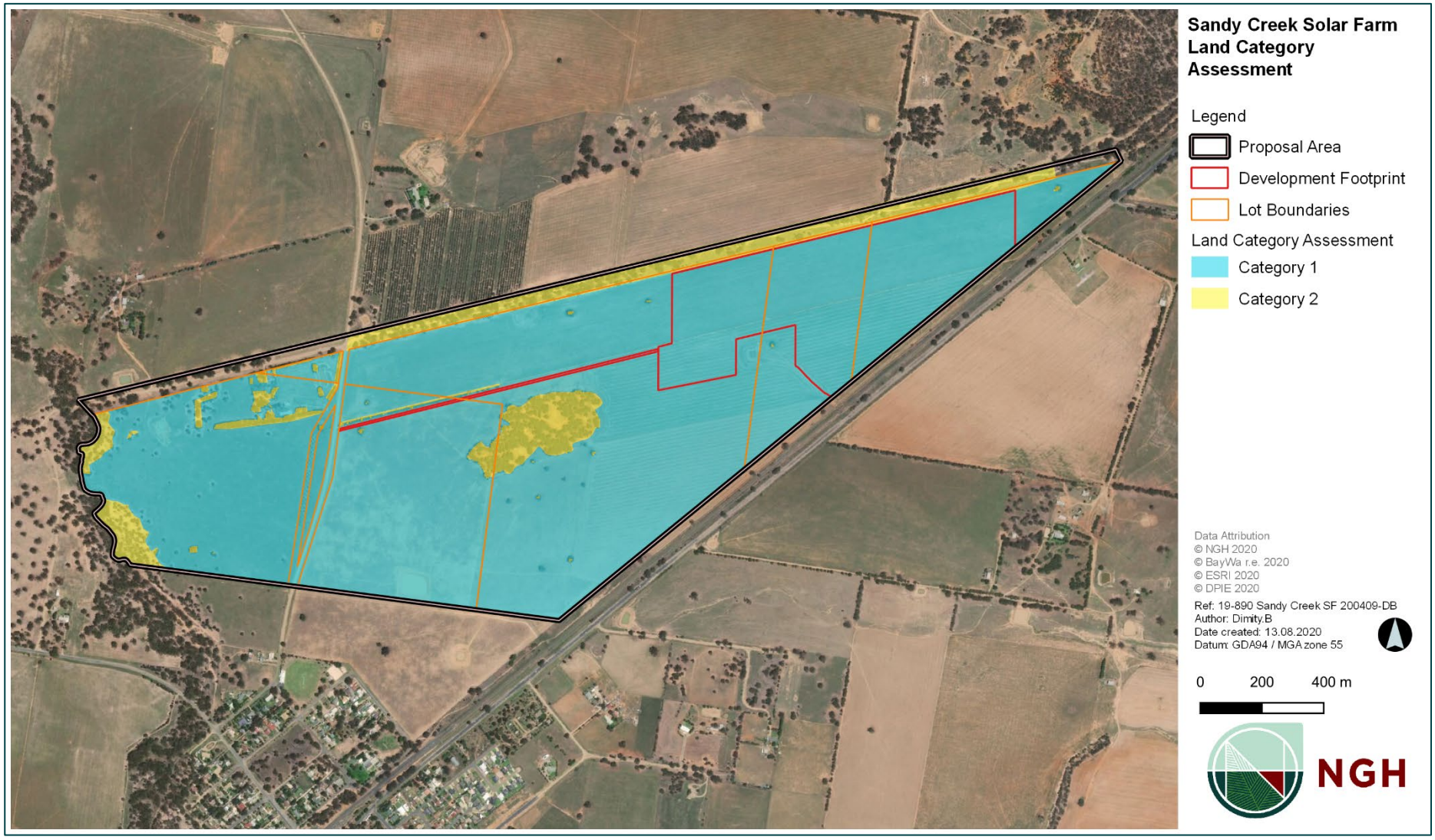


Figure 8-4: Land categorisation

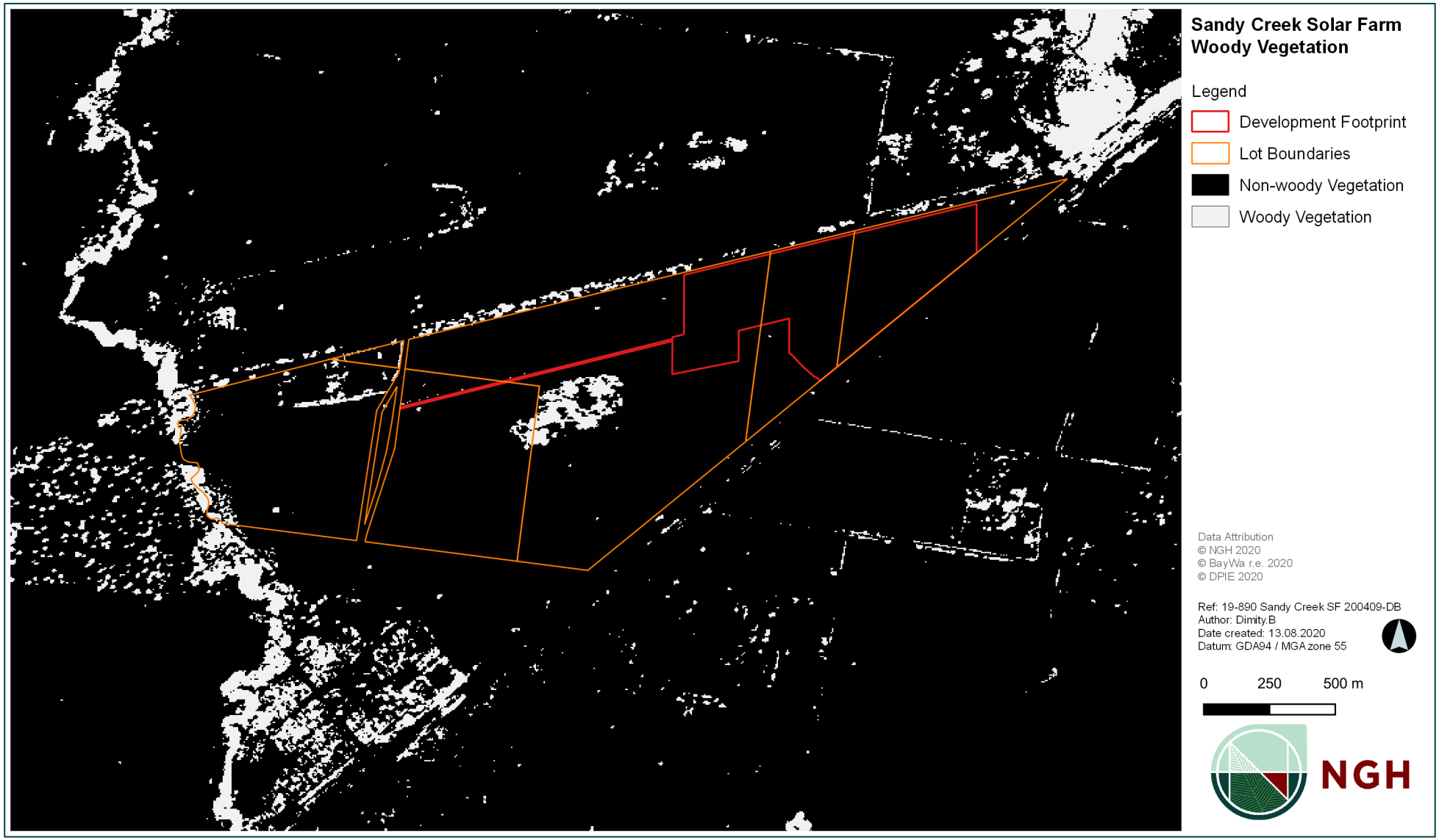


Figure 8-5: NSW Woody Vegetation Extent and FPC 2011



Figure 8-6: Aerial imagery 1990 (Department SDS, 2020)

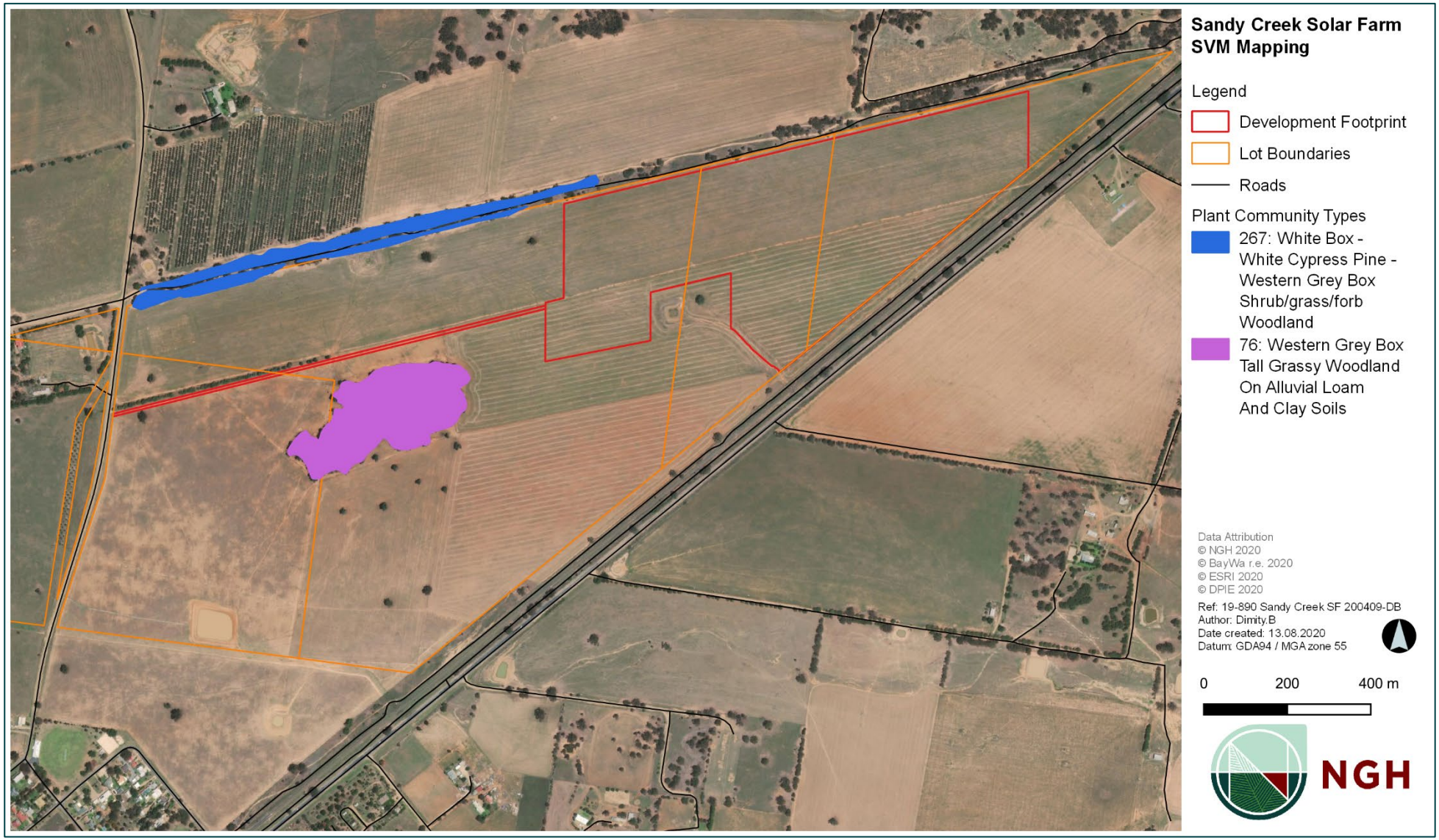


Figure 8-7: Riverina state vegetation mapping (OEH 2020)



Figure 8-8: Land Use Dataset 2017

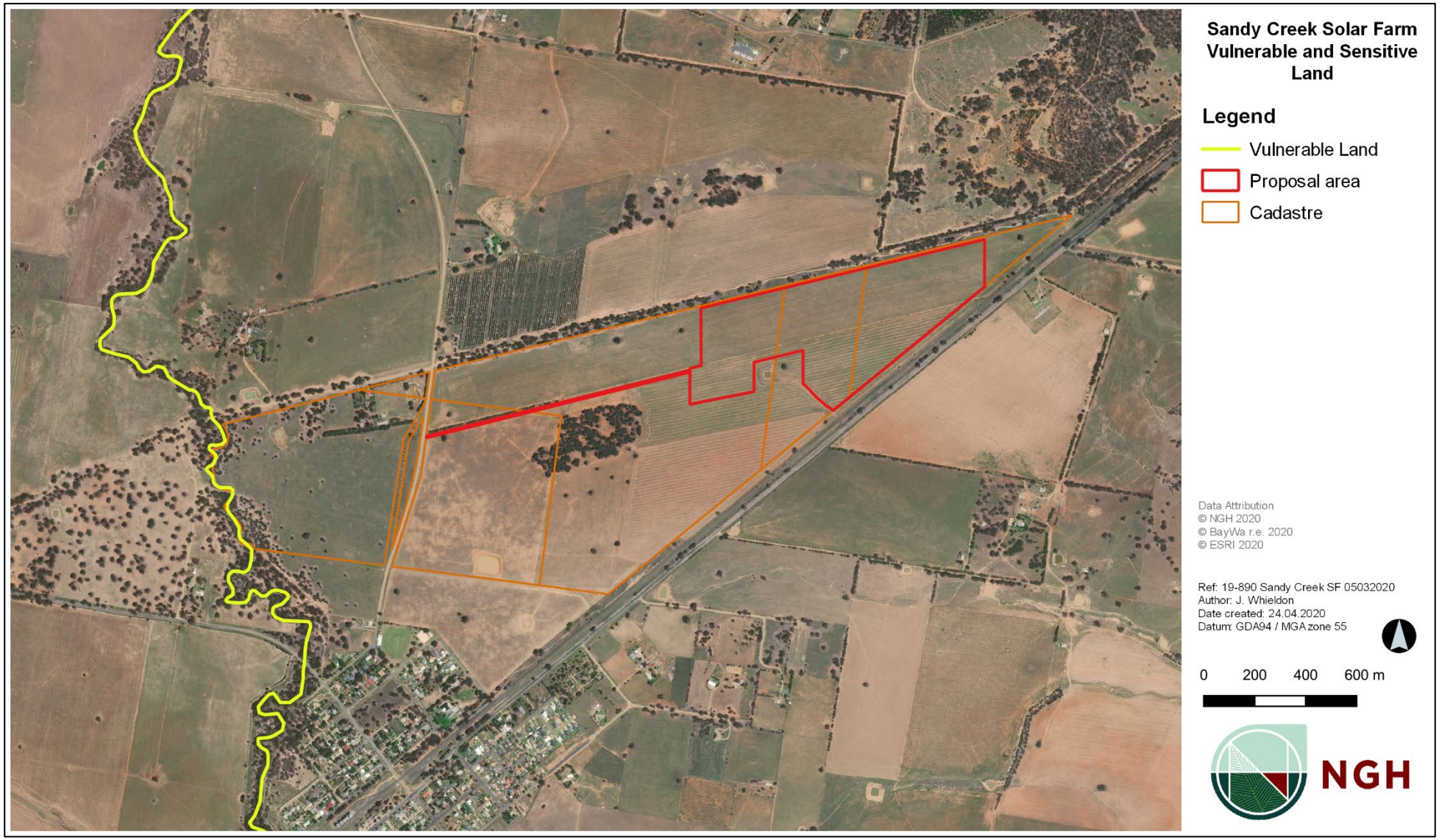


Figure 8-9: Sensitive regulated and vulnerable lands (NVR Map Portal 2020)



Figure 8-10: Land Use Zoning WWLEP 2020

BUSHFIRE ASSESSMENT REPORT

Proposed Electricity Generating Works
190 Rodhams Road, Uranquinty

August 2020

Project Number: 19-890





DOCUMENT VERIFICATION

Project Title:	Proposed Electricity Generating Works 190 Rodhams Road, Uranquinty
Project Number:	19-890
Project File Name:	19-890 Sandy Creek Solar Farm Bushfire Assessment Final

Revision	Date	Prepared by	Reviewed by	Approved by
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TABLE

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ACRONYMS AND ABBREVIATIONS

APZ	Asset Protection Zone
AS 3959-2018	Australian Standard – Construction of Buildings in Bushfire Prone Areas
BAL	Bushfire Attack Level
BFSA	Bush Fire Safety Authority
BPL	Bushfire Prone Land
BPL Map	Bushfire Prone Land Map
BPMs	Bushfire Protection Measures
EPA Act	Environmental Planning and Assessment Act 1979 (NSW)
EPA Reg	Environmental Planning and Assessment Regulation 2000 (NSW)
FFDI	(Forest) Fire Danger Index (also FDI)
FMP	Fuel Management Plan
Ha	Hectare
IPA	Inner Protection Area
kW/m2	kilowatts per square metre (being a measure of radiant heat)
LGA	Local Government Area
NCC	National Construction Standard (comprising Building Code of Australia)
OPA	Outer Protection Area
PBP	Planning for Bush Fire Protection (2019)
RF Act	Rural Fires Act 1997
RF Regulation	Rural Fires Regulation 2013

EXECUTIVE SUMMARY

BayWa r.e. Projects Australia proposes the construction of a 17 MW photovoltaic solar farm, located at Lots 55, 118, 129 and 149 DP 754567 at 190 Rodhams Road, Uranquinty. The development footprint would comprise an area of approximately 40 hectares, located in the north-eastern sector of the subject land. The solar farm would include installation of approximately 40,000 solar photovoltaic (PV) panels on a ground-mounted tracking system of pole driven steel posts.

In accordance with relevant legislative requirements, this bushfire assessment report provides an assessment of the potential bushfire hazard that may impact the proposed photovoltaic solar farm (electricity generating works). The proposal is assessed in terms of its compliance with key bushfire planning legislation and referenced guidelines.

As the proposed photovoltaic solar farm is located on bush fire prone land, this assessment is prepared under Section 4.14 of the *Environmental Planning and Assessment Act 1979*. Accordingly, the proposal has been assessed in accordance with *Planning for Bush Fire Protection* (PBP) 2019 by the NSW Rural Fire Service to ensure that appropriate application of bushfire protection measures are applied to the proposed development. Mandatory bushfire protection measures identified in Section 8.3.5 of PBP are listed below:

Asset Protection Zones

A minimum 10m wide area adjacent the proposed solar array footprint (as identified in Figure 1-4), in addition to an area provided around ancillary buildings, shall be managed in perpetuity as an Asset Protection Zone (APZ) in accordance with Table 7.4a & Appendix 4 of PBP, refer to the summary provided in Appendix A.

With reference to Section 8.3.5 of PBP, an APZ shall be established in the following manner:

- Inner Protection Area – no less than 10m in width.

Landscaping

Future landscaping shall be in accordance with Appendix 4 of PBP, to ensure APZ specifications are not compromised.

Emergency Management

A Bush Fire Emergency Management and Operations Plan would outline appropriate management and maintenance of bushfire protection measures, for the life of the development. This plan should be developed in consultation with local NSW RFS or Fire & Rescue NSW.

Recommendations are also included in Section 4 (and outlined below) to better inform the determining authority and proponent of mitigation and ongoing measures that should apply to the site.

Access

Property access and internal access arrangements should comply with the design specifications of Table 7.4a of PBP, to ensure access to the site is suitable for emergency response vehicles.

Water and Utilities (Electricity and Gas)

Water supply requirements shall comply with Table 7.4a of PBP.

- A water supply no less than 20, 000 litres (stored in a non-combustible storage tank), shall be provided to improve property protection measures and/or to act as a static water supply for emergency services.
- Electricity and Gas where provided within the defendable space, shall comply with Table 7.4a of PBP, where practicable.

Construction Standards

Construction standards prescribed under AS3959 do not apply to ancillary buildings within the proposal. Notwithstanding this, it is recommended that essential equipment be housed, or stored, so not to contribute to spreading fire to nearby vegetation.

The bushfire risk outlined in this report can be managed through ongoing appropriate maintenance of the property, which the operator shall implement throughout the construction and operational phase of the proposed development.

This report has been prepared by Brad Draper, a person who is recognised by the NSW Rural Fire Service as a qualified consultant in Bush Fire Risk Assessment. This bushfire assessment report addresses the submission requirements of Appendix 2.2 of Planning for Bush Fire Protection 2019 and demonstrates that the proposal, in conjunction with the recommendations made throughout this document, can conform to the specifications and requirements of Planning for Bush Fire Protection, as prescribed by Section 4.14 of the *Environmental Planning and Assessment Act 1979*.



BPAD Bushfire Planning & Design Accredited Practitioner Level 2

Brad Draper
Registered Planner (RPIA) & BPAD Accredited Bushfire Practitioner (49517)

SITE PARTICULARS

Title Particulars	Lots 118, 129 and 149 DP 754567
Property Address	190 Rodhams Road, Uranquinty
Assessment Date	May 2020
FFDI	80
Local Government Area	Wagga Wagga City Council
Zoning	RU1 – Primary Production
Local Environmental Planning Instrument	Wagga Wagga Local Environmental Plan 2010
Proposed Development	Photovoltaic Solar Farm (Electricity Generating Works)

1. INTRODUCTION

Pursuant to Section 4.14 of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) the proposed development, being a photovoltaic solar farm, triggers the requirement for a bushfire assessment report. This assessment has been prepared in accordance with the provisions of Planning for Bush Fire Protection 2019 (PBP), specifically Appendix 2 'Submission Requirements', to best inform the consent authority. This assessment considers the bushfire threat that may impact the proposed development and accordingly, the key bushfire protection measures that apply. The proposal must comply with PBP.

The objective of this report is to inform the consent authority that the requirements and specifications of PBP are (or can be) complied with, for determination under Section 4.14(1)(a) of the EP&A Act.

1.1. PROPOSAL

BayWa r.e. Projects Australia Pty Ltd (BayWa) proposes the construction of a 17 MW photovoltaic solar farm at Uranquinty. The subject land is agricultural land with a history of clearing for cropping. It is currently used for cropping and sheep grazing. The development footprint would comprise an area of approximately 40 hectares, located in the north-eastern sector of the subject land. The solar farm would include installation of approximately 40,000 solar photovoltaic (PV) panels on a ground-mounted tracking system of pole driven steel posts. The proposed development would connect to the existing 22kV line via a new switching station. The solar farm would also comprise of perimeter landscape buffers, internal access tracks, security fencing and potentially include ancillary operational site facilities. The proposed development would be serviced by direct access provided by Churches Plain Road (a public road). The subject land is currently vacant/grazing land (as identified in Figure 1-3).

Aims and Objectives for Planning for Bush Fire Protection (2019)

This proposal has also had due regard to the overarching aims and objectives of Planning for Bush Fire Protection, as outlined below.

Objectives	Comment
Afford buildings and their occupants protection from exposure to a bush fire;	Buildings and/or other structures on site, and workers will be afforded protection from exposure to bushfire due to the application of bushfire protection measures.
Provide for a defendable space to be located around buildings;	A defendable space would be provided for the proposed development through management of an APZ around the perimeter of the solar array. An APZ shall also be provided around all substations, switchboard and switch-room buildings to increase the defendable space on site.
Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent the likely fire spread to buildings;	APZs would be provided to enable appropriate separation between hazard vegetation and the solar array and associated buildings. Furthermore, ground cover underneath the solar array footprint would be maintained. On-site water supply and defendable spaces provide increased bushfire protection for the site.
Ensure that appropriate operational access and egress for emergency service	The proposed development would have access roads located around the perimeter of the solar array. Internal access roads would be designed with

personnel and occupants is available;	consideration to property access road specifications, outlined in Table 7.4a of PBP.
Provide for ongoing management and maintenance of BPMs; and	The proposed development would be accompanied by a Bush Fire Emergency Management and Operations Plan (usually a condition of consent), which would outline appropriate management and maintenance of bushfire protection measures, for the life of the development.
Ensure that utility services are adequate to meet the needs of firefighters.	On-site water supply and defendable spaces provide increased bushfire protection for the site. Electricity lines, where practicable shall be provided by underground means.

Wagga Wagga City Council Bushfire Prone Land Map

Part of the subject land is mapped as bushfire prone land on Wagga Wagga City Council (WWCC) Bush Fire Prone Land (BFPL)map. The subject land comprises both bushfire prone land, and is in close proximity to Category 1 (red) vegetation, as identified in Figure 1-1 below.

The proposed development footprint is limited to Lots 55, 118, 129 and 149 DP 754567 identified in Figure 1-3. Accordingly, this assessment has been undertaken to assess the proposal against PBP to ensure appropriate asset protection zones are provided for within the proposed development.



Figure 1-1 Extract: Wagga Wagga City Council Bushfire Prone Land Map

The site and the immediate surrounding area are identified below in Figure 1-2 and Figure 1-3.

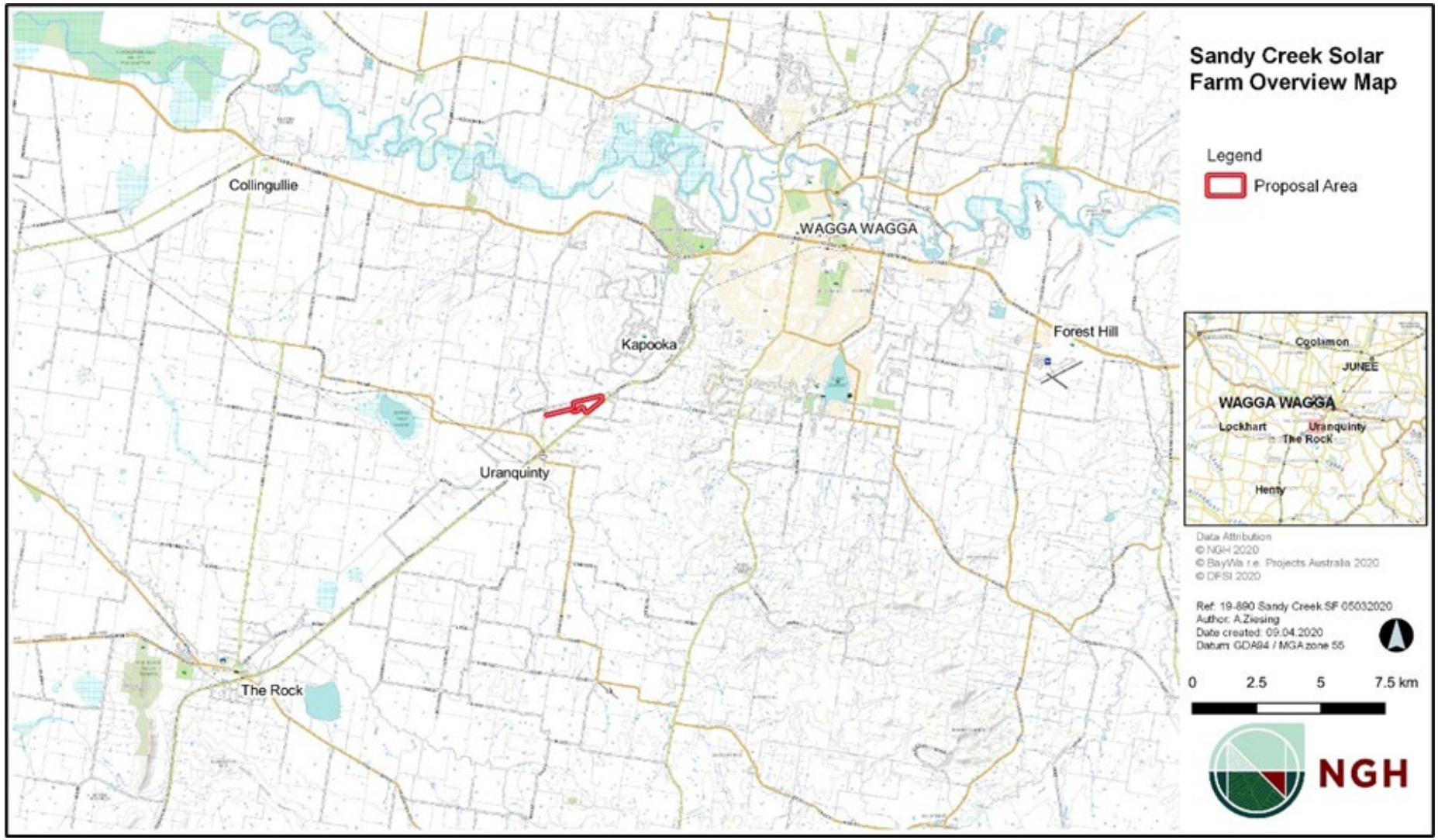


Figure 1-2 Regional Locality Map

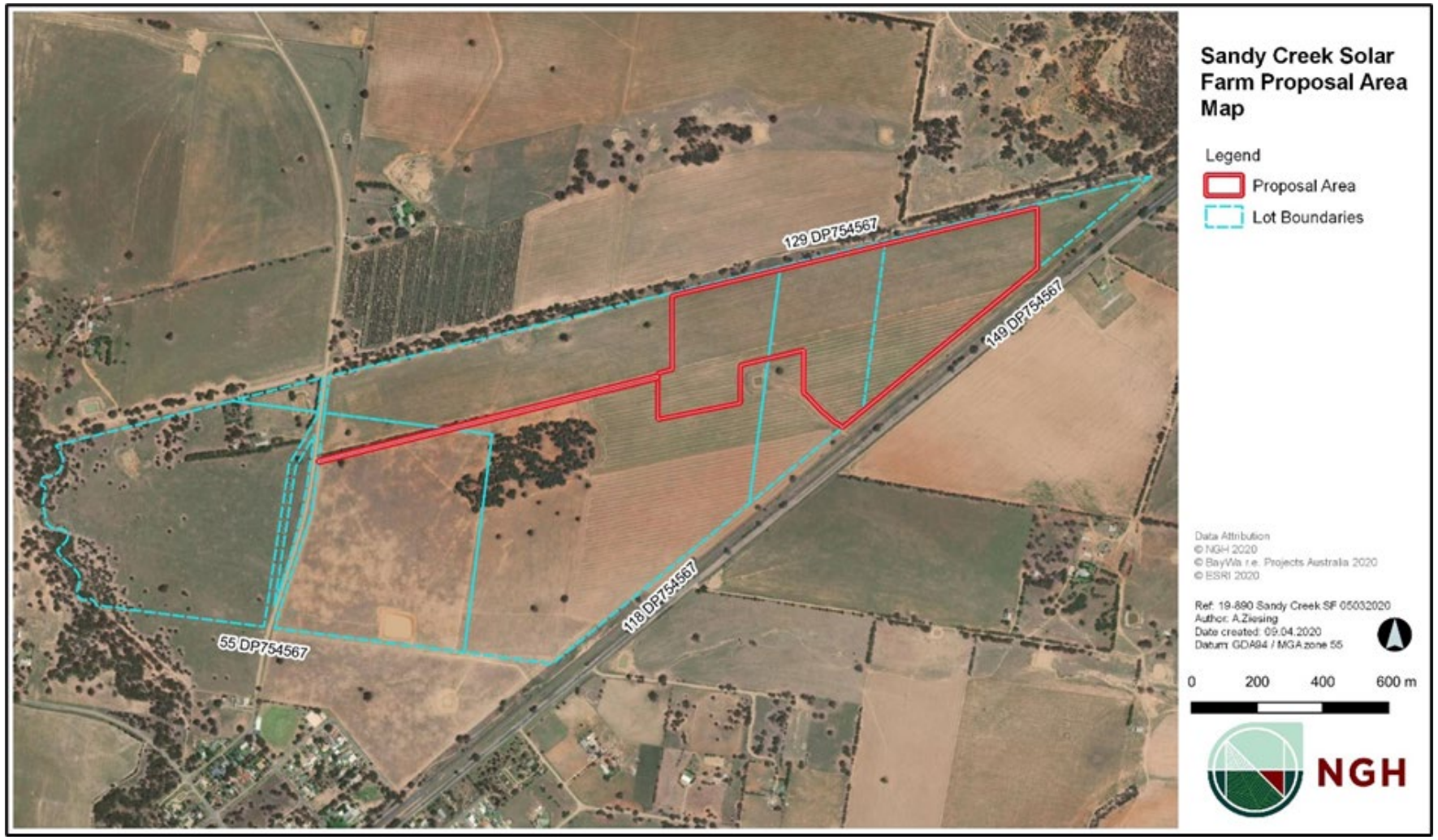
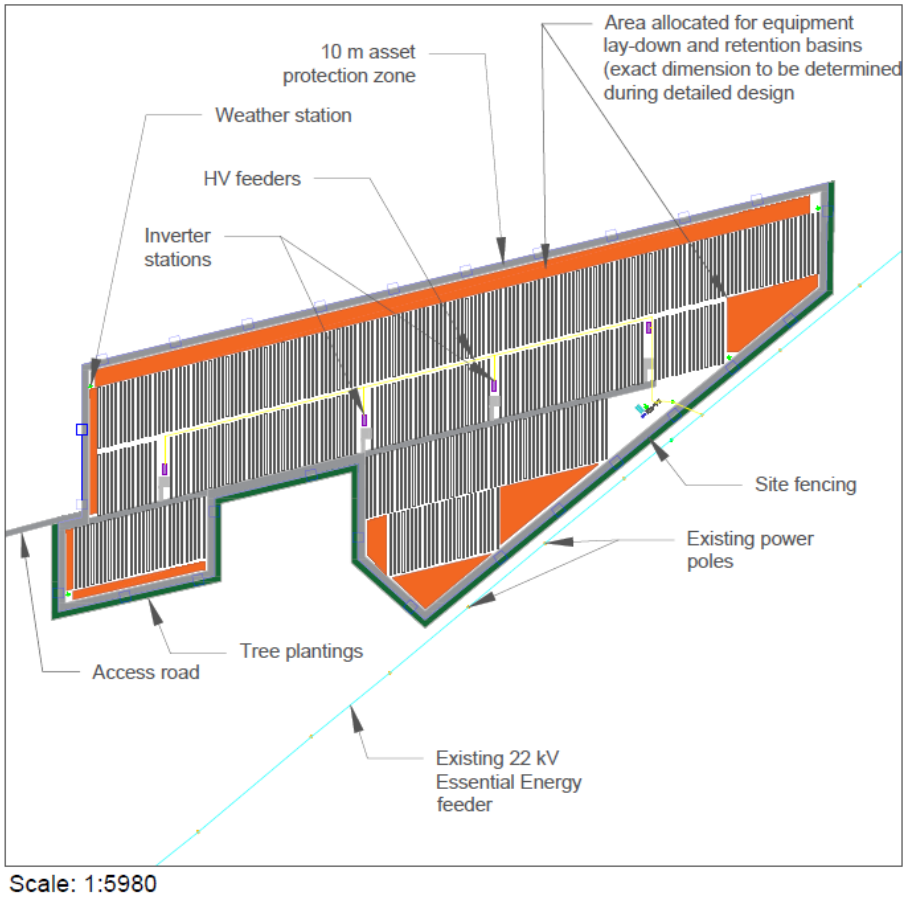
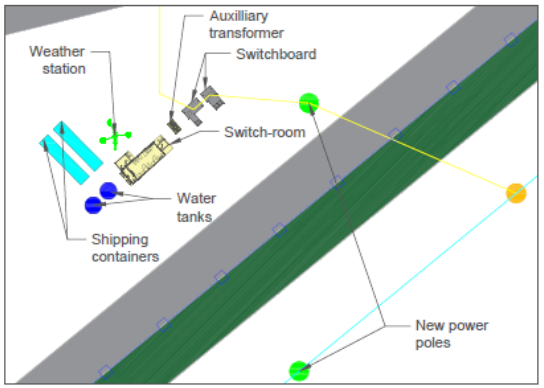


Figure 1-3 Aerial Image of subject land, development footprint and immediate surrounds .



Scale: 1:5980



Scale: 1:840

LEGEND:

- Fencing
- Internal track
- Laydown areas / retention basins
- 22 kV feeders
- 22 kV power-line
- Solar panel tables
- Inverter stations
- Existing power poles
- New power poles
- Weather stations

Rev	Date	Name Editor	Modification / Adaptation of the drawing
2	21.04.2020	TSP	Number of inverter stations increased to 4.
1	13.02.2020	TSP	PRELIMINARY ISSUED

BayWa r.e.

BayWa r.e. Projects Australia Pty Ltd
45 Denison street
Bondi Junction 2022 | Australia

	Date:	Name:
Drawn:	13.02.2020	TSP
Changed:		
Checked:		

Project: Sandy Creek Solar Farm 12 MVA

Drawing Title: Concept site layout

File Name: BWre-AU-SAN-001-GAL

Format: A3

Figure 1-4 Site Plan of Proposed Photovoltaic Solar Farm (supplied by BayWa r.e Projects Australia Pty Ltd, 2020)

2. BUSHFIRE SITE ASSESSMENT

Identify APZs

Determination of Bushfire Attack Level (BAL) shall follow the site assessment methodology found in Appendix 1 of PBP, which includes the following steps:

1. Determine vegetation formation in all directions around the building to a distance of 140 metres;
2. Determine the effective slope of the land from the building for a distance of 100 metres;
3. Determine the relevant FFDI for the council area in which the development is to be undertaken; and
4. Match the relevant FFDI, vegetation formation and effective slope to determine the APZ required.

The above methodology is expanded through the points below and further summarised in Table 2-1 and Figure 2-1. It is acknowledged that required APZs specified in Section 8.3.5 of PBP prevail in this instance, over FFDI 80 APZs identified in Table A1.12.3 of PBP, which the above methodology is in connection to.

Note: The methodology prescribed by PBP to determine appropriate construction standards has not been applied due to the category of the proposed development.

2.1. VEGETATION

Analysis of vegetation up to 140 metres from the proposed site has been conducted by:

- Aerial and Satellite imagery to identify vegetation location and cover; and
- Inspection of vegetation within and surrounding the development footprint to confirm vegetation classification and structure.

Vegetation within and surrounding the development footprint land to a distance of 140 metres is assessed in accordance with Keith (2004), and further classified in accordance with PBP.

With reference to PBP, *'Where mixes of vegetation formations are located together, the vegetation formation providing the greater hazard shall be used for the purpose of assessment'*. The predominant hazard vegetation near the development footprint is identified as Western Slope Grassy Woodland with regard to Keith (2004), which is recognised as Woodland vegetation under Figure A1.2 of PBP. Results are provided in the Bushfire Site Plan (Figure 2-1) and summarised in Table 2-1. Results are supported by site photographs in Figure 2-2 - Figure 2-9.

Areas of vegetation in relation to the subject land are identified below:

- Hazard vegetation - located north-east of and within the centre of the subject land is identified as Western Slope Grassy Woodland, refer to Figure 2-3. An isolated area of woodland vegetation also exists within the subject land, south west of the development footprint. In accordance with Keith (2004), the vegetation will be assessed as Woodland for assessment under PBP. Furthermore, due to the regional and agricultural context of the subject land, Grassland vegetation is present in all other areas surrounding the subject land, refer to Figure 2-1.
- Non hazard vegetation – categorised as managed land, is present in isolated areas, typically due to the construction of access roads and railway infrastructure. Furthermore, a proposed landscape buffer (proposed to be 5m in width) is identified with Figure 1-4 around part of the proposed footprint perimeter (namely along the southern and eastern edge). If this vegetation is provided in a single formation (i.e. a windbreak), it would be considered low-threat vegetation in accordance with A.1.10 of PBP and is therefore excluded from this assessment.

2.2. DISTANCE

The achievable APZ as indicated in Table 2-1 is prescribed by Section 8.3.5 of PBP. A10m APZ is to be provided adjacent and/or around the proposed asset that may be impacted by a bushfire event. The landholder of the subject land has no legal control over threatening vegetation located off site, unless an Asset Protection Zone exists via easement and enforced by 88B instrument.

An FFDI of 80 applies to the Eastern Riverina region, as set out in the NSW RFS' NSW Local Government Areas FDI (2017). Vegetation and slope are indicated in the Bushfire Site Plan (Figure 2-1).

With reference to Section 8.3.5 of PBP and Appendix 4 of PBP, a minimum 10m APZ shall be provided wholly within the property boundary, around the proposed development footprint (solar array, associated buildings and infrastructure), indicatively shown in Figure 1-4, in the following manner:

- Inner Protection Area: No less than 10m in width.

2.3. SLOPE

With reference to the vegetation formations, the predominant (effective slope) is determined and identified in Table 2-1. PBP states *'The effective slope is considered to be the slope under the vegetation which will most significantly influence the bush fire behaviour for each aspect'*. The effective slope is determined by topography over a distance of 100m. This was confirmed through topographic mapping, LiDAR Data (5m point cloud).

The effective slope located under hazard vegetation include:

- North, North East & East – Upslope,
- South – Flat and Upslope, and
- South West and West – Downslope 0^{o} – 5^{o} .

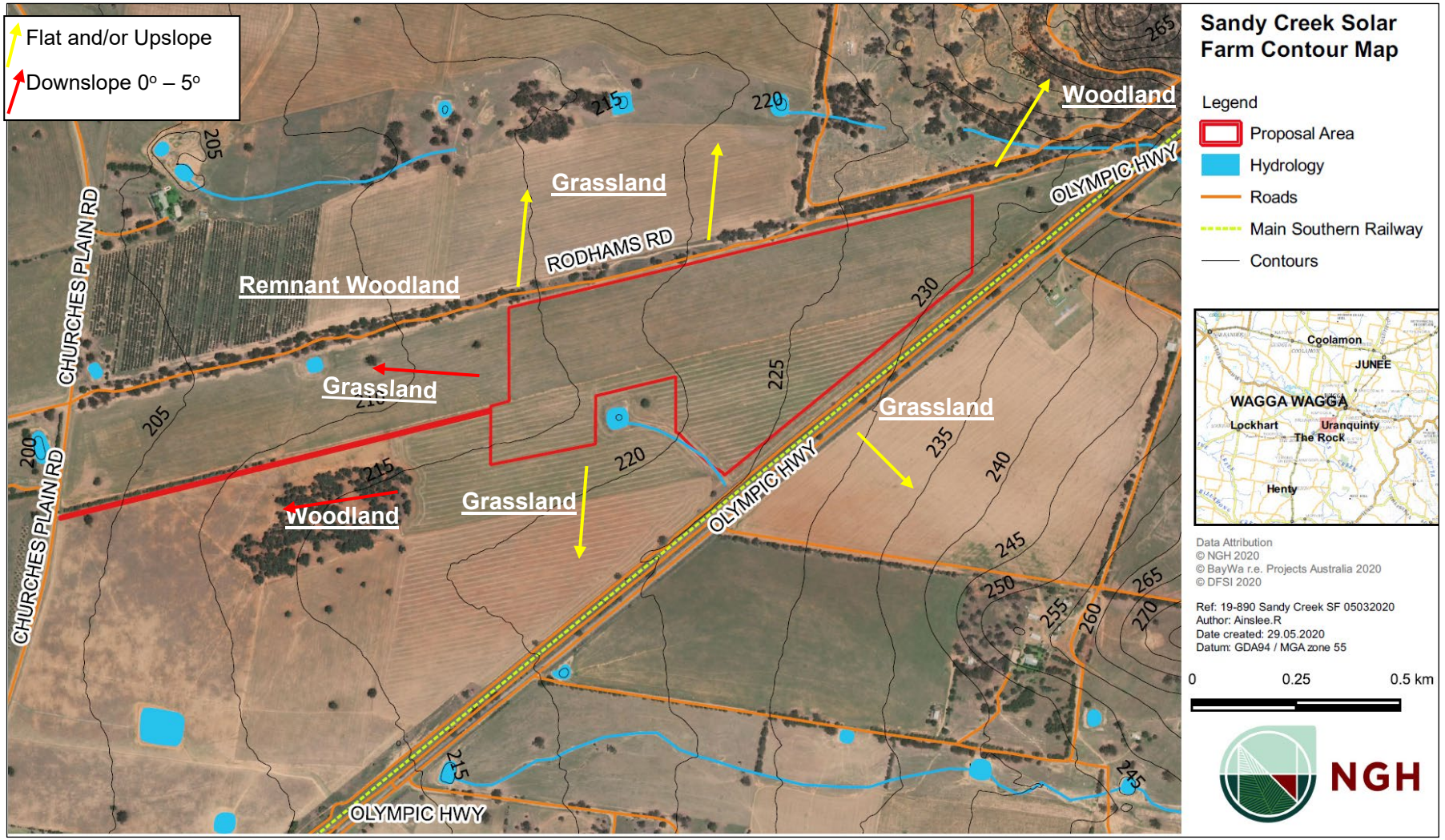


Figure 2-1 Bushfire Site Plan.



Figure 2-2 Grassland vegetation (used for pastures/grazing) located North of the subject land.



Figure 2-3 Woodland vegetation located North East of the subject land.



Figure 2-4 Grassland vegetation (used for pastures/grazing) located East of the subject land, adjacent Olympic Highway.



Figure 2-5 Woodland vegetation located within Lot 118 (approximately 6 hectares in size).



Figure 2-6 The subject land, taken from the centre of Lot 118 identifies existing agricultural land.



Figure 2-7 Isolated remnant Woodland vegetation located within Rodhams Road reserve, located North West of the Development footprint extent



Figure 2-8 Grassland vegetation located West of Churches Plain Road



Figure 2-9 An established orchid located in Lot 117 in DP 754567, located adjacent Rodhams Road, located North West of the subject land

2.4. BUSHFIRE HAZARD ASSESSMENT

The appropriate classes of vegetation, slope and achievable setbacks are identified in Table 2-1 below.

Table 2-1 Determination of achievable Asset Protection Zones for the proposed development.

Direction	Vegetation	Slope	Minimum Setback required to conform to Solar Farm APZ specifications	Achieved setback (APZ) for proposed development
North	Grassland	Upslope	10m	10m
North East	Woodland	Upslope	10m	10m
East	Grassland[1]	Upslope	10m	10m
South	Grassland	Flat	10m	10m
South West	Woodland[2]	Downslope 0º – 5º	10m	10m
West	Grassland	Downslope 0º – 5º	10m	10m

Note:
[1] An unformed road reserve is present adjacent the eastern boundary of the subject land, currently consisting of grassland vegetation before infrastructure (railway and highway) is present. Grassland vegetation is also prevalent in the locality due to agricultural land-uses, East of Olympic Highway.

[2] Woodland vegetation is located within the subject land, however outside the development footprint. On the basis that Woodland vegetation is retained in its current size (approximately 6ha) and shape, the slope assessment is measured in a direction from east to west (worst case scenario).

Bush Fire Attack Level

For the purpose of this assessment, the NCC does not provide bush fire specific performance requirements for these particular classes of buildings. Therefore, a Bush Fire Attack Level (BAL) assessment was not undertaken to determine levels of radiant heat that site specific infrastructure, or buildings may be experience in the event of a fire.

Therefore, with regard to the above, no mandatory construction standards prescribed under AS3959 apply to ancillary buildings within the proposal.

3. BUSHFIRE PROTECTION MEASURES (BPMS)

This assessment also considers key Bush Fire Protection Measures (BPMs) as identified in Section 8 of PBP. BPMs are a series of controls, when combined, aim to minimise the risk of bush fire attack, and provide protection for emergency services personnel and others assisting firefighting activities. The measures considered for the proposed development derive from Section 8 of PBP (NSW RFS, 2019) and include:

- Asset Protection Zones

Asset Protection Zones			
Performance Criteria	**Acceptable Solutions**	**Complies**	**Comment**
The intent may be achieved where:			
• **APZs are provided commensurate with the construction of the building; and** • **A defendable space is provided.**	• an APZ is provided in accordance with Section 8.3.5	Yes	A 10m APZ is provided around the perimeter of the development site. APZs are sometimes provided in conjunction with perimeter access roads. A defendable space is provided around the switch room, switchboard and auxiliary transformer area, where on site water supply is available to facilitate protection of nearby buildings and/or infrastructure, or otherwise is available for use by responding emergency services.
• **APZs are managed and maintained to prevent the spread of a fire to the building.**	• APZs are managed in accordance with the requirements of Appendix 4 of PBP.	Yes	Management of APZ requirements would conform to Appendix 4 specifications for Inner Protection Area (IPA) standards.
• **the APZ is provided in perpetuity.** • **APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is minimised.**	• APZs are wholly within the boundaries of the development site. • APZ are located on lands with a slope less than 18 degrees.	Yes	The proposed APZ can be maintained in perpetuity, or for the life of the proposed development. APZs are not located on land that exceed 18 degrees.

Section 8.3.5 of PBP does not prescribe additional bushfire protection measures to Solar Farm proposals. However, as bushfire protection measures are most effective when applied in combination with each other, at a minimum Property Access and Water Supply requirements are outlined below. It is recommended that Access and Water supply requirements are incorporated into the design of the proposal, to ensure provision of these measures are considered an operational perspective and able to be integrated into in the Bush Fire Emergency Management and Operations Plan, when prepared in the future.

Access (Table 7.4a extract of PBP)			
Performance Criteria	**Acceptable Solutions**	**Complies**	**Comment**
The intent may be achieved where:			
• **firefighting vehicles are provided with safe, all-weather access to structures and hazard vegetation.**	• property access roads are two-wheel drive, all-weather roads.	Yes	Property access roads are all weather roads.
• **the capacity of access roads is adequate for firefighting vehicles.**	• the capacity of road surfaces and any bridges/causeways is sufficient to carry fully loaded firefighting vehicles (up to 23 tonnes), bridges and causeways are to clearly indicate load rating.	Can comply	The capacity of internal access road surfaces would be sufficient for firefighting vehicles. No bridges or causeways are located or required to facilitate property access.
• **there is appropriate access to water supply.**	• hydrants are provided in accordance with the relevant clauses of AS 2419.1:2005;	Not applicable	Not applicable
	• there is suitable access for a Category 1 fire appliance to within 4m of the static water supply where no reticulated supply is available.	Can comply	Suitable access would be provided for Category 1 fire appliances within 4m of the static water supply.

• **firefighting vehicles can access the dwelling and exit the property safely**	• at least one alternative property access road is provided for individual dwellings or groups of dwellings that are located more than 200 metres from a public through road;	Not applicable	Not applicable
	• There are no specific access requirements in an urban area where an unobstructed path (no greater than 70m) is provided between the most distant external part of the proposed dwelling and the nearest part of the public access road (where the road speed limit is not greater than 70kph) that supports the operational use of emergency firefighting vehicles.	Not applicable	Not applicable
	In circumstances where this cannot occur, the following requirements apply: • minimum 4m carriageway width; • in forest, woodland and heath situations, rural property roads have passing bays every 200m that are 20m long by 2m wide, making a minimum trafficable width of 6m, at the passing bay; • a minimum vertical clearance of 4m to any overhanging obstructions, including tree branches; • property access must provide a suitable turning area in accordance with Appendix 3; • curves have a minimum inner radius of 6m and are minimal in number to allow for rapid access and egress; • the minimum distance between inner and outer curves is 6m;	Can comply	Due to the established agricultural use and gentle topography of the site, minimal obstructions are present. Suitable design of access for firefighting vehicles could be complied with.

	• the crossfall is not more than 10 degrees; maximum grades for sealed roads do not exceed 15 degrees and not more than 10 degrees for unsealed roads; and • a development comprising more than three dwellings has formalised access by dedication of a road and not by right of way.	Not applicable	Not applicable
Water Supplies (Table 7.4a extract of PBP)			
Performance Criteria	**Acceptable Solutions**	**Complies**	**Comment**
The intent may be achieved where:			
• **an adequate water supply is provided for firefighting purposes.**	• reticulated water is to be provided to the development, where available; and • a static water supply is provided where no reticulated water is available.	Yes	As reticulated water supply is not available, a static water supply is incorporated into the design, refer to Figure 1-4
• **water supplies are located at regular intervals; and** • **the water supply is accessible and reliable for firefighting operations.**	• fire hydrant spacing, design and sizing comply with the relevant clauses of AS 2419.1:2005; • hydrants are not located within any road carriageway; and • reticulated water supply to urban subdivisions uses a ring main system for areas with perimeter roads.	Not applicable	Not applicable
• **flows and pressure are appropriate.**	• fire hydrant flows and pressures comply with the relevant clauses of AS 2419.1:2005.	Not applicable	Not applicable

• **the integrity of the water supply is maintained.**	• all above-ground water service pipes external to the building are metal, including and up to any taps.	Can comply	Above ground water service pipes would be metal.
• **a static water supply is provided for firefighting purposes in areas where reticulated water is not available.**	• where no reticulated water supply is available, water for firefighting purposes is provided in accordance with Table 5.3d;	Yes	Water supply no less than 20,000 litres would be provided adjacent the switch-room, refer to Figure 1-4
	• a connection for firefighting purposes is located within the IPA or non-hazard side and away from the structure; 65mm Storz outlet with a ball valve is fitted to the outlet;	Can comply	The position of on-site water supply is located within the IPA
	• ball valve and pipes are adequate for water flow and are metal; • supply pipes from tank to ball valve have the same bore size to ensure flow volume; • underground tanks have an access hole of 200mm to allow tankers to refill direct from the tank; • a hardened ground surface for truck access is supplied within 4m; • above-ground tanks are manufactured from concrete or metal; • raised tanks have their stands constructed from non-combustible material or bush fire-resisting timber (see Appendix F of AS 3959); • unobstructed access can be provided at all times; • underground tanks are clearly marked; • tanks on the hazard side of a building are provided with adequate shielding for the protection of firefighters; • all exposed water pipes external to the building are metal, including any fittings;	Can comply	Non-reticulated water supply requirements would be provided throughout the construction and operational phase of the proposed development.

	• where pumps are provided, they are a minimum 5hp or 3kW petrol or diesel-powered pump, and are shielded against bush fire attack; • any hose and reel for firefighting connected to the pump shall be 19mm internal diameter; and • fire hose reels are constructed in accordance with AS/NZS 1221:1997, and installed in accordance with the relevant clauses of AS 2441:2005.		

4. CONCLUSION

Pursuant to Section 4.14 of the EP&A Act, a bushfire assessment for a proposed photovoltaic solar farm has been prepared. The proposed development has been assessed against the appropriate provisions of PBP Chapter 8 specifications, specific to solar farm development sites. The proposed development can conform to the specifications outlined in Section 8.3.5 of PBP.

The proposed development would incorporate the following **mandatory** bushfire protection measures into its design and operational plans.

Asset Protection Zones

- With reference to Section 8.3.5 of PBP a minimum 10m wide area adjacent the proposed solar array footprint (as identified in Figure 1-4), in addition to an area provided around ancillary buildings, shall be managed in perpetuity as an APZ to Inner Protection Area standards, in accordance with Table 7.4a & Appendix 4 of PBP, refer to the summary provided in Appendix A.

Landscaping

- Future landscaping shall be in accordance with Appendix 4 of PBP, to ensure APZ specifications are not compromised.

Emergency Management

- A Bush Fire Emergency Management and Operations Plan would outline appropriate management and maintenance of bushfire protection measures, for the life of the development. This plan should be developed in consultation with local NSW RFS or Fire & Rescue NSW.

In addition to the mandatory measures identified above, bushfire protection measures identified below are **recommended** to improve property protection measures and to ensure suitable access is provided for emergency services, in addition to facilitating the egress of the construction and/or operational workforce.

Access

- Property access and internal access arrangements should comply with the design specifications of Table 7.4a of PBP, to ensure access to the site is suitable for emergency response vehicles.

Water and Utilities (Electricity and Gas)

- Water supply requirements shall comply with Table 7.4a of PBP.
    - A water supply no less than 20, 000 litres (stored in a non-combustible storage tank), shall be provided to improve property protection measures and/or to act as a static water supply for emergency services.
    - Electricity and Gas where provided within the defendable space, shall comply with Table 7.4a of PBP, where practicable.

Construction Standards

- Construction standards prescribed under AS3959 do not apply to ancillary buildings within the proposal. Notwithstanding this, it is recommended that essential equipment be housed, or stored, so not to contribute to spreading fire to nearby vegetation.

Please Note:

Any significant future development on this site must be separately assessed under Section 4.14 of the EP&A Act 1979 or by assessment and issue of a BAL Certificate for complying development works identified under State Environmental Planning Policy (Exempt and Complying Development Codes) 2008.

5. REFERENCES

Australian Building Codes Board. (2019). *National Construction Code, 2019, Volume Two.* Canberra.

Keith, D. (2004). *Ocean shores to desert dunes: the native vegetation of NSW and the ACT (Selected Extracts).* Department of Environment and Conservation (NSW).

NSW Rural Fire Service. (2019). *Planning for Bushfire Protection – A Guide for Councils, Planners, Fire Authorities and Developers.*

NSW Rural Fire Service. (n.d.). *Bush Fire Survival Plan.*

Standards Australia. (2018). *Construction of buildings in bushfire-prone Areas, AS3959.*

Advisory Comments:

Notwithstanding the construction requirements assessed and the recommendations provided, the property and structure must be adequately maintained for the life of the proposed development. This will assist in providing a reduced level of risk to the property, its occupants and any emergency services personnel that may attend to the property.

> Quote from Planning for Bush Fire Protection (2019), *'Due to a range of limitations, the measures contained in this document do not guarantee that loss of life, injury and/or property damage will not occur during a bush fire event. Limitations of this document include, but are not limited to uncertainties in the following areas: Fire Danger Index; fuel loads; existing developments; human behaviour; and maintenance.'*
>
> Quote from Standards Australia (AS 3959-2018), *'Although this standard is designed to improve the performance of buildings when subjected to bushfire attack in designated bushfire-prone areas there can be no guarantee that a building will survive a bushfire event on every occasion. This is substantially due to the unpredictable nature and behavior of fire and extreme weather conditions.*

APPENDIX A SUMMARY OF ASSET PROTECTION ZONE REQUIREMENTS

An APZ is a fuel-reduced area surrounding a building or structure. It is located between the building or structure and the bush fire hazard. An APZ provides:

- *a buffer zone between a bush fire hazard and an asset;*
- *an area of reduced bush fire fuel that allows for suppression of fire;*
- *an area from which backburning or hazard reduction can be conducted; and*
- *an area which allows emergency services access and provides a relatively safe area for firefighters and home owners to defend their property.*

An APZ, if designed correctly and maintained regularly, will reduce the risk of:

- *direct flame contact on the building;*
- *damage to the building asset from intense radiant heat; and*
- *ember attack.*

In accordance with Appendix 4 of PBP 2019, an APZ comprises of two key elements; an inner protection area (IPA) and outer protection area (OPA). An APZ surrounds a development to provide a managed or reduced fuel area, to reduce the bushfire hazard to an acceptable level to mitigate risk posed to persons and the built environment. Components of an APZ are identified below.

INNER PROTECTION AREA

An IPA is located in immediate proximity to the asset and provides a defendable space consisting of minimal fuel loads. An IPA shall display characteristics that include, but are not limited to: a tree canopy cover of less than 15% at maturity, a maximum 30% of the IPA may contain shrubs, trees should have lower limbs (up to 2m in height) removed, shrubs are not to have a connection with tree canopy layer, shrubs should not form more than 10% ground cover, maintain 2 – 5m canopy separation of trees and branches are not to overhang buildings. Wooden sheds, combustible material storage areas, stacked flammable building materials, woodpiles, large areas of garden mulch, for example, are not permitted in the IPA.

In forest vegetation, the APZ can be made up of an Inner Protection Area (IPA) and an Outer Protection Area (OPA).

OUTER PROTECTION AREA

The OPA is located between the IPA and the unmanaged vegetation in order to provide a reduced fuel area, which substantially decreases the intensity of an approaching fire. An OPA is vital in restricting the ability of a crown fire/fuels, which can reduce the level of direct flame, ember attack and radiant heat on the IPA. An OPA should not have a mature tree canopy cover in excess of 30%, canopies should be separated by 2 to 5m and should have the understorey managed to limit shrubs to no more than 20% of ground cover and grasses should be kept mown to a height of less than 100mm).

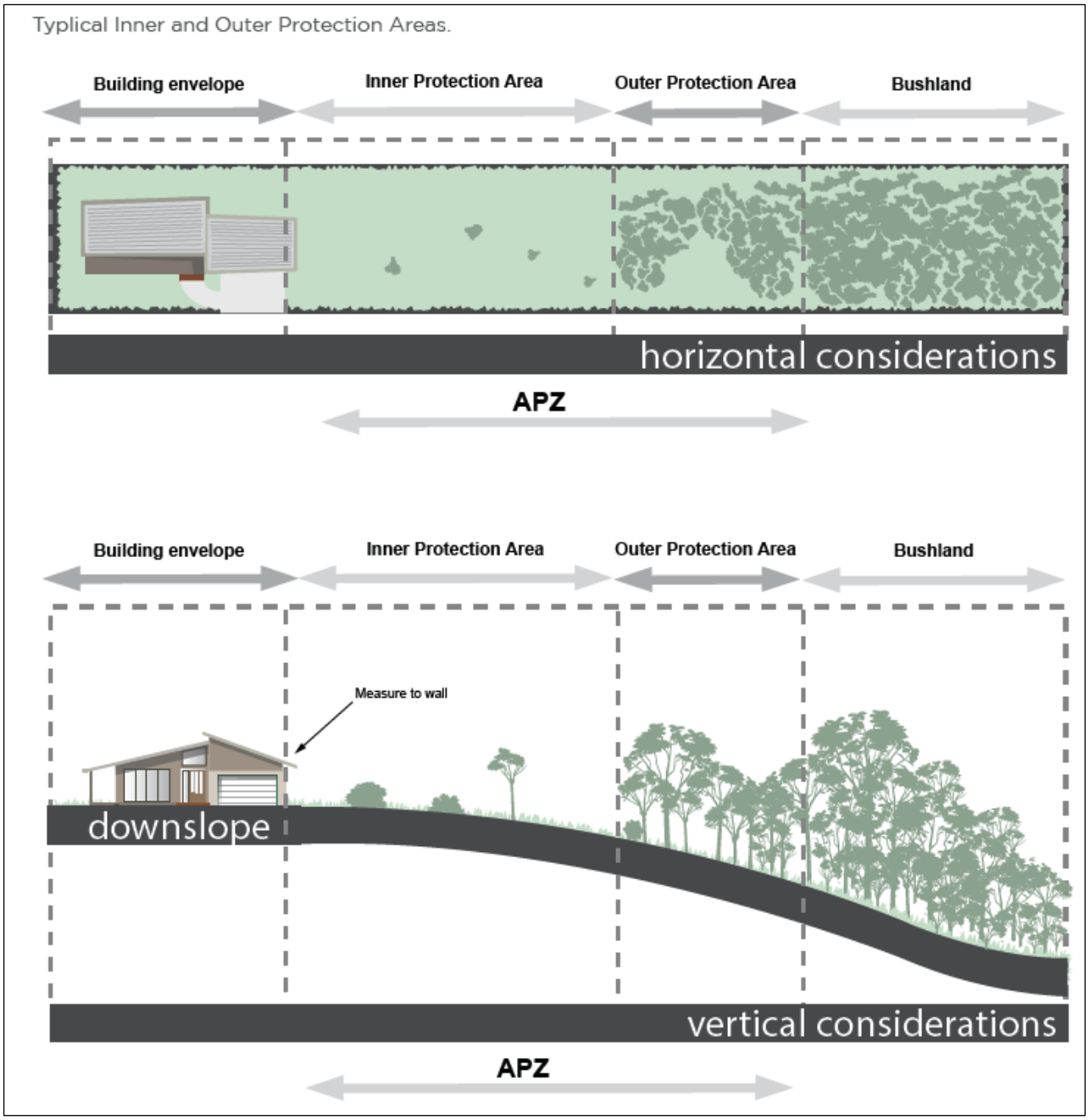


Image: Extract: PBP 2019, Appendix 4, pg. 108 (NSW RFS).

It is the responsibility of the owner/occupier of each property to maintain their property in perpetuity. Both the IPA & OPA should be regularly mown and any excess fuels (i.e. bark, branches, and leaf litter) should be removed. Grasses should be kept below a height of 100mm (NSW RFS, 2019).

Distanced Based Assessment (Construction Scenario)

Please pick from drop-down list in orange cells

Noise area category		R1
RBL or L_{A90} Background level (dB(A))	**Day**	40
	Evening	35
	Night	30
$L_{Aeq(15minute)}$ Noise Mangement Level (dB(A))	**Day**	50
	Day (OOHW)	45
	Evening	40
	Night	35
Scenario		Compound site establishment
Is there line of sight to receiver?		Yes

Steps for Screening Assessment:

1. Schedule noisy works to occur in standard hours where possible or before 11pm and implement Standard Measures.
2. Select the representative noise area category. The worksheet titled 'Representative Noise Environ.' provides a number of examples to help select the noise area category.
3. Select the scenario. If not found in drop-down list, refer to 'Source List' and select a representative scenario with similar plant combination.
4. Is there line of sight to receiver? Select the appropriate scenario from the drop down list .

Identify and implement standard mitigation measures where feasible and reasonable. Include any shielding implemented as part of the standard mitigation measures by changing the selection in the 'Is there line of sight to receiver' drop-down list. Solid barrier can be in the form of road cutting, solid construction hoarding, acoustic curtain, timber lapped and capped fence, shipping container, site office, etc. Please note that vegetation and trees are not considered to be a form of solid barrier and any gaps would compromise the acoustic integrity of the solid barrier.

6. Determine if there are any receivers (both residential and non-residential receivers) within the affected distance for each relevant time period . Consider background noise measurements to check assumption in Step #2 if:

(a) there are many affected receivers and the impact duration at any one receiver is more than 3 weeks; or

(b) there are a few affected receivers and the impact duration at any one receiver is more than 6 weeks.

Note that consideration need to be given to the construction staging plan when determining impact duration.

7. Identify if there are any receivers within the additional mitigation measures distances and identify feasible and reasonable measures at each receiver
8. Where night works are involved, identify sleep disturbance affected distance.
9. Document the outcomes of these steps.

(Note that suitable noise management levels for other noise-sensitive businesses not identified in the Construction Noise Estimator should be investigated on a project-by-project basis. Please

Abbreviation	Measure
N	Notification
SN	Specific notifications
PC	Phone calls
IB	Individual briefings
RO	Respite offer
R1	Respite period 1
R2	Respite period 2
DR	Duration respite
AA	Alternative accommodation
V	Verification

Note that spot check verification of noise levels and individual briefings are not required for projects with less than 3 weeks impact duration

Residential receiver

			$L_{Aeq(15minute)}$ noise level above background (L_{A90})												$L_{Aeq(15minute)}$ 75 dB(A) or greater (Highly affected)			Sleep disutrbance L_{Amax} 65 dB(A)
			5 to 10 dB(A)			10 to 20 dB(A)			20 to 30 dB(A)			> 30 dB(A)						
			Noticeable			Clearly audible			Moderately intrusive			Highly intrusive						
		Affected distance (m)	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Affected distance (m)
Undeveloped green fields, rural areas with isolated dwellings	**Day**	360							N	170	60	N	65	70	N, PC, RO	35	75	
	Day (OOHW)	525				N, R1, DR	360	50	N, R1, DR	170	60	N, R1, DR, PC, SN	65	70	N, PC, RO	35	75	
	Evening	755				N, R1, DR	525	45	N, R1, DR	250	55	N, R1, DR, PC, SN	115	65	N, PC, RO	35	75	
	Night	1085	N	1085	35	N, R2, DR	755	40	N, PC, SN, R2, DR	360	50	AA, N, PC, SN, R2, DR	170	60	N, PC, RO	35	75	115
	Highly Affected	35													N, PC, RO	35	75	
Developed settlements (urban and suburban)	**Day**	460							N	200	60	N	75	70	N, PC, RO	40	75	
	Day (OOHW)	685				N, R1, DR	460	50	N, R1, DR	200	60	N, R1, DR, PC, SN	75	70	N, PC, RO	35	75	
	Evening	1010				N, R1, DR	685	45	N, R1, DR	305	55	N, R1, DR, PC, SN	130	65	N, PC, RO	40	75	
	Night	1455	N	1455	35	N, R2, DR	1010	40	N, PC, SN, R2, DR	460	50	AA, N, PC, SN, R2, DR	200	60	N, PC, RO	40	75	130
	Highly Affected	40													N, PC, RO	40	75	
Propagation across a valley / over water	**Day**	630							N	250	60	N	90	70	N, PC, RO	40	75	
	Day (OOHW)	955				N, R1, DR	630	50	N, R1, DR	250	60	N, R1, DR, PC, SN	90	70	N, PC, RO	40	75	
	Evening	1415				N, R1, DR	955	45	N, R1, DR	405	55	N, R1, DR, PC, SN	150	65	N, PC, RO	40	75	
	Night	2005	N	2005	35	N, R2, DR	1415	40	N, PC, SN, R2, DR	630	50	AA, N, PC, SN, R2, DR	250	60	N, PC, RO	40	75	155
	Highly Affected	40													N, PC, RO	40	75	

Traffic Impact Assessment

Sandy Creek Solar Farm

Churches Plain Road

Uranquinty NSW

Report 8 December 2020

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APPENDIX A
Traffic Volume Data

APPENDIX B
Semi-trailer swept paths

1. Executive Summary

This Traffic Impact Assessment report (TIAR) provides an assessment of the traffic impacts to for the construction of a 17MW DC / 12MW AC solar farm at Churches Plain Road, Uranquinty NSW.

The development site includes approximately 40 hectares of Lot 118, Lot 129 and Lot 149 of DP754567, Uranquinty NSW. The site is located approximately 1.8 kilometres north of the Uranquinty Township, within the Wagga Wagga City Council Local Government Area and is bounded to the east by the Olympic Highway and west by Churches Plain Road. The main access to the development site is via Churches Plain Road. *Refer to Figures 1.1 Locality Plan and 1.2 Site Plan for details.*

This TIAR investigates the traffic impacts of construction and operational vehicle movements along the proposed primary transportation routes and recommends any mitigation measures that are required as a result of the Sandy Creek Solar Farm development.

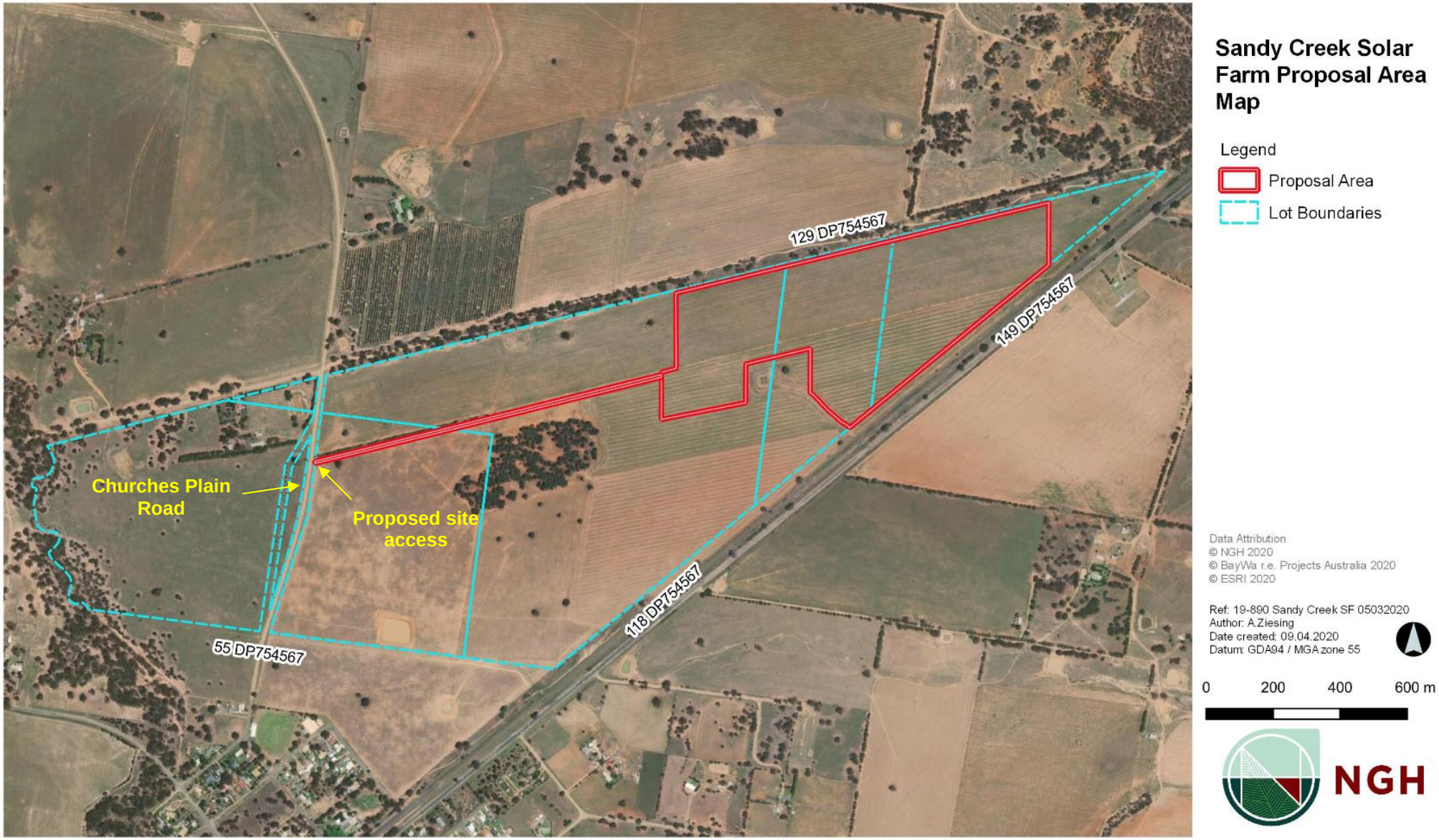
It is determined that there will be minimal impact from the Sandy Creek Solar Farm development on the roads identified as the primary transportation routes for construction activities as all primary transportation roads meet the Austroads standards for road capacity.

In addition, it is concluded that the additional peak construction traffic of **46 vehicles per day and 5 vehicles per hour in both the AM and PM peaks**, generated by the solar farm development will have a minimal impact on the operations of the following primary transport routes and intersections:

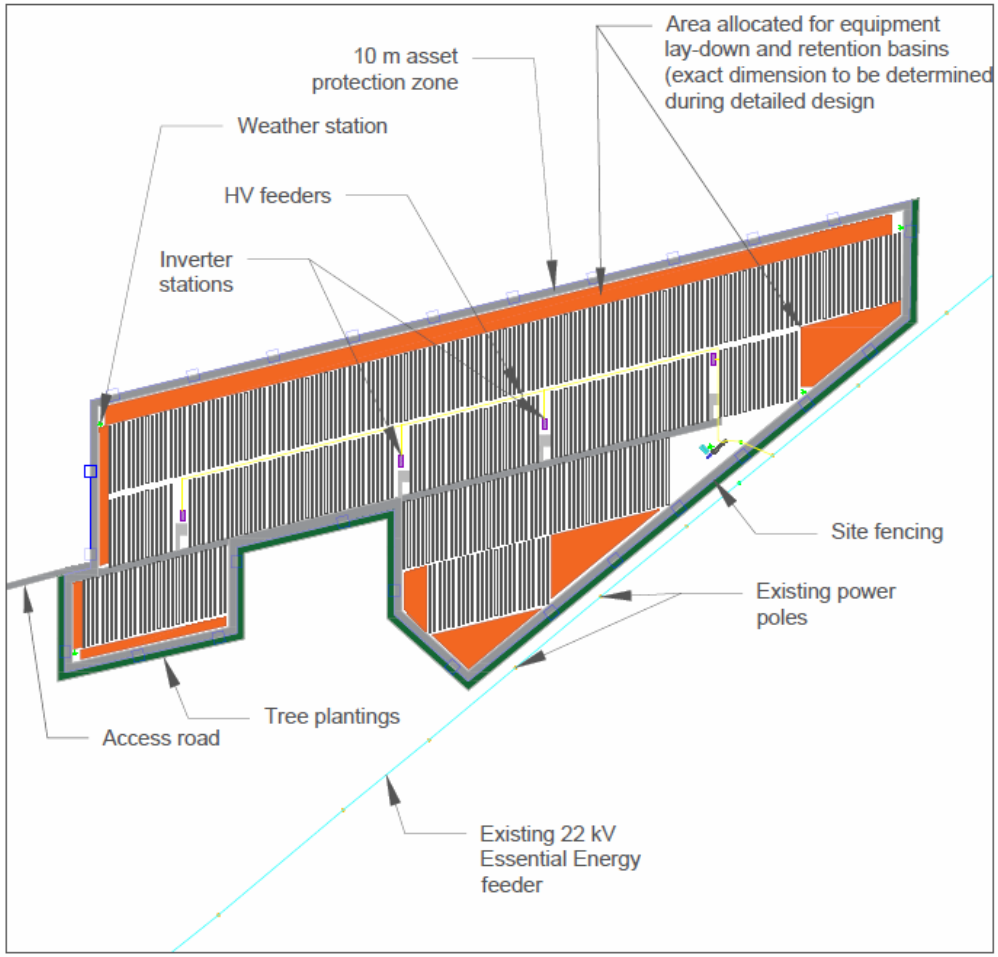
- Churches Plain Road and the intersection of Solar Farm Access Gate;
- Baker Street and the intersection of Yarragundry Street;
- Yarragundry Street and the intersection of Olympic Highway MR78;
- Olympic Highway MR78

It is recommended that a Construction Traffic Management Plan be prepared for the gravel section of Churches Plain Road (750m) from the end of the seal at Baker Street and the Solar Farm Access Gate to ensure the gravel pavement is maintained to accommodate construction traffic and other road users.

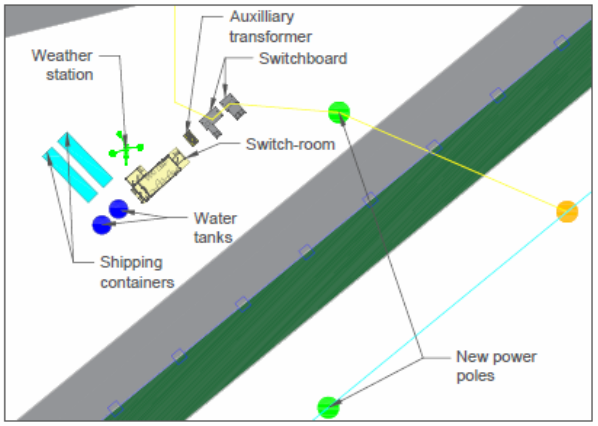
1.1 Locality Plan



1.2 Site Plan



Scale: 1:5980



Scale: 1:840

LEGEND:

- Fencing
- Internal track
- Laydown areas / retention basins
- 22 kV feeders
- 22 kV power-line
- Solar panel tables
- Inverter stations
- Existing power poles
- New power poles
- Weather stations

Rev	Date	Name Editor	Modification / Adaptation of the drawing
2	21.04.2020	TSP	Number of inverter stations increased to 4.
1	13.02.2020	TSP	PRELIMINARY ISSUED

BayWa r.e.

BayWa r.e. Projects Australia Pty Ltd
45 Denison street
Bondi Junction 2022 | Australia

	Date:	Name:
Drawn:	13.02.2020	TSP
Changed:		
Checked:		

Project: Sandy Creek Solar Farm 12 MVA

Drawing Title: Concept site layout

File Name: BWre-AU-SAN-001-GAL

Format: A3

1.3 Site Characteristics

Address	Lot 118, Lot 129 and Lot 149 of DP754567, Uranquinty NSW
Road Hierarchies Primary Access Roads	• Churches Plain Road is classified as a rural road. • Baker Street and Yarragundry Street are classified as an urban road. All roads are managed by Wagga Wagga City Council. • The Olympic Highway is classified as State Roads and are under the management of RMS. The Olympic Highway is a designated B-double route and Churches Plain Road between Baker Street and the Sturt Highway is a designated unladen B-double route. All roads are acceptable for use by semi-trailer and truck and trailer combinations.
Proposed Use	17MW DC / 12MW AC Solar Farm
Accesses	Churches Plain Road
Existing Traffic volumes and Speed Environment	Refer to Section 3.3 Tables 3.1, 3.2 and 3.3 of report
Traffic Generation	**During Peak Construction** • 756 vehicle movements per month; • 36 vehicle movements per day; • Allow 4 vehicle movements AM and PM peak hour movements **During Operations** • 8 movements per day; • Allow 4 vehicle movements for PM peak hour

1.4 Recommendation

Wagga Wagga City Council concurs with the proposed Sandy Creek Solar Farm development access and the use of the nominated roads as primary transportation routes for construction activities.

2. Introduction

BayWa r.e. Projects Australia proposes the construction of a 17MW DC / 12MW AC photovoltaic solar farm at, Uranquinty NSW. The development site is located at a rural property described as Lot 118, Lot 129 and Lot 149 of DP754567, Uranquinty NSW. The site is located approximately 1.8km north of the Uranquinty Township, within the Wagga Wagga City Local Government Area and is bounded to the south-east by the Olympic Highway MR78 and to the west by Churches Plain Road. *Refer to Locality Plan in Section 1.1*

The main access to the development site is via the Olympic Highway MR78, Yarragundry Street, Baker Street and Churches Plain Road. Access to the solar plant areas is via a property access crossing on Churches Plain Road. *Refer to Figures 1.1 Locality Plan and 1.2 Site Plan for details.*

Peter Meredith Consulting has been engaged to prepare a TIAR investigating the traffic impacts of construction and operational vehicle movements along the proposed site access routes and the wider road network and provide a description of any mitigation measures that are required as a result of the Sandy Creek Solar Farm development.

The assessment uses existing traffic flow data obtained from Roads and Maritime Services (RMS) and Wagga Wagga City Council, on-site observations, construction and operational traffic volumes generated by the proposed Sandy Creek Solar Farm from BayWa r.e. Projects Australia and future traffic growth predictions.

2.1 Documentation

The documentation and information provided for this assessment includes:

- *Solar Farm Estimated Total Heavy Vehicle Construction Traffic, Construction Schedule and other operational details supplied by BayWa r.e. Projects Australia.*

2.2 References

References used in the preparation of this assessment include the following:

- *Roads and Maritime Services (RMS) Guide to Traffic Generating Developments, Version 2.2 October 2002 for traffic generation predictions and Technical Direction TDT 2013/04a Updated Traffic Surveys.*
- *Austroads Guide to Traffic Management Part 12: Traffic Impacts of Development*
- *Austroads Guide to Road Design (AGRD) Part 4A: Unsignalised and Signalised Intersections.*
- *RMS supplement to Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections.*
- *Austroads Guide to Road Design Part 4: Intersections and Crossings - General*
- *Austroads Guide to Road Design Part 6: Roadside Design, Safety and Barriers.*

3. Existing Conditions

The Sandy Creek Solar Farm development site is located at a rural property described as Lot 118, Lot 129 and Lot 149 of DP754567, Uranquinty NSW and is bounded to the south-east by the Olympic Highway MR78 and to the west by Churches Plain Road.

3.1 Land Use

The proposed development site shown in Section 1.1 and 1.2 is presently used for agriculture and grazing and comprises flat open paddocks. The development footprint would comprise an area of approximately 40 hectares, located in the north-eastern sector of the subject land. The solar farm would include installation of approximately 40,000 solar photovoltaic (PV) panels on a ground-mounted tracking system of pole driven steel posts. The proposed development would connect to the existing 22kV line via a new switching station. The solar farm would also comprise of perimeter landscape buffers, internal access tracks, onsite parking for staff and construction vehicles, security fencing and potentially include ancillary operational site facilities. *Refer to Site Plan in Section 1.2.*

3.2 Road Network and Transport Routes

The site location has been selected because of the close proximity to the existing electricity grid and sub-station and the locations of the major road network. The major road network is suitable for the transport of project infrastructure and equipment to the site during construction, operations and decommissioning stages, and for the workforce to easily travel from the site during each stage of the project. The following roads have been identified as the primary transportation routes for heavy vehicles involved with the delivery of materials for the construction of the Uranquinty Solar Farm.

- Churches Plain Road
- Baker Street
- Yarragundry Street
- Olympic Highway MR78

Below is a description of the characteristics of the roads and their suitability as a project transportation route. *Refer to the Traffic Volume Plan in Section 3 Figure 3.1 for details.*

3.2.1 Churches Plain Road

Churches Plain forms the main access road to the Sandy Creek Solar Farm areas. Churches Plain Road is a formed gravel road running in a north south direction connecting to Barker Street where the surface changes to bitumen and is also the start of the Uranquinty residential area. Churches Plain Road is classified as a local rural road under the management of Wagga Wagga City Council. Churches Plain Road is a designated unladen B-double route and currently serves as access to the farming property described as Lot 118, Lot 129 and Lot 149 of DP754567, Uranquinty NSW.

Adjacent to the development site access Churches Plain Road has a road reserve width of approximately 20m between fence lines and consists of the following characteristics:

- Gravel formation 7.0m wide in good condition;

- Shallow table drains and grass verges;
- Guide post delineation on curves and at culvert crossings;
- The proposed access to the solar farm (existing farm gates mark the location) is located 750m from the start of the bitumen at Baker Street and start of the Uranquinty residential aera;
- At 150m north from the end of the bitumen at Baker Street, Churches Plain Road dips to form a floodway. The location of the floodway is signed on both approaches with 'Floodway' warning signs;
- Churches Plain Road has a default rural road speed limit of 100km/h and is not sign posted;
- The Urban 50km/h speed limit extents 430m from the end of bitumen at Baker Street along Churches Plain Road.



Photo 1: Churches Plain Road looking at existing gate and access to development site



Photo 2: Churches Plain Road looking north bound from proposed access gate



Photo 3: Churches Plain Road looking south bound from proposed access gate



Photo 4: Churches Plain Road looking north bound from Baker Street

Conclusion: Churches Plain Road is suitable as a site access road for heavy vehicles (semi-trailers) carrying materials to the construction site subject to the proposed maintenance measures. *Refer to Section 6 Impacts and Mitigating Works for more detail.*

3.2.2 Baker Street

Baker Street connects to Churches Plain Road (north) and Yarragundry Street (south) and runs in a north and south direction. Baker Street connects to Yarragundry Street as a T-junction and is controlled by Give-way signs. Baker Street is classified as an urban road under the management of Wagga Wagga City Council and has a posted urban speed limit of 50km/h.

Baker Street between Yarragundry Street and Churches Plain Road has a road reserve width of approximately 30m and consists of the following characteristics:

- An undivided two-way road with a sealed carriageway width of 6.2 metres;

- Formed gravel shoulders at 1.0m wide with shallow table drains and grass verges;
- Pipe culvert property access crossings;
- Guide post delineation and street lighting;



Photo 5: Baker Street looking north bound towards bend in Baker Street



Photo 6: Baker Street mid-block looking south bound towards Yarragundry Street

Conclusion: Baker Street is suitable as a site access road for heavy vehicles (semi-trailers) carrying materials to the construction site subject to the proposed maintenance measures. *Refer to Section 6 Impacts and Mitigating Works for more detail.*

3.2.3 Yarragundry Street

Yarragundry Street connects to the Olympic Highway MR78 and runs in an east and west direction and crosses the Great Southern Railway Line. At the town limits Yarragundry Street becomes Uranquinty Cross Road. In Uranquinty, Yarragundry Street is classified as an urban road under the management of Wagga Wagga City Council and has a posted urban speed limit of 50km/h and is a designated school bus route.

Yarragundry Street between Baker Street and the Olympic Highway MR78 has a road reserve width of approximately 41m and consists of the following characteristics:

- An undivided two-way road with a sealed carriageway width of 6.6 metres with;
- Marked centre line along whole route and in some section marked edge lines;
- In some sections wide grass verges to table drains with pipe culvert property access crossings and in other sections seal verges to kerb and gutter with layback access crossings;
- Street lighting;
- The eastern section is subject to a 40km/h school speed zone during school times and 40km/h pavement patches, line marking and signage is installed;
- Near its junction with the Olympic Highway MR78 (approximately 55m) Yarragundry Street crosses the Great Southern Railway Line. The railway crossing is controlled by boom gates and flashing lights. Signage and marking are installed.



Photo 7: Yarragundry Street looking west bound at the give-way line in Baker Street



Photo 8: Yarragundry Street looking east bound at the give-way line in Baker Street



Photo 8: Yarragundry Street looking east bound mid-block between Baker Street and railway crossing



Photo 9: Yarragundry Street looking east bound towards Olympic Highway from railway crossing



Photo 10: Yarragundry Street looking west bound towards railway crossing from Olympic Highway

Conclusion: Yarragundry Street is a suitable site access road for heavy vehicles (semi-trailers) carrying materials to the construction site. No traffic mitigating works have been identified.

3.2.4 Olympic Highway MR78

The Olympic Highway MR78 and runs in a north and south direction and is a major regional transport corridor and is under the management of the RMS. In Uranquinty, the Olympic Highway has a posted urban speed limit of 50km/h and is a designated school bus and B-double route.

The Olympic Highway MR78 on the approaches to Yarragundry Street consists of the following characteristics:

- An undivided two-way road with 2 x 4.2m traffic lanes and wide sealed shoulder parking lanes at approximately 5.0m on the northern approach;
- An undivided two-way road with 2 x 4.0m traffic lanes with a wide sealed shoulder parking/left turn lane on the east side at approximately 5.0m and seal edge and gravel shoulders on the western side;
- On the northern approach prior to the intersection with Yarragundry Street there is a School Children's Crossing. The school crossing is supervised and has kerb extensions to reduce the crossing width. The crossing is controlled during the morning and afternoon school peaks;
- On both approaches to the School Children's Crossing the Olympic Way is subject to a 40km/h school speed zone during school times and 40km/h pavement patches, line marking and flashing signage is installed;
- Marked centre and edge lines with RRPM delineation;
- Street lighting.



Photo 11: Olympic Highway looking north bound towards Yarragundry Street and School Children's Crossing



Photo 12: Olympic Highway looking north bound towards Yarragundry Street



Photo 13: Olympic Highway looking south bound towards Yarragundry Street and School Children's Crossing



Photo 14: Olympic Highway looking south bound towards Yarragundry Street

Conclusion: The Olympic Highway MR78 is suitable as a site access road for heavy vehicles (semi-trailers) carrying materials to the construction site. No traffic mitigating works have been identified.

3.3 Existing Traffic Volumes

Traffic volumes for the RMS classified road the Olympic Highway which will be used as the project transportation route have been sourced from the RMS interactive traffic volume viewer at www.rms.nsw.gov.au. A summary of the latest traffic count data for the above roads is shown in Table 3.1 below.

Table 3.1: RMS Classified Roads ADT AM and PM Peak hour and % Heavy Vehicles traffic volumes

Location	Year	ADT	AM Peak 8 – 9am	PM Peak 4 – 5pm	% HV
Olympic MR78 ID 95551 50m East of Mangoplah Road, The Rock 2655	2010	3,063	122 Nth 81 Sth	114 Nth 150 Sth	21.7%
Olympic MR78 ID 95065 180m North of Red Hill Road, Moorong 2650	2010	4,178	215 Nth 91 Sth	125 Nth 196 Sth	17.0%

It is estimated that the traffic volumes for the Olympic Highway at Uranquinty would be roughly the same as The Rock with a 1.0% pa traffic growth applied to give forecast 2020 traffic volumes at Uranquinty. *Refer Section 3 Figure 1 Primary Transportation Routes and Traffic Volumes below.*

In addition, traffic volumes of roads that will be used as the primary transportation routes for the project have been sourced from Wagga Wagga City Council. *Refer to Appendix A for a copy of the latest traffic count data supplied by the Wagga Wagga City Council.* A summary of the latest traffic count data for Yarragundry Street a primary transportation road is shown in Table 3.2 below.

Table 3.2: Wagga Wagga City Council ADT *estimated AM and PM Peak hour % Heavy Vehicles traffic volumes and 85th Percentile Speed

Location	Year	ADT	*AM & PM Peak	% HV	85th % speed
Yarragundry Street (between Best St and Pearson St)	2017	496	5	7.7	44

***Determining AM and PM Peak traffic volumes:** The RMS Traffic Modelling Guidelines Section 9.15.2 Demand Modelling states that: '*In general, peak hour is assumed to be around 10 per cent of AADT. This varies from city to city depending on the magnitude of the study area, spatial distribution of activities and network congestion…'*

No traffic volume data was available for Baker Street or Churches Plain Road. To determine the traffic volumes using Baker Street and Churches Plain Road, estimated traffic volumes are established using the rates suggested in the *RMS Guide to Traffic Generating Developments Technical Direction TDT 2013/04a Updated Traffic Surveys* for Low Density Residential Dwellings (regional areas). Assumed generation rates are as follows:

- Daily vehicle trips (vpd) = 7.4 per dwelling

- Weekday average evening (PM) peak hour vehicle trips (vph) = 0.78 per dwelling
- Weekday average morning (AM) peak hour vehicle trips (vph) = 0.71 per dwelling

By applying the above rates, the estimate traffic volumes for Baker Street and Churches Plain Road are listed below:

Churches Plain Road 4 Dwellings

- Daily vehicle trips = 4 dwellings x 7.4 = **30 vpd**
- PM peak hour vehicle trips = 4 dwellings x 0.78 = **3vph**
- AM peak hour vehicle trips = 4 dwellings x 0.71 = **3vph**

Baker Street 10 Dwellings

- Daily vehicle trips = 14 (4+10) dwellings x 7.4 = **104 vpd**
- PM peak hour vehicle trips = 14 dwellings x 0.78 = **11vph**
- AM peak hour vehicle trips = 14 dwellings x 0.71 = **10vph**

The number of existing dwellings on Baker Street and Churches Plain Road were counted using Google Maps and also adding the additional new homes on Baker Street.

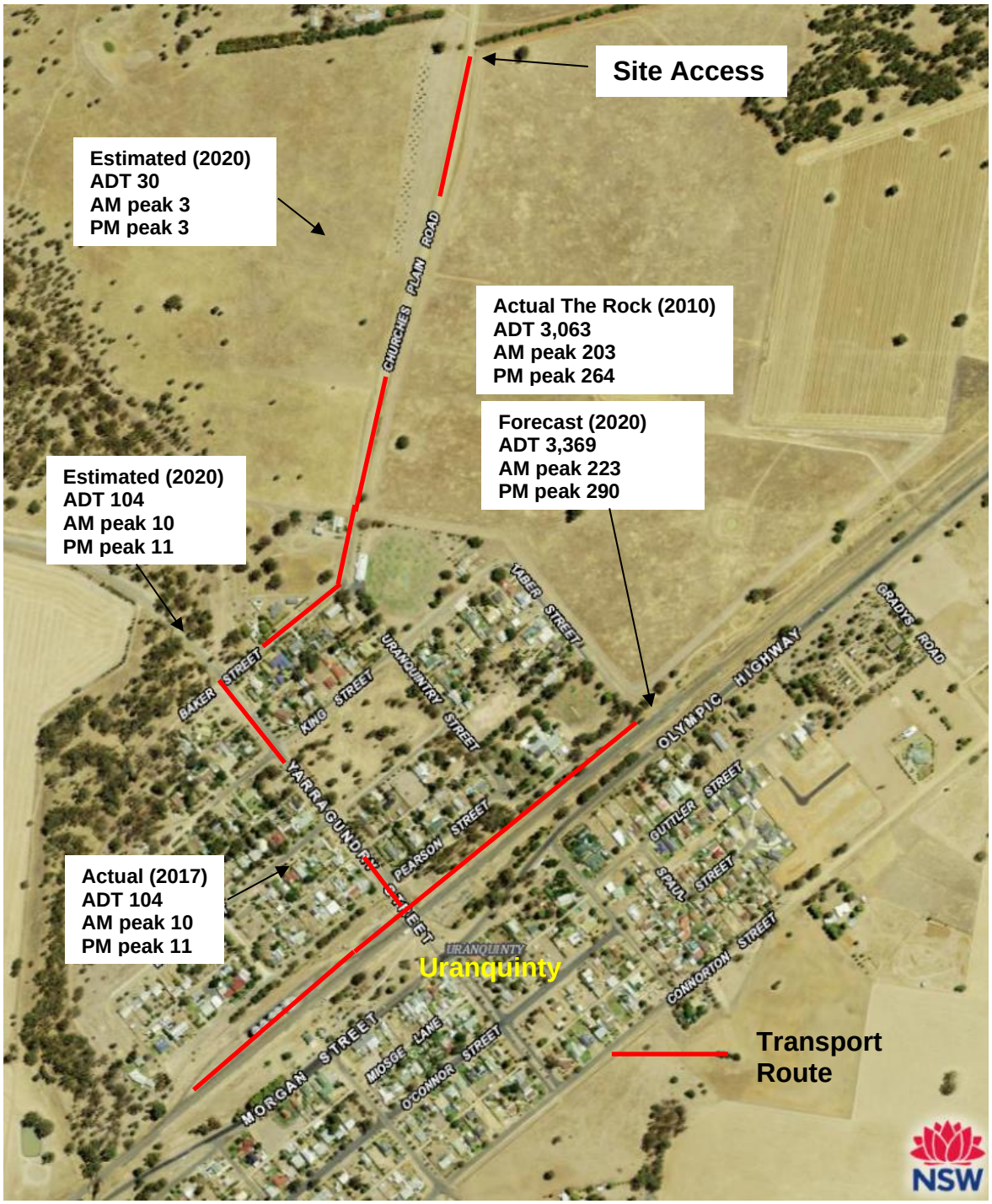
A summary of the estimated traffic volumes for Baker Street and Churches Plain Road both primary transportation roads is shown in Table 3.3 below.

Table 3.3: Estimated ADT, AM and PM Peak hour traffic volumes

Location	Year	ADT	AM Peak	PM Peak
Baker Street (between Yarragundry St and Churches Plain Rd)	2020	104	10	11
Churches Plain Road (from end of Baker St)	2020	30	3	3

The existing, estimated and forecast traffic volumes for the routes are shown in Figure 1 below.

Figure 3.1: Project Primary Transport Route with Existing, Estimated and Forecast Traffic Volumes



3.4 Road Capacity Standards

3.4.1 Lane Capacity

Road width design standards for high volume (urban) and low volume (rural) roads are defined by the *Austroads Guide to Road Design Part 3: Geometric Design* and are based on daily traffic volumes. The current design standards applicable to the proposed primary transportation routes are presented below in Table 3.4.

Table 3.4 Daily Volumes of Primary Transportation Routes and Corresponding Design Standard

Daily Traffic	Austroads Design Standard	Relevant Roads	Meets design Volume Standard
1-150	Rural Road. Traffic lanes 3.7m (1x3.7m)	Churches Plain Road Existing gravel 7.0m	Yes
150-500	Urban Road. Traffic lanes 6.2m (2 x 3.1m)	Barker Street	Yes
150-500	Urban Road. Traffic lanes 6.2m (2 x 3.1m)	Yarragundry Street Existing sealed 6.6m	Yes
> 3,000	Urban Road. Traffic lanes 4.2-4.5m locations where motorists and cyclists use the same lane. High truck volumes and wide kerb side lane	Olympic Highway MR78 Existing seal 8.4	Yes

The primary transportation routes have acceptable road cross sections which meet the Austroads road design standard for the daily traffic volumes using each route. In all cases there is also a margin of extra traffic capacity to accommodate any daily traffic increases, without requiring any increase to the design standard of the route.

3.4.2 Semi-trailer Swept Paths

Swept path analysis was carried out for the following primary transportation route intersections:

- Olympic Highway and Yarragundry Street;
- Yarragundry Street and Baker Street;
- Churches Plain Road and 8m wide site access gate.

Plans of the semi-trailer swept paths are shown in Appendix B and indicate that semi-trailers can readily access the solar farm site with minimal impact to the local street network.

4. Proposed Development

4.1 Site Construction

BayWa r.e. Projects Australia is proposing to development and operate a 17MW DC / 12MW AC solar farm at, Uranquinty NSW consisting of the following key infrastructure elements:

- Land area approximately 40 hectares
- Main access is from Churches Plain Road via an 8.0m wide gravel road to main gate
- Installation of 40,000 solar photovoltaic (PV) panels in regular arrays
- Ground-mounted tracking system of pole driven steel posts
- Above ground and underground DC cabling (low voltage)
- Central inverters, step up transformers, and switchgear
- Underground AC cabling that would run from the PCUs to the solar substation (high voltage)
- Four step-up transformers one in each inverter station
- The solar farm would also comprise of perimeter landscape buffers, internal access tracks, security fencing and potentially include ancillary operational site facilities
- Supervisory control and data acquisition (SCADA) control systems
- Site office and staff amenities
- Maintenance shed
- Permanent staff and contractor car parking onsite
- Permanent all-weather site access (8 m wide) from Churches Plain Road
- Internal vehicle access tracks (4 metres) leading to solar arrays and PCUs
- Temporary site compound, lay-down area, and equipment storage areas during construction for loading-unloading of materials and heavy vehicle parking. All construction vehicle parking is on-site. Verges and edges of roadways will not be used for parking.
- Monitoring systems, and electrical protection systems.

Construction and Delivery Equipment

Construction equipment required for the establishment of the solar farm will be limited to heavy machinery and plant generally used across the wider construction industry;

- Semi-trailers for delivery of materials (B-doubles will not be used)
- Truck and dog for civil works
- D6 dozer or equivalent for levelling and road development
- 24 tonne excavators for earthworks
- Grader for road development and levelling activities
- Mulcher for the mulching and re-use of vegetation material onsite

- 7 tonne vibrating rollers for road construction
- Front end loader for the movement and loading of soil and aggregate materials
- Water cart for road construction and dust suppression;
- Piling rig for installing PV piles
- Franna crane for the lifting of loads, erection of steel, and movement of heavy plant
- Trenchers for the installation of underground conduits and cabling
- Portable generator for temporary site power

Construction Schedule

The construction of the Sandy Creek Solar Farm is expected to take up to 8 months, which each construction aspect and duration detailed below in Table 4.1.

Table 4.1 Construction Schedule

Activity	Month							
	1	2	3	4	5	6	7	8
Site Preparation and Establishment								
Civil Works (roads & drainage)								
Installation of PV piles, support structures, and trackers								
Installation of PV panels								
Cabling of PV Strings								
Installation of Central Inverters								
Installation of Underground Cabling from Central Inverters								
Installation of grid connection equipment and Site Office								
Connection to distribution line								
Commissioning								

Hours and Workforce

Standard daytime construction hours would be 7.00am to 6.00pm Monday to Friday and 8.00am to 1.00pm on Saturdays. No work would be undertaken on Sundays or public holidays. The client has advised that 40 workers will

be required per day during the peak and 15 per day during off-peak periods. It is estimated that there will be a minimum of two workers per vehicle travelling to and from the work site.

It is estimated that there will be 40 light vehicle movements per day during peak construction and 15 per day during off-peak.

5. Future Traffic Generation and Distribution

5.1 Traffic Generation

Traffic generation volumes during the construction of the solar farm have been determined using the indicative construction traffic movements provided by the proponent as shown in Table 5.1 below.

Table 5.1 Solar Farm Estimated Total Heavy Vehicle Construction Traffic

Plant / equipment	Description	Heavy vehicles
Modules	Estimate no more than 36,000 modules delivered on 56 x 42.5 tonne semi-trailers.	56
Mounting frames	Estimate no more than 5x 40' containers per MWdc inclusive of piles, torque tubes and all associated hardware, delivered on 78 x 42.5 tonne semi-trailers.	78
Inverter stations	Estimate no more than 4 inverter station deliveries, delivered on 4 x 42.5 tonne semi-trailers	4
Concrete	Estimate no more than 30x 11 m^3 concrete trucks.	30
Gravel	Estimate gravel delivered in 200x 42.5 tonne truck & dog trailers.	200
Sand	Estimate 25x 50 tonne truck & dog trailers.	25
Miscellaneous	Provision for 8 miscellaneous deliveries (fencing, switching station equipment, materials for the site facilities, water for dust suppression etc.) a week during the 26 weeks peak, dropping to 4 trucks a week for the 12 weeks shoulder periods. Semi-trailers and rigid body trucks.	256
ESTIMATED TOTAL		649

Note: All heavy vehicles are required to operate within the legal weight limits as required by RMS.

Table 5.2 Indicative Monthly Construction Traffic Movements - Heavy Vehicles

Material Delivery	Month									
	1	2	3	4	5	6	7	8	9	Total
Modules					14	14	14	14		**56**
Inverter Stations		1	1	1	1					**4**
Tracking System		16	16	16	15	15				**78**
Civil Construction Concrete, sand and gravel	8	8	56	56	56	56	8	7		**255**
Miscellaneous	16	32	40	40	40	40	32	16		**256**
Estimated Total monthly Heavy Vehicle Movements	24	40	112	112	126	126	55	38		**649**

Average Daily Heavy Vehicle Movements (21 working days per month)	2	2	6	6	6	6	3	2		

Indicative Monthly Construction Traffic - Light Vehicles (Workers)

Construction Labour	**Month**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
Estimated Total Monthly Light Vehicle Movements	315	315	840	840	840	840	315	315		**4,620**
Average Daily Light Vehicle Movements (21 working days per month)	15	15	40	40	40	40	15	15		

It is anticipated that the average **traffic generation during the construction** phase will peak during months five and six with 756 vehicle movements per month (126 heavy vehicle + 840 light vehicles), or 46 movements per day (6 heavy vehicles + 40 light vehicles). Construction traffic will be generated from the following sources:

- Light vehicle movements for construction workers;
- Delivery of high voltage equipment, PV components, and related construction materials;
- Delivery of construction materials for the permanent site office, switch yard, and maintenance buildings;
- Delivery of temporary construction worker toilets, lunchrooms, and site office;
- Mobilisation and de-mobilisation of heavy plant and equipment; and
- Delivery of aggregates and concrete for civil works.

In addition, it is expected that during the non-peak construction periods (months 1-2 and 7-8) the average traffic vehicle generation is expected to peak at 14 movements per day.
At least three (3) semi-trailers with oversized dimensioned loads will be required during construction stage. These vehicles will comply with the maximum legal tonnage of 42.5 tonne and will be subject to oversize permit conditions regulated by the RMS.

It is anticipated that the average **traffic generation during construction** will peak at 46 movements per day, **or less than four (5)** movements during AM and PM peak per hours (*10% of AADT). Traffic generation during operational periods is estimate at 4 staff with 8 vehicle movements per day.

5.1.1 Summary

During Construction

- **966** vehicles per month (126 heavy vehicle + 840 light vehicles);
- **46** vehicles per day (6 heavy vehicles + 40 light vehicles);
- **5** vehicles per AM and PM peak.

Operational

- **8** vehicles per day
- **4** per PM peak hour

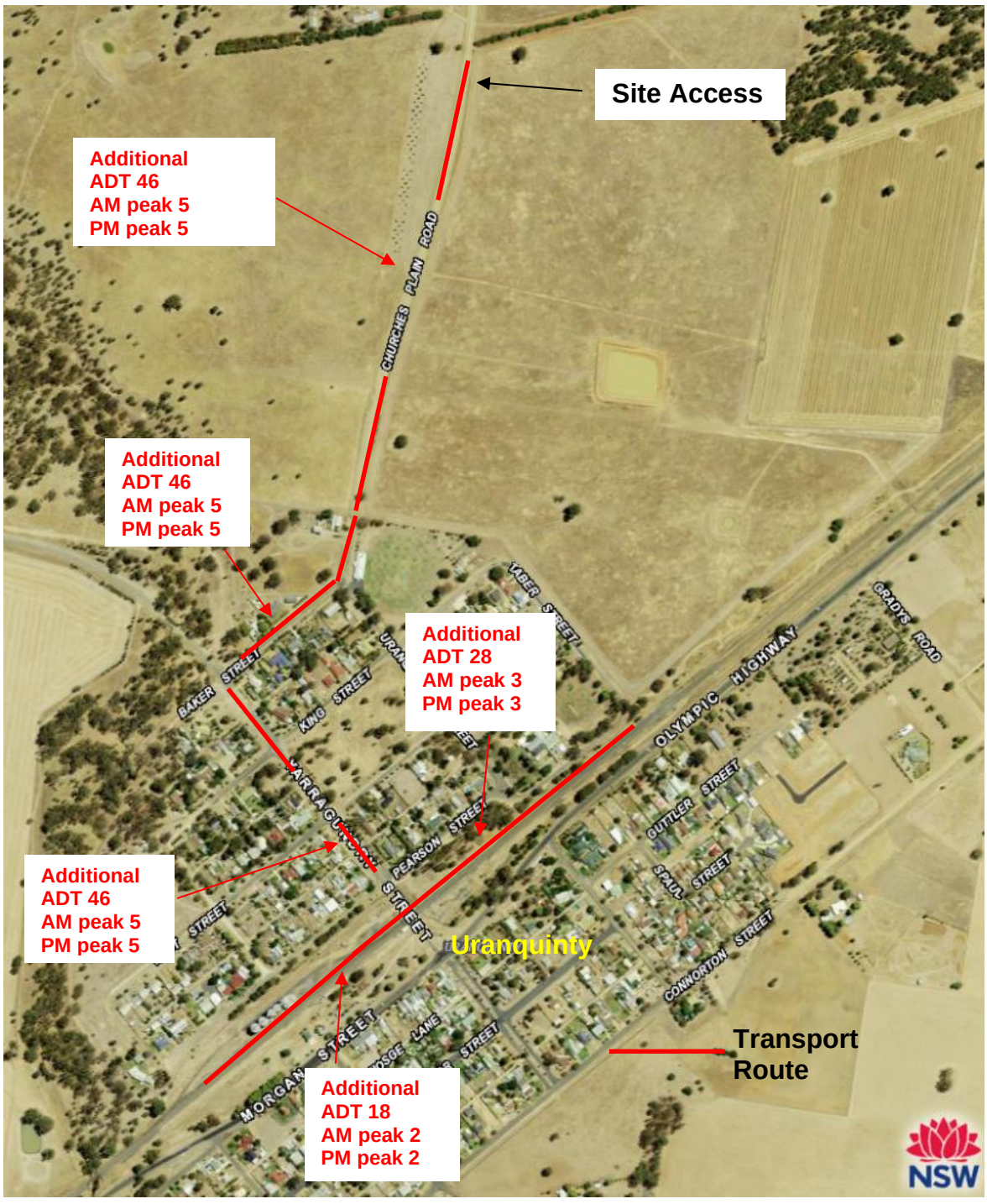
5.2 Traffic Distribution and Analysis

It is anticipated that traffic generated by the solar farm development will be distributed throughout the existing greater road network depending on origin/destination and route choices of delivery, construction and operational traffic. This can be estimated by assessing likely origins and destinations based on existing traffic flows on the primary transportation routes.

It is assumed that 60% of construction and operation traffic will arrive at the site south bound on the Olympic Highway, turning right into Yarragundry Street, turning right into Barker Street and continuing onto Churches Plain Road to the site access gate. The other 40% of construction and operation traffic will arrive at the site north bound on the Olympic Highway, turning left into Yarragundry Street, turning right into Barker Street and continuing onto Churches Plain Road to the site access gate. Traffic exiting the site will travel in the reverse direction.

A summary of the additional daily (ADT) and AM and PM peak hour traffic movements for the Sandy Creek Solar Farm are shown in Figure 5.1 below.

Figure 5.1: Additional Solar Farm Peak Hour Traffic Movements



6. Impacts & Mitigating Works

The impacts of the proposed solar farm development are primarily related to the increase in heavy vehicle movements delivering materials for construction and the day to day operations of construction vehicles and personnel at the following locations:

- On the existing road network, mainly related to the primary transportation routes;

- At the proposed T-junction intersection of Churches Plain Road and the Solar Farm Access gate primarily related to the increase in heavy vehicle turning traffic volumes generated by the construction traffic;

The impacts are quantified below and appropriate mitigating works are recommended, if required.

6.1 Sight Distance

Churches Plain Road

The existing rural speed limit for the intersection of Churches Plain Road and the site access gate is 100km/h. The minimum safe intersection sight distance (SISD) as set out in the *Austroads Guide to Road Design Part 4A: Section 3 Sight Distance, Table 3.2* for a design speed of 100km/h is 262 metres for a reaction time of 2.5 seconds. These criteria are satisfied at the proposed T-junction intersection in both directions with measured inter-visible sight distances of over 350 metres in both directions. *Refer to Photos 2 and 3.*

Yarragundry Street

The existing speed limit for Yarragundry Street Olympic Highway at the intersection of Baker Street is 50km/h. The minimum safe intersection sight distance (SISD) as set out in the *Austroads Guide to Road Design Part 4A: Section 3 Sight Distance, Table 3.2* for a design speed of 50km/h is 97 metres for a reaction time of 2.0 seconds. These criteria are satisfied at the intersection with measured inter-visible sight distances of over 250 metres in both directions. *Refer to Photos 7 and 8 above.*

Olympic Highway

The existing speed limit for the Olympic Highway at the intersection of Yarragundry Street is 50km/h. The minimum safe intersection sight distance (SISD) as set out in the *Austroads Guide to Road Design Part 4A: Section 3 Sight Distance, Table 3.2* for a design speed of 50km/h is 97 metres for a reaction time of 2.0 seconds. These criteria are satisfied at the intersection with measured inter-visible sight distances of over 250 metres in both directions. *Refer to Photos 12 and 13 above.*

6.2 Primary Transportation Routes

The impact of the solar farm development on the roads identified as the primary transportation routes for the delivery of construction materials and the day to day access by construction personnel is considered minimal and acceptable. All primary transportation roads are acceptable as semi-trailer and truck and trailer combination routes and meet the Austroads standards for road capacity and swept path movements for semi-trailers as shown in Appendix B. In addition, it is determined that the existing carriageway widths, signage/delineation, speed limits and intersection treatments (give way conditions) and railway crossing treatments will more than satisfactorily cope with the minor increase of 46 vehicle movements per day or 5 AM and 5 PM peak hour vehicle movements of construction traffic. *Refer to Section 3.2 Road Network and Transport Routes and Section 3.4 Road Capacity Standards for more details.*

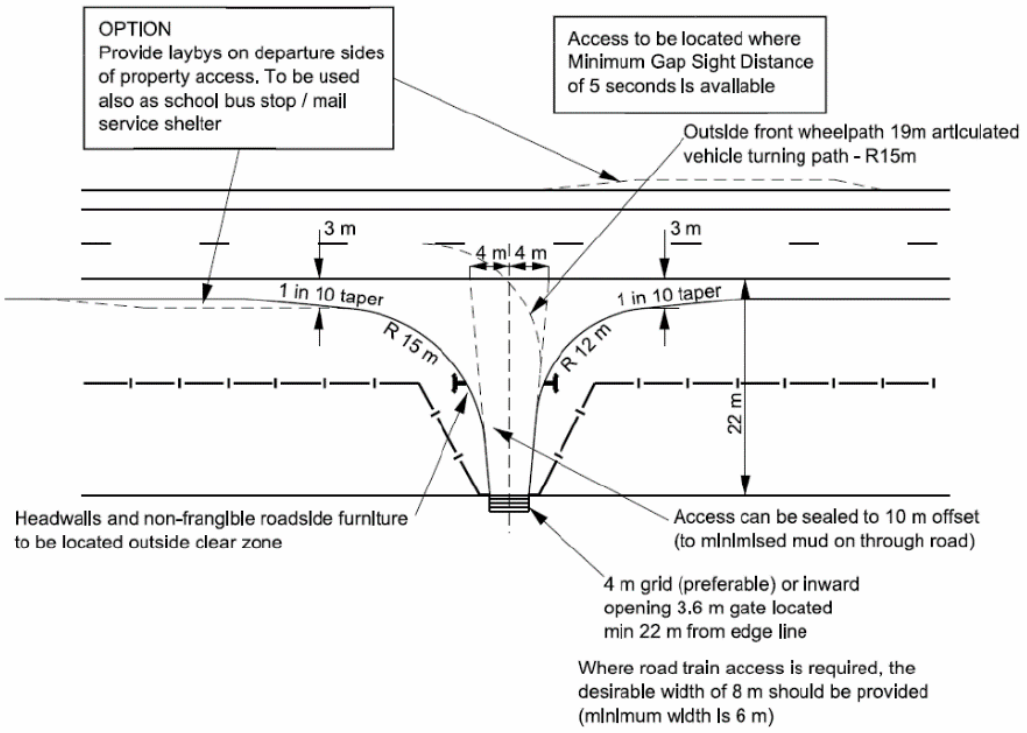
6.3 Intersection of Churches Plain Road and Solar Farm Access Gate

An examination of the addition construction traffic volumes at the proposed intersection of Churches Plain Road and the access gate demonstrates the intersection will operate well within capacity in both the AM and PM peak periods for all movements with minimal delays*. Refer to Figure 5.1 for additional traffic volumes.*

However, to ensure traffic safety and to allow for heavy vehicles turning at the intersection of Churches Plain Road and the Solar Farm Access Gate, the road connection should at a minimum be reconstructed in accordance with *Austroads Guide to Road Design Part 4: Intersections and Crossings – General Figure 7.4*

Figure 7.4. This treatment allows for articulated vehicles and the right-in/left-out dual access for trucks. An offset of 22m to the access gate/ramp from the edge of gravel on Churches Plain Road and a minimum width of 8 metres should be provided to allow for the safe two-way passing of larger vehicles.

Figure 7.4: Example of a rural property access specifically designed for articulated vehicles



Note: Minimum requirement for a single carriageway with design AADT < 2000 or minimum requirement for dual carriageway left-in–left-out access for single unit truck. Where AADT > 1000 and access is required for a semi-trailer then use the layout.

Source: Department of Main Roads (2006)[10].

6.4 Construction Traffic Management Plan

A Construction Traffic Management Plan, which will utilise Austroads and RMS guidelines will be developed for Churches Plain Road adjacent to the site including the intersection of Churches Plain Road and the Solar Farm Access Gate. The Construction Traffic Management Plan shall be produced in accordance with RMS Traffic Control at Worksites 2018 Version 5 after an appropriate risk assessment has been carried out.

In addition, to comply with Wagga Wagga City Council and RMS standards, the Construction Traffic Management Plan should address the following on Churches Plain Road:

- Dust control with water cart along Churches Plain Road during dry periods;
- Periodic grading and gravel pavement repairs, particularly during wet periods;
- Temporary traffic control arrangements at the intersection of Churches Plain Road and the Solar Farm Access Gate during the peak stages of construction traffic activity and on days when deliveries by oversize vehicles may be required;
- Reduction in speed limit on Churches Plain Road between the end of the existing 50km/h zone and the Solar Farm Access Gate to help reduce damage to the gravel pavement by heavy vehicles.

7. Conclusions and Recommendations

It is concluded that:

- The additional peak construction traffic of 46vpd and 5vph in the AM And PM peaks generated by the solar farm development will have a minimal impact on the roads identified as the primary transportation routes for construction activities and the existing intersections and it will continue operate well within capacity in both the AM and PM peak periods for all movements;

- Sight distance criteria is satisfied at all existing intersections and the Solar Farm Access Gate;

- The set back and widening of the Solar Farm Access Gate will ensure the safe operations of heavy vehicles at the intersection Churches Plain Road and the Access Gate;

It is recommended that:

Wagga Wagga City Council concurs with the proposed Sandy Creek Solar Farm development access and the use of the nominated roads as primary transportation routes for construction activities.

Appendix A

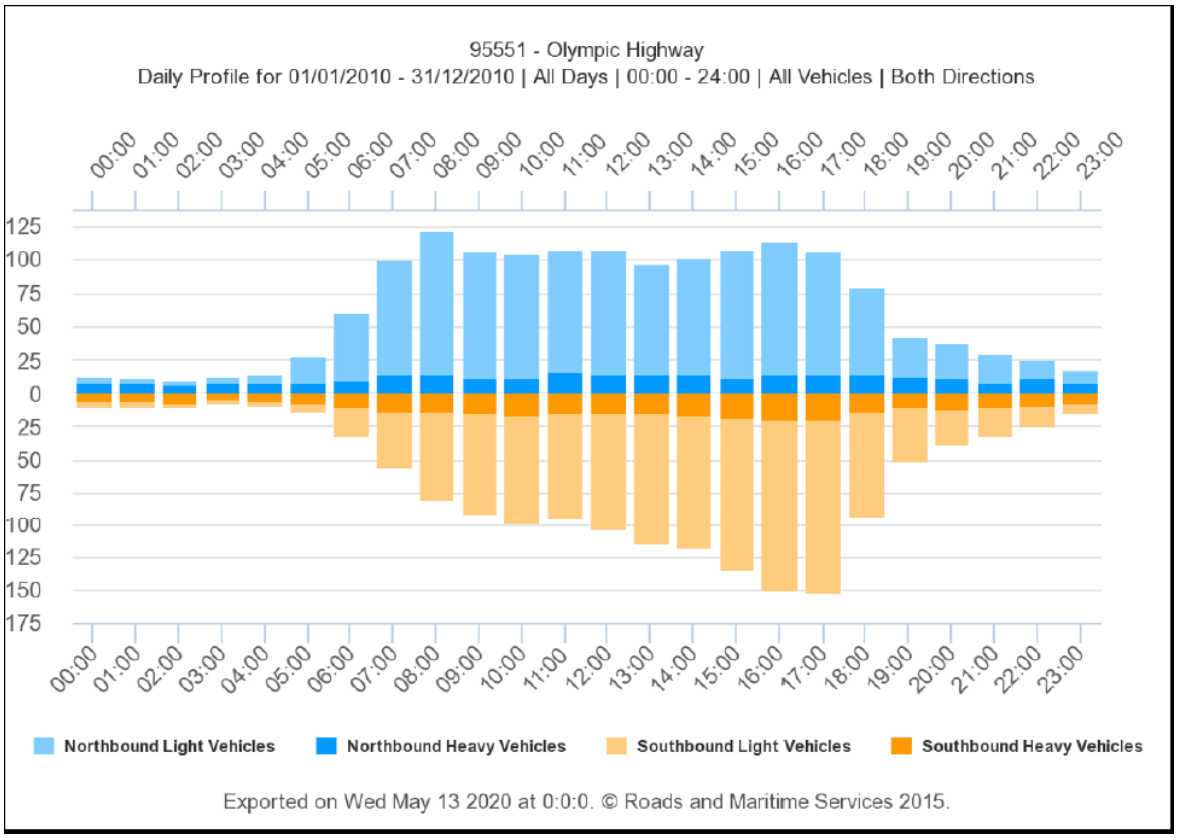
RMS Traffic Data obtained from traffic viewer www.rms.nsw.gov.au

A1: Olympic MR78 The Rock

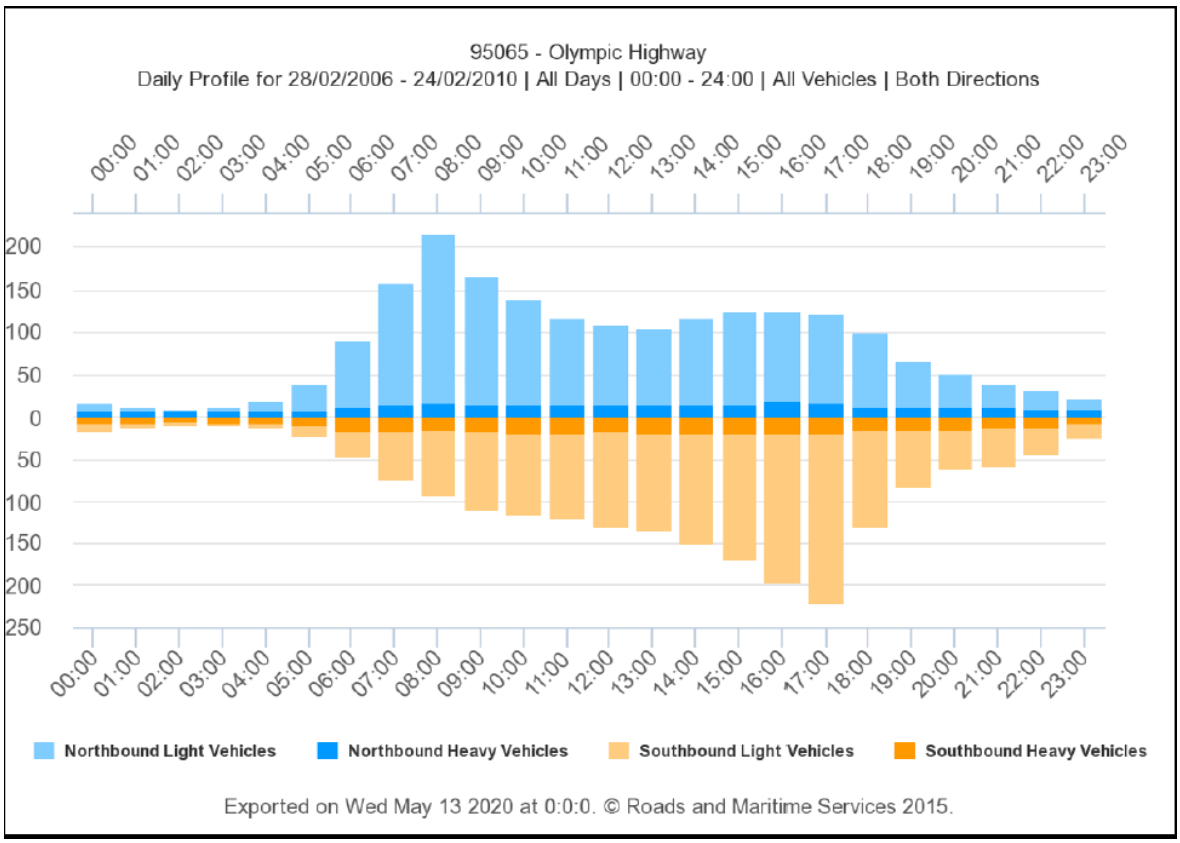
A2: Olympic MR78 Moorong

A3: Wagga Wagga City Council Traffic Data at Uranquinty

A1: Olympic MR78 ID 95551 50m East of Mangoplah Road, The Rock 2655



A2: Olympic MR78 ID 95065 180m North of Red Hill Road, Moorong 2650



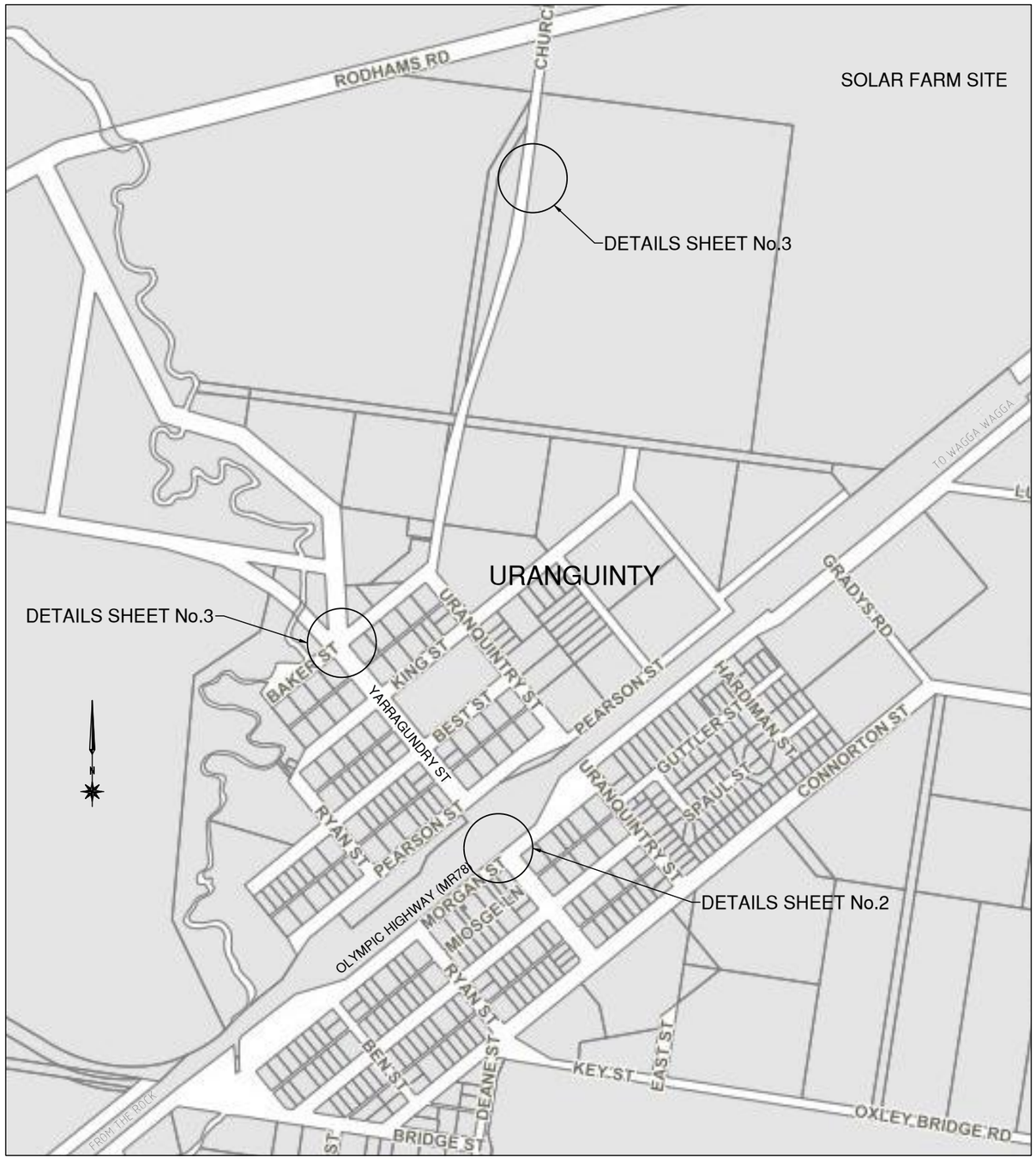
A3: Wagga Wagga City Council Traffic Data at Uranquinty

Uranquinty

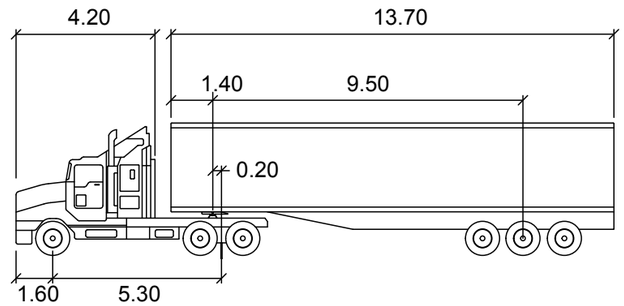
Location	Date From	Date to	AADT 5	AADT 7	AADT 5 HV	AADT 5 Art	% HV	% Art	Av Speed	Max Speed	Comments
Uranquintry st	12/11/2017	16/11/2017	434	379	40	0	9.2%	0.00%	28	41	
Connorton st	12/11/2017	16/11/2017	100	88	13	1	13.0%	1.00%	45	82	
Yarragundry St bewteen Best St and Pearson St	12/11/2017	16/11/2017	507	496	39	5	7.7%	0.99%	44	75	

Key

AADT5	Average Annual Daily Traffic weekdays
AADT7	Average Annual Daily Traffic full week
HV	Heavy vehicles = AustRoads94 Classes 3-12
Art	Articulated vehicles Class 6-12



LOCALITY PLAN
NTS



S ARTICULATED 19M

	Meters		
Tractor Width	: 2.50	Lock to Lock Time	: 6.0 s
Trailer Width	: 2.50	Steering Angle	: 27.7 deg
Tractor Track	: 2.50	Articulating Angle	: 70.0 deg
Trailer Track	: 2.50		

DESIGN VEHICLE
NTS

DATE	AMENDMENT	INIT.
REVISIONS		

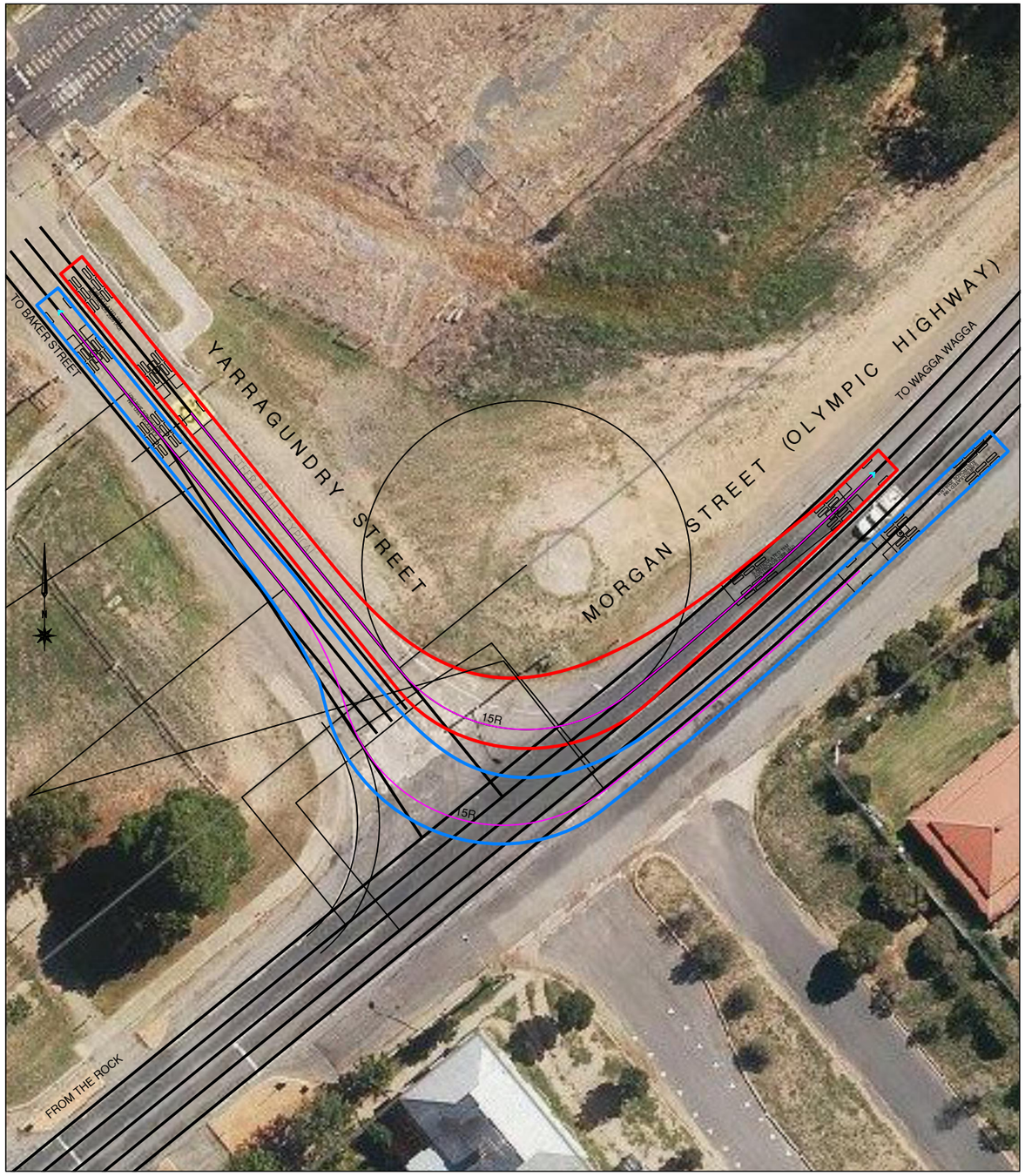
SURVEY
FIELD BOOK | LEVEL BOOK
DATUM
GRID

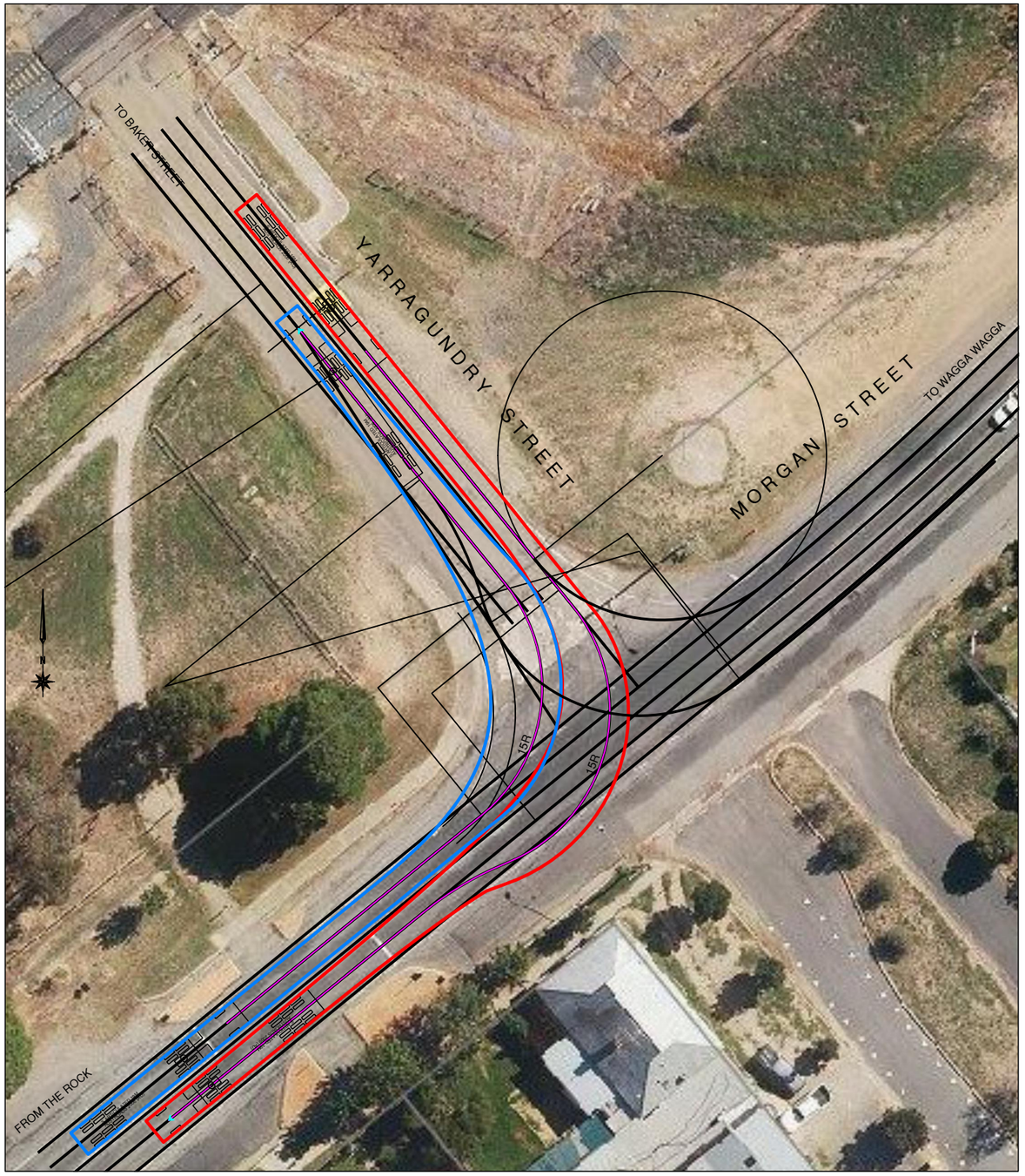
DESIGNED BDC
DRAWN BDC
...../...../.....
APPROVED

PETER MEREDITH CONSULTING

SANDY CREEK SOLAR FARM
CHURCHES PLAIN ROAD
URANQUINTY NSW
LOCALITY PLAN

SCALE NOT TO SCALE
No OF SHEETS 3 | SHEET No. 1
DRAWING NUMBER | REV.





DETAILS - NORTHERN TRAFFIC

INTERSECTION DETAILS MORGAN ST / YARRAGUNDRY ST

SCALE 10 5 00 5 10 15 20

DETAILS - SOUTHERN TRAFFIC

DATE	AMENDMENT	INIT.
	REVISIONS	

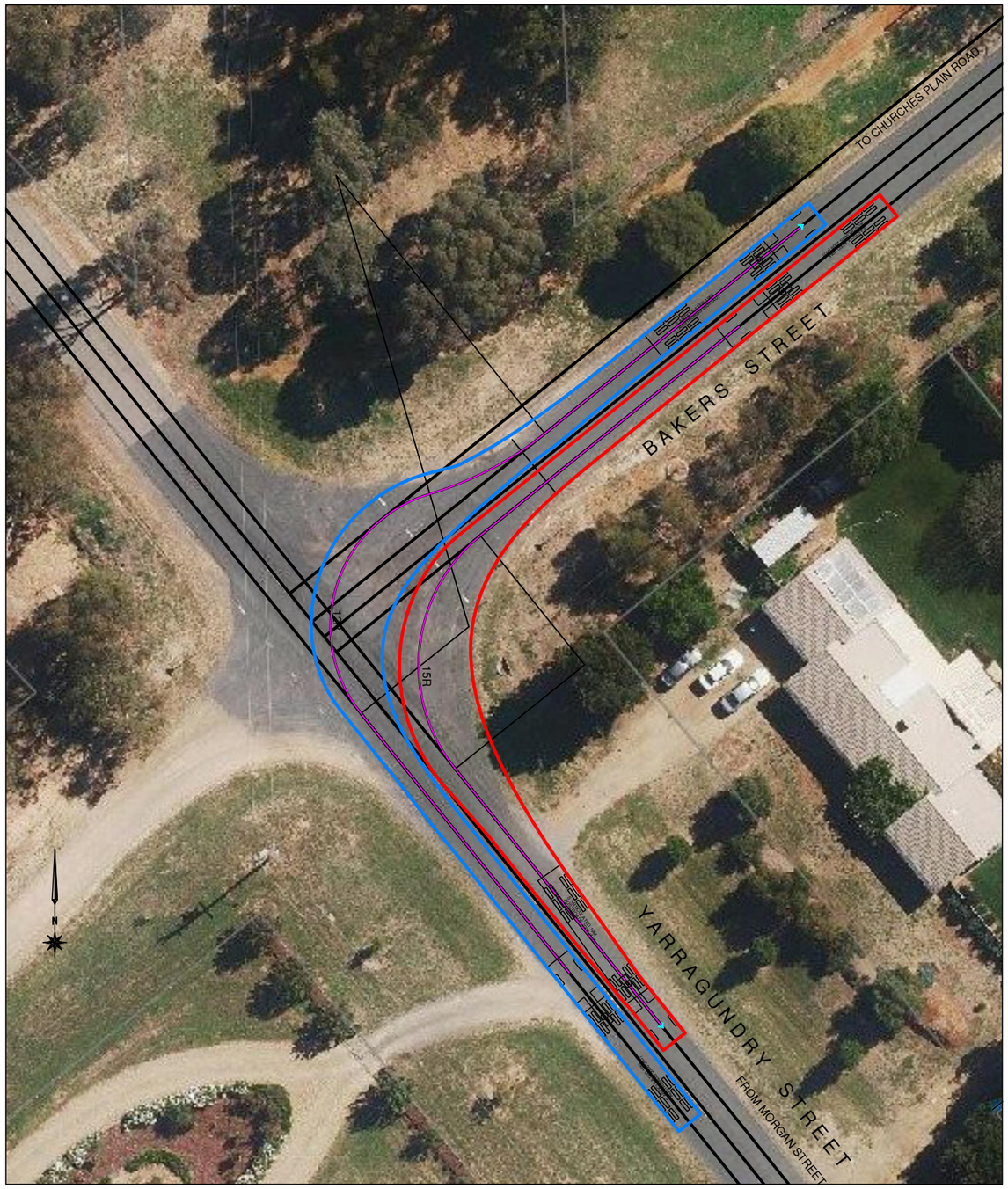
SURVEY
FIELD BOOK | LEVEL BOOK
DATUM
GRID

DESIGNED BDC
DRAWN BDC
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APPROVED

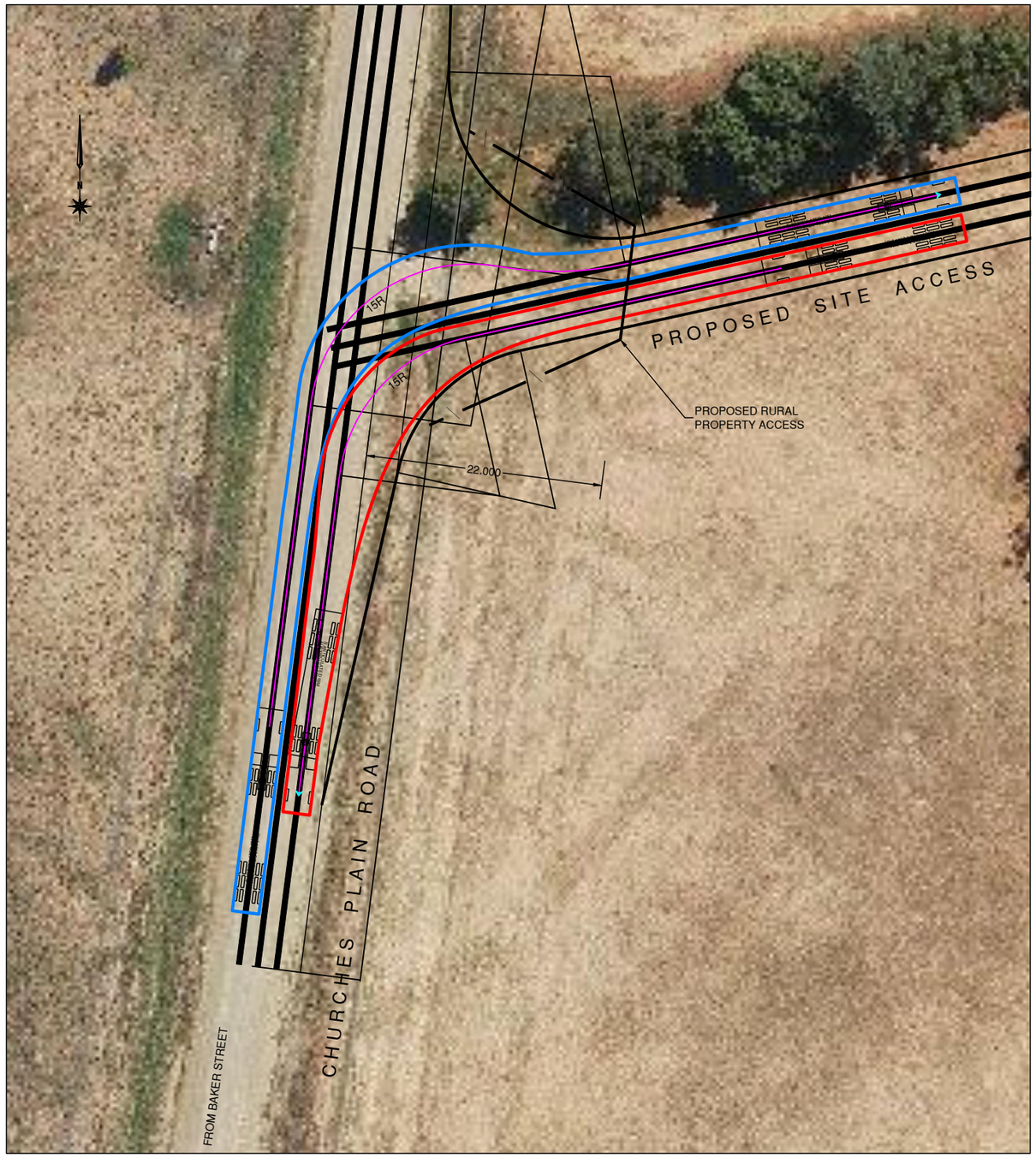
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SANDY CREEK SOLAR FARM
CHURCHES PLAIN ROAD
URANQUINTY NSW
DETAILS - MORGAN ST / YARRAGUNDRY ST INTERSECTION

SCALE 1 : 250
No OF SHEETS 3 | SHEET No. 2
DRAWING NUMBER | REV.



INTERSECTION DETAILS
YARRAGUNDRY ST / BAKER ST



INTERSECTION DETAILS
CHURCHES PLAIN RD / SITE ACCESS RD

SCALE 10 5 0 0 5 10 15 20

DATE	AMENDMENT	INIT.
REVISIONS		

SURVEY
FIELD BOOK | LEVEL BOOK
DATUM
GRID

DESIGNED BDC
DRAWN BDC
...../...../.....
APPROVED

PETER MEREDITH CONSULTING

SANDY CREEK SOLAR FARM
CHURCHES PLAIN ROAD
URANQUINTY NSW
YARRAGUNDRY / BAKERS : CHURCHES PLAIN / SITE ACCESS INTS

SCALE 1 : 250
No OF SHEETS 3 | SHEET No. 3
DRAWING NUMBER | REV.

BayWa r.e.

Sandy Creek Solar Farm

Hydrology Assessment Report

Prepared by:

BayWa r.e.

February 2019

BayWa r.e.

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1. Executive Summary

The Sandy Creek Solar Farm is a development that will be located approximately 6 km southwest of Wagga Wagga, Central New South Wales. The site is approximately 9 km south of one of the main water courses in NSW, the Murrumbidgee River, and within 2 km of Sandy Creek, in Uranquinty.

This hydrology assessment report has been prepared with consideration to the flood regime of the nearby watercourses, and the historical significance of flooding in the region. The project site is located on a hill that slopes down to the southwest towards the town of Uranquinty and Sandy Creek. Existing flood studies have been analysed to estimate the extent of the 1 % AEP design flood, which are contained within the creek bed and immediate surrounds. The development site poses no risk to the enhancement of flood magnitude or volume in the surrounding region.

Recommendations are made to ensure the development complies with certain design measures to mitigate the potential impact a change in land use could have on the surrounding hydrology. These recommendations include: the configuration of access tracks such that they do not retain flood waters within the site; the avoidance of low-lying areas; and, the tapering of engineered structures to encourage flow through natural flow paths. No further flood modelling is required on site to validate the conclusions drawn in the creation of this report.

2. Introduction

The Sandy Creek Solar Farm is a proposed development located within the Murray Darling Basin, approximately 6 km southwest of Wagga Wagga in Uranquinty, NSW. Flood management in this region is significant from a development perspective, as the site is within 9 km of the Murrumbidgee River, one of the major river systems in NSW, and lies just north of Sandy Creek, which runs through Uranquinty and has historical flood significance. As such, there is a well-documented flood history of Wagga Wagga Local Government Area, encompassing flooding through avenues of both overland flow runoff accumulation and overbank riverine flooding.

The NSW Government *Floodplain Development Manual* outlines measures that can be taken to identify, quantify and propose mitigation strategies against floodplain risk in flood prone areas. This manual has been consulted in order to understand the need for floodplain risk management, and to aid in the preparation of this hydrology assessment report.

3. Methodology

This report aims to assess the watercourses and hydrology of, and surrounding the proposed Sandy Creek Solar Farm in Uranquinty, NSW. In order to determine the flood risk and potential impact of the development, a preliminary assessment is undertaken as a desktop study. Historic flood data, as well as real time stream and climate data have been consulted in preparation of this assessment. Outcomes of this report will give an indication of further need for modelling and surveying.

Site drainage and water diversion structures are considered, to ensure the project can withstand 1 % AEP magnitude rainfall and runoff. This report gives preliminary recommendations for further modelling and research required, and potential limitations of on-site capacity to withstand extreme weather events.

The development recognizes the significance of flood planning for Central NSW and aims to establish an understanding of the existing risks the proposed site faces and determine the potential for this to be

affected and to affect the development. The site is relatively flat, so drainage measures should be considered if the site is determined to be at risk of flooding.

4. Local Waterways

The closest major river system to the project site is the Murrumbidgee River, which has a history of significant flooding. After the 1950s flood, levees were constructed in the Wagga Wagga town on the riverbanks. The levees offered some flood protection from the southern and main part of the town during the significant flood events of 1974 and 2012, the former being the second highest flood level on record at the Hampden Bridge gauge.

It has been estimated that due to aggradation of the Murrumbidgee channel during low flow periods, the river has been transporting less discharge for an equivalent stage, which contributed to the exceedance of the design height of the levees in 2012, inciting overbank flooding. The monitoring and management of these flood mitigation structures in Wagga Wagga are integral to the safety and sustainability of the town, and upgrades to the levees has been proposed.

Wagga Wagga City Council commissioned a flood study in 2015 of Sandy Creek, a tributary of the Murrumbidgee River that runs through Uranquinty. The study maps the flood extent of a 1 % AEP flood of Sandy Creek that extends through Uranquinty and around the southern and western side of the creek. The modelled flow does not encroach on to the project site. In the event of increased rainfall up to 30%, the footprint of the stormwater will navigate toward the north-west and south-east of Uranquinty, the project site remains unimpacted This map is shown in Figure 1 and gives a good indication of the current design flood regime. Nevertheless, the site should be designed to avoid retention of flow, the panels should be elevated above a minimum height to avoid flood waters, and the designs should be conservative to accommodate changes in flood regime.

Following the significant flood event in October 2010, a review on the towns and villages was prepared for NSW State Emergency Service in 2012. The flooding behaviour was mapped, the floodwater mainly travelled along the north-west direction and down Olympic Highway. Having an elevation difference between Uranquinty (200mAHD) and the proposed development site (230m AHD), the risk of flood at the project site is considered low. Figure 2 shows the topography of the site and its vicinity to adjacent watercourses. The site slopes down towards the creek line in the southwest, and there is a difference in elevation of around 10 m from the northern corner to the south west extent. Sandy creek lies around 18 m lower than the lowest extent of the site, so it is unlikely the floodwaters would extend further upslope towards the project site.

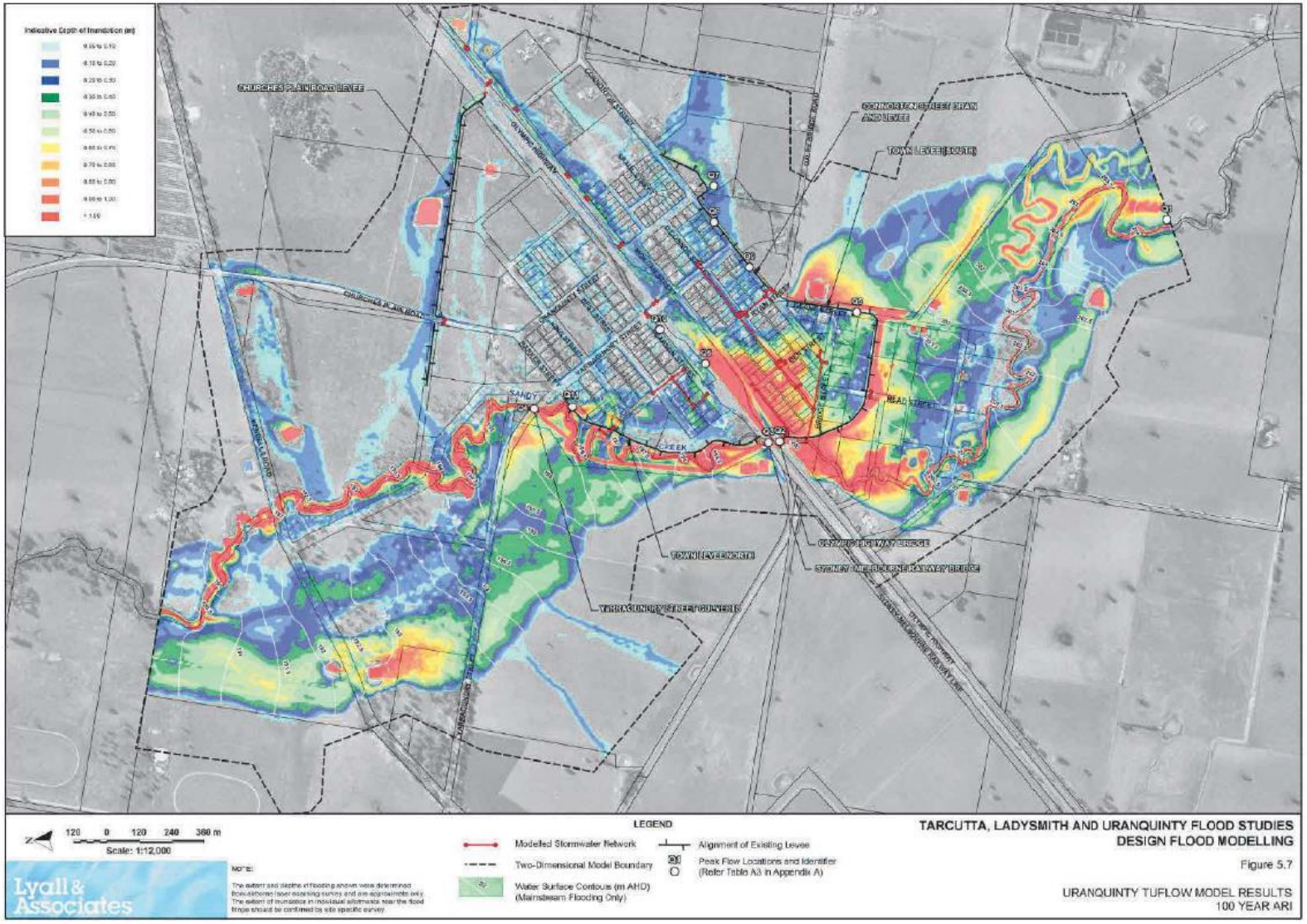


Figure 1 – Flood Extent of 1 % AEP Overbank Flooding of Sandy Creek

5. Overland Flow

The project site is in a region that experiences flooding through runoff accumulation. Water is expected to travel overland towards areas of lower elevation, along creek lines, and flow is likely to be greatly attenuated where the land is vegetated. In times of high flood, the floodwaters can pool and persist for long periods on flat land, however due to the proximity of Sandy Creek, and the steepness of the land sloping down towards the creek, overland flow is likely to dissipate away from the project site.

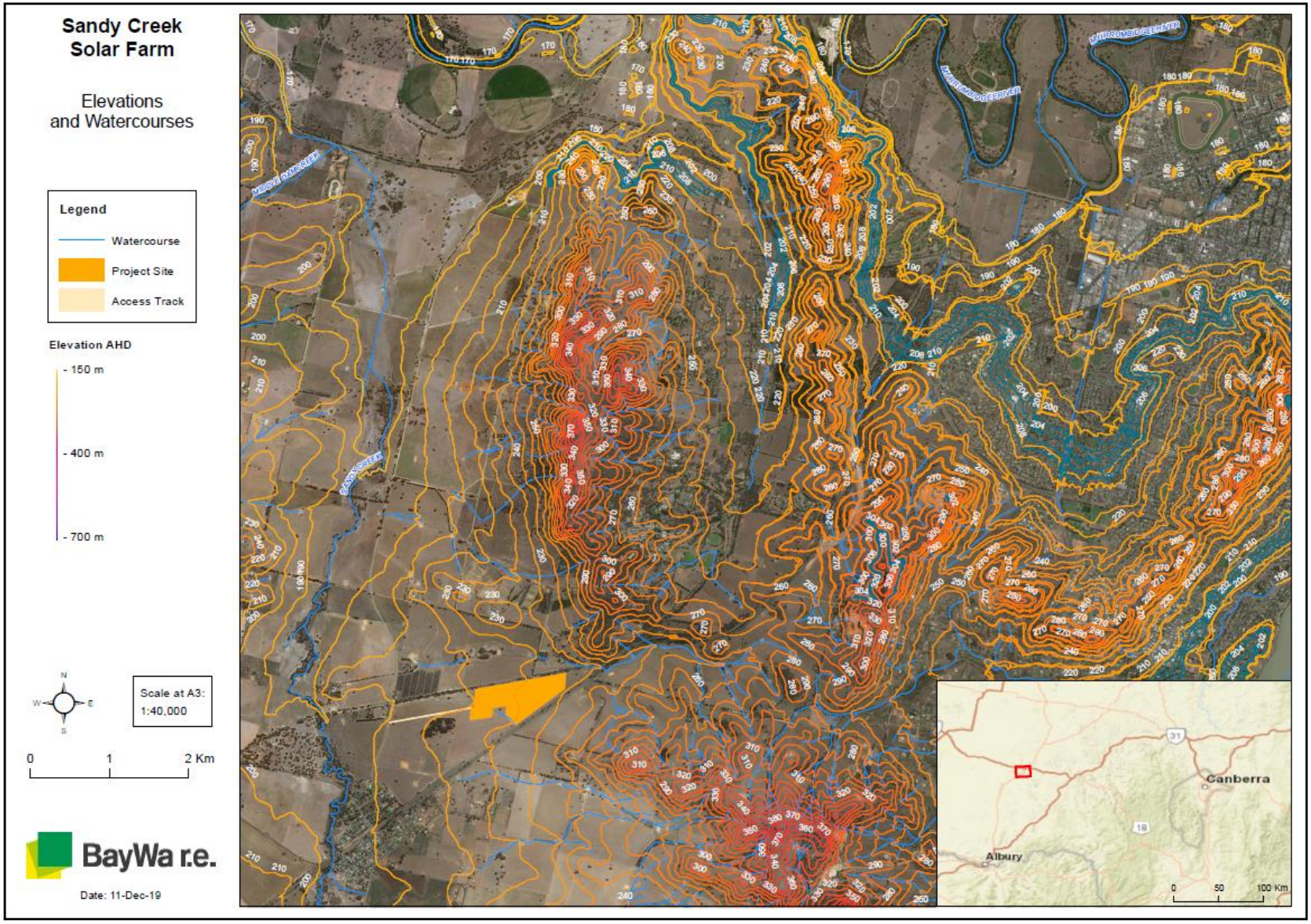


Figure 2 – Regional Topography and Site Location

6. Development Risk to Watercourses and Hydrology

The proposed site for Sandy Creek Solar Farm is located approximately 9 km away from the nearest major water course, the Murrumbidgee River, and within 2 km of Sandy Creek. An analysis of the extent of a 1 % AEP flood in Sandy Creek identifies that a flow of this magnitude would be contained within the creek line, and although it would impact Uranquinty town, the project site, being higher in altitude would not be impacted.

The site is bordered to the south by a highway and to the west downslope by Sandy Creek. In the event of an overland flood the flow would preferentially travel along the roadway. Cook & McCuen (2013) stipulate that the construction of a solar facility does not cause significant change to the existing runoff regime experienced on site. The risk of elevated runoff from site affecting the surrounding environment is already low, and the construction of a solar facility does not elevate this risk greatly.

Flooding

There are several means by which flooding can occur onsite, namely: riverine flooding, where flow overtops riverbanks and spills out onto the floodplain; flash flooding, where heavy rainfall events saturate soils and flows travel in sheet flow with little attenuation across the landscape; dam failure flooding and coastal or lacustrine flooding. Due to the isolated location of the project site, and its distance from major lakes, coast, the latter flood events are not relevant. Due to the higher elevation of the project site relative to the surrounding watercourses, and the slope of the site, neither overbank flooding of the Murrumbidgee or Sandy Creek, nor runoff accumulation pose a significant risk to the development on site.

Drainage

The proposed site slopes down to the south west, with the lowest elevation around 10 m lower than the north eastern corner. The lack of gully or flow erosion features present on site indicates that flow will travel as shallow sheet flow. Runoff that reaches the site will migrate southwest towards Sandy Creek. The development of a solar farm is not likely to have any material impact on the flood regime of the site, but the development should be designed such that the access tracks and construction compounds do not obtrude natural flow paths. Alternatively, that the site is designed such that water will not pool on site.

7. Recommendations

The risk of flooding on site either by runoff retention or overbank flooding of adjacent creek lines is low. The project site has a relatively steep slope and floodwaters are unlikely to encroach on the project site.

Nevertheless, the following recommendations are proposed in order to mitigate ponding or flow retention on site, and will be considered in the design and construction of the facility:

- Project site land will be revegetated, in order to cover exposed soil
- Where engineered surfaces are constructed, the edges will be tapered to allow for runoff to disperse to the surrounding land and follow natural flow paths
- Where there are significant localised dips and areas of lower elevation (such as farm dams), ensure they are either connected to the main creek beds or are located away from any large project infrastructure

The project site does not lie within the floodplain of the nearest watercourses, nor has it been affected historically by a 1 % AEP magnitude flood. Hence, the available information is sufficient to determine whether the site will be impacted or have an impact on the local flood regime. No further flow modelling is required.

8. Conclusions

The Sandy Creek Solar Farm is a proposed development located away from major watercourses and floodway. The project site lies on sloping land, where water travels towards the adjacent watercourses at the lowest localised elevation. The site is not currently at risk to inundation in rare flood events, but design measures are recommended so this risk remains low. It is recommended that existing drainage onsite should be enough to divert stormwater flow to natural creek lines and drainage channels, and proposed measures should be considered in the design and construction of the facility to enhance natural drainage courses and mitigate ponding.

References

NSW Government 2005, Floodplain Development Manual <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/floodplain-development-manual.pdf>

Wagga Wagga City Council 2014, Detailed Flood Model Revision, WMA Water, <https://wagga.nsw.gov.au/__data/assets/pdf_file/0020/65405/Part_1-1.pdf>

Wagga Wagga City Council 2019, Flood Watch <https://wagga.nsw.gov.au/city-of-wagga-wagga/engineering-services/emergency-management/flood-watch>

Cook, L & McCuen, R 2013. Hydrologic Response of Solar Farms. Journal of Hydrologic Engineering. 18. 536-541. 10.1061/(ASCE)HE.1943-5584.0000530.

WaterNSW – Real Time Water Data 2019, <https://realtimedata.waternsw.com.au/>

Murray-Darling Basin floodplain inundation 1 in 100 year extent 2018, <https://data.gov.au/dataset/ds-dga-d8c1d437-f5d1-4a40-8986-8527da20eeb0/details> Data.NSW dataset

SIXMaps Data acquisition tool 2019, <https://maps.six.nsw.gov.au/clipnship.html> NSW Hydrolines dataset

Parliamentary Council's Office 2008, Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources, <https://www.legislation.nsw.gov.au/#/view/regulation/2008/202/whole#%2Fsch4>

Food and Agriculture Organisation, *Watershed Management Field Manual 1998,* <http://www.fao.org/3/t0099e/t0099e04.htm > Accessed: 9 August 2019

NSW State Emergency Service 2012, Flood Intelligence Collection and Review for Towns and Villages in the Murray and Murrumbidgee Regions following the October 2010 Flood, < https://flooddata.ses.nsw.gov.au/flood-projects/murray-and-murrumbidgee-regions-following-the-oct-2010-flood >

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26th March 2021

ngh Consulting
PO Box 5464
Wagga Wagga NSW 2650

Attention: Steph Anderson

To whom it may concern

Re: DA Stormwater Calculations
Proposed Sandy Creek Solar Farm
190 Rodhams Rd Uranquinity NSW 2652
Client: Baywa R.E Projects
File No.: 210024
DA Application No.: 20/0558
Revision: B

Please find attached drawings detailing the layout and preliminary basin locations.

1.0 Council Requirements

The proposed development consists of a solar farm with internal maintenance tracks, solar panels and supporting infrastructure. Council requires:

That a flood (overland flow) impact assessment be prepared to address *Post development effects on outlet flood magnitude or volume should be investigated with consideration to the new impervious area (e.g. road and developed hardstand areas).*

The storms that have been modelled to meet this condition are the 10% AEP and 1% AEP storms. These storms will be used to asses the on site detention size to meet the councils requirement.

2.0 Site Conditions and Data

The site generally falls to the west, although there is a ridge running through the middle that splits the flow with the majority of the site running to a central lowpoint. The existing land is currently being used as farmland and has been cropped previously. The flows move in a north westerly direction towards Rodahms Rd and flow along the road to the west. There is currently a number of lowpoints along the road which hold water this conditions is not going to change post development. The site area to be developed is 77.69ha, which was divided into a number of sub catchments for analysis giving the following results:

Riverina Consulting Engineers Pty Ltd, A.C.N. 137 881 853

PHILIP XEROS (Partner)
B.E.(Hons), L.G.E., M.I.E. (Aust), NPER

ANGELO PICCOLO (Partner)
B.E. (Civil.) M.I.E (Aust)

- The peak pre-developed flow rate from the site in a 10% AEP storm event is 1,060 L/s.
- The peak pre-developed flow rate from the site in a 1% AEP storm event is 2,900 L/s.

Post-development, the site will have a number of new impervious areas consisting of:

- Maintenance tracks
- Electrical sub-stations
- Hardstand areas
- Site buildings

These impervious areas will drain via overland flow to the boundary drainage controls and OSD system. The proposed stormwater detention system for the site comprises of three OSD basins and banks to control the overland flow. These basins will have storage volumes of approximately 600-1,100m³ subject to final configurations and design.

The preliminary detention volume in the basins limits the peak post developed stormwater flows from the developed area to 0.891 L/s in a 10% AEP storm event and 2,810 L/s in a 1% AEP storm event. Noting that final flows and volumes are subject to detailed design calculations.

The overland flow post development has been designed to follow the natural water course and make use of the existing fall of the site. As the impervious areas added are relatively small compared to the overall area, overland flow is a suitable method of moving the water through the site.

3.0 Conclusion

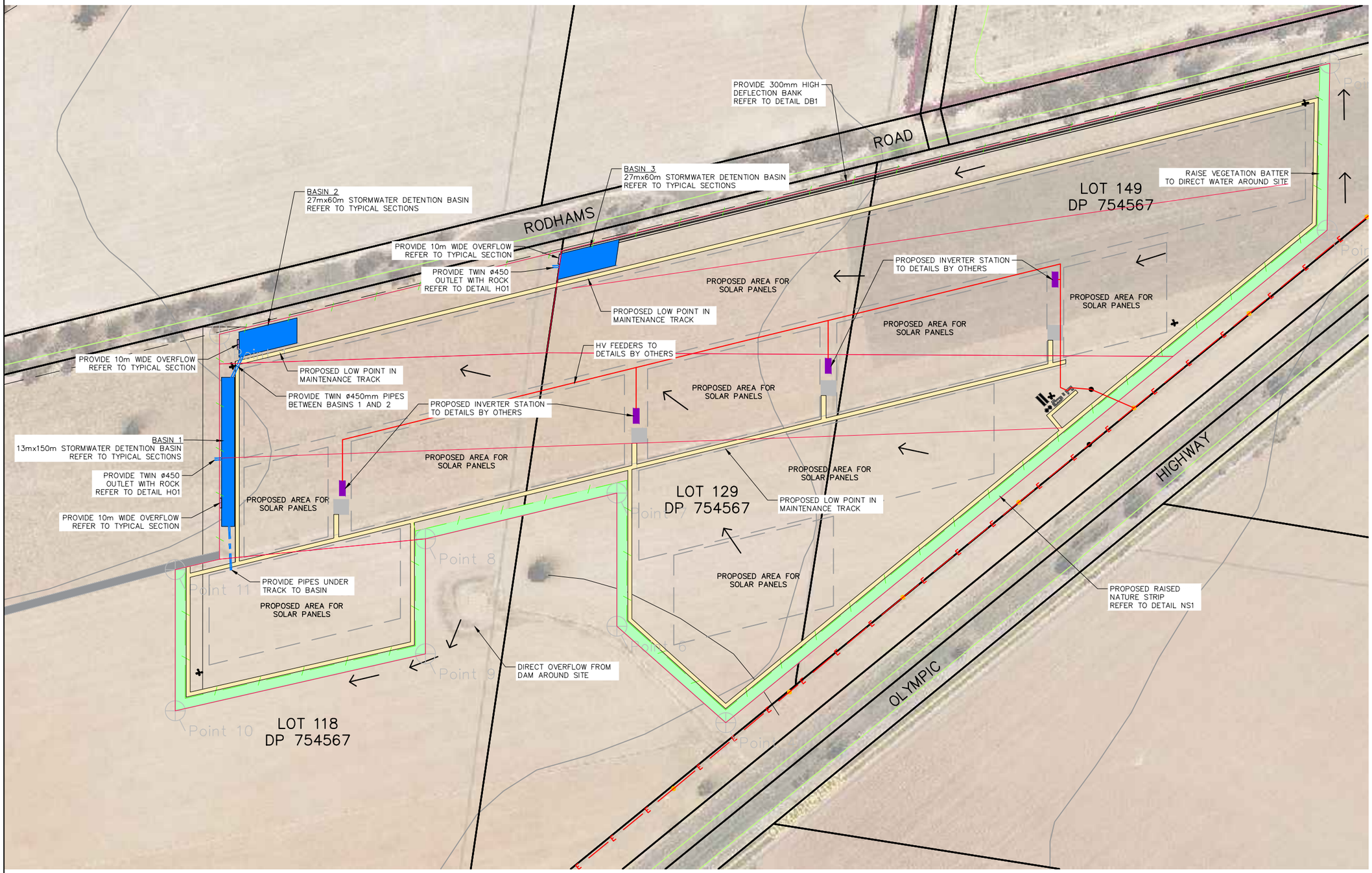
Council's requirements of pre-developed flows meeting post-developed flows have been met from the provision of on-site detention within the proposed stormwater basins. Further to this the result of providing OSD will reduce the storm flows to equal or less than pre developed flows. This means the downstram system will likely have reduce flows post development. The possibly of erosion at the OSD outlets cause by increase flow duration will be dealt with by providing approrpate rock hardering as required. Flow restriction is provided by the provision of the outlet pipes from basins, which limits flows to below pre-developed rates, in accordance with Council requirements. Final sizing basins and outlet pipes is subject to detailed design, but the site has space and geometry to allow for appropriate stormwater mitigation measures.

Please do not hesitate to contact the undersigned should you have any queries.

Yours faithfully,

XEROS PICCOLO

Alastair Xeros BE (Civil) MIEAust.



LEGEND

MARK	ITEM
— / —	PROPOSED SITE FENCE
— E —	EXISTING OVERHEAD ELECTRICAL LINE
	PROPOSED RAISED NATURE STRIP
	PROPOSED 4m WIDE ACCESS TRACK REFER TO DETAIL P1
	PROPOSED AREA FOR SOLAR PANELS
	PROPOSED STORMWATER RETENTION BASIN REFER TO TYPICAL SECTIONS
	PROPOSED STATION INVERTER TO DETAILS BY OTHERS
→	FLOW ARROWS

NOTES

1) CONTRACTOR TO CONFIRM DEPTH AND LOCATION OF EXISTING SERVICES PRIOR TO EXCAVATION AND ORDERING MATERIALS.
2) DO NOT SCALE OFF DRAWINGS. DRAWINGS ARE FOR ENGINEERING PURPOSES ONLY. REFER TO ARCHITECTURALS FOR SETOUT OF BUILDING AND RELEVANT REGULATORY PLANS FOR RELEVANT INFORMATION.
3) ALL EARTHWORKS TO COMPLY WITH AS3798.
4) ALL DRAINAGE AND PLUMBING WORKS TO COMPLY WITH AS3500.
5) LEVELS ARE FINISHED PAVEMENT LEVELS AND NOT TOP OF KERB UNLESS NOTED OTHERWISE.
6) OVERLAND ESCAPE FLOW PATHS TO BE MAINTAINED FOR THE LIFE OF THE DEVELOPMENT. OBSTRUCTIONS ARE NOT TO BE PLACED IN THE OVERLAND ESCAPE FLOW PATH. MINIMUM 150mm TO BE PROVIDED FROM FLOOR LEVELS TO OVERLAND FLOW ESCAPE BREAK–OUT POINTS

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CONTACT RELEVANT AUTHORITY PRIOR TO ANY EXCAVATION OR CONSTRUCTION.

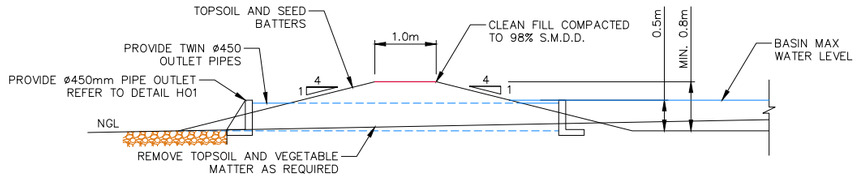
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No.	DATE	DETAILS	BY
B	26.03.2021	ISSUED FOR DA	E.Z
A	27.02.2021	ISSUED FOR REVIEW	J.S

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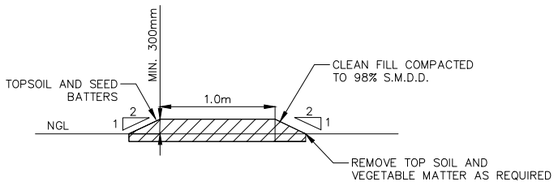
Project:
OSD– PROPOSED SANDY CREEK SOLAR FARM
LOT 118,129,149 DP 754567
190 RODHAMS ROAD, URANQUINTY NSW 2652

Sheet Title: LAYOUT PLAN
Client: NGH PTY LTD
Checked:
Scale: 1:2000 (A1) 1:4000 (A3)
Approved:
Design: A.X
Drawn: J.S
Date: JAN 2021
Project Number: 210024
Sheet Number: C1
Revision Number: B
Sheets in Set: 3



TYPICAL SECTION THROUGH DETENTION BASIN

SCALE 1:50 (A1) 1:100 (A3)

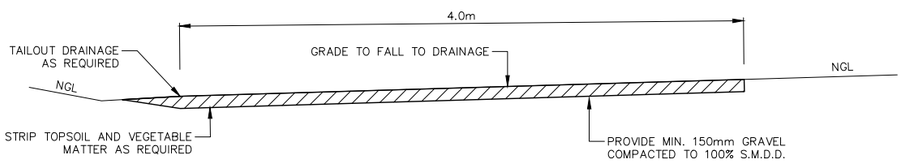


DETAIL DB1
TYPICAL SECTION THROUGH DETENTION BANK

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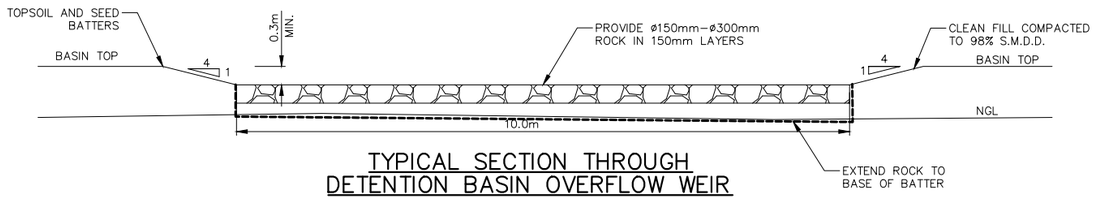
TYPICAL SECTION THROUGH MAINTENANCE TRACK GENERAL

SCALE 1:20 (A1) 1:40 (A3)



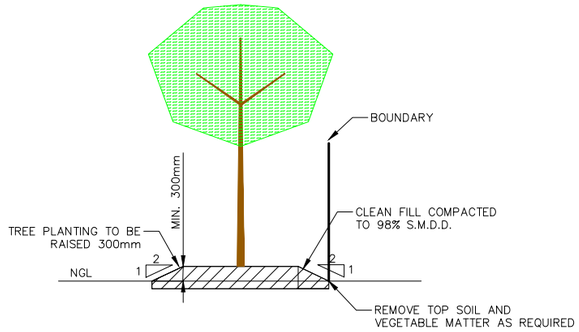
TYPICAL SECTION THROUGH MAINTENANCE TRACK LOW POINT

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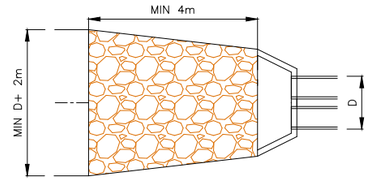
TYPICAL SECTION THROUGH DETENTION BASIN OVERFLOW WEIR

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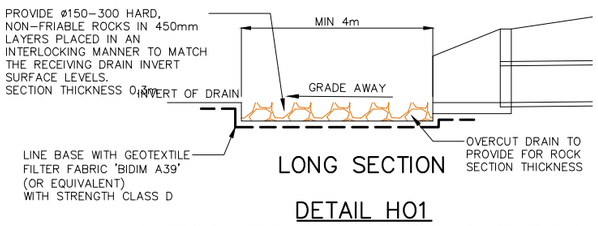


DETAIL NS1
TYPICAL SECTION THROUGH NATURE STRIP

SCALE 1:40 (A1) 1:80 (A3)



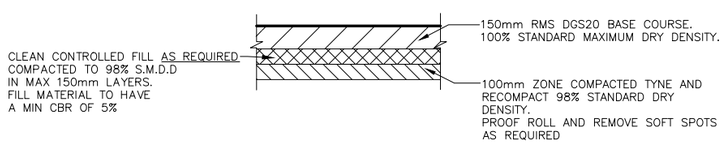
PLAN



LONG SECTION

DETAIL HO1
TYPICAL CULVERT HEADWALL OUTLET ROCK RIP RAP DETAIL

NOT TO SCALE



DETAIL P1
TYP. GRAVEL DETAIL FOR MAINTENANCE TRACK ONLY (150mm THICK)

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No.	DATE	DETAILS	BY
B	26.03.2021	ISSUED FOR DA	E.Z
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Project: OSD– PROPOSED SANDY CREEK SOLAR FARM
LOT 118,129,149 DP 754567
190 RODHAMS ROAD, URANQUINTY NSW 2652

Sheet Title: TYPICAL SECTIONS AND DETAILS
Client: NGH PTY LTD
Scale: 1:20 (A1) 1:40 (A3) OR AS SHOWN
Design: A.X | Drawn: J.S | Date: JAN 2021
Checked:
Approved:

Project Number: 210024
Sheet Number: C2 | Revision Number: B | Sheets In Set: 3

SITE MANAGEMENT NOTES

1. CONTRACTOR TO PLAN DAYS ACTIVITIES TO ENSURE THAT TRENCHES EXCAVATED ARE BACKFILLED ON THE SAME DAY AND THE FINISHED SURFACE TOPSOILED AND SEEDED ETC AS SPECIFIED. CONTRACTOR TO ENSURE THAT ALL TRENCHES ARE WHEEL ROLLED TO PREVENT SETTLEMENT
2. WORKS THAT DON'T COMPLY WITH THE LAND AND WATER MANAGEMENT PLAN MAY RESULT IN A STOP WORK ORDER ON THE PROJECT. THIS STOP WORK ORDER WILL NOT BE LIFTED UNTIL THE NOMINATED WORKS HAVE BEEN RECTIFIED. NO EXTENSION TO THE CONTRACT PERIOD WILL BE ALLOWED FOR FOLLOWING THE STOP WORK ORDER.
3. IF SITE CONDITIONS ARE SUCH THAT VEHICLE MOVEMENTS WILL DAMAGE THE EXISTING LAND COVER, REFER TO THE SUPERINTENDENT FOR INSTRUCTION.
4. ALL DISTURBED AREAS TO HAVE 75 MIN TOPSOIL. IF COMPACTED, RIP TO LOOSEN AND SEED AS SPECIFIED.
5. WHERE CONTRACTOR DISTURBS AREAS WHICH ARE NOT REQUIRED FOR THE EXECUTION OF THE WORKS, THE CONTRACTOR WILL STABILIZE THE AREAS AT HIS OWN COST TO THE SATISFACTION OF THE SUPERINTENDENT. LIMIT OF WORKS 3m FROM BATTER LINE OR 5m FROM PIPE TRENCH.
6. EROSION CONTROL
   - 6.1. CONTRACTOR TO CONSIDER POTENTIAL FUTURE EROSION PROBLEMS IN ALL STAGES OF WORKS. IF THERE IS A POTENTIAL PROBLEM THAT HAS NOT ALREADY BEEN ACCOUNTED FOR, XEROS PICCOLO CONSULTING ENGINEERS ARE TO BE CONTACTED
   - 6.2. VEGETATION TO BE PRESERVED AS MUCH AS POSSIBLE. WHERE SEEDLINGS ARE GROWING ON STEEP BATTERS PROVIDE MULCHES TO CONSERVE MOISTURE AND PROMOTE GROWTH.
   - 6.3. PROVIDE SILT FENCES OR STRAW BALES AS SHOWN ON PLANS OR AS NOMINATED BY THE SUPERINTENDENT
   - 6.4. SILT FENCES TO BE MOVED DURING CONSTRUCTION TO SUIT LOCATION OF CURRENT WORKS
7. TOPSOIL STOCKPILES SITES TO BE SEEDED WITH PERENNIAL RYE GRASS AT 25KG/HA AND RYE CORN AT 5KG/HA TO PREVENT SOIL MIGRATION.
8. ALL COMPLETED BATTERS, SWALE DRAINS, DEFLECTION BANKS ETC TO BE LIGHTLY RIPPED 50mm DEEP, COVERED WITH 75 MIN TOPSOIL AND SEEDED AS SPECIFIED. ON COMPLETION PROVIDE 1 PASS WITH PAD FOOT ROLLER.
9. AS ASPECTS OF WORK ARE COMPLETED, TOPSOIL AND SEED AS DETAILED WITHIN 3 WORKING DAYS
10. SURPLUS SPOIL STOCKPILE LOCATION TO BE DETERMINED ON SITE.

CONSTRUCTION SEQUENCE

1. BEFORE/DURING STRIPPING OF TOPSOIL
   - 1.1. CONSTRUCT DEFLECTION BANKS AROUND TOPSOIL STOCKPILE AND ASSOCIATED SILT FENCES.
   - 1.2. CONSTRUCT 200 HIGH PUSH UP BANKS AND ASSOCIATED SILT FENCES.
2. CONSTRUCTION OF 300 HIGH DEFLECTION BANKS AND BUNDING FORMED FROM BULK EARTHWORKS AND ASSOCIATED SILT FENCES CONSTRUCTED AS DETAILED.
3. STOCKPILE TO BE SEEDED AS SPECIFIED WITHIN 7 WORKING DAYS.
4. AFTER CONSTRUCTION OF DRAINAGE LINES DISTURBED AREAS TO BE RECTIFIED AS DETAILED WITHIN 7 DAYS OF BACKFILLING.
5. REMOVABLE STRAW BALE SILT FENCE TO BE AVAILABLE ON SITE FOR PROTECTION OF THE SITE IF RAIN IMMINENT.
6. SERVICES TO BE INSTALLED PRIOR TO TOPSOILING AND SEEDING OF BATTERS AND FOOTPATHS.

REHABILITATION & REGENERATION NOTES

PREPARE AREA TO BE REHABILITATED AND REGENERATED AS PER SPECIFICATIONS

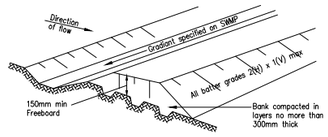
7. AREAS SHOULD BE RESHAPED TO BLEND IN WITH NATURAL LANDSCAPE AS MUCH AS POSSIBLE. STABILIZE WHERE REQUIRED
8. SITE TO BE SHAPED TO BE FREE DRAINING WHERE POSSIBLE.
9. TYNE COMPACTED AREAS TO IMPROVE 'ROUGHNESS' AT THE SEED BED IN PREPARATION FOR TOPSOIL. DEEP RIPPING MAY BE REQUIRED FOR HARD PAVEMENTS.
10. REDUCE ALL SLOPES TO A GRADIENT OF 1:3 OR LESS. BENCH IN THE AREAS WHERE SLOPE LENGTHS EXCEED 15m. WHERE BENCHING IS NOT PRACTICAL PROVIDE CONTOUR BANK MIN 500mm HIGH.
11. SPREAD TOP SOIL AND LEAVE WITH ROUGH SURFACE. CARE TO BE TAKEN TO ENSURE THAT TOP SOIL IS NOT TOO WET AS THIS WILL NOT PERFORM ADEQUATELY.
12. IF ADDITIONAL CHUTES ARE REQUIRED CONTACT XEROS PICCOLO.

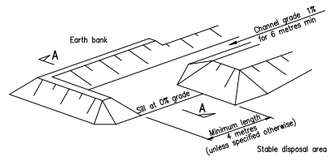
SEEDING NOTES

1. SEEDING TO PROVIDED AS SPECIFIED ON PLANS
2. SEED IS TO BE PLANTED AS PER STANDARD PRACTICE IN REGARDS TO WATERING AND PLANTING SEASON. USE HIGH QUALITY SEEDS THAT DON'T CONTAIN NOXIOUS WEEDS.
3. CONTRACTOR TO TAKE INTO ACCOUNT SEASON AND WEATHER PRIOR TO SEEDING TO ALLOW SEED THE BEST OPPORTUNITY TO GERMINATE.
4. ALL DISTURBED AREAS THAT ARE NOT BEING USED FOR A TRACK OF OTHER PURPOSES ARE TO BE TOPSOILED AND SEEDED.
5. PREPARE A SMOOTH SEEDBED AND APPROX. 75mm – 100mm OF TOPSOIL. GRADE SMOOTHLY TO REMOVE IRREGULARITIES AND FOOT PRINTS. SEED, FERTILIZE AND WATER.
6. WATERING SHOULD START IMMEDIATELY AFTER PLANTING. WATERING SHOULD COMPLY WITH SPECIFICATIONS SUPPLIED WITH APPROVED SEED. WATERING SHOULD VARY DEPENDING ON WEATHER, SEASON AND SOIL CONDITIONS. BUT AS A MINIMUM THE FOLLOWING SHOULD BE DONE.
   - 25mm EVERY SECOND DAY FOR THE FIRST THREE WATERINGS
   - 25mm TWICE A WEEK FOOR THE NEXT THREE WEEKS
   - 25mm OUNCE WEEKLY FOR A FURTHER TWO WEEKS.
6. IF BATTER SLOPE OF DISTURBED AREA IS 1 IN 4 OR GREATER PROVIDE JUTE LINING. ALL DEDICATED DRAINAGE PATHS SHALL BE JUTE LINED. REFER JUTE LINING NOTES AND DETAILS

TURFING NOTES

1. TURFING TO BE PROVIDED AS SPECIFIED ON PLANS
2. PREPARATION
   - 2.1. REMOVE ANY EXISTING TURF, WEEDS AND DEBRIS FROM ALL AREAS TO BE TURFED. CULTIVATE EXISTING SUBGRADE TO 100mm DEPTH
3. TOPSOIL
   - 3.1. ALL TOPSOIL SHALL COMPLY WITH AS4419 'SOILS FOR LANDSCAPING AND GARDEN USE'.
   - 3.2. TOPSOIL SHALL BE A SOIL BLEND WITH MAX. 30% SCREENED COMPOSTED ORGANIC MATTER, HYDRAULIC CONDUCTIVITY 15–30cm/hr. PH RANGE TO BE 5–6.5.
   - 3.3. AFTER APPROVAL OF THE PROPOSED TOPSOIL, DEPOSIT AND SPREAD TOPSOIL TO ACHIEVE 100mm THICKNESS TO ALL DISTURBED AREAS
4. TURFING
   - 4.1. TURF SHALL BE 'KIKUYU' UNLESS OTHERWISE DIRECTED BY A LANDSCAPE ARCHITECT OR SUPERINTENDENT. TURF SHALL BE 'A' GRADE, TYPICAL OF THE SPECIES, FREE FROM ALL PESTS, DISEASES, WEEDS AND OTHER PLANT MATTER.
   - 4.2. TURF SHALL BE GUARANTEED FREE FROM NUT GRASS, 'CYPERUS ROTUNDUS',
   - 4.3. TURF SHALL BE CUT TO A MINIMUM 25mm THICK IN LONG 300m WIDE STRIPS.
5. LAYING
   - 5.1. LAY PIECES OF TURF IN STRAIGHT LINES RUNNING PERPENDICULAR TO THE SLOPE, WITH CROSS JOINTS STAGGERED, AND CLOSE BUTTING.
   - 5.2. LAY TURF WITH AN EVEN GRADIENT, FREE FROM LUMPS AND DEPRESSIONS AND NOT ABLE TO POND WATER. ENSURE THAT NEW TURF FINISHES FLUSH WITH EXISTING GRASS OR TURF.
   - 5.3. TAMP DOWN AND FILL ALL JOINTS WITH TOP DRESSING. TOP DRESSING IS TO BE PIT SAND TO COMPLY WITH AS 4419. SPREAD SAND EVENLY OVER SURFACE OF GRASS IN LAYERS OF NOT MORE THAN 10mm. DO NOT BURY GRASS.
6. TOP DRESSING
   - 6.1. WHEN TURFED AREAS HAVE BECOME ESTABLISHED AND IMMEDIATELY AFTER THE FIRST CUT, TOP DRESS TURF WITH 10mm LAYER OF TOP DRESSING TO AS4419.
   - 6.2. DO NOT TOP DRESS DURING WINTER MONTHS UNLESS DIRECTED BY SUPERINTENDENT
7. PROTECTION – ALL NEW TURF SHALL BE PROTECTED FROM TRAMPLING BY THE ERECTION OF BARRIERS.

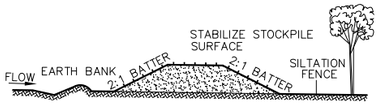




LEVEL SPREADER (OR SILL)

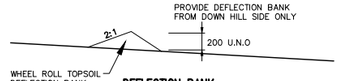
JUTE LINING NOTES

1. JUTE LINING TO BE PROVIDED AS SPECIFIED ON PLANS
2. CONTRACTOR TO COMPLY WITH ALL MANUFACTURES REQUIREMENTS OF THE SELECTED PRODUCT BUT MUST MEET THE BELOW REQUIREMENTS AS A MINIMUM.
3. REFER TO APPROVED PLANS AND NOTES FOR THE LOCATION AND EXTENT OF WORKS REQUIRED.
4. SOIL SURFACE IRREGULARITIES AND ROCKS ON SURFACE ARE TO BE REMOVED.
5. PREPARE A SMOOTH SEEDBED AND APPROX. 75mm OF TOPSOIL. GRADE SMOOTHLY TO REMOVE IRREGULARITIES AND FOOT PRINTS. COMPLETE ALL SEEDING, FERTILIZING AND WATERING PRIOR TO LAYING MATTING
6. PREFERABLY STARTING AT THE DOWN STREAM END, ALIGN FABRIC ROLLS IN THE DIRECTION OF THE FLOW. IF THE AREA IS SUBJECT TO MULTIPLE FLOWS, ALIGN WITH DOMINANT FLOW.
7. WHEN SPREADING THE FABRIC DO NOT STRETCH THE TEXTILE MESH. THE BLANKETS MUST BE IN GOOD CONTACT WITH GROUND AT ALL POINTS.
8. FABRIC BLANKETS TO BE STAPLED AT 1m CTS IN EXPOSED AREAS AND 0.5m CTS ALONG ALL EDGES
10. THE UPSTREAM END OF TOP MOST SHEETS SHALL BE PLACED IN A 300mm DEEP TRENCH, STAPLED AT 0.15m CTS, BURIED AND TAMPED. REFER DETAIL
11. MINIMUM EVERY THIRD SHEET TO BE PLACED IN A 300mm DEEP TRENCH, STAPLED AT 0.15m CTS, BURIED AND TAMPED. REFER DETAIL
12. OVERLAP ENDS BY 300mm WITH THE UPSTREAM SHEET PLACED OVER THE DOWNSTREAM SHEET. STAPLE AT 0.5m CTS
13. STAPLES SHOULD BE A "U" SHAPE 8 GAUGE WIRE 100mm WIDE WITH 150–300mm PENETRATION LENGTH
14. WHEREVER THE BLANKET DOES NOT TOUCH THE GROUND ADDITIONAL STAPLES MUST BE PLACED.

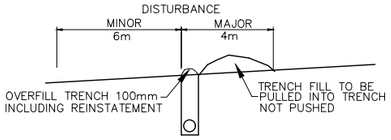


STOCKPILE SD 4–1

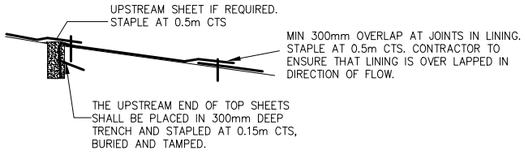
CONSTRUCTION NOTES
1. LOCATE STOCKPILE AT LEAST 5 METRES FROM EXISTING VEGETATION, CONCENTRATED WATER FLOWS, ROADS & HAZARD AREAS.
2. CONSTRUCT ON THE CONTOUR AS A LOW, FLAT, ELONGATED MOUND.
3. WHERE THERE IS SUFFICIENT AREA TOPSOIL STOCKPILES SHALL BE LESS THAN 2 METRES IN HEIGHT.
4. REHABILITATE IN ACCORDANCE WITH THE SWMP/ESCP.
5. CONSTRUCT EARTH BANK (STANDARD DRAWING 5–2) ON THE UPSLOPE SIDE TO DIVERT RUN OFF AROUND THE STOCKPILE & A SEDIMENT FENCE (STANDARD DRAWING 6–8) 1 TO 2 METRES DOWNSLOPE OF STOCKPILE.



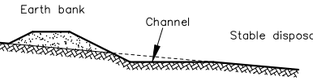
DEFLECTION BANK



TRENCH DISTURBANCE



TRANSVERSE OVERLAP DETAIL

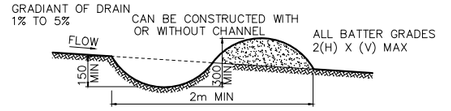


SECTION A–A

EARTH BANK(HIGH FLOW) SD 5–3

FOR CATCHMENT > 2ha

CONSTRUCTION NOTES
1. CONSTRUCT ALONG GRADIANT AS SPECIFIED.
2. AVOID REMOVING TREES & SHRUBS IF POSSIBLE.
3. DRAINS TO BE OF PARABOLIC OR TRAPEZOIDAL CROSS SECTION AS OPPOSED TO V–SHAPE.
4. EARTH BANKS TO BE ADEQUATELY COMPACTED IN ORDER TO PREVENT FAILURE.
5. PERMANENT OR TEMPORARY STABILISATION OF THE EARTH BANK TO BE COMPLETED WITHIN 10 DAYS OF CONSTRUCTION.
6. ALL OUTLETS FROM DISTURBED LANDS ARE TO FEED INTO A SEDIMENT BASIN OR SIMILAR.
7. DISCHARGE RUNOFF COLLECTED FROM UNDISTURBED LANDS ONTO EITHER A STABILISED OR AN UNDISTURBED DISPOSAL SITE WITHIN THE SAME SUBCATCHMENT AREA FROM WHICH THE WATER ORIGINATED
8. COMPACT BANK WITH A SUITABLE IMPLEMENT IN SITUATIONS WHERE THEY ARE REQUIRED TO FUNCTION FOR MORE THAN FIVE DAYS.
9. EARTH BANKS TO BE FREE OF PROJECTIONS OR OTHER IRREGULARITES THAT WILL IMPEDE NORMAL FLOW.

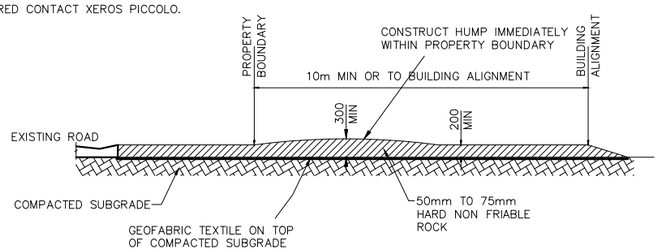


NOTE: ONLY TO BE USED AS TEMPORARY BANK WHERE MAXIMUM UPSLOPE LENGTH IS 80 METRES

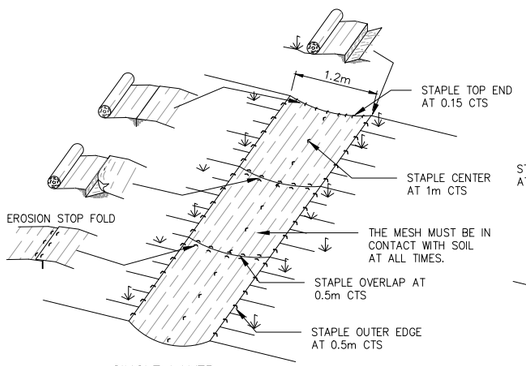
EARTH BANK(LOW FLOW) SD 5–5

FOR CATCHMENT <2ha

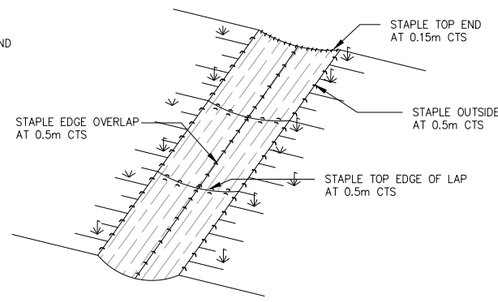
CONSTRUCTION NOTES
1. CONSTRUCT WITH GRADIANT OF 1 PER CENT TO 5 PER CENT.
2. AVOID REMOVING TREES & SHRUBS IF POSSIBLE.
3. DRAINS TO BE OF CIRCULAR, PARABOLIC OR TRAPEZOIDAL CROSS SECTION NOT V–SHAPED.
4. EARTH BANKS TO BE ADEQUATELY COMPACTED IN ORDER TO PREVENT FAILURE.
5. PERMANENT OR TEMPORARY STABILISATION OF THE EARTH BANK TO BE COMPLETED WITHIN 10 DAYS OF CONSTRUCTION.
6. ALL OUTLETS FROM DISTURBED LANDS ARE TO FEED INTO A SEDIMENT BASIN OR SIMILAR.
7. DISCHARGE RUNOFF COLLECTED FROM UNDISTURBED LANDS ONTO EITHER A STABILISED OR AN UNDISTURBED DISPOSAL SITE WITHIN THE SAME SUBCATCHMENT AREA FROM WHICH THE WATER ORIGINATED
8. COMPACT BANK WITH A SUITABLE IMPLEMENT IN SITUATIONS WHERE THEY ARE REQUIRED TO FUNCTION FOR MORE THAN FIVE DAYS.
9. EARTH BANKS TO BE FREE OF PROJECTIONS OR OTHER IRREGULARITES THAT WILL IMPEDE NORMAL FLOW.



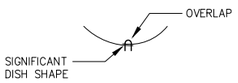
STABILIZED ACCESS POINT SD 6–14



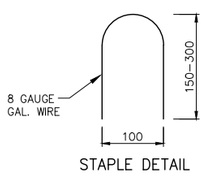
SINGLE LAYER



MULTIPLE LAYERS

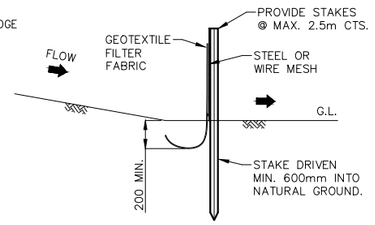


LONGITUDINAL OVERLAP DETAIL



STAPLE DETAIL

JUTE LINING DETAIL



TYP. SEDIMENT CONTROL FENCE DETAIL SD 6–8

NOTE: THE FOLLOWING CONDITIONS MUST NOT BE EXCEEDED WITHIN THE CONTRIBUTING AREA:
DRAINAGE AREA = 0.6ha
SLOPE GRADIENT = 1:2
SLOPE LENGTH = 60m

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UNDER GROUND SERVICES ARE APPROXIMATE ONLY. CONTACT RELEVANT AUTHORITY PRIOR TO ANY EXCAVATION OR CONSTRUCTION.

NOT FOR CONSTRUCTION

No.	DATE	DETAILS	BY
B	26.03.2021	ISSUED FOR DA	E.Z
A	27.02.2021	ISSUED FOR REVIEW	J.S

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Sheet Title: SEDIMENT AND EROSION CONTROL DETAILS
Client: NGH PTY LTD
Scale: N/A
Design: A.X
Drawn: J.S
Date: JAN 2021
Checked:
Approved:
Project Number: 210024
Sheet Number: C3
Revision Number: B
Sheets in Set: 3

PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

NGH Consulting

Sandy Creek Solar Farm

April 2021







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ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	March 2021	Initial issue
2	April 2021	Proposed screening considered in the analysis and other minor amendments

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development located north-east of Uranquinty in Australia. This glint and glare assessment concerns the possible impact upon surrounding roads users, dwellings, and railway operations and infrastructure.

Pager Power

Pager Power has undertaken over 600 glint and glare assessments internationally. The company's own glint and glare guidance is based on industry experience and extensive consultation with industry stakeholders, including airports and aviation regulators.

Conclusions

All dwellings in the locality appear to be suitably screened and therefore no impact is predicted. Following the implementation of the tree planting as indicated by the developer in the site plan on page 13, no significant impact is predicted on roads or railways in the area because all predicted solar reflections will be screened. This is assuming that the screening will be entirely opaque along its length and at a sufficient height to eliminate views from the relevant receptors along the assessed sections of Olympic Highway and the railway line.

Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. However, a specific methodology for determining the impact upon road safety, residential amenity and railway operations has not been produced to date. Therefore, Pager Power has reviewed existing guidelines and the available studies (discussed below) in the process of defining its own glint and glare assessment guidance and methodology[1]. This methodology defines the process for determining the impact upon road safety, residential amenity, and railway operations.

Pager Power's approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels. The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that the reflections

[1] Source: Solar Photovoltaic Development – Glint and Glare Guidance, Third Edition, December 2020. Pager Power.

produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel[2].

Assessment Results

Roads

The modelling has shown that solar reflections are geometrically possible towards 21 of the 32 assessed receptors along Olympic Highway.

For road receptors 12 – 14, views of the reflecting panels may be possible, despite partial screening in the form of the elevated railway embankment. The impact is moderate according to the guidance presented in Appendix D; however, no mitigation is required because the reflections occur outside of a road user's primary field of view in both directions of travel (50 degrees either side) and there is partial screening in the form of the elevated railway embankment. Furthermore, the developer has already proposed mitigation in the form of tree planting along the site boundary (see the site plan on page 13). Following the implementation of the tree planting, no impact is predicted because views of reflecting panels should not be possible.

For road receptors 15 – 25, views of the reflecting panels may be possible within a road user's primary field of view when travelling in the north-east to south-west direction, despite partial screening in the form of the elevated railway embankment. There does not appear to be any significant screening between the road and the proposed solar development location. The impact is moderate according to the guidance presented in Appendix D. However, the developer has already proposed mitigation in the form of tree planting along the site boundary. Following the implementation of the tree planting, no impact is predicted because views of reflecting panels should not be possible. No further mitigation is required.

For road receptors 26 – 32, solar reflections are not predicted to be experienced in practice as the reflecting solar panels are expected to be significantly screened by the elevated railway embankment and intervening vegetation. The proposed tree planting along the site boundary will provide further screening. No impact is predicted.

Railways

The modelling has shown that solar reflections are geometrically possible towards 16 of the 21 assessed receptors along the railway line.

For receptors 6 – 8, views of the reflecting panels may be possible. The impact is moderate according to the guidance presented in Appendix D; however, no mitigation is required because the reflections occur outside of a train driver's primary field of view in both directions of travel (30 degrees either side). Furthermore, the developer has already proposed mitigation in the form of tree planting along the site boundary (see the site plan on page 13). Following the implementation of the tree planting, no impact is predicted because views of reflecting panels should not be possible.

---

[2] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).

For receptors 9 – 19, views of the reflecting panels may be possible within a train driver's primary field of view when travelling in the north-east to south-west direction. There does not appear to be any significant screening between the railway and the proposed solar development location. The impact is moderate according to the guidance presented in Appendix D. However, the developer has already proposed mitigation in the form of tree planting along the site boundary. Following the implementation of the tree planting, no impact is predicted because views of reflecting panels should not be possible. No further mitigation is required.

For receptors 20 – 21, solar reflections are not predicted to be experienced in practice as the reflecting solar panels are expected to be significantly screened by intervening terrain and vegetation. The proposed tree planting along the site boundary will provide further screening. No impact is predicted.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 49 countries within Europe, Africa, America, Asia and Australasia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems.

Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development located north-east of Uranquinty in Australia. This glint and glare assessment concerns the possible impact upon surrounding roads users, dwellings, and railway operations and infrastructure.

This report contains the following:

- Solar development details.
- Explanation of glint and glare.
- Overview of relevant guidance.
- Overview of relevant studies.
- Overview of Sun movement.
- Assessment methodology.
- Identification of receptors.
- Glint and glare assessment for identified receptors.
- Results discussion.
- High-Level Overview of Mitigation

Following this, a summary of findings and overall conclusions and recommendations from the desk-based analysis is presented. No site survey has taken place at this stage.

1.2 Pager Power's Experience

Pager Power has undertaken over 600 Glint and Glare assessments in the UK and internationally. The studies have included assessment of civil and military aerodromes, railway infrastructure and other ground-based receptors including roads and dwellings.

1.3 Glint and Glare Definition

The definition of glint and glare can vary however, the definition used by Pager Power is as follows[3]:

- Glint – a momentary flash of bright light typically received by moving receptors or from moving reflectors.
- Glare – a continuous source of bright light typically received by static receptors or from large reflective surfaces.

The term 'solar reflection' is used in this report to refer to both reflection types.

[3] These definitions are aligned with those of the Federal Aviation Administration (FAA) in the United States of America.

2 PROPOSED SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Layout Plan

The layout of the proposed solar development is shown in Figure 1[4] below, received from NGH Consulting. The black lines represent the location of solar panels and the green lines represent proposed tree planting.

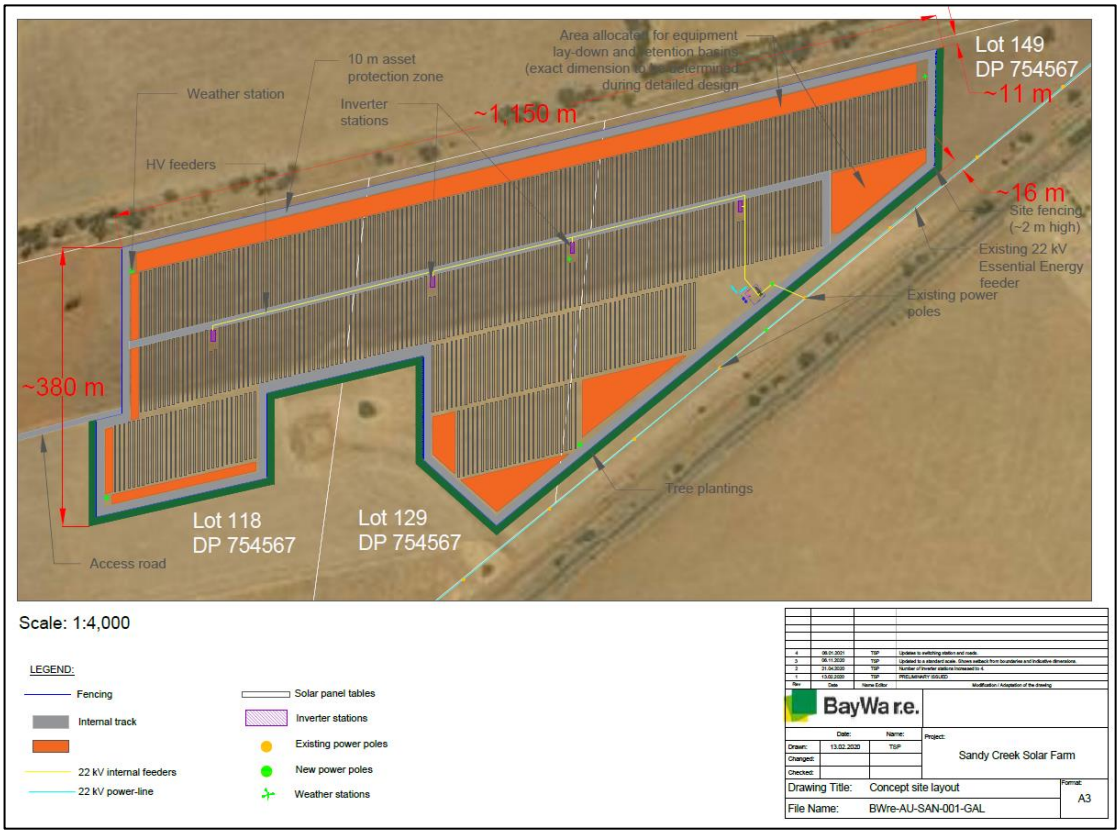


Figure 1 *Site layout plan*

[4] Source: 20210105 SAN site layout BWre-AU-SAN-001-GAL rev 4-2.pdf

2.2 Proposed Solar Development Location – Aerial Image

Figure 2[5] below shows the location of the proposed solar development. The red line represents the outer red line boundary, and the blue shaded area represents the assessed area of solar panels. Based on the information in Figure 1, panels may not actually be located in the whole of this blue area, however this is a conservative assessment and a worst-case scenario panel area has been considered.



Figure 2 *Proposed development location – aerial image*

[5] Copyright © 2021 Google.

2.3 Solar Panel Information

The design of the solar panel table is shown in Figure 3[6] below, received from NGH Consulting. The technical characteristics used for the modelling are presented in Table 1.

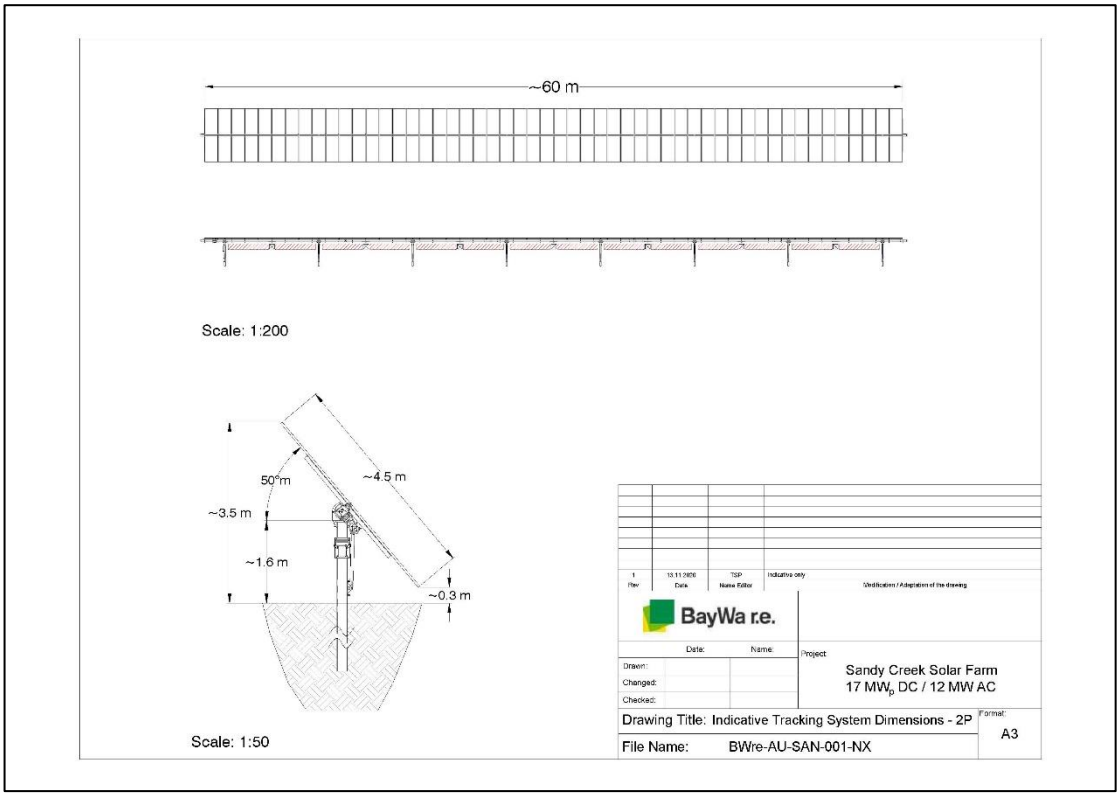


Figure 3 *Design of the solar panel table*

Solar Panel Technical Information	
Azimuth angle (°)	0
Axis height (m)	2.15 agl (above ground level)
Tracking	Horizontal Single Axis tracks Sun East to West
Tracker Range of Motion (°)	±60°
Resting angle (°)	0°

Table 1 *Solar panel technical information*

[6] Source: 2P Tracking System Drawing BWre-AU-SAN-001-NX-2P.pdf

2.3.1 Solar Panel Backtracking

Shading considerations dictate the panel tilt. This is affected by:

- The elevation angle of the Sun;
- The vertical tilt of the panels;
- The spacing between the panel rows.

This means that early in the morning and late in the evening, the panels will not be directed exactly towards the Sun, as the loss from shading of the panels (caused by facing the sun directly when the Sun is low in the horizon), would be greater than the loss from lowering the panels to a less direct angle in order to avoid the shading. Figure 4 below illustrates this.

Note the graphics in Figure 4 show two lines illustrating the paths of light from the Sun towards the solar panels. In reality, the lines from the Sun to each panel would be effectively parallel due to the large separation distance. The figure is for illustrative purposes only.

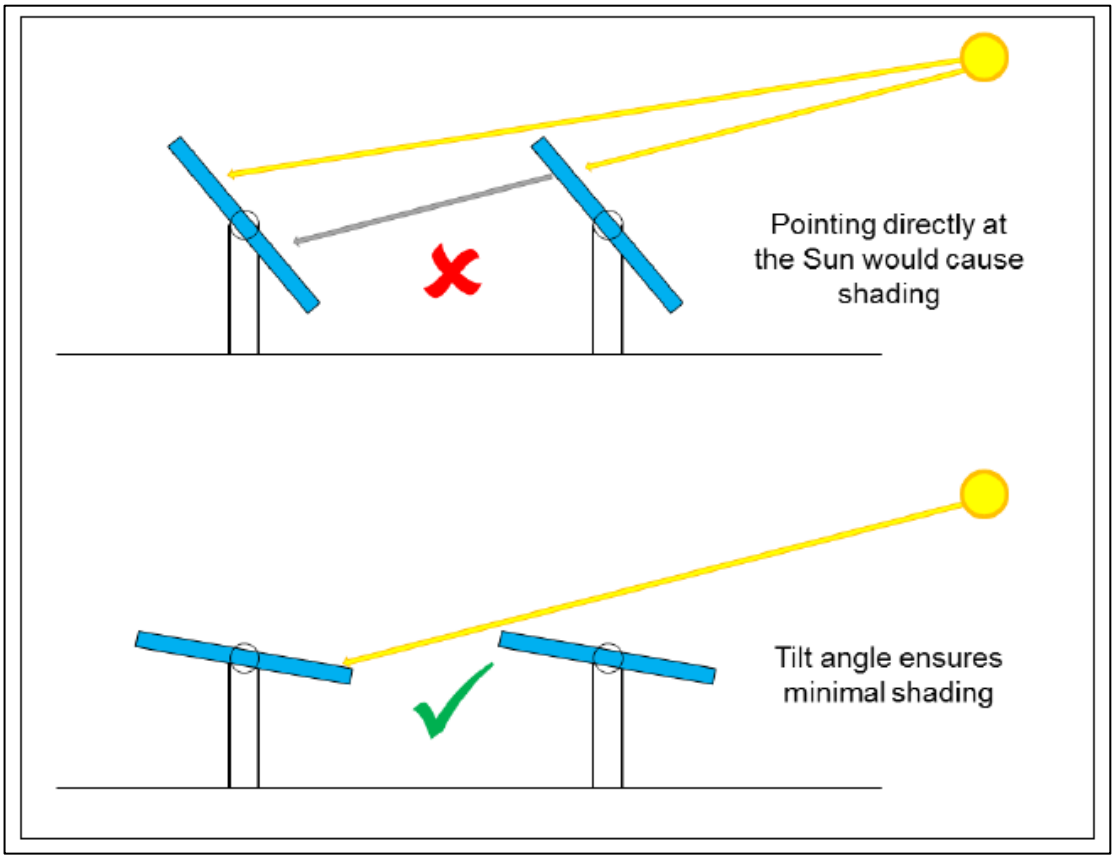


Figure 4 *Shading Considerations*

Later in the day, the panels can be directed towards the Sun without any shading issues. This is illustrated in Figure 5 on the next page.

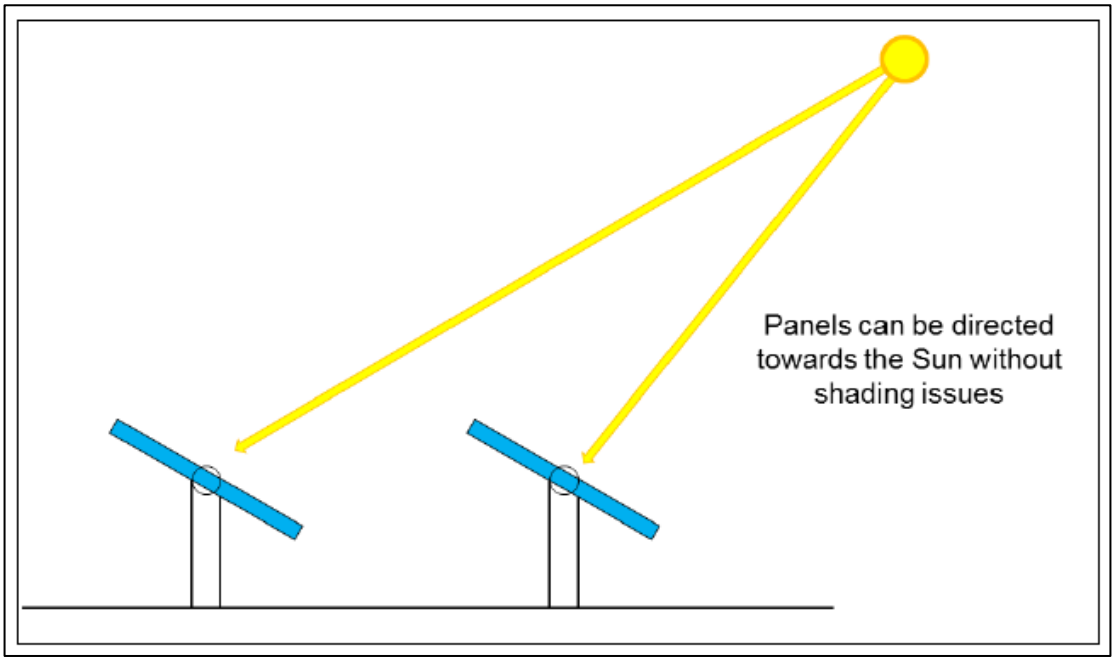


Figure 5 *Panel alignment at high solar angles*

Note that in reality, the lines from the Sun to each panel would be effectively parallel due to the large separation distance. The two previous figures are for illustrative purposes only.

The solar panels backtrack (where the panel angle gradually declines to prevent shading) by reverting to 0 degrees (flat) once the maximum elevation angle of the panels (60 degrees) becomes ineffective due to the low height of the Sun above the horizon and to avoid shading.

3 RAILWAYS AND GLINT AND GLARE

3.1 Overview

A railway stakeholder may request further information regarding the potential effects of glint and glare from reflective surfaces when a development is located adjacent to a railway line (typically 50-100m from its infrastructure). The request may depend on the scale, percentage of reflective surfaces and the complexity of the nearby railway, for example. The following section presents details regarding the most common concerns relating to glint and glare.

3.2 Common Concerns and Signal Overview

Typical reasons stated by a railway stakeholder for requesting a glint and glare assessment often relate to the following:

1. The development producing solar reflections towards train drivers;
2. The development producing solar reflections, which causes a train driver to take action; and
3. The development producing solar reflections that affect railway signals.

With respect to point 1, a reflective panel could produce solar reflections towards a train driver. If this reflection occurs where a railway signal, crossing etc., is present, or where the driver's workload is particularly high, the solar reflection may affect operations. This is deemed to be the most concern with respect to solar reflections.

Following from point 1, point 2 identifies whether a modelled solar reflection could be significant depending on the technical and operational context. Only where a solar reflection occurs under certain conditions may it cause a reaction from a train driver and thus potentially affect safe operations. Therefore, any predicted reflections are evaluated based on technical and operational considerations to determine whether they could potentially affect the safety of operations. Points 1 and 2 are completed in a 2-step approach.

With respect to all points, railway lines use light signals to manage trains on approach towards particular sections of track. If a signal is passed when not permitted, a SPAD (Signal Passed At Danger) is issued. The concerns will relate specifically to the possibility of the reflections appearing to illuminate signals that are not switched on (known as a phantom aspect illusion) or a distraction caused by the glare itself, both of which could lead to a SPAD. The definition is presented below:

'Light emitted from a Signal lens assembly that has originated from an external source (usually the sun) and has been internally reflected within the Signal Head in such a way that the lens assembly gives the appearance of being lit.[7]*'*

Details regarding the identified railway receptors are presented in Section 5 of this report.

[7] Source: Glossary of Signalling Terms, Railway Group Guidance Note GK/GN0802. Issue One. Date April 2004.

4 GLINT AND GLARE ASSESSMENT METHODOLOGY

4.1 Guidance and Studies

Appendices A and B present a review of relevant guidance and independent studies with regard to glint and glare issues from solar panels. The overall conclusions from the available studies are as follows:

- Specular reflections of the Sun from solar panels are possible.
- The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence.
- Published guidance shows that the intensity of solar reflections from solar panels are equal to or less than those from water. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces, which are common in an outdoor environment.

4.2 Background

Details of the Sun's movements and solar reflections are presented in Appendix C.

4.3 Pager Power's Methodology

The glint and glare assessment methodology has been derived from the information provided to Pager Power through consultation with stakeholders and by reviewing the available guidance and studies. The methodology for glint and glare assessments is as follows:

- Identify receptors in the area surrounding the solar development.
- Consider direct solar reflections from the solar development towards the identified receptors by undertaking geometric calculations.
- Consider the visibility of the panels from the receptor's location. If the panels are not visible from the receptor then no reflection can occur.
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur.
- Consider both the solar reflection from the solar development and the location of the direct sunlight with respect to the receptor's position.
- Consider the solar reflection with respect to the published studies and guidance.
- Determine whether a significant detrimental impact is expected in line with the process presented in Appendix D.

Within the Pager Power model, the solar development area is defined, as well as the relevant receptor locations. The result is a chart that states whether a reflection can occur, the duration and the panels that can produce the solar reflection towards the receptor.

4.4 Assessment Limitations

Further technical details regarding the methodology of the geometric calculations and limitations are presented in Appendix E and Appendix F.

5 IDENTIFICATION OF RECEPTORS

5.1 Receptors Overview

There is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. From a technical perspective, there is no maximum distance for potential reflections. The significance of a reflection however decreases with distance because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases. Terrain and shielding by vegetation are also more likely to obstruct an observer's view at longer distances.

The above parameters and extensive experience over a significant number of glint and glare assessments undertaken show that a 1km buffer[8] (yellow lines on the proceeding figures) from the proposed development (blue areas), is considered appropriate for glint and glare effects on ground-based receptors, and a 500m buffer (white lines) for railway receptors.

Potential receptors are identified based on mapping and aerial photography of the region. The initial judgement is made based on a high-level consideration of aerial photography and mapping i.e. receptors are excluded if it is clear from the outset that no visibility would be possible. A more detailed assessment is made if the modelling reveals a reflection would be geometrically possible.

Terrain elevation heights are based on Forge SRTM data. An overview of the buffer zones is presented in Figure 6[5] on the following page and the receptors are further clarified in the following sections. Receptor details can be found in Appendix G.

[8] Guidance from the Victoria State Government agrees with this. See Page 23 of Solar Energy Facilities Design and Development Guideline from August 2019.

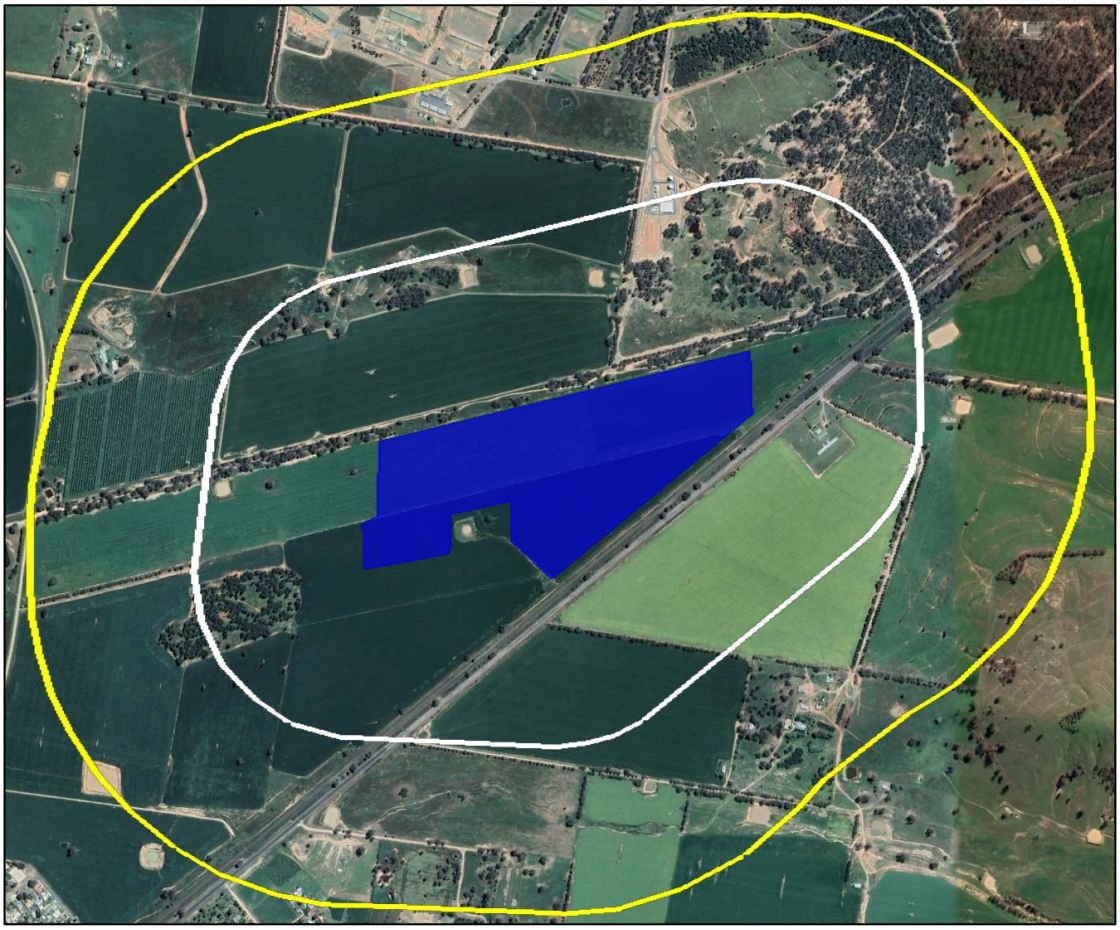


Figure 6 *Buffer zones overview– aerial image*

5.2 Road Receptors

Road types can generally be categorised as:

- Major National – Typically a road with a minimum of two carriageways with a maximum speed limit of up to 110kph. These roads typically have fast-moving vehicles with busy traffic.
- National – Typically a road with a one or more carriageways with a maximum speed limit of up to 100kph or 110kph. These roads typically have fast-moving vehicles with moderate to busy traffic density.
- Regional – Typically a single carriageway with a maximum speed limit of up to 100kph. The speed of vehicles will vary with a typical traffic density of low to moderate; and
- Local - Typically roads and lanes with the lowest traffic densities. Speed limits vary.

Assessment is not recommended for local roads, where traffic volumes and/or speeds are likely to be relatively low, as any solar reflections from the proposed development that are experienced by a road user would be considered 'low' impact in the worst case. The analysis has therefore considered any major national, national, and regional roads that:

- Are within, or close to one kilometre of the proposed development.
- Have a potential view of the panels.

A 3.15 km section of Olympic Highway was identified for assessment, running adjacent to the south boundary of the site, as shown by the orange line in Figure 7[5] below. 32 receptors were identified, distanced circa 100m apart. A height of 1.5 metres above ground level has been taken as typical eye level for a road user. This height has therefore been added to the ground height at each receptor location. Visibility and direction of travel is considered in the assessment of all receptors.



Figure 7 *Assessed road receptors – aerial image*

5.3 Dwellings

The analysis has considered dwellings that:

- Are within, or close to one kilometre of the proposed development.
- Have a potential view of the panels.

The surrounding area within 1km of the site has been reviewed based on the available aerial and street view imagery. Considering the results of this review, no dwelling receptors have been taken forward for geometric and detailed modelling because any dwellings within 1km of the site were found to be significantly screened. The identified dwellings and associated screening are shown in Figures 8 to 10 on the following pages.

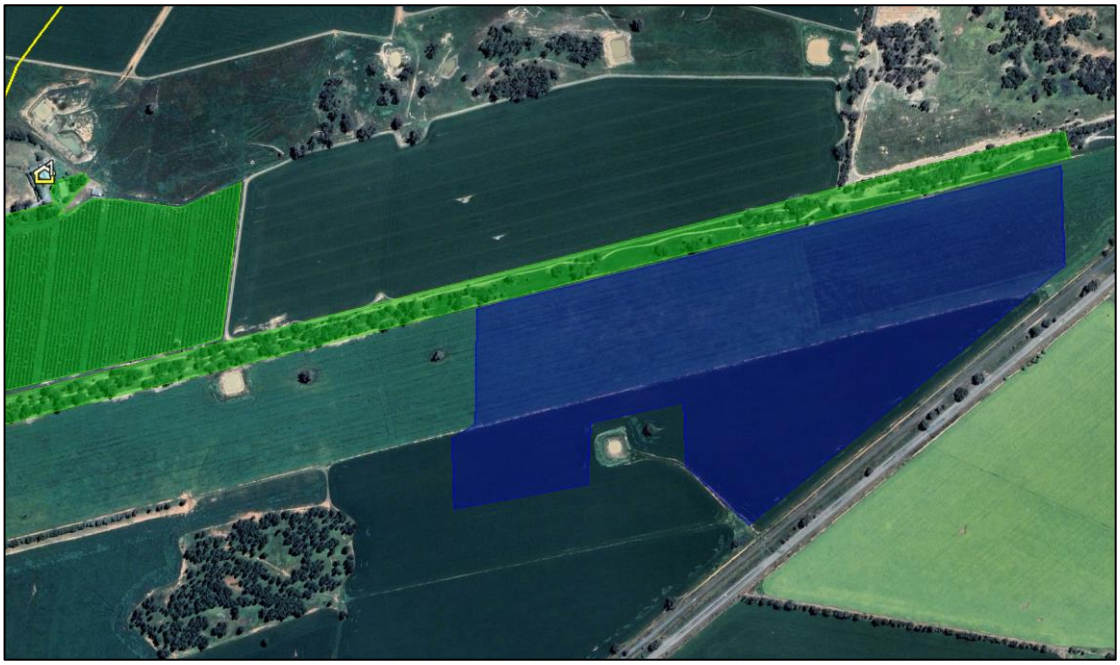


Figure 8 *Dwelling 1 with associated screening (green)– aerial image*



Figure 9 *Dwellings 2-3 with associated screening (green)– aerial image*



Figure 10 *Dwellings 2-3 with associated screening (green)– closeup aerial image*

5.4 Railway Signals

Following a conservative review of available imagery, no railway signals were identified within 500m of the proposed development. This report can be updated if railway signals are identified at a later date.

5.5 Train Driver Receptors

The impact of a solar reflection is assessed by identifying locations along the sections of railway line that could potentially receive a solar reflection from the reflective surfaces on the development. Railways have been considered out to a maximum of approximately 500m from the proposed development.

A 2.05 km section of railway running adjacent to the south boundary of the site was identified for assessment, as shown by the orange line in Figure 11[5] on the following page. 21 receptors were identified, distanced circa 100m apart. Based on previous consultation[9] the driver's eye level is assumed to be 2.75m above rail level[10]. This height has therefore been added to the ground height at each receptor location. Visibility and direction of travel is considered in the assessment of all receptors.

[9] Consultation undertaken with Network Rail in the UK.

[10] This height may vary based on driver height however this figure is used as the industry standard in the UK. There does not appear to be an industry standard figure for Australia. It is a reasonable assumption that this height will be similar in Australia and any differences are not expected to change the results of the assessment.

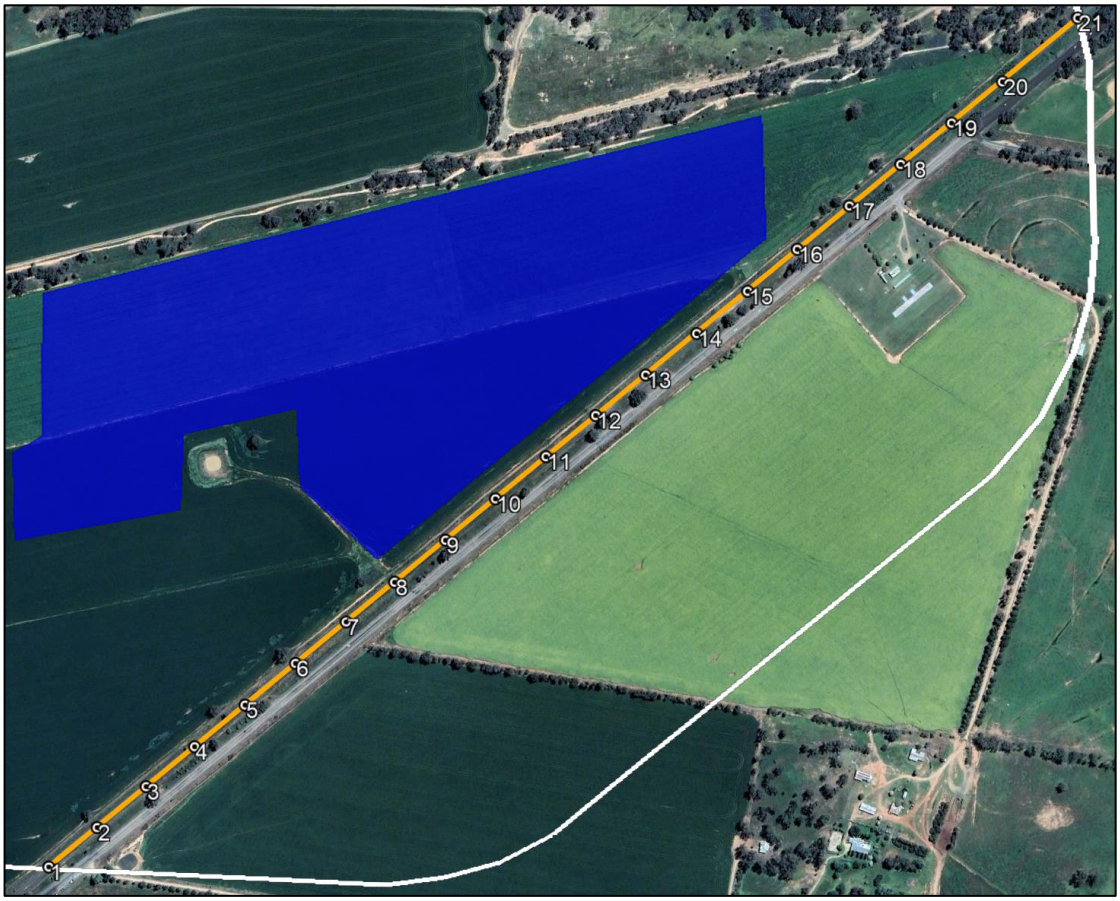


Figure 11 *Assessed train driver receptors – aerial image*

6 ASSESSED REFLECTOR AREA

6.1 Reflector Area

The bounding coordinates for the proposed solar farm development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 12 below shows the assessed reflector area that has been used for modelling purposes.



Figure 12 *Assessed reflector area – aerial image*

7 GLINT AND GLARE ASSESSMENT – TECHNICAL RESULTS

7.1 Summary of Results

The tables in the following subsections summarise the results of the assessment. The predicted glare times are based solely on bare-earth terrain i.e. without consideration of screening from buildings and vegetation. The final column summarises the predicted impact considering the level of predicted screening based on a desk-based review of the available imagery. The significance of any predicted impact is discussed in the subsequent report sections. The modelling output showing the precise predicted times and the reflecting panel area is shown in Appendix H.

7.2 Geometric Calculation Results Overview – Road Receptors

Table 2 below presents the results of the roads analysis.

Receptor	Results		Comments
	Reflection possible towards the road user? (AEDT[11])		
	am	pm	
1 – 11.	No.	No.	Solar reflections are not geometrically possible. No impact predicted.
12 – 14.	No.	Yes.	Predicted solar reflections are predicted to occur outside of a road user's primary field of view, partially screened by the elevated railway embankment and significantly screened by the proposed tree planting along the site boundary. No impact predicted.
15 – 25.	No.	Yes.	Predicted solar reflections are predicted to be partially screened by the elevated railway embankment and significantly screened by the proposed tree planting along the site boundary. No impact predicted.

[11] Modelling was run in AEDT but conclusions for AEST would be the same; only the glare curves would shift one hour in accordance with sunset and sunrise times shifting by one hour.

Receptor	Results		Comments
	Reflection possible towards the road user? (AEDT[11])		
	am	pm	
26 – 32.	No.	Yes.	Predicted solar reflections are predicted to be significantly screened by the elevated railway embankment, existing vegetation and proposed tree planting along the site boundary. No impact predicted.

Table 2 *Geometric analysis results – road receptors*

7.3 Geometric Calculation Results Overview – Train Driver Receptors

Table 3 below presents the results of the train driver analysis.

Receptor	Results		Comments
	Reflection possible towards the train driver? (AEDT)		
	am	pm	
1 – 5.	No.	No.	Solar reflections are not geometrically possible. No impact predicted.
6 – 8.	No.	Yes.	Predicted solar reflections are predicted to occur outside of a train driver's primary field of view and significantly screened by proposed tree planting along the site boundary. No impact predicted.
9 – 19.	No.	Yes.	Predicted solar reflections are predicted to be significantly screened by proposed tree planting along the site boundary. No impact predicted.

Receptor	Results		Comments
	Reflection possible towards the train driver? (AEDT)		
	am	pm	
20 – 21.	No.	Yes.	Predicted solar reflections are predicted to be significantly screened by intervening terrain, existing vegetation and proposed tree planting along the site boundary. No impact predicted.

Table 3 *Geometric analysis results – train driver receptors*

8 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

8.1 Roads

The process for quantifying impact significance is defined in the report appendices. For road users, the key considerations are:

- Whether a reflection is predicted in practice.
- The type of road (and associated likely traffic levels/speeds).
- The location of the reflecting panels relative to a road user's direction of travel (a reflection directly in front of a driver is more hazardous than a reflection from a location off to one side).

The modelling has shown that solar reflections are geometrically possible towards 21 of the 32 assessed receptors along Olympic Highway (12 – 32).

For road receptors 12 – 14, marginal views of the reflecting panels may be possible, despite partial screening in the form of the elevated railway embankment. The impact is moderate according to the guidance presented in Appendix D; however, no mitigation is required because the reflections occur outside of a road user's primary field of view in both directions of travel (50 degrees either side). Furthermore, the developer has already proposed mitigation in the form of tree planting along the site boundary (see Figure 1 on page 13). Following the implementation of the tree planting, no impact is predicted because views of reflecting panels should not be possible.

For road receptors 15 – 25, views of the reflecting panels may be possible within a road user's primary field of view when travelling in the north-east to south-west direction, despite partial screening in the form of the elevated railway embankment. There does not appear to be any significant screening between the road and the proposed solar development location. The impact is moderate according to the guidance presented in Appendix D. However, the developer has already proposed mitigation in the form of tree planting along the site boundary. Following the implementation of the tree planting, no impact is predicted because views of reflecting panels should not be possible. No further mitigation is required.

For road receptors 26 – 32, solar reflections are not predicted to be experienced in practice as the reflecting solar panels are expected to be significantly screened by the elevated railway embankment and intervening vegetation, as shown in Figures 14 and 15[5] on the following pages. The proposed tree planting along the site boundary will provide further screening. No impact is predicted.

Figure 13[5] on the following page shows the section of road where solar reflections are geometrically possible (orange line) and the area of proposed tree planting (green line).



Figure 13 *Section of Olympic Highway where solar reflections are geometrically possible (orange) and proposed tree planting (green) – aerial image*



Figure 14 *Significant screening (green highlighted area) for road receptors 26 to 32 – closeup aerial image*

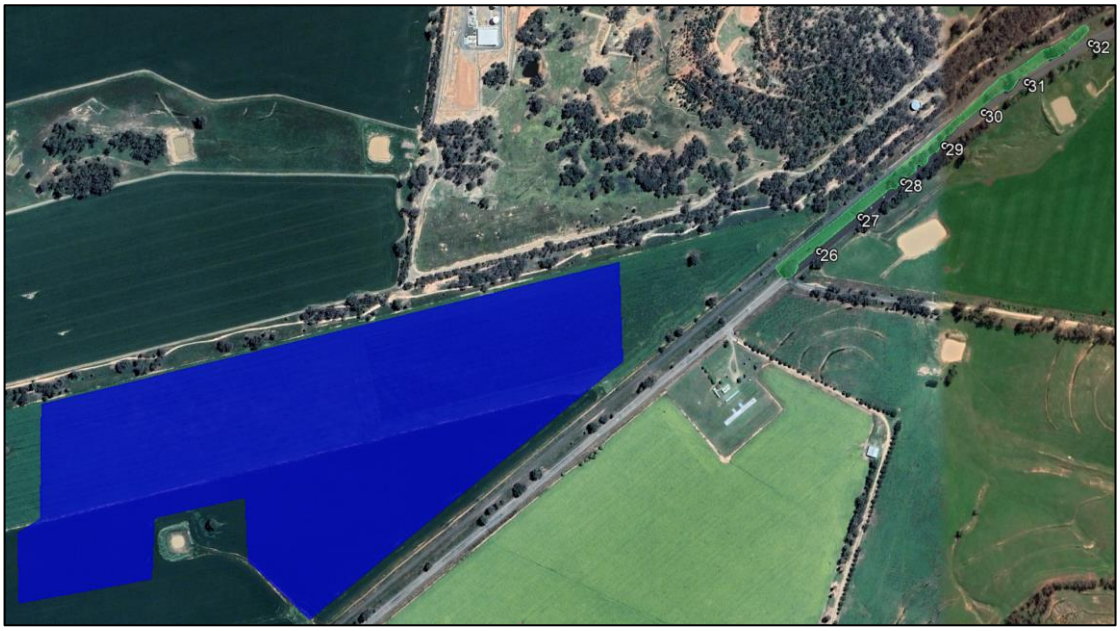


Figure 15 *Significant screening (green highlighted area) for road receptors 26 to 32 – aerial image*

8.2 Train Drivers

The process for quantifying impact significance is defined in the report appendices. For train driver receptors, the key considerations are:

- Whether a significant reflection is predicted in practice.
- Whether the reflection originates in front of the train driver.

The modelling has shown that solar reflections are geometrically possible towards 16 of the 21 assessed receptors along the railway line (6 – 21).

For receptors 6 – 8, views of the reflecting panels may be possible. The impact is moderate according to the guidance presented in Appendix D; however, no mitigation is required because the reflections occur outside of a train driver's primary field of view in both directions of travel (30 degrees either side). Furthermore, the developer has already proposed mitigation in the form of tree planting along the site boundary (see Figure 1 on page 13). Following the implementation of the tree planting, no impact is predicted because views of reflecting panels should not be possible.

For receptors 9 – 19, views of the reflecting panels may be possible within a train driver's primary field of view when travelling in the north-east to south-west direction. There does not appear to be any significant screening between the railway and the proposed solar development location. The impact is moderate according to the guidance presented in Appendix D. However, the developer has already proposed mitigation in the form of tree planting along the site boundary. Following the implementation of the tree planting, no impact is predicted because views of reflecting panels should not be possible. No further mitigation is required.

For receptors 20 – 21, solar reflections are not predicted to be experienced in practice as the reflecting solar panels are expected to be significantly screened by intervening terrain and vegetation, as shown in Figures 17 and 18[5] on the following page. The proposed tree planting along the site boundary will provide further screening. No impact is predicted.

Figure 16 below shows the section of road where solar reflections are geometrically possible (orange line) and the area of proposed tree planting (green line).



Figure 16 *Section of railway where solar reflections are geometrically possible (orange) and proposed tree planting (green) – aerial image*



Figure 17 *Significant screening (green highlighted area) for train driver receptors 20 and 21 – closeup aerial image*

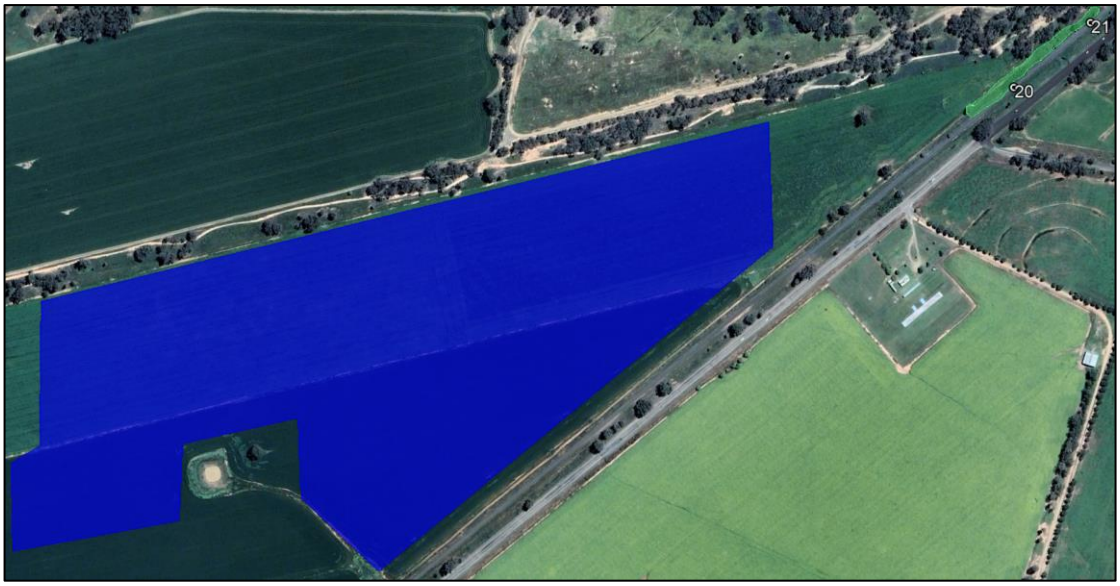


Figure 18 *Significant screening (green highlighted area) for train driver receptors 20 and 21 – aerial image*

8.3 High-Level Mitigation Recommendation

Mitigation in the form of tree planting has already been included in the site plan as shown in Figure 1 on page 13. The height of this planting should be managed such that views of the reflecting panels are sufficiently obstructed. The required height will depend on the relative elevation of the receptors, the base of the planting itself, and the reflecting panels. Consideration of this should inform the landscaping / LVIA aspect of the proposal. Further to the implementation of this tree planting, no impact is predicted (assuming that the screening will be entirely opaque along its length and at a sufficient height to eliminate views from the relevant receptors along the assessed sections of Olympic Highway and the railway line).

9 OVERALL CONCLUSIONS

All dwellings in the locality appear to be suitably screened and therefore no impact is predicted. Following the implementation of the tree planting as indicated by the developer in the site plan on page 13, no significant impact is predicted on roads or railways in the area because all predicted solar reflections will be screened. This is assuming that the screening will be entirely opaque along its length and at a sufficient height to eliminate views from the relevant receptors along the assessed sections of Olympic Highway and the railway line.

APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

This section presents details regarding the relevant guidance and studies with respect to the considerations and effects of solar reflections from solar panels, known as 'Glint and Glare'.

This is not a comprehensive review of the data sources, rather it is intended to give an overview of the important parameters and considerations that have informed this assessment.

UK Planning Policy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[12] (specifically regarding the consideration of solar farms, paragraph 013) states:

'What are the particular planning considerations that relate to large scale ground-mounted solar photovoltaic Farms?

The deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively.

Particular factors a local planning authority will need to consider include:

…

- *the proposal's visual impact, the effect on landscape of glint and glare (see guidance on landscape assessment) and on **neighbouring uses and aircraft safety**;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun.*

…

The approach to assessing cumulative landscape and visual impact of large-scale solar farms is likely to be the same as assessing the impact of wind turbines. However, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography the area of a zone of visual influence could be zero.'

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare are, however, provided for assessing the impact of solar reflections upon surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant. The Pager Power approach

[12] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 17/06/2020

has been informed by the policy presented above, current studies (presented in Appendix B) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document[13] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

Assessment Process – Railways

Railway operations is not mentioned specifically within this guidance however it is stated that a developer will need to consider *'the proposal's visual impact, the effect on landscape of glint and glare and on neighbouring uses…'*. In the UK, Network Rail is a statutory consultee when a development is located in close proximity to its infrastructure. In New South Wales, ARTC would be a consultee if a development impacts its infrastructure.

No process for determining and contextualising the effects of glint and glare are, however, provided. Therefore, the Pager Power approach is to determine whether a reflection from a development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

Railway Assessment Guidelines

The following section provides an overview of the relevant railway guidance with respect to the siting of signals on railway lines. Network Rail is the stakeholder of the UK's railway infrastructure. Whilst the guidance is not strictly applicable in Australia, the general principles within the guidance is expected to apply.

A railway operator's concerns would likely to relate to the following:

1. The development producing solar glare that affects train drivers; and
2. The development producing solar reflections that affect railway signals and create a risk of a phantom aspect signal.

Railway guidelines are presented below. These relate specifically to the sighting distance for railway signals.

Reflections and Glare

The extract below and on the following page is taken from Section A5 – Reflections and glare (pages 64-65) of the 'Signal Sighting Assessment Requirements'[14] which details the requirement for assessing glare towards railway signals.

Reflections and glare

Rationale

Reflections can alter the appearance of a display so that it appears to be something else.

[13] Solar Photovoltaic Development – Glint and Glare Guidance, Third Edition, December 2020. Pager Power.

[14] Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 18.10.2016.

Guidance

A5 is present if direct glare or reflected light is directed into the eyes or into the lineside signalling asset that could make the asset appear to show a different aspect or indication to the one presented.

A5 is relevant to any lineside signalling asset that is capable of presenting a lit signal aspect or indication.

The extent to which excessive illumination could make an asset appear to show a different signal aspect or indication to the one being presented can be influenced by the product being used. Requirements for assessing the phantom display performance of signalling products are set out in GKRT0057 section 4.1.

Problems arising from reflection and glare occur when there is a very large range of luminance, that is, where there are some objects that are far brighter than others. The following types of glare are relevant:

a) Disability glare, caused by scattering of light in the eye, can make it difficult to read a lit display.

b) Discomfort glare, which is often associated with disability glare. While being unpleasant, it does not affect the signal reading time directly, but may lead to distraction and fatigue.

Examples of the adverse effect of disability glare include:

a) When a colour light signal presenting a lit yellow aspect is viewed at night but the driver is unable to determine whether the aspect is a single yellow or a double yellow.

b) Where a colour light signal is positioned beneath a platform roof painted white and the light reflecting off the roof can make the signal difficult to read.

Options for militating against A5 include:

a) Using a product that is specified to achieve high light source: phantom ratio values.

b) Alteration to the features causing the glare or reflection.

c) Provision of screening.

Glare is possible and should be assessed when the luminance is much brighter than other light sources. Glare may be unpleasant and therefore cause distraction and fatigue, or may make the signal difficult to read and increase the reading time.

Determining the Field of Focus

The extract on the following pages is taken from Appendix F - Guidance on Field of Vision (pages 98-101) of the 'Signal Sighting Assessment Requirements'[15] which details the visibility of signals, train drivers' field of vision and the implications with regard to signal positioning.

[15] Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 28.08.2020.

Asset visibility

The effectiveness of an observer's visual system in detecting the existence of a target asset will depend upon its:

a) Position in the observer's visual field.

b) Contrast with its background.

c) Luminance properties.

d) The observer's adaptation to the illumination level of the environment.

It is also influenced by the processes relating to colour vision, visual accommodation, and visual acuity. Each of these issues is described in the following sections.

Field of vision

The field of vision, or visual field, is the area of the visual environment that is registered by the eyes when both eyes and head are held still. The normal extent of the visual field is approximately 135o in the vertical plane and 200o in the horizontal plane.

The visual field is usually described in terms of central and peripheral regions: the central field being the area that provides detailed information. This extends from the central point (0°) to approximately 30° at each eye. The peripheral field extends from 30o out to the edge of the visual field.

F.6.3 Objects positioned towards the centre of the observer's field of vision are seen more quickly and identified more accurately because this is where our sensitivity to contrast is the highest. Peripheral vision is particularly sensitive to movement and light.

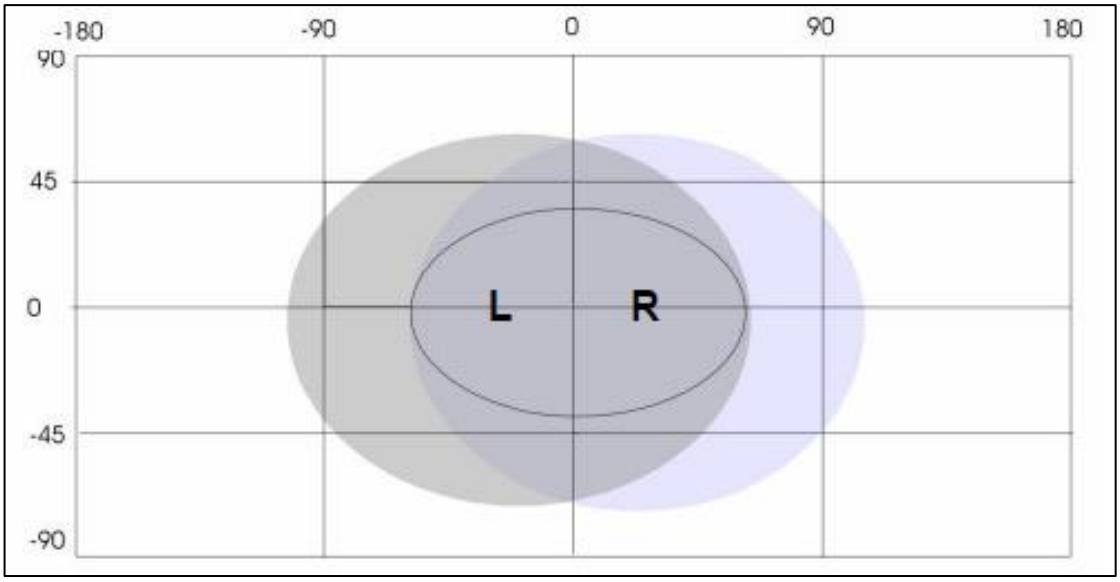


Figure G 21 - Field of view

In Figure G 21, the two shaded regions represent the view from the left eye (L) and the right eye (R) respectively. The darker shaded region represents the region of binocular overlap. The oval in the centre represents the central field of vision.

Research has shown that drivers search for signs or signals towards the centre of the field of vision.

Signals, indicators and signs should be positioned at a height and distance from the running line that permits them to be viewed towards the centre of the field of vision. This is because:

a) *As train speed increases, drivers become increasingly dependent on central vision for asset detection. At high speeds, drivers demonstrate a tunnel vision effect and focus only on objects in a field of + 8° from the direction of travel.*

b) *Sensitivity to movement in the peripheral field, even minor distractions can reduce the visibility of the asset if it is viewed towards the peripheral field of vision. The presence of clutter to the sides of the running line can be highly distracting (for example, fence posts, lamp-posts, traffic, or non-signal lights, such as house, compatibility factors or security lights).*

Figure G 22 and Table G 5 identify the radius of an 8o cone at a range of close-up viewing distances from the driver's eye. This shows that, depending on the lateral position of a stop signal, the optimal (normal) train stopping point could be as far as 25 m back from the signal to ensure that it is sufficiently prominent.

The dimensions quoted in Table G 5 assume that the driver is looking straight ahead. Where driver-only operation (DOO) applies, the drivers' line of sight at the time of starting the train is influenced by the location of DOO monitors and mirrors. In this case it may be appropriate to provide supplementary information alongside the monitors or mirrors using one of the following:

a) *A co-acting signal.*

b) *A miniature banner repeater indicator.*

c) *A right away indicator.*

d) *A sign to remind the driver to check the signal aspect.*

In order to prevent misreading by trains on adjacent lines, the co-acting signal or miniature banner repeater may be configured so that the aspect or indication is presented only when a train is at the platform to which it applies.

'Car stop' signs should be positioned so that the relevant platform starting signals and / or indicators can be seen in the driver's central field of vision.

If possible, clutter and non-signal lights in a driver's field of view should be screened off or removed so that they do not cause distraction.

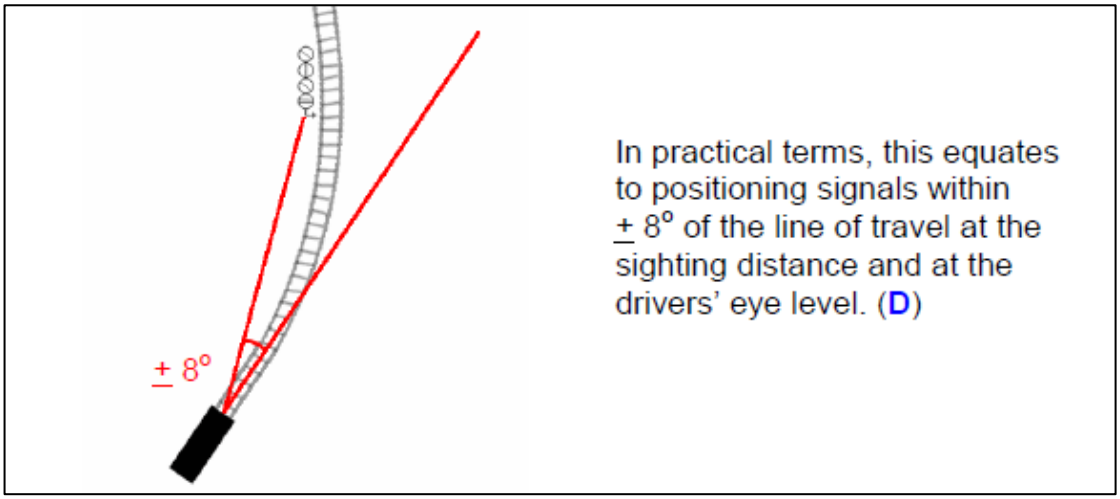


Figure G 22 - Signal positioning

'A' (m)	'B' (m)	Typical display positions
5	*0.70*	-
6	*0.84*	-
7	*0.98*	-
8	*1.12*	-
9	*1.26*	-
10	*1.41*	-
11	*1.55*	-
12	*1.69*	-
13	*1.83*	-
14	*1.97*	-
15	*2.11*	*A stop aspect positioned 3.3 m above rail level and 2.1 m from the left hand rail is within the 8º cone at 15.44 m in front of the driver*
16	*2.25*	-
17	*2.39*	-
18	*2.53*	*A stop aspect positioned 5.1 m above rail level and 0.9 m from the left hand rail is within the 8º cone at 17.93 m in front of the driver*
19	*2.67*	-
20	*2.81*	-
21	*2.95*	-
22	*3.09*	-
23	*3.23*	-
24	*3.37*	-
25	*3.51*	*A stop aspect positioned 3.3 m above rail level and 2.1 m from the right hand rail is within the 8º cone at 25.46 m in front of the driver*

Table G 5 – 8º cone angle co-ordinates for close-up viewing

The distance at which the 8° cone along the track is initiated is dependent on the minimum reading time and distance which is associated to the speed of trains along the track. This is discussed below.

Determining the Assessed Minimum Reading Time

The extract below is taken from section B5 (pages 8-9) of the 'Guidance on Signal Positioning and Visibility' which details the required minimum reading time for a train driver when approaching a signal.

'B5.2.2 Determining the assessed minimum reading time

GE/RT8037

The assessed minimum reading time shall be no less than eight seconds travelling time before the signal.

The assessed minimum reading time shall be greater than eight seconds where there is an increased likelihood of misread or failure to observe. Circumstances where this applies include, but are not necessarily limited to, the following:

a) the time taken to identify the signal is longer (for example, because the signal being viewed is one of a number of signals on a gantry, or because the signal is viewed against a complex background)
b) the time taken to interpret the information presented by the signal is longer (for example, because the signal is capable of presenting route information for a complex layout ahead)
c) there is a risk that the need to perform other duties could cause distraction from viewing the signal correctly (for example, the observance of lineside signs, a station stop between the caution and stop signals, or DOO (P) duties)
d) the control of the train speed is influenced by other factors (for example, anticipation of the signal aspect changing).

The assessed minimum reading time shall be determined using a structured format approved by the infrastructure controller.'

The distance at which a signal should be clearly viewable is determined by the maximum speed of the trains along the track. If there are multiple signals present at a location then an additional 0.2 seconds reading time is added to the overall viewing time.

Signal Design and Lighting System

Many railway signals are now LED lights and not filament (incandescent) bulbs. The benefits of an LED signal over a filament bulb signal with respect to possible phantom aspect illuminations are as follows:

- An LED railway signal produces a more intense light making them more visible to approaching trains when compared to the traditional filament bulb technology[16];

[16] Source: Wayside LED Signals – Why it's Harder than it Looks, Bill Petit.

- No reflective mirror is present within the LED signal itself unlike a filament bulb. The presence of the reflective surfaces greatly increases the likelihood of incoming light being reflecting out making the signal appear illuminated.

Many LED signal manufacturers[17,18,19] claim that LED signal lights significantly reduce or completely remove the likelihood of a phantom aspect illumination occurring.

[17] Source: http://www.unipartdorman.co.uk/assets/unipart_dorman_rail_brochure.pdf. (Last accessed 21.02.18).
[18] Source: http://www.vmstech.co.uk/downloads/Rail.pdf. (Last accessed 21.02.18).
[19] Source: Siemens, Sigmaguard LED Tri-Colour L Signal – LED Signal Technology at Incandescent Prices. Datasheet 1A-23. (Last accessed 22.02.18).

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

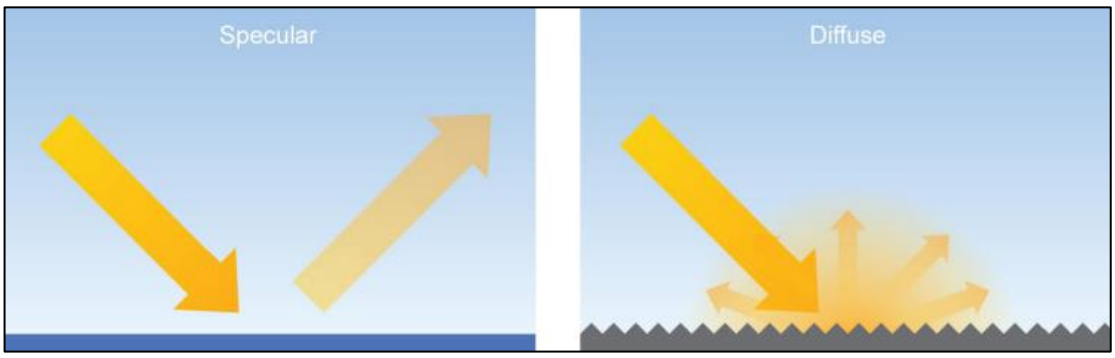
Overview

Studies have been undertaken assessing the type and intensity of solar reflections from various surfaces including solar panels and glass. An overview of these studies is presented below.

The guidelines presented are related to aviation safety. The results are applicable for the purpose of this analysis.

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance[20], illustrates the difference between the two types of reflections. Because solar panels are flat and have a smooth surface most of the light reflected is specular, which means that incident light from a specific direction is reradiated in a specific direction.



Specular and diffuse reflections

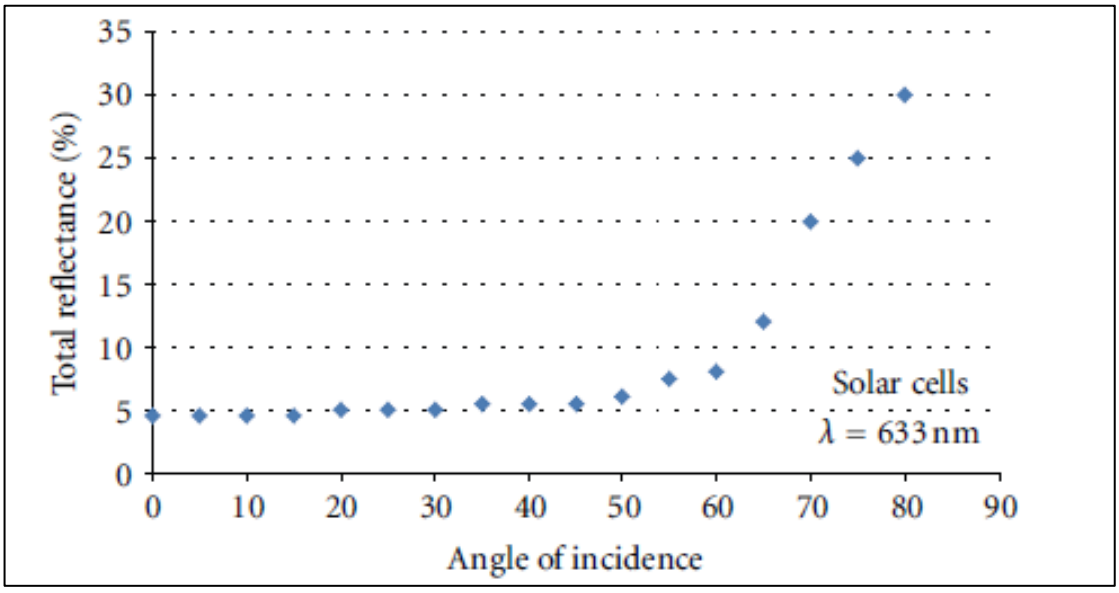
[20] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

Solar Reflection Studies

An overview of content from identified solar panel reflectivity studies is presented in the subsections below.

Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems"

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[21]". They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure below.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

- The potential for hazardous glare from flat-plate PV systems is similar to that of smooth water;
- Portland white cement concrete (which is a common concrete for runways), snow, and structural glass all have a reflectivity greater than water and flat plate PV modules.

[21] Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems," ISRN Renewable Energy, vol. 2011, Article ID 651857, 6 pages, 2011. doi:10.5402/2011/651857

FAA Guidance – "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[22]

The 2010 FAA Guidance included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. A table of reflectivity values, sourced from the figure within the FAA guidance, is presented below.

Surface	Approximate Percentage of Light Reflected[23]
Snow	80
White Concrete	77
Bare Aluminium	74
Vegetation	50
Bare Soil	30
Wood Shingle	17
Water	5
Solar Panels	5
Black Asphalt	2

Relative reflectivity of various surfaces

Note that the data above does not appear to consider the reflection type (specular or diffuse).

An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel.

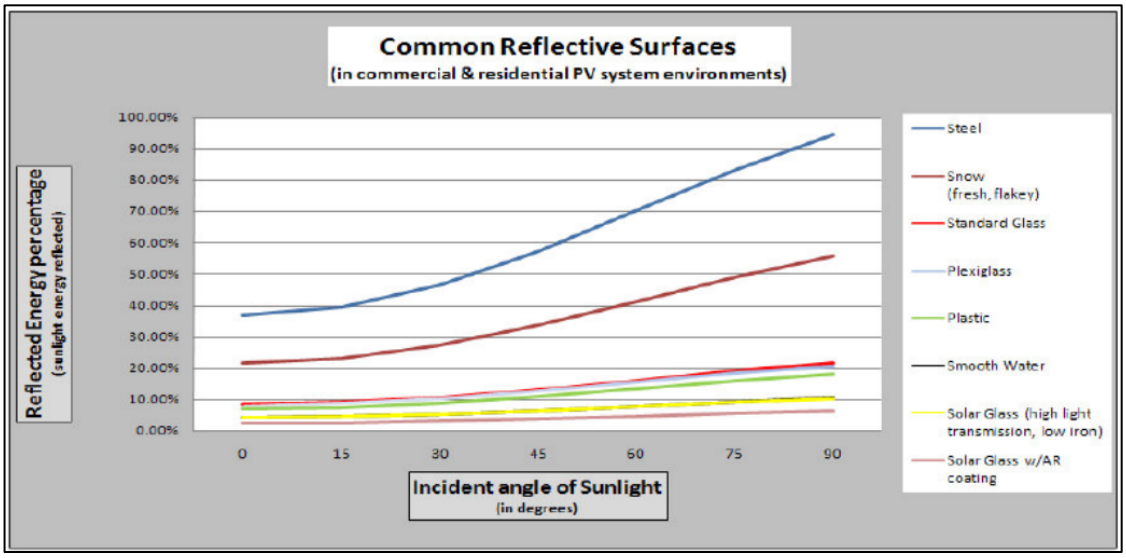
The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

[22] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.
[23] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

SunPower Technical Notification (2009)

SunPower published a technical notification[24] to 'increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment'.

The figure presented below shows the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel.



Common reflective surfaces

The results, similarly to those from Riley and Olsen study (2011) and the FAA (2010), show that solar panels produce a reflection that is less intense than those of '*standard glass and other common reflective surfaces*'.

With respect to aviation and solar reflections observed from the air, SunPower has developed several large installations near airports or on Air Force bases. It is stated that these developments have all passed FAA or Air Force standards with all developments considered "No Hazard to Air Navigation". The note suggests that developers discuss any possible concerns with stakeholders near proposed solar farms.

[24] Source: Technical Support, 2009. SunPower Technical Notification – Solar Module Glare and Reflectance.

APPENDIX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

The Sun's position in the sky can be accurately described by its azimuth and elevation. Azimuth is a direction relative to true north (horizontal angle i.e. from left to right) and elevation describes the Sun's angle relative to the horizon (vertical angle i.e. up and down).

The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- Time.
- Date.
- Latitude.
- Longitude.

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a reflector.

APPENDIX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

The significance of glint and glare will vary for different receptors. The following section presents a general overview of the significance criteria with respect to experiencing a solar reflection.

Impact Significance Definition

The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels.	No mitigation required.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case.	Whilst the impact may be acceptable, consultation and/or further analysis should be undertaken to determine the requirement for mitigation.
Major	A solar reflection is geometrically possible and visible under conditions that will produce a significant impact. Mitigation and consultation is recommended.	Mitigation will be required if the proposed solar development is to proceed.

Impact significance definition

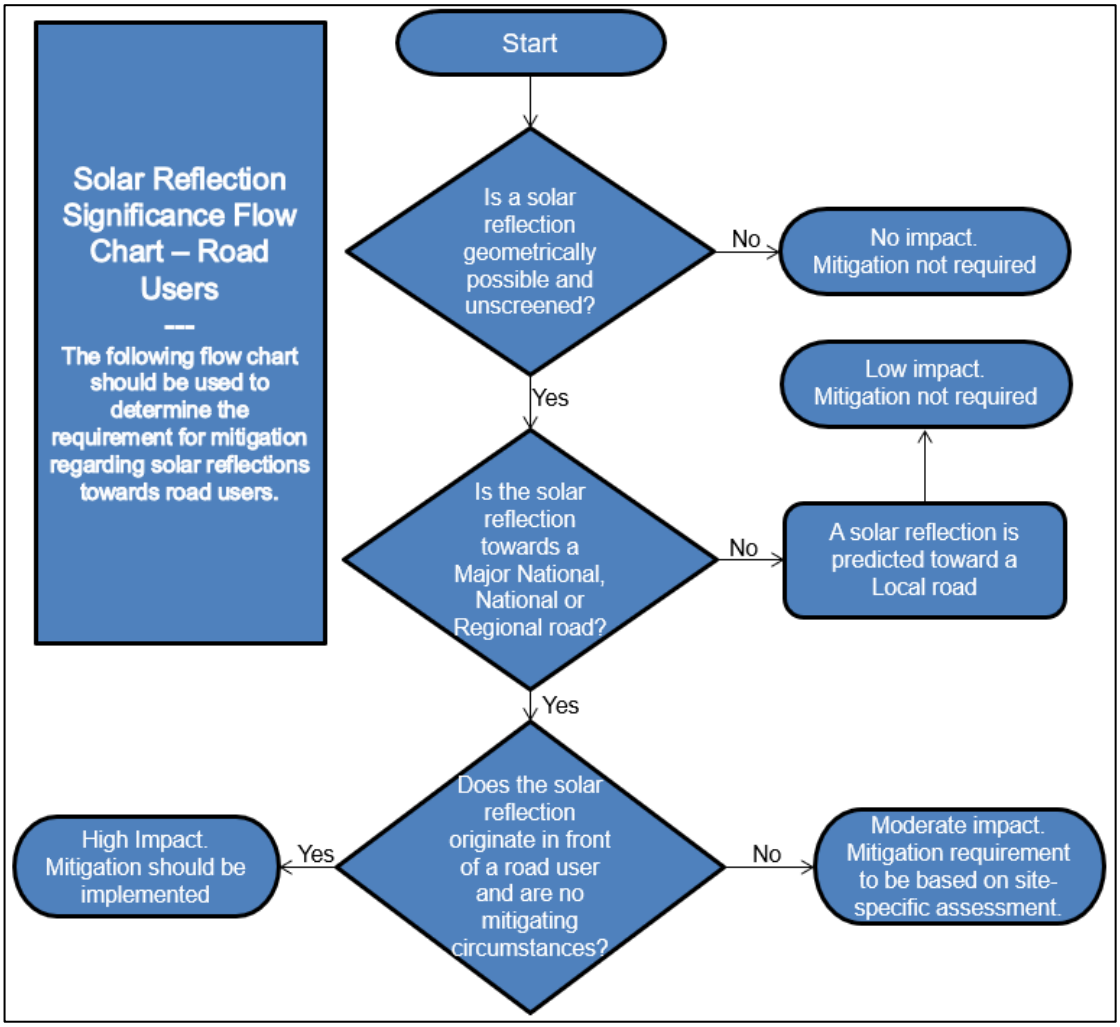
The following is an extract taken from Victoria State Government guidance for solar panel developments[8]. This agrees with Pager Power methodology.

The impacts of solar reflection vary for each type of receptor. The following criteria for glint and glare effects, should be used to guide an assessment.

- *No impact: a solar reflection is not geometrically possible, or it will not be visible from the assessed receptor. No mitigation is required.*
- *Low impact: a solar reflection is geometrically possible, but the intensity and duration of an impact is considered to be small and can be mitigated with screening or other measure.*
- *Moderate impact: a solar reflection is geometrically possible and visible, but the intensity and duration of an impact varies according to conditions. Mitigation measures (such as through design, orientation, landscaping or other screening method) to reduce impacts to an acceptable level will be required.*
- *Major impact: a solar reflection is geometrically possible and visible under a range of conditions that will produce impacts with significant intensity and duration. Significant mitigation measures are required if the proposed development is to proceed.*

Assessment Process for Road Receptors

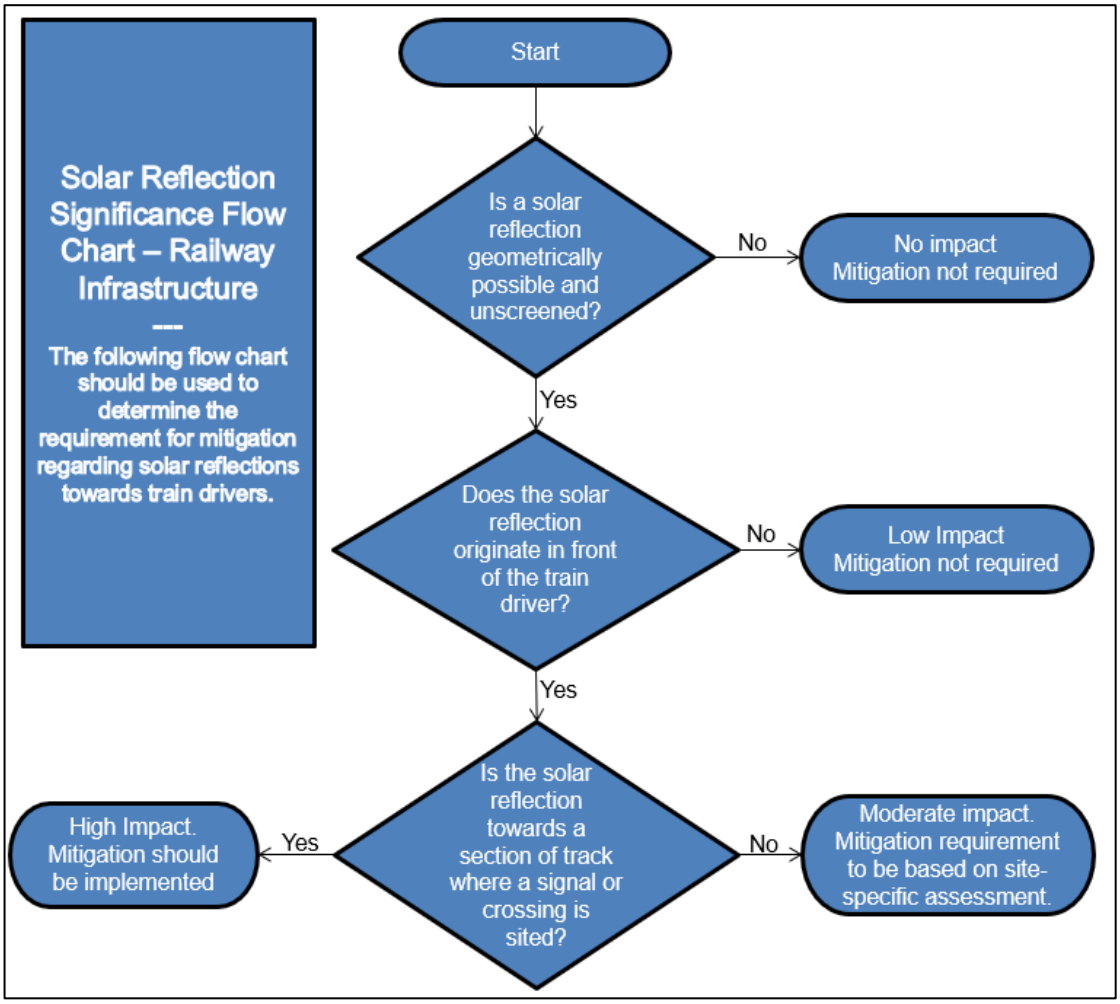
The flow chart presented below has been followed when determining the mitigation requirement for road receptors.



Road receptor mitigation requirement flow chart

Assessment Process for Railway Receptors

The flow chart presented below has been followed when determining the mitigation requirement for railway receptors.



Train driver impact significance flow chart

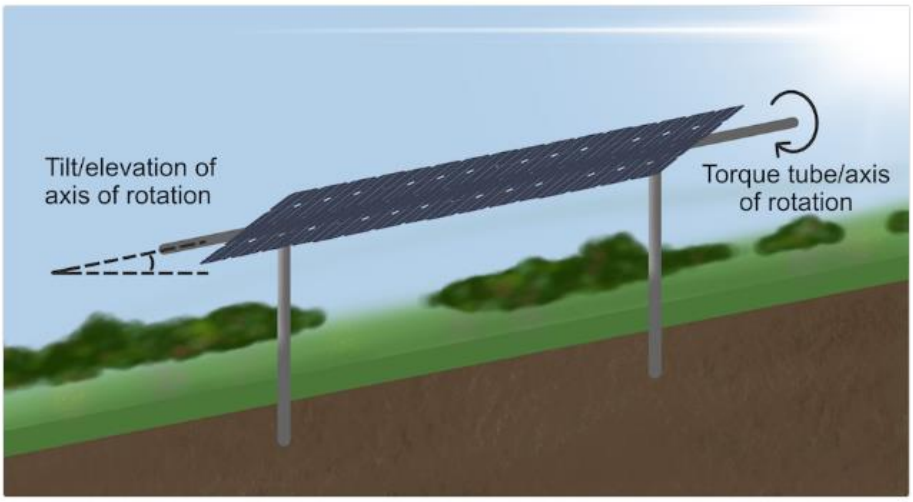
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Forge Reflection Calculations Methodology

Extracts taken from the Forge Solar Model.

Tracking System Parameters

Single-axis module tracking systems are described by a unique set of parameters. These angular inputs model the tracking axis, rotation range and backtracking behavior. Dual-axis module tracking systems are assumed to track the sun at all times.



Single-axis tracking system with torque tube tilted due to geography

Tilt of tracking axis (°)
Tilt above flat ground of axis over which panels rotate (e.g. torque tube). System on flat, level ground would have axis tilt of 0°.

Orientation of tracking axis (°)
Azimuthal angle of axis over which panels rotate. Angle represents the facing of the axis and system. For example, typical tracking system in northern hemisphere has tracking axis oriented north-south with an orientation of 180°, allowing panels to rotate east-west with potential south-facing tilt. Typical tracking system in southern hemisphere runs south-north with axis orientation of 0°, yielding east-west rotation with potential north-facing tilt.

Offset angle of module (°)
Additional tilt angle of PV module elevated above tracking axis/torque tube. Offset angle is measured from the torque tube.

Maximum tracking angle (°)
Maximum angle of rotation of tracking system in one direction. For example, a typical system with a 120° range of rotation has a *max tracking angle* of 60° (east/west).

Resting angle (°)
Angle of rotation of panels when sun is outside tracking range. Used to model backtracking. Panels will revert to the position described by this rotation angle at all times when the sun is outside the rotation range. Setting this equal to the *maximum tracking angle* implies the panels do not backtrack.

ForgeSolar utilizes a simplified model of backtracking which assumes panels instantaneously revert to the *resting angle* whenever the sun is outside the rotation range. For example, panels with *max tracking angle* of 60° and *resting angle* of 0° would lie flat from sunrise until the sun enters the rotation range, and immediately after the sun leaves the rotation range until sunset daily.

Tracking System Parameters

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Forge's Sandia National Laboratories' (SGHAT) Model[25]

Summary of assumptions and abstractions required by the SGHAT/ForgeSolar analysis methodology

1. Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
2. Result data files and plots are now retained for two years after analysis completion. Files should be downloaded and saved if additional persistence is required.
3. The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
4. Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects analyses of path receptors.
5. Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
6. The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
7. The algorithm assumes that the PV array is aligned with a plane defined by the total heights of the coordinates outlined in the Google map. For more accuracy, the user should perform runs using minimum and maximum values for the vertex heights to bound the height of the plane containing the solar array. Doing so will expand the range of observed solar glare when compared to results using a single height value.
8. The algorithm does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
9. The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
10. The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
11. The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
12. Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
13. Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
14. Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
15. PV array tracking assumes the modules move instantly when tracking the sun, and when reverting to the rest position.

[25] https://www.forgesolar.com/help/#assumptions

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Terrain Height

Terrain Height is calculated by Forge from SRTM data, based on the coordinates of the point of interest.

Road Receptor Data

The table below presents the coordinates for the assessed road receptors.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.25511	-35.18640	17	147.26870	-35.17725
2	147.25597	-35.18582	18	147.26957	-35.17666
3	147.25681	-35.18525	19	147.27042	-35.17609
4	147.25770	-35.18465	20	147.27128	-35.17551
5	147.25852	-35.18409	21	147.27210	-35.17495
6	147.25938	-35.18352	22	147.27297	-35.17436
7	147.26022	-35.18296	23	147.27384	-35.17379
8	147.26111	-35.18239	24	147.27470	-35.17319
9	147.26193	-35.18182	25	147.27555	-35.17262
10	147.26277	-35.18127	26	147.27643	-35.17203
11	147.26362	-35.18068	27	147.27729	-35.17145
12	147.26444	-35.18014	28	147.27817	-35.17085
13	147.26529	-35.17953	29	147.27902	-35.17024
14	147.26611	-35.17899	30	147.27984	-35.16968
15	147.26697	-35.17841	31	147.28074	-35.16916
16	147.26785	-35.17783	32	147.28206	-35.16851

Road Receptor Data

Train Driver Receptor Data

The table below presents the coordinates for the assessed train driver receptors.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.26016	-35.18262	12	147.26944	-35.17636
2	147.26098	-35.18207	13	147.27028	-35.17580
3	147.26182	-35.18150	14	147.27115	-35.17522
4	147.26264	-35.18095	15	147.27201	-35.17464
5	147.26350	-35.18037	16	147.27284	-35.17406
6	147.26436	-35.17979	17	147.27372	-35.17347
7	147.26521	-35.17921	18	147.27459	-35.17289
8	147.26604	-35.17866	19	147.27544	-35.17232
9	147.26690	-35.17808	20	147.27630	-35.17176
10	147.26775	-35.17751	21	147.27754	-35.17090
11	147.26860	-35.17692			

Train Driver Receptor Data

Panel Boundary Data

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.272229	-35.172240	7	147.262361	-35.177713
2	147.260027	-35.174684	8	147.262408	-35.176646
3	147.259986	-35.176672	9	147.264354	-35.176292
4	147.259613	-35.176805	10	147.264408	-35.177379
5	147.259489	-35.176907	11	147.265721	-35.178382
6	147.259561	-35.178130	12	147.272300	-35.173957

Panel Boundary Data

APPENDIX H – DETAILED MODELLING RESULTS

Overview

The following charts are taken from Forge and present relevant information for the potentially affected receptors for completeness. Each chart shows:

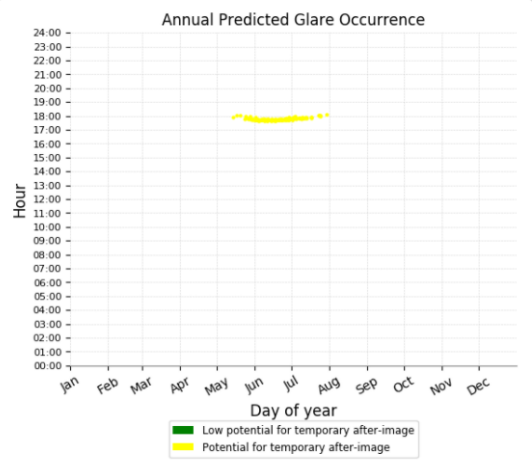
- The reflection date/time graph – top left graph. This relates to reflections from the yellow areas;
- The daily duration of glare – top right image.
- The reflecting panels – bottom left image. The reflecting area is shown in yellow. If the yellow panels are not visible from the observer location, no issues will occur in practice. Additional obstructions which may obscure the panels from view are considered separately within the analysis;

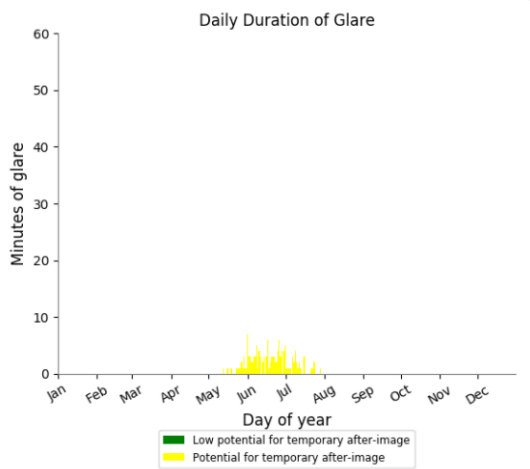
Road Receptors

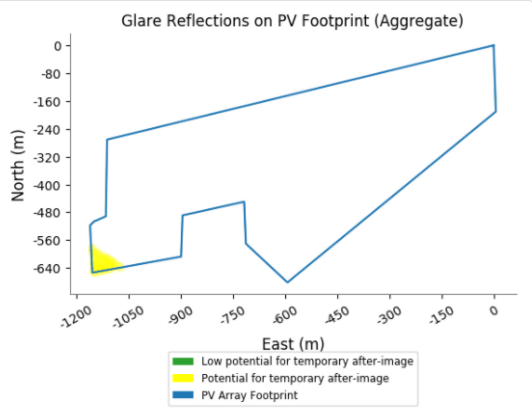
PV array 1 - OP Receptor (OP 12)

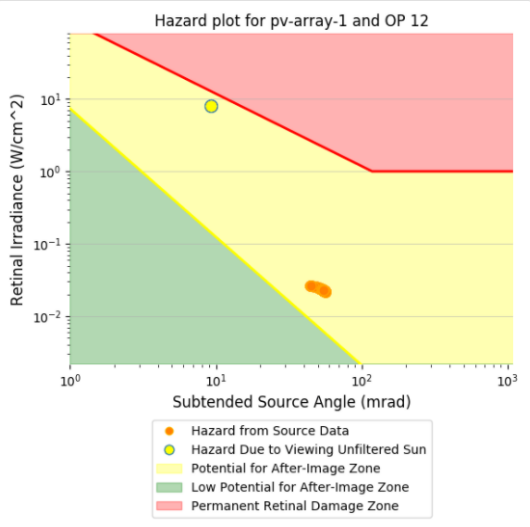
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 134 minutes of "yellow" glare with potential to cause temporary after-image.





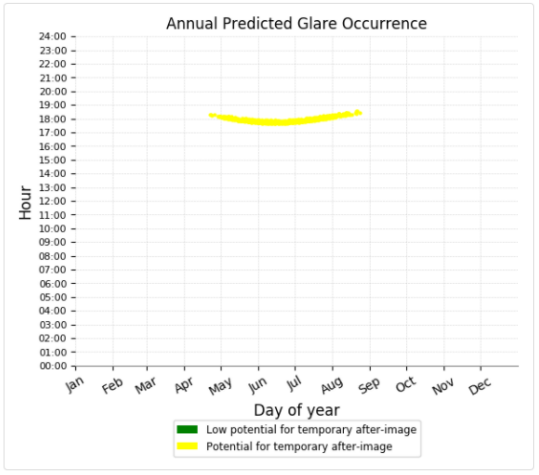


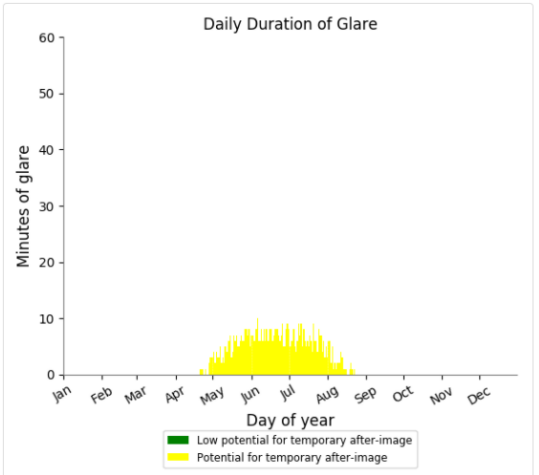


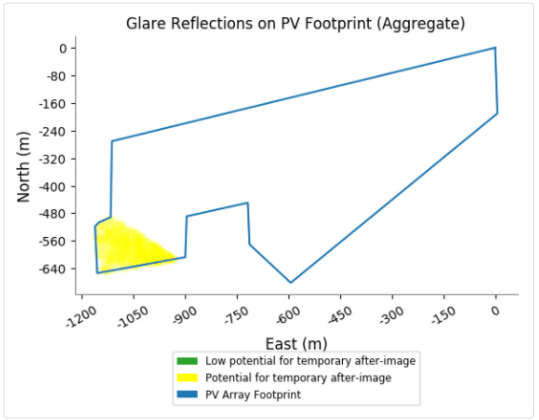
PV array 1 - OP Receptor (OP 13)

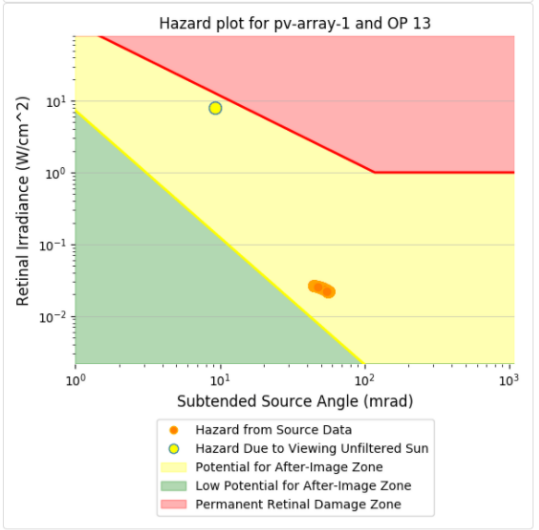
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 617 minutes of "yellow" glare with potential to cause temporary after-image.





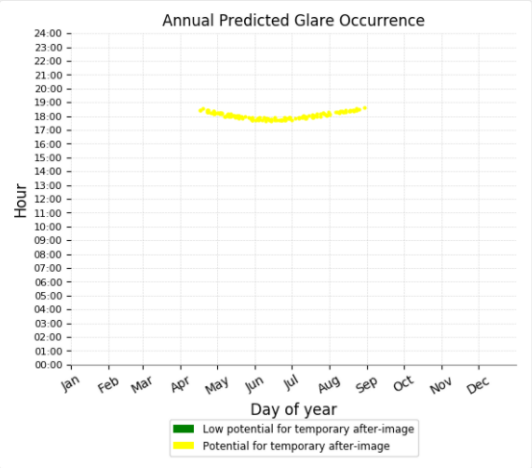


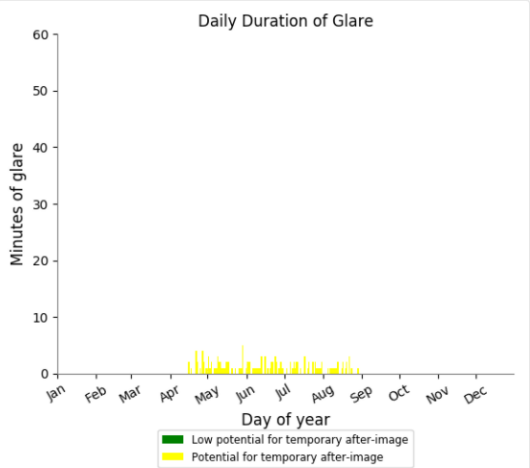


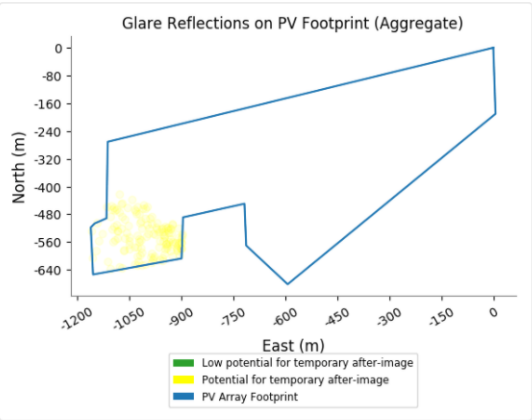
PV array 1 - OP Receptor (OP 14)

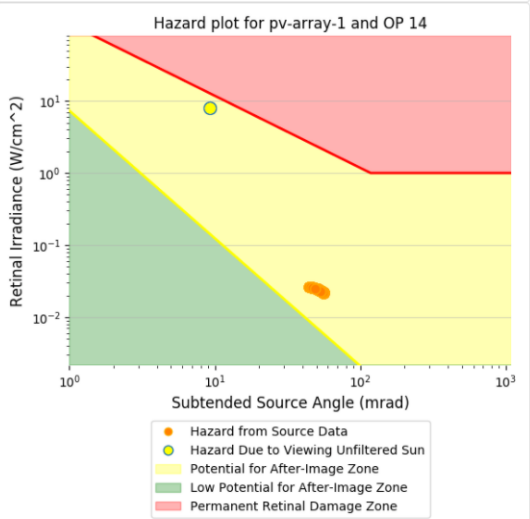
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 143 minutes of "yellow" glare with potential to cause temporary after-image.





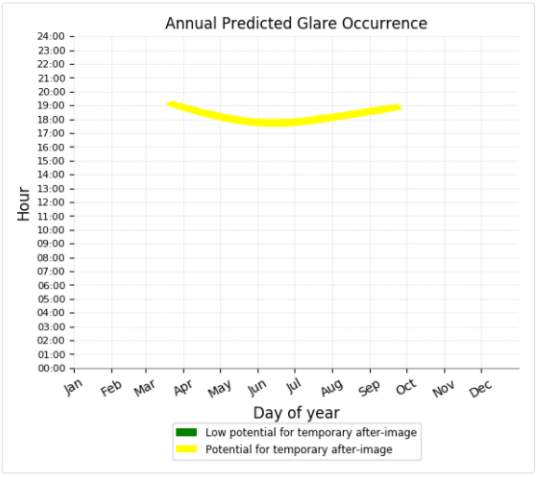


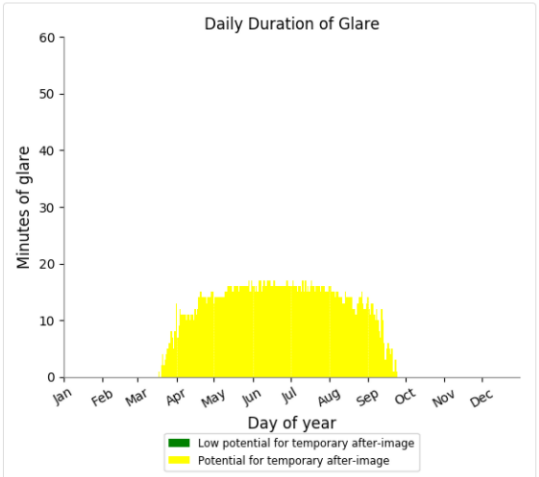


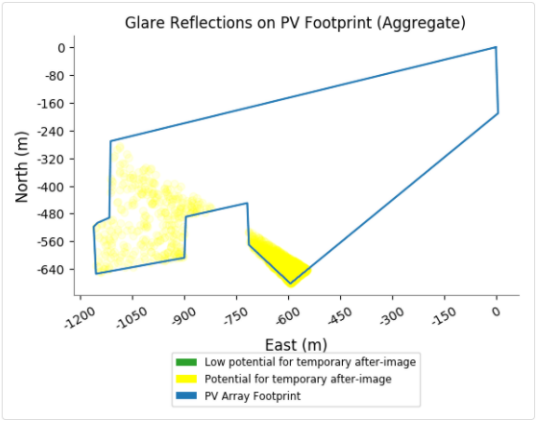
PV array 1 - OP Receptor (OP 15)

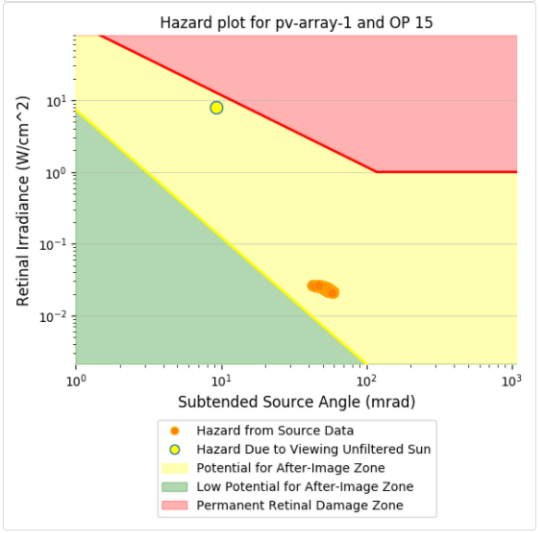
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,485 minutes of "yellow" glare with potential to cause temporary after-image.





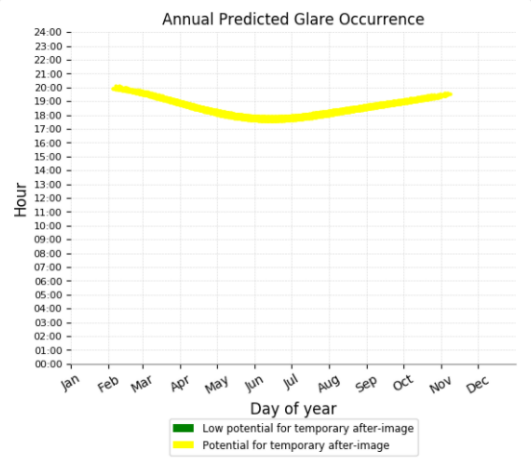


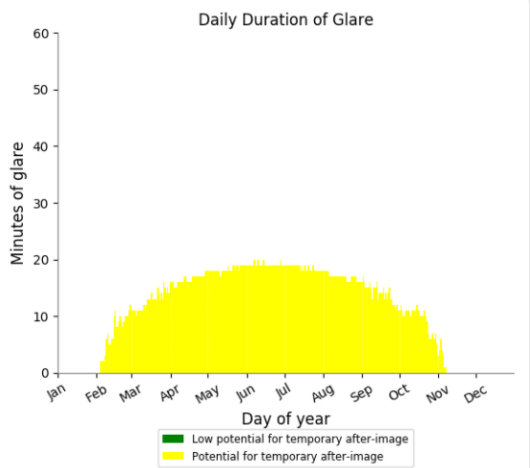


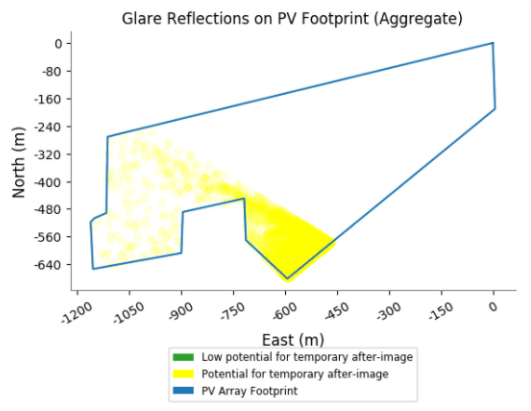
PV array 1 - OP Receptor (OP 16)

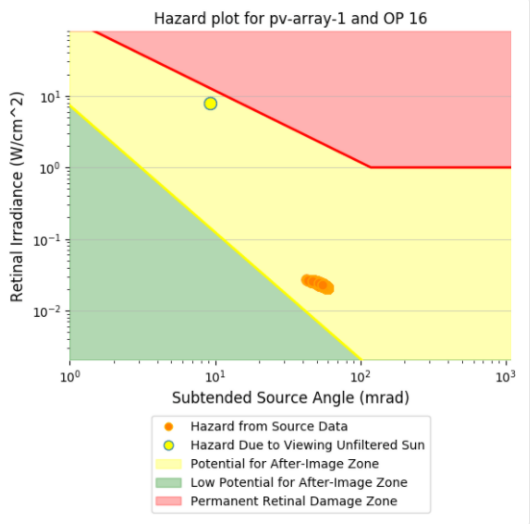
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 4,050 minutes of "yellow" glare with potential to cause temporary after-image.





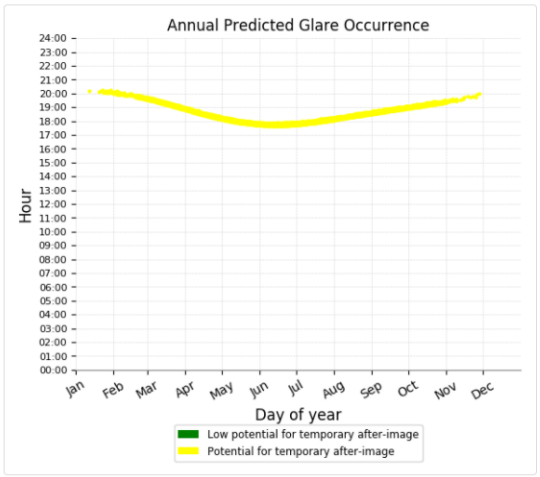


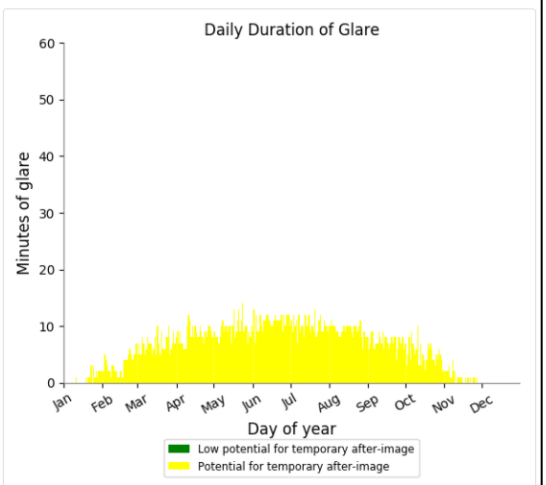


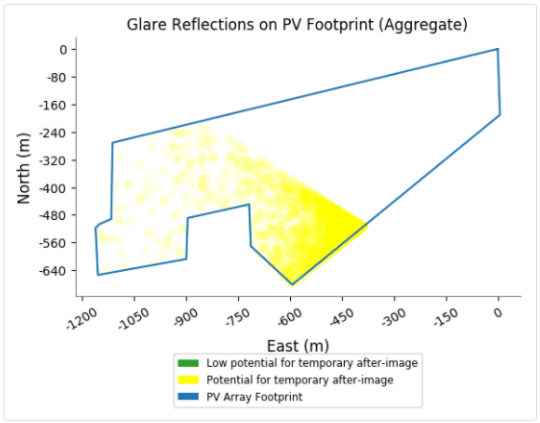
PV array 1 - OP Receptor (OP 17)

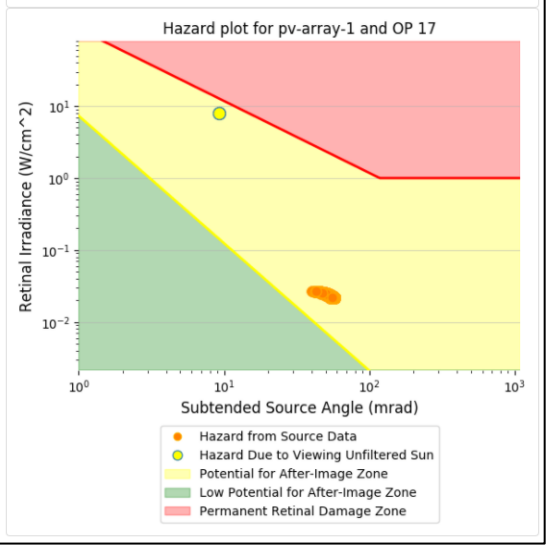
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 2,205 minutes of "yellow" glare with potential to cause temporary after-image.





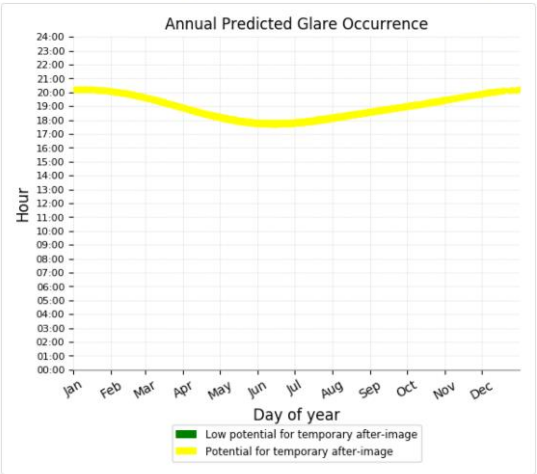


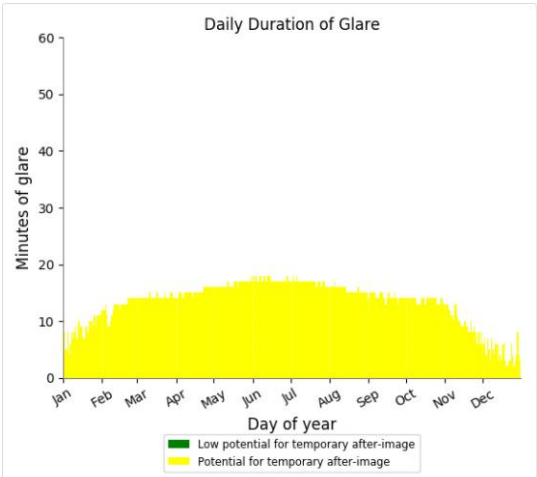


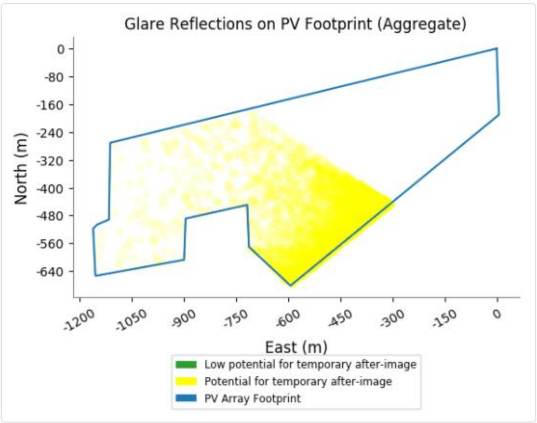
PV array 1 - OP Receptor (OP 18)

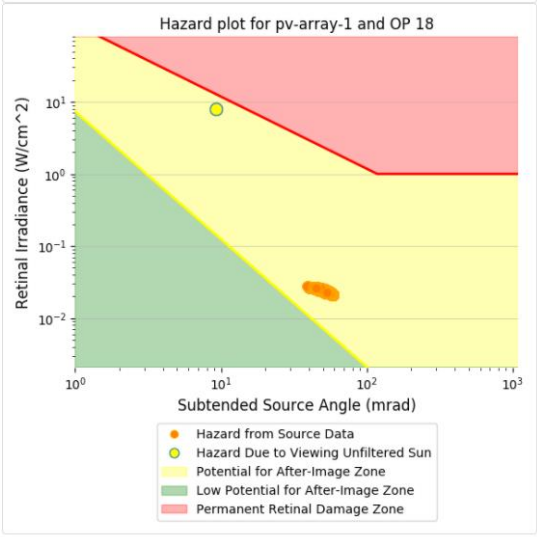
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 4,824 minutes of "yellow" glare with potential to cause temporary after-image.





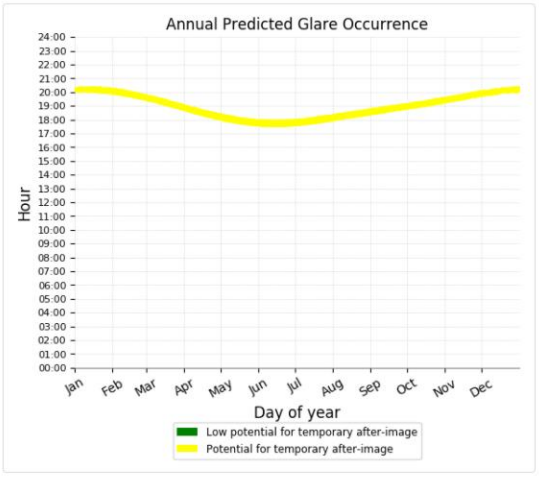


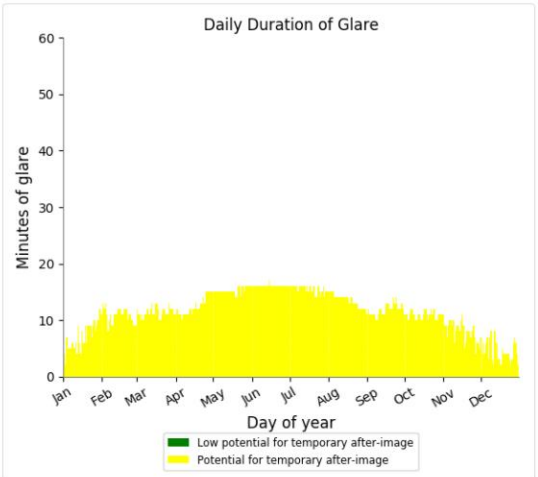


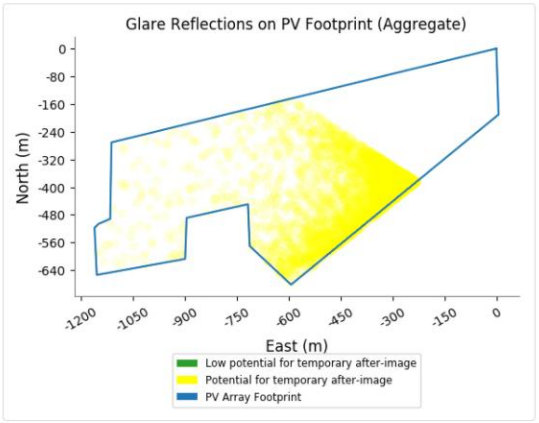
PV array 1 - OP Receptor (OP 19)

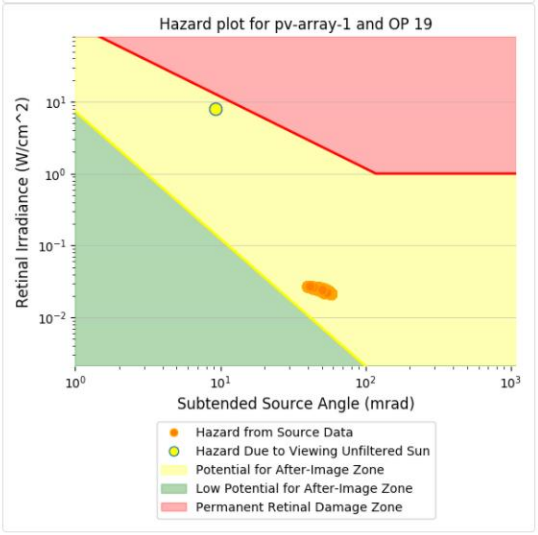
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 4,180 minutes of "yellow" glare with potential to cause temporary after-image.





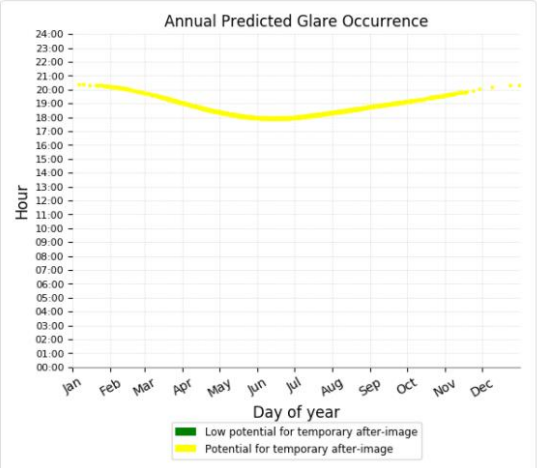


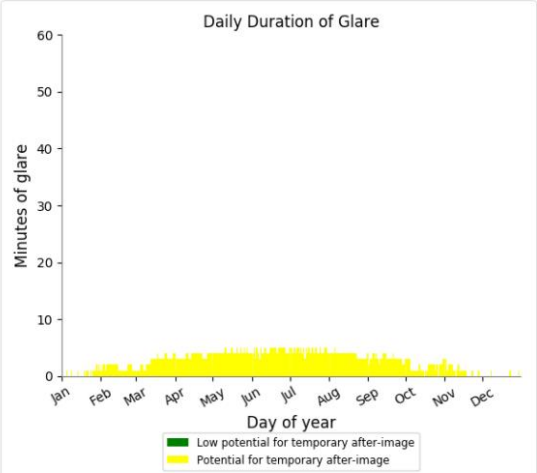


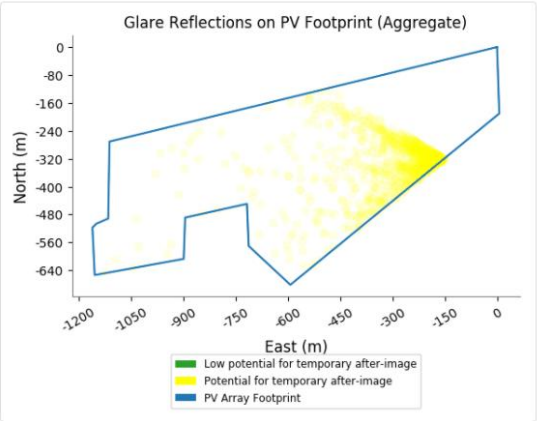
PV array 1 - OP Receptor (OP 20)

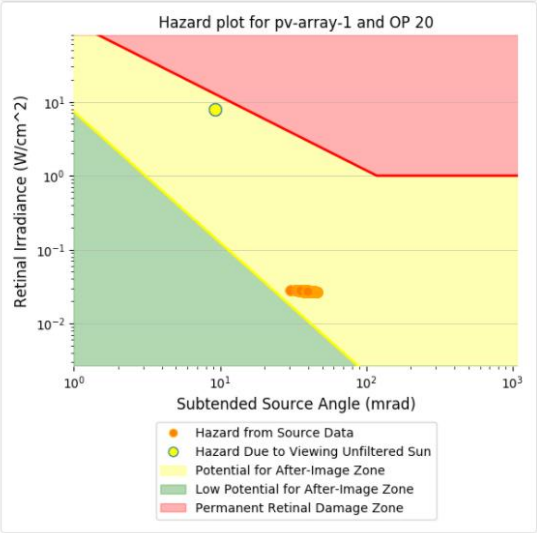
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 935 minutes of "yellow" glare with potential to cause temporary after-image.





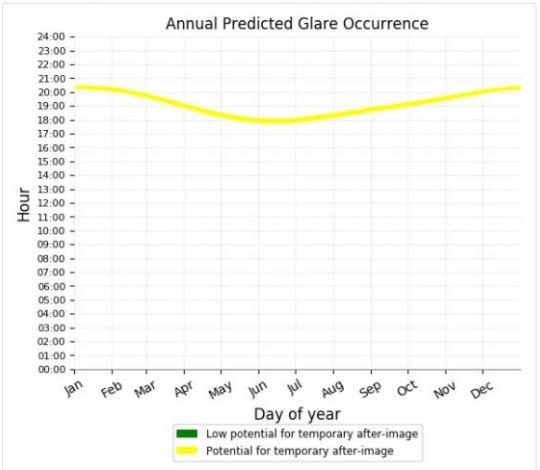


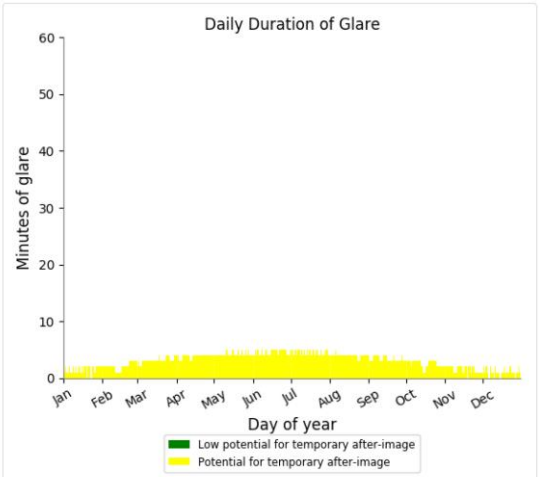


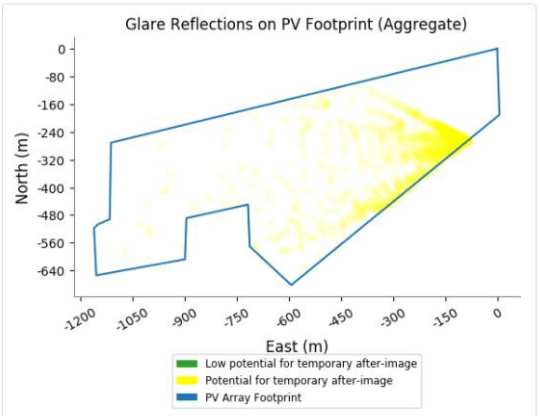
PV array 1 - OP Receptor (OP 21)

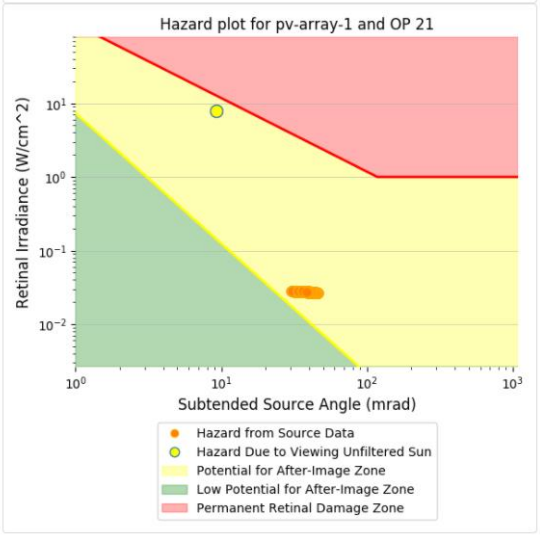
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,099 minutes of "yellow" glare with potential to cause temporary after-image.





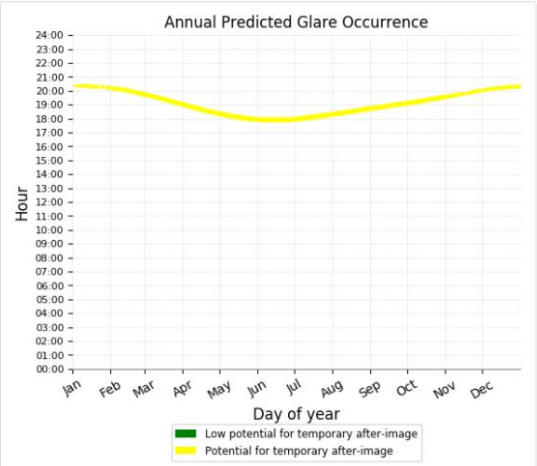


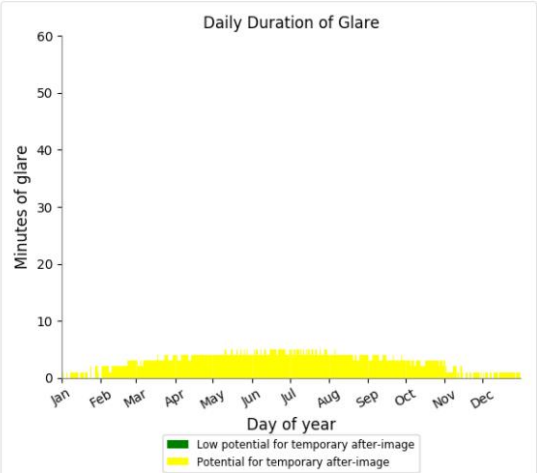


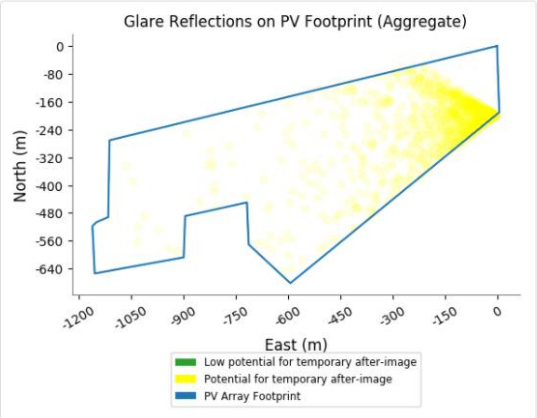
PV array 1 - OP Receptor (OP 22)

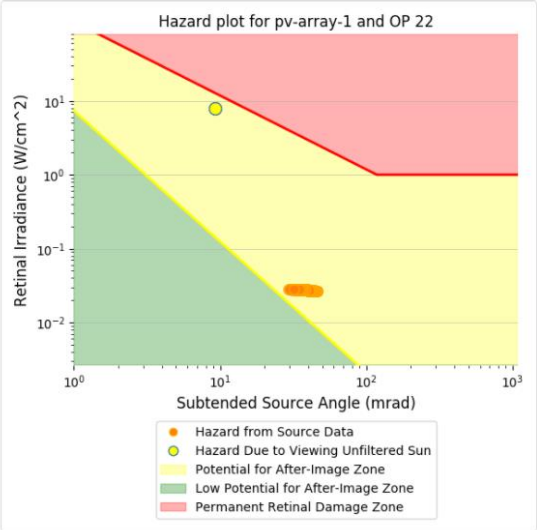
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,055 minutes of "yellow" glare with potential to cause temporary after-image.





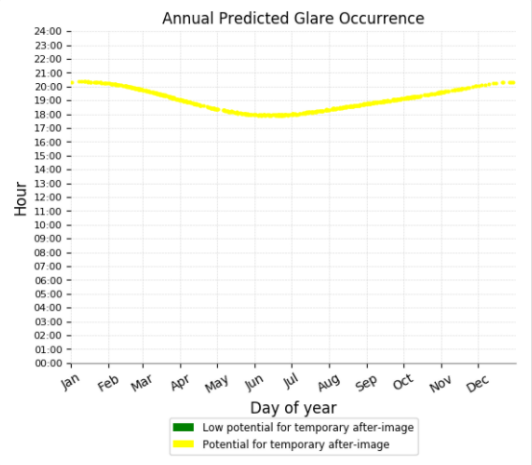


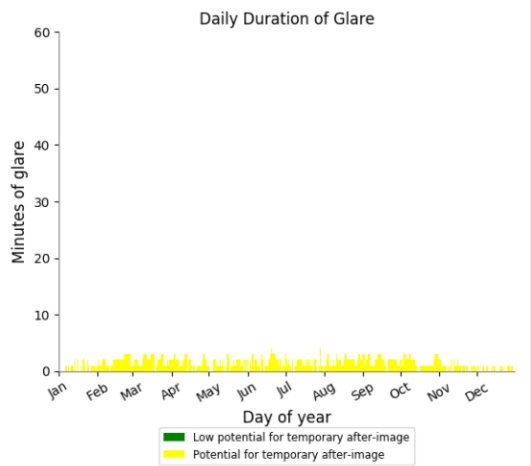


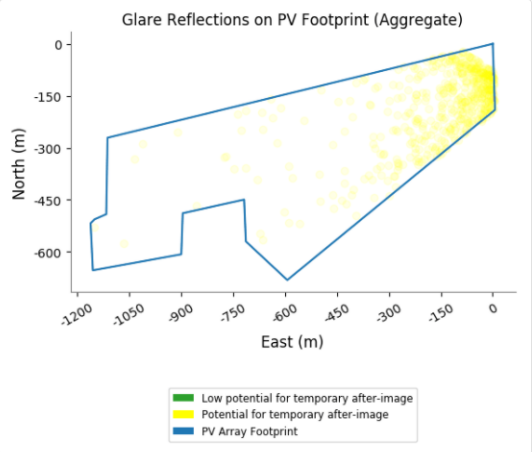
PV array 1 - OP Receptor (OP 23)

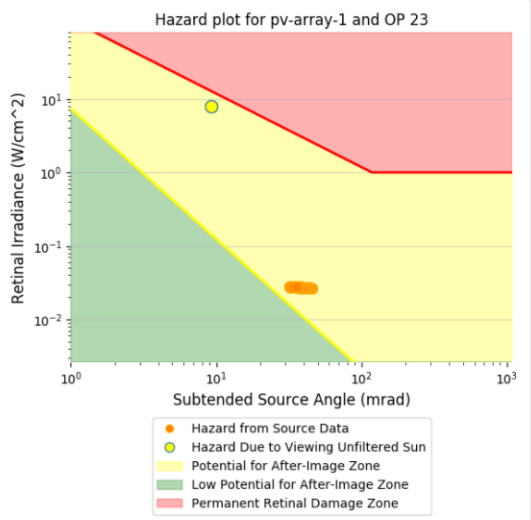
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 504 minutes of "yellow" glare with potential to cause temporary after-image.





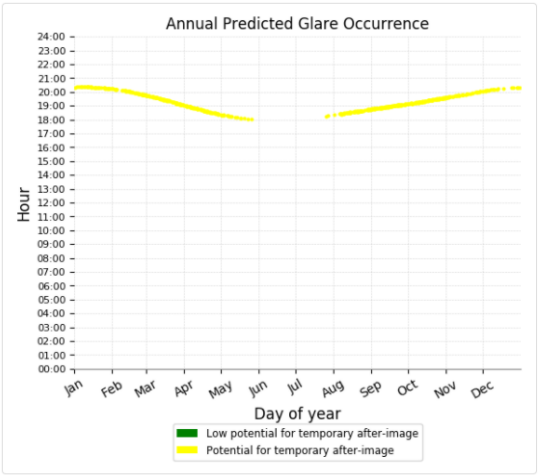


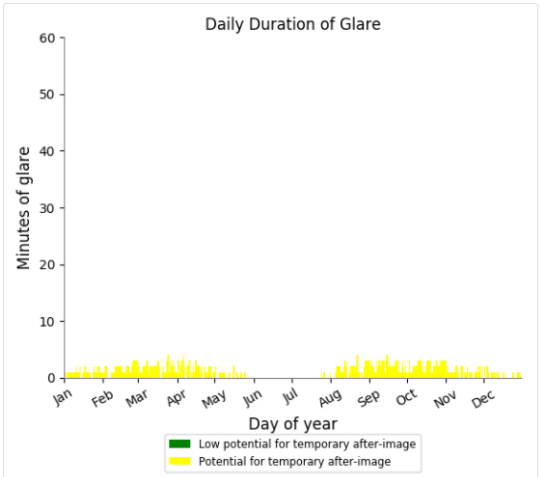


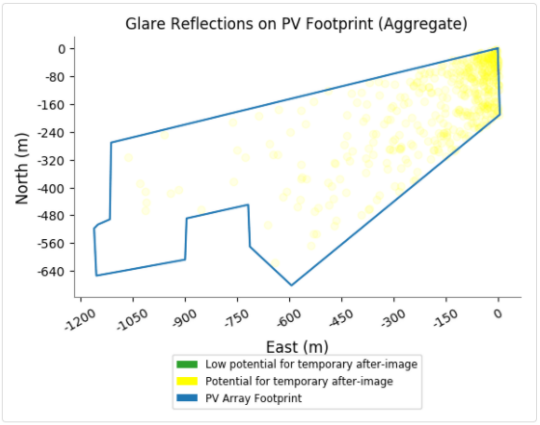
PV array 1 - OP Receptor (OP 24)

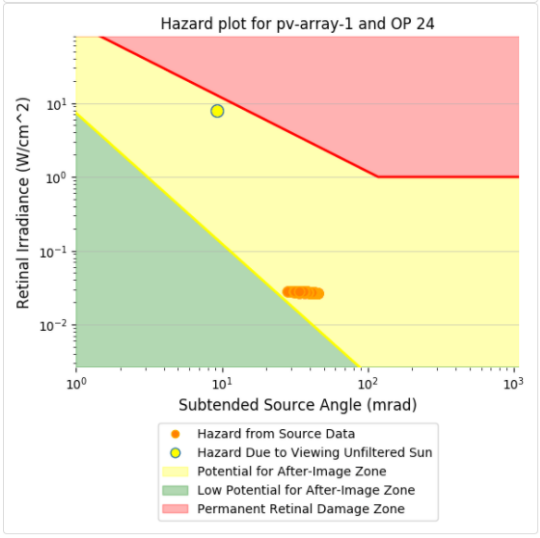
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 446 minutes of "yellow" glare with potential to cause temporary after-image.





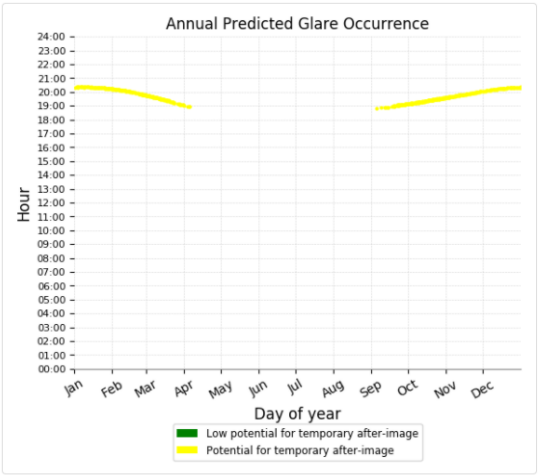


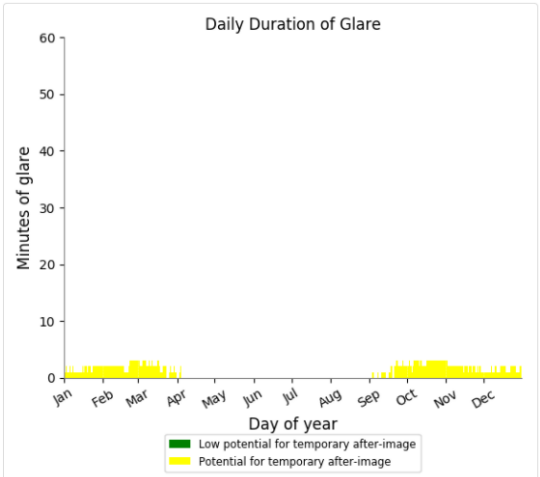


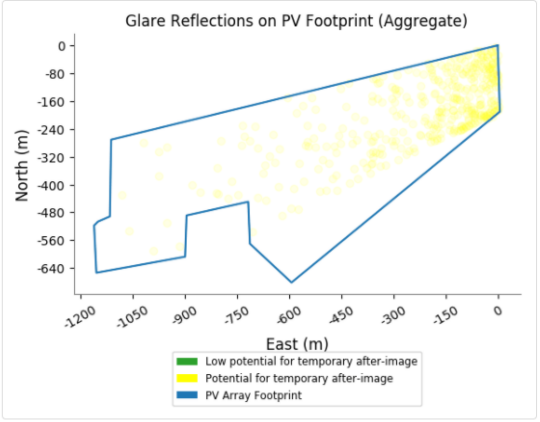
PV array 1 - OP Receptor (OP 25)

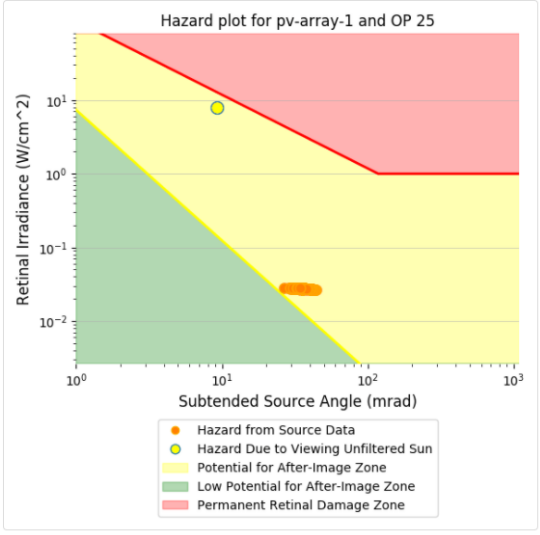
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 382 minutes of "yellow" glare with potential to cause temporary after-image.





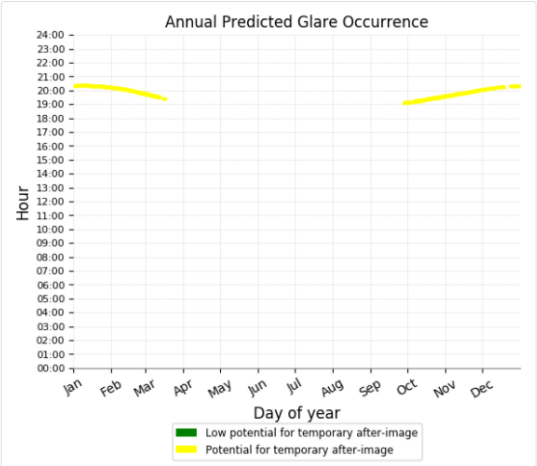


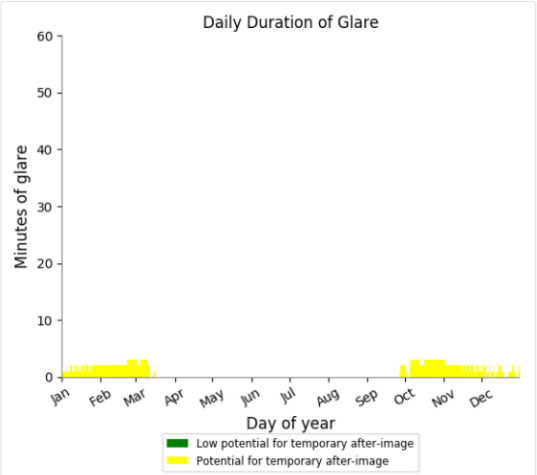


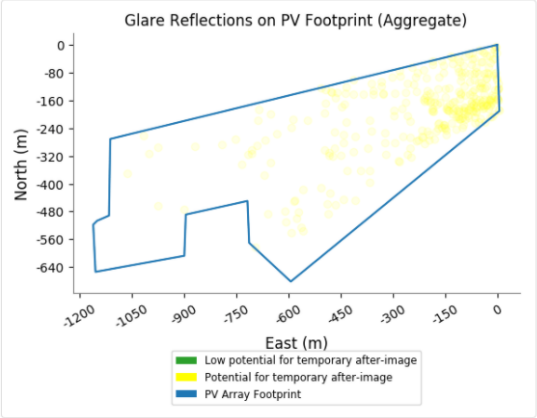
PV array 1 - OP Receptor (OP 26)

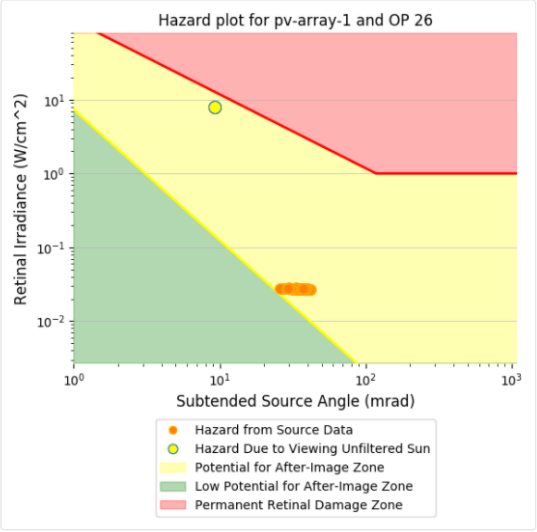
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 319 minutes of "yellow" glare with potential to cause temporary after-image.





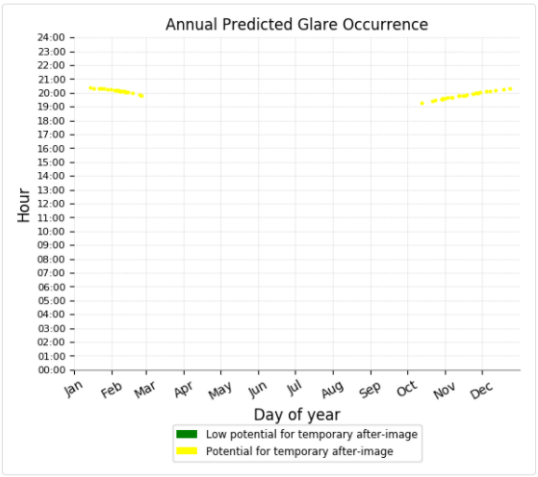


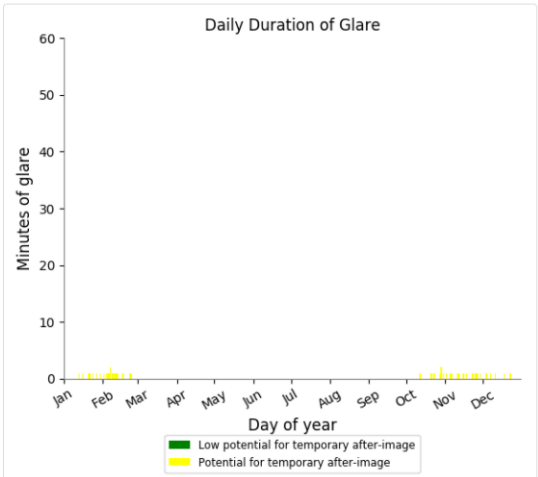


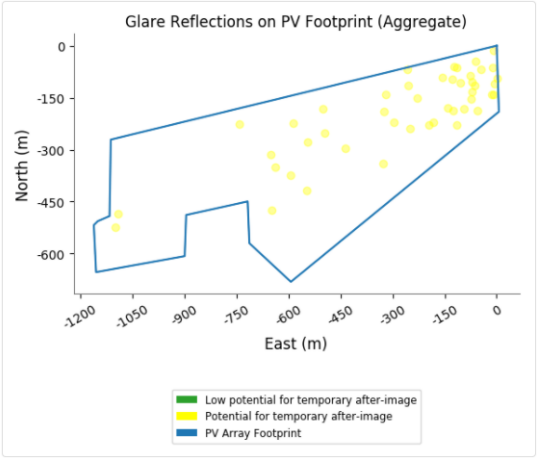
PV array 1 - OP Receptor (OP 27)

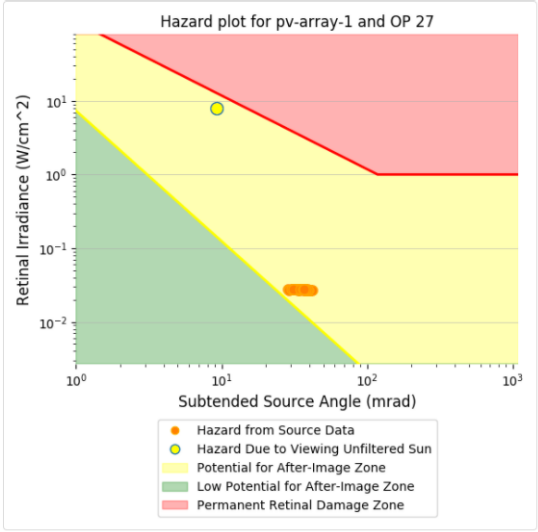
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 46 minutes of "yellow" glare with potential to cause temporary after-image.





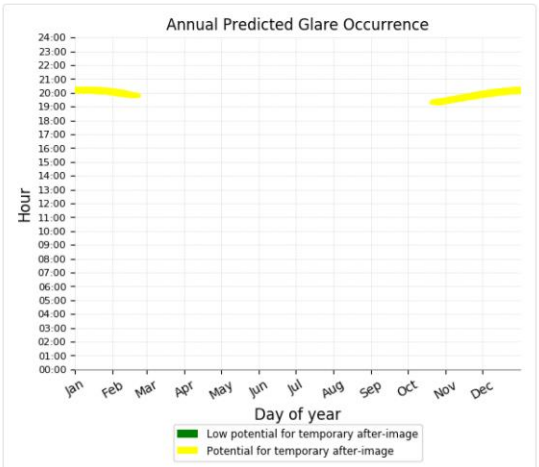


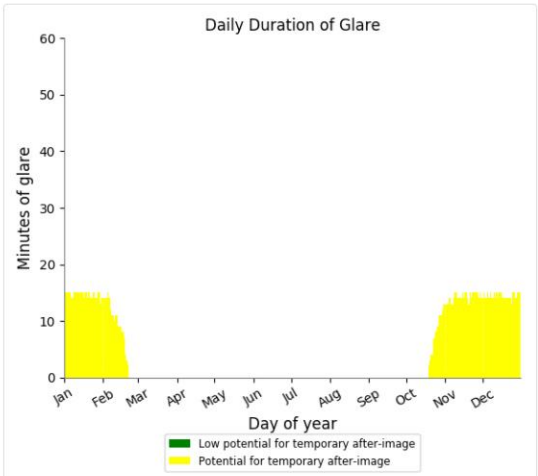


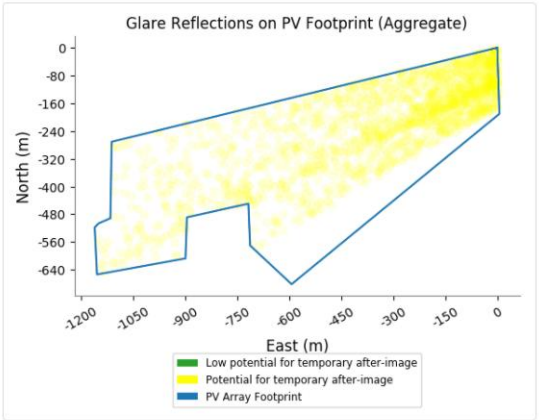
PV array 1 - OP Receptor (OP 28)

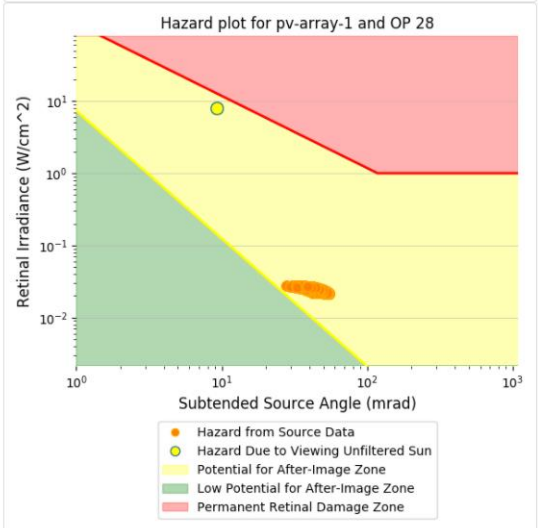
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,639 minutes of "yellow" glare with potential to cause temporary after-image.





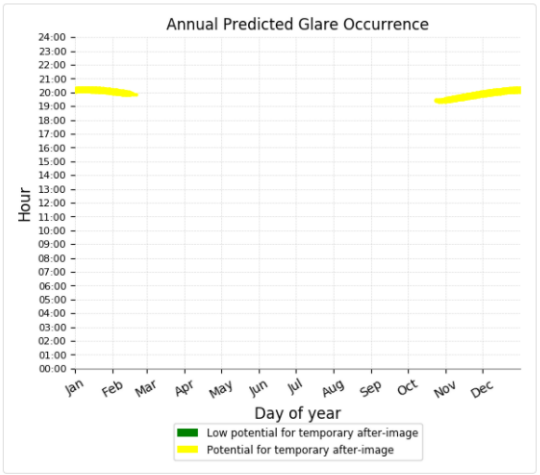


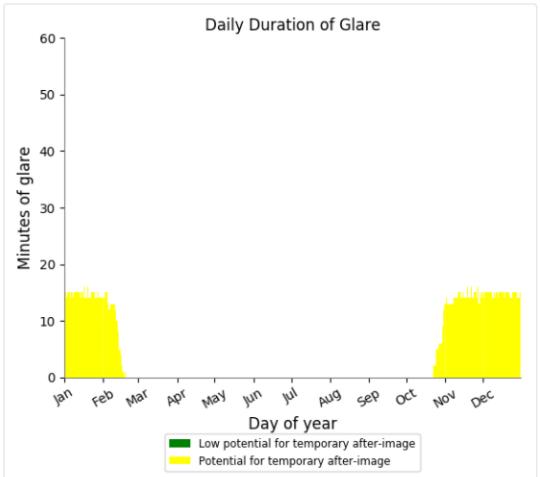


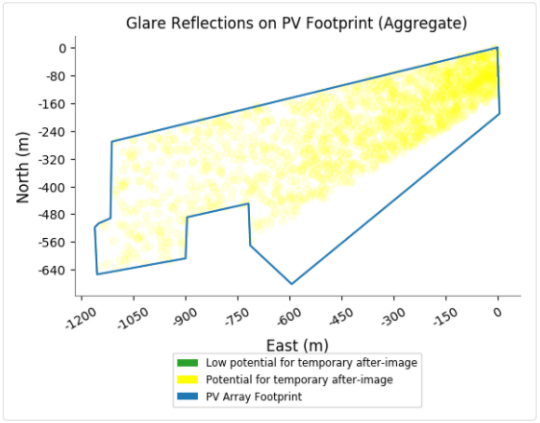
PV array 1 - OP Receptor (OP 29)

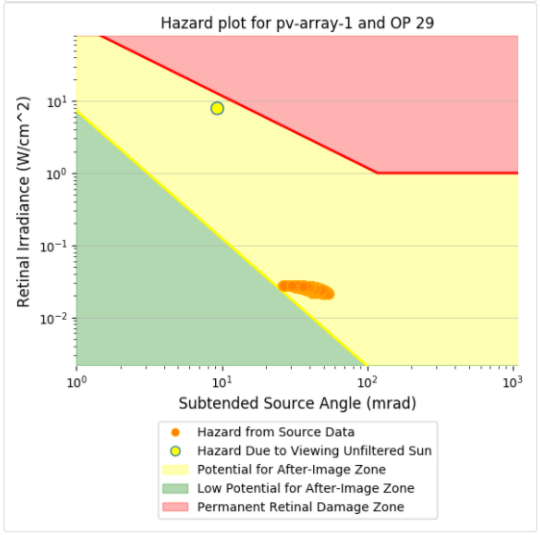
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,565 minutes of "yellow" glare with potential to cause temporary after-image.





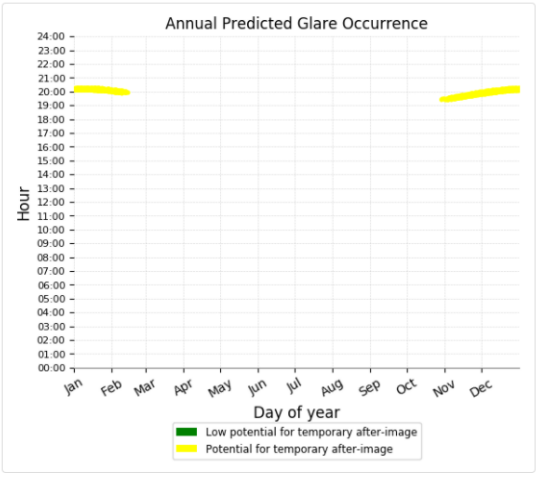


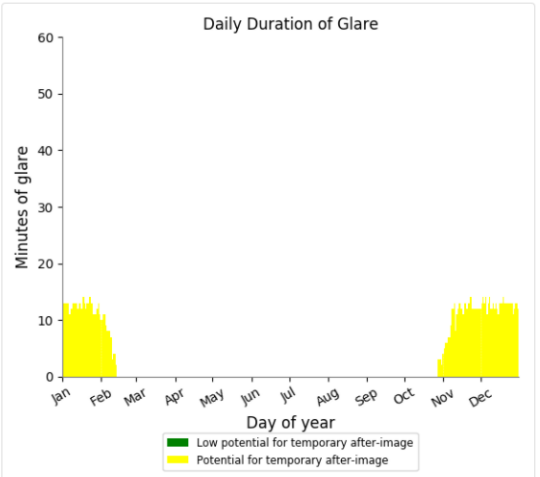


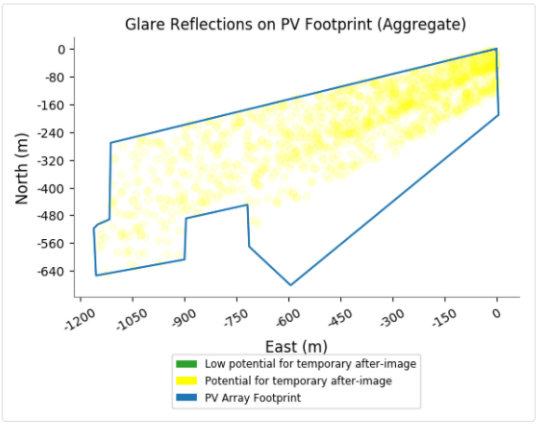
PV array 1 - OP Receptor (OP 30)

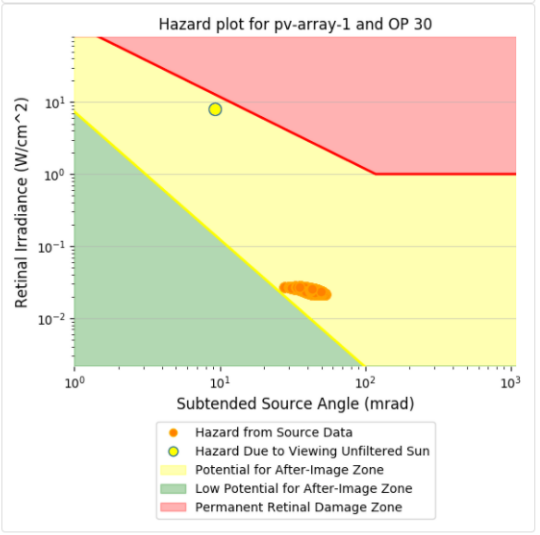
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,208 minutes of "yellow" glare with potential to cause temporary after-image.





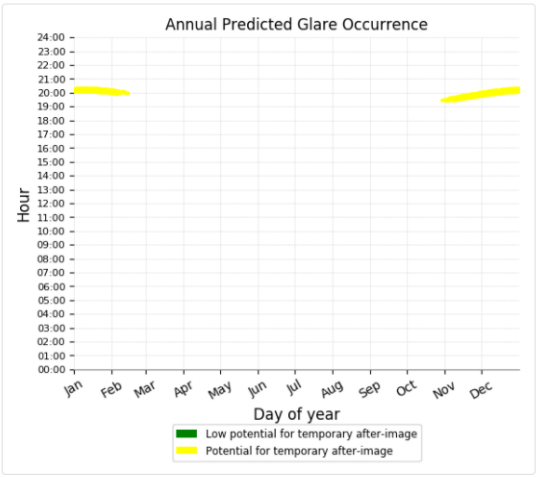


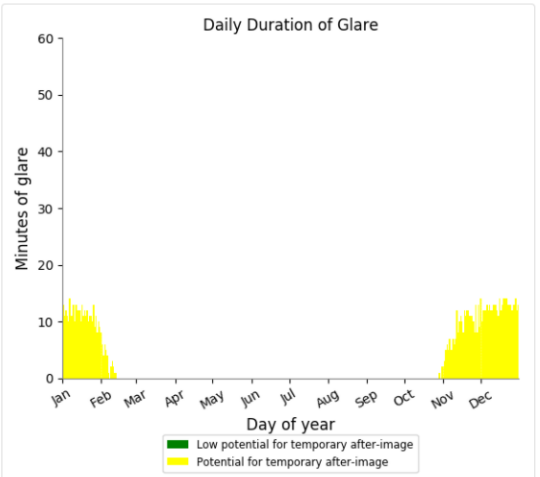


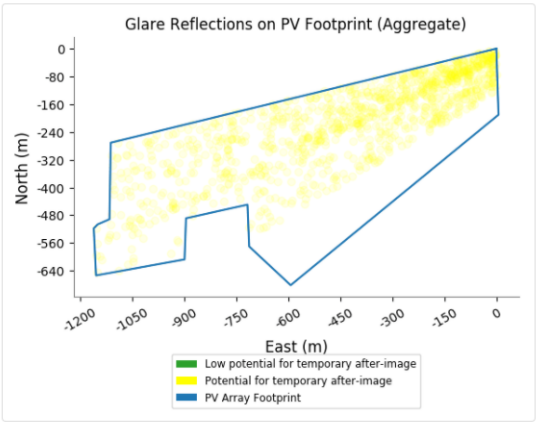
PV array 1 - OP Receptor (OP 31)

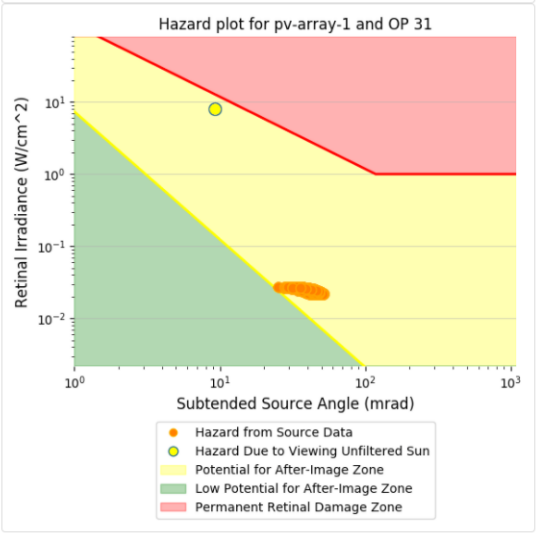
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,047 minutes of "yellow" glare with potential to cause temporary after-image.





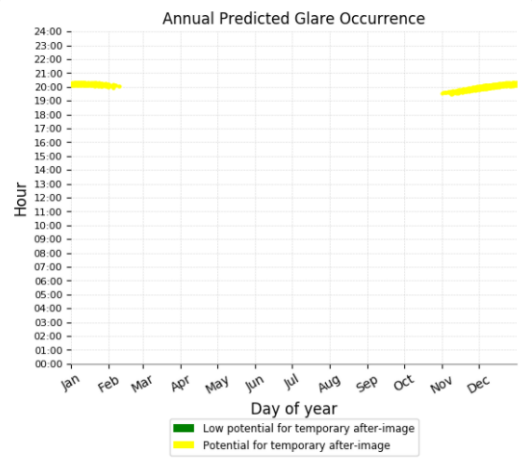


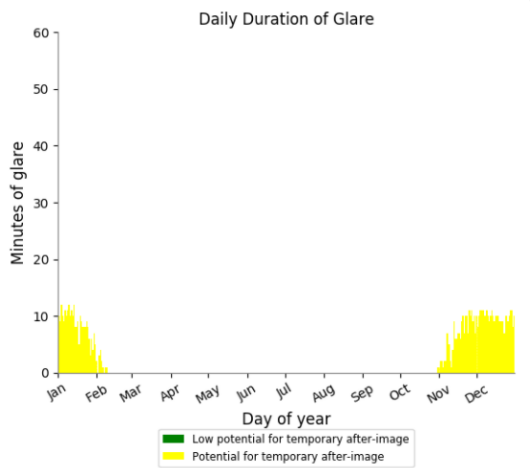


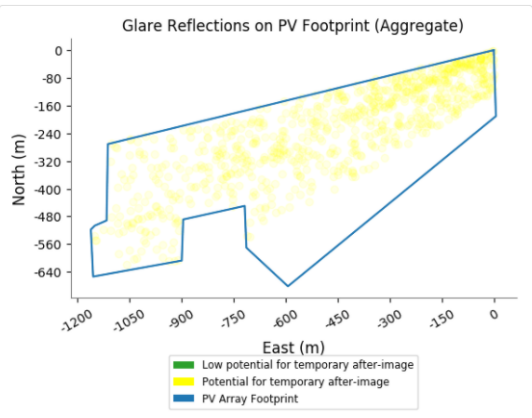
PV array 1 - OP Receptor (OP 32)

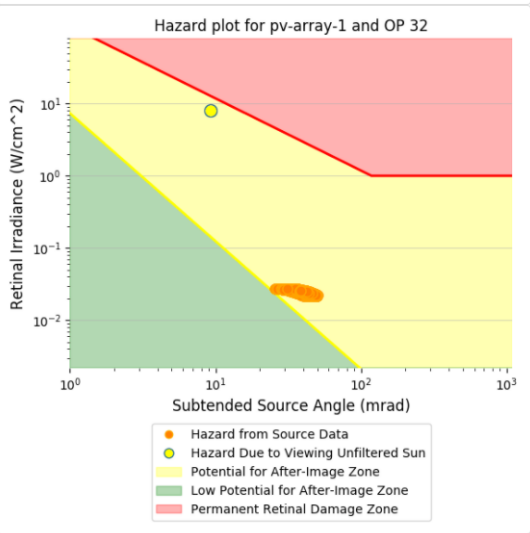
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 773 minutes of "yellow" glare with potential to cause temporary after-image.







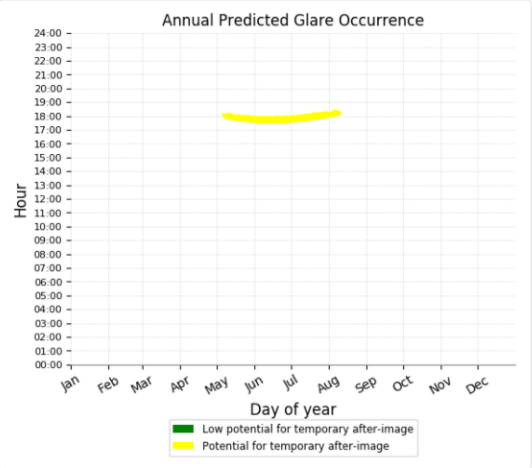


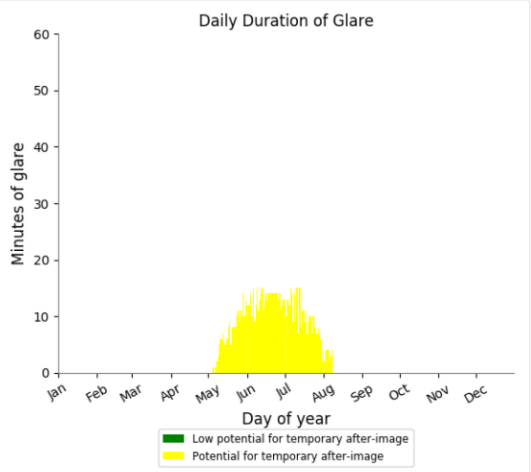
Train Driver Receptors

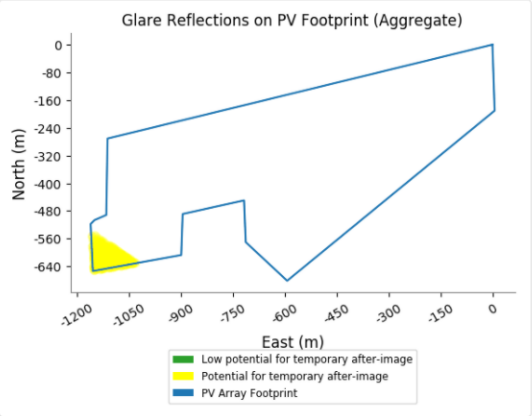
PV array 1 - OP Receptor (OP 6)

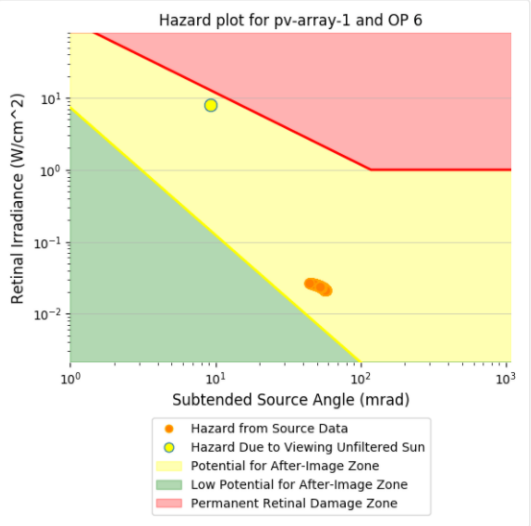
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 912 minutes of "yellow" glare with potential to cause temporary after-image.





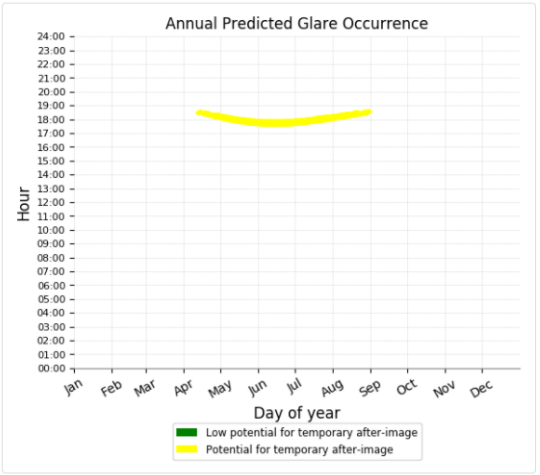


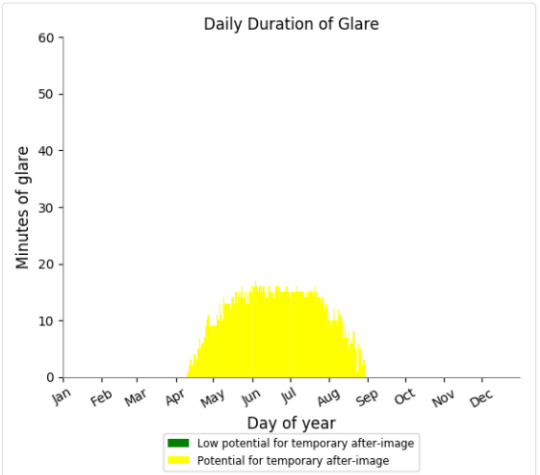


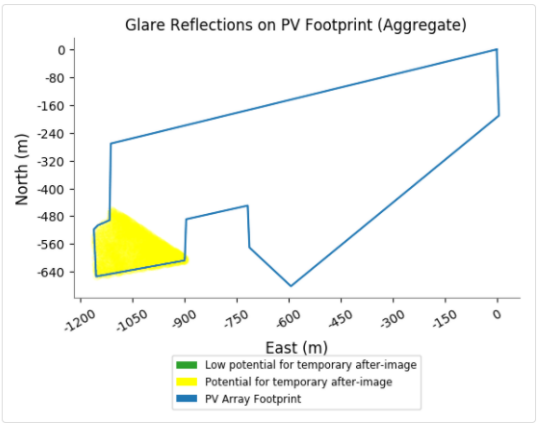
PV array 1 - OP Receptor (OP 7)

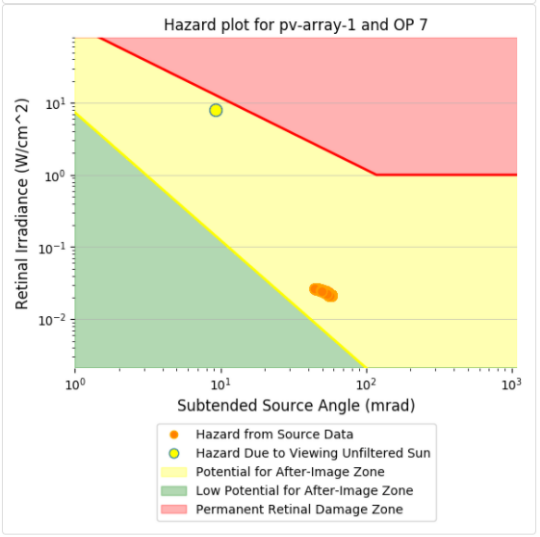
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,642 minutes of "yellow" glare with potential to cause temporary after-image.





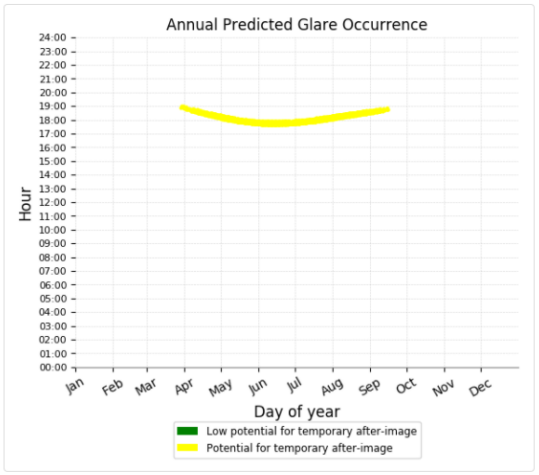


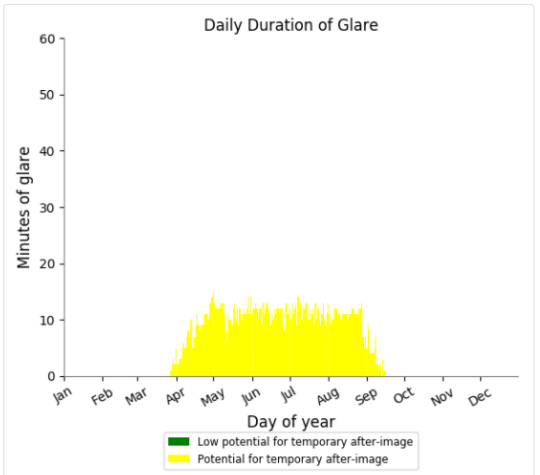


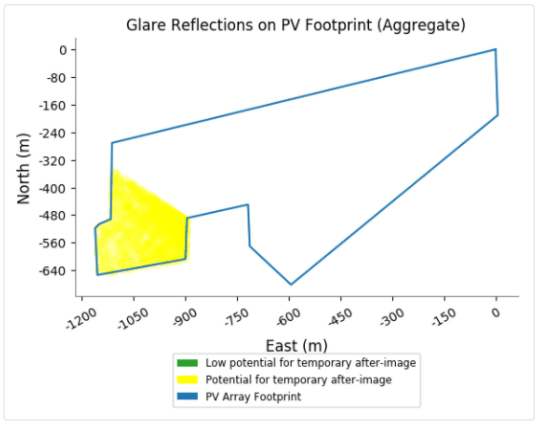
PV array 1 - OP Receptor (OP 8)

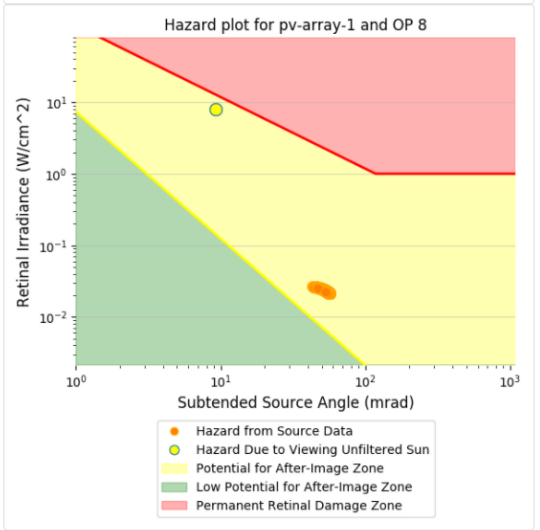
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,671 minutes of "yellow" glare with potential to cause temporary after-image.





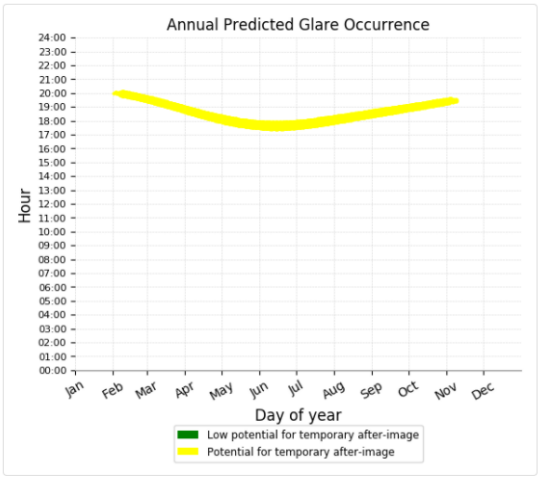


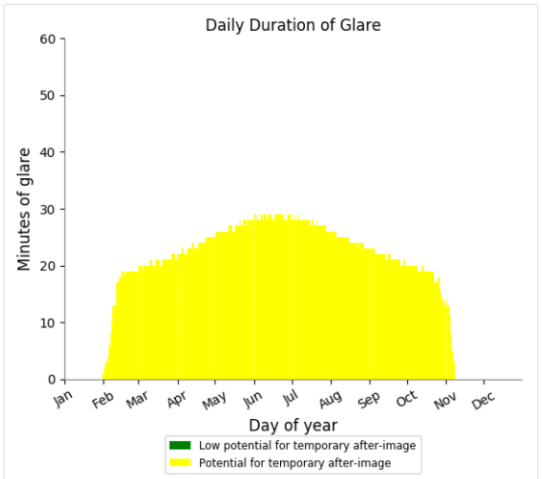


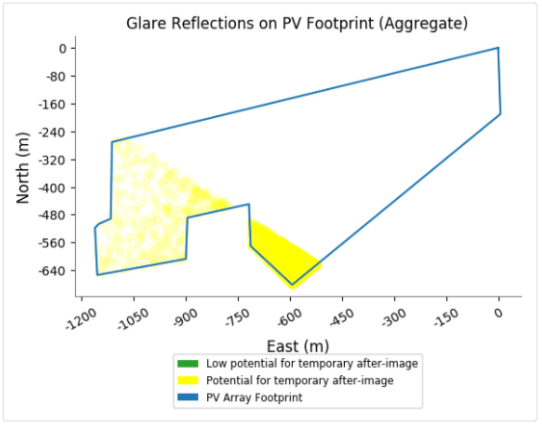
PV array 1 - OP Receptor (OP 9)

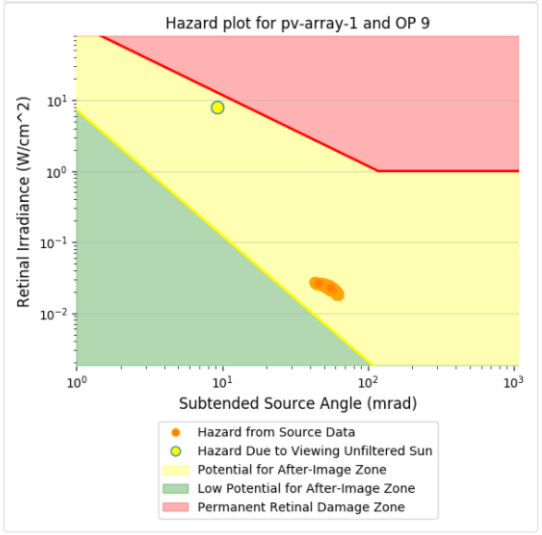
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 6,321 minutes of "yellow" glare with potential to cause temporary after-image.





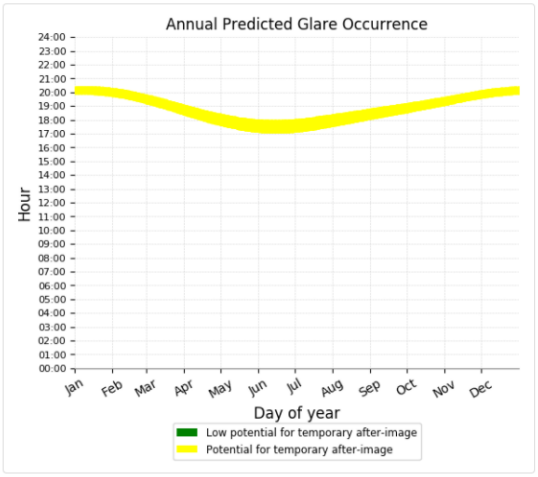


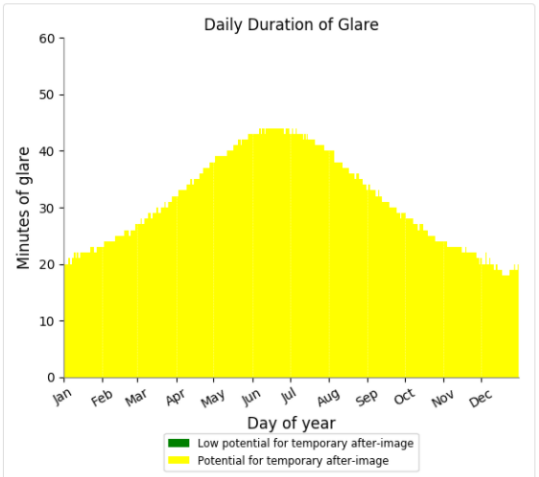


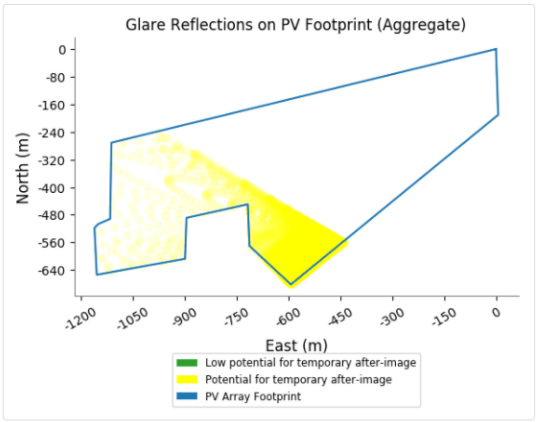
PV array 1 - OP Receptor (OP 10)

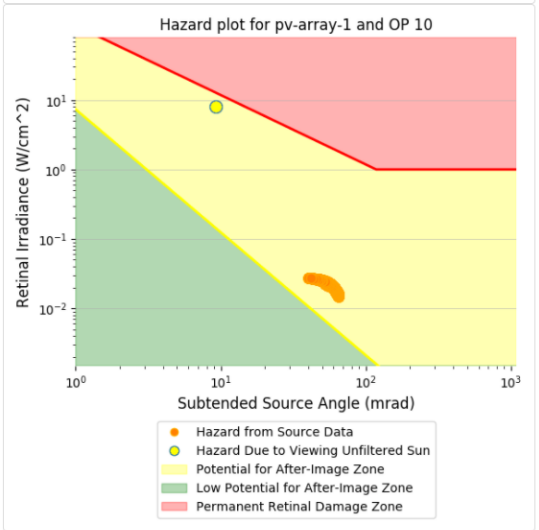
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 11,356 minutes of "yellow" glare with potential to cause temporary after-image.





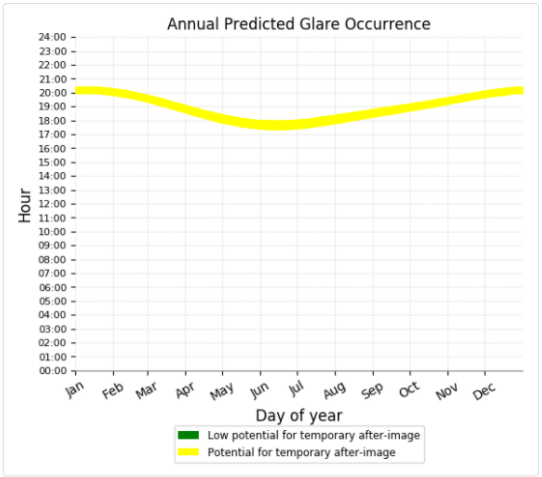


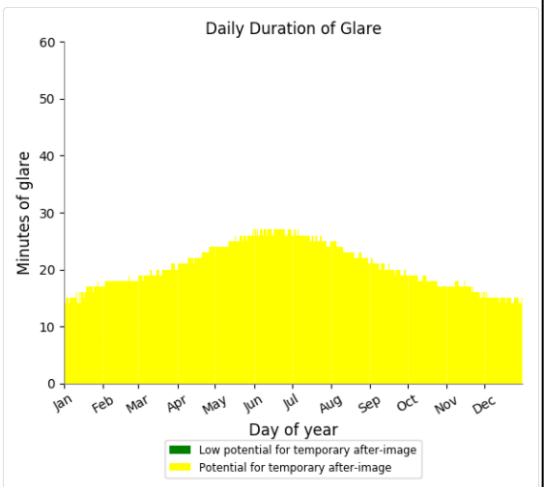


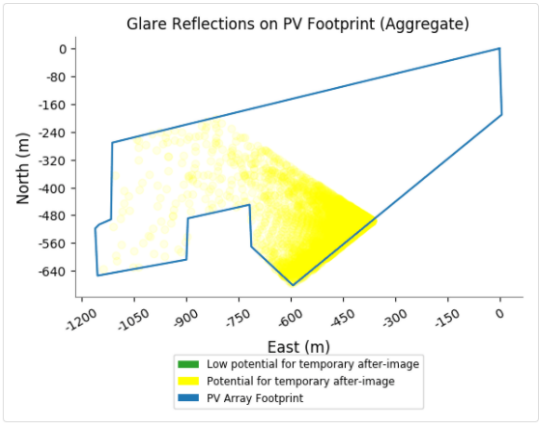
PV array 1 - OP Receptor (OP 11)

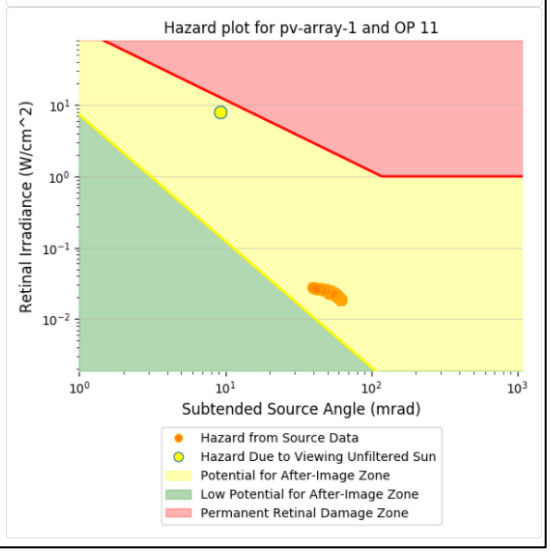
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 7,489 minutes of "yellow" glare with potential to cause temporary after-image.





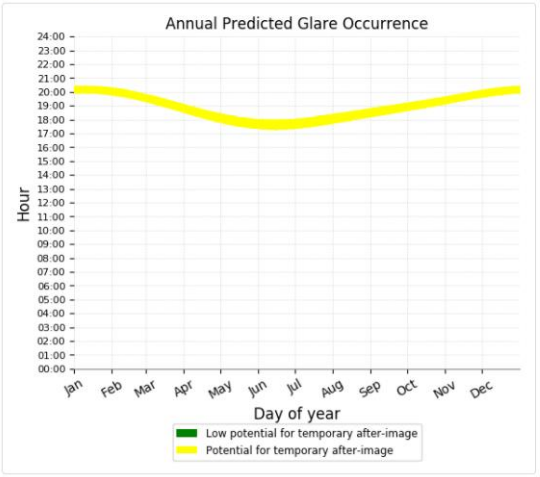


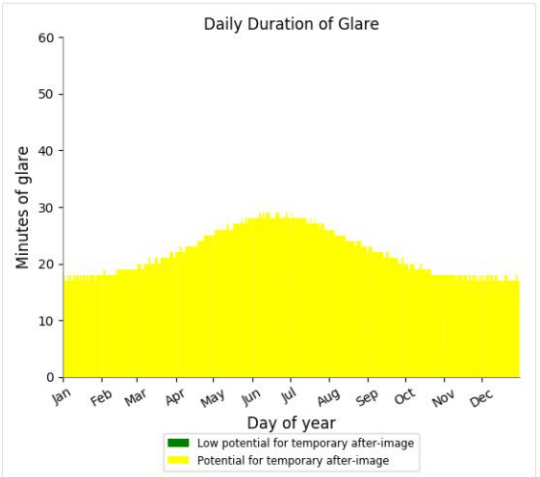


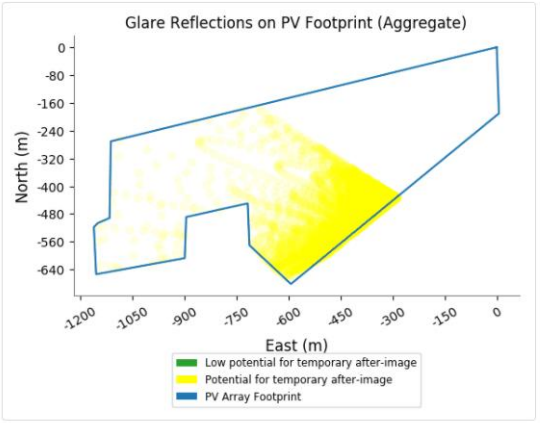
PV array 1 - OP Receptor (OP 12)

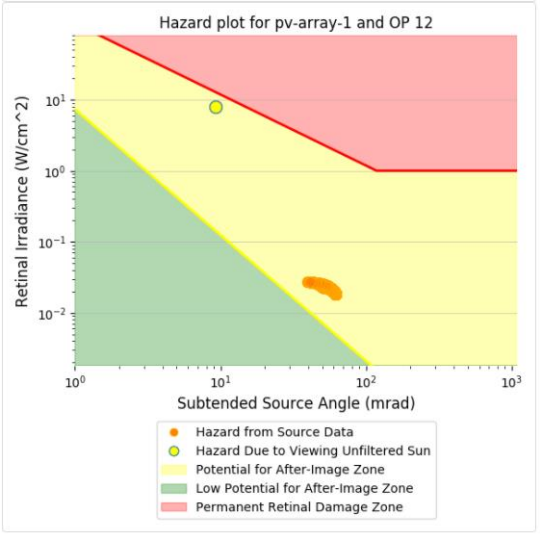
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 7,989 minutes of "yellow" glare with potential to cause temporary after-image.





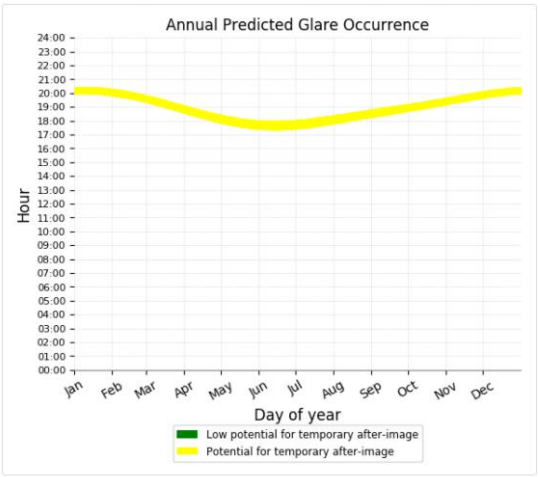


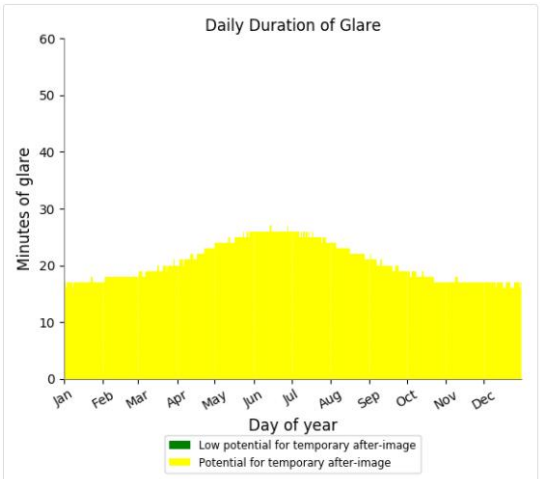


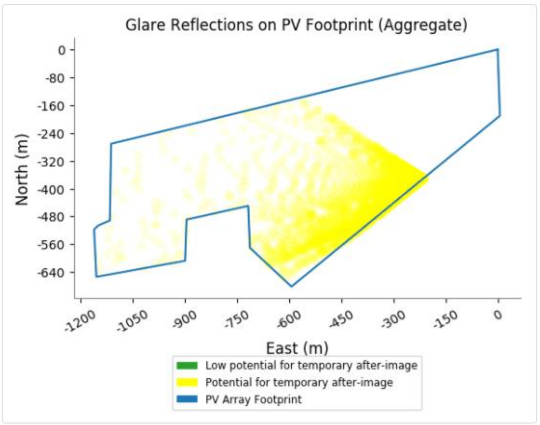
PV array 1 - OP Receptor (OP 13)

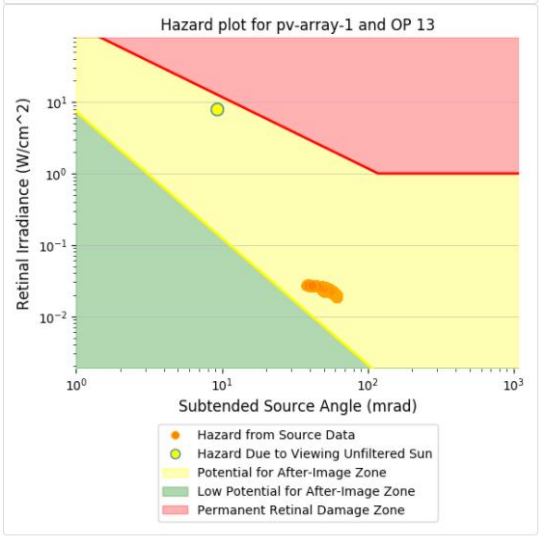
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 7,500 minutes of "yellow" glare with potential to cause temporary after-image.





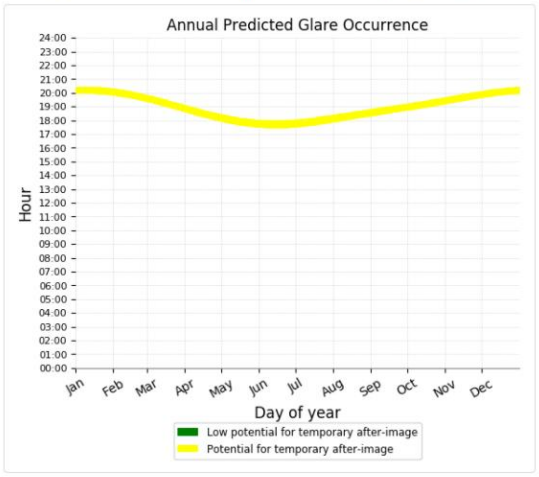


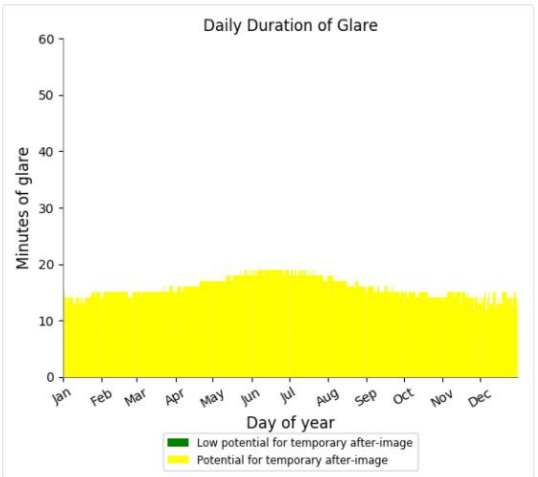


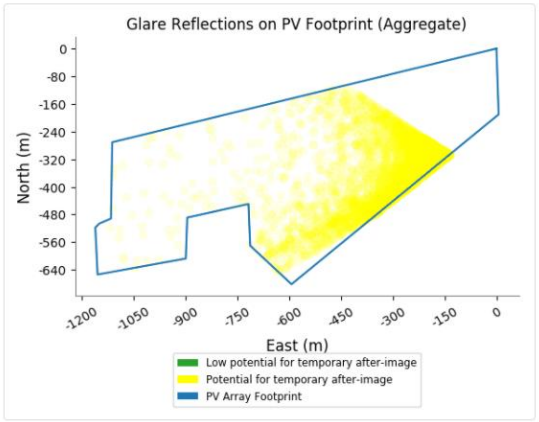
PV array 1 - OP Receptor (OP 14)

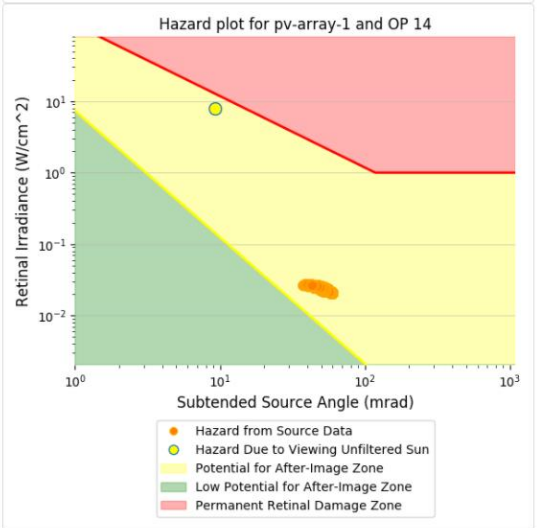
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 5,771 minutes of "yellow" glare with potential to cause temporary after-image.





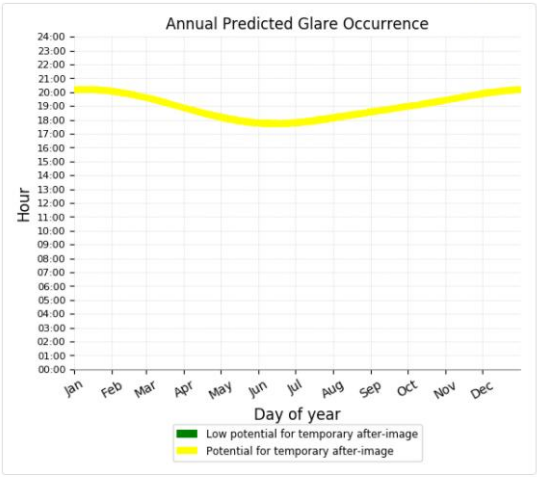


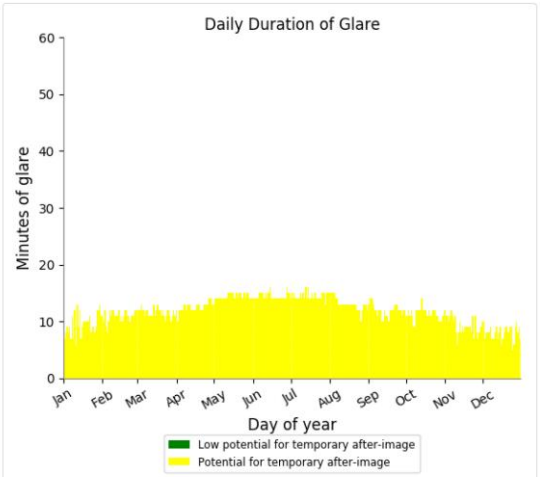


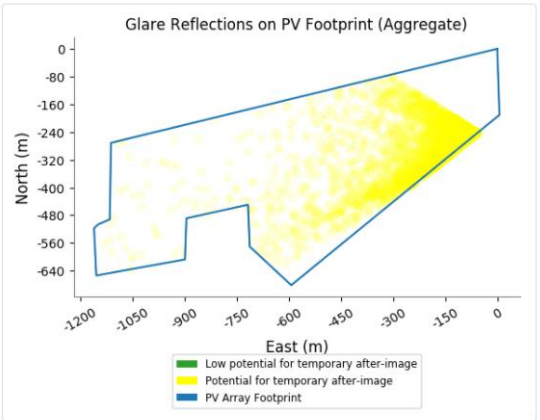
PV array 1 - OP Receptor (OP 15)

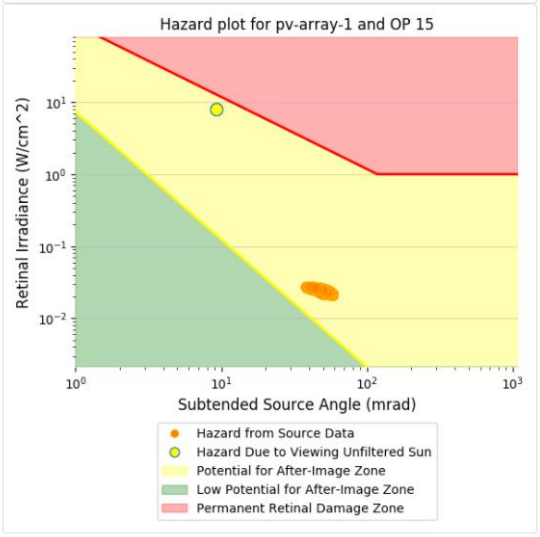
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 4,313 minutes of "yellow" glare with potential to cause temporary after-image.





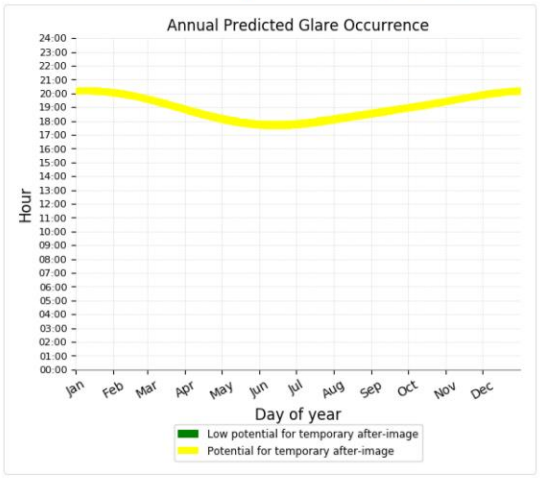


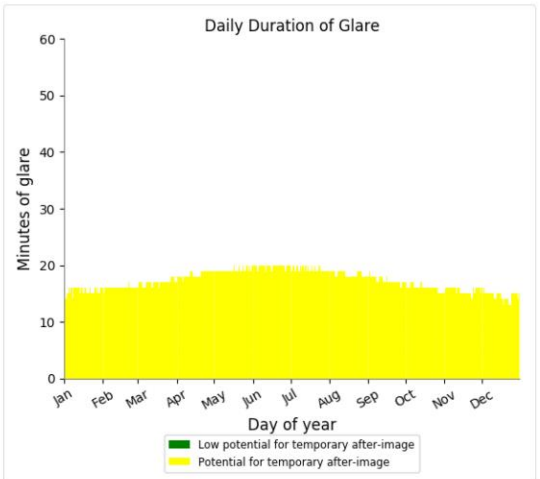


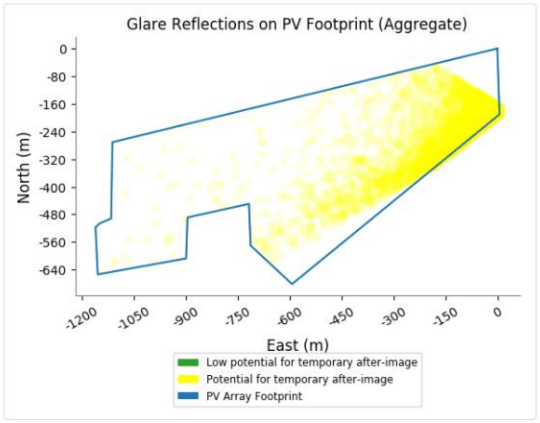
PV array 1 - OP Receptor (OP 16)

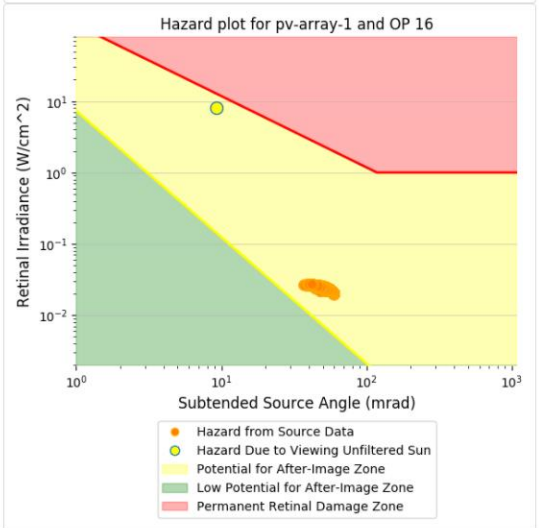
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 6,296 minutes of "yellow" glare with potential to cause temporary after-image.





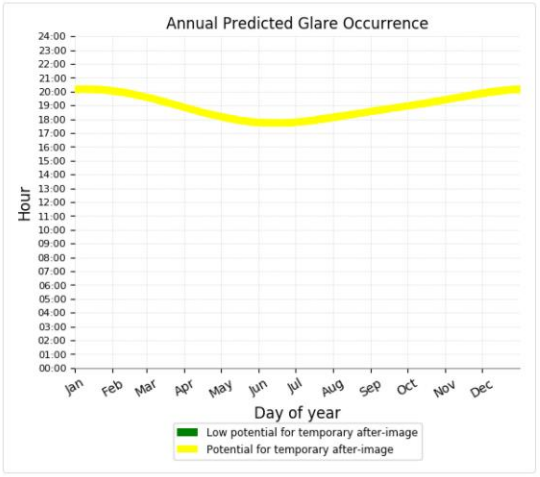


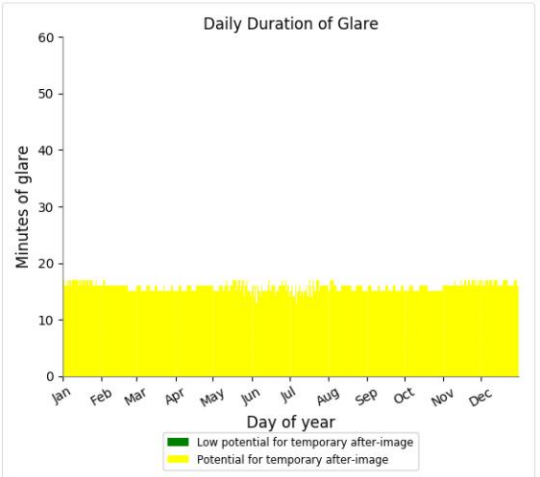


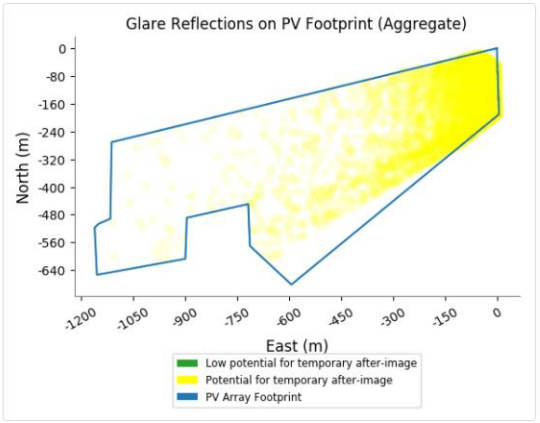
PV array 1 - OP Receptor (OP 17)

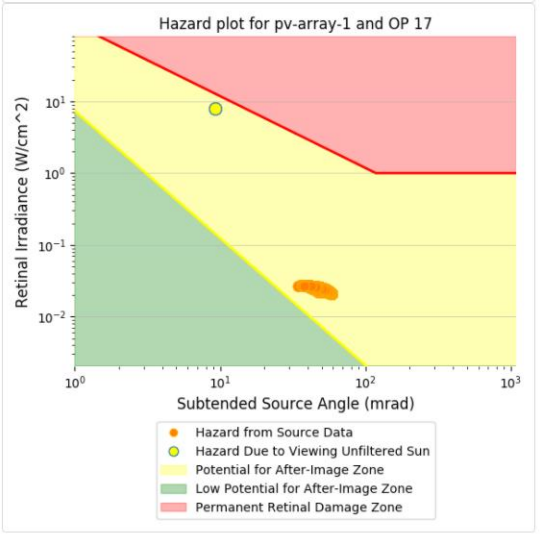
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 5,753 minutes of "yellow" glare with potential to cause temporary after-image.





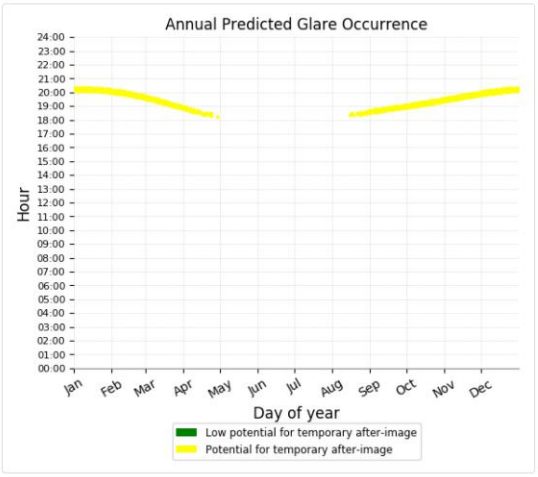


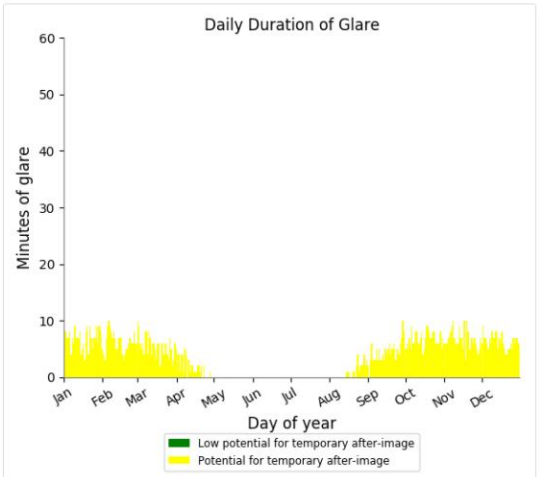


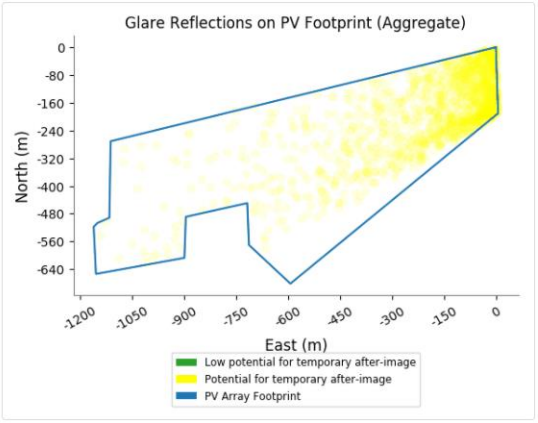
PV array 1 - OP Receptor (OP 18)

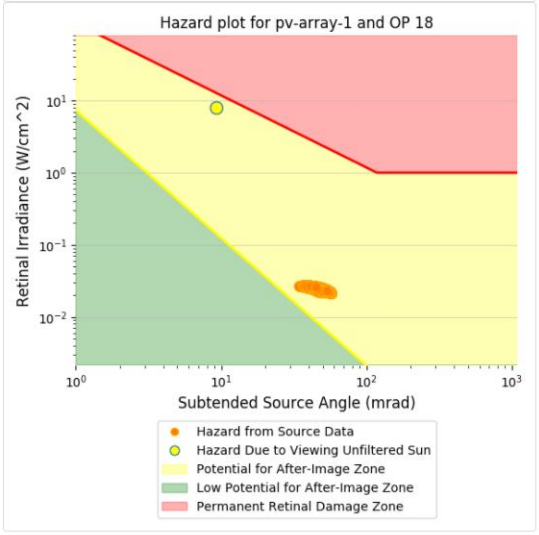
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,375 minutes of "yellow" glare with potential to cause temporary after-image.





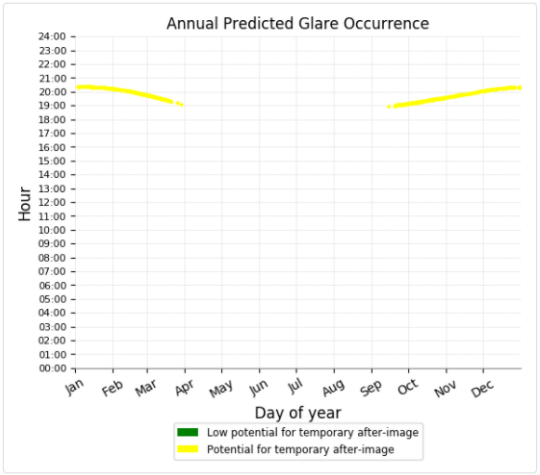


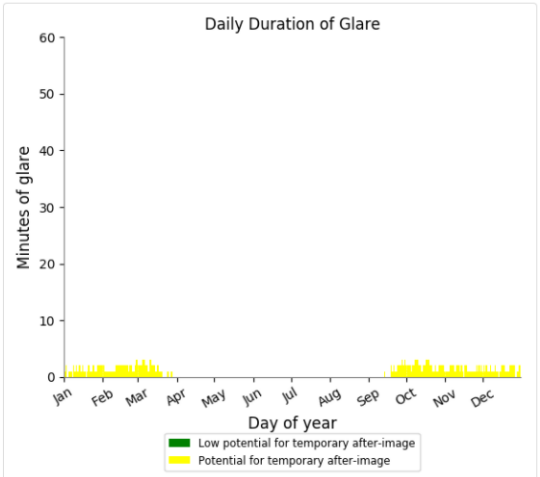


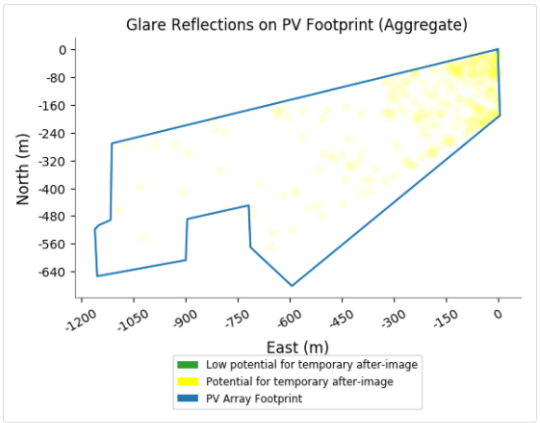
PV array 1 - OP Receptor (OP 19)

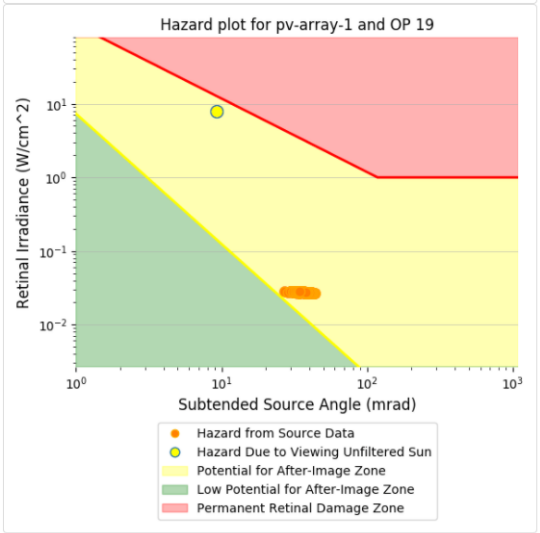
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 291 minutes of "yellow" glare with potential to cause temporary after-image.





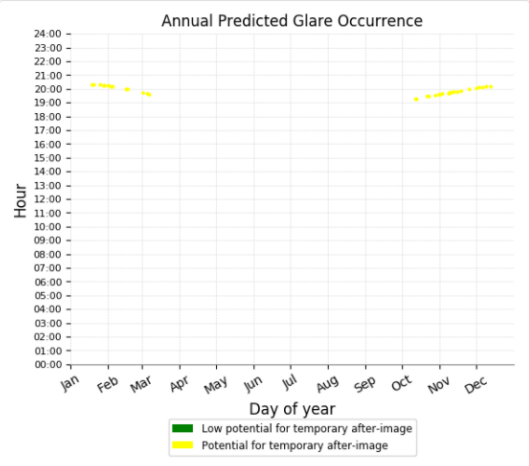


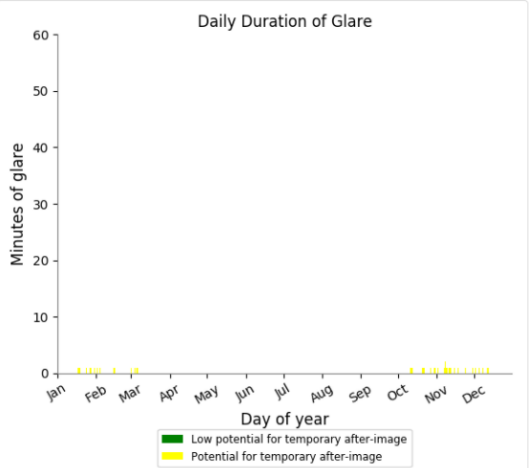


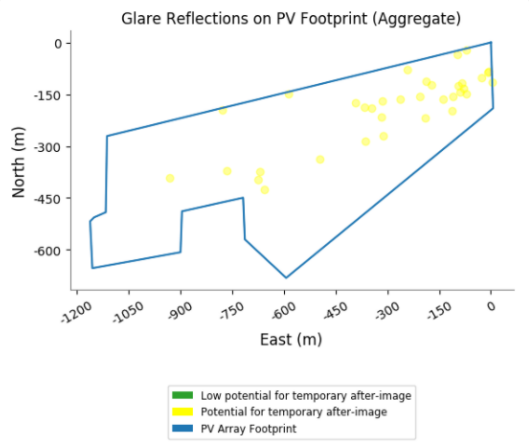
PV array 1 - OP Receptor (OP 20)

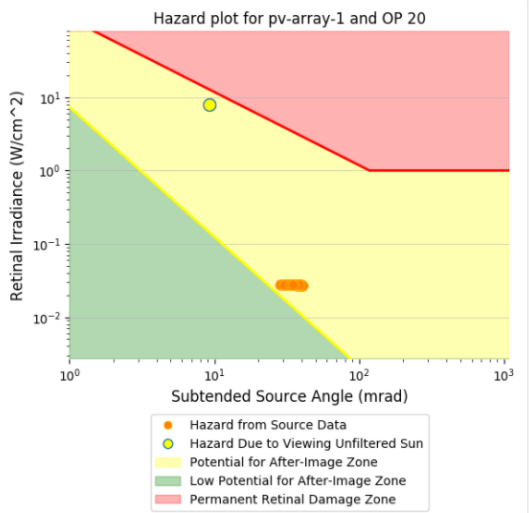
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 35 minutes of "yellow" glare with potential to cause temporary after-image.





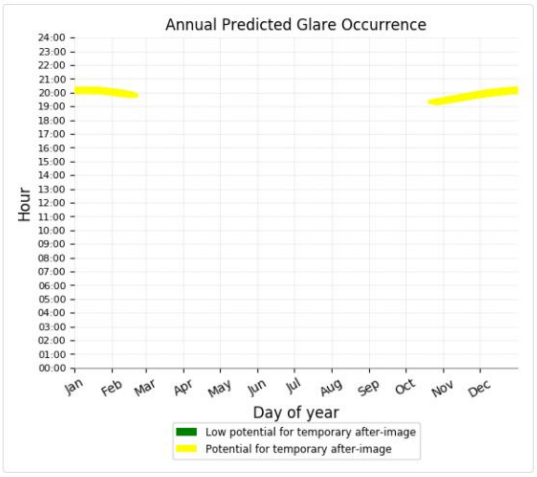


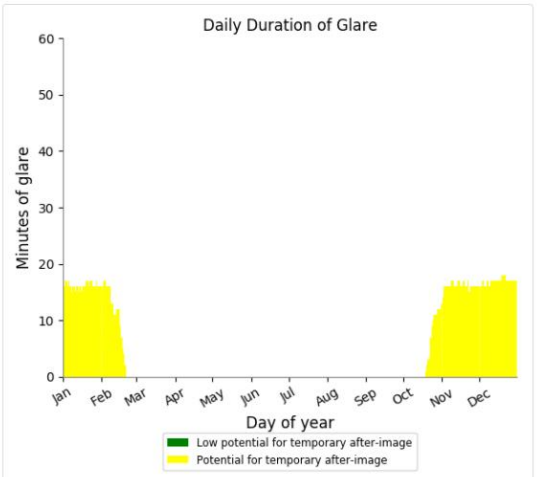


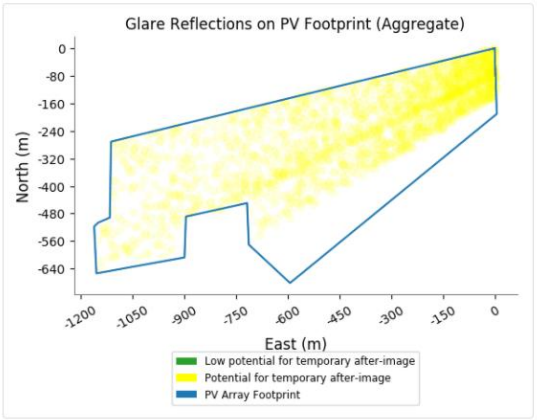
PV array 1 - OP Receptor (OP 21)

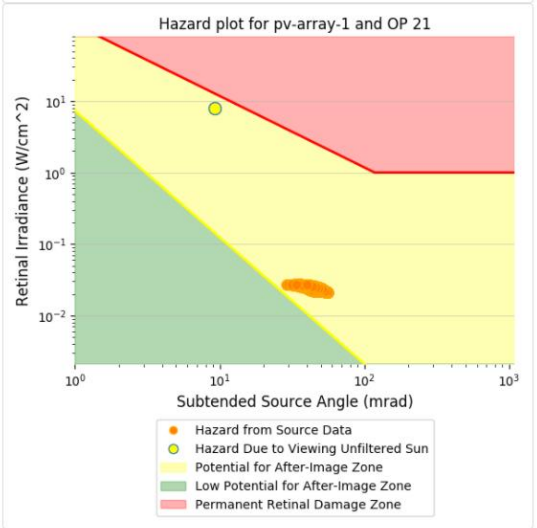
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 1,852 minutes of "yellow" glare with potential to cause temporary after-image.









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Addendum – Consideration of Alternative Resting Angles

NGH Consulting

Sandy Creek Solar Farm

August 2021







PLANNING SOLUTIONS FOR:

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ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	August 2021	Initial issue

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ADDENDUM – CONSIDERATION OF ALTERNATIVE RESTING ANGLES

Purpose of this Addendum

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development located north-east of Uranquinty in Australia. This document forms an addendum to the previously completed glint and glare assessment concerning the possible impact upon surrounding road users, dwellings, and railway operations and infrastructure. Additional modelling has been undertaken to investigate alternative resting angle scenarios using the previously modelled road and railway receptors.

Conclusions

Changing the resting angle to 5 degrees eliminates all possible glare towards the assessed road and railway sections[1]. In this scenario, no impacts are predicted and mitigation is not required.

Analysis

The resting angle of the solar panels when the sun is outside of the rotation range was previously modelled in the original study at 0° (sitting flat on the horizontal). This is generally considered to be the worst-scenario for glare in the early morning and late evening, when the sun is low in the sky beyond the reflecting panels. This was particularly significant in the original study because all solar reflections that were geometrically possible were in the evening.

In this study, further modelling has been undertaken, increasing the resting angle at intervals of 1°, until no glare was geometrically possible towards the receptors. The originally modelled road receptors and railway receptors were carried forward.

[1] Confirmed by both Pager Power and Forge models.

Geometric Calculation Results Overview

Table 1 below presents the results of the Pager Power and Forge analysis.

Resting angle (°)	Pager Power Results		Forge Results		Comments
	Reflection possible? (AEST[2])		Reflection possible? (AEST[2])		
	Road	Railway	Road	Railway	
0	Yes.	Yes.	Yes.	Yes.	Solar reflections are geometrically possible towards the assessed road and railway according to both models.
1	Yes.	Yes.	Yes.	Yes.	Solar reflections are geometrically possible towards the assessed road and railway according to both models.
2	No.	Yes.	Yes.	Yes.	Solar reflections are geometrically possible towards the assessed road according to Forge only. Solar reflections are geometrically possible towards the assessed railway according to both models.
3	No.	Yes.	No.	Yes.	Solar reflections are not geometrically possible towards the assessed road according to both models. Solar reflections are geometrically possible towards the assessed railway according to both models.
4	No.	Yes.	No.	Yes.	Solar reflections are not geometrically possible towards the assessed road according to both models. Solar reflections are geometrically possible towards the assessed railway according to both models.

[2] Modelling was run in AEST but conclusions for AEDT would be the same; only the glare curves would shift one hour in accordance with sunset and sunrise times shifting by one hour.

Resting angle (°)	Pager Power Results		Forge Results		Comments
	Reflection possible? (AEST[2])		Reflection possible? (AEST[2])		
	Road	Railway	Road	Railway	
5	No.	No.	No.	No.	**Solar reflections are not geometrically possible towards the assessed road and railway according to both models.**

Table 1 *Geometric analysis results – road and railway receptors*

Table 1 shows that 5° is the minimum resting angle that would eliminate all possible glare according to both models.

The small difference between the results of the two models could be due to:

- Forge accounts for the solar panel's diffusivity while the Pager Power model does not.
- Forge uses SRTM data to calculate terrain height while the Pager Power model uses OS Panorama 50m DTM.
- Differences in the geometric model of the Sun and glare produced by the solar panels.

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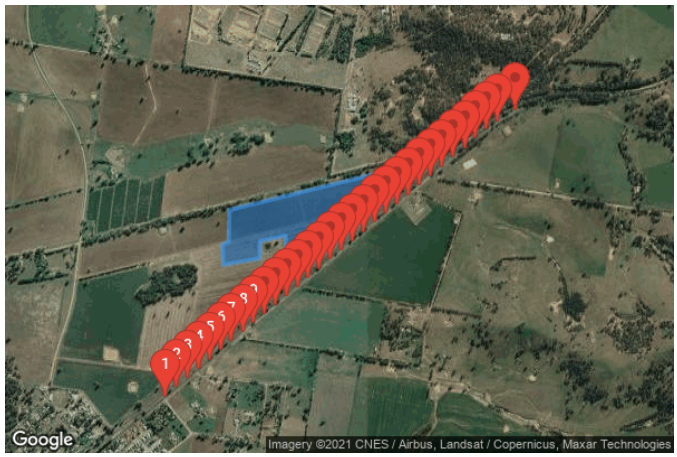
ForgeSolar

10333A - Sandy Creek Solar Farm

Roads 5 deg rest

Created Aug. 23, 2021
Updated Aug. 23, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 57742.8862

Project type V1
Project status: active



Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:
- Observation point: **Version 1**
- 2-Mile Flight Path: **Version 1**
- Route: **Version 1**

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 409,350 m^2

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 5.0 deg
Footprint area: 409,350 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad



Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-35.172240	147.272229	228.97	2.15	231.12
2	-35.174684	147.260027	215.42	2.15	217.57
3	-35.176672	147.259986	211.49	2.15	213.64
4	-35.176805	147.259613	211.65	2.15	213.80
5	-35.176907	147.259489	212.16	2.15	214.31
6	-35.178130	147.259561	215.79	2.15	217.94
7	-35.177713	147.262361	218.97	2.15	221.12
8	-35.176646	147.262408	216.88	2.15	219.03
9	-35.176292	147.264354	221.06	2.15	223.21
10	-35.177379	147.264408	220.95	2.15	223.10
11	-35.178382	147.265721	224.33	2.15	226.48
12	-35.173957	147.272300	231.08	2.15	233.23

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	-35.186403	147.255107	211.16	1.50	212.66
OP 2	-35.185823	147.255966	211.94	1.50	213.44
OP 3	-35.185250	147.256812	212.97	1.50	214.47
OP 4	-35.184650	147.257696	215.85	1.50	217.35
OP 5	-35.184094	147.258516	218.11	1.50	219.61
OP 6	-35.183517	147.259383	220.00	1.50	221.50
OP 7	-35.182957	147.260216	220.16	1.50	221.66
OP 8	-35.182386	147.261108	221.00	1.50	222.50
OP 9	-35.181822	147.261932	222.11	1.50	223.61
OP 10	-35.181266	147.262773	223.42	1.50	224.92
OP 11	-35.180682	147.263615	224.19	1.50	225.69
OP 12	-35.180138	147.264436	224.69	1.50	226.19
OP 13	-35.179531	147.265294	225.56	1.50	227.06
OP 14	-35.178992	147.266114	225.93	1.50	227.43
OP 15	-35.178407	147.266974	227.34	1.50	228.84
OP 16	-35.177826	147.267851	228.94	1.50	230.44
OP 17	-35.177253	147.268703	228.83	1.50	230.33
OP 18	-35.176656	147.269575	230.44	1.50	231.94
OP 19	-35.176090	147.270419	230.99	1.50	232.49
OP 20	-35.175506	147.271279	231.05	1.50	232.55
OP 21	-35.174954	147.272102	231.32	1.50	232.82
OP 22	-35.174362	147.272965	232.81	1.50	234.31
OP 23	-35.173790	147.273843	234.12	1.50	235.62
OP 24	-35.173189	147.274701	234.67	1.50	236.17
OP 25	-35.172615	147.275545	234.79	1.50	236.29
OP 26	-35.172029	147.276431	234.73	1.50	236.23
OP 27	-35.171446	147.277292	237.73	1.50	239.23
OP 28	-35.170852	147.278170	241.30	1.50	242.80
OP 29	-35.170240	147.279018	243.99	1.50	245.49
OP 30	-35.169677	147.279838	243.90	1.50	245.40
OP 31	-35.169161	147.280736	244.02	1.50	245.52
OP 32	-35.168506	147.282059	245.96	1.50	247.46

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0
OP: OP 22	0	0
OP: OP 23	0	0
OP: OP 24	0	0
OP: OP 25	0	0
OP: OP 26	0	0
OP: OP 27	0	0
OP: OP 28	0	0
OP: OP 29	0	0
OP: OP 30	0	0
OP: OP 31	0	0
OP: OP 32	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results fo large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

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10333A - Sandy Creek Solar Farm

Train Drivers 5 deg rest

Created Aug. 23, 2021
Updated Aug. 25, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 57741.8862

Project type V1
Project status: active



Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:
- Observation point: **Version 1**
- 2-Mile Flight Path: **Version 1**
- Route: **Version 1**

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 409,350 m^2

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 5.0 deg
Footprint area: 409,350 m^2
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad



Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-35.172240	147.272229	228.97	2.15	231.12
2	-35.174684	147.260027	215.42	2.15	217.57
3	-35.176672	147.259986	211.49	2.15	213.64
4	-35.176805	147.259613	211.65	2.15	213.80
5	-35.176907	147.259489	212.16	2.15	214.31
6	-35.178130	147.259561	215.79	2.15	217.94
7	-35.177713	147.262361	218.97	2.15	221.12
8	-35.176646	147.262408	216.88	2.15	219.03
9	-35.176292	147.264354	221.06	2.15	223.21
10	-35.177379	147.264408	220.95	2.15	223.10
11	-35.178382	147.265721	224.33	2.15	226.48
12	-35.173957	147.272300	231.08	2.15	233.23

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	-35.182622	147.260155	219.62	2.75	222.37
OP 2	-35.182071	147.260980	220.74	2.75	223.49
OP 3	-35.181500	147.261816	222.24	2.75	224.99
OP 4	-35.180945	147.262641	223.00	2.75	225.75
OP 5	-35.180366	147.263498	224.02	2.75	226.77
OP 6	-35.179787	147.264355	224.92	2.75	227.67
OP 7	-35.179213	147.265214	225.22	2.75	227.97
OP 8	-35.178663	147.266036	225.35	2.75	228.10
OP 9	-35.178080	147.266900	226.93	2.75	229.68
OP 10	-35.177508	147.267745	229.74	2.75	232.49
OP 11	-35.176924	147.268600	228.50	2.75	231.25
OP 12	-35.176355	147.269440	229.62	2.75	232.37
OP 13	-35.175795	147.270284	230.30	2.75	233.05
OP 14	-35.175223	147.271147	230.31	2.75	233.06
OP 15	-35.174639	147.272006	230.82	2.75	233.57
OP 16	-35.174062	147.272841	232.51	2.75	235.26
OP 17	-35.173466	147.273718	233.81	2.75	236.56
OP 18	-35.172892	147.274585	233.62	2.75	236.37
OP 19	-35.172322	147.275443	233.73	2.75	236.48
OP 20	-35.171757	147.276298	235.00	2.75	237.75
OP 21	-35.170897	147.277536	241.68	2.75	244.43

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results fo large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

NGH Consulting

Sandy Creek Solar Farm

October 2021



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ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	October 2021	Initial issue

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development located north-east of Uranquinty in Australia. This glint and glare assessment concerns the possible impact upon surrounding local roads users, and activity at Connorton Model Airfield (Wagga Model Aero Club).

Pager Power

Pager Power has undertaken over 700 glint and glare assessments internationally. The company's own glint and glare guidance is based on industry experience and extensive consultation with industry stakeholders, including airports and aviation regulators.

Conclusions

Reflections are geometrically possible towards some of the local road receptors at certain times of the year. These reflections have been evaluated with reference to the Victoria State Government guidelines for solar developments, along with industry best-practice and experience. There are sufficient mitigating factors in place such that no further mitigation requirement has been identified.

Guidance and Studies

The Department of Environment, Land, Water and Planning in the Victoria State Government has created its own set of guidelines for the design and development of solar energy facilities, including a methodology for determining the impact upon road safety[1]. This set of guidelines was reviewed in the context of the proposed development.

Guidelines also exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. However, a specific methodology for determining the impact upon road safety and model aircraft activity has not been identified to date. Pager Power has consulted with relevant stakeholders and reviewed existing guidelines and the available studies (discussed below) in the process of defining its own glint and glare assessment guidance and methodology[2]. This methodology defines the process for determining the impact upon road safety.

Pager Power's approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels. The scenario in which a solar reflection can occur for all

[1] Source: Solar Energy Facilities Design and Development Guideline, August 2019
[2] Source: Pager Power Glint and Glare Guidance, Third Edition (3.1), April 2021

receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact. The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that 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[3].

The methodology for this assessment was formed with reference to the Victoria State Government guidelines for solar developments, along with industry best-practice and experience.

Assessment Results

Local Roads

Following a review of the available imagery and local topography, any solar reflections that are geometrically possible towards four of the 15 assessed road routes are predicted to be significantly screened under baseline conditions. No impacts are predicted, and no mitigation is required.

Any solar reflections that are geometrically possible towards three of the 15 assessed road routes are predicted to be significantly filtered under baseline conditions, such that only marginal views of reflecting panels may be possible. The intensity and duration of any impact is considered to be small. A low impact is predicted on these routes according to Pager Power's interpretation of the Victoria State Government guidelines for solar developments. Mitigation is not recommended due to sufficient mitigating factors already being in place.

Any solar reflections that are geometrically possible towards two of the 15 assessed road routes are predicted to be filtered under baseline conditions, however views of reflecting panels may be possible. The intensity and duration of any impact varies according to conditions. A moderate impact is predicted on these routes according to Pager Power's interpretation of the Victoria State Government guidelines for solar developments. Mitigation is not recommended due to sufficient mitigating factors already being in place.

Connorton Model Airfield

The modelling has shown that solar reflections are geometrically possible towards the assessed point at Connorton Model Airfield when the resting angle of the solar panels is set to zero degrees. The maximum daily duration of glare per day is four minutes. The intensity and duration of any impact is considered to be small. A low impact is therefore predicted. Mitigation is not recommended because:

- Reflections would only be possible in the evening when the Sun is low in the sky. Therefore, an observer will likely have a view of the Sun within the same viewpoint of the reflecting solar panels. The Sun is a far more significant source of light.

[3] Source: SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).

- The tree belt proposed in the layout plan at the site boundary will significantly screen reflections once fully developed.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 51 countries within Europe, Africa, America, Asia and Australasia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems.

Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the possible effects of glint and glare from a proposed solar photovoltaic (PV) development located north-east of Uranquinty in Australia. This glint and glare assessment concerns the possible impact upon surrounding local roads users, and activity at Connorton Model Airfield (Wagga Model Aero Club).

This report contains the following:

- Solar development details.
- Explanation of glint and glare.
- Overview of relevant guidance.
- Overview of relevant studies.
- Overview of Sun movement.
- Assessment methodology.
- Identification of receptors.
- Glint and glare assessment for identified receptors.
- Results discussion.

Following this, a summary of findings and overall conclusions and recommendations from the desk-based analysis is presented. No site survey has taken place at this stage.

1.2 Pager Power's Experience

Pager Power has undertaken over 700 glint and glare assessments internationally. The company's own glint and glare guidance is based on industry experience and extensive consultation with industry stakeholders, including airports and aviation regulators.

1.3 Glint and Glare Definition

The definition of glint and glare can vary however, the definition used by Pager Power is as follows:

- Glint – a momentary flash of bright light typically received by moving receptors or from moving reflectors.
- Glare – a continuous source of bright light typically received by static receptors or from large reflective surfaces.

These definitions are aligned with those of the Federal Aviation Administration (FAA) in the United States of America. The term 'solar reflection' is used in this report to refer to both reflection types.

2 PROPOSED SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Layout Plan

The layout of the proposed solar development is shown in Figure 1[4] below, received from NGH Consulting. The black lines represent the location of solar panels and the green lines represent proposed tree planting.

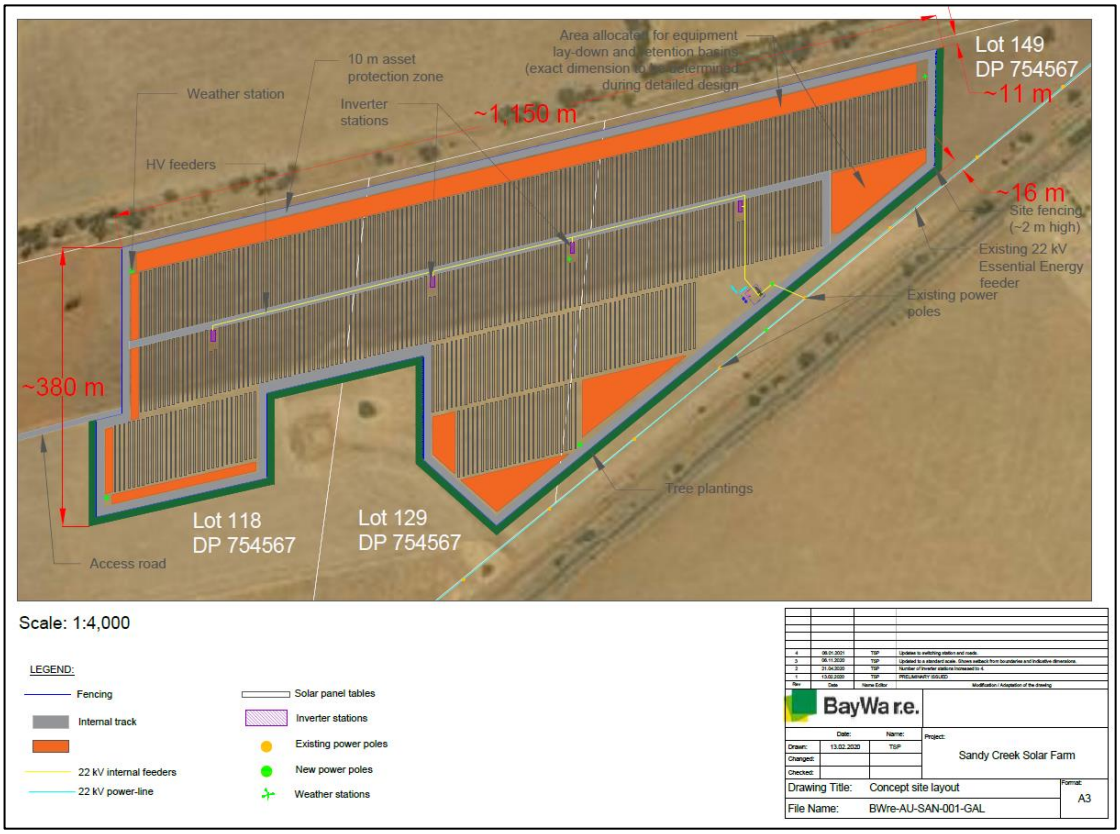


Figure 1 *Site layout plan*

[4] Source: 20210105 SAN site layout BWre-AU-SAN-001-GAL rev 4-2.pdf

2.2 Proposed Solar Development Location – Aerial Image

Figure 2[5] below shows the location of the proposed solar development. The red line represents the outer red line boundary, and the blue shaded area represents the assessed area of solar panels. Based on the information in Figure 1, panels may not actually be located in the whole of this blue area, however this is a conservative assessment and a worst-case scenario panel area has been considered.



Figure 2 *Proposed development location – aerial image*

[5] Copyright © 2021 Google.

2.3 Solar Panel Information

The design of the solar panel table is shown in Figure 3[6] below, received from NGH Consulting. The technical characteristics used for the modelling are presented in Table 1.

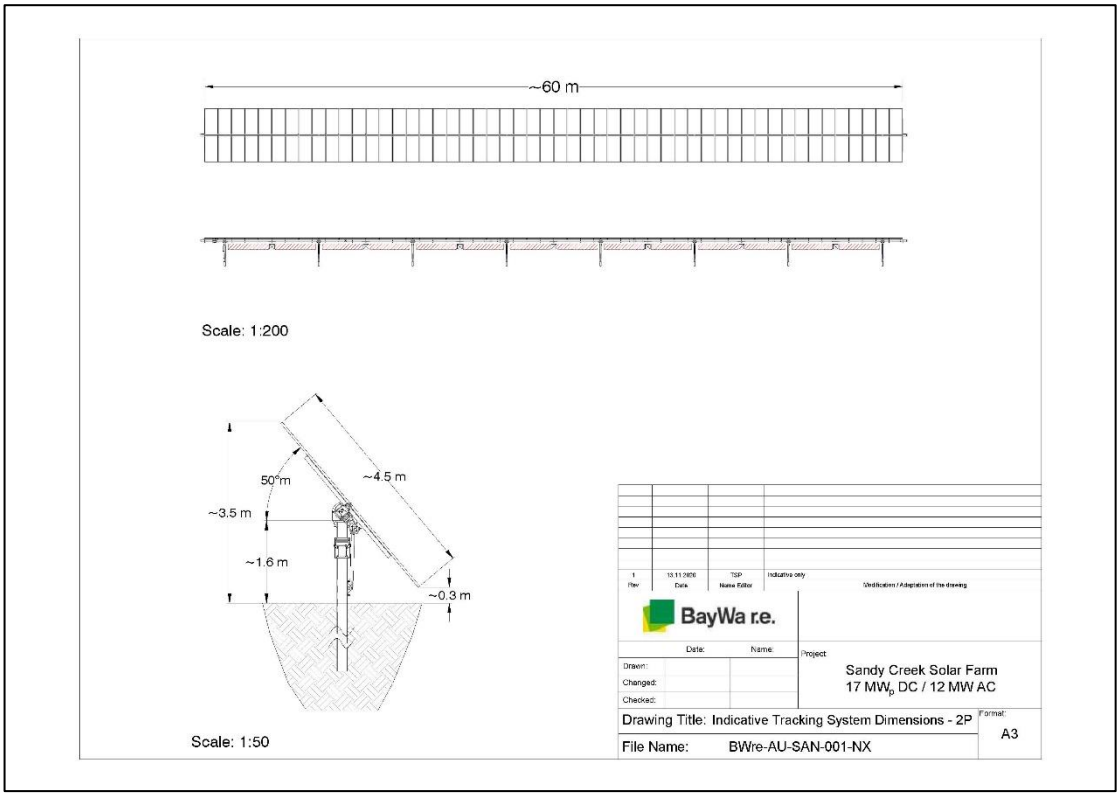


Figure 3 *Design of the solar panel table*

Solar Panel Technical Information	
Azimuth angle (°)	0
Axis height (m)	2.15 agl (above ground level)
Tracking	Horizontal Single Axis tracks Sun East to West
Tracker Range of Motion (°)	±60°
Resting angle (°)	0 or 5°

Table 1 *Solar panel technical information*

[6] Source: 2P Tracking System Drawing BWre-AU-SAN-001-NX-2P.pdf

2.3.1 Solar Panel Backtracking

Shading considerations dictate the panel tilt. This is affected by:

- The elevation angle of the Sun;
- The vertical tilt of the panels;
- The spacing between the panel rows.

This means that early in the morning and late in the evening, the panels will not be directed exactly towards the Sun, as the loss from shading of the panels (caused by facing the sun directly when the Sun is low in the horizon), would be greater than the loss from lowering the panels to a less direct angle in order to avoid the shading. Figure 4[7] below illustrates this.

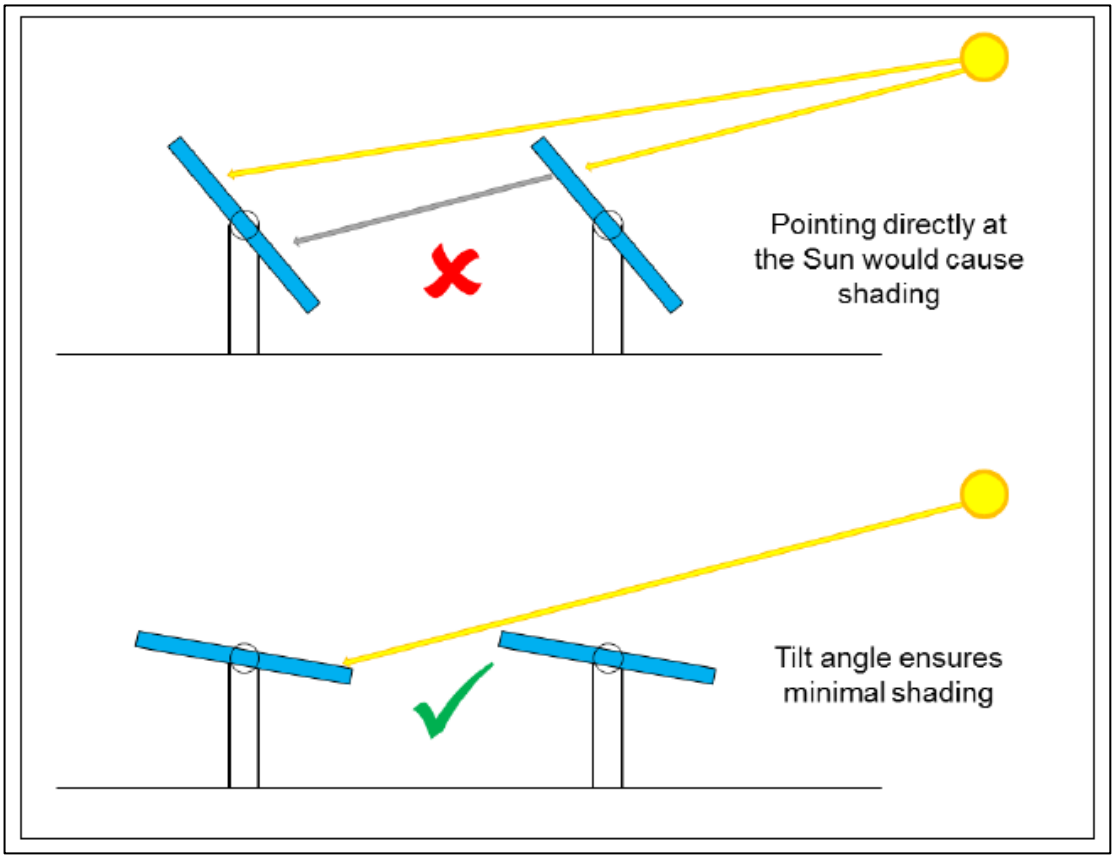


Figure 4 *Shading Considerations*

Later in the day, the panels can be directed towards the Sun without any shading issues. This is illustrated in Figure 5[7] on the following page.

[7] Note the graphics in Figure 4 and Figure 5 show two lines illustrating the paths of light from the Sun towards the solar panels. In reality, the lines from the Sun to each panel would be effectively parallel due to the large separation distance. The figure is for illustrative purposes only.

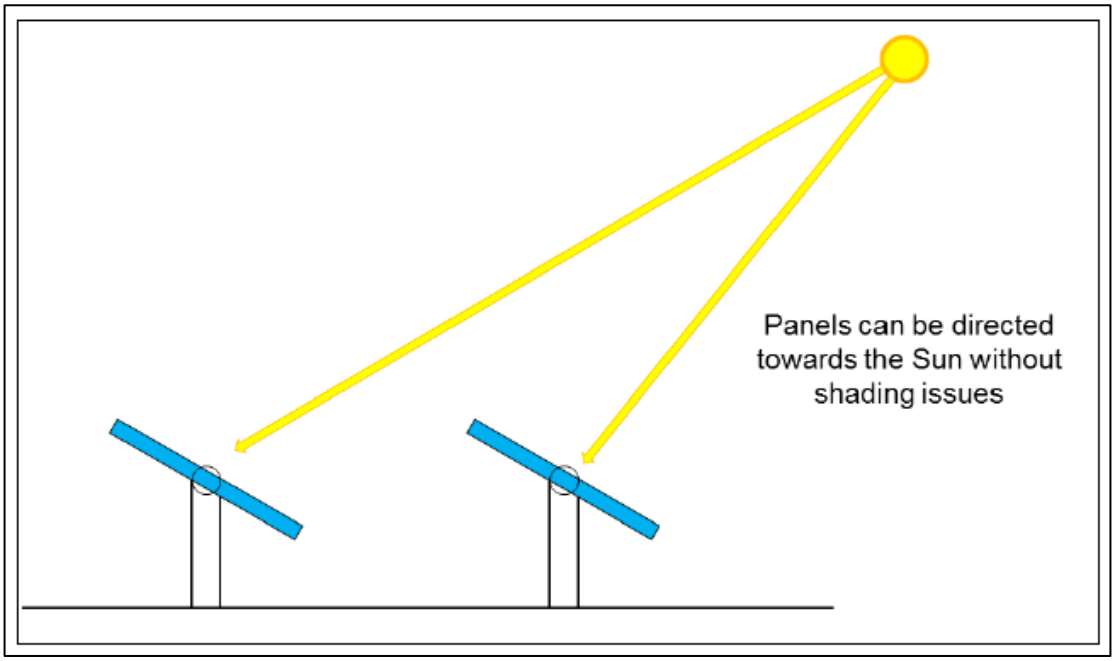


Figure 5 *Panel alignment at high solar angles*

The solar panels backtrack (where the panel angle gradually declines to prevent shading) by reverting to either 0 degrees (flat) or 5 degrees, once the maximum elevation angle of the panels (60 degrees) becomes ineffective due to the low height of the Sun above the horizon and to avoid shading.

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Guidance and Studies

Appendices A and B present a review of relevant guidance and independent studies with regard to glint and glare issues from solar panels. The overall conclusions from the available studies are as follows:

- Specular reflections of the Sun from solar panels are possible.
- The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence.
- Published guidance shows that the intensity of solar reflections from solar panels are equal to or less than those from water. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces, which are common in an outdoor environment.

3.2 Background

Details of the Sun's movements and solar reflections are presented in Appendix C.

3.3 Victoria State Government Guidelines

The Department of Environment, Land, Water and Planning in the Victoria State Government produced a set of guidelines for the design and development of solar energy facilities in 2019[8]. It states that any assessment of glint and glare should use an accepted methodology based on best practice.

The guidelines also state that any assessment should consider impacts on:

- dwellings and roads within 1 km of the proposed facility, taking into consideration their height within the landscape.
- aviation infrastructure including any air traffic control tower or runway approach path close to the proposed facility
- any other receptor to which a responsible authority considers solar reflection may be a hazard.

3.4 Methodology

The methodology for this assessment was formed with reference to the Victoria State Government guidelines, along with industry best-practice and experience and is as follows:

- Identify receptors within 1km of the solar development.
- Consider direct solar reflections from the solar development towards the identified receptors by undertaking geometric calculations.

[8] Solar Energy Facilities Design and Development Guideline

- Consider the visibility of the panels from the receptor's location. If the panels are not visible from the receptor then no reflection can occur.
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur.
- Consider both the solar reflection from the solar development and the location of the direct sunlight with respect to the receptor's position.
- Consider the solar reflection with respect to the published studies and guidance.
- Determine whether a significant detrimental impact is expected in line with the process stated in the Victoria State Government guidelines. This is presented in Appendix D.

In this assessment, Forge was exclusively used for the modelling. Within the model, the solar development area is defined, as well as the relevant receptor locations. The result is a chart that states whether a reflection can occur, the duration and the panels that can produce the solar reflection towards the receptor.

3.5 Assessment Limitations

Further technical details regarding the methodology of the geometric calculations and limitations are presented in Appendix E and Appendix F.

4 IDENTIFICATION OF RECEPTORS

4.1 Receptors Overview

The Victoria State Government guidelines for solar developments[8] state that any assessment should consider impacts on relevant receptors within 1 km of the proposed facility, taking into consideration their height within the landscape. Therefore, the assessment area has been designed accordingly as a 1km boundary from solar panels (white outlined areas on the proceeding figures).

Potential receptors are identified based on mapping and aerial photography of the region. The initial judgement is made based on a high-level consideration of aerial photography and mapping i.e. receptors are excluded if it is clear from the outset that no visibility would be possible. A more detailed assessment is made if the modelling reveals a reflection would be geometrically possible.

Terrain elevation heights are based on Forge SRTM data. An overview of the one-kilometre assessment area is presented in Figure 6[5] below and the receptors are further clarified in the following sections. Receptor details can be found in Appendix G.



Figure 6 *One-kilometre assessment area overview – aerial image*

4.2 Road Receptors

Road types can generally be categorised as:

- Major National – Typically a road with a minimum of two carriageways with a maximum speed limit of up to 110kph. These roads typically have fast-moving vehicles with busy traffic.
- National – Typically a road with a one or more carriageways with a maximum speed limit of up to 100kph or 110kph. These roads typically have fast-moving vehicles with moderate to busy traffic density.
- Regional – Typically a single carriageway with a maximum speed limit of up to 100kph. The speed of vehicles will vary with a typical traffic density of low to moderate; and
- Local - Typically roads and lanes with the lowest traffic densities. Speed limits vary.

In this assessment, the analysis has considered any local roads that are within one kilometre of the proposed development.

15 local road routes were identified for assessment, as shown by the blue lines in Figure 7[5] below and labelled. A height of 1.5 metres above ground level has been taken as typical eye level for a road user. This height has been added to the ground height at each receptor location. Visibility and direction of travel is considered in the assessment of all receptors.

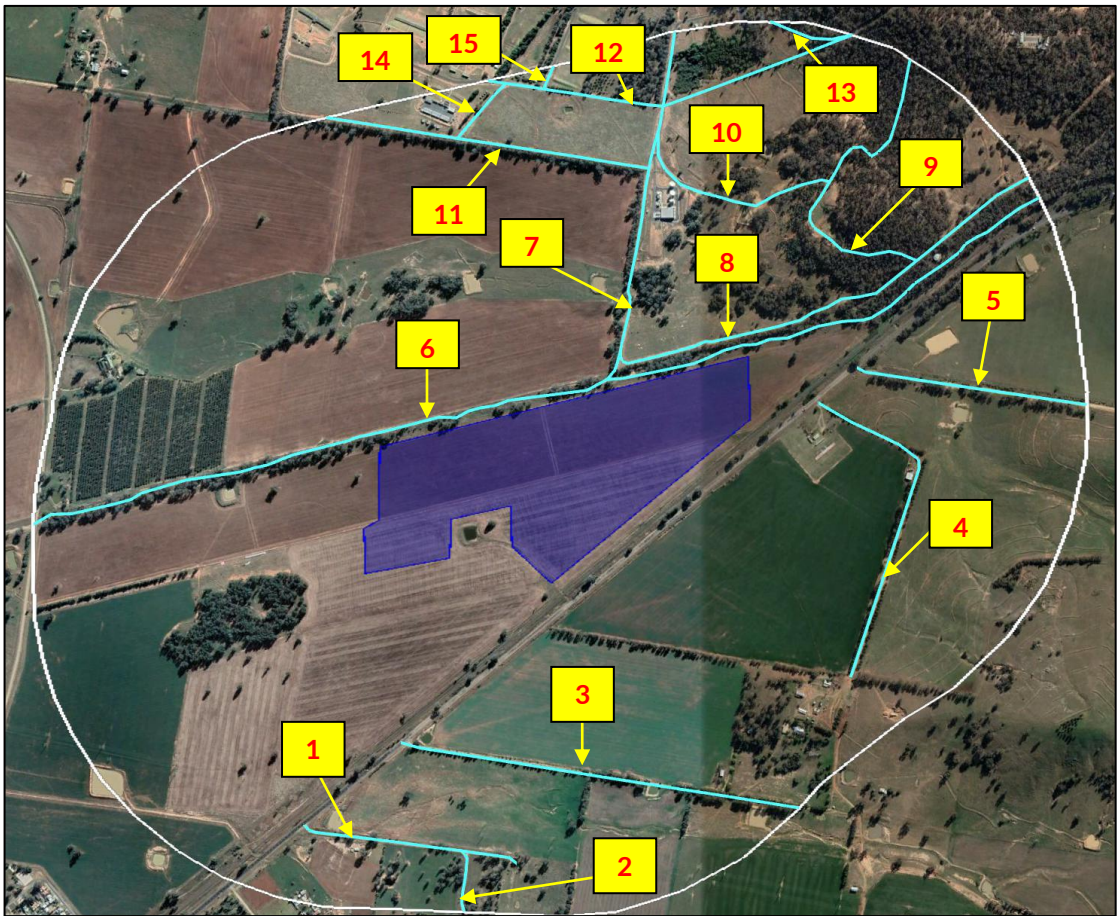


Figure 7 *Assessed road routes – aerial image*

4.3 Connorton Model Airfield

The analysis has considered Connorton Model Airfield, where activities related to model aircraft flight take place, following the criteria for a dwelling observer. A height of 1.8 metres above ground level has been taken as typical eye level for an observer standing on the ground.

An overview of the receptor location is shown in Figure 8[5] below.

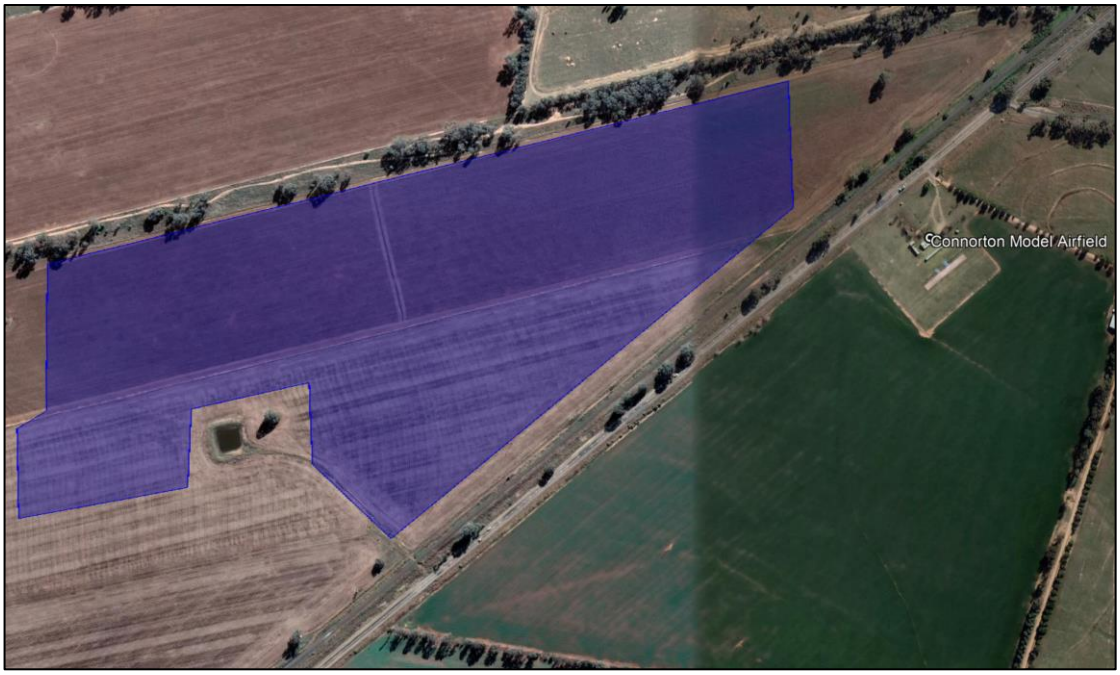


Figure 8 *Connorton Model Airfield Receptor*

5 ASSESSED REFLECTOR AREA

5.1 Reflector Area

The bounding coordinates for the proposed solar farm development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 9 below shows the assessed reflector area that has been used for modelling purposes.



Figure 9 *Assessed reflector area – aerial image*

6 GLINT AND GLARE ASSESSMENT – GEOMETRIC CALCULATION RESULTS

6.1 Geometric Calculation Results Overview

The tables in the following subsections present the results of the geometric calculations for the ground-based receptors. The predicted glare times are based solely on bare-earth terrain i.e. without consideration of screening from buildings and vegetation.

Section 7 summarises the predicted impact considering the level of identified screening based on a desk-based review of the available imagery. The flowcharts setting out the impact characterisation and presented in Appendix D. The list of assumptions and limitations are presented in Appendix F. The significance of any predicted effects has been evaluated based on Pager Power's interpretation of the Victoria State Government guidance for solar developments**Error! Bookmark not defined.**. The modelling output for key receptors showing the precise predicted times and the reflecting panel area(s) can be provided on request.

When evaluating visibility in the context of glint and glare, it is only the *reflecting* panel area that must be considered. For example, if the western half of the development is visible, but reflections would only be possible from the eastern half, it can be concluded that the reflecting area is not visible and no impacts are predicted. This is why there can be instances where visibility of the development is predicted, but glint and glare issues are screened.

6.2 Road Routes

6.2.1 0-degree resting angle

The results of the geometric calculations towards the road routes for a 0-degree resting angle are presented in Table 2 below.

Route	Results		Comments
	Reflection possible towards the road user? (AEDT[9])		
	am	pm	
1 – 2.	No.	No.	Solar reflections are not geometrically possible. No impact is predicted.

[9] Modelling was run in AEDT but conclusions for AEST would be the same; only the glare curves would shift one hour in accordance with sunset and sunrise times shifting by one hour.

Route	Results		Comments
	Reflection possible towards the road user? (AEDT[9])		
	am	pm	
3	No.	Yes.	Solar reflections predicted to originate from south-western panel areas.
4 – 5.	No.	Yes.	Solar reflections predicted to originate from all panel areas.
6	Yes.	Yes.	Solar reflections predicted to originate from upper panel areas.
7	Yes.	Yes.	Solar reflections predicted to originate from north-eastern and north-western panel areas.
8	Yes.	Yes.	Solar reflections predicted to originate from upper panel areas.
9	No.	Yes.	Solar reflections predicted to originate from northern and north-western panel areas.
10	No.	Yes.	Solar reflections predicted to originate from north-western panel areas.
11	Yes.	No.	Solar reflections predicted to originate from north-eastern panel areas.
12 – 15.	No.	No.	Solar reflections are not geometrically possible. No impact is predicted.

Table 2 *Geometric analysis results for a 0-degree resting angle – road routes*

6.2.2 5-degree resting angle

The results of the geometric calculations towards the road routes for a 5-degree resting angle are presented in Table 3 below.

Route	Results		Comments
	Reflection possible towards the road user? (AEDT[9])		
	am	pm	
1 – 15.	No.	No.	Solar reflections are not geometrically possible. No impacts are predicted.

Table 3 *Geometric analysis results for a 5-degree resting angle – road routes*

6.3 Connorton Model Airfield

The results of the geometric calculations towards the Connorton Model Airfield receptor are presented in Table 4 below.

Resting angle	Results		Comments
	Reflection possible? (AEDT)		
	am	pm	
0	No.	Yes.	Solar reflections predicted to originate from panel areas around the site.
5	No.	No.	Solar reflections are not geometrically possible.

Table 4 Geometric analysis results – Connorton Model Airfield receptor

7 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

7.1 Road Routes

The modelling has shown that solar reflections are geometrically possible towards:

- Route 3 originating from south-western panel areas;
- Routes 4 and 5 originating from all panel areas;
- Route 6 originating from upper panel areas;
- Route 7 originating from north-eastern and north-western panel areas;
- Route 8 originating from upper panel areas;
- Route 9 originating from northern and north-western panel areas;
- Route 10 originating from north-western panel areas; and
- Route 11 originating from north-eastern panel areas.

These sections of road are represented by the yellow lines in Figure 10[5] below. The reflections are only possible when the resting angle of the solar panels is set to 0 degrees. The modelling output for these receptors showing the precise predicted times and the reflecting panel area(s) can be provided on request.



Figure 10 *Sections of road where solar reflections are geometrically possible (yellow lines) – aerial image*

Table 5 below summarises the predicted impact significance and mitigation requirement for the road routes where solar reflections are geometrically possible. The impact significance was determined following the recommended definitions stated in Victoria State Government guidance for solar panel developments and outlined in Appendix D. The proposed screening from the developer has been considered where required.

Road Route	Analysis of Baseline Conditions	Impact Classification according to Victoria Guidelines	Relevant Factors	Further Mitigation Recommended?
3	Maximum daily duration of glare per day is 3 minutes. Existing vegetation and intervening terrain screening will significantly filter views. Marginal views within field of view may be possible.	Low impact predicted.	Tree Belt proposed in layout plan at site boundary will significantly screen reflections once fully developed. The reflecting area within the proposed development is more than a kilometre away from the section of the road route where reflections are possible.	No.
4	Maximum daily duration of glare per day is 16 minutes. Existing vegetation screening will filter views. Views within field of view may be possible.	Moderate impact predicted.	Tree Belt proposed in layout plan at site boundary will significantly screen reflections once fully developed. A large part of the reflecting area within the proposed development is more than a kilometre away from the section of the road route where reflections are possible.	No.

Road Route	Analysis of Baseline Conditions	Impact Classification according to Victoria Guidelines	Relevant Factors	Further Mitigation Recommended?
5	Maximum daily duration of glare per day is 19 minutes. Existing vegetation and intervening terrain screening will significantly filter views. Marginal views within field of view may be possible.	Low impact predicted.	Tree Belt proposed in layout plan at site boundary will significantly screen reflections once fully developed.	No.
6	Maximum daily duration of glare per day is 45 minutes. Existing vegetation screening will filter views. Views within field of view may be possible.	Moderate impact predicted.	The route appears to be a single lane track, with no markings, and is difficult to identify on aerial imagery. The level of traffic on this road is likely to be extremely low.	No.
7	Maximum daily duration of glare per day is 18 minutes. Existing vegetation screening will significantly filter views. Marginal views within field of view may be possible.	Low impact predicted.	The route appears to be a single lane track, with no markings. The level of traffic on this road is likely to be extremely low.	No.
8	Maximum daily duration of glare per day is 33 minutes. Existing vegetation screening will significantly filter views. Views are not expected to be possible.	No impact predicted.	The route appears to be an single lane track, with no markings. The level of traffic on this road is likely to be extremely low.	No.

Road Route	Analysis of Baseline Conditions	Impact Classification according to Victoria Guidelines	Relevant Factors	Further Mitigation Recommended?
9	Maximum daily duration of glare per day is 23 minutes. Existing vegetation screening will significantly filter views. Views are not expected to be possible.	No impact predicted.	The route appears to be a single lane track, with no markings, and is difficult to identify on aerial imagery. The level of traffic on this road is likely to be extremely low.	No.
10	Maximum daily duration of glare per day is 7 minutes. Existing vegetation screening will significantly filter views. Views are not expected to be possible.	No impact predicted.	The route appears to be a single lane track, with no markings. The level of traffic on this road is likely to be extremely low.	No.
11	Maximum daily duration of glare per day is 8 minutes. Existing vegetation screening and intervening terrain will significantly filter views. Views are not expected to be possible.	No impact predicted.	The route appears to be a single lane track, with no markings. The level of traffic on this road is likely to be extremely low.	No.

Table 5 *Assessment of mitigation requirement – dwelling receptors*

Following a review of the available imagery and local topography, any solar reflections that are geometrically possible towards road routes 8 – 11 are predicted to be significantly screened under baseline conditions. No impacts are predicted, and no mitigation is required.

Any solar reflections that are geometrically possible towards road routes 3, 5, and 7, are predicted to be significantly filtered under baseline conditions, such that only marginal views of reflecting panels may be possible. The intensity and duration of any impact is considered to be small. A low impact is predicted on these routes according to Pager Power's interpretation of the Victoria State Government Reflections are geometrically possible towards some of the local road receptors at certain times of the year. These reflections have been evaluated with

reference to the Victoria State Government guidelines for solar developments, along with industry best-practice and experience. There are sufficient mitigating factors in place such that no further mitigation requirement has been identified.

for solar developments. Mitigation is not recommended due to sufficient mitigating factors already being in place, as per Table 5.

Any solar reflections that are geometrically possible towards road routes 4 and 6 are predicted to be filtered under baseline conditions, however views of reflecting panels may be possible. The intensity and duration of any impact varies according to conditions. A moderate impact is predicted on these routes according to Pager Power's interpretation of the Victoria State Government guidance for solar developments. Mitigation is not recommended due to sufficient mitigating factors already being in place, as per Table 5.

7.2 Connorton Model Airfield

The modelling has shown that solar reflections are geometrically possible towards the Connorton Model Airfield receptor when the resting angle of the solar panels is set to 0 degrees. The maximum daily duration of glare per day is 4 minutes. The intensity and duration of any impact is considered to be small. A low impact is therefore predicted. Mitigation is not recommended because:

- Reflections would only be possible in the evening when the Sun is low in the sky. Therefore, an observer will likely have a view of the Sun within the same viewpoint of the reflecting solar panels. The Sun is a far more significant source of light.
- The tree belt proposed in the layout plan at the site boundary will significantly screen reflections once fully developed.

7.3 Overall Conclusions

Reflections are geometrically possible towards some of the local road receptors at certain times of the year. These reflections have been evaluated with reference to the Victoria State Government guidelines for solar developments, along with industry best-practice and experience. There are sufficient mitigating factors in place such that no further mitigation requirement has been identified.

APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

This section presents details regarding the relevant guidance and studies with respect to the considerations and effects of solar reflections from solar panels, known as 'Glint and Glare'.

This is not a comprehensive review of the data sources, rather it is intended to give an overview of the important parameters and considerations that have informed this assessment.

UK Planning Policy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[10] (specifically regarding the consideration of solar farms, paragraph 013) states:

'What are the particular planning considerations that relate to large scale ground-mounted solar photovoltaic Farms?

The deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively.

Particular factors a local planning authority will need to consider include:

…

- *the proposal's visual impact, the effect on landscape of glint and glare (see guidance on landscape assessment) and on **neighbouring uses and aircraft safety**;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun.*

…

The approach to assessing cumulative landscape and visual impact of large-scale solar farms is likely to be the same as assessing the impact of wind turbines. However, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography the area of a zone of visual influence could be zero.'

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare are, however, provided for assessing the impact of solar reflections on surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the

[10] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 17/06/2020

relevant guidance/studies to determine whether the reflection is significant. The Pager Power approach has been informed by the policy presented above, current studies (presented in Appendix B) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document[11] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

[11] Source: Pager Power Glint and Glare Guidance, Third Edition (3.1), April 2021

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

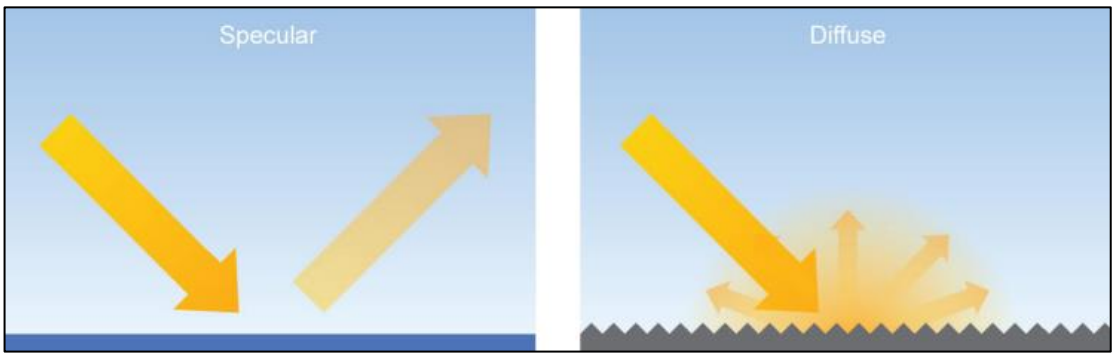
Overview

Studies have been undertaken assessing the type and intensity of solar reflections from various surfaces including solar panels and glass. An overview of these studies is presented below.

The guidelines presented are related to aviation safety. The results are applicable for the purpose of this analysis.

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance[12], illustrates the difference between the two types of reflections. Because solar panels are flat and have a smooth surface most of the light reflected is specular, which means that incident light from a specific direction is reradiated in a specific direction.



Specular and diffuse reflections

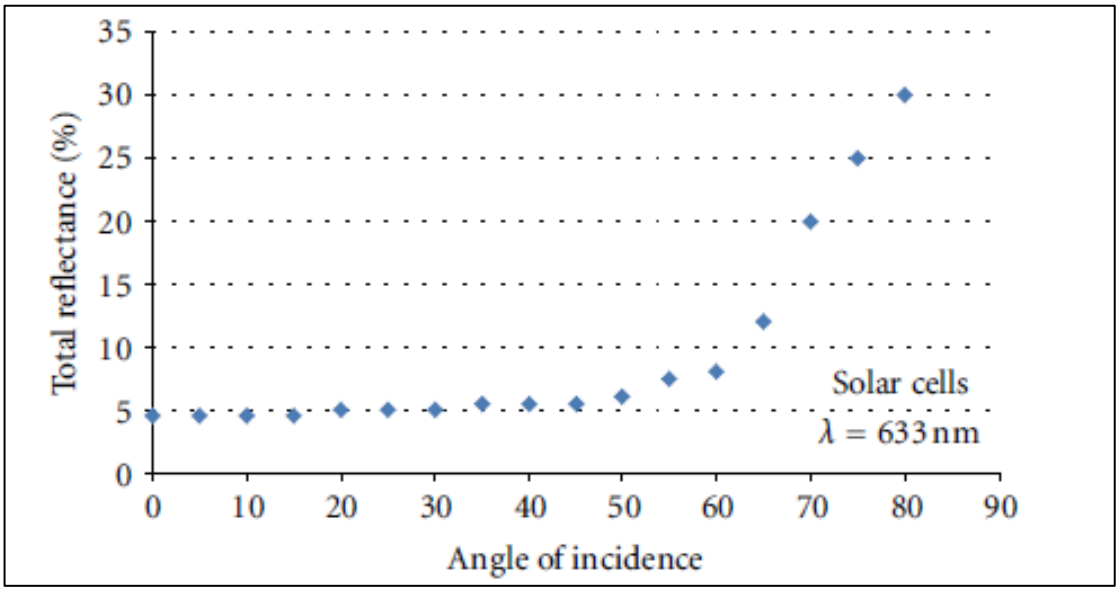
[12] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

Solar Reflection Studies

An overview of content from identified solar panel reflectivity studies is presented in the subsections below.

Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems"

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[13]". They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure below.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

- The potential for hazardous glare from flat-plate PV systems is similar to that of smooth water;
- Portland white cement concrete (which is a common concrete for runways), snow, and structural glass all have a reflectivity greater than water and flat plate PV modules.

[13] Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems," ISRN Renewable Energy, vol. 2011, Article ID 651857, 6 pages, 2011. doi:10.5402/2011/651857

FAA Guidance – "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[14]

The 2010 FAA Guidance included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. A table of reflectivity values, sourced from the figure within the FAA guidance, is presented below.

Surface	Approximate Percentage of Light Reflected[15]
Snow	80
White Concrete	77
Bare Aluminium	74
Vegetation	50
Bare Soil	30
Wood Shingle	17
Water	5
Solar Panels	5
Black Asphalt	2

Relative reflectivity of various surfaces

Note that the data above does not appear to consider the reflection type (specular or diffuse).

An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel.

The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

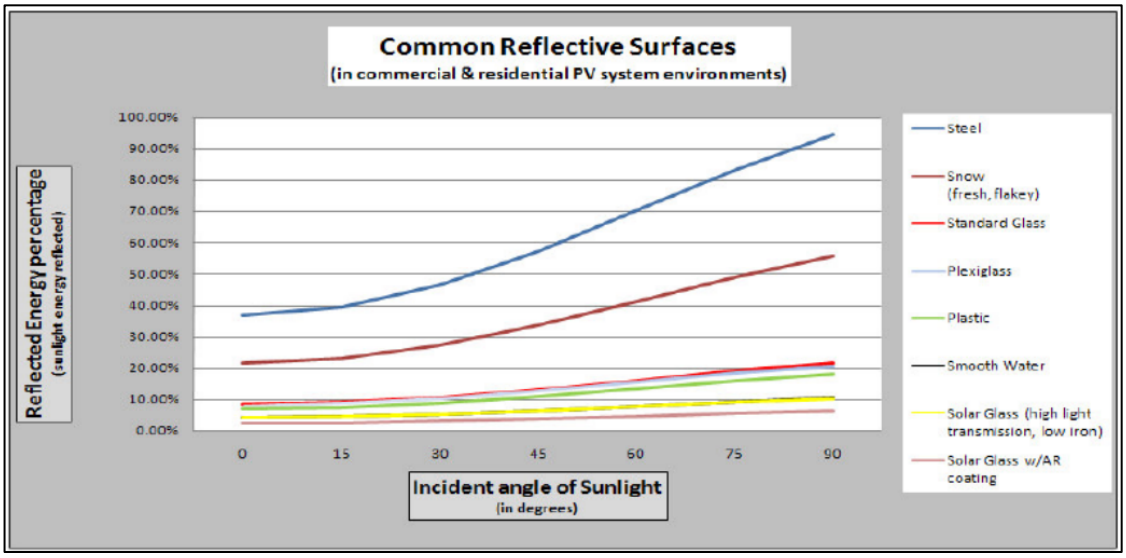
[14] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

[15] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

SunPower Technical Notification (2009)

SunPower published a technical notification[16] to 'increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment'.

The figure presented below shows the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel.



Common reflective surfaces

The results, similarly to those from Riley and Olsen study (2011) and the FAA (2010), show that solar panels produce a reflection that is less intense than those of '*standard glass and other common reflective surfaces*'.

With respect to aviation and solar reflections observed from the air, SunPower has developed several large installations near airports or on Air Force bases. It is stated that these developments have all passed FAA or Air Force standards with all developments considered "No Hazard to Air Navigation". The note suggests that developers discuss any possible concerns with stakeholders near proposed solar farms.

[16] Source: Technical Support, 2009. SunPower Technical Notification – Solar Module Glare and Reflectance.

APPENDIX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

The Sun's position in the sky can be accurately described by its azimuth and elevation. Azimuth is a direction relative to true north (horizontal angle i.e. from left to right) and elevation describes the Sun's angle relative to the horizon (vertical angle i.e. up and down).

The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- Time.
- Date.
- Latitude.
- Longitude.

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a reflector.

APPENDIX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

The significance of glint and glare will vary for different receptors. The following section presents a general overview of the significance criteria with respect to experiencing a solar reflection.

Impact Significance Definition

The table below presents the recommended definition of 'impact significance' in glint and glare terms according to Victoria State Government guidance for solar panel developments**Error! Bookmark not defined.**.

Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible, but the intensity and duration of an impact is considered to be small.	Can be mitigated with screening or other measure.
Moderate	A solar reflection is geometrically possible and visible, but the intensity and duration of an impact varies according to conditions.	Mitigation measures (such as through design, orientation, landscaping or other screening method) to reduce impacts to an acceptable level will be required.
Major	A solar reflection is geometrically possible and visible under a range of conditions that will produce impacts with significant intensity and duration.	Significant mitigation measures are required if the proposed development is to proceed.

Impact significance definition – Victoria State Government guidance

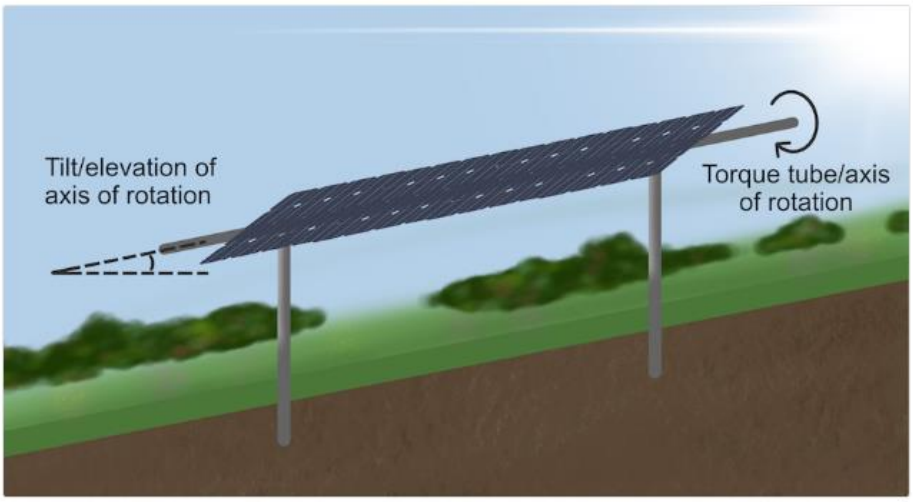
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Forge Reflection Calculations Methodology

Extracts taken from the Forge Solar Model.

Tracking System Parameters

Single-axis module tracking systems are described by a unique set of parameters. These angular inputs model the tracking axis, rotation range and backtracking behavior. Dual-axis module tracking systems are assumed to track the sun at all times.



Single-axis tracking system with torque tube tilted due to geography

Tilt of tracking axis (°)
Tilt above flat ground of axis over which panels rotate (e.g. torque tube). System on flat, level ground would have axis tilt of 0°.

Orientation of tracking axis (°)
Azimuthal angle of axis over which panels rotate. Angle represents the facing of the axis and system. For example, typical tracking system in northern hemisphere has tracking axis oriented north-south with an orientation of 180°, allowing panels to rotate east-west with potential south-facing tilt. Typical tracking system in southern hemisphere runs south-north with axis orientation of 0°, yielding east-west rotation with potential north-facing tilt.

Offset angle of module (°)
Additional tilt angle of PV module elevated above tracking axis/torque tube. Offset angle is measured from the torque tube.

Maximum tracking angle (°)
Maximum angle of rotation of tracking system in one direction. For example, a typical system with a 120° range of rotation has a *max tracking angle* of 60° (east/west).

Resting angle (°)
Angle of rotation of panels when sun is outside tracking range. Used to model backtracking. Panels will revert to the position described by this rotation angle at all times when the sun is outside the rotation range. Setting this equal to the *maximum tracking angle* implies the panels do not backtrack.

ForgeSolar utilizes a simplified model of backtracking which assumes panels instantaneously revert to the *resting angle* whenever the sun is outside the rotation range. For example, panels with *max tracking angle* of 60° and *resting angle* of 0° would lie flat from sunrise until the sun enters the rotation range, and immediately after the sun leaves the rotation range until sunset daily.

Tracking System Parameters

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Forge's Sandia National Laboratories' (SGHAT) Model[17]

Summary of assumptions and abstractions required by the SGHAT/ForgeSolar analysis methodology

1. Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
2. Result data files and plots are now retained for two years after analysis completion. Files should be downloaded and saved if additional persistence is required.
3. The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
4. Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects analyses of path receptors.
5. Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
6. The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
7. The algorithm assumes that the PV array is aligned with a plane defined by the total heights of the coordinates outlined in the Google map. For more accuracy, the user should perform runs using minimum and maximum values for the vertex heights to bound the height of the plane containing the solar array. Doing so will expand the range of observed solar glare when compared to results using a single height value.
8. The algorithm does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
9. The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
10. The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
11. The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
12. Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
13. Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
14. Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
15. PV array tracking assumes the modules move instantly when tracking the sun, and when reverting to the rest position.

[17] https://www.forgesolar.com/help/#assumptions

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Terrain Height

Terrain Height is calculated by Forge from SRTM data, based on the coordinates of the point of interest.

Road Route 1 Data

The table below presents the coordinates defining the vertices defining the assessed road route 1.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.257485	-35.184852	3	147.264319	-35.185738
2	147.25771	-35.185071	4	147.264566	-35.185948

Road Route 1

Road Route 2 Data

The table below presents the coordinates defining the vertices defining the assessed road route 2.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.262774	-35.185589	3	147.262742	-35.187027
2	147.262913	-35.185782	4	147.262913	-35.187334

Road Route 2

Road Route 3 Data

The table below presents the coordinates defining the vertices defining the assessed road route 3.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.260864	-35.182621	3	147.273961	-35.184357
2	147.261143	-35.182735			

Road Route 3

Road Route 4 Data

The table below presents the coordinates defining the vertices defining the assessed road route 4.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.274411	-35.173402	4	147.277801	-35.174971
2	147.275055	-35.173761	5	147.277844	-35.175182
3	147.277576	-35.174796	6	147.275559	-35.180803

Road Route 4

Road Route 5 Data

The table below presents the coordinates defining the vertices defining the assessed road route 5.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.275802	-35.172497	3	147.283291	-35.17355
2	147.276532	-35.172743			

Road Route 5

Road Route 6 Data

The table below presents the coordinates defining the vertices defining the assessed road route 6.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.248487	-35.176724	21	147.267438	-35.17291
2	147.249259	-35.176496	22	147.267604	-35.172823
3	147.249989	-35.176496	23	147.268028	-35.172818
4	147.250874	-35.176284	24	147.268929	-35.172665
5	147.251926	-35.176078	25	147.270147	-35.172463
6	147.25207	-35.175907	26	147.270753	-35.172336
7	147.253658	-35.175543	27	147.271498	-35.172025
8	147.254999	-35.175206	28	147.272019	-35.171911

9	147.256464	-35.174951	29	147.272453	-35.171919
10	147.257539	-35.174827	30	147.27292	-35.17177
11	147.25925	-35.174428	31	147.273612	-35.171726
12	147.260801	-35.174116	32	147.274063	-35.171525
13	147.261466	-35.173985	33	147.274604	-35.171384
14	147.261923	-35.173862	34	147.275667	-35.171248
15	147.26261	-35.173879	35	147.276407	-35.171051
16	147.263076	-35.173656	36	147.277727	-35.170345
17	147.263827	-35.173542	37	147.278644	-35.169784
18	147.264562	-35.173366	38	147.279577	-35.169104
19	147.265254	-35.173287	39	147.280725	-35.168477
20	147.266332	-35.173213	40	147.281728	-35.168039

Road Route 6

Road Route 7 Data

The table below presents the coordinates defining the vertices defining the assessed road route 7.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.267608	-35.172829	6	147.268809	-35.167848
2	147.267897	-35.172452	7	147.269077	-35.166804
3	147.268112	-35.171566	8	147.269314	-35.165822
4	147.26838	-35.170496	9	147.269485	-35.164971
5	147.268509	-35.169233	10	147.269786	-35.16341

Road Route 7

Road Route 8 Data

The table below presents the coordinates defining the vertices defining the assessed road route 8.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.267994	-35.172049	7	147.275171	-35.170724
2	147.268026	-35.172329	8	147.275654	-35.170698
3	147.268241	-35.172417	9	147.276513	-35.170488
4	147.270826	-35.171821	10	147.27942	-35.168541
5	147.273712	-35.171338	11	147.280965	-35.16762
6	147.274088	-35.171189	12	147.281353	-35.16746

Road Route 8

Road Route 9 Data

The table below presents the coordinates defining the vertices defining the assessed road route 9.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.277716	-35.169692	9	147.275431	-35.16678
2	147.277073	-35.169438	10	147.275796	-35.166544
3	147.276236	-35.16928	11	147.276225	-35.166491
4	147.275431	-35.169131	12	147.276622	-35.166719
5	147.274465	-35.16892	13	147.276901	-35.166333
6	147.27424	-35.168622	14	147.277083	-35.165684
7	147.274208	-35.168377	15	147.27733	-35.164281
8	147.274648	-35.167798			

Road Route 9

Road Route 10 Data

The table below presents the coordinates defining the vertices defining the assessed road route 10.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.269198	-35.166324	7	147.272845	-35.168035
2	147.269305	-35.16693	8	147.273167	-35.167807
3	147.269863	-35.167508	9	147.273886	-35.167684
4	147.27071	-35.167754	10	147.274251	-35.167614
5	147.27203	-35.16807	11	147.274691	-35.167693
6	147.272405	-35.168193			

Road Route 10

Road Route 11 Data

The table below presents the coordinates defining the vertices defining the assessed road route 11.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.268994	-35.167149	2	147.258222	-35.165772

Road Route 11

Road Route 12 Data

The table below presents the coordinates defining the vertices defining the assessed road route 12.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.263694	-35.164816	6	147.273704	-35.164237
2	147.264434	-35.16486	7	147.274755	-35.163939
3	147.267213	-35.165237	8	147.27498	-35.163842
4	147.269412	-35.165465	9	147.275141	-35.163527
5	147.271687	-35.164816			

Road Route 12

Road Route 13 Data

The table below presents the coordinates defining the vertices defining the assessed road route 13.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.272802	-35.163237	4	147.274991	-35.163851
2	147.273757	-35.163579	5	147.275764	-35.163667
3	147.27453	-35.163834			

Road Route 13

Road Route 14 Data

The table below presents the coordinates defining the vertices defining the assessed road route 14.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.262632	-35.166346	3	147.264316	-35.164855
2	147.26334	-35.165592			

Road Route 14

Road Route 15 Data

The table below presents the coordinates defining the vertices defining the assessed road route 15.

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.265453	-35.164987	2	147.265829	-35.164312

Road Route 15

Connorton Model Airfield Receptor Details

The table below presents the coordinates and overall altitude of the Connorton Model Airfield receptor.

Longitude (°)	Latitude (°)	Overall Assessed Altitude (m amsl)
147.274493	-35.174389	237.43

Connorton Model Airfield Receptor Details

Panel Boundary Data

Location	Longitude (°)	Latitude (°)	Location	Longitude (°)	Latitude (°)
1	147.272229	-35.172240	7	147.262361	-35.177713
2	147.260027	-35.174684	8	147.262408	-35.176646
3	147.259986	-35.176672	9	147.264354	-35.176292
4	147.259613	-35.176805	10	147.264408	-35.177379
5	147.259489	-35.176907	11	147.265721	-35.178382
6	147.259561	-35.178130	12	147.272300	-35.173957

Panel Boundary Data

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