STATEMENT OF ENVIRONMENTAL EFFECTS
MOAMA SOLAR FARM

PREPARED FOR
TERRAIN SOLAR

FEBRUARY 2018

• Civil, Environmental & Structural Engineering • Surveying • Environmental • Planning • Architecture

STATEMENT OF ENVIRONMENTAL EFFECTS

MOAMA SOLAR FARM

PREPARED FOR:

TERRAIN SOLAR

FEBRUARY 2018

GEOLYSE

POSTAL ADDRESS PO BOX 1963 ORANGE NSW 2800
LOCATION 154 PEISLEY STREET ORANGE NSW 2800
TELEPHONE 02 6393 5000 **FACSIMILE** 02 6393 5050
EMAIL ORANGE@GEOLYSE.COM **WEB SITE** WWW.GEOLYSE.COM

Report Title:	*Statement of Environmental Effects*
Project:	*Moama Solar Farm*
Client:	*Terrain Solar*
Report Ref.:	*217439_SEE_001A.docx*
Status:	*Final*
Issued:	*21 February 2018*

Geolyse Pty Ltd and the authors responsible for the preparation and compilation of this report declare that we do not have, nor expect to have a beneficial interest in the study area of this project and will not benefit from any of the recommendations outlined in this report.

The preparation of this report has been in accordance with the project brief provided by the client and has relied upon the information, data and results provided or collected from the sources and under the conditions outlined in the report.

All maps, plans, and cadastral information contained within this report are prepared for the exclusive use of Terrain Solar to accompany this report for the land described herein and are not to be used for any other purpose or by any other person or entity. No reliance should be placed on the information contained in this report for any purposes apart from those stated therein.

Geolyse Pty Ltd accepts no responsibility for any loss, damage suffered or inconveniences arising from, any person or entity using the plans or information in this study for purposes other than those stated above.

TABLE OF CONTENTS

FIGURES

TABLES

DRAWINGS

APPENDICES

APPENDIX A
Aboriginal Cultural Heritage Assessment

APPENDIX B
Biodiversity Assessment

APPENDIX C
Noise and Vibration Assessment

APPENDIX D
Glare Assessment

APPENDIX E
Consideration of DCP

ABBREVIATIONS

Acronyms

AC	Alternating Current
AER	Australian Energy Regulator
AHIP	Aboriginal Heritage Impact Permit
ANL	Acceptable Noise Levels
ARENA	Australian Renewable Energy Agency
ARPNSA	Australian Radiation Protection and Nuclear Safety Agency
APZ	Asset Protection Zone
BA	Biodiversity Assessment
BOM	Bureau of Meteorology
BSAL	Biophysical Strategic Agricultural Land
CEMP	Construction Environmental Management Plan
CO_2e	Carbon Dioxide Equivalent
CRTN	Calculation of Road Traffic Noise
DA	Development Application
DC	Direct Current
DCP	Development Control Plan
DMP	Decommissioning Management Plan
DoE	Department of Environment
DPE	NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
EEC	Endangered Ecological Community
EMF	Electric and Magnetic Field
EPA	Environment Protection Authority
EPC	Engineering Procurement Construction
ESD	Ecologically Sustainable Development
FPL	Flood Planning Level
FTE	Full Time Equivalent
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gas
HV	High Voltage
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
LEP	Local Environmental Plan
LGA	Local Government Area
LGC	Large Generation Certificates
LLS	Local Land Service
LV	Low Voltage
MLLS	Murray Local Land Services
MRC	Murray River Council
MSF	Moama Solar Farm
NEM	National Electricity Market
NERR	National Energy Retail Rules
NHMRC	National Health and Medical Research Council
NPfI	Noise Policy for Industry
OEH	Office Environment and Heritage
OEMP	Operations Environmental Management Plan
OHTL	Overhead Transmission Line
UGTL	Underground Transmission Line
PCT	Plant Community Type
PV	Photovoltaic
REAP	Renewable Energy Action Plan
RET	Renewable Energy Target
RFS	Rural Fire Service
RMS	Roads and Maritime Service
RNP	Road Noise Policy
SAT	Single-Axis Tracking System
SEPP	State Environmental Planning Policy
WJRPP	Western Joint Regional Planning Panel

Units of measure

dB(A)	A-weighted decibel
GW	Gigawatt
GWh	Gigawatt Hour
Ha	Hectare
Km	Kilometre
kV	Kilovolt
kV/m	kilo Volts per metre
kW	Kilowatt
kWh	Kilowatt hour
m	Metre
mAHD	Metres Australian Height Datum
m/s	Metres per second
ML	Megalitre
MW	Megawatt
MWh	Megawatt Hour
MWp	Megawatt Peak
µT	micro Teslas

Executive Summary

The proposed Moama Solar Farm is a 28 MW_{AC} electricity generation works that will be comprised of solar photovoltaic modules, steel racking and piled supports, electrical transformers and inverters, electrical cabling, telecommunications equipment, an operations and maintenance building, site switching station and perimeter fencing. Infrastructure will occupy a footprint of approximately 80 hectares.

The generated electricity will be exported into the network through underground connection to Essential Energy's Zone Substation located approximately 2.5 km to the south.

The development is consistent with the Commonwealth's Renewable Energy Target and both the NSW Government's *Renewable Energy Action Plan* and *Climate Change Policy Framework*. At a regional level the development complements the *Riverina Murray Regional Plan's* objectives of diversified energy production, promoting energy supply through renewable energy generation and encouraging renewable energy projects at locations with renewable energy potential and ready access to connect with the electricity network. At a local level the Moama Solar Farm, at the location proposed, is not inconsistent with the land use zoning objectives of Council's *Local Environmental Plan* or conflicts with the *Strategic Land Use Plan* that guides the future development and use of land within the Shire to 2030 and beyond.

The site has a good solar resource and there is available capacity in the existing electricity network.

Once built the MSF will generate approximately 70,000 MWh of clean electricity a year, enough to power over 8,230 households annually during the life of the farm: almost double the electricity demand of all existing homes in the Murray River LGA.

Generating 70,000 MWh/year of clean electricity will also equates to a savings of 58,100 tonnes of greenhouse gas emissions annually.

During the estimated twelve (12) month construction effort it will require a peak workforce of up to 100 on-site and provide economic opportunities in the Moama district. The benefits of the proposed MSF are clear and significant.

The impacts of the development are localised, minor and easily managed. The capacity and development footprint of the farm has been refined through the identification of constraints and opportunities mapped through the environmental impact assessment process. Impacts to native vegetation have been minimised and the site is free of Aboriginal heritage constraints. The site does not contain bushfire prone land and is not in proximity any natural watercourses or wetlands. An existing licenced flood levee provides for protection, and the development of the solar farm would not exacerbate flooding impacts to any third party.

The MSF will not compromise acoustic amenity values for neighbours, nor restrict opportunities for future urban or industrial development at Moama. The development of the 80 ha site would not result in any significant reduction in the agricultural production capacity of the district and the land can be returned to primary production use if the solar farm is decommissioned at the end of the project life. Harvesting sunlight is a passive land use that has no irreversible impact on the productive capacity of the land.

The MSF represents an ecologically sustainable development. There is no risk of serious or irreversible environmental damage. Biological diversity and ecological integrity is being protected. The health, diversity and productivity of the environment is being maintained and enhanced for future generations, and producing carbon free electricity from solar energy embodies the principle of improving how natural resources are valued.

Introduction

1.1 BACKGROUND

Terrain Solar is an Australian owned and operated business that is developing innovative and strategically located solar farms across regional Australia.

The company brings together industry leaders with a strong track record in the development of large-scale renewable energy projects. The team have collectively developed over 2,000 megawatts of renewable energy projects across Australia, South Africa and the Pacific Region and are specialists in the land use, planning, engineering, energy and finance sectors.

Terrain Solar is the development proponent of the Moama Solar Farm (MSF).

1.2 DEVELOPMENT OVERVIEW

The MSF will generate electrical energy by converting solar radiation into electricity through the use of solar PV panels. The farm will operate year-round to generate electricity during daylight hours when electricity demand in NSW is at its peak. The farm will be monitored remotely with a limited on-site presence, apart from routine maintenance.

The farm will consist of solar panels, steel racking and piled supports, inverter stations, electrical cabling, telecommunications equipment, an Operations and Maintenance Building, site switching station, perimeter security fencing and landscape screen plantings.

The solar panels will be similar to those used for domestic purposes and will operate as a single axis tracking system (SAT) which follows the sun during the course of the day to ensure optimal energy generation. The farm will consist of linear strings of mounted panels organised into blocks. Each block will connect to an inverter station that will convert the direct current (DC) energy into grid compatible alternating current (AC) energy.

The farm's switching station will comprise electrical switch gear and protection equipment. The generated electricity will be exported into the network by an underground 22 kV transmission line into Essential Energy's Moama Zone Substation located approximately 2.5 km south of the development site.

The farm will have a generation capacity of 28 MW_{AC} and infrastructure will occupy a footprint of approximately 80 ha.

1.3 DEVELOPMENT LOCATION

The development site is located adjacent the Cobb Highway approximately 5 km north of Moama, NSW (refer **Figure 1**). The site is located within the Murray River Local Government Area (LGA).

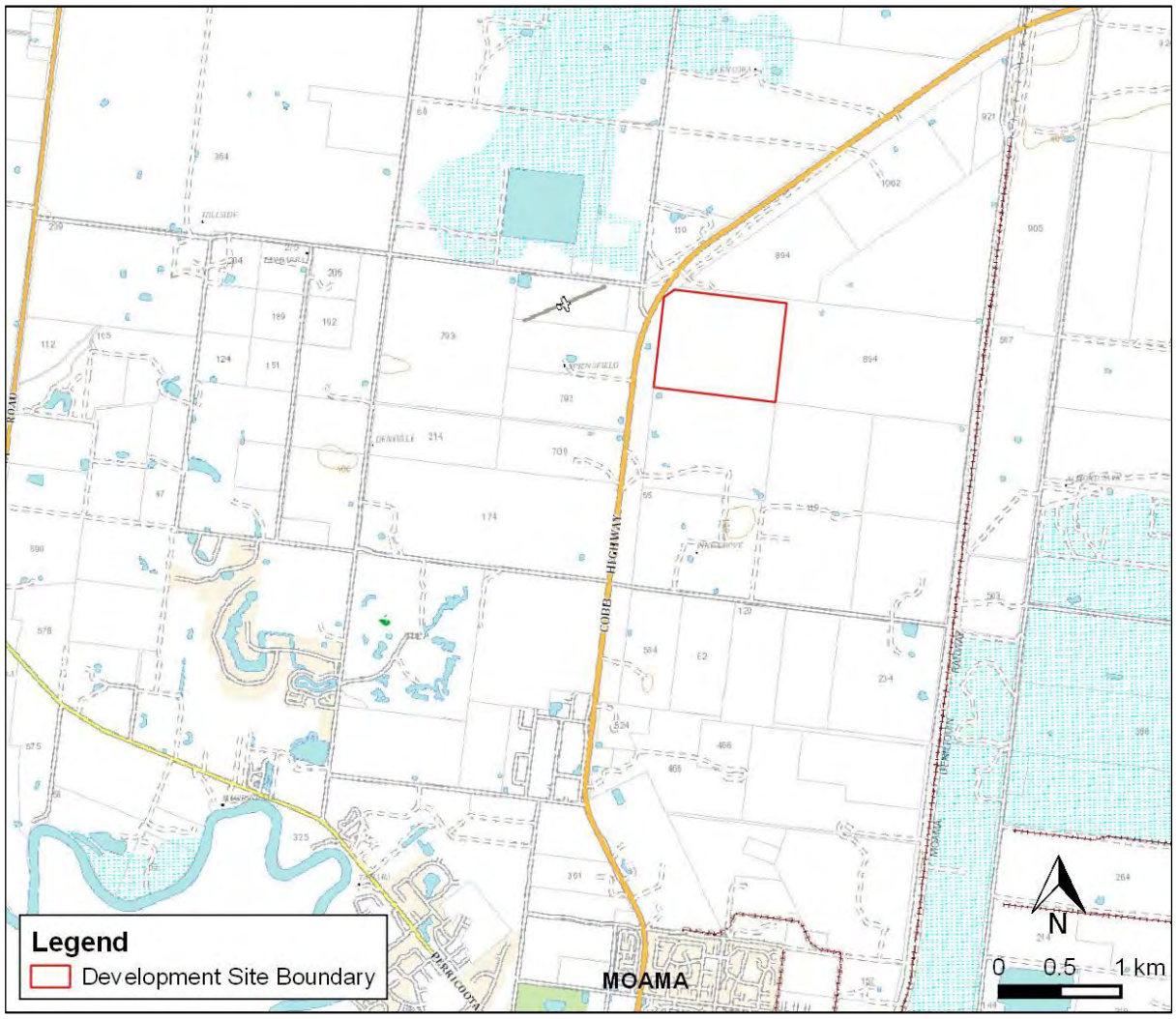


Figure 1: Development Location

1.4 STATEMENT PURPOSE

The construction and operation of the MSF requires development approval under NSW planning legislation. This Statement of Environmental Effects (SEE) has been prepared to support a Development Application (DA) lodged with Murray River Council (MRC).

1.5 STATEMENT SCOPE

1.5.1 SOLAR FARM

This SEE identifies and assesses the environmental impacts associated with the construction, operation, upgrading and decommissioning of the proposed MSF.

1.5.2 GRID CONNECTION

This SEE does not identify or assess the environmental impacts associated with the grid connection. The reason for this is because the grid connection (comprising both the switching station and underground 22 kV feeder back to the Moama Zone Substation will be a 'gifted' asset – subject to further detailed investigations), will be owned by Essential Energy.

Essential Energy's policy is that works associated with their assets must be subject to assessment under Part 5 of the *Environmental Planning and Assessment Act 1979*.

Further, Essential Energy's position is that as the MSF is a development going through a local assessment process under Part 4 (ie. non-state significant development), then Terrain Solar is unable to include the powerline in the DA as Part 4 and Part 5 are mutually exclusive.

This SEE does not identify or assess the environmental impacts associated with the grid connection.

This SEE does, however, provide information about the necessary feeder line, including the proposed location, timing of decision-making, interaction with the timelines of the solar energy project and relevant stakeholders, in order to assist the consideration of all aspects of the project. This approach is consistent with the NSW Government's *Draft – Large Scale Solar Energy Guideline* (November 2017) which notes the following with respect to grid connection.

> ***Planning Approval - Transmission Lines***
>
> *Transmission and distribution lines are usually owned and operated by an electricity transmission operator or distributor (under the Electricity Supply Act 1995, or an 'authorised network operator' under the Electricity Network Assets (Authorised Transactions) Act 2015, rather than the solar energy generation operator. The Infrastructure SEPP makes development for the purpose of an electricity transmission or distribution network permissible without consent when carried out by or on behalf of an electricity supply authority or a public authority. Such development may be assessed under Part 5 of the EP&A Act. The environmental impacts of transmission or distribution lines required for a solar energy SSD project will still be considered in the assessment of the application for the development, even though they are to be assessed under Part 5 of the EP&A Act.*
>
> *In these instances, an applicant should provide information in the EIS about the necessary transmission lines, including the proposed location, timing of decision-making, interaction with the timelines of the solar energy project and relevant stakeholders, in order to assist the consideration of all aspects of the project.*
>
> *Applicants should consult with the relevant transmission operator and distribution network service provider early in the project planning process to clarify responsibilities and the applicable assessment pathways for transmission and distribution infrastructure, available capacity and any requirements with respect to connection to the relevant electricity grid (p.10).*

Whilst the MSF is not a SSD (State Significant Development), the principles and intent behind the NSW Government's draft guidelines have been adopted for the Moama Solar Farm.

Subject to securing approval for the solar farm detailed investigations will then be finalised with the service provider, Essential Energy, with respect to the grid connection.

1.6 STATEMENT STRUCTURE

This SEE has been structured to address those matters for consideration that a consent authority is to take into consideration general in determining a DA pursuant to s.79(c) of the *Environmental Planning and Assessment Act 1979*.

Section 2 describes the proposed development, including a description of associated infrastructure, and the solar farm's construction and operation.

Section 3 identifies the statutory planning context.

Section 4 identifies the process of identifying environmental issues associated with the solar farm.

Sections 5 – 17 identifies the receiving environment and assesses potential impacts associated with the solar farm's construction and operation.

Section 18 collates all environmental safeguards and mitigation measures that form part of the development proposal and the proponent's statements of commitment.

Section 19 provides a development justification.

Section 20 provides a checklist against s.79(c) matters for consideration.

Appendix A – provides an Aboriginal Cultural Heritage Assessment.

Appendix B – provides a Biodiversity Assessment Report.

Appendix C – provides a Noise and Vibration Assessment.

Appendix D – provides a Glare Analysis.

Appendix E – provides a compliance assessment against relevant Development Control Plan provisions.

The Development

2.1 DEVELOPMENT OBJECTIVE

The objective of the MSF is to use solar PV panels to convert sunlight into carbon free electricity which will be sold in the National Electricity Market (NEM), create Large Generation Certificates (LGC) which will be sold to liable entities under the *Renewable Energy Act 2000* and produce electricity that will contribute to the Federal Government's RET of 33,000 gigawatt hours (GWh) by 2020.

2.2 DEVELOPMENT PROPOSAL

The development proposal includes the construction, operation, upgrading and potential future decommissioning of a 28 MW_{AC} PV electricity generating works and associated infrastructure.

2.3 FARM CAPACITY

The MSF will have a capacity of 28 MW_{AC} and once operational will generate approximately 70,000 megawatt hours (MWh) of carbon free electricity annually.

Census data on the number of households by Local Government Area (LGA) from 2016 reported a total of 4,467 occupied dwellings in the Murray River LGA, with an average household size of 2.3 persons.

In October 2017 the Australian Energy Regulator (AER) reported that average annual household electricity usage, in the climatic zone within which Moama is located, for a three person household, is 8,497 kWh (ACIL, 2017).

Based on the above, the energy generated from the MSF will be sufficient to service approximately 8,238 homes annually during the life of the farm: almost double the electricity demand of all homes in the Murray River LGA.

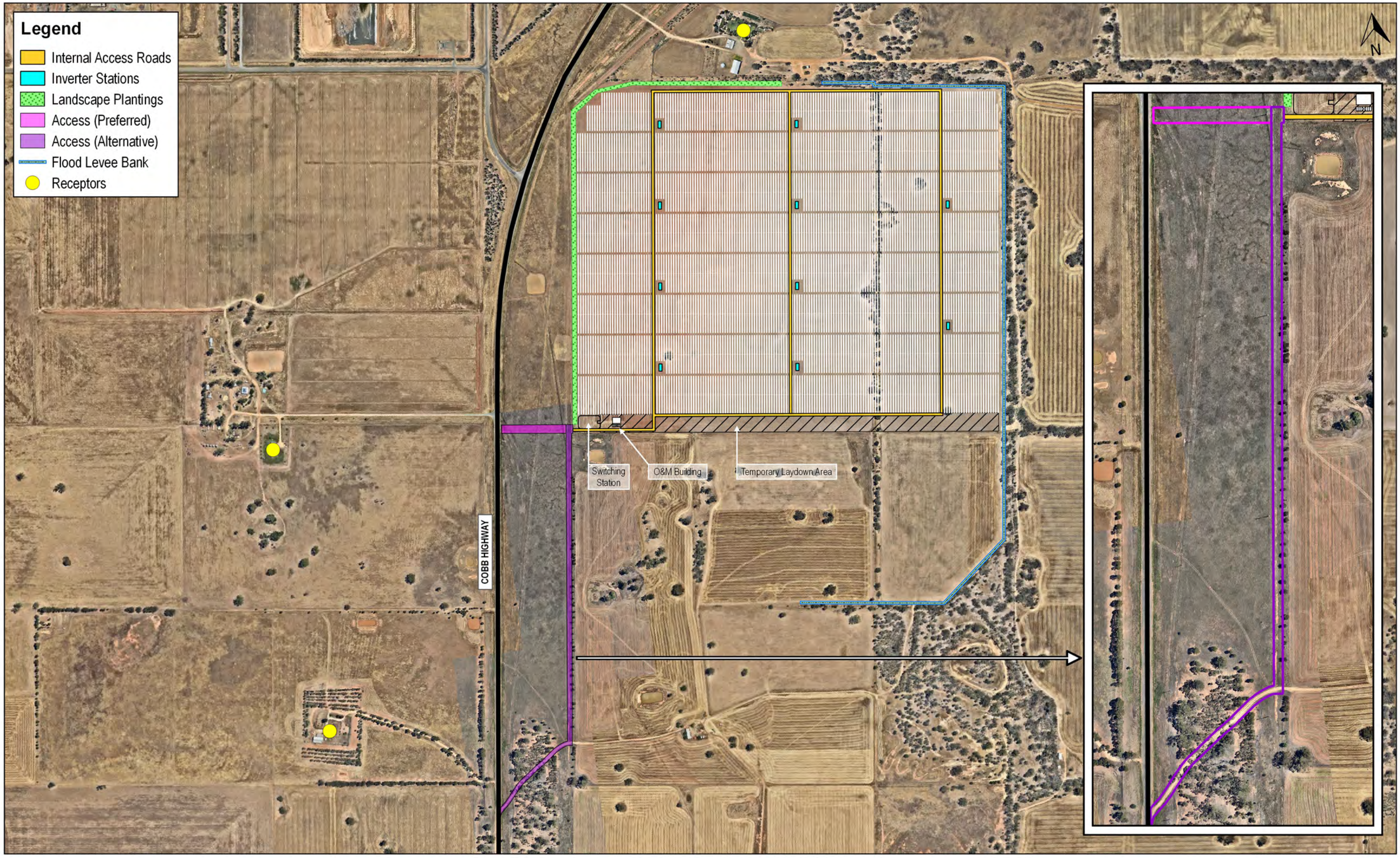
2.4 FARM DESIGN

2.4.1 CONCEPT DESIGN PRINCIPLES

The development footprint of the MSF has been refined through consideration of the results of site investigations, including consideration of potential constraints and opportunities identified during the environmental impact assessment process.

Through this process a 80 ha buildable development footprint has been identified. This development footprint would accommodate all electricity generating infrastructure and facilities associated with the development.

Drawing EV01 identifies the MSF concept layout, showing farm infrastructure inclusive of modules, internal access roads, switching station, O&M building, temporary construction laydown area and the site access options. The layout as shown is indicative and may be subject to minor changes following detailed design and final equipment selection. Notwithstanding, the location, form and extent of the infrastructure footprint is accurate.



GEOLYSE
ORANGE
154 PEISLEY STREET
P.O. BOX 1963
ORANGE NSW 2800
orange@geolyse.com
www.geolyse.com
Ph. (02) 6393 5000
Fx. (02) 6393 5050

GIS PROJECT DETAILS

Datum: GDA 1994 MGA Zone 55 (EPSG: 28355)
Directory: O:\Projects\217\217439\Out\GIS\217439.qgs
Data Source: NearMap (Imagery)
Project Number: 217439

DRAWING SCALE

0 100 200 300 m

A3

APPROVAL AUTHORITY

MURRAY SHIRE

NSW GOVERNMENT Western Joint Regional Planning Panel

CLIENT

TERRAIN SOLAR

PROJECT

MOAMA SOLAR FARM

DRAWING

Name: Concept Farm Plan
Reference: 217439_01A_EV01-EV03
Sheet: EV01 of EV03
Status: Final
Date: 19/02/2018

©2018. Whilst every care has been taken to prepare this map, Geolyse Pty Ltd makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damaged and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

2.4.2 DETAILED DESIGN PROCESS

Contingent on securing planning approval the next step in the MSF project would be to progress to detailed design. Terrain Solar will undertake this through awarding an Engineering Procurement and Construction (EPC) contract. An EPC contract is the most common form of contract used to undertake construction works for utility scale solar farms in New South Wales.

Under an EPC contract a contractor is appointed to deliver a complete project for a fixed price by a fixed date. The EPC contractor carries out the detailed engineering design of the project, procures all the equipment and materials necessary, and then constructs to deliver a functioning facility to their client.

For the MSF Terrain Solar will have an EPC contractor design most elements of the farm and other elements will be designed by Terrain Solar.

As part of the detailed design a suite of very specific and targeted additional site investigations would be completed. These investigations are undertaken to 'lock-in' a final farm layout and inform the need for or extent of any preparatory earthworks around the solar arrays as required to meet structural tolerances for the tracker equipment, or site specific construction methodologies that may be required to mitigate potential impacts.

Development consent is a standard and logical 'hold-point' on projects before progressing to detailed design. It not only defers some project expenditure until there is greater project certainty, it also ensures all relevant consent conditions can be incorporated into the detailed design process.

The need to secure approval on a Construction Environmental Management Plan (CEMP), before works can commence, provides the regulatory check and mechanism for ensuring that what is built, and how, is consistent with the development consent and complies with all consent conditions.

2.5 FARM LAYOUT

2.5.1 ELECTRICAL GENERATION EQUIPMENT

The solar PV panel technology will be either crystalline silicone or Cadmium Telluride thin film. The panel modules will be connected together via a DC collection system consisting of cables mounted on the module support structure. The tracking system will be Single Axis Tracking (SAT).

Fixed tilt systems hold the modules in a fixed orientation in relation to the sun and have no moving parts. A SAT system tracks the daily movement of the sun and motorised linkages rotate the modules from the east in the morning to the west in the afternoon; constantly aligning towards the sun to maximise energy output performance.

The modules are laid out in rows or strings, typically 5-7 m apart, depending on the technology used. The relative flatness of the MSF site will lead to optimal spacing without output being affected by shading of adjacent strings. The racking system will be supported by steel piles. These are either hollow or C-sections or I beams which are either driven into the ground, screw piled or pre-drilled and driven into place.

Inverters convert the DC current to AC current and medium voltage transformers increase the voltage to the collection system rating. Contingent on detailed design and procurement, the MSF will have up to 10 inverter stations. These inverter stations will be positioned throughout the module arrays with each power block of the solar farm corresponding to the capacity of the inverter station.

The AC collection system will consist of cabling at 22 kV which will connect to each inverter station and deliver the farm's electricity to a site switching station.

The location of the switching station is in south west corner of the solar farm. The switching station will consist of a secure enclosure with several items of electrical equipment and supporting structures. This will include switch gear, protection equipment and a small control room. The equipment and structures will be installed on concrete foundations and the switching station yard will be kept free of vegetation.

2.5.2 GRID CONNECTION

Grid compliant energy will be delivered to the network by a 22 kV underground transmission line (UGTL) from the MSF's switching station, connecting to Essential Energy's Moama Zone Substation located approximately 2.5 km south of the farm. The MSF has been sized to take advantage of available capacity in the network. Studies are currently underway to design the connection and to identify the technical requirements for the operation of the farm.

2.5.3 ANCILLARY INFRASTRUCTURE

An Operations and Maintenance (O&M) building will be located in the south western corner of the farm. Staff will utilise this building during commissioning in order to advance the farm to its operational readiness. Once the farm is operational staff will occasionally visit the building as needed to monitor the performance of the farm and to diagnose faults. From the building there will be communications connections to the electricity market operator, Essential Energy and the operation's team.

The building will provide basic amenities (sink and toilet), with a rainwater tank providing the water supply and a proprietary sewage treatment system for the minor volumes of domestic grade effluent that will be generated. The latter will be subject to a future application for a s.68 approval under the *Local Government Act 1993*.

2.5.4 SECURITY FENCE

A security fence will be installed around the solar farm perimeter. This fence will be up to 2.1 m chain link with three barbs on top, for a total height of up to 2.4 m.

Inside this fence a 10 m wide asset protection zone (APZ) will be maintained to provide for bush fire control and tanker access.

2.5.5 LANDSCAPE PLANTINGS

On the western half of the northern boundary, and along the full western boundary that fronts the Cobb Highway, landscape screen plantings are proposed.

These plantings will be located on the outside of the security fence.

2.6 FARM CONSTRUCTION

2.6.1 DEVELOPMENT PROGRAM

Construction is estimated to take up to 12 months with an indicative scheduled program of activities provided below.

MOAMA SOLAR FARM INDICATIVE PROJECT SCHEDULE																		
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Detailed Design																		
Civil Design																		
Structural and Mechanical Design																		
Electrical Design																		
Grid Connection Design																		
Procurement																		
Piling																		
Modules																		
Inverters																		
Cabling																		
Switching Station																		
Construction																		
Mobilisation																		
Site Preparations, survey and set-out																		
Civil Works																		
Trenching and Conduits																		
Piling																		
Module / Tracker Installation																		
Inverters and Cabling																		
Grid connection Works																		
Commissioning																		

Figure 2: Indicative Project Schedule

2.6.2 SITE ACCESS

The first task will be establishing a fit-for-purpose access off the Cobb Highway to enable vehicles to safely enter and exit the development site. The development site is not currently provided any direct access off the Cobb Highway, or any public road. As detailed in **Section 10**, Terrain Solar's preferred access is located adjacent to the southern boundary of the development site. An alternate access is located approximately 900 m further south, utilising an existing access track. Consultation with the property owner that uses this track to access their property has established that they have no concerns or objection to the use of this track for this purpose.

The alternate access is a back-up option and is required because of the potential occurrence of the critically endangered *Prasophyllum* sp. 'Moama' and *Pterostylis despectans* at the location of the preferred access, and to accommodate project scheduling. A specialist Expert Report (refer **Appendix B**) has determined that there is a 'moderate' likelihood of occurrence in the preferred access, and that targeted surveys are required to establish its presence, or not. The requisite survey window is October-November for the *Pterostylis despectans* and September for the *Prasophyllum sp. 'Moama'*.

Assuming either of these species is not in the location of the preferred access, or that an access treatment can be constructed at this location if they are present, but without a likely significant impact on this species, then the intent is to utilise the preferred access location. If the species are present, or construction of the access road into the solar farm can't be constructed without a likely significant impact on these species, then the alternate access location is proposed. A mitigation measure that forms part of the development is to provide the Office of Environment and Heritage, Murray Local Land Services and Murray Regional Council the results of these targeted surveys if the preferred access is intended.

In either case, access will be off the Cobb Highway and traverse the Travelling Stock Reserve. Consultation with Murray Local Land Services (MLLS) has confirmed there is no in-principle issue with the TSR interaction; noting that the *Local Land Services Act 2013* allows occupiers of land a right of access over travelling stock reserves, in certain circumstances and subject to certain requirements.

2.6.3 SITE PREPARATION

Site facilities and construction laydown areas will be established within the development footprint and construction equipment will then be mobilised to the site. The security fence will then be erected.

The internal roads will then be formed and any site levelling completed to provide for the necessary PV panel ground clearance tolerances. Due to the flat nature of the site it is noted that the extent of earthworks required is expected to be negligible.

2.6.4 SWITCHING STATION

The site switching station will also be commenced at this phase. Civil works will be required to prepare the base including establishment of slab foundations and cable trenches. Concrete slab foundations will be poured and a gravel base will be laid down to create an all-weather compound. The site preparation and switching station construction will require the use of plant such as bulldozers, water trucks, graders, flatbed trucks, skid steers, front end loaders, roller compactors, trenchers, backhoes, gravel trucks, cranes and aerial lifts.

2.6.5 SOLAR PV MODULES

Following site preparation the supporting structures and the solar modules will be installed. The site will be surveyed and locations of all the major equipment will be pegged or marked on the ground. The hollow sections or flanged sectioned steel piles which support the racking system will be driven into the ground pneumatically or alternatively, holes will be screwed or bored and the piles will be either driven or grouted in position.

Piles may be cut off to height and the steel racking assembly will be attached according to the manufacturer's proprietary system. The solar PV modules will then be installed on the racking and secured in position to withstand wind loading. Once the modules have been installed the DC collection cables will be laid on the structure and terminated to the modules.

This phase will require the use of equipment including all-terrain plant like telehandlers, pile drivers, augers, forklifts, welders, oxy acetylene, trenchers, excavators, pickup trucks, water trucks, flatbed trucks and cranes.

2.6.6 INVERTER STATIONS AND ELECTRICAL COLLECTION SYSTEM

Once the PV modules have been installed, or in parallel with the post installation, cable trenches will be excavated and AC and DC cables will be laid. Trenches will be backfilled with excavated material or imported thermal fill and cables will be terminated to the modules. Trench details are determined by *Australian Standards* and voltage specifications. The medium voltage cables will be terminated to the inverter stations. Testing and quality assurance will be carried out as connections are made.

2.6.7 COMMISSIONING

Once all the inverter stations and electrical collection system has been installed commissioning of equipment will be undertaken. Commissioning will include terminations, testing, calibration and troubleshooting. The inverters, transformers, collection system, solar PV array and switching station will be tested prior to commencement of commercial operations to ensure any system issues are rectified. Upon completion of successful pre-functional testing the solar farm, and grid connection to Essential Energy's Moama Zone Substation, the farm will be ready to export electricity.

2.6.8 CONSTRUCTION COMPOUND

To facilitate construction there will be a construction compound containing site offices and amenities, vehicle parking and equipment laydown areas.

2.6.9 CONSTRUCTION WORKFORCE

Over the twelve (12) month construction effort the demand for labour will vary depending on the site activities being undertaken. Installation and commissioning of modules is labour intensive and employment is expected to peak at approximately 100 on-site workers involved directly in project construction. This peak period is expected to extend over a six (6) month period. Outside this peak the workforce is expected to drop to 20 or less.

These jobs will include construction managers, electricians, fitters, various plant operators, mechanics and other skilled and semi-skilled labour, including general labourers.

Terrain Solar's intent is to award a contract to an Engineering, Procurement and Construction (EPC) contractor that has a commitment to maximise local employment opportunities.

2.6.10 MATERIALS AND RESOURCES

2.6.10.1 Water

Water demand during construction will be limited to that required for dust mitigation and/or moisture conditioning of material, as well as a potable supply for construction staff. The former will be sourced from a legal supply point and trucked to the site in a bulk tanker. The potable supply will be provided through bottled water.

Dry port-a-loos will be provided for amenities throughout construction negating the need for on-site domestic sewage treatment.

The development does not require access to either reticulated water or sewerage services.

2.6.10.2 Sand and Gravel

The establishment of internal access roads and compacted hardstand areas around the construction compound will require gravel. Sand will be required for the bedding of cabling in the trenches before backfilling. These materials will be sourced from local suppliers.

2.6.11 HOURS OF WORK

Construction activity is proposed to be undertaken generally in accordance with the Environment Protection Authority's (EPA) recommended standard hours for construction; these being:

- 7 am to 6 pm Monday to Friday
- 8 am to 1 pm on Saturday
- No works on Sunday's or Public Holidays.

Further detail on the opportunity to undertake some works outside these standard hours is provided in **Section 8**.

2.7 FARM OPERATION

2.7.1 MAINTENANCE ACTIVITIES

Following commissioning the MSF will begin operating with the production of electricity fed into the electricity grid. The solar modules will operate during daylight hours, seven days per week, 365 days a year.

Up to three (3) employees will be stationed on-site. The farm will also be monitored remotely from an off-site location and apart from a routine maintenance program, specialist operators will only visit the farm when responding to any performance issues (i.e. where actual output measured by the monitoring system deviates from generation forecasts and other key performance metrics).

Activities at the farm that will be part of a routine maintenance program will generally be limited to:

- Equipment, cabling, switching station and communications system inspection, maintenance and testing, and repair and replacement as required.
- Fence, access and internal road, and control room maintenance and management.
- Vegetation (fuel load), weed and pest management.
- Possible solar PV module washing on an as-needed basis.
- Security monitoring.

2.7.2 SOLAR PV MODULE WASHING

Water use for regular washing of modules is not expected to be required. In the event of an abnormal soiling event (e.g. due to a particularly severe dust storm) water would be trucked to the site and the modules cleaned with a portable pressure washer without the use of any detergent or cleaning agent.

2.7.3 FUEL MANAGEMENT

Fuel management will be a key ongoing activity targeting bushfire risk prevention. Groundcover within the solar farm will be proactively managed to avoid excessive fuel loads (which would also compromise the solar farm's performance) and prevent the proliferation of any noxious weeds.

2.8 FARM UPGRADING

Upgrading of the farm would include the augmentation and/or replacement of solar panels and ancillary infrastructure within the development footprint.

2.9 FARM DECOMMISSIONING

It is proposed that no later than 12 months before the intent to decommission the MSF the owner of the MSF will provide a Decommissioning Management Plan (DMP) to MRC for approval.

The DMP would detail what decommissioning would entail and how it would be conducted. The primary objective of the DMP would be to restore the land capability to its pre-existing agricultural value and use.

Statutory Planning

3.1 DEVELOPMENT SITE

Infrastructure associated with the solar farm will be located on lands as described in **Table 3.1** and shown on **Drawing EV02**.

Table 3.1 – Development Land

Development Component	Lot/Deposited Plan
Solar Farm	Lot 71 DP 751152 Lot 112 DP 751152 Lot 114 DP 751152

3.2 PERMISSIBILITY

Pursuant to *State Environmental Planning Policy (Infrastructure) 2007:*

- an electricity generating works means a building or place used for the purpose of making or generating electricity; and
- a solar energy system means, amongst other things, a PV electricity generating system.

The MSF will be both a place used for the making of electricity and a PV electricity generating system. The MSF is therefore both an electricity generating works and a solar energy system.

Development for the purpose of electricity generating works may be carried out by any person with consent on any land in a prescribed rural zone. The development site, zoned RU1 – Primary Production under the *Murray Local Environmental Plan 2011* (Murray LEP), is a prescribed rural zone.

A solar energy system is permitted with consent on any land.[1]

The MSF is a permissible development subject to securing development consent.

The development site is not mapped riverine land pursuant to the *Murray Regional Environmental Plan No 2 - Riverine Land*.

3.3 REGIONAL PLANNING PANEL

The MSF is an electricity generating works with a capital investment value of more than $5 million and pursuant to Schedule 4A of the *Environmental Planning and Assessment Act 1979* constitutes a regional development. As such, the responsibility for determining the DA is conferred upon the Western Joint Regional Planning Panel (WJRPP).

The MSF does not have a capital investment value >$30 million and is not a state significant development.

3.4 INTEGRATED DEVELOPMENT

The MSF is not integrated development on the basis that no other approvals or consents pursuant to s.91 of the *Environmental Planning and Assessment Act 1979* are required to facilitate the development.

[1] The exception to this is a system > 100 kW on residential land – which is not the case for the MSF project.

Legend

- Development Site Boundary
- Cadastre
- Solar Farm Footprint
- Access (Preferred)
- Access (Alternative)

COBB HIGHWAY

N

Lot 112
DP751152

Lot 71
DP751152

Lot 114
DP751152

COBB HIGHWAY

GEOLYSE
ORANGE
154 PEISLEY STREET
P.O. BOX 1963
ORANGE NSW 2800
orange@geolyse.com
www.geolyse.com
Ph. (02) 6393 5000
Fx. (02) 6393 5050

GIS PROJECT DETAILS

Datum: GDA 1994 MGA Zone 55 (EPSG: 28355)
Directory: O:\Projects\217\217439\Out\GIS\217439.qgs
Data Source: NSW Spatial Services (Cadastre)
Project Number: 217439

DRAWING SCALE

0 100 200 300 400 500 m

A3

APPROVAL AUTHORITY

MURRAY SHIRE

NSW GOVERNMENT Western Joint Regional Planning Panel

CLIENT

TERRAIN SOLAR

PROJECT

MOAMA SOLAR FARM

DRAWING

Name: Development Site
Reference: 217439_01A_EV01-EV03
Sheet: EV02 of EV03
Status: Final
Date: 19/02/2018

©2018. Whilst every care has been taken to prepare this map, Geolyse Pty Ltd makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

3.5 CONCURRENCE

Construction of the access off Cobb Highway will require works on a public road. Under the *Roads Act 1993* (the Act) a person must not carry out a work in, on or over a public road without the consent of the appropriate roads authority. The Cobb Highway is a classified road and Murray River Council (MRC) is the roads authority pursuant to s.7(4) of the Act. The application is therefore not integrated pursuant to s.91(3) of the *Environmental Planning and Assessment Act 1979* on the basis that MRC is both the consent authority and the roads authority.

Notwithstanding, MRC, as the roads authority, may not grant consent to works affecting a classified road without the concurrence of Roads and Maritime Service (RMS) pursuant to s.138(2) of the Act.

3.6 STATE PLANNING POLICIES

3.6.1 SEPP 55 - REMEDIATION OF LAND

A search of the NSW EPA *List of NSW contaminated sites notified to EPA* and the *Contaminated Land Record* did not identify contaminated sites at or near the site. The draft *Moama and District Rural Residential Strategy* (Zenith, 2017) states there are no contamination potential in the vicinity of the development site. MRC has also confirmed that there are no contamination records for the development site. The Pursuant to Clause 7 of *State Environmental Planning Policy No 55 – Remediation of Land* there is no apparent reason to consider that land to be disturbed by the proposed development would be contaminated.

3.6.2 SEPP – RURAL LANDS 2008

Pursuant to clause 2 of the Rural Lands SEPP the aims of the policy include:

> *(a) to facilitate the orderly and economic use and development of rural lands for rural and related purposes,*
>
> *(b) to identify the Rural Planning Principles and the Rural Subdivision Principles so as to assist in the proper management, development and protection of rural lands for the purpose of promoting the social, economic and environmental welfare of the State,*
>
> *(c) to implement measures designed to reduce land use conflicts,*
>
> *(d) to identify State significant agricultural land for the purpose of ensuring the ongoing viability of agriculture on that land, having regard to social, economic and environmental considerations,*
>
> *(e) to amend provisions of other environmental planning instruments relating to concessional lots in rural subdivisions.*

The site is not identified as being state significant agricultural land under the Rural Lands SEPP.

The MSF will not compromise the orderly and economic use and development of rural lands for rural and related purposes, compromise the proper management, development and protection of rural lands for the purpose of promoting the social, economic and environmental welfare of the State, increase land use conflicts or impact significantly on state significant agricultural land.

3.6.3 SEPP 44 – KOALA HABITAT PROTECTION

SEPP 44 encourages the conservation and management of natural vegetation areas that provide habitat for Koalas to ensure that permanent free living populations will be maintained over their present range. Murray LGA (and by extension Murray River LGA) is listed as a Local Government Area to which the SEPP applies. The ecological survey and assessment undertaken as part of site investigations did not record habitat for the Koala or the presence of any resident population of Koalas.

3.6.4 SEPP 33 – HAZARDOUS AND OFFENSIVE DEVELOPMENT

The proposed MSF does not pose a significant risk in relation to the locality to human health, life or property, or to the biophysical environment. It is not a potentially hazardous industry. Similarly, the MSF would not emit a polluting discharge which would have a significant adverse impact in the locality or on the existing or likely future development on other land. The proposed MSF is neither a hazardous nor offensive industry.

3.7 COMMONWEALTH LEGISLATION

3.7.1 ENVIRONMENT PROTECTION BIODIVERSITY CONSERVATION ACT

Referral to the Australian Government Minister for the Environment under the Commonwealth's *Environment Protection Biodiversity Conservation Act 1999* is not required (refer **Appendix B**).

3.7.2 RENEWABLE ENERGY ACT 2000

The *Renewable Energy Act 2000* establishes solar as an eligible energy source under the Commonwealth's RET. Creating LGC's from the MSF, which can then be sold to liable entities, is subject to the approval of the Clean Energy Regulator pursuant to the *Renewable Energy Act 2000.*

Environmental Issues

4.1 IDENTIFYING POTENTIAL CONSTRAINTS

The process of identifying key potential environmental issues associated with the construction and operation of the MSF commenced with a preliminary desktop risk assessment that identified the likely planning and environmental issues associated with the development and discussions with MRC in a Pre-Lodgement Meeting.

Site inspections and specialist surveys were then completed to ground truth the biophysical data sourced from the desktop assessment and inspect the features in and around the development site.

The objective has been to accurately identify and map features of the development site and its surrounds that could represent a design constraint and to inform the impact assessment methodologies.

4.2 ENVIRONMENTAL ISSUES

The following have been identified as the key potential environmental issues associated with the MSF:

- Land Use
- Aboriginal Heritage
- Biodiversity
- Amenity values for neighbours (visual and noise impacts)
- Access
- Flooding

Other environmental issues include:

- Water quality
- Air quality
- Waste management
- Electromagnetic Interference

Land Use

5.1 ZONE OBJECTIVES

The development site is located on land zoned RU1 – Primary Production under the *Murray Local Environmental Plan 2011* (Murray LEP). The objectives of this zoning are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.

A solar farm is not inconsistent with these objectives.

It will not diminish or degrade the natural resource base. To the contrary, as a passive land use harvesting sunlight a solar farm provides a capacity to reduce impacts on soil and water resources compared to farming and grazing, and have no off-site impact that would compromise the continued use of neighbouring lands for primary production purposes.

It will not fragment or alienate resource lands, nor create conflicts between land uses within this zone and/or existing and future planned land uses within adjoining zones.

Whilst the MSF will impact on the existing rural landscape character of the subject land, as detailed below, the landscape character in the general vicinity of the MSF will also undergo minor change due to the presence of general industrial activities.

As shown in **Figure 3** the development site is located adjacent to lands zoned IN1 - General Industrial, with the objectives of this zone:

- To provide a wide range of industrial and warehouse land uses.
- To encourage employment opportunities.
- To minimise any adverse effect of industry on other land uses.
- To support and protect industrial land for industrial uses; and
- To define and consolidate the existing industrial area in and near Moama.

Permitted activities in this industrial zoning include Depots; Freight transport facilities; Funeral homes; Garden centres; General industries; Hardware and building supplies; Heliports; Industrial training facilities; Kiosks; Landscaping material supplies; Light industries; Neighborhood shops; Places of public worship; Plant nurseries; Roads; Rural supplies; Take away food and drink premises; Timber yards; Vehicle sales or hire premises and Warehouse or distribution centres.

A solar farm, at the location proposed, is not inconsistent with these land use objectives nor would it compromise industrial land use opportunities in this zoning, or create land use conflicts.

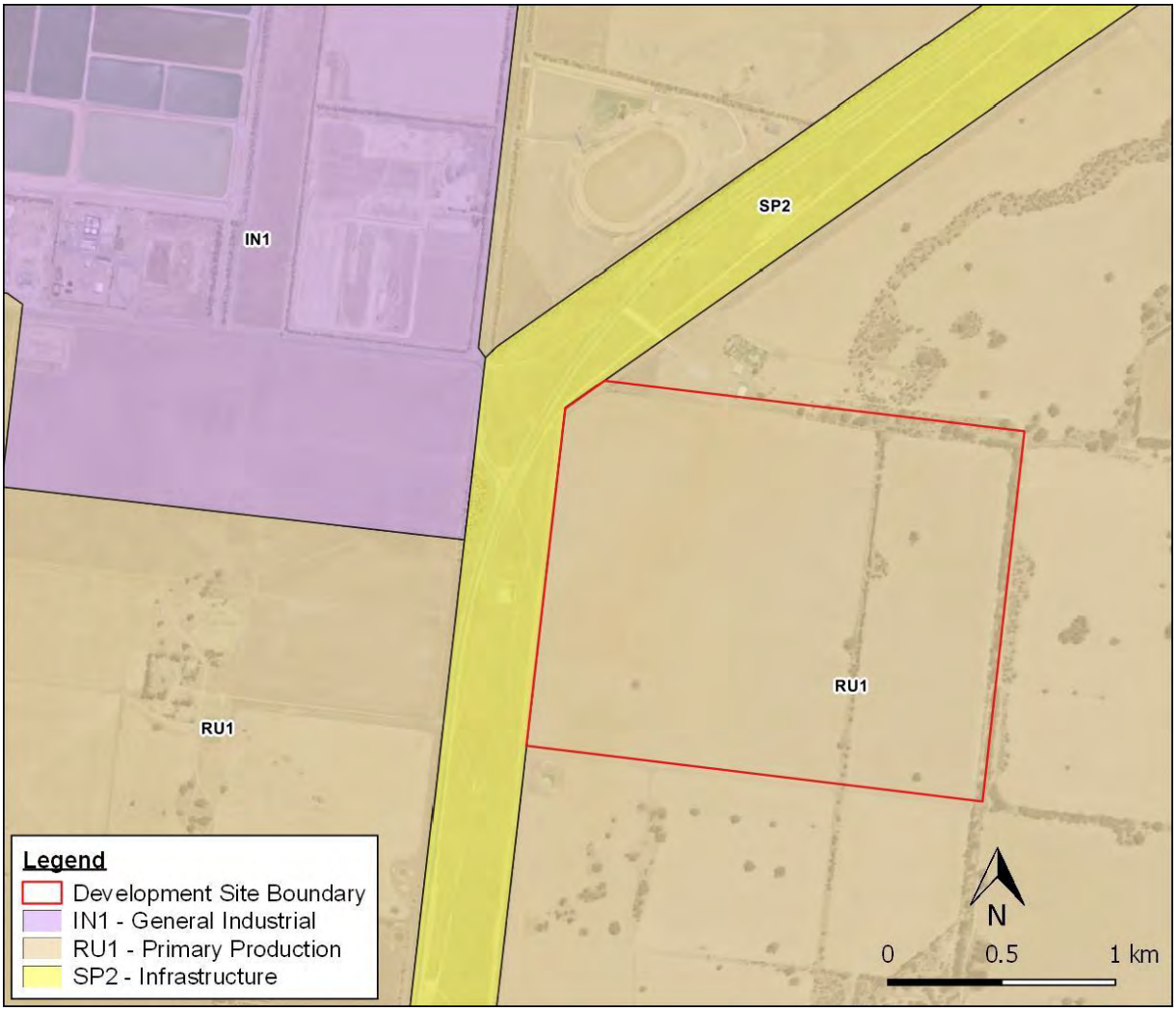


Figure 3: Land use zoning

5.2 STRATEGIC SUITABILITY

The prospect of future residential encroachment upon the solar farm is highly unlikely. Similarly, the use of the land for a solar farm at the location proposed will not compromise the capacity for Council to accommodate future growth at Moama.

The *Murray Shire Strategic Land use Plan 2010-2030* (the 'Plan') was prepared to guide the future development and use of land within the Shire to 2030 and beyond. The Plan noted that land east of the Cobb Highway and flood levee around Moama is flood prone.

This was identified as severely constraining the eastern expansion of Moama for urban purposes and essentially confirmed that the future growth of the township could only be in a north-westerly direction generally between Perricoota Road and the Cobb Highway.

The Plan also identified the area west of Twenty-four Lane as suitable for rural residential development (refer **Figure 4**).

The Plan noted that no urban expansion or intensification of development should take place on land that is located east of the Cobb Highway and subject to a 1:100 year flood event and not protected by the town flood levee. All urban expansion, including rural residential development should therefore be to the west of town.

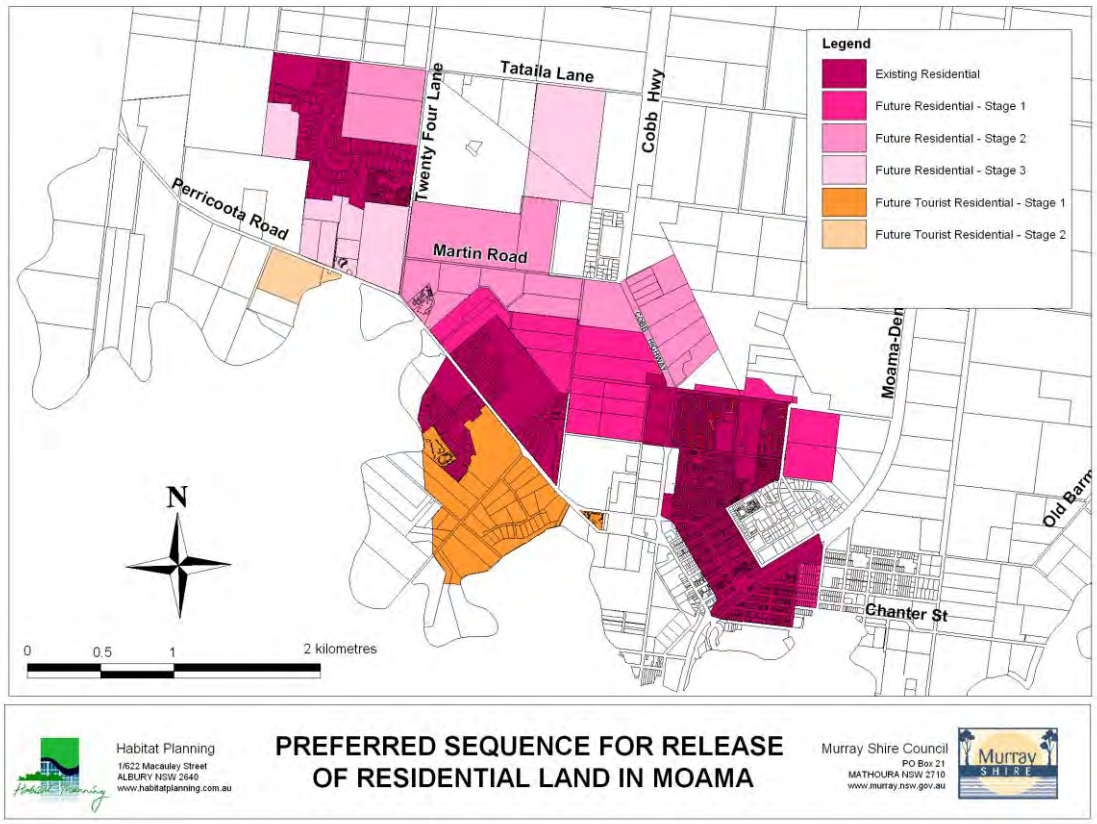


Figure 4: Murray Shire Strategic Land Use Plan

More recently (March 2017) the draft *Moama and District Rural Residential Strategy* (the "Strategy") was placed on public exhibition. The primary aim of the Strategy is to identify rural residential development opportunities in the vicinity of the township of Moama. It is also an aim of the Strategy to identify short, medium and long term rural residential land releases to assist Council to co-ordinate the orderly and economic use and development of land surrounding Moama.

One of the study areas (Study Area 1) considered in the Strategy extends over the proposed MSF site (refer **Figure 5**) while another of the study areas (Study Area 2) is immediately west of the proposed MSF site (refer **Figure 6**).

In terms of these areas' potential for rural residential development, the Strategy included an analysis of the suitability of each and concluded:

- On balance and primarily due to being flood prone, Area 1 is not considered suitable for rural residential development.
- Within Area 2, land to the east of Twenty Four Lane and fronting the Cobb Highway comprises twelve 40 hectare lots. Some of this land is under cultivation and the north-western allotment is zoned IN1 General Industrial. As direct access to the Cobb Highway would not be supported by Roads and Maritime Service, internal roads would need to be created that would result in rear yards and fences to the highway. This would detract from the surrounding rural landscape and have adverse visual impacts to motorists. There is potential for land use conflict between existing and future industrial uses including the sewer treatment plant and neighbouring rural residential uses due to dust, odours, noise, truck movements and the like.

Figure 5: Moama & District Rural Residential Strategy (Area 1)

Figure 6: Moama & District Rural Residential Strategy (Area 2)

Despite being relatively unconstrained Area 2 is not considered suitable for rezoning to permit rural residential development at the time of writing this Strategy and should remain zoned for rural uses until such time as additional urban or rural residential land is required. There are other sites considered more suitable and able to provide an adequate supply of land for rural residential development.

> The Strategy notes, however, that as Moama grows and land supply shrinks Area 2 should be further investigated to provide for rural living or as an extension of the urban residential zone. It also notes, however, that the gradual or staged development of this land (the eastern extent of Area 2) may necessitate buffers to agricultural and industrial uses on adjoining land to be applied through an amendment to the Murray DCP 2011 in order to avoid land use conflict due to spray drift, odours and machinery noise, and (relevant to the proposed MSF), screening of rear yards by vegetation may also be required between setbacks to lots and the Cobb Highway.

Based on the above strategic land use planning documents the prospect of future residential encroachment and the diminution of existing buffers between the proposed MSF and residential receptors is highly unlikely on the eastern side of the Cobb Highway. Any possible future residential encroachment on the western side of the Cobb Highway would also be separated through vegetation screening and setbacks.

And for context, the Strategy notes that Area 2 would only be considered for further investigation if the supply of land zoned R5 or RU4 is 10 years or less or the take-up of rural residential land resulting from the Strategy is higher than anticipated and supply is constrained. In this scenario, further investigation of Area 2 would need to be carried out to assess the suitability for the allocation of dwelling entitlements to existing lots by way of an amendment to the Lot Size Map, or, depending upon the nature of demand, rezoned to R5 Large Lot Residential or RU4 Primary Production Small Lots and made available to be subdivided for smaller rural residential lots. Alternatively, if the supply of residential land reaches a critical low point in the future then Council may seek to investigate the potential to rezone this area for the expansion of the urban settlement of Moama. Residential encroachment on the western side of the highway is a remote and distant possibility only.

The MSF, at the site proposed, will not compromise future opportunities for accommodating the planned urban growth in Moama.

5.3 POTENTIAL IMPACTS

Potential land use impacts associated with the construction, operation and (possible) future de-commissioning of the solar farm in 30 years include the following:

- loss of agricultural land;
- creating land use conflicts through compromising the continued use of adjoining lands for primary production purposes by neighbours; and
- restricting access to mineral resources.

Each of these potential impacts is discussed below.

5.3.1 LOSS OF AGRICULTURAL LAND

The land to be occupied by the development is not mapped as Biophysical Strategic Agricultural Land (BSAL) and the site is not identified as being state significant agricultural land under the Rural Lands SEPP.

The development site is not irrigated country.

Approximately 1,012,762.6 ha (85%) of the land in the Murray River LGA is zoned RU 1 – Primary Production for rural purposes. The 80 ha development footprint would occupy 0.008% of this land. The solar farm will not compromise or significantly diminish the availability of land for primary production purposes in the Moama district and wider LGA.

Nor, as a land use, would the solar farm result in an irreversible impact that would compromise the ability for the land to be returned to primary production in the future.

As a manager of land in a rural environment, the owners of the MSF will, like their neighbours, have responsibilities to manage the land appropriately. In particular this will include obligations to manage any noxious weeds and to control fuel loads. Standard management techniques for ensuring these outcomes can be implemented include slashing and/or crash grazing, and treatment (spot spraying) of any noxious weeds.

With the financial return on the land linked to solar generation rather than grazing or cropping, there will be an enhanced capacity to retain groundcover at all times. The 30 – 50 year use of the 80 ha as a solar farm would provide benefits to the land in terms of soil health (i.e. less disturbance associated with farming, less compaction from grazing, enhanced ability to retain a groundcover, etc) and an improvement to organic carbon levels in the soil can be realistically expected.

A solar farm compared to dryland broad-acre farming and grazing is a passive land use that would effectively rest the soil resource.

At the end of the project life, if the owner of the MSF determines that it will decommission the solar farm and the land reverted to agricultural use then the land needs to be 'fit-for-purpose'. Decommissioning would entail the following:

- Disconnection from the Essential Energy substation.
- Removal of the solar farm switching station.
- Removal of inverter stations, modules, racking system and posts.
- Removal of the O&M building and foundations.
- Removal of security fencing.
- Rehabilitation of access tracks.

5.3.2 PRIVATE AIRSTRIP

As demonstrated in **Section 9.2.2** the proximity of the solar farm to the private airstrip located 1.7 km to the south would not cause glare issues or a hazard to aircraft operations and pilots using this airstrip.

5.3.3 TRAVELLING STOCK RESERVE

Either the preferred or alternate access to the solar farm site from the Cobb Highway (refer **Section 2.6.2**) requires traversing the Travelling Stock Reserve. Consultations with Murray Local Land Services (MLLS) has confirmed that, subject to appropriate controls in accordance with s.75 of the *Local Land Services Act 2013*, a right of way can be established over sections of the TSR and MLLS has no in-principle objection to this happening.

5.3.4 LOSS OF MINERAL RESOURCES LAND

Review of the DP&E online MinView database confirms that there are no mining or exploration titles or applications affecting the development site.

5.4 CONCLUSION

The proposed MSF would not compromise the capacity for neighbours to continue existing or future primary production or industrial land uses. The existing and likely future surrounding agricultural and industrial land uses are known and the MSF is not an incompatible land use with a potential to create land use conflicts. The MSF is not a threat to continued primary production or industrial activities by neighbours or future neighbours. It will not compromise or significantly diminish the availability of land for primary production purposes in the Moama district and wider LGA. As a land use it will not result in an irreversible impact that could compromise the ability for the land to be returned to primary production in the future. At the location proposed it does not impede Council's plans for accommodating future residential growth at Moama.

The MSF represents a high value and benign use of land at a location that is compatible with Council's strategic land use objectives.

Heritage

6.1 ABORIGINAL HERITAGE

6.1.1 LEGISLATIVE CONTEXT

Aboriginal objects and places are protected in New South Wales under Part 6 of the *National Parks and Wildlife Act 1974* (NPW Act). Section 90 of the NPW Act requires an Aboriginal heritage impact permit (AHIP) for harm to an Aboriginal object or Aboriginal place. Significant penalties are in place for harm to Aboriginal objects or places regardless of whether the harm was committed knowingly or not. Defences against prosecution include impacts in compliance with an AHIP, acting in accordance with specified codes of practice or the conduct of certain low impact activities. The Act defines an Aboriginal object as:

> *any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises NSW, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains.*

Harm is defined as:

> *any act or omission that: (a) destroys, defaces or damages the object or place, or (b) in relation to an object—moves the object from the land on which it had been situated, or (c) is specified by the regulations, or (d) causes or permits the object or place to be harmed in a manner referred to in paragraph (a), (b) or (c), but does not include any act or omission that: (e) desecrates the object or place, or (f) is trivial or negligible, or (g) is excluded from this definition by the regulations.*

6.1.2 DUE DILIGENCE ASSESSMENT

The *NSW National Parks and Wildlife Regulation 2009* (NPW Regulation) is subsidiary legislation made under its parent act, the NPW Act. The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (due diligence guidelines) (DECCW 2010) is adopted by the NPW Regulation under Clause 80A. Compliance with the due diligence guidelines provides a defence for harming Aboriginal objects and places.

The due diligence guidelines provide a generic code of practice used to determine whether activities will harm an Aboriginal object and, if so, what measures can be taken to avoid that harm.

The advantages of due diligence for assessing potential harm to Aboriginal objects are that it:

- provides a defence against prosecution for inadvertent impacts if the process is followed;
- assists in avoiding unintended harm to Aboriginal objects;
- provides certainty to land managers and developers about appropriate measures for them to take;
- encourages a precautionary approach; and
- results in more effective conservation outcomes for Aboriginal cultural heritage.

EMM Consulting (EMM) was engaged to undertake an Aboriginal Due Diligence Assessment as part of investigations for the MSF. A full copy of this assessment is provided in **Appendix A**, with a summary of the assessment provided below.

6.1.3 ASSESSMENT METHOD

The assessment followed the due diligence guidelines and, in summary, involved:

- a search of the Aboriginal Heritage Information System (AHIMS) database on 17 October 2017;
- consideration of existing Aboriginal cultural heritage studies in the area and region for the presence of Aboriginal objects or places;
- consideration of the environmental context for the presence of Aboriginal objects or places;
- a site inspection of the project areas by an EMM archaeologist to identify any Aboriginal objects or areas of potential archaeological deposit (PAD); and
- a determination of whether further heritage investigation and impact assessment is required.

6.1.4 CONCLUSION

This Aboriginal due diligence assessment considers background research and a visual inspection of the site and found the project area is of low archaeological potential. The project area does not meet the known indicators expected for the presence of Aboriginal artefacts. The high levels of disturbance through ploughing and harvesting, and the removal of native vegetation is likely to have destroyed any sites that may have existed.

The alternate access has previously been subject to a heritage assessment by Navin Officer (2010), and no Aboriginal sites were detected. The topography, soils, geology and distance to water make this area undesirable for habitation therefore the potential of this area for Aboriginal objects is low.

6.1.5 MITIGATION MEASURES

The following mitigation measures have been incorporated into the development to respond to the site conditions and current legislation and guidelines protecting Aboriginal and historical heritage. The recommendations below are informed by the background research and fieldwork undertaken.

- In the unlikely event that sites are discovered work should immediately cease and archaeological advice sought.
- In the unlikely event that known or suspected human remains (generally in skeletal form) are encountered during the activity, the following procedure will be followed immediately upon discovery:
  - all work in the immediate vicinity will cease and the find will be immediately reported to the work supervisor;
  - the supervisor or other nominated senior staff member will promptly notify the police and the state coroner (as required for all human remains discoveries);
  - the supervisor or other nominated senior staff member will contact OEH for advice on identification of the human remains;
  - if it is determined that the human remains are Aboriginal ancestral remains, the Local Aboriginal Land Council will be contacted and consultative arrangements will be made to discuss ongoing care of the remains; and
  - if it is determined that the human remains are not Aboriginal ancestral remains, further investigation will be conducted to determine if the remains represent a historical grave or if police involvement is required.

6.2 HISTORIC HERITAGE

6.2.1 DATA REVIEW

A search of the NSW State Heritage Inventory (including the State Heritage Register, Interim Heritage Orders, State Agency Heritage Registers and Murray LEP heritage items) did not identify any heritage items at the development site. No historic buildings or sheds exist within the development footprint.

Similarly, a search of the Australian Heritage Database (including items on the National Heritage List, World Heritage List and Commonwealth Heritage List) did not identify any heritage items at the development site.

The Register of National Estate (Non-Statutory archive) does list the Travelling Stock Route that adjoins the Cobb Highway as an Indicative Place.

This TSR (No:10439) was notified as such on 21 December 1889. As reported by Navin Officer (201)):

> *The Cobb Highway has a long association with the history of the region. As towns developed, the need for transport grew and Cobb and Co linked towns through its coach services. The Cobb Highway takes its name from the coach company and mail service. The modern Cobb Highway links the towns of Hay, Deniliquin and Echuca and Wilcannia on the Darling to the north. The highway follows a historic route that is part of the great network that became The Long Paddock, a web of tracks and trails that linked the stock breeding areas of the inland with the growing markets to the south. It also provided the only escape route from drought when the seasons failed. Movement of livestock along this route grew with the droving of animals to market, in particular, the Victorian goldfields during the 1850s and 1860s. The route was a major part of a larger stock route network through to Queensland, which was used to move livestock between properties, especially in times of drought. Wool was transported to ports along the river systems before being sent by rail to the coast for export by sea.*

The NSW Department of Planning Heritage Branch has previously clarified that the TSR is not classified as a 'relic' as defined under the *NSW Heritage Act 1977*. A relic excludes a range of above ground structures and a range of ground features "*which may include roads, embankments and other forms of constructed ground relief*." This matter was clarified as part of the environmental impact assessment undertaken for Essential Energy's Deniliquin to Moama 132 kV Transmission Line Route (2010).

It is also noted that the heritage assessment undertaken as part of the Review of Environmental Factors for this transmission line did not identify the likelihood of any relics along the entirety of the proposed route of the transmission line.

6.2.1 MITIGATION MEASURE

Should any object or item of historic heritage be uncovered during construction, work in that area will cease and the item cordoned off.

A qualified heritage specialist will attend the site to determine the nature of the find and determine the required course of action; including consultation with MRC.

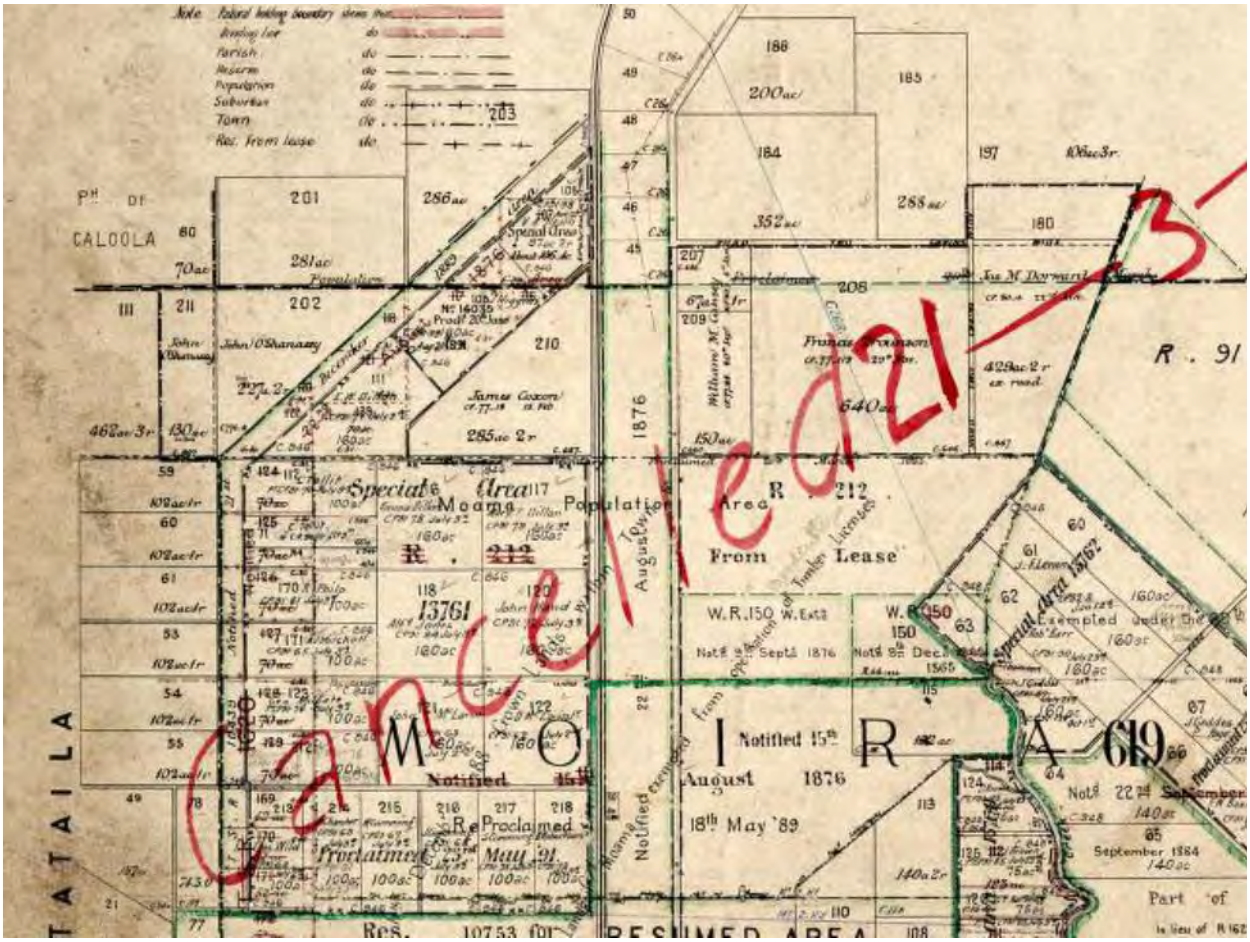


Figure 7: Moama 1887 Parish Map showing TSR 10439

Source: Navin Officer (2010)

Biodiversity

7.1 INTRODUCTION

A specialist Biodiversity Assessment (BA) for the MSF has been undertaken by EMM and is provided in **Appendix B**. A summary of this assessment follows.

7.2 LEGISLATIVE CONTEXT

The *NSW Biodiversity Conservation Act 2016* (BC Act) commenced on 25 August 2017, replacing the former *NSW Threatened Species Conservation Act 1995* (TSC Act). However, Clause 28(1) of the *NSW Biodiversity Conservation (Savings and Transitional) Regulation 2017* (the regulation) has delayed operation of the Biodiversity Offset Scheme (BOS) associated with Part 7 of the BC Act until 25 February 2018 for pending or interim planning applications. Pending or interim planning applications are defined under clause 27 of the regulation, and includes:

> *(e) except in the case of State significant development—an application for development consent under Part 4 of the Environmental Planning and Assessment Act 1979 (or for the modification of such a development consent) made within 6 months after the commencement of the new Act ...*

The MSF satisfies the definition of a pending or interim planning application in accordance with clause 27(e) of the regulation, because a DA will be lodged for the project under Part 4 of the EP&A Act within six months of the commencement of the BC Act (ie the DA will be lodged prior to 25 February 2018). Clause 28 of the regulation states:

> *28 Former planning provisions continue to apply to pending or interim planning applications*
>
> *(1) The former planning provisions continue to apply (and Part 7 of the new Act does not apply) to the determination of a pending or interim planning application.*
>
> *(2) However, Part 7 of the new Act applies to the determination of a pending or interim planning application referred to in paragraph (b), (c) or (d) of the definition of pending or interim planning application in clause 27 (1) if the applicant or proponent and the planning approval body for the application agree in writing that Part 7 of the new Act is to apply to the determination of the application instead of the former planning provisions.*

As the project is classified as a pending or interim planning application in accordance with clause 27(1)(e), the former planning provisions apply in accordance with clause 28(1) of the regulation.

> *... the provisions of the Environmental Planning and Assessment Act 1979 that would be in force if that Act had not been amended by the new Act.*

Accordingly, this biodiversity assessment assesses the potential for species, populations and communities now listed under the BC Act (in accordance with clause 31 of the regulation) but uses the assessment of significance from the former provisions (ie section 5A of the EP&A Act) to determine the potential for significant impacts. Field methods have been based on the *Biodiversity Assessment Method* (OEH 2017).

This biodiversity assessment also assesses the likelihood that threatened species and ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) would occur within the project area, and provides an assessment of significance in accordance with *Significant Impact Guidelines 1.1 EPBC Act* (DoE 2013) for species and communities recorded or predicted to occur.

7.3 ASSESSMENT METHODS

7.3.1 DESKTOP ASSESSMENT

A detailed desktop assessment was undertaken for the project area to identify any threatened species, populations or communities listed under the BC Act or EPBC Act. Several sources of information were reviewed to gather information on the landscape and ecological context of the project area, including:

- ArcMap aerial images for the project area and locality;
- State Vegetation Type Map: Riverina Region Version 1.2 - VIS ID 4469 (OEH 2016a);
- Map of Interim Biographic Regionalisation for Australia (IBRA) version 7 (IBRA7) bioregions and subregions (DoEE 2017a);
- Mitchell Landscapes NSW v3 2011 map (OEH 2011);
- BioNet (OEH 2017) resources to access the following:
    - Threatened Biodiversity Data Collection;
    - Threatened species profiles;
    - BioNet Atlas data; and
    - Vegetation Classification System.
- Protected Matters Search Tool (DoEE 2017b).

7.3.2 FIELD SURVEY

Six floristic plots were completed within the project area, in accordance with the field methods described in the *Biodiversity Assessment Method* (BAM, OEH 2017). The floristic plots targeted areas cropped/cleared areas and native vegetation. All paddock trees within the project area were identified to species level and inspected for the presence of tree hollows.

Timed diurnal bird surveys were completed at six plot locations to target threatened woodland birds, with the exception of the Swift Parrot and Superb Parrot. Accordingly, surveys were completed to target Swift Parrot and Superb Parrot potential habitat in woodland areas, as identified in *Survey guidelines for Australia's threatened birds* (DEWHA 2010).

Targeted searches for were completed for the Turnip Copperburr (*Sclerolaena napiformis*) and Slender Darling Pea in the two access option areas previous records on the Bionet Atlas of NSW Wildlife. Surveys were completed by inspecting the locations of previous records and walking parallel transects in accordance with *NSW Guide to Surveying Threatened Plants* (OEH 2016b).

Field surveys to support preparation of an expert report were also completed as potential was identified for a threatened orchid, *Prasophyllum* sp. Moama, to occur in parts of the project area.

7.4 LANDSCAPE FEATURES

The development site is located in the Riverina IBRA Region, Murray Fans IBRA sub-region. No rivers or streams are present within the project area. The project area is located at approximately 9 km to the west and 6 km to the north of the Murray River. No wetlands are present within the project area, or within a 10 km radius. A small farm dam is present in the north-east of Moama Solar Farm. At the time of survey, it did not contain any aquatic vegetation and water depth was approximately 2 cm.

The project area is within a rural landscape that has been extensively cleared. Native vegetation surrounding the project area is restricted to a grassy vegetated corridor in a travelling stock reserve that runs parallel to the project area, acting as a linking zone.

7.5 NATIVE VEGETATION

7.5.1 GROUND-TRUTHED VEGETATION MAPPING

A total of 30 flora species were identified during plots undertaken in the project area, comprising 24 native and 6 exotic species. A further 25 native and four exotic plant species were identified in the project area during rapid assessments completed by FloraSearch. Accordingly, a total of 49 native and 10 exotic species were recorded in the project area during the two surveys.

Three PCTs were mapped within the project area, predominantly to the west of the project area (in the travelling stock reserve) and two windrows in the east of the project area.

Table 7.1 – Plant Community Types

Plant Community Type	Solar Farm (ha)	Preferred Access (ha)	Alternate Access (ha)
Non native and cleared	76.5	0	1
Black Box Lignum woodland wetland of the inner floodplains (PCT 13)	4.6	0	0
Forb-rich Speargrass – Windmill Grass – White Top Grassland (PCT 44)	0	0.8	0
Western Grey Box tall grassy woodland (PCT 76)	0	0	0.1
TOTAL	**81.2**	**0.8**	**1.1**

A description of non-native vegetation and PCTs recorded the project area is provided in the following sections.

7.5.2 NON-NATIVE VEGETATION

Non-native vegetation in the project area comprises recently cropped Common Wheat (*Triticum aestivum*). The ground in these areas has been extensively ripped and no longer supports native vegetation communities. Four isolated Western Grey Box (*Eucalyptus microcarpa*) occur within areas of non-native vegetation, none of which contained hollows.

7.5.3 CLEARED LAND

Cleared land comprises previously cleared access tracks and ploughed paddocks that do not contain any native vegetation. Cleared land occurs in part of the alternate access option.

7.5.4 BLACK BOX WOODLAND

Black Box Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly in the Riverina Bioregion and Murray Darling Depression Bioregion) (PCT 13) is present within the proposed Moama Solar Farm. The community exists as windrows on the northern and eastern borders, connected by a north-south running windrow.

The canopy comprises Black Box (*Eucalyptus largiflorens*) trees with a sparse understorey dominated by Lignum (*Duma florulenta*) and chenopods Creeping Saltbush (*Atriplex semibaccata*), Black Cottonbush (*Maireana decalvans*), Black Rolypoly (*Sclerolaena muricata*) and Spiny Saltbush (*Rhagodia spinescens*).

The community occurs as a woodland/wetland and derived native grassland (ie where trees have been previously removed, however a native and representative understorey remains.

PCT 13 does not represent any ecological community listed under the BC Act or EPBC Act known or predicted to occur in the locality.

Plate 1: Black Box Lignum woodland wetland of the inner floodplains in the semi arid (warm) climate zone (mainly in the Riverina Bioregion and Murray Darling Depression Bioregion)

7.5.5 GRASSY WOODLAND

Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions (PCT 76) is present in the alternate access. It comprises tall woodland with Western Grey Box as the dominant canopy species. An understorey of native grasses and few forbs are present, comprising Speargrass (*Austrostipa setacea*), Windmill Grass (*Chloris truncata*), Cotton Panic Grass (*Digitaria brownii*), Wheat Grass (*Anthosachne setacea*) and Redleg Grass (*Bothriochloa macra*) and Corrugated Sida (*Sida corrugata*) are present. The community occurs as a woodland/wetland and derived native grassland (ie where trees have been previously removed, however a native and representative understorey remains. One threatened species, namely Turnip Copperburr, occurs within this PCT, in the preferred access and adjacent to the alternate access.

The woodland and derived native grassland forms of this vegetation community represents Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions listed as an EEC under the BC Act. It satisfies the listing criteria in the final determination for the community (NSWSC 2011) as it is located in the Riverina bioregion, the canopy is dominated by Grey Box and it has a variable ground layer of grass and herbaceous species.

The woodland form also represents Grey Box Grassy Woodlands and Derived Native Grassland of South-eastern Australia, listed as an EEC under the EPBC Act, satisfying criterion 1 of the condition thresholds in the Commonwealth listing advice (TSSC 2010). The derived native grasslands satisfy criterion 5a of the condition thresholds in the Commonwealth listing advice (TSSC 2010) as it is a derived native grassland with clear evidence that the site formerly was a woodland with a tree canopy dominated by Inland Grey Box and at least 50% of the vegetative cover in the ground layer is made up of perennial native species at any time of year, and although only nine native groundcover species were recorded, it is reasonable to assume that during more favourable conditions following wet weather, the understorey would contain 12 native understorey species.

Plate 2: Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions

7.5.6 GRASSLAND

Forb-rich Speargrass – Windmill Grass – White Top grassland of the Riverina Bioregion (PCT 44) is present in the preferred access. It comprises tall grassland with a variety of grasses, chenopods and forbs. These include Speargrass (*Austrostipa setacea*), Native Millet (*Panicum decompositum*), Wallaby Grass (*Rytidosperma duttonianum*), Cotton Panic Grass (*Digitaria brownii*), Black Cottonbush, Spiny Saltbush, the threatened Turnip Copperburr, Woolly New Holland Daisy (*Vittadinia gracilis*) and Billy Buttons (*Craspedia variabilis*) and *Wurmbea dioica* and the threatened Turnip Copperburr.

PCT 44 represents Natural Grasslands of the Murray Valley Plains, listed as a critically endangered ecological community under the EPBC Act. The Commonwealth listing advice (TSSC 2012) recognises that PCT 44 represents the EPBC Act listed community.

Plate 3: Forb-rich Speargrass – Windmill Grass – White Top grassland of the Riverina Bioregions

7.6 THREATENED SPECIES

7.6.1 FAUNA HABITATS

Fauna habitat is limited across much of the project area as native vegetation has been largely removed and replaced with cropped and cleared land. However, some habitat features remain, comprising woodland that may provide foraging and nesting habitat for woodland birds. No nests were observed in this area. No hollow trees were observed in the project area, and therefore hollow-dependent fauna would not occur.

7.6.2 THREATENED SPECIES PREVIOUSLY RECORDED

Eleven threatened species listed under the BC Act and/or EPBC Act have previously been recorded within 10 km of the project area, comprising:

- threatened flora: Turnip Copperburr, Slender Darling Pea (*Swainsona plagiotropis*), *Pterostylis despectans* and *Prasophyllum sp.* Moama
- threatened birds: Brown Treecreeper (eastern subspecies, *Climacteris picumnus victoriae),* Bush Stone-curlew (*Burhinus grallarius*), Diamond Firetail (*Stictonetta naevosa*), Grey-crowned Babbler (*Pomatostomus temporalis temporalis*), Little Lorikeet (*Glossopsitta pusilla*) and Superb Parrot (*Polytelis swainsonii*); and
- threatened frog: Sloane's Froglet (*Crinia sloanei*).

7.6.3 THREATENED SPECIES LIKELIHOOD OF OCCURRENCE

The likelihood that threatened species previously recorded within 10 km of the project area is assessed in detail in **Appendix B**.

One threatened flora species, Turnip Copperburr, was recorded during the survey. Given the presence of potentially suitable habitat and previous records in the locality, there is a moderate potential for *Prasophyllum sp.* Moama to occur in the preferred access route and for threatened woodland birds including the Diamond Firetail, Grey-crowned Babbler, Little Lorikeet, Superb Parrot and Swift Parrot to forage in the Western Grey Box Woodland These species are unlikely to breed as no nests or hollow-bearing trees were observed.

7.7 IMPACTS

7.7.1 AVOIDANCE, MINIMISATION AND MITIGATION

Biodiversity constraints have been identified within the project area such that impacts can be avoided and/or minimised by the design. Direct biodiversity impacts have been largely avoided by locating the project in a largely cleared area.

Project activities with potential to impact biodiversity comprise the clearing of woodlands, native paddock trees in the project area and minor clearing for site access. Impacts are anticipated to be restricted to the construction phase, with no operational impacts expected.

Direct biodiversity impacts would be further avoided and/or minimised through implementation of the following measures:

- Committing to no significant impact on *Prasophyllum sp.* Moama and *Pterostylis despectans*. The following process would be followed:
    - undertaking a targeted pre-clearance survey for *Prasophyllum sp.* Moama in the preferred access route during the species optimal flowering season (September);
    - undertaking a targeted pre-clearance survey for *Pterostylis despectans* in the preferred access route during the species optimal flowering season (October-November);
    - if the species are not recorded, the preferred access would be constructed;
    - if the species are recorded, evaluate if the 10 m wide construction zone impact for the access road can be constructed within the 50 m wide area surveyed as part of the biodiversity assessment without significant impact. If this is possible, the preferred access would be constructed; and
    - if the species are recorded and significant impacts cannot be avoided, the alternate access would be constructed.
- Avoidance of clearing the two Turnip Copperburr plants in the preferred access (should it be constructed);
- Retention of Black Box Woodland on the northern and eastern boundaries of the farm; and
- If feasible, minimising the impact on the Western Grey Box Woodland to the lopping of branches overhanging the existing cleared track, should the alternate access be constructed.

Indirect biodiversity impacts would be mitigated through implementation of the following measures:

- development of a sediment and erosion control plan for implementation prior to and during construction of the project; and
- selection of a native or non-invasive cover crop (eg Wallaby Grass (*Rytidosperma duttonianum*), Native Millet (*Panicum decompositum*) and Wheat Grass (*Anthosachne scabra*)) for the Moama Solar Farm to minimise the potential for weed invasion into retained woodlands in the project area.

It is recommended that the above biodiversity management measures are incorporated into the Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan for the project.

7.7.2 RESIDUAL IMPACTS

7.7.2.1 Direct Impacts

Following the implementation of avoidance and minimisation measures the development would result in the following direct residual impacts:

Table 7.2 – Direct Impacts

Plant Community Type	Solar Farm (ha)	Preferred Access (ha)	Alternate Access (ha)
Non native and cleared	76.5	0	1
Black Box Lignum woodland wetland of the inner floodplains (PCT 13)	2.2	0	0
Forb-rich Speargrass – Windmill Grass – White Top Grassland (PCT 44)	0	0.2	0
Western Grey Box tall grassy woodland (PCT 76)	0	0	0.1
TOTAL	**78.7**	**0.2**	**1.1**

The location of these impacts is shown on **Figure 8**.

7.7.2.2 Indirect Impacts

No residual indirect impacts are expected following the implementation of mitigation measures.

7.7.2.3 Impacts on Threatened Ecological Communities

Threatened ecological communities are absent from Moama Solar Farm, and therefore would not be impacted.

Both access options would have minor impacts on threatened ecological communities, comprising:

- removal of 0.2 ha of Natural Grasslands of the Murray Valley Plains listed under the EPBC Act for the preferred access; or
- removal of 0.1 ha of Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions listed under the BC Act/ Grey Box Grassy Woodlands and Derived Native Grassland of South-eastern Australia for the alternate access.

An assessment of significance has been completed in accordance with Section 5A of the EP&A Act and EPBC Act Policy Statement 1.1 (DoE 2013) to assess the impact of vegetation removal on the above listed communities. The assessments concluded that the development would not result in significant impacts on the listed communities given the minor scale of disturbance.

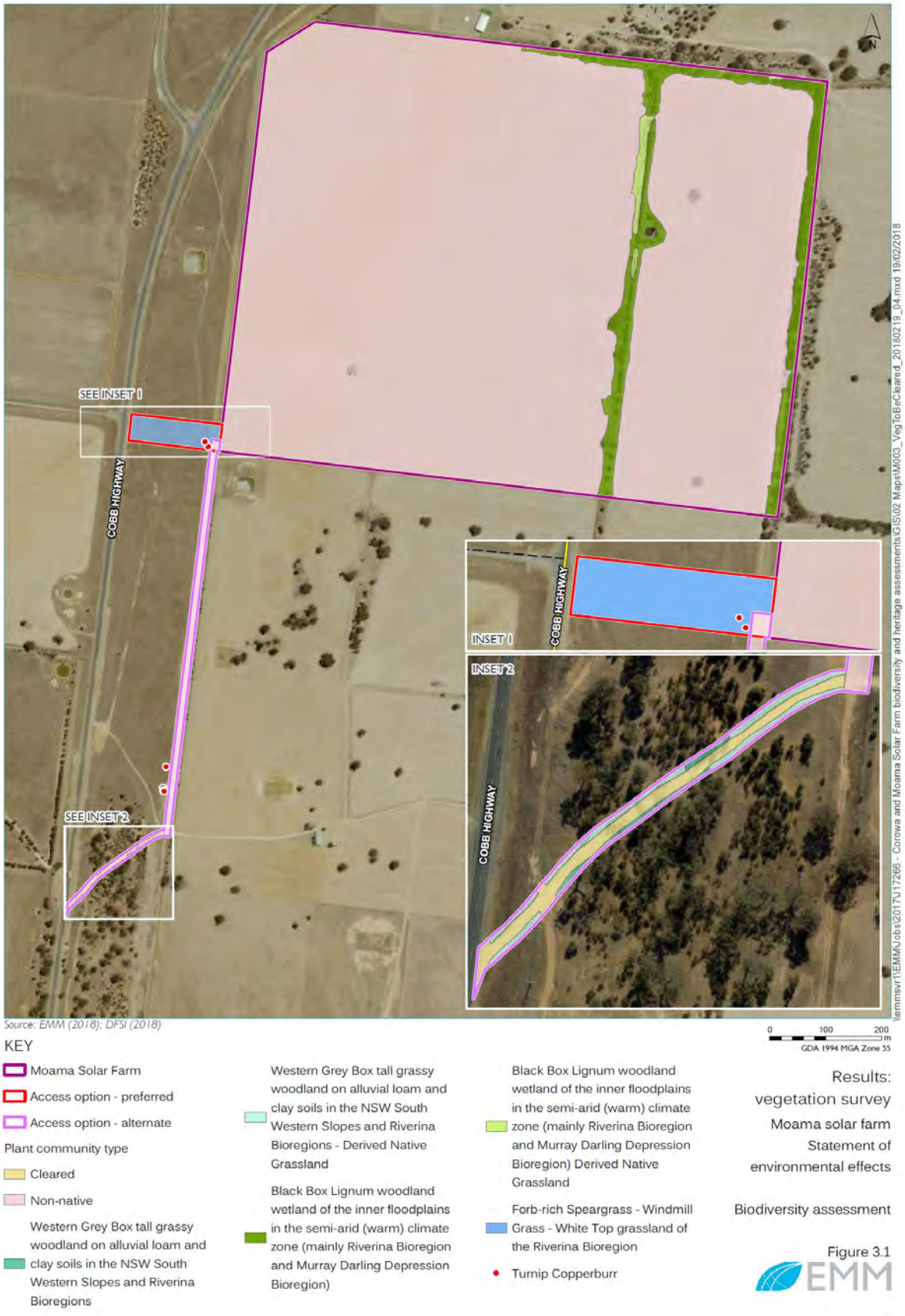


Figure 8: Vegetation to be Cleared

7.7.2.1 Impacts on Threatened Species Habitat

There is a moderate potential for *Prasophyllum sp.* Moama and *Pterostylis despectans* to occur in the preferred access. The removal of individuals from a population of *Prasophyllum sp.* Moama or *Pterostylis despectans* (if present) would likely be significant given that only one population of each species is known from north of Moama. Accordingly, the proponent has committed to no significant impact on the species. In addition, should the preferred access be constructed, impacts on the two Turnip Copperburr plants would also be avoided. As impacts will be avoided, no further assessment has been conducted for these flora species.

There is a moderate potential for threatened woodland birds including the Diamond Firetail, Grey-crowned Babbler, Little Lorikeet, Superb Parrot and Swift Parrot to forage in the Western Grey Box Woodland in the alternate access. These species are unlikely to breed as no nests or hollow-bearing trees were observed. If constructed, the alternate access would remove 0.1 ha of potential foraging habitat for the above species.

Assessments of significance were completed for the above species in accordance with Section 5A of the EP&A Act for species listed under the BC Act and EPBC Act Policy Statement 1.1 (DoE 2013) for species listed under the EPBC Act. The assessment concluded that if the alternate the project would not result in significant impacts on the threatened species given the removal of an area that only represents potential foraging habitat and the minor scale of disturbance.

7.8 CONCLUSION

The biodiversity assessment has been completed to assess potential impacts of the project on species and communities listed under the BC Act and EPBC Act.

An ecological community listed under the EPBC Act, namely Natural Grasslands of the Murray Valley Plains occurs in the preferred access. An ecological community listed under the BC Act and EPBC Act, namely Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions listed under the BC Act and EPBC Act occurs in the alternate access. The project will result in only minor disturbance to these communities.

There is a moderate potential for *Prasophyllum sp.* Moama and *Pterostylis despectans* to occur in the preferred access, and two individuals of the Turnip Copperburr were recorded within the 50 m wide area surveyed. Significant impacts on these species will be avoided.

Project activities with potential to impact biodiversity comprise the removal of four paddock trees, 2.2 ha of a non-threatened ecological community for the solar farm, and small-scale vegetation removal for site access. Impacts are anticipated to be restricted to the construction phase, with no operational impacts expected.

Measures have been implemented to avoid and minimise direct and indirect biodiversity impacts. No indirect residual impacts are predicted.

Assessments of significance were completed in accordance with Section 5A of the EP&A Act and EPBC Act Policy Statement 1.1 (DoE 2013) for the listed community and species. The assessments concluded that the development would not result in significant impacts on these listed communities and species.

Noise and Vibration

8.1 INTRODUCTION

A noise study has been undertaken to assess the potential impacts of the construction and operation of the proposed solar farm on nearby sensitive receptors in accordance with the following NSW policies and guidelines:

- *Noise Policy for Industry* (EPA, 2017)
- *Assessing Vibration: a technical guideline* (DEC, 2006);
- *NSW Road Noise Policy* (DECCW, 2011); and
- *Interim Construction Noise Guideline* (DECCW, 2009)

In accordance with the requirements of the above guidelines, computational modelling and first principle calculations have been undertaken to support the assessment of the potential for adverse amenity impacts as a result of the development.

A full copy of this study is provided in **Appendix C**. Provided below is a summary of the methodology, results and conclusions of the noise and vibration impact assessment.

8.2 SENSITIVE RECEPTORS

The area surrounding the proposed development includes a range of industrial, agricultural and rural uses with the Moama Golf Course located approximately 2.5 km to the south west of the subject site. To the north east of the site is Moama Waste Disposal Depot and sewage treatment plant. There are 16 residences located within 3 km of the proposed solar farm.

Table 8.1 lists those closest receptors surrounding the development site, while **Figure 9** shows the location of all receptors within 3 km.

Table 8.1 – Potentially Sensitive Receptors

Receptor	Description	Distance to Development Site Boundary
R1	Existing Dwelling	920 m
R2	Existing Dwelling	80 m
R3	Existing Dwelling	700 m
R4	Existing Dwelling	1,280 m

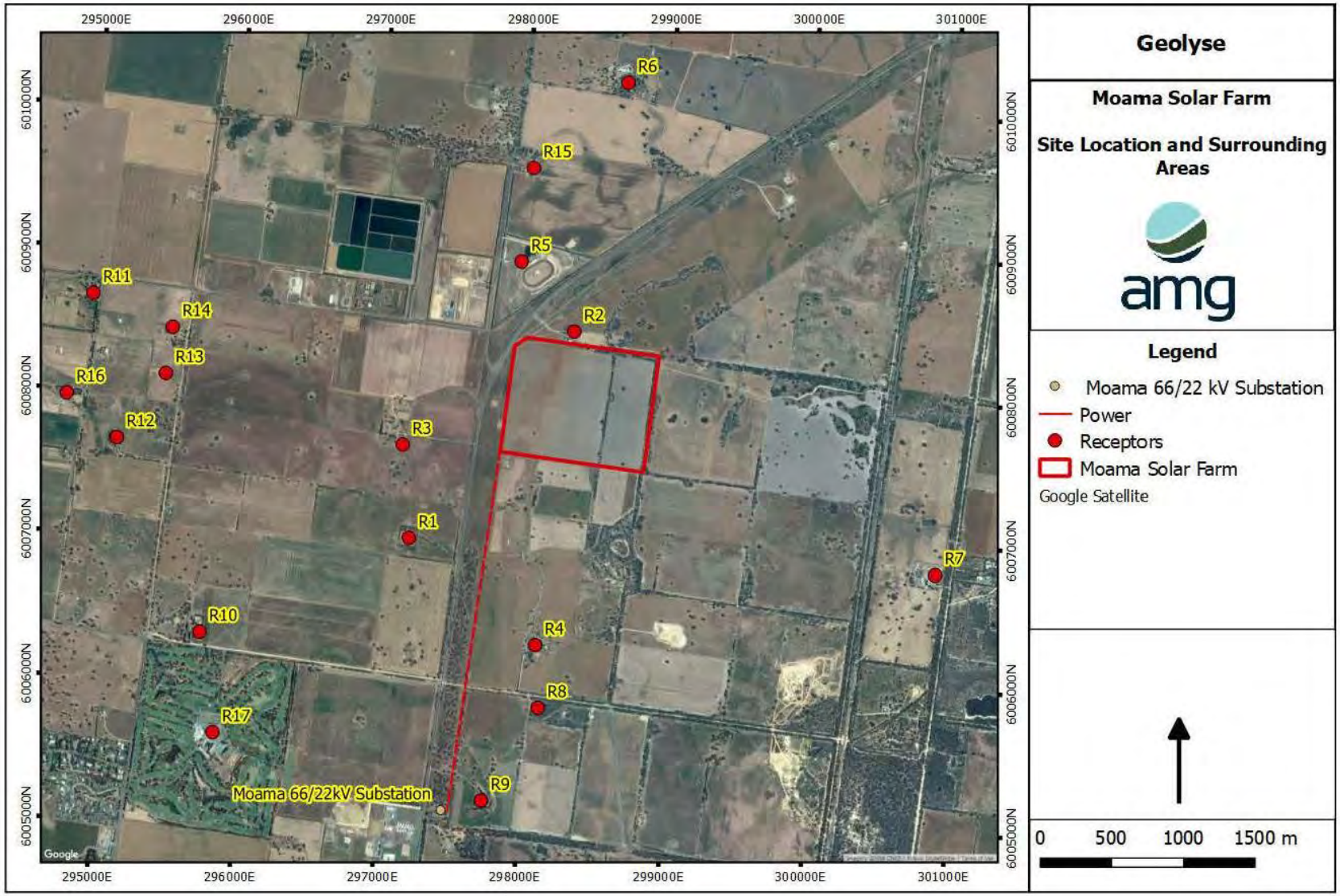


Figure 9: Receptors and Surrounding Land Uses

8.3 CONSTRUCTION NOISE ASSESSMENT

8.3.1 DURATION OF CONSTRUCTION WORKS

The construction of the MSF is expected to take approximately 12 months with a number of different activities undertaken over that time.

Table 8.2 below presents an overview of each of the construction tasks along with their expected duration. It is noted that some of these tasks are likely to occur concurrently. Activities such as civil works, trenching, piling and installation may occur concurrently, and site preparation and construction of the switching station is likely to be undertaken at the same time as installation of the solar PV modules and cabling.

Table 8.2 – Construction Phases and Expected Duration

Construction Phase	Duration
Site clearing and preparation	3 months
Piling – installation of module mounting structures	3 months
Installation of solar PV modules & inverter assemblies	5 months
Commissioning	3 months

Given the separation distance to the nearest existing sensitive receptors to the subject site there is potential for the duration of construction to be minimised through construction works outside standard hours.

The assessment has therefore considered the potential for adverse amenity impacts associated with construction outside what the EPA term 'normal construction hours': which are between 7 am and 6 pm Monday to Friday and 8 am to 1 pm Saturday, with no works on Sundays or Public Holidays.

8.3.2 INTERIM CONSTRUCTION NOISE GUIDELINES

Guidance on the assessment and management of construction noise in NSW is provided in the *Interim Construction Noise Guideline 2009* (ICNG) published by the EPA.

The main objectives of the Guideline are to:

- Promote a clear understanding of ways to identify and minimise noise from construction works;
- Focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts;
- Encourage construction to be undertaken only during the recommended standard hours, unless approval is given for works that cannot be undertaken during these hours;
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage;
- Provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts; and
- Provide guidelines for assessing noise generated during the construction phase of developments.

In achieving these objectives, the guideline provides a framework for the qualitative and quantitative assessment of potential construction noise impacts noting that, for major projects, a quantitative assessment is the preferred approach.

Table 8.3 presents construction noise criteria outlined in the guideline. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

Table 8.3 – NSW EPA Construction Noise Criteria – Residential Receivers

Time of Day	Management Level (Free field)	How to Apply
Recommended standard hours: Monday to Friday, 7 am to 6 pm Saturday, 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices 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 dB (A)	The highly noise affected 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 restricting the hours that the very noisy activities can occur, taking into account: • 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 • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected 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(A) above the noise affected level, the proponent should negotiate with the community.

Where nearby sensitive uses are predicted to be noise affected, the proponent is required to apply reasonable and feasible noise mitigation measures. A noise mitigation measure is feasible if it is capable of being put into practice, and is practical given the project constraints.

Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

For construction outside standard hours, the assessment criteria has been determined based on the minimum allowable RBL as provided in the NPfI. That is, for the purpose of the assessment it is assumed that the RBL is 30 dB(A) for night periods thereby resulting in a noise affected limit of 35 dB(A) for construction outside standard hours.

8.3.3 CONSTRUCTION NOISE SOURCES

In terms of noise emissions, the site preparation activities and installation of the solar PV modules (specifically driving the support posts into the ground) are expected to represent those with the most significant potential for adverse impacts. The indicative project schedule has determined these two activities may occur concurrently. Therefore, for the purposes of the assessment, the impacts associated with these two elements have been assessed cumulatively.

It is noted that construction works are expected to progress across the site such that plant and equipment would only be in a single area for a short period of time. For example, each post takes approximately 25-30 seconds to drive into the ground thereby providing the ability to install a new pile approximately every 2.5 minutes. Given this, the potential for adverse impacts at any one receptor is expected to only occur for a short period of time.

Table 8.4 presents a summary of the plant and equipment likely to be required to complete the on-site construction works. The sound power levels presented have been sourced from published noise emission datasets and the library of source noise levels maintained by AMG.

Table 8.4 – Construction Phases and Expected Duration

Construction Phase	Plant Item	Number Assume	Sound Power Level, dB(A)	Acoustical Usage Factor, %
Site preparation and construction of site switching station [a)]	Truck and Dog	2	110	40
	Compactor	2	103	20
	Bulldozer	2	109	40
	Mulcher	1	116	20
	Grader [c)]	2	108	40
	Water Cart (as required)	2	103	40
	Vibratory Roller	2	103	20
Installation of solar PV modules & inverter assemblies	Piling Drill Rig [f)]	2	112-124	20
	Franna Crane	2	107	16
	Trencher	2	97	40
	Loader	2	107	40
	Generator	1	73	50
	Trucks	20/day	108	40

a) Construction plant used intermittently as required. Continuous use not expected.
b) Truck movements associated with deliveries assumed to move through site at 10 km per hour as a moving point source.
c) Grader required for construction of access tracks, switching station, maintenance building, construction offices car park, minor earthworks and grading around the solar array area as required to meet structural tolerances for the tracker equipment.
d) Deliveries to site only to occur during standard construction hours.
e) The 'Acoustical Usage Factor' represents the percentage of time that a particular item of equipment is assumed to be running at full power while working on site.
f) Includes a correction for tonality

8.3.4 ASSESSMENT OF IMPACTS

For the purposes of predicting impacts associated with noise emissions from the development site on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (version 2017 build 161.4800). Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with ISO Standard 9613 (1996) *Acoustics - Attenuation of sound during propagation outdoors*.

The model is utilised to assess the potential noise emissions from the site under a range of operating scenarios and meteorological conditions. In the event that non-compliance with the assessment criterion is predicted, the noise modelling also allows investigation of possible noise management solutions.

For the construction phase of the proposed project, predictive noise modelling has considered the range of potential impacts likely noting that noise generating activities will progressively move across the site over the duration of construction. As such, the highest noise levels would not be expected to be experienced at a single receptor for more than one day while construction equipment (e.g. piling drill rig) is at the closest point to the receptor.

Table 8.5 presents below presents predicted receptor noise levels during concurrent construction phases of the proposed solar farm.

Table 8.5 – Predicted Receptor Noise Levels – Concurrent Construction Activities, dB(A)

Receptor	Predicted Construction Noise Levels, LAeq 15min	Noise Management Level		Compliance
		Standard Hours	Outside Standard Hours	
R1	40	40	35	Standard hours only
R2	40	40	35	Standard hours only
R3	39	40	35	Standard hours only
R4	37	40	35	Standard hours only

Review of the predicted noise levels confirms that compliance with the noise management level provided in the ICNG is predicted to be achieved for all receptors during standard hours only.

8.3.5 MITIGATION OF CONSTRUCTION NOISE

Based on the results of the assessment, acceptable noise amenity impacts can be achieved throughout the construction works. Management controls to be implemented during construction will include:

- Consultation with adjoining neighbours, providing detail on the construction schedule and providing contact details for discussing issues if they arise.
- Using broad-band reversing alarms on all mobile plant and equipment where possible.
- Examining different types of machines that perform the same function and compare the noise level data to select the least noisy machine.
- Select quieter items of plant and equipment where feasible and reasonable.
- Operating plant in a quiet and efficient manner.
- Reduce throttle setting and turn off equipment when not being used.
- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.

Given the size of the development site there is potential for construction works to be undertaken outside standard hours subject to the effective implementation of the above mitigation measures and consultation with neighbours. Further, given the tendency for agricultural activities to be undertaken during evening and night periods (e.g. during harvest season etc.), construction during these periods, when undertaken concurrently with these agricultural activities is unlikely to represent a significant amenity impact for residences in the area.

8.4 OPERATIONS NOISE ASSESSMENT

8.4.1 OPERATIONAL NOISE CRITERIA

8.4.1.1 Overview

The acoustic assessment has been completed in accordance with the procedure identified in the EPA's *Noise Policy for Industry* (NPfI).

The NPfI recognises that scientific literature has identified that both the increase in noise level above background levels (that is, intrusiveness of a source), as well as the absolute level of noise are important factors in how a community will respond to noise from industrial sources.

The derivation of the two sets of criteria are presented below. For residential dwellings the noise criteria are assessed at the most-affected point (i.e. highest noise level) on or within the property boundary. Where the property boundary is more than 30 m from the house, then the criteria applies at the most affected point within 30 m of the house.

8.4.1.2 Intrusiveness Criteria

The project intrusiveness noise level is intended to protect against significant changes in noise levels as a result of industrial development. To achieve this, the NPfI describes intrusive noise as noise that exceeds background noise levels (as defined by the Rating Background Level or RBL) by more than 5 dB.

For the purposes of the assessment baseline noise levels have been assumed to be equivalent to the minimum background noise levels provided in the NPfI. At some receptors, where there is likely to be an influence during day periods from existing industrial activity in the area, this is considered to represent a conservative assumption. **Table 8.6** presents the derivation of the intrusiveness criteria based on the minimum background noise level established by the NPfI.

Table 8.6 – Derived Intrusiveness Noise Criteria

Receptor	Intrusiveness $L_{Aeq,15\text{-}minute}$ Criteria		
	Day	Evening	Night
All nearby residential receptors [a)]	40 [b)]	35 [b)]	35 [b)]

a) Receptor noise limit applies at a location 30 m from the dwelling façade.
b) Minimum background noise level established by the NPfI 2017 (35 dB(A)) for day periods and 30 dB(A) for evening and night periods + 5 dB.

8.4.1.3 Amenity Criteria

The project amenity noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Review of the surrounding area has identified that to the north west of the proposed solar farm there is an industrial zone incorporating a landfill, sewage treatment plant and a scrap metal yard. Therefore, in accordance with the NPfI, the project amenity noise criteria are derived in **Table 8.7** for land uses in the area.

Table 8.7 – NPfI Acceptable Noise Levels for Sensitive Receivers

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level (db(A))	
			Total Industrial Noise	Project Specific
Residence	Rural	Day	50	45
		Evening	45	40
		Night	40	35
Recreational Area (golf course)	All	When in use	55	50

8.4.1.4 Project Trigger Levels

The project trigger level is the lower value of the project intrusiveness noise level and the project amenity level, after the conversion to $L_{Aeq,15min}$ dB(A) equivalent level. **Table 8.8** presents the standardised intrusiveness noise level and the project amenity level as derived by adding 3 dB to each period of the day.

Table 8.8 – Project Trigger Levels

Receiver	Time of Day	Standardised $L_{Aeq,\ 15\ min}$ Noise Level (dB)		
		Intrusiveness Criteria	Project Specific ANL	Project Trigger Level
Residential	Day	40	48	40
	Evening	35	43	35
	Night	35	38	35
Golf Course	When In Use	a)	53	53

a) Intrusive noise levels are only applied to residential receivers. For all other types ANL are used.

8.4.1.5 Sleep Disturbance

NSW EPA have identified a screening assessment for sleep disturbance based on the night time noise levels at a residential location. Where noise levels at a residential location exceed:

- $L_{Aeq,\ 15\ min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is greater; and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 whichever is the greater,

a detailed maximum noise level event assessment should be undertaken.

For the operational phase of the project, loud impact noises associated with sleep disturbance are considered unlikely with all plant and equipment continuous or semi-continuous in its operations. Furthermore, the operation of plant and equipment on-site only occurs during daylight hours where solar energy is available with peak operations.

Given the lack of short-term impact noise sources on site consideration of sleep disturbance impacts for the operational phase of this project is considered unnecessary. Rather, where compliance can be demonstrated with the intrusive noise criteria established for the development, compliance with the sleep disturbance provisions would also be expected.

8.4.2 NOISE SOURCES

The MSF is to consist of solar photovoltaic (PV) plant and associated infrastructure producing electricity for supply into the grid. It is expected that, at completion, infrastructure installed on site will incorporate:

- approximately 1330 NexTracker tracking motors and
- ten (10) solar inverters with integrated transformers.

The PV panels will be mounted onto fixed support structures by single axis tracking panels which track the suns movement across the day through the use of small motors which rotate the panel arc of the sun to maximise the solar effect. Noise emissions from the tracking motors are expected to occur for approximately one minute out of each 15-minute period (providing for up to five degrees' rotation per hour) during day periods. For the purposes of the assessment it is assumed that these tracking motors would be evenly distributed across the development area.

Table 8.9 presents a summary of the source noise levels considered in the assessment.

Table 8.9 – Source Noise Levels

Source	Sound Power Level (dB(A))
NexTracker	60 (each)
Inverter [a)]	92 (each)
Light Vehicle	88

a) Based on previous experience with similar sources there is potential for tonal influences associated with this source. Therefore, in accordance with the NPfI, a +5 dB penalty has been applied to this source

8.4.3 NOISE MODELLING METHODOLOGY

For the purposes of predicting impacts associated with noise emissions from the development site on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (version 2018 build 161.4800) developed by DataKustik. Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with *ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors*.

The model is utilised to assess the potential noise emissions from the site under a range of operating scenarios and meteorological conditions. The noise modelling also allows investigation of possible noise management solutions, in the event that non-compliance with the assessment criterion is predicted.

8.4.4 METEOROLOGY

The NPfI presents guidelines for the consideration of meteorological effects on noise propagation. Specifically, temperature inversions and/or gradient winds should be modelled if each factor is a feature of the local environment. The following conditions for modelling temperature inversions or gradients winds are provided:

- temperature inversions:
  - use default parameters for temperature inversions and drainage-flow wind speed where inversions are present for at least 30 percent of the total night time during winter as specified; or
  - use parameters determined by direct measurement. Wind data should be collected at a 10-m height.
- gradient winds:
  - where there is 30 percent or more occurrence of wind speeds below 3 m/s (source-to-receiver component), then the highest wind speed (below 3 m/s) is used instead of the default.
  - where there is less than 30 percent occurrence of wind speeds of up to 3 m/s (source-to-receiver component), wind is not included in the noise prediction calculation.

Given the location of the site, the presence of temperature inversions is considered possible for night-periods. Therefore, in accordance with the requirements of the NPfI, the following scenarios have been considered:

- Day Periods - Source to receptor wind at 3 m/s representing a worst-case assessment of potential impacts for day-periods; and
- Night Periods - Moderate temperature inversion with light source to receptor winds representing a worst-case assessment of potential impacts for night periods.

8.4.5 PREDICTED NOISE LEVELS

Table 8.10 below presents predicted receptor noise levels during the operational phase of the proposed solar farm. Review of the predicted noise levels confirms that compliance with the trigger level noise criteria established in accordance with the NPfI can be achieved for all receptors for both day and night periods under worst-case meteorological conditions.

Table 8.10 – Predicted Receptor Noise Levels – Operational Phase, dB(A)

Receptor	Predicted Operational Noise Levels, $L_{Aeq, 15min}$		Day/Evening/Night Trigger Level Criteria	Comply (Y/N)
	Day Periods	Night Periods		
R1	25	26	40/35/35	Y
R2	29	35	40/35/35	Y
R3	26	28	40/35/35	Y
R4	23	23	40/35/35	Y
Golf Course	<10	<10	53	Y

Given the predicted compliance with the noise limits derived in accordance with the NPfI. No further noise mitigation is considered necessary.

8.5 ROAD TRAFFIC NOISE ASSESSMENT

8.5.1 INTRODUCTION

Noise impacts associated with vehicle movements during the operational phase of the MSF are expected to be negligible given the small number of movements expected (maximum of six per day for three staff). During the construction phase of the project however, significantly higher traffic volumes are expected for the duration of the construction works.

Construction is expected to be completed over a 12-month period with an expected peak period of six months during which a range of construction tasks are concurrently undertaken. During this peak, it is anticipated that up to 100 workers would be on-site daily, dropping to 20 workers for the six-month shoulder periods.

While it is expected that the contractor would provide a shuttle bus service, for noise assessment purposes it is assumed that only 30% of the 100 workers would participate in some form of carpooling. Therefore, the modelling has assumed an estimated maximum of 70 private light vehicles travelling to and from the site daily for this peak period.

The infrastructure will be delivered to the site via the Cobb Highway and off-loaded within a designed lay-down area located at the south-western corner of the development site.

The maximum number of heavy vehicles accessing the site during the peak of the construction period is not expected to exceed 20 (i.e. generating a total of 40 heavy vehicle movements in a day).

Given this, the assessment has considered the potential impacts associated with noise emissions from the maximum expected 140 light and 40 heavy vehicle movements from the site entry onto the Cobb Highway as summarised below

Table 8.11 – Construction Phase Traffic Generation

Road	Vehicle Type	Vehicle Speed	Number of Movements	
			Day (7.00 am – 10 pm)	Night (Peak 1 hour)
Cobb Highway	Light	100 km/hr [b)]	140	70
	Heavy	100 km/hr [b)]	40	0

a) Assumes all truck deliveries to site occur during the hours of 7 am to 10 pm.
b) At the entry and approach to the site access vehicle speeds are expected to be significantly low than the sign-posted limits.

8.5.2 ASSESSMENT CRITERIA

The ICNG does not provide criteria for the assessment of construction road traffic during the project. Given this reference is made to the noise criteria provided in the NSW *Road Noise Policy* (RNP). Based on the type of roadway, **Table 8.12** presents the applicable road traffic noise criteria for existing residences affected by traffic on existing roadways.

Table 8.12 – Applicable Road Traffic Noise Criteria

Road Category	Type of Project & Land Use	Assessment Criteria (external)
Freeway / arterial / sub-arterial road	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	Day: $L_{Aeq,15\ hour}$ 60 dB(A) Night: $L_{Aeq,9\ hour}$ 55 dB(A) (external)

8.5.3 NOISE MODELLING METHODOLOGY

Predicting impacts associated with road traffic noise emissions was completed using the proprietary software Cadna (version 2018 build 161.4800) developed by DataKustik. The model incorporates the influence of terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with Calculation of Road Traffic Noise (CRTN) methodology developed by the UK Department of Transport. In accordance with the requirements of the RNP, the predictive noise modelling incorporated the following assumptions:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CRTN methodology using the approximation $L_{Aeq,1\ hour} = L_{A10,1\ hour} – 3$.
- Noise source heights were set at 0.5 m above road level for cars, 1.5 m for heavy vehicle engines and 3.6 m for heavy vehicle exhausts.
- Noise from heavy vehicle exhausts is 8 dB lower than the steady continuous engine noise; and
- Corrections established for Australian conditions applied through a negative correction to the CRTN predations of -1.7 dB for façade-corrected levels (Samuels and Sauders, 1982).

Table 8.13 below presents predicted noise levels for the nearest potential receptor to the Cobb Highway assuming a minimum setback distance of 60 m. It should be noted that this is considered to represent a conservative assumption with the majority of dwellings along the Cobb Highway noted to be setback more than 100 m from the roadway.

Review of the predicted noise levels confirms that compliance with the RNP is predicted by a considerable margin. As such, adverse amenity impacts due to peak traffic levels generated by the proposed construction works is considered unlikely.

Table 8.13 – Predicted $L_{Aeq,15}$ Noise Levels – Road Traffic Noise

Receptor	Setback from Roadway	Period	Parameter	Criteria	Predicted Noise Level	Comply (Y/N)
Nearest to Cobb Highway	60 m	Day	L_{Aeq}, 1 hour	60 dB(A)	53	Y
		Night	L_{Aeq}, 1 hour	55 dB(A)	46	Y

8.6 VIBRATION ASSESSMENT

8.6.1 INTRODUCTION

A review of the proposal indicates there is potential for impacts as a result of vibration generated by plant and equipment during the construction phase. Given this, an assessment of the potential for vibration impacts has been undertaken. In particular, the assessment has considered the potential for impacts on both human comfort and structural damage for the nearest residence to the construction works.

8.6.2 ASSESSMENT CRITERIA

The vibration criteria presented in the *Environmental Noise Management – Assessing Vibration: A Technical Guide* (2006) published by the NSW Department of Environment Climate Change and Water (DECCW) have been adopted for the assessment. The technical guide provides vibration criteria associated with amenity impacts (human annoyance) for the three categories of vibration:

- Continuous vibration (e.g. road traffic, continuous construction activity);
- Impulsive vibration includes less than 3 distinct vibration events in an assessment period (e.g. occasional dropping of heavy equipment); and
- Intermittent vibration includes interrupted periods of continuous vibration (e.g. drilling), repeated periods of impulsive vibration (e.g. pile driving) or continuous vibration that varies significantly in amplitude.

Table 8.14 and **Table 8.15** present the criteria for continuous and impulsive vibration and intermittent vibration respectively.

Table 8.14 – Continuous & Impulsive Vibration Criteria for Residence – Peak Velocity

Location	Vibration Type	Preferred Limit (mm/s)	Maximum Limit (mm/s)
Residences	Continuous	0.28	0.56
Residences	Impulsive	8.6	17

Table 8.15 – Intermittent Vibration Criteria for Residences

Location	Assessment Period	Preferred Value ($m/s^{1.75}$)	Maximum Value ($m/s^{1.75}$)
Residences	Day-time	0.20	0.40

The above criteria are suitable for assessing human annoyance in response to vibration levels. In order to assess potential damage to buildings, reference has been made to British Standard BS 7385-2: 1993 *Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration*. **Table 8.16** presents vibration criteria for assessing the potential for building damage.

Table 8.16 – Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Particle Velocity (mm/s)	
	4 Hz to 15 Hz	15 Hz and above
Unreinforced or light framed structures – residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

8.6.3 POTENTIAL VIBRATION SOURCES

Table 8.17 identifies the vibration source levels for the equipment likely to be used for the construction of the solar farm.

Table 8.17 – Vibration Source Levels – Peak Particle Velocity

Equipment Item	PPV at 10 m (mm/s)	Sources
Piling	1 – 2	Rockhill D.J et. al. [b)]
Roller	5 - 6	DECCW
7 tonne compactor	5 - 7	DECCW
Loaded trucks (rough surface)	5	USA DT [a)]
Loaded trucks (smooth surface)	1 – 2	USA DT [a)]
Excavator	2.5 – 4	DECCW

a) Transit Noise and Vibration Impact Assessment, US Department of Transportation, May 2006.
b) Rockhill, D.J., Bolton, M.D. & White, D.J. (2003) 'Ground-borne vibrations due to press-in piling operations'

8.6.4 ASSESSMENT OF POTENTIAL IMPACTS

Based on the vibration source levels at 10 m peak particle velocities have been predicted at various separation distances. **Table 8.18** presents PPV predictions for the various construction equipment.

Table 8.18 – Predicted Peak Particle Velocity at Sensitive Receptors (mm/s)

Distance from Source (m)	Predicted Peak Particle Velocity (mm/s)					
	Roller	7 tonne compactor	Excavator	Piling	Loaded trucks (rough surfaces)	Loaded trucks (smooth surfaces)
10	6.00	7.00	4.00	0.35-0.71	5.00	1-2
20	2.12	2.47	1.41	0.19-0.38	1.77	0.35-0.71
30	1.15	1.35	0.77	0.13-0.25	0.96	0.19-0.38
40	0.75	0.88	0.50	0.09-0.18	0.63	0.13-0.25
50	0.54	0.63	0.36	0.07-0.14	0.45	0.09-0.18
60	0.41	0.48	0.27	0.02-0.11	0.34	0.07-0.14
70	0.32	0.38	0.22	0.04-0.09	0.27	0.06-0.11
80	0.27	0.31	0.18	0.07-0.07	0.22	0.05-0.09
90	0.22	0.26	0.15	0.03-0.06	0.19	0.04-0.07
100	0.19	0.22	0.13	0.02-0.03	0.16	0.03-0.06
150	0.1	0.12	0.07	0.35-0.71	0.09	0.02-0.03
Type	Continuous	Continuous	Continuous	Intermittent	Intermittent	Intermittent
Nuisance Criteria	Residential 0.28 (preferred)/0.56 (max) School 0.56 (preferred)/1.1 (max)					
Building Criteria	Residential 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above					

The predicted vibration levels indicate compliance with the continuous preferred vibration nuisance criteria for locations at a separation distance of 50-60 m. Compliance with the building damage criteria is predicted at 10 m from construction for each source.

For intermittent vibration associated with haul vehicles and piling, it is difficult to provide an appropriate comparison with the relevant criteria (which is presented as a Vibration Dose Value (VDV) in $m/s^{1.75}$). The calculation of a VDV requires both the overall weighted RMS (root mean square) acceleration (m/s^2) typically obtained from on-site measurements and the estimated time period for vibration events.

It is noted, however, that the piling PPV at a distance of >220m (the distance to the nearest sensitive receptor from potential piling) is predicted to be within the maximum continuous criteria of 0.56 mm/s. This comparison with the continuous criteria (as a conservative approach) indicates that vibration levels associated with piling are not considered to be significant (which is expected given the significant separation distances).

8.7 CONCLUSION

The impact assessment has considered the potential for adverse impacts resulting from noise (construction, road traffic and operational) and vibration (construction) emissions on neighbours.

Overall, based on the results of the assessment, the risk of adverse impacts as a result of the proposed MSF is considered to be low and complies with all applicable criteria. Hence, from an acoustic perspective, the proposed development site is considered acceptable for the proposed use.

Visual Impact

9.1 FARM INFRASTRUCTURE

Above ground infrastructure associated with the solar farm will include a perimeter security fence, modules (including the supporting piles and tracking mounts), an O&M building, the inverter stations and the site switching station. The grid connection will be underground.

Modules

The solar PV panel technology will be either crystalline silicone or Cadmium Telluride thin film. The panel modules will be connected together via a DC collection system consisting of cables mounted on the module support structure. The racking system will be SAT, which tracks the daily movement of the sun and motorised linkages rotate the modules from the east in the morning to the west in the afternoon. The height of the module infrastructure will be approximately 2.6 m above ground level.

The modules are laid out in rows or strings, typically 5-7 m apart, depending on the technology used. The gentle slopes of the CSF site will lead to optimal spacing without output being affected by shading of adjacent strings. The racking system will be supported by steel piles. The module arrays occupy the bulk of the 80 ha solar farm footprint.

Plate 4: Indicative Single Axis Tracking

Inverter Stations

Contingent on detailed design and procurement the MSF will have up to 10 inverter stations. The inverter stations are self-contained units comparable in appearance to a shipping container or open skid type structures on elevated platforms up to 3.5 m in total height. Inverter dimensions are typically 2.59 m high, 6.05 m long and 2.43 m wide. These inverter stations will be positioned throughout the module arrays with each power block of the solar farm corresponding to the capacity of the inverter station.

Plate 5: Typical Container Type Inverter Station

Switching Station

The site switching station will consist of a secure enclosure (up to 30m x 30m) with several items of electrical equipment and supporting structures. The equipment and structures will be installed on concrete foundations and the switching station yard will be kept free of vegetation.

The switching station will be positioned in the south western corner of the solar farm.

Plate 6: Typical Switching Station Arrangement

Grid connection

The grid connection will be via an underground transmission line from the MSF's switching station connecting to Essential Energy's substation station located approximately 2.5 km south of the solar farm

Security fence

A security fence will be installed around the solar farm perimeter. This fence will be up to 2.1 m chain link with three barbs on top, for a total height of up to 2.4 m.

Operations and Maintenance Building

An Operations and Maintenance (O&M) Building will be located on south western side of the farm. The building proposed is a modular Ausco/Stratco type building with colorbond roof and exterior finish. A storage facility will also be included as part of the O&M building (or separate to the O&M building) and will generally be of the same type of construction.

Plate 7: Typical Operations and Maintenance Building

9.2 IMPACTS

9.2.1 LANDSCAPE

A dominant feature of the locality is the very flat terrain. The surrounding landscape is characterised by agricultural land uses with industrial facilities to the north west and raceway to the north.

There are no formally recognised landscape conservation areas as listed in local, State or Commonwealth heritage registers, or noted scenic or significant vistas in the locality. Visual amenity would be valued most by neighbours: local people who live and work in the locality.

The site is located east of the Cobb Highway, with the adjacent Travelling Stock Reserve devoid of trees. At present, open and expansive views of the site exist for motorists.

A neighbouring residence exists immediately to the north, with two others located within 1 km of the site, on the western side of the highway.

Drawing EV03 shows an aerial montage of how and where the MSF will sit within the landscape.

9.2.2 GLARE

Glare is a continuous source of excessive brightness relative to ambient lighting (Ho, 2009). Solar PV panels are specifically designed to absorb not reflect solar energy. Reflected sunlight is lost energy and represents lost revenue. For this reason the glass used in solar PV systems can reflect just 2% of the light received (Spaven, 2012).

Further, single-axis tracking modules which track east to west with the sun. This means the angle of incident (AOI) sunlight onto the solar panel is generally perpendicular, resulting in more energy hitting the module and less reflection than a fixed-axis module which has a greater AOI as the sun moves. Fixed-axis modules do not move so the angle that the sun hits the fixed panels earlier and later in the day is much greater, and more likely to result in glare.

A glare analysis for the MSF has been undertaken using the Solar Glare Hazard Analysis Tool (SGHAT) developed by Sandia National Laboratories and meets the United States Federation Aviation Administration (FAA) standards and guidelines. GlareGauge computes the potential for glare for flight paths and receptor points (https://www.forgesolar.com/tools/glaregauge/).

GlareGauge provides a quantified assessment of when and where glare will occur throughout the year for a prescribed solar installation. The tool employs an interactive Google map where the user can locate a site, identify the proposed PV arrays, and specify observer locations or paths. Coordinates and elevation are automatically recorded through the Google interface, providing necessary information for sun position and vector calculations. Additional information regarding the orientation and tilt of the PV panels, reflectance, environment, and ocular factors are entered by the user.

Significantly, GlareGauge does not account for the mitigating effects of physical obstructions between the solar arrays and the receptor. These obstructions include buildings and vegetation and as such, the assessment provides more conservative results than would actually occur.

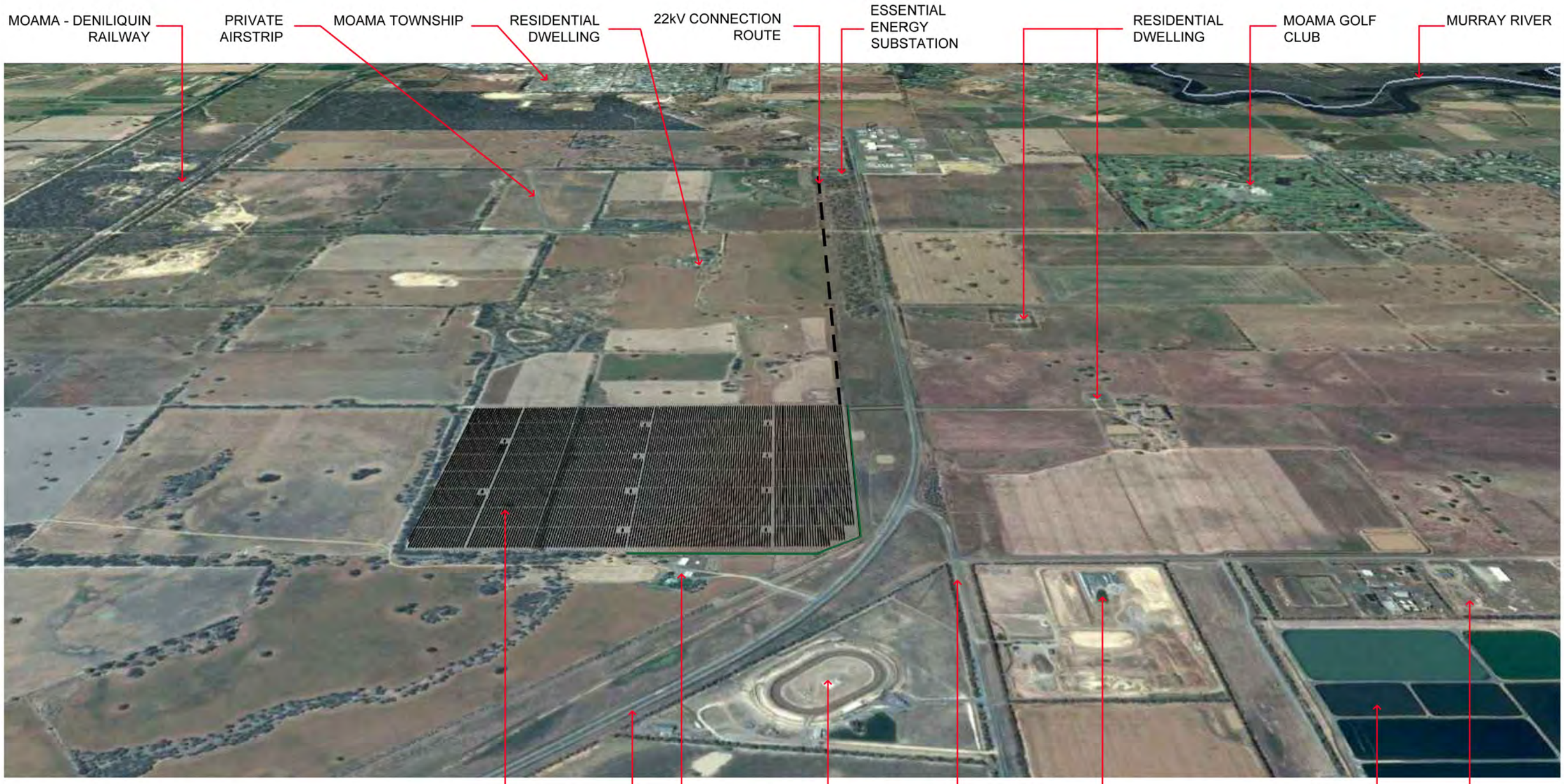
The analysis produces a report that identifies whether there is glare potential for any given receptor. If glare is predicted the model output provides the following information:

- A plot showing on what days of the year, at what times during those days, and for how long each day (to minute accuracy) that glare is predicted.
- A plot of glare reflections on the solar farm footprint showing the location that glare is predicted to be visible.

It is also noted that the GlareGauge analysis is based on a 1 minute interval. This allows the sun's position to be determined as it changes throughout the year and produces high resolution results (refer Sandia National Laboratories (2016) Solar Glare Hazard Analysis Tool User's Manual v. 3.0).

AERIAL VIEW FROM NORTH

The image shown below is based on an indicative conceptual layout.



LEGEND

LOCATION OF PROPOSED NEW LANDSCAPE PLANTING

Artist's impression - elevation approx 1500m

GEOLYSE
ORANGE
154 PEISLEY STREET
P.O. BOX 1963
ORANGE NSW 2800
orange@geolyse.com
www.geolyse.com
Ph. (02) 6393 5000
Fx. (02) 6393 5050

PROJECT DETAILS
Directory: O:\Projects\217\217439\Out\SketchUp
Data Source: Google Earth (Imagery)
Project Number: 217439

DRAWING SCALE
Do not scale from this drawing. All measurements shall be confirmed onsite and with Geolyse Pty Ltd prior to construction.

APPROVAL AUTHORITY
Murray Shire
Western Joint Regional Planning Panel

CLIENT
TERRAIN SOLAR

PROJECT
MOAMA SOLAR FARM

DRAWING
Name: Aerial View
Reference: 217439_01A_EV01-EV03
Sheet: EV03 of EV03
Status: Final
Date: 19/02/2018

©2018. Whilst every care has been taken to prepare this map, Geolyse Pty Ltd makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damaged and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

The glare analysis undertaken considered impacts on the following:

- motorists travelling on the Cobb Highway;
- residences located within 3 km of the arrays; and
- pilots using the private airstrip located approximately 1.7 km south of the solar farm.

The results of the glare analysis, for all receptors, indicate that there is no potential for the proposed MSF to cause adverse glare impacts for neighbours, motorists on the Cobb Highway or pilots using the private airstrip to the south.

The results of the modelling analysis are provided in **Appendix D**.

9.2.3 LIGHTING

The only night lighting associated with the MSF would be targeted security lighting. This will generally be for the O&M building, front gate, inverter stations and switching station. Full perimeter security lighting is not proposed.

Lighting would be designed and operated to comply with *Australian Standard AS4282 Control of Obtrusive Effects of Outdoor Lighting*. In so doing there would be negligible light spill above the horizontal plane and no impacts to adjoining properties.

9.3 MITIGATION MEASURES

The development incorporates establishment of landscape screen plantings along the entire eastern and partial northern boundaries of the farm to provide screening from the Cobb Highway and neighbours.

The screen planting will be 5 m wide and planted with species associated with the Black Box Lignum woodland community present in the area.

The extent of these plantings are shown on **Drawing EV01**.

Traffic

10.1 INTRODUCTION

Once commissioned and operational the MSF will generate negligible traffic. The farm will have up to three (3) staff stationed on-site who will only need light vehicles for regular access. Visitation will be limited to periodic maintenance and possible infrequent plant and equipment replacement that could generate heavy vehicle access. As a land use, a solar farm is not a significant traffic generating development.

It will be during construction and any future decommissioning of the farm that traffic movements will, in a relative sense, be more significant.

10.2 TRAFFIC GENERATION

10.2.1 LIMITATIONS

While it is possible to estimate the likely quantum, type and routes of construction traffic, the way in which a large scale solar project like the MSF is delivered means that this can only be an estimate; albeit an informed one, at this stage.

As noted earlier Terrain Solar will, subject to securing development consent, appoint an Engineering Procurement and Construction (EPC) contractor to build and commission the MSF. The EPC contractor carries out the detailed engineering design of the project, procures all the equipment and materials necessary, and then constructs to deliver a functioning facility to their client.

What this means is that until the EPC contract is executed, and an EPC contractor subsequently determines the logistics program, definitive and precise information about construction traffic is not known.

This inability to lock in definitive logistics information is managed as follows. An informed estimate of likely traffic volumes and likely routes is presented to inform the determination of the Development Application then, subject to securing Development Consent, and before any construction works can commence, MSF's EPC contractor submits a Traffic Management Plan to both Murray Shire Council and the Roads and Maritime Service (RMS) for approval.

This hold point ensures that the impact of generated traffic and the measures proposed to ensure the efficiency and safety of the public road network can be validated by these road authorities against a definitive traffic profile and traffic management regime. At this point construction scheduling and staging detail, peak times and duration for project related traffic, transportation routes, etc. will be known.

It is in this context that the information presented below in relation to construction traffic should be considered.

10.2.2 TOTAL VEHICLE MOVEMENTS

Construction is expected to be completed over a twelve (12) month period with an expected peak period of six (6) months during which a range of construction tasks will be undertaken concurrently. During this peak it is anticipated that up to 100 workers will be on-site daily, dropping to 20 workers or less for the six (6) month shoulder periods.

As has been typical for utility scale solar construction in New South Wales, it is expected that the EPC contractor will look to provide a shuttle bus service for workers during the six month peak. For traffic assessment purposes it is assumed that 90% of workers will utilize the shuttle service with a total of two (2) buses travelling to and from the site in both the morning and evening.

Estimates of total heavy vehicle movements associated with the delivery of farm infrastructure and associated materials and resources to build the MSF are provided in **Table 10.1**.

Table 10.1 – Heavy Vehicle Numbers

Plant/Equipment	Description	Heavy Vehicles
Modules	576 modules per 40' container: 101,562 modules delivered on 176 semi-trailers.	176
Mounting frames	4 x 40' container per MWdc, inclusive of piles, torque tubers and all associated hardware, delivered on 130 semi-trailers.	130
Inverter Stations	10 x ~2.5 MW inverter stations; delivered 1 per semitrailer.	10
Concrete	Estimated 360m^3 required for switching-station compound, inverter assembly foundations and security fence: generate 33 X 11m^3 concrete trucks.	33
Gravel	Estimated 5,500 tonne of gravel for internal access roads and temporary hardstand lay down and construction compound area: delivered in 42.5 tonne truck & dog trailers. Assumes 3,800 m of 5m wide access road and construction compound/hardstand 100 m x 200 m – all at 100 mm	130
Sand	Estimated 700m^3 of sand (~1000 tonne) would be delivered in 20 x 50 tonne truck & dog trailers	20
Miscellaneous	Provision for 5 miscellaneous deliveries (fencing, switching station equipment, building materials for the operations building, water for dust suppression, etc) a week during the six month peak, dropping to 2 trucks a week for the six month shoulder periods.	182
TOTAL		**~680**

10.2.3 PEAK VEHICLE MOVEMENTS

For the purposes of this assessment the peak weekday traffic movements associated with the six (6) month peak construction period will be considered.

10.2.3.1 Daily Traffic Generation

In order to determine the Annual Average Weekday Traffic (AAWT) generated by the development during the six (6) month peak construction period the following daily traffic generation rates were assumed:

- 8 shuttle bus trips per day;
- 50 light vehicle trips per day (made up of 20 trips per day for contractors travelling to and from site each day and 30 additional trips per day for visitors and/or contractors entering/leaving the site throughout the day); and
- 40 heavy vehicle trips per day (assuming a maximum of 20 heavy vehicles accessing the site daily, during the peak of the construction period).

Based on these estimations the AAWT generated by the construction of the MSF, at its busiest, is calculated as 98 vehicle trips per day.

10.2.3.2 Peak Hour Traffic Generation

During the peak six (6) month construction period it is assumed that the peak hour traffic generation will occur between 6:00 – 7:00 am and 5:00 – 6:00 pm when contractors arrive at and leave the site each day. In order to determine the peak hour traffic generated by the development the following assumptions are made:

- All heavy vehicle deliveries will be scheduled to be made outside the peak hours of 6:00 – 7:00 am and 5:00 – 6:00 pm; and
- All visitors will access the site outside the peak hours 6:00 – 7:00 am and 5:00 – 6:00 pm.

Based on these estimations the Peak Hour Traffic generated is calculated as 14 vehicles per hour occurring between 6:00 – 7:00 am and 5:00 – 6:00 pm.

As noted above until the EPC contractor completes their investigations, equipment and material supply contracts executed and transport logistics finalised it is not possible to specify haulage routes. Notwithstanding, it is reasonable to assume that the port of entry for the bulk of infrastructure for the MSF will be the Port of Melbourne, and the bulk of heavy vehicle (and light vehicle) traffic will approach the site from the south (ie. northbound along Cobb Highway), with a right turn entry into the solar farm. For the purposes of this assessment it is assumed that 90% of traffic generated by the development will have an origin/destination south of the site.

Based on the assumptions above the peak hour turning movements at the access into the solar farm site during the peak of the construction period have been calculated as indicated in **Table 10.2** below.

Table 10.2 – Peak Hour Turning Movements

Turning Movement	AM Peak (vehicles/hr)	PM Peak (vehicles/hr)
Right Turn Into Site	11	2
Left Turn Into Site	1	Nil
Right Turn Out of Site	2	1
Left Turn Out of Site	Nil	11

10.3 EXISTING TRAFFIC

Review of the NSW RMS *Traffic Volume Viewer* provided hourly daily traffic volumes split between heavy and light vehicles from 2012 for the Cobb Highway, 200 m north of Nicholas Drive, Moama, and approximately 5 km south of the proposed solar farm site (Station No: 97233).

A summary of the Annual Average Weekday Traffic (AAWT) and the Weekday Peak Hour Traffic volumes calculated from the RMS data is provided in **Table 10.3**

Table 10.3 – Cobb Highway Existing Traffic Volumes (2012)

Vehicle Type	Northbound Direction	Southbound Direction
Annual Average Weekday Traffic (vehicles/day)		
Light Vehicles	2,512	3,039
Heavy Vehicles	305	341
Total	2,817	3,380
AM (8:00 – 9:00 am) Peak Hour Traffic (vehicles/hour)		
Light Vehicles	146	375
Heavy Vehicles	19	26
Total	165	401
PM (3:00 – 4:00 pm) Peak Hour Traffic (vehicles/hour)		
Light Vehicles	214	282
Heavy Vehicles	21	32
Total	235	314

Source: RMS Traffic Volume Viewer (29 November 2017)

It is noted that the existing peak hour traffic for the morning peak occurred between 8:00 – 9:00 am whilst the peak hour traffic for the morning peak generated by the proposed development is estimated to occur between 6:00 - 7:00 am. The hourly traffic volume during the peak hour of traffic generation for the morning is provided in **Table 10.4**.

Table 10.4 – Cobb Highway Existing Traffic Volumes during Development Peak Hour

Vehicle Type	Northbound Direction	Southbound Direction
AM (6:00 – 7:00 am) Hour Traffic (vehicles/hour)		
Light Vehicles	66	88
Heavy Vehicles	13	11
Total	79	99

Source: RMS Traffic Volume Viewer (29 November 2017)

10.4 SITE ACCESS

10.4.1 PREFERRED/ALTERNATIVE

The development site is not currently provided any direct access off the Cobb Highway.

Terrain Solar's preferred access is located adjacent to the southern boundary of the development site. An alternate access is located approximately 900 m further south, utilising an existing access track (refer **Drawing EV01**). Consultation with the property owner that uses this track to access their property has established that they have no concerns or objection to the use of this track for this purpose.

The speed limit on the Cobb Highway at both these locations is 100 km/h and sight distances at both are well in excess of 300 m (which is the Safe Intersection Sight Distance for a 2.5 second response time in a 110 km/hr design speed).

The alternate access is a back-up option and is required because of the potential occurrence of the critically endangered *Prasophyllum* sp. 'Moama' and *Pterostylis despectans* at the location of the preferred access. A specialist Expert Report (refer **Appendix B**) has determined that there is a 'moderate' likelihood of occurrence, and that a targeted surveys are required to establish its presence, or not. The requisite survey window is October-November for the *Pterostylis despectans* and September for the *Prasophyllum sp. 'Moama'*.

Assuming either of these species is not in the location of the preferred access, or that an access treatment can be constructed at this location if they are present, but without a likely significant impact on this species, then the intent is to utilise the preferred access location. If the species are present, or construction of the access road into the solar farm can't be constructed without a likely significant impact on this species, then the alternate access location is proposed.

In either case, access will be off the Cobb Highway and traverse the Travelling Stock Reserve. Consultation with Murray Local Land Services (MLLS) has confirmed there is no in-principle issue with the TSR interaction; noting that the *Local Land Services Act 2013* allows occupiers of land a right of access over travelling stock reserves, in certain circumstances and subject to certain requirements.

10.4.2 PROPOSED INTERSECTION TREATMENT

The Austroads *Guide to Traffic Management Part 6: Intersection, Interchanges and Crossings* provides warrants for major road turn treatments based on peak hour turning volumes and the major road traffic volumes. The proposed access (both preferred and alternate) is located in relative close proximity to the Moama township and traffic control measures including the use of cautionary signage and temporary speed reduction will be implemented during the construction phase. Hence Figure 2.23(b) from the Austroads guide is appropriate to use in determining the type of turn treatments warranted.

For the left turn in treatment the estimated Peak Turn Volume "Q_L" is estimated as 1 veh/hr (occurring during the 6:00 – 7:00 am peak) and the Major Road Traffic Volume "Q_M" associated with this turn movement is 99 veh/hr. Based on these volumes and reference to Figure 2.23(b) in the Austroads Guide a basic left turn (BAL) treatment is proposed. **Figure 10** shows a typical BAL treatment proposed to be adopted at the site.

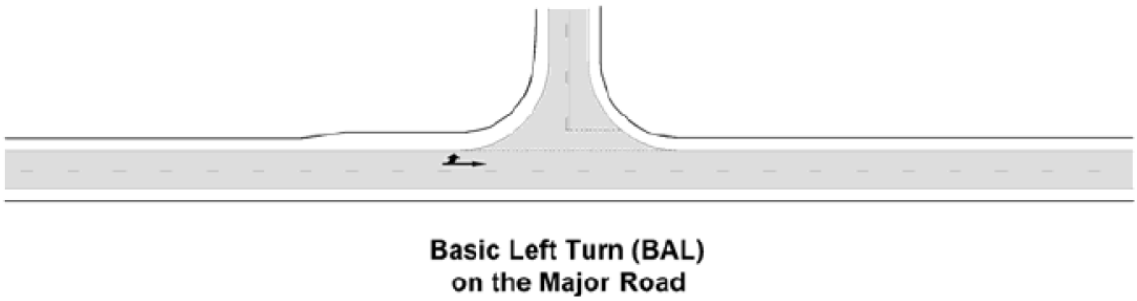


Figure 10: Typical BAL Intersection Treatment

For the right turn in treatment the estimated Peak Turn Volume "Q_R" is estimated as 11 veh/hr and the Major Road Traffic Volume "Q_M" associated with this turn movement is 179 veh/hr. Based on these volumes and reference to Figure 2.23(b) in the Austroads Guide a basic right turn (BAR) treatment is proposed. **Figure 11** shows a typical BAR treatment proposed to be adopted at the site.

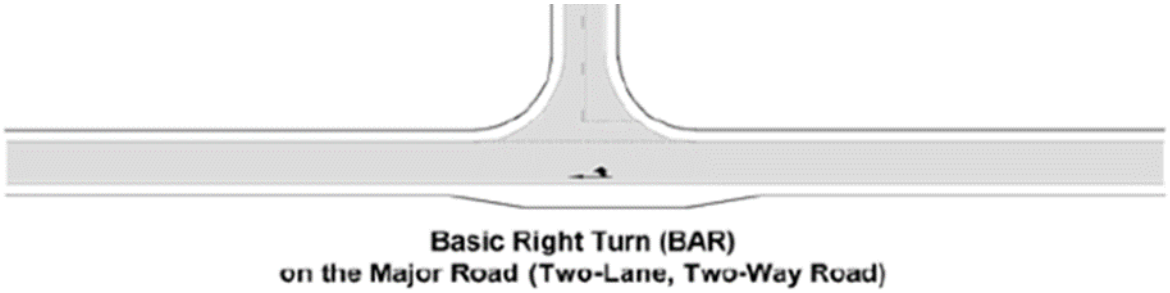


Figure 11: Typical BAR Intersection Treatment

10.5 MITIGATION MEASURES

A number of actions/works would be undertaken prior to construction activity commencing. An overview of these is provided below.

10.5.1 SELECTION OF ACCESS OPTION

Contingent on approval, either project timing and/or the results of the targeted Leek Orchid survey will determine which access option is selected. Once a decision has been made this will be communicated to MSC, RMS and MLLS.

10.5.2 TRAFFIC MANAGEMENT PLAN

A Traffic Management Plan (TMP) would then be prepared and submitted to MSC and RMS for approval. This TMP would do essentially do two things.

Firstly, it would provide the definitive construction traffic profile that the EPC Contractor proposes. This would provide the check that the assumptions used to justify the access treatment (ie. BAR/BAL) in this Statement of Environmental Effects are consistent with the traffic profile that the EPC Contractor specifies. For example, that a shuttle bus service during the construction peak will be provided, and that all heavy vehicle deliveries will be scheduled to be made outside the peak hours of 6:00 – 7:00 am and 5:00 – 6:00 pm. The value and need in doing this is to confirm, to the satisfaction of MSC and RMS, that the BAR/BAL access treatment proposed is appropriate.

Secondly, the TMP would detail the measures to be implemented to provide traffic safety and minimize any disruption to users of the road network, including

- Temporary traffic controls, including signage and speed reductions.
- Notifying the local community about project-related traffic.
- Scheduling of haulage vehicle movements to minimize the potential for convoy lengths or platooning.
- Ensuring all vehicles are loaded and unloaded on site and enter and leave the site in a forward direction.
- A driver's code of conduct that addresses travelling speeds; procedures to ensure that drivers adhere to the designated transport routes; and procedures to ensure that drivers implement safe driving practices.
- Ensuring there is sufficient parking on site for all vehicles and no parking occurs on the public road network in the vicinity of the site.
- Procedures for maintaining accurate records of the number of heavy vehicles entering or leaving the site each day.

10.5.3 HIGHWAY ACCESS TREATMENT

Subject to approval of the TMP the access treatment would then be subject to detailed design and approval by the RMS in accordance with the *Austroads Guide to Road Design* (as amended by RMS supplements): to then be built in accordance with RMS standards prior to commencement of construction of the solar farm.

10.5.4 TSR ACCESS TREATMENT

Subject to approval of the TMP detail of the road works within the TSR would then be provided to MLLS. This would include information on the position, construction and/or improvements to the access road proposed and enable both MLLS and Terrain Solar to satisfy the requirements of s.75 of the *Local Land Services Act 2013*, which states:

> *75 Certain occupiers of land to have a right of access over travelling stock reserves*
>
> *(1) An occupier of land is entitled to a right of way over a travelling stock reserve (whether controlled or managed) to and from the road nearest to the land if no other access to and from the land by means of an established road or track is available.*
> *(2) A right of way is subject to such conditions as to its exercise (including any conditions as to its position, construction or improvement) as may be imposed by Local Land Services in a particular case.*
> *(3) Local Land Services is to give notice to the occupier of land of any condition imposed by it on a right of way of the occupier.*
> *(4) The occupier may, with the approval of Local Land Services, and must if directed to do so by Local Land Services by notice in writing, construct or make improvements to the occupier's right of way over the reserve.*
> *(5) Any construction or improvements are to be made at the expense of the occupier.*

10.6 IMPACT

Potential; traffic impacts associated with the MSF will be limited to the construction phase. These impacts will be temporary and, through implementation of measures specified in an approved Traffic Management Plan will not compromise the efficiency or safety of the public road network for motorists.

Flooding and Drainage

11.1 PLANNING CONSIDERATIONS

11.1.1 FLOOD PLANNING OBJECTIVES

The development site is land susceptible to flooding in a Probable Maximum Flood (PMF) event and therefore categorised as *flood prone land*. As such the relevant provisions of *Moama Development Control Plan 2012* (DCP) apply.

Objectives of the DCP, in relation to developments on flood prone land, include:

- providing detailed controls and criteria for the assessment of development applications on land affected by flooding in Murray Shire;
- reducing the impact of flooding and flood liability on individual property owners and occupiers;
- reducing private and public losses resulting from flooding;
- restricting the intensification of development below the Flood Planning Level (FPL);
- limiting development below the FPL to those activities and works considered to have an essential relationship with the river and its floodplain;
- providing specific measures for the control of development types within flood affected areas;
- providing for the consideration of the cumulative effects of any development on flood affected land, which in or of itself may be considered to be insignificant;
- providing for and protecting the natural passage, storage and quality of flood waters;
- recognising and helping sustain the natural ecosystems of floodplains and riparian zones including the protection of associated vegetation and wetlands; and
- encouraging the development and use of land which is compatible with the indicated flood hazard.

Similarly, the eastern half of the development site is located on land mapped as a *flood planning area* and as such the relevant provisions of the *Murray Local Environmental Plan 2011* (LEP) apply. Relevant objectives of the LEP in relation to flood planning include:

- minimising the flood risk to life and property associated with the use of land,
- allowing development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,
- avoiding significant adverse impacts on flood behaviour and the environment.

Pursuant to the LEP, development consent can not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:

- is compatible with the flood hazard of the land, and
- is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and
- incorporates appropriate measures to manage risk to life from flood, and
- is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and
- is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

11.1.2 DECISION GUIDELINES

The DCP notes that proposed developments will be considered on their merits in terms of flooding impacts. Issues to be taken into consideration regarding the particular merits of development on flood liable land include the following:

- Whether the proposed development is reasonable having regard for the flood risk and resources available to the location. Applicants should place no reliance on the implementation of a condition specifying a private evacuation/flood management plan as a means to overcome an unacceptable flood risk.
- The need for a benefit/cost assessment that takes account of the full cost to the community of the flood response and flood damage likely to be incurred to the development and upon other development.
- Specific principles relating to flood liable land contained within *Murray Regional Environmental Plan No.2 - -Riverine Land* (MREP2) including:
    - the benefits to riverine ecosystems of periodic flooding;
    - the hazard risks involved in the development of that land;
    - the redistribution effect of the proposed development on floodwater;
    - the availability of other suitable land in the locality not liable to flooding;
    - the availability of flood free access for essential facilities and services;
    - the pollution threat represented by any development in the event of a flood;
    - the cumulative effect of the proposed development on the behaviour of floodwater;
    - the cost of providing emergency services and replacing infrastructure in the event of a flood; and
    - flood mitigation works constructed to protect new urban development should be designed and maintained to meet the technical specifications of the NSW government department responsible for such works.

11.2 FLOODING CHARACTERISTICS

11.2.1 FLOOD PLANNING AREAS

The DCP delineates three *Flood Planning Areas* within flood prone land based on defined parameters, as detailed in **Table 11.1**.

Table 11.1 – Flooding Definitions

Term	Meaning
Annual Exceedance Probability (AEP)	Is the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example if a peak flood discharge of 500m3/s has an AEP of 5%, it means that there is a 5% chance (that is 1-in-20 chance) of a 500m3/s or larger events occurring in any one year (see ARI).
Average Recurrence Interval (ARI)	Is the long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event (see AEP).
Flood Planning Area (FPA)	Is the area or areas to which planning controls relating to flooding apply (i.e. flood liable land). For the purposes of the DCP there are three FPA's identified.
Flood Planning Level (FPL)	The FPL is the level 500 mm above a 1% AEP or 1 in 100 Year ARI flood event. The height of the 1% AEP was modelled in the Moama Floodplain Management Study 1999 based on a height of 95.34 metres AHD at the Echuca Wharf gauge
Flood storage areas	Flood storage areas are those parts of the floodplain utilised for the temporary storage of floodwaters during the passage of a flood. Substantial reduction of the capacity of flood storage in an area may cause a significant redistribution of flood flows or increase peak discharge downstream.
Floodway areas	Floodways are those areas where a significant volume of water flows during flood events and are often aligned with obvious natural channels. They are areas that, even if only partially blocked, would cause a significant increase in flood levels and/or a significant redistribution of flood flow, which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.
Probable Maximum Flood (PMF)	The PMF is mapped as the "extreme flood" and was derived by modelling a flood with peak discharge and volume twice that of the one percent flood down the Murray, Goulburn and Campaspe Rivers. The PMF is the largest flood that could conceivably occur, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event and consequently the PMF is identified for the purpose of flood awareness and emergency response rather than development control.
Low hazard	Low hazard refers to the depth and velocity of flood waters that should it be necessary, trucks could evacuate people and their possessions, able bodied adults would have little difficulty in wading to safety. Water depths are less than 1.0 m.
High hazard	High hazard refers to the depth and velocity of flood waters where there is possible danger to personal safety, evacuation by trucks difficult, able bodied adults would have difficulty in wading to safety, potential for significant structural damage to buildings. The depth of flood waters are generally 1.0 m or more.

Flood Planning Area 1 (FPA1) is defined as land considered to be subject to inundation in a 1 in 200 year ARI flood within the area to which the *Moama Floodplain Management Study 1999* applies. For the purposes of applying development controls to FPA1, two hydraulic categories of flood prone land (flood storage and floodway) and two hazard categories (low and high) have been identified. In combination, these categories provide for four separate categories within which issues relating to land use and development in FPA1 can be assessed. These categories are Low Hazard Flood Storage, High Hazard Flood Storage, Low Hazard Floodway and High Hazard Floodway.

Flood Planning Area 2 (FPA2) is defined as land in the *Moama Floodplain Management Study 1999* between FPA1 and that inundated in an "extreme flood" or Probable Maximum Flood (PMF).

As it is not possible to accurately map the limits of flooding in a PMF event Council uses its discretion in determining whether land to which a proposal relates is within the PMF. Generally, it is not physically or economically possible to provide complete protection against this event and consequently the PMF is identified for the purpose of flood awareness and emergency response rather than development control. However, applications for development within FPA2 need still address the impact on flood waters as well as the risk of flooding to public safety and potential evacuation routes in the event of a PMF occurring.

11.2.2 SITE CHARACTERISATION

The category which a development is assessed against is determined at the Development Application stage, based on the flooding characteristics at the development site.

To this end mapping in the DCP indicates that:

- essentially the eastern half of the development site is located within FPA1 (refer **Figure 12**); and
- the entirety of the development site is located within FPA2 (refer **Figure 13**).

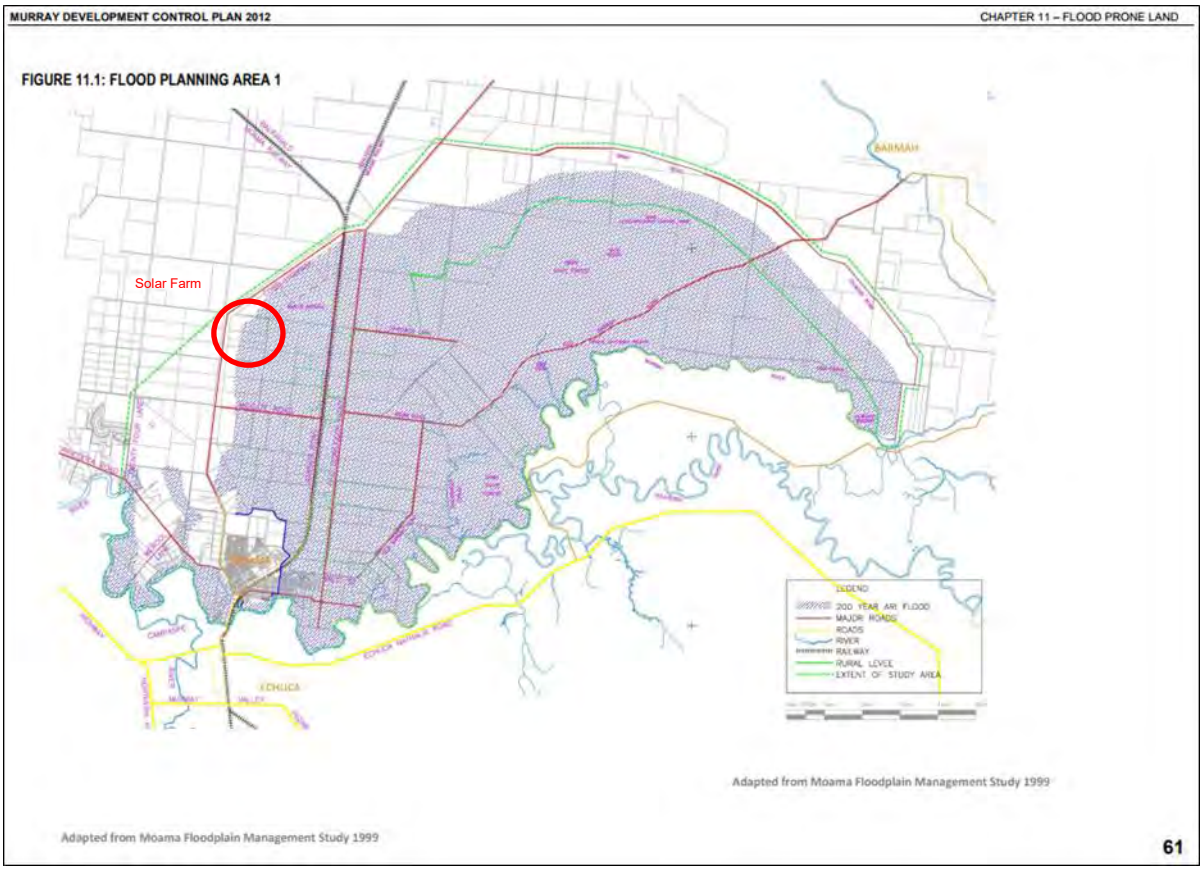


Figure 12: Flood Planning Area 1 (FPA1)

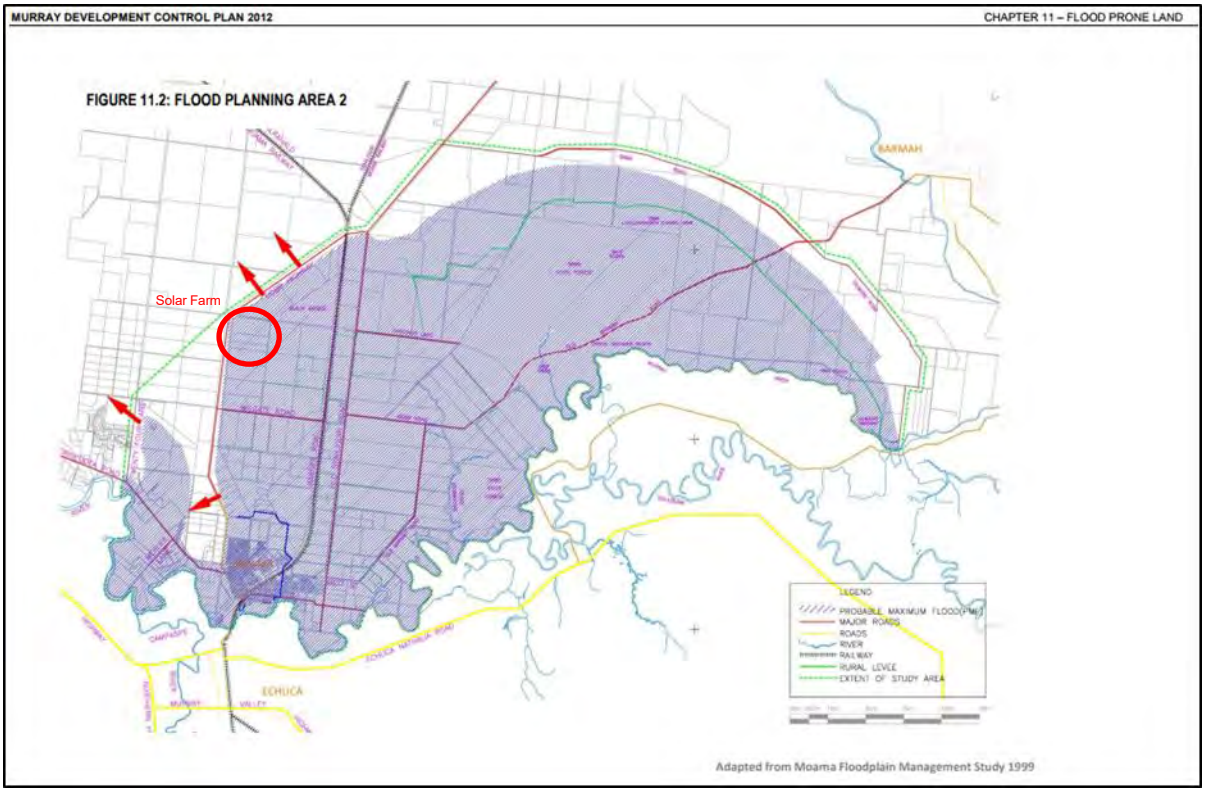


Figure 13: Flood Planning Area 2 (FPA2)

Mapping in the *Moama Floodplain Management Study* (SKM, 2001) indicates that for the FPA1 category, the development site for the proposed MSF is considered to be a low hazard flood storage area in a 1 in 100 and 1 in 200 year ARI flood event. That is, it is part of the floodplain utilised for the temporary storage of flood waters during the passage of a flood. In a low hazard flood storage area water depths do not exceed 1.0 m and pose a low damage potential to existing infrastructure.

As shown on **Figure 14** the development site is not located within a floodway.

11.2.3 FLOOD LEVEE

The development site also benefits from a levee bank that extends around part of the northern and all of the western boundary of the site (extending further south). The levee is in place to minimise the impact of flood waters on the site in the instance of a major flooding event.

Survey data indicates the crest of the level is 95.698 m AHD.

This levee is a licenced structure (Flood Work Approval: 50FW513130).

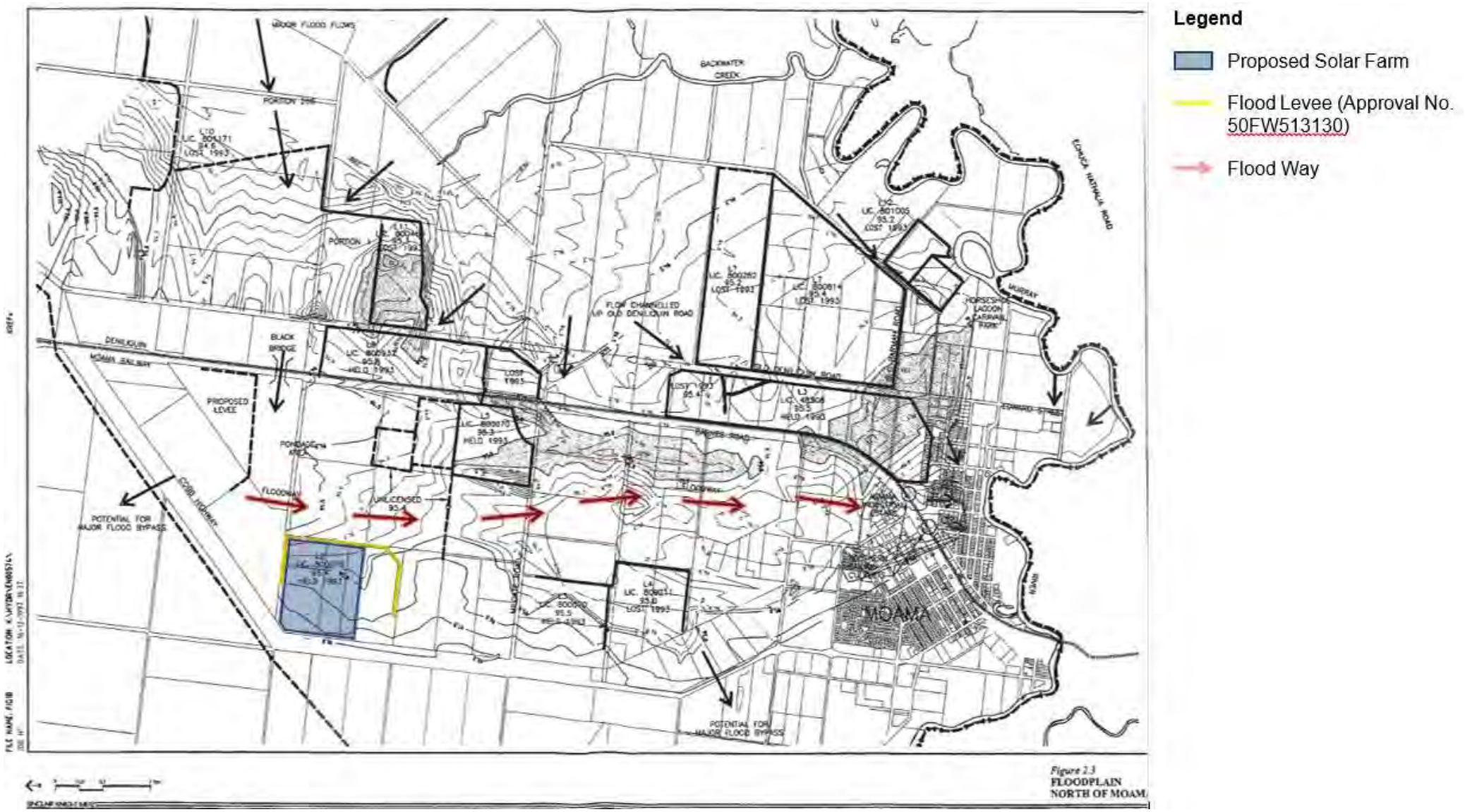


Figure 14: Major Flood Flows (SKM 2001)

11.3 IMPACT

11.3.1 FLOOD STORAGE CAPACITY

In terms of impacting on a part of the floodplain utilised for the temporary storage of floodwaters, the solar farm will not result in a substantial reduction of the capacity of flood storage in the area and cause a significant redistribution of flood flows or increase peak discharge downstream.

Internal road works will be finished at grade. The security fence will be chain mesh. The inverter stations and PV panels will be positioned above the FPL (ie. 95.84 metres AHD), on piles/posts that will permit temporary storage of any floodwaters underneath these structures.

The only exception to the above would be the switching station compound (30m x 30m) and O&M building (12m x 4m) which would be constructed on a pad built to the FPL.

11.3.2 GENERATED RUNOFF

Construction of the MSF will not require extensive or significant earthworks and will not result in any fundamental changes to existing drainage patterns. The existing flood levee on the northern and western boundary of the site will not be altered or impacted in any way. The flood protection it currently provides will remain as is.

In terms of runoff volumes the solar farm would not introduce large areas of impermeable surface that will cause increased runoff. The internal access roads will be unsealed gravel and the inverter stations will be raised above the ground on support piles. The panel arrays are positioned off-ground and the SAT technology, compared to fixed tilt systems, will not create drip lines under the panels that concentrate flows and increase the potential for runoff as they move throughout the day.

A reduction in rainfall infiltration across the solar farm will not result because of any diminution of permeable ground surface. With an enhanced capacity to retain a vegetated groundcover across the site (compared to farming/grazing the country), and with appropriate drainage design on the internal access roads, no discernible change to site runoff is expected. The proposed development will not result in increased volumes and flow velocity of runoff leaving the site. Adverse downstream hydrological impacts in terms of localised flooding will not occur.

11.4 CONCLUSION

The proposed MSF site is located in a low hazard flood storage area, protected by a licenced flood levee. It will not result in a significant reduction in flood storage capacity or change in flood behaviour.

Pursuant to the relevant provisions of *Moama Development Control Plan 2012* the MSF will not:

- increase the impact of flooding or flood liability on property owners and occupiers;
- increase private or public losses resulting from flooding;
- result in the significant intensification of development below the Flood Planning Level (FPL);
- have an impact on the relationship with the Murray River and its floodplain;
- have any cumulative effects of any development on flood affected land;
- impact on the natural passage, storage and quality of flood waters;
- compromise the natural ecosystems of floodplains and riparian zones; and
- constitute a development and use of land which is incompatible with the indicated flood hazard.

Pursuant to the relevant provisions of the *Murray Local Environmental Plan 2011* (LEP) the MSF:

- will not increase the flood risk to life and property associated with the use of land;
- is compatible with the land's flood hazard;
- avoids significant adverse impacts on flood behaviour and the environment;
- will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and
- will not significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and
- will not result in unsustainable social and economic costs to the community as a consequence of flooding.

Pursuant to the relevant provisions of the *Murray Regional Environmental Plan No.2 --Riverine Land* the MSF:

- will have no impact on the benefits to riverine ecosystems of periodic flooding;
- can safely accommodate the flood hazard risks involved in the development of the site;
- will not have a redistribution effect on floodwater;
- does not require flood free access for essential facilities and services;
- does not pose a pollution threat in the event of a flood;
- will not a cumulative effect on the behaviour of floodwater;
- will not incur any public cost of providing emergency services or replacing infrastructure in the event of a flood; and
- does not require any flood mitigation works.

Soil and Water Resource

12.1 EXISTING ENVIRONMENT

12.1.1 SURFACE WATER

No mapped drainage lines or waterways are located within the development site, and the development site is not mapped as riverine land pursuant to the *Murray Regional Environmental Plan No 2*.

A dominant feature of the site is its relative flatness, with the site sloping gently at approximately 1° to 3° in the western third of the site from west to east.

12.1.2 GROUNDWATER

The development site is not located within land mapped as a Groundwater Sensitive Area and a review of the NSW Government online SEED database identifies that neither the *Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources 2011* or *Water Sharing Plan for the Lower Murray Shallow Groundwater Source 2012* (both of which apply to the development site) identify any high priority groundwater dependent ecosystems in the locality.

A review of the NSW Office of Water (NOW) online *All Groundwater Map* identified five bores within 2 km of the development site. The depths are from 12.1 m to 134 m, WBZ from 12 m to 134 m and SWL from 8 m to 11.28 m. Available bore data is detailed below in **Table 12.1**.

Table 12.1 – Nearby Groundwater Bores

I.D.	Licence Status	Purpose	Depth	WBZ	SWL
GW062152	Lapsed	Stock, irrigation	14.5 m	12 to 14.5 m	8 m
GW057750	Cancelled	Stock, domestic	134 m	97 to 134 m	9 m
GW504172	Current	Stock, domestic	20 m	16 to 19 m	11 m
GW500816	Active	Monitoring	12.1 m	-	11.28 m
GW500817	Active	Monitoring	12.1 m	-	10.97 m

Source: NSW Office of Water 'All Groundwater Map'

Test pitting as part of preliminary geotechnical investigations of the site did not detect groundwater inflows in any of the test pits during excavation. It was concluded unlikely that groundwater will be encountered at the site to a depth of 3 m; noting that fluctuations in groundwater levels or perched water should be anticipated seasonally and following rain events (Coffey 2017).

12.1.3 GEOLOGY AND SOILS

The development site is located within the Bunnaloo Soil Landscape. Dominant soils within the landscape comprise red or brown chromosol (transitional Red-brown Earth/Red-brown Earth). The site landscape is underlain by the Shepparton Formation (NSW OEH eSpade).

A preliminary geotechnical investigation has been completed over the development site by Coffey (2017) to help inform design considerations and included.

- A site walkover including geomorphological and geological mapping of the site;
- An assessment of the subsurface soil and groundwater conditions at the site relevant to the proposed solar farm development, including depth to rock;
- Provision of information on the aggressivity of subsurface material with respect to buried structures;

- Provision of recommendations on the suitability of a driven pile foundation system at various locations including design values;
- Provision of recommendations on shallow pad foundations;
- Comments on the presence of expansive or collapsible soils (if encountered);
- Provision of recommendations on the excavatability of materials including batter slopes for temporary and permanent excavated slopes;
- Provision of geotechnical advice on drainage, earthworks, and site preparation relevant to the proposed solar farm development.

A summary of subsurface conditions across the site is reproduced in **Table 12.2**.

Table 12.2 – Summary of Subsurface Conditions

Ground Type	Material	Encountered subsurface conditions	Typical depth range of unit (m)
A	SILT	SILT: low plasticity, grey brown, dark brown, with fine grained sand, dry, firm to stiff	0.1 – 0.15
B1	CLAY	CLAY: medium plasticity, brown, dark brown, grey, with fine grained sand, moist, stiff to hard	0.6 - > Test depth
B2	SAND	Clayey SAND / Silty SAND / SAND: fine to coarse grained, yellow-brown	2.2 – > test depth

Source: Coffey (2017) Moama Solar Farm, Preliminary Geotechnical Investigation

Coffey also undertook laboratory chemical testing on selected soil samples to assess the material aggressivity to steel and concrete structures. The results indicate the soils are basic with a pH value of > 8.7, have low concentration of sulphates (<1,690 ppm) and chlorides (<630 ppm), and a resistivity of between 885Ohm.com and 5560Ohm.com. Based on the above, an exposure classification of 'non-aggressive' to 'moderate' will apply to the site.

Five Emerson Class Number tests were undertaken on soil samples recovered from a number of test pits. The tests returned Emerson Class Numbers of between 2 and 4. Class 2 indicates that moderate dispersion of soil is experienced when in water. Class 4 indicates the remoulded soil does not disperse in water and that calcium carbonate (calcite) or calcium sulfate (gypsum) is present in the soil.

Review of the NSW Government online SEED database confirms that there is no known Naturally Occurring Asbestos (NOA) at or near the development site.

Review of the CSIRO Australian Soil Resource Information System (ASRIS) identifies the development site as having an 'extremely low probability' of occurrence of acid sulphate soils.

12.2 IMPACTS

The flat nature of the development site and the absence of receiving surface waters in proximity, and the depth to groundwater mean that the risk for adverse impacts to water quality or the soil resource are low, and manageable.

Potential impacts to water quality are primarily restricted to the construction phase and can be readily managed through installation and maintenance of standard erosion and sedimentation control measures. Post-construction, as a land use, a solar farm presents less potential risk to water quality than conventional primary production. With returns driven by passive harvesting of sunlight as opposed to primary production, ground disturbance will be significantly less, there will not be a need for fertiliser inputs, there will be less grazing pressure, an improved capacity to retain groundcover, and less herbicide/pesticide applications.

Subsurface works would be limited to trenching (typically to 1 m depth), shallow excavations for foundation and hardstand for the switching station and inverter stations, and driving array posts into the ground to support panels. The prospect of interfering with any groundwater resource through inflow or seepage is negligible. The development does not involve any aquifer interference activity pursuant to the *NSW Aquifer Interference Policy*. The MSF will not require works that would penetrate an aquifer, interfere with water in an aquifer, obstruct the flow of water in an aquifer or take water from an aquifer. GDEs will not be impacted. Further, there is no requirement or intent to source groundwater for either construction or operation of the MSF.

Land use developments that require significant cut and fill earthworks and create large impermeable surfaces change drainage patterns in terms of both flow paths and the volume of stormwater runoff generated in rainfall events. Increased volumes of runoff at higher velocities can cause adverse impacts within the site and lower in the catchment.

Construction of the MSF will not require extensive or significant earthworks and will not result in any fundamental changes to existing drainage patterns. The post development scenario involves the inclusion of minimal impervious area (restricted to access roads and switching station compound) which will be evenly distributed throughout the site and are expected to result in a negligible increase to runoff from the 80 ha farm.

The panel arrays are positioned off-ground and the SAT technology, compared to fixed tilt systems, will not create drip lines under the panels that concentrate flows and increase the potential for runoff. A significant reduction in rainfall infiltration across the solar farm will not result because of any diminution of permeable ground surface.

12.3 MITIGATION MEASURES

12.3.1 SOIL AND WATER MANAGEMENT PLAN

Erosion and sedimentation impacts associated with construction can be minimised by undertaking works in accordance with *Managing Urban Stormwater: Soils and Construction* series, in particular:

- *Managing Urban Stormwater: Soils and Construction*, Volume 1, 4th edition (Landcom 2004), known as 'the Blue Book'.
- *Volume 2A Installation of Services* (DECC, 2008a).
- *Volume 2C Unsealed Roads* (DECC, 2008b).

Prior to construction commencing a Soil and Water Management Plan (SWMP) will be prepared and submitted to MRC for approval.

12.3.2 OPERATIONS ENVIRONMENTAL MANAGEMENT PLAN

Post construction an Operations Environmental Management Plan (OEMP) will be prepared prior to the MSF commencing operation. The OEMP will include procedures, reporting, and the allocation of responsibilities designed to minimise environmental impacts. The OEMP will document the environmental procedures and controls that would be implemented to operate the solar farm as a responsible rural land owner. A key component of the OEMP will be procedures for monitoring and managing groundcover.

The long term performance measure will be to establish a healthy, self-sustaining, noxious weed free groundcover over the solar farm that does not create a fuel hazard. How this can best be achieved, and maintained, through a combination of mechanical slashing and/or periodic crash grazing will require monitoring and implementation of adaptive management principles. Specifically, this will entail adapting the frequency, duration and intensity of any grazing and the timing of any mechanical slashing to suit and accommodate the prevailing seasonal conditions. It will also require regular inspection across the site following intense rainfall events to check that drainage is stable and localised scouring hot-spots are not appearing.

Bushfire

13.1 RISK

The development footprint does not contain bushfire prone land. The closest bushfire prone land is to the immediate north and approximately 650 m west of the development site boundary. (Refer **Figure 15**).

Notwithstanding mapping, the development site has the potential to carry grass fires.

The *Rural Fires Act 1997* places a duty of care on all land managers/owners to prevent a fire spreading on or from their land. This duty of care for the MSF will be addressed through solar farm design, construction and operation.

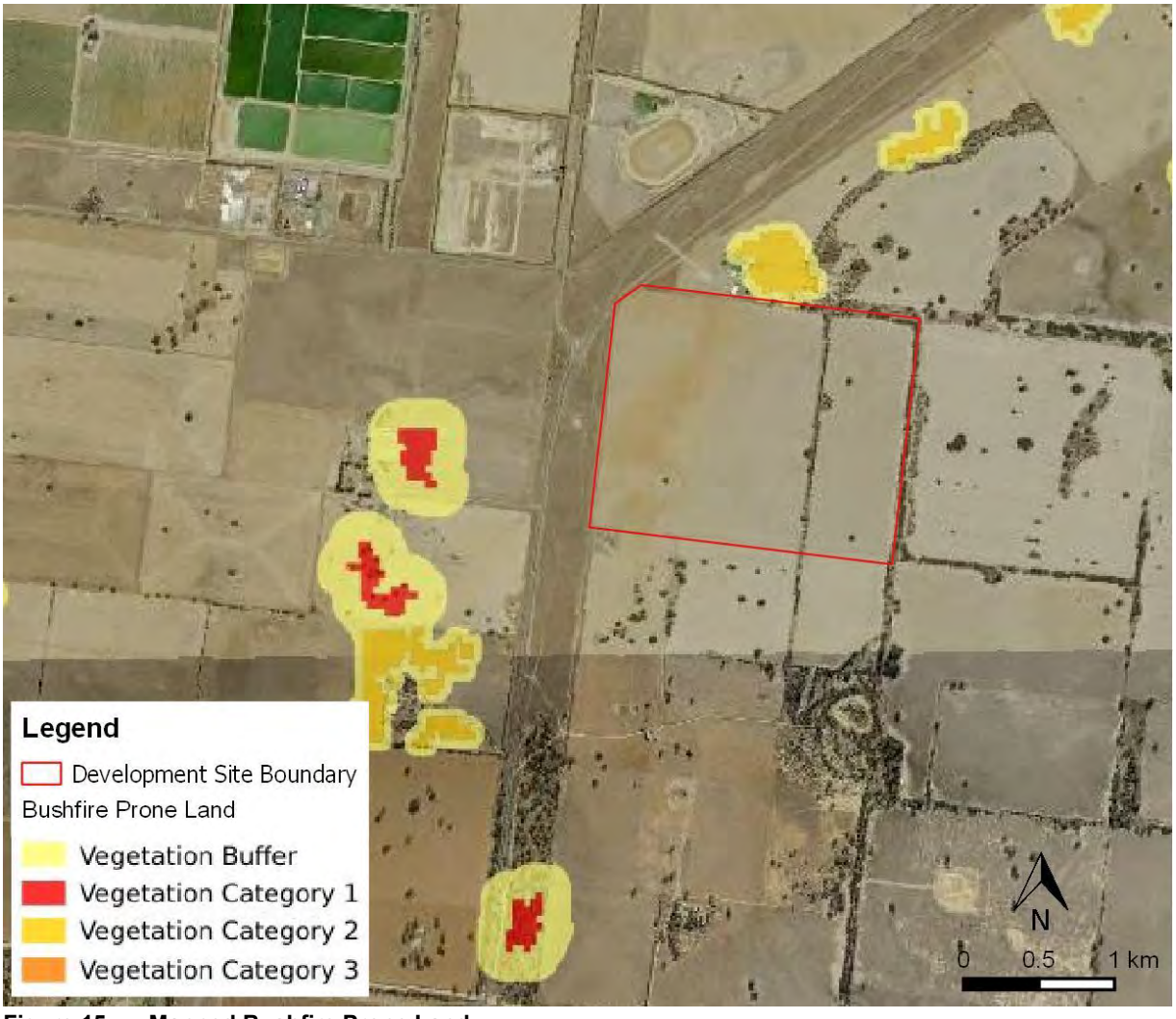


Figure 15: Mapped Bushfire Prone Land

13.2 DESIGN

Detailed design of the solar farm will incorporate the following design features relevant to minimising bushfire risk.

13.2.1 ASSET PROTECTION ZONE

A security fence will be installed around the solar farm infrastructure. Inside this fence a 10 m wide asset APZ will be maintained to provide for bush fire control and tanker access. A further 5 m buffer from the APZ to the solar modules will also be provided.

The APZ will be maintained consistent with the standards prescribed in the Rural Fire Service (RFS) *Practice Note for Telecommunication Towers in Bush Fire Prone Areas* (RFS, 2012).

These standards are considered appropriate given that the development site is not located on land mapped as bush fire prone land and the RFS Practice Note is predicated on the assumption that telecommunications towers are critical infrastructure.

Compliance with these standards means the APZ must be free of surface fuel, noting that there will be no canopy providing any elevated fuel source. The APZ will provide the requisite defendable space around the solar farm infrastructure.

13.2.2 TANKER ACCESS

The layout of the solar farm will provide for appropriate emergency vehicle access across the entire site, with setbacks from the site boundary wide enough to permit required fire tanker manoeuvrability. Internal access tracks will provide rapid access routes to all inverter stations.

13.3 CONSTRUCTION

- Prior to construction commencing contact will be made with the Local Brigade of the RFS and details about the construction schedule, contact numbers and site access arrangements will be shared.
- During bushfire season a mobile firefighting unit will be provided on-site.
- The fuel load over the site prior to and during construction will be monitored and reduction measures implemented as required. These measures will be restricted to mechanical slashing or stock crash grazing.
- The CEMP will include specific procedures and responsibilities for minimising bushfire risk through work practices. These would include:
  - No burning of vegetation or any waste material would take place on the construction site;
  - Fire extinguishers will be available in all vehicles;
  - All vehicle and plant movements beyond formed roads and trafficable hard stand areas will be restricted to diesel, not petrol vehicles;
  - During the bushfire season the fire danger status would be monitored daily (through the RFS website *http://www.rfs.nsw.gov.au*) and communicated to personnel;
  - Total Fire Ban rules will be adhered to. That is, the EPC Contractor (and any of its contractors) will not (in any grass, crop or stubble land) drive or use any motorised machine unless the machine is constructed so that any heated areas will not come into contact with combustible matter; or carry out Hot Works (e.g. welding operations or use an angle grinder or any other implement that is likely to generate sparks), unless the necessary exemption from the RFS Commissioner has been obtained and work complies with all requirements specified in the exemption; and
- It is not anticipated that any fuel or flammable liquid will be stored on-site. If any is, this material would be stored in a designated area and will be sign posted “Fuel Storage Area.” A register will be maintained that confirms the quantities and location of any flammable material stored on-site.

13.4 OPERATIONS

Unmanaged grasslands can create a bushfire risk hazard. The performance measure for managing the bushfire risk will be to operate the MSF and maintain the site in a such a manner that no grass fire originates from within the MSF site, and/or any approaching bushfire does not intensify as a consequence of entering the MSF site because of excessive fuel loads.

The fuel load over the MSF will need to be constantly monitored and fuel load reduction measures implemented as required. These measures will be either mechanical slashing or stock crash grazing. Procedures for ensuring this outcome will be specified in the OEMP.

Air Quality

14.1 CONSTRUCTION IMPACTS

Potential adverse air quality impacts associated with the solar farm are restricted to the construction phase. Any activity that entails the use of plant and equipment and earthworks has the potential to generate localised dust emissions.

These impacts can, however, be readily managed through the adoption of suitable mitigation measures during the construction effort. Such measures would include:

- Restricting vehicle movements and ground disturbance to the minimum area that is safely practicable.
- Undertaking dust suppression through strategic watering, as required.
- If necessary, temporary cessation of some works during excessively dry and windy conditions.

14.2 OPERATIONAL IMPACTS

The change in land use from agricultural land to a solar farm will reduce the potential for localised particulate emissions from this land. The principal source of dust is ground disturbance and wind exposure to an un-vegetated ground surface. In this context agriculture provides a greater risk exposure of fugitive particulates than the solar farm.

With the financial return on the land asset driven principally by passive harvesting of solar energy above ground, rather than grazing and/or farming and the associated periodic ground disturbance and changes to groundcover, the retention of groundcover over the site will be comparatively easier to maintain.

As a source of particulates and localised dust emissions the solar farm will, in comparative terms, be a land use that has the potential to improve local air quality.

From a broader perspective the 28 MW_{AC} MSF will generate 70,000 MWh of electricity annually. Indirect emissions of GHG are emissions generated in the wider economy as a consequence of an organisation's or individual's activities (particularly from its/their demand for goods and services), but which are physically produced by the activities of another organisation. The most important category of indirect emissions in Australia is from the consumption of electricity.

To this end the Department of Environment and Energy's (DoEE) Australian National Greenhouse Accounts specifies indirect emission factors to calculate GHG emissions from the generation of electricity purchased and consumed as kilograms of carbon dioxide equivalent (CO_2e) per unit of electricity consumed ($kgCO_{2\text{-}e}/kWh$). For NSW the indirect emission factor for the consumption of purchased electricity from the grid is 0.83 $kgCO_{2\text{-}e}/kWh$ (DoEE, July 2017).

Generating 70,000 MWhr/year of electricity equates to a savings of 58,100 tonnes of GHG a year.

Waste Management

15.1 INTRODUCTION

Waste generation associated with the MSF will be mainly restricted to the construction phase. Once operational the farm will not routinely generate any waste.

15.2 CONSTRUCTION

Solid waste generated during construction would include packaging materials, metal off-cuts, cabling, excess building materials, general refuse and other non-putrescible general solid wastes.

General refuse would be stored in secure covered skips.

Dry port-a-loos would be provided for amenities throughout construction negating the need for on-site domestic sewage treatment.

15.3 OPERATIONS

Up to three (3) employees will be stationed on-site. The farm will also be monitored remotely from an off-site location and apart from a routine maintenance program, specialist operators will only visit the farm when responding to any performance issues.

Wastes generated during operation is anticipated to be minor and would not be stored or disposed of on-site. All wastes would be disposed of at an approved waste management facility.

15.4 DECOMMISSIONING

Any future decommissioning would entail removing the grid connection infrastructure and switching station equipment. Opportunities for recycling this equipment will be investigated at the time, with off-site lawful disposal at an approved waste management facility the fall back option.

Foundations would be broken up and removed off site. Modules and the racking system would be removed and it could be expected that a significant amount of the support structure could be reused or recycled off-site. Piles will be lifted out of the ground and recycled wherever possible. Cables are also likely to be worth removing and recycling. However underground cables which are more than 500 mm below ground level, and are stable and inert, may be left buried to avoid unnecessary ground disturbance. At this depth, leaving cabling in the ground would not impinge future farming.

15.5 MITIGATION MEASURES

A Waste Management Sub-Plan will be prepared and form part of the CEMP prior to construction commencing. This sub-plan will include tracking of all waste leaving the site, identifying the waste classification, quantities and fate of materials to be recycled or disposed.

Electromagnetic Interference

Electric and magnetic fields (EMF) are produced naturally as well as by human activity. The earth has both a magnetic field, produced in the earth's core, and an electric field produced by electrical activity like storms in the atmosphere. Electrical equipment of all sizes and voltages produces EMF. Both fields drop away rapidly with distance from the source or due to shielding by insulation or earth (in the case of buried installations).

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has issued *Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields*. The relevant authority in Australia is the Australian Radiation Protection and Nuclear Safety Agency (ARPNSA) and it refers to the ICNIRP guidelines. These supersede earlier guidelines published by National Health and Medical Research Council (NHJSF).

The ICNIRP EMF guidelines provide relevant limits for the general public for 50 Hz sources as follows:

- Electrical Field Strength (E): 5 kilo Volts per metre (kV/m)
- Magnetic Flux Density (B): 100 micro Teslas (μT)

EMF increases with voltage and proximity to the apparatus producing, transmitting or consuming electricity. EMF varies according to specific design and construction parameters such as conductor height, electrical load and phasing, and most importantly, whether the conductors are overhead or buried, as burying cables close together has a cancelling effect.

On the site of the MSF the various EMF generating components would be the buried cables, inverters, step up transformers and switching station. In relative terms the existing 66 kV overhead transmission lines that run parallel to the western boundary of the site already emit higher EMF than will infrastructure associated with the solar farm, which mainly comprises buried cables grouped together which has a cancelling effect on EMF.

Terrain Solar and/or the EPC Contractor will ensure that in detailed design and equipment procurement that the ICNIRP EMF guidelines will be complied with.

Economic Opportunity

17.1 OPPORTUNITIES

Construction will generate local employment opportunities and a demand for services and resources that can be locally sourced. The project is expected to take twelve months to build; inclusive of a six month peak period when there will be a requirement for up to 100 workers to be on site. For the other six months there is expected to be up to 20 workers on site.

The roles required will vary from highly skilled electricians able to work with solar PV systems (both low and high voltage) to general labourers. There will be contracts let for the provision of raw materials (eg. gravel, sand, concrete) and civil works plant and operators (e.g. graders, piling rigs, mobile cranes, trenchers, loaders, rollers, water carts). Money will be spent in town on accommodation, meals and support services. Construction will bring economic benefits to Moama through business opportunities for local suppliers.

Post construction the MSF will employ up to three full time equivalent positions. There will, however, also be a demand for contracted support services as regular maintenance on infrastructure and land management (e.g. weed spraying) will be required on an ongoing basis.

17.2 COMMUNITY EXPECTATIONS

A key finding of the Australian Renewable Energy Agency (ARENA) report *Establishing the social licence to operate large scale solar facilities in Australia: insights from social research for industry* is that local community's expect and want to benefit from these type of projects. They want project related expenditure money to be spent in the district, and they wants the opportunity to secure as many jobs, contracts and supplies as possible. There is no reason to expect that the Moama community would want or expect anything less.

Employment and contracting opportunities for local residents are seen as the key benefit to local economies, as well as the benefits to local businesses from the influx of workers from outside the local area. Job creation and the corresponding opportunities for local businesses and residents are seen as the key economic benefits of a large scale solar project.

ARENA's research showed that these expectations of developer engagement with the local economy included measures such as contacting local employment services and advertising tenders for contracting work in the local print media. In cases where these measures were perceived not to have been taken, or to have been taken half-heartedly, frustrations were expressed about lost opportunities. There was general acceptance, however, that in relatively small communities where labour resources and skills were not always available or appropriate for the job, that workers would inevitably be brought in from outside.

Based on the above it is reasonable to assume that any community support for the MSF will be influenced, in part, on the expectation that it will provide opportunities for local business and workers to benefit from the project spend.

17.3 DEVELOPER COMMITMENT

To help ensure that the local economic opportunity is realised Terrain Solar is committed to do the following.

17.3.1 LOCAL ENGAGEMENT

Terrain Solar will deliver the MSF through awarding an EPC contract. Typically a myriad of factors and criteria influence the decision on how and to who a contract is awarded. These include considerations relating to technical capabilities, demonstrated experience, scheduling availability and price.

In awarding the EPC contract for the MSF Terrain Solar will add 'local engagement' as a selection criterion. That is, the EPC Contractor's commitment and means for maximising the local 'spend' will be considered in awarding the EPC contract.

17.3.2 WORKING GROUP

Terrain Solar will ensure that opportunities are actively 'pushed' into the community through working collaboratively with MRC to establish a forum and means for maximising opportunities for local businesses and contractors. This is expected to include providing:

- accurate information about the project and associated timelines; and
- timely information about the job and contracting opportunities at each stage of construction.

Mitigation Measures

18.1 INTRODUCTION

This section of the SEE provides a consolidated summary of all proposed safeguards and environmental mitigation measures that form part of the proposed development. It collates all commitments made in this SEE and includes a description of the measures that would be implemented to monitor and report on the environmental performance of the development.

18.2 ENVIRONMENTAL MANAGEMENT STRATEGY

Potential environmental impacts will be avoided, minimised and managed through adoption of mitigation measures incorporated into all phases of the project, including:

- Detailed design;
- Construction;
- Operations;
- Upgrading; and
- Decommissioning.

The strategy for ensuring these commitments are acted upon will be to prepare and submit for Council approval a number of management plans at relevant stages of the development. These will include:

- Construction Environmental Management Plan;
- Operations Environmental Management Plan;
- Revised layout plans; and
- Decommissioning Management Plan.

These management plans will include, but may not be restricted to, inclusion of all relevant safeguards and environmental mitigation measures identified in this SEE and any associated conditions of consent.

The timing and scope of these management plans is detailed below.

18.3 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

Prior to construction commencing a CEMP will be prepared and submitted to MRC for approval. The CEMP will document the environmental procedures and controls that would be implemented throughout construction, including detail on how neighbours would be kept informed about the construction program and how any complaint would be received, resolved and reported.

The CEMP would describe the role, responsibility, authority and accountability of all key personnel involved in construction and detail all monitoring that would be undertaken.

The CEMP would comprise various sub-plans detailing the specific mitigation measures that would be implemented to avoid and manage potential environmental impacts. These would include plans covering traffic management, biodiversity, Aboriginal heritage, soil and water protection, dust, noise and vibration, waste management and bushfire prevention.

Mitigation measures relevant to these issues, as identified in this SEE, are detailed below.

18.3.1 LANDOWNER CONSULTATION

- Early, regular and honest consultations with neighbours will be a core commitment.
- A procedure will be prepared for receiving, investigation and reporting any complaint received.

18.3.2 NOISE AND VIBRATION

Management controls to be implemented during construction will include:

- Consultation with adjoining neighbours, providing detail on the construction schedule and providing contact details for discussing issues if they arise.
- Using broad-band reversing alarms on all mobile plant and equipment where possible.
- Examining different types of machines that perform the same function and compare the noise level data to select the least noisy machine.
- Select quieter items of plant and equipment where feasible and reasonable.
- Operating plant in a quiet and efficient manner.
- Reduce throttle setting and turn off equipment when not being used.
- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.
- Any works undertaken outside standard hours of construction would be subject to the effective implementation of the above mitigation measures and consultation with potentially impacted neighbours.

  Recommended standard hours of construction are:

  - Monday to Friday 7 am to 6 pm
  - Saturday 8 am to 1 pm
  - No work on Sundays or public holidays

18.3.3 TRAFFIC MANAGEMENT

A number of actions/works would be undertaken prior to construction activity commencing. An overview of these is provided below.

18.3.3.1 Selection of Access Option

Either project timing and/or the results of the targeted *Pterostylis despectans* (October-November) and *Prasophyllum sp. Moama* (September) surveys will determine which access option is selected. Once a decision has been made this will be communicated to MSC, RMS and MLLS.

18.3.3.2 Traffic Management Plan

A Traffic Management Plan (TMP) would then be prepared and submitted to MSC and RMS for approval. This TMP would do essentially do two things.

Firstly, it would provide the definitive construction traffic profile that the EPC Contractor proposes. This would provide the check that the assumptions used to justify the access treatment (ie. BAR/BAL) in this Statement of Environmental Effects are consistent with the traffic profile that the EPC Contractor specifies. For example, that a shuttle bus service during the construction peak will be provided, and that all heavy vehicle deliveries will be scheduled to be made outside the peak hours of 6:00 – 7:00 am and 5:00 – 6:00 pm. The value and need in doing this is to confirm, to the satisfaction of MSC and RMS, that the BAR/BAL access treatment proposed is appropriate.

Secondly, the TMP would detail the measures to be implemented to provide traffic safety and minimize any disruption to users of the road network, including

- Temporary traffic controls, including signage and speed reductions.
- Notifying the local community about project-related traffic.
- Scheduling of haulage vehicle movements to minimize the potential for convoy lengths or platooning.
- Ensuring all vehicles are loaded and unloaded on site and enter and leave the site in a forward direction.
- A driver's code of conduct that addresses travelling speeds; procedures to ensure that drivers adhere to the designated transport routes; and procedures to ensure that drivers implement safe driving practices.
- Ensuring there is sufficient parking on site for all vehicles and no parking occurs on the public road network in the vicinity of the site.
- Procedures for maintaining accurate records of the number of heavy vehicles entering or leaving the site each day.

18.3.3.3 Highway Access Treatment

Subject to approval of the TMP the access treatment would then be subject to detailed design and approval by the RMS in accordance with the *Austroads Guide to Road Design* (as amended by RMS supplements): to then be built in accordance with RMS standards prior to commencement of construction of the solar farm.

18.3.3.4 TSR Access Treatment

Subject to approval of the TMP detail of the road works within the TSR would then be provided to MLLS. This would include information on the position, construction and/or improvements to the access road proposed and enable both MLLS and Terrain Solar to satisfy the requirements of s.75 of the *Local Land Services Act 2013* with respect to formalising the right of way.

18.3.4 ABORIGINAL HERITAGE

- In the unlikely event that sites are discovered work should immediately cease and archaeological advice sought.
- In the unlikely event that known or suspected human remains (generally in skeletal form) are encountered during the activity, the following procedure will be followed immediately upon discovery:
  - all work in the immediate vicinity will cease and the find will be immediately reported to the work supervisor;
  - the supervisor or other nominated senior staff member will promptly notify the police and the state coroner (as required for all human remains discoveries);
  - the supervisor or other nominated senior staff member will contact OEH for advice on identification of the human remains;
  - if it is determined that the human remains are Aboriginal ancestral remains, the Local Aboriginal Land Council will be contacted and consultative arrangements will be made to discuss ongoing care of the remains; and
  - if it is determined that the human remains are not Aboriginal ancestral remains, further investigation will be conducted to determine if the remains represent a historical grave or if police involvement is required.

18.3.5 HISTORIC HERITAGE

Should any object or item of historic heritage be uncovered during construction, work in that area will cease and the item cordoned off.

A qualified heritage specialist will attend the site to determine the nature of the find and determine the required course of action; including consultation with MRC.

18.3.6 BIODIVERSITY

Direct biodiversity impacts would be avoided and/or minimised through implementation of the following measures:

- Committing to no significant impact on *Prasophyllum sp.* Moama and *Pterostylis despectans*. The following process would be followed:
    - undertaking a targeted pre-clearance survey for *Prasophyllum sp.* Moama in the preferred access route during the species optimal flowering season (September);
    - undertaking a targeted pre-clearance survey for *Pterostylis despectans* in the preferred access route during the species optimal flowering season (October-November);
    - if the species are not recorded, the preferred access would be constructed;
    - if the species are recorded, evaluate if the 10 m wide construction zone impact for the access road can be constructed within the 50 m wide area surveyed as part of the biodiversity assessment without significant impact, the preferred access would be constructed; and
    - if the species are recorded and significant impacts cannot be avoided, the alternate access would be constructed.

    The Office of Environment and Heritage, Murray Local Land Services and Murray Regional Council will be provided with the results of these targeted surveys if the preferred access is intended.
- Avoidance of clearing the two Turnip Copperburr plants in the preferred access (should it be constructed);
- Retention of Black Box Woodland on the northern and eastern boundaries of the farm;
- If feasible, minimising the impact on the Western Grey Box Woodland to the lopping of branches overhanging the existing cleared track, should the alternate access be constructed; and
- Selection of a native or non-invasive cover crop (eg Wallaby Grass (*Rytidosperma duttonianum*), Native Millet (*Panicum decompositum*) and Wheat Grass (*Anthosachne scabra*) for the site to minimise the potential for weed invasion into retained woodlands in the project area.

18.3.7 SOIL AND WATER MANAGEMENT

Five principle measures will be adhered to during construction.

- Compliance with the approved Soil and Water Management Plan.
- At all times, in all locations, the area of ground disturbance will be limited to that which is the smallest possible footprint that is practicably possible.
- Erosion and sediment controls will be suitably maintained, including regular monitoring to ensure the measures and controls in place are effective.
- Immediate stabilisation of worked sections complemented by progressive rehabilitation.
- Erosion and sediment control measures only to be removed once the area is successfully rehabilitated.

Erosion and sedimentation impacts associated with construction will be minimised by undertaking works in accordance with *Managing Urban Stormwater: Soils and Construction* series, in particular:

- *Managing Urban Stormwater: Soils and Construction*, Volume 1, 4th edition (Landcom 2004), known as 'the Blue Book'.
- *Volume 2A Installation of Services* (DECC, 2008a).
- *Volume 2C Unsealed Roads* (DECC, 2008b).

18.3.8 BUSHFIRE PREVENTION

- Prior to construction commencing contact will be made with the Local Brigade of the RFS and details about the construction schedule, contact numbers and site access arrangements will be shared.
- Static Water Supplies dedicated exclusively for firefighting purposes will be located strategically around the site and appropriately plumbed for the duration of construction.
- The fuel load over the site prior to and during construction will be monitored and reduction measures implemented as required.
- No burning of vegetation or any waste material would take place on the construction site.
- Fire extinguishers will be available in all vehicles.
- During bushfire season all vehicle and plant movements beyond formed roads and trafficable hard stand areas will be restricted to diesel, not petrol vehicles.
- During the bushfire season the fire danger status would be monitored daily (through the RFS website *http://www.rfs.nsw.gov.au*) and communicated to personnel.
- Total Fire Ban rules will be adhered to. That is, the EPC Contractor will not (in any grass, crop or stubble land) drive or use any motorised machine unless the machine is constructed so that any heated areas will not come into contact with combustible matter; or carry out Hot Works (e.g. welding operations or use an angle grinder or any other implement that is likely to generate sparks), unless the necessary exemption from the NSW RFS Commissioner has been obtained and work complies with all requirements specified in the exemption; and
- Any fuel or flammable liquid be stored on-site will be in a designated area and will be sign posted A register will be maintained that confirms the quantities and location of any flammable material stored on-site.

18.3.9 AIR QUALITY

Implementation of the following mitigation measures during construction will minimise potential impacts to air quality:

- Limit the area of soil disturbance at any one time.
- Maintain all disturbed areas, stockpiles and handling areas in a manner that minimises dust emissions (including windblown, traffic-generated or equipment generated emissions).
- Where required undertake strategic watering to achieve dust suppression.
- Where required, minimise vehicle movement and speed.
- Avoid dust generating activities during windy and dry conditions.
- Ensure all construction plant and equipment are operated and maintained to manufacturer's specifications in order to minimise exhaust emissions.
- Restricting vehicle movements and ground disturbance to the minimum area that is safely practicable.
- If necessary, temporary cessation of some works during excessively dry and windy conditions.

18.3.10 WASTE MANAGEMENT

- The work site will be kept free of rubbish and cleaned up at the end of each working day.
- All waste that cannot be recycled will be disposed at a legally operating waste facility.
- No waste will be burnt or buried on-site.
- All opportunities for recycling will be implemented.
- All waste would be classified in accordance with the EPA's *Waste Classification Guidelines* and stored and handled in accordance with its classification.
- All wastes removed from the site will be recorded. Details will include the quantity of material removed, the contractor transporting it off-site, its fate (ie. disposal or recycling) and its classification.

18.3.11 FUEL AND CHEMICAL STORAGE AND MANAGEMENT

- Storage, handling and use of any potentially hazardous materials will be in accordance with the WorkCover NSW *Storage and Handling of Dangerous Goods – Code of Practice* (2005).
- A suitable spill response and containment kit will be available on site whenever and wherever refuelling of plant is undertaken.

18.3.12 INCIDENT MANAGEMENT

- Adequate procedures will be established including notification requirements for any incident that causes or has the potential to cause material harm to the environment.

18.3.13 INDUCTION

- All contractors undertaking any works on-site will, before commencing works, be inducted on the requirements of the CEMP and their specific responsibilities.

18.3.14 LANDSCAPE PLANTINGS

- The development incorporates establishment of landscape screen plantings along the entire eastern and partial northern boundaries of the farm to provide screening from the Cobb Highway and neighbours.
- The screen planting will be 5 m wide and planted with species associated with the Black Box Lignum woodland community present in the area.

18.4 OPERATIONS ENVIRONMENT MANAGEMENT PLAN

An OEMP will be prepared prior to the MSF commencing operation. The MSF will be operational after commissioning and equipment trials and electricity is being distributed into the transmission network.

The OEMP will include procedures, reporting, and the allocation of responsibilities designed to minimise environmental impacts. The OEMP will document the environmental procedures and controls that would be implemented to operate the solar farm as a responsible rural land owner.

The OEMP would comprise various sub-plans detailing the specific mitigation measures that would be implemented to avoid and manage potential environmental impacts and minimise risks. These would include plans covering land management (specifically relating to fuel loads and noxious weeds) and emergency preparedness. Mitigation measures relevant to these issues, as identified in this SEE, are detailed below.

18.4.1 NEIGHBOUR ENGAGEMENT

- Ongoing and honest consultation with neighbours will be a core commitment.
- A procedure will be established for receiving, investigating and reporting any complaint received.

18.4.2 INCIDENT MANAGEMENT

- Adequate procedures would be established including notification requirements for any incident that causes or has the potential to cause material harm to the environment.

18.4.3 GROUNDCOVER, FUEL LOAD AND WEED MANAGEMENT

The long term performance measure is to establish a healthy, self-sustaining, noxious weed free groundcover over the solar farm that does not create a fuel hazard.

How this can best be achieved, and maintained, through a combination of mechanical slashing and/or periodic crash grazing will require monitoring and implementation of adaptive management principles.

Specifically, this will entail adapting the frequency, duration and intensity of crash grazing, and the timing of any mechanical slashing to suit and accommodate the prevailing seasonal conditions. It will also require regular inspection across the site following intense rainfall events to check that drainage is stable and localised scouring hot-spots are not appearing.

18.4.4 EMERGENCY MANAGEMENT PLAN

Prior to the commencement of operations an Emergency Response Plan will be prepared in consultation with RFS and/or Fire & Rescue NSW. This plan will identify the procedures that would be implemented if there is a fire on site or in the vicinity of the site or if the site was subject to a flood event.

18.4.5 BIODIVERSITY

- Declared priority weeds will be managed according to the requirements stipulated by the *Biosecurity Act 2015*.
- Regular targeted control of priority weeds should take place for at least 24 months following rehabilitation of disturbed areas.
- 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.

18.5 FARM UPGRADING

Over time the owner of the MSF may upgrade the farm. Upgrading of the farm would include the augmentation and/or replacement of solar panels and ancillary infrastructure within the development footprint.

Prior to carrying out any such upgrades, the owner of the MSF will provide revised layout plans of the development to MRC incorporating the proposed upgrades.

18.6 DECOMMISSIONING

18.6.1 TIMING

No later than 12 months before the intent to decommission the MSF the owner of the solar farm will provide a DMP to MRC for approval.

18.6.2 DECOMMISSIONING MANAGEMENT PLAN

The objective of the DMP would be to restore the land capability to its pre-existing agricultural use.

The design life of the PV modules will be at least 30 years. At the end of their useful life modules and electrical equipment will be either replaced and the farm re-commissioned, or the farm will be decommissioned and the site returned to agricultural land use. This will be a commercial decision based on the relative economics of solar PV generation compared to alternatives at the time (i.e. year 2048). In all likelihood the economics will be favourable because the farm infrastructure, including network connection, underground cabling, foundations, and access tracks will continue to be serviceable and the cost of replacing modules and inverter stations favourable compared to competing generating technologies. Further, the technology available in 30 years' time is likely to have much higher efficiency factors than today's modules.

Decommissioning would include initially disconnecting the solar farm from the Essential Energy network. The switching station equipment would be removed and disposed of off-site, reusing and recycling wherever possible. Foundations would be broken up and removed off site. Modules and the racking system would be removed and it could be expected that a significant amount of the support structure could be reused or recycled off-site. Piles will be lifted out of the ground and recycled wherever possible. In general, cables are likely to be worth removing and recycling. However underground cables which are deeper than 500 mm below ground level may be left buried to avoid excessive ground disturbance. The site control room and facilities would be lifted off their foundations and transported off site on flatbed trucks.

The ground would be then be worked, stabilised and returned to agricultural use.

Justification

19.1 STRATEGIC FIT

The development is consistent with the Commonwealth's Renewable Energy Target (RET) and both the NSW Government's *Renewable Energy Action Plan* and *Climate Change Policy Framework*. At a regional level the development complements the *Riverina Murray Regional Plan's* objectives of diversified energy production, promoting energy supply through renewable energy generation and encouraging renewable energy projects at locations with renewable energy potential and ready access to connect with the electricity network. At a local level the MSF, at the location proposed, is not incompatible with MRC's strategic land use planning objectives for Moama.

19.2 SITE SUITABILITY

The MSF site was selected for development after an extensive screening process. It offers a number of key attributes which provide the opportunity to optimise the solar farm configuration and deliver lower cost energy. It is located suitably close to Essential Energy's Moama Zone Substation which provides for efficient connection into the transmission network, which has the capacity to accommodate the output of the MSF. The solar resource at Moama is also suitable with enough cloud-free days over the year to generate significant energy.

19.3 ALTERNATIVES

19.3.1 DEVELOPMENT OBJECTIVES

The objectives of the MSF are to:

- Select and develop a site to generate clean, long-term cost competitive power.
- Contribute to the NSW and Commonwealth Government's renewable energy and GHG emission reduction targets.
- Build and operate a solar farm with minimal environmental impact and which protects amenity values for neighbours.
- Provide local opportunities for economic benefits.

19.3.2 ALTERNATIVE SITES

During the site selection process for the proposed solar farm a number of alternative locations were considered. Minimising environmental and social impacts and maximising efficiency were major considerations in the evaluation of alternatives. The site as proposed was selected based on the:

- Availability of a suitable solar resource.
- Proximity to an existing electricity switching station with sufficient connection capacity.
- Close proximity to the grid connection point, minimising transmission loss and connection costs as well as avoiding impacts to any third party.
- Network electrical efficiencies (e.g. low transmission and distribution losses for generation at this connection point in the network).
- Availability of suitable land.
- Suitability of the land in terms of factors that affect solar yield and construction costs (minimal shading, accessibility, low relief topography).

19.3.3 ALTERNATIVE TECHNOLOGY

Solar PV technology has been selected for the MSF due to the following benefits:

- Commercially proven, robust and low technical risk.
- Low environmental impact in comparison to other power generation technologies.
- Fast deployment in comparison with other renewable and non-renewable power generation technologies.
- Solar projects are highly reversible at the end of the project's life which allows for the return of the land to agricultural use.

19.4 REASONS FOR APPROVAL

The benefits of the proposed MSF are clear and significant. The farm will produce clean energy, displace GHG emissions, create employment opportunities and inject expenditure into the district. The costs, through the identification of site constraints and then avoiding these to inform the buildable development footprint, are minor and acceptable.

Impacts to native vegetation have been minimised. Biological diversity and ecological integrity will be maintained. Acoustic amenity values will not be adversely impacted.

The MSF should be approved because the development site is suitable for a solar farm as it has a good solar resource and there is available capacity in the existing electricity network. The infrastructure can be built without impacting surrounding agricultural land uses.

The development of the 80 ha site would not result in any significant reduction in the overall agricultural productivity of the district and the land can be easily returned to agricultural use if the solar farm is decommissioned in 30 years.

The MSF can be approved as this will be an outcome whereby the present generation is making a land use decision that does not compromise the health, diversity or productivity of the environment for the benefit of future generations. The MSF will generate 70,000 MWh of clean electricity a year, enough to power 8,238 households (almost double the electricity demand of all homes in the Murray River LGA) and displace 58,100 tonnes of GHG emissions a year.

The MSF is a development that is in the public interest.

Matters for Consideration

An assessment of matters for consideration pursuant to s.79(c) *Environmental Planning and Assessment Act 1979* follows.

(a)(i) the provisions of any environmental planning instrument,

Relevant environmental planning instruments are addressed in **Section 3.2**.

(a)(ii) the provisions of 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 (unless the Director-General has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and

There are no proposed environmental planning instruments that have been publicly exhibited and applicable to the proposed development.

(a)(iii) the provisions of any development control plan, and

The *Murray Development Control Plan 2012* applies in part to the development site and is addressed in **Appendix E**.

(a)(iiia) the provisions of any planning agreement that has been entered into under section 93F, or any draft planning agreement that a developer has offered to enter into under section 93F, and

The development is not subject to any known planning, or draft planning agreement that has been entered into under section 93F.

(a)(iv) the provisions of the regulations (to the extent that they prescribe matters for the purposes of this paragraph),

The only provision of the regulations specified for the purpose of this section of the Act that is relevant to the proposed development is clause 92(1)(d)(ii), as the development is included in Schedule 4A to the Act.

(b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality,

Likely impacts of the proposed development are addressed in **Section 4 – 17**.

(c) the suitability of the site for the development,

The site is suitable for the development as proposed, as detailed in **Section 5** and **Section 19**.

(d) any submissions made in accordance with this Act or the regulations,

To be determined following advertising of the DA.

(e) the public interest.

The proposed development does not compromise the public interest.

References

ACIL Allen Consulting, March 2015. *Electricity Bill Benchmarks for Residential Customers*

Australian Bureau of Statistics (ABS), (2010). *Data by Region – Murray River (LGA) (NSW).*

Australian Renewable Energy Agency, n.d. *Establishing the social licence to operate large scale solar facilities in Australia: insights from social research for industry*

Bureau of Meteorology (BOM), 2017. *Groundwater Dependent Ecosystems Atlas*. [ONLINE]

CSIRO, n.d. *Atlas of Australian Acid Sulphate Soils*. [ONLINE] Available at: http://www.asris.csiro.au/themes/AcidSulfateSoils.html

Department of Environment and Energy, July 2017. *National Greenhouse Accounts Factors – Australian National Greenhouse Accounts*

Department of Planning and Environment (DoPE), October 2016. *Environmental Impact Assessment Improvement Project – Discussion Paper*

Ho, C.K. & Simms, C.A., 2013. *Hazard Analysis of Glint and Glare from Concentrating Solar Power Plants*

International Association for Public Participation, 2014. *Engagement Essential and Engagement Methods*

Landcom, 2004. *Managing Urban Stormwater: Soils and Construction*. [ONLINE]

Murray Shire Council, 2011. *Murray Local Environmental Plan*

Murray Shire Council, 2012. *Murray Development Control Plan*

Murray Shire Council *Community Strategic Plan 2015/2016 – 2024/2025*

Murray Shire Council. *Murray Shire Strategic Land use Plan 2010-2030.*

Navin Officer 2010 *Deniliquin to Moama 132kV Transmission Line Route Aboriginal and Historical Archaeological Assessment*

NSW Department of Environment & Climate Change (DECC), 2008a. *Managing Urban Stormwater: Soils and Construction Volume 2A Installation of Services.*

NSW Department of Environment & Climate Change (DECC), 2008b. *Managing Urban Stormwater: Soils and Construction Volume 2C Unsealed Roads.*

NSW Department of Planning and Environment *Riverina Murray Regional Plan 2036*

NSW DPI Office of Water, 2012. *Risk assessment guidelines for groundwater dependent ecosystems: Volume 1* [ONLINE]

NSW EPA, n.d. *Contaminated Land Record.* [ONLINE] Available at: http://www.epa.nsw.gov.au/prclmapp/searchregister.aspx

NSW EPA, n.d. *List of NSW contaminated sites notified to EPA*. [ONLINE] Available at: http://www.epa.nsw.gov.au/clm/publiclist.htm

NSW Government, 2016. *NSW Renewable Energy Action Plan*

NSW Office of Water (NOW), n.d. *All Groundwater Map*. [ONLINE] Available at: http://allwaterdata.water.nsw.gov.au/water.stm

NSW Government, n.d. *SEED Portal*. [ONLINE] Available at: https://www.seed.nsw.gov.au/

NSW Government, November 2016. *Climate Change Policy Framework*

NSW Government, November 2016. *Climate Change Fund: Draft Strategic Plan 2017 – 2022*

Rural Fire Service, 2006. *Planning for Bush Fire Protection*

Rural Fire Service, 2012. *Practice Note for Telecommunication Towers in Bush Fire Prone Areas*

Sinclair Knight Merz, 2010. *Deniliquin to Moama 132 kV Transmission Line – Review of Environmental Factors*

Sinclair Knight Merz, 2001. *Moama Floodplain Management Study*

Zenith Town Planning, July 2017. *Moama and District Rural Residential Strategy.*

Appendix A

ABORIGINAL CULTURAL HERITAGE ASSESSMENT

Moama Solar Farm Statement of Environmental Effects

Aboriginal archaeological due diligence assessment

Prepared for Terrain Solar Pty Limited | 19 December 2017

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065

T +61 2 9493 9500
F +61 2 9493 9599
E info@emmconsulting.com.au

www.emmconsulting.com.au

Moama Solar Farm Statement of Environmental Effects

Draft Report

Report J17290RP1 | Prepared for Terrain Solar Pty Limited | 19 December 2017

Prepared by	**Kerryn Armstrong**	Approved by	**Pamela Kottaras**
Position	Consultant Archaeologist	Position	Heritage Services Manager
Signature		Signature	
Date	15 February 2017	Date	15 February 2017

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

© Reproduction of this report for educational or other non-commercial purposes is authorised without prior written permission from EMM provided the source is fully acknowledged. Reproduction of this report for resale or other commercial purposes is prohibited without EMM's prior written permission.

Document Control

Version	Date	Prepared by	Reviewed by
V1	14 December2017	Kerryn Armstrong	Pamela Kottaras
V2	15 February.2018	Kerryn Armstrong	Pamela Kottaras

T +61 (0)2 9493 9500 | F +61 (0)2 9493 9599

Ground Floor | Suite 01 | 20 Chandos Street | St Leonards | New South Wales | 2065 | Australia

www.emmconsulting.com.au

Table of contents

Appendices

Tables

Figures

1 Introduction

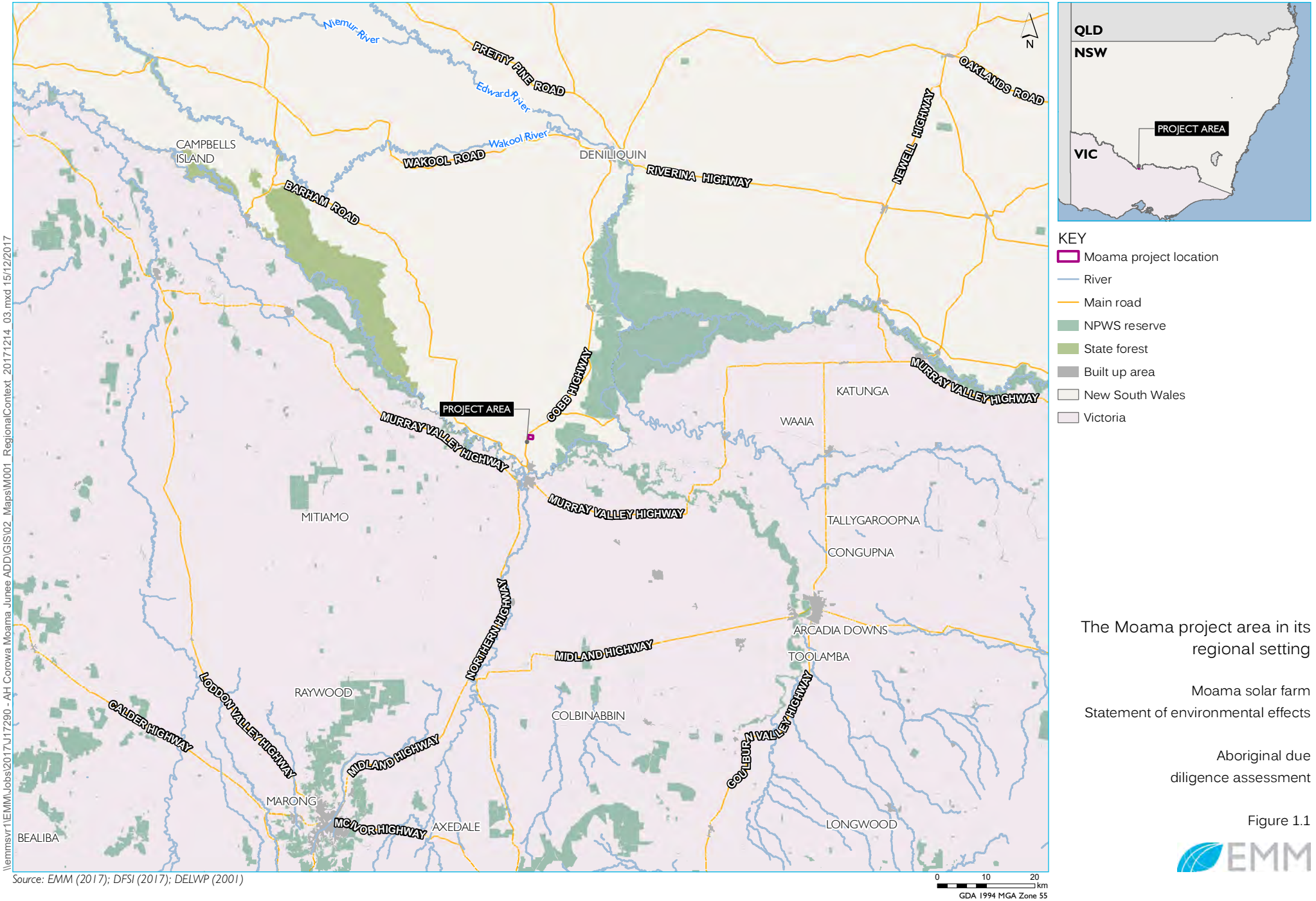
1.1 Overview

Geolyse is preparing a Statement of Environmental Effects (SEE) on behalf of Terrain Solar to support development applications for the proposed Moama Solar Farm (the project). The project will be assessed under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) by Murray River Council.

A grid connection for the project will be assessed under Part 5 of the EP&A Act by Essential Energy through the preparation of a Review of Environmental Factors (REF). A due diligence assessment was prepared to support the REF separately to this stage of the project (Navin Officer Heritage Consultants 2009).

1.2 Description of the activity

Terrain Solar's proposed works include installing piled supports with steel racking to hold the solar panels. In addition the works will include inverter stations running electrical cabling and telecommunication equipment. There will also be a maintenance building, switching station and the entire perimeter will have security fencing.



\\emmsvr1\EMM\Jobs\2017\J17290 - AH Corowa Moama Junee ADD\GIS\02_Maps\M001_RegionalContext_20171214_03.mxd 15/12/2017

Source: EMM (2017); DFSI (2017); DELWP (2001)

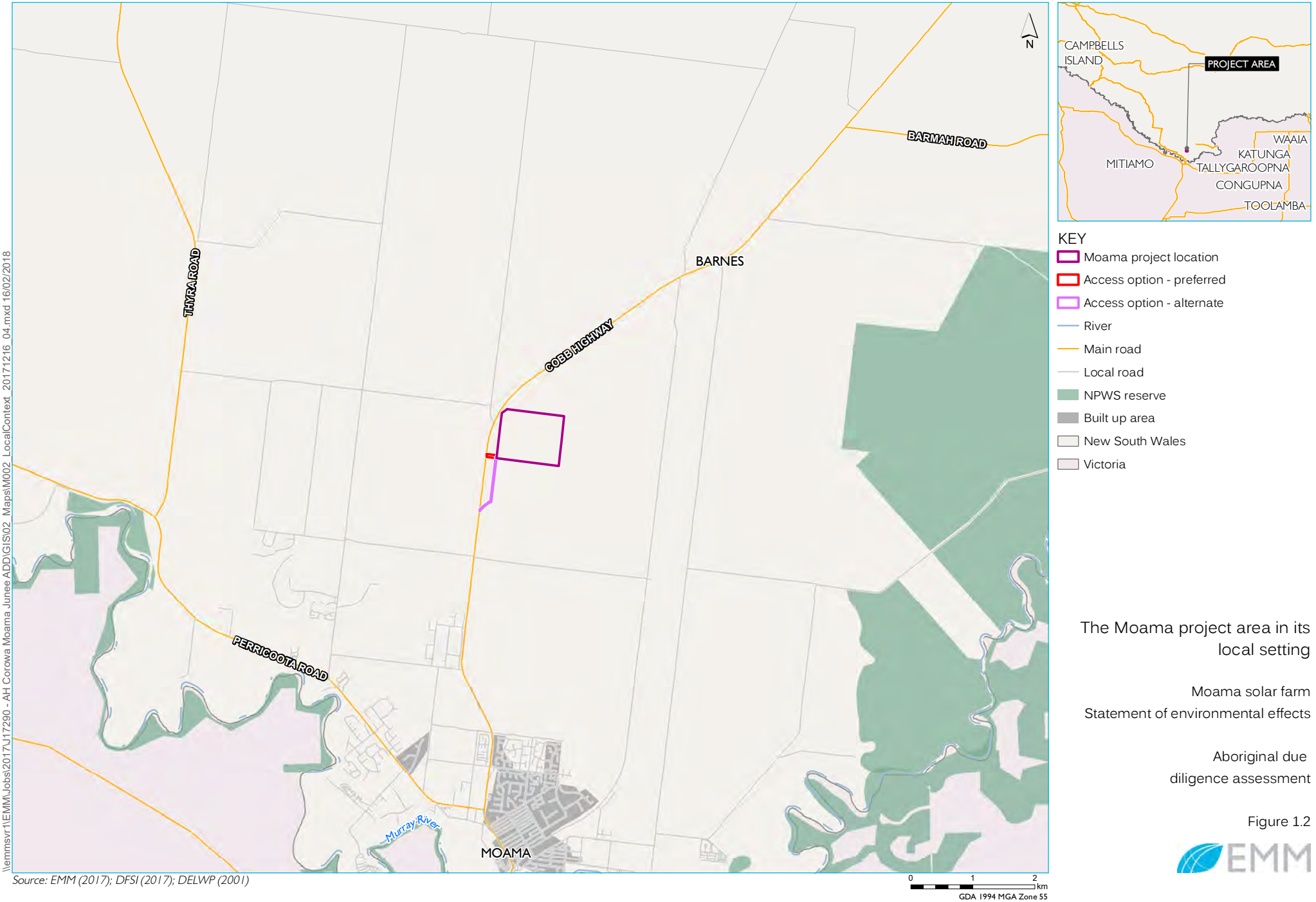
The Moama project area in its regional setting

Moama solar farm
Statement of environmental effects

Aboriginal due diligence assessment

Figure 1.1

EMM



\\emmsvr1\EMM\Jobs\2017\J117290 - AH Corowa Moama Junee ADD\GIS\02_Maps\M002_LocalContext_20171216_04.mxd 16/02/2018

Source: EMM (2017); DFSI (2017); DELWP (2001)

The Moama project area in its local setting

Moama solar farm
Statement of environmental effects

Aboriginal due diligence assessment

Figure 1.2

EMM

1.3 Legislative context

1.3.1 Environmental Planning and Assessment Act 1979

1.3.2 National Parks and Wildlife Act 1974

Aboriginal objects and places are protected in New South Wales (NSW) under Part 6 of the NSW *National Parks and Wildlife Act 1974* (NPW Act). Section 90 of the NPW Act requires an Aboriginal heritage impact permit (AHIP) for harm to an Aboriginal object or Aboriginal place. Significant penalties are in place for harm to Aboriginal objects or places, regardless of whether the harm was committed knowingly or not. Defences against prosecution include impacts in compliance with an AHIP, acting in accordance with specified codes of practice or the conduct of certain low impact activities. The Act defines an Aboriginal object as:

> any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises NSW, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains.

Harm is defined as:

> any act or omission that: (a) destroys, defaces or damages the object or place, or (b) in relation to an object—moves the object from the land on which it had been situated, or (c) is specified by the regulations, or (d) causes or permits the object or place to be harmed in a manner referred to in paragraph (a), (b) or (c), but does not include any act or omission that: (e) desecrates the object or place, or (f) is trivial or negligible, or (g) is excluded from this definition by the regulations.

1.3.3 National Parks and Wildlife Regulation 2009

The NSW National Parks and Wildlife Regulation 2009 (NPW regulation) is subsidiary legislation made under its parent act, the NPW Act. The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (due diligence guidelines) (DECCW 2010) is adopted by the NPW Regulation under Clause 80A. Compliance with the due diligence guidelines provide a defence for harming Aboriginal objects and places.

The due diligence guidelines provide a generic code of practice used to determine whether activities will harm an Aboriginal object and, if so, what measures can be taken to avoid that harm. A summary of the due diligence is shown in (Plate 1.1)

The advantages of due diligence for assessing potential harm to Aboriginal objects are that it:

- Provides a defence against prosecution for inadvertent impacts if the process is followed;
- assists in avoiding unintended harm to Aboriginal objects;
- provides certainty to land managers and developers about appropriate measures for them to take;
- encourages a precautionary approach; and
- results in more effective conservation outcomes for Aboriginal cultural heritage.

If the due diligence assessment determines that Aboriginal objects or places are likely to be harmed, an AHIP is required to manage harm as defined by Part 6, Section 86 of the NPW Act.

The preparation of an Aboriginal due diligence report does not require the participation of Aboriginal representatives or consultation with the Aboriginal community. EMM invited one member from and Moama Local Aboriginal Land Council (MLALC) to participate in the field survey assist the archaeologist with recording requirements and to provide insights into the landscape. A response from the MLALC was not received.

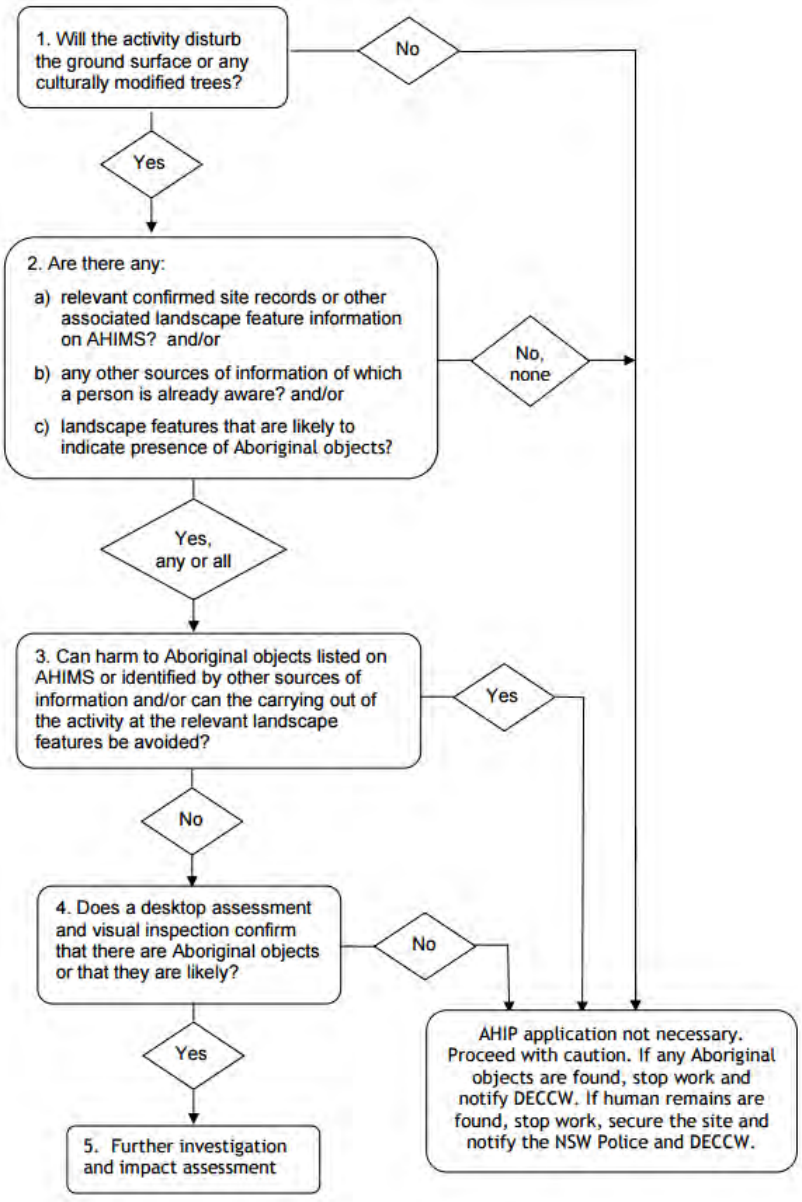


Plate 1.1 Due diligence process summary (source: due diligence guidelines (DECCW 2010)

1.4 Assessment methods

This report follows the due diligence guidelines (refer Section 1.3.3). In summary, the assessment involves:

- a search of the Aboriginal Heritage Information System (AHIMS) database on 17 October 2017;
- consideration of existing Aboriginal cultural heritage studies in the area and region for the presence of Aboriginal objects or places;
- consideration of the environmental context for the presence of Aboriginal objects or places;
- a site inspection of the project areas by two EMM archaeologists to identify any Aboriginal objects or areas of potential archaeological deposit (PAD); and
- a determination of whether further heritage investigation and impact assessment is required.

Table 1.1 describes the basic steps of a due diligence assessment as set out in Section 8 of the guidelines (Plate 1.1). It also provides an overview of the assessment results in accordance with these steps and lists the section(s) in the report where each of these is addressed in full.

Table 1.1 Due diligence summary

Step	Results	Section in this report
STEP 1: Check for records of Aboriginal objects and places in area of proposed activity.	An AHIMS search covering the study area was conducted on 17 October 2017.	Sections 3.1
STEP 2: Is the activity a 'Low Impact Activity', as defined in the National Parks and Wildlife Regulation?	The activity is not considered to be a 'Low Impact Activity' as it will involve installing piers to support solar panels, into the ground.	Section 1.2
STEP 3: Are there any landscape features on undisturbed land that are likely to indicate the presence of Aboriginal objects?	No. The project area is low lying and the surrounding land is farmland that has been ploughed regularly over the last few decades. Dams have also been built in the surrounding landscape.	Section 2.2
STEP 4: Does a desktop assessment and visual inspection confirm that there are Aboriginal objects present or likely to be present?	Desktop assessment and visual inspection show that north of the Murray River banks sites are most likely to be modified trees. Within 500 m of the Murray River, sites are a mixture or burials, open scatters, middens and modified trees.	Sections 3.3
STEP 5: Can the activity be relocated away from the known/likely area for Aboriginal objects?	Not applicable	
STEP 6: Commence investigation for an Aboriginal heritage impact permit (AHIP).	Not applicable	

1.5 Authorship

This report was prepared by Kerryn Armstrong (consultant archaeologist EMM), and reviewed by Pamela Kottaras (Heritage Services Manager EMM). The site inspection was undertaken by Kerryn Armstrong and Pamela Kottaras.

2 Landscape context

2.1 Rationale

The environmental context is used to predict the spatial distribution, preservation and the likelihood of archaeological material in the project area. Landscape features were an important factor for the choice of camping, transitory and ceremonial areas used in the past by Aboriginal people. Natural resources, including raw stone materials and local flora and fauna, would have provided food, tools and material resources. These resources are linked to the topography, hydrology, geology and soil types in the region. Additionally, natural and cultural (anthropogenic) site formation processes influence the present location of archaeological material (eg if moved through disturbance), along with its preservation and archaeological integrity.

2.2 Landform and topography

The Riverina bioregion of NSW forms part of the south-west, and both the Murrumbidgee River and the Murray River flow through 9,704,469 hectare area. This is area is known for food production, and has long be known for agriculture and farming (Department of Environment and Energy 2017). Within this region the landform shifts from the mountains of the Great Dividing Range to the east, down to the alluvial flats surrounding the rivers.

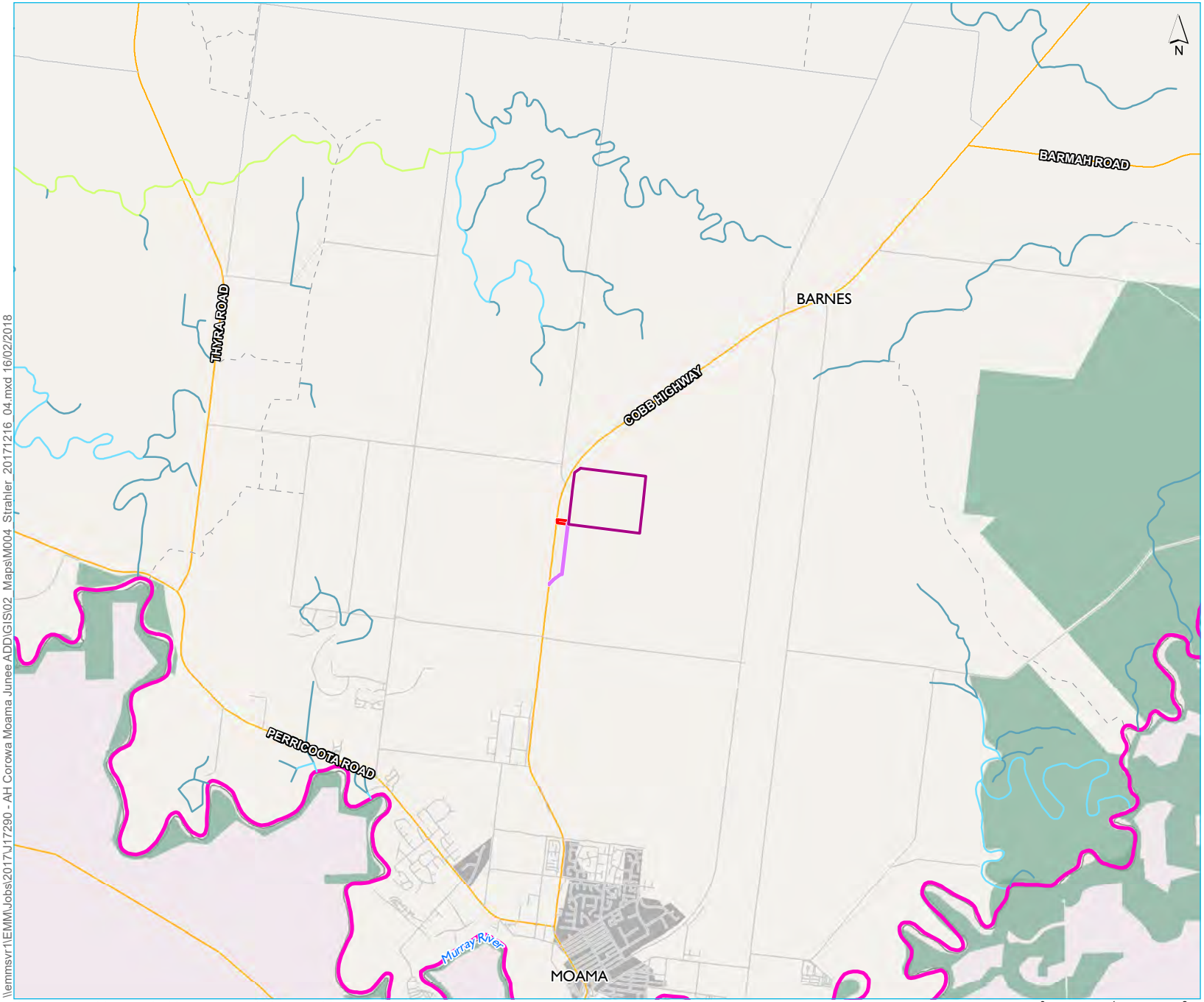
The project area and the surrounding region lies within the floodplain of the Murray River. Although the eastern boundary slopes upward very gently, the entire project area sits quite low at approximately 100 m above sea level (Office of Environment and Heritage 2017).

2.3 Hydrology

The Moama project area is located within the Murray basin, which is a catchment for both the Murray and the Darling rivers. It covers a large part of NSW, and connects with the Queensland, Victoria and South Australia borders. Within this basin the Lower Murray Groundwater Source supplies water to towns north of the Murray River, up to and including Moulamein and Jerilderie.

The Murray River, located 5 km south of the Moama project area, is a tenth order stream according to the Strahler system of organisation. The Murray River has provided generations with a strong inland river economy, it has produced a healthy number of native fish including trout and perch as well as a variety of crayfish and turtles.

North of the site, approximately 1.5 km is a first order Strahler stream which runs into second and third order streams north of the project area. The site itself is absent of any water courses, and the average rainfall of the area regularly falls below national average at 426.8 ml (Eucha BOM).



\\emmsvr1\EMM\Jobs\2017\J17290 - AH Corowa Moama Junee ADD\GIS\02 Maps\M004 Strahler 20171216 04.mxd 16/02/2018

Source: EMM (2017); DFSI (2017); DELWP (2001); DPI (2015)

Hydrology of the project area

Moama solar farm
Statement of environmental effects

Aboriginal due diligence assessment

Figure 2.1

EMM

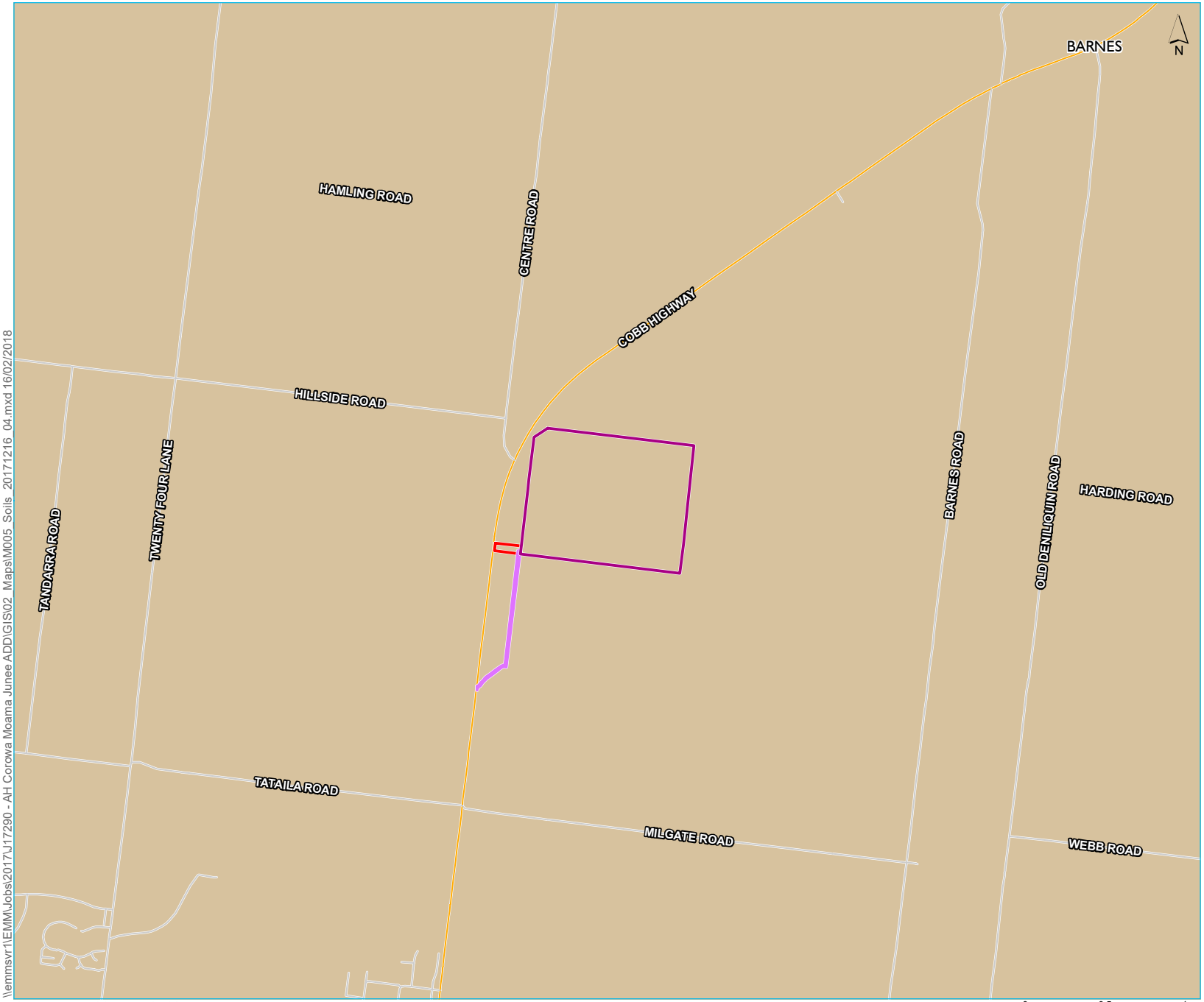
2.4 Geology and soils

The Moama site sits upon Shepparton formation geology, which is comprised of fine grain quartz and mica grains, limonite and lithic sandstones. The beds extend to a possible 10 m depth but predominately average 2 – 5 m. This geology is a part of cenozoic formation of the larger Murray basin (NSW Geoscience 2017).

The soil stratigraphy topping the Shepparton formation geology builds from the alluvial plain near the Murray River. It is known for rich sediment, which promotes agricultural use; the soil landscape present at the site is also consistent with the native vegetation.

The soil (Figure 2.2) is red and brown chromosol found often in level or slightly undulating plains. The A1 horizon is a hardset silty clay loam; it is a dark greyish brown with strong pedality. The acidity level for the A1 horizon is routinely 6 pH, which is ideal for many crops and vegetation. Below, in the B2 horizon the clay is a medium heavy texture, and slightly less acidic at 6.5 pH. The B2 horizon is a dark yellowing brown and also exhibits strong pedality.

In areas where the slopes are more prominent, erosion of the A1 horizon is common and widespread, this can occur through wind or rain and once exposed the lower stratigraphy hardens due to the clay composition (eSPADE 2017).



\\emmsvr1\EMM\Jobs\2017\J117290 - AH Corowa Moama Junee ADD\GIS\02_Maps\M005_Soils_20171216_04.mxd 16/02/2018

Source: EMM (2017); DFSI (2017)

Soils of the project area

Moama solar farm
Statement of environmental effects

Aboriginal due diligence assessment

Figure 2.2

EMM

2.5 Land use history and vegetation

Moama was first known as Maiden's Punt, this small town on the Murray River was home to few in 1845 and took on the name of Moama after being surveyed by Thomas S Townsend in 1851 (Shepparton Advertiser 19 October 1937, pp. 43). At one stage Moama was a thriving stock route on the pathway to Bendigo, however in the late 1800s Echuca took on this role and Moama began to decline. The fertile grounds and access to the Murray River ensured Moama stayed relevant as an agricultural hub, specifically wheat. Over the years Moama has been home to coach builders, boot makers, and blacksmith and continues to hold an annual agricultural show in conjunction with Echuca (Discover Murray 2017).

The indigenous vegetation of the site is Riverine plain grasslands, which is made up of shrubs and tussock grassland. Native grass covers the ground sporadically, and is predominately white top grass, windmill grass and forb rich speargrass. Peppered along the border of the subject area is a row of Grey Box Eucalyptus (*Eucaluptus microcarpa*), which are commonly found along the western length of the Murray River. This combination of vegetation leads to generally fertile plains, situated in fairly flat or low sloped areas, all congruent with the Moama site (Bioregion OEH 2017).

3 Aboriginal heritage context

3.1 Register searches

Searches were made on the 17 October 2017 of the following heritage databases:

- The Aboriginal heritage information management system (AHIMS: and
- The Aboriginal places register (accessed via State Heritage Inventory): and
- The Native Title Vision website.

Table 3.1 Register searches

Register	Results
AHIMS and Heritage database search	No sites were found within the project area, search results for the study area can be found in Figure 3.1
Aboriginal places register	No sites were found within the project area
Native Title Claims	No claims were found within the project area
Indigenous Land Use Agreements (ILUAs)	No ILUAs found within the project area

3.2 Aboriginal history

The Murray River began to develop at the end of the Pleistocene, and by the Holocene was one of Australia's most productive inland coastal economy societies. This broad-based economy ensured that year round there was an abundance of crayfish, wild fowl or freshwater fish and the topography around the river encouraged small game to the lagoons and billabongs surrounding the channel. The river gums that lined the bank were ideal for watercrafts typically used on inland water systems and the plant fibres were useful in weaving traps and nets in order to catch fish, ducks and emu (Mulvaney & Kamminga 1999, pp. 302-309).

The Murray River also encouraged British exploration, which had a devastating effect on the local people through newly introduced diseases such as small pox and influenza. At the time of the European arrival, the Yorta Yorta were estimated to be 5-6000 strong. Within a single generation that number dropped 85% reducing the population significantly in what is now known as central Murray-Goulburn region. The Yorta Yorta who remained were removed from their land in 1874 and taken to Maloga Mission in NSW (Yorta Yorta Nation 2017).

3.3 Review of previous archaeological investigations

EMM Consulting conducted a review of previous archaeological investigations within the area, of which there was only one, as part of the due diligence process. The chosen investigations were a direct result of the AHIMS search and are outlined below.

3.3.1 Investigations in the regional area

Lance, A & Webb, S 1985, *An archaeological investigation of a sand dune on the murray river at moama, NSW,* prepared for National Parks and Wildlife Services by ANU Archaeological Consultancies

Lance & Webb (1985) prepared a report in order to conduct an archaeological investigation of a sand dune, approximately 7 km south of the project area in Moama after skeletal remains were found in sand that was removed from the Moama quarry. It had been delivered to a nearby town, when the remains were discovered. The investigation was conducted in two parts, the quarry itself was excavated, and the previously removed sand was sieved.

Along the dune crest of the quarry, 21 pits were excavated; the test excavation squares were 1 m x 1 m. Each pit was approximately 1 m deep, with several going down to 1.5 m. At the base of each hole further augured holes extended the depth an additional 1.2 m, bringing the possible depth of each pit to 2.7 m. During this phase of the excavation, sparse occupation deposits were uncovered, which included stone artefacts (exact details were not included in the report). No other human remains were discovered in the test pits.

Phase 2 of the project included sieving the sand that had already been moved from the quarry location. This involved sieving approximated 10 m^3 of sand, which revealed a small amount of skeletal remains, belonging to two Aboriginal or Torres Strait Islander individuals. The site is regarded as low significance; no other evidence was uncovered at the site leading archaeologists to believe no further burials were present.

Johnson, H 1997, *Report on aboriginal burial at moama, NSW*, prepared by National Parks and Wildlife Service, NSW

Johnson (1997) prepared a report after human skeletal material was handed into the Moama Police. The remains initially did not have any of the cranial elements and was therefore more challenging to identify. The remains were discovered in an excavation for swimming pool construction, at approximately 1.5-1.8 m

After the discovery Johnston examined the site which is located 5.8 km from the current project area, and sieved the excavated dirt either through a 6mm hand sieve or a larger mechanical sieving screen. Through this process a further 67 bones or bone fragments were unearthed. The remains were identified as a female adult, likely Aboriginal or Torres Strait Islander and had borne children.

3.3.2 Investigations in the local area

Lloyd, A 1993, *Archaeological survey of proposed moama sewerage treatment works moama, NSW*, prepared for Moama Shire Council by Annemaree Lloyd

Lloyd (1993) prepared a report on behalf of Moama Shire Council to do an assessment of a proposed sewerage development site. The survey covered 176,756 m^2 north approximately 4 km from the project area, it was conducted on foot and included both transect lines for the large area, and inspection units for the heavily wooded sections.

The survey revealed 18 scar trees with a total of 21 scars. They were identified as predominately Grey Box (Eucalyptus *microcarpa*) and had scars ranging from 25 cm to 500 cm. Scars this length indicate that the wood was being used for a wide range of tools; the smaller scars may have been for coolamon or shield use, while the larger was long enough for canoes. The survey also discovered an oven mound, with a

length of 8.10 m, width 10 m and height of 12 cm. Recommendations were developed to encourage protection of all scar trees as well as the mound.

Navin Officer Heritage Consultants Pty Ltd 2009, *Deniliquin to Moama 132 kV Transmission Line Route Aboriginal and Historical Archaeological Assessment*, prepared for Sinclair Knight Merz

Navin Officer Heritage Consultants Pty Ltd, 2010 (Navin Officer) prepared a report for Sinclair Knight Merz (SKM) to survey a 69 km route for a 132kV transmission line to run from Moama to Deniliquin. The sites identified were nine scar trees; these sites were all found over 20 km north of the project area and ranged in size from 42cm to 230cm. Within 2 km of the project area two historical sites were located, the first a concrete plinth survey mark 1.7 km north of the project area. Secondly the Travelling Stock Route (TSR) was identified along the Cobb Highway (Plate 3.1). The TSR is considered to be a "work" under the NSW Heritage Act; therefore works were able to proceed (NSW Government correspondence 2010).

The Navin Officer assessment included the area proposed for the alternate access seen in Figure 1.2, more information can be found regarding this in section 5.1.

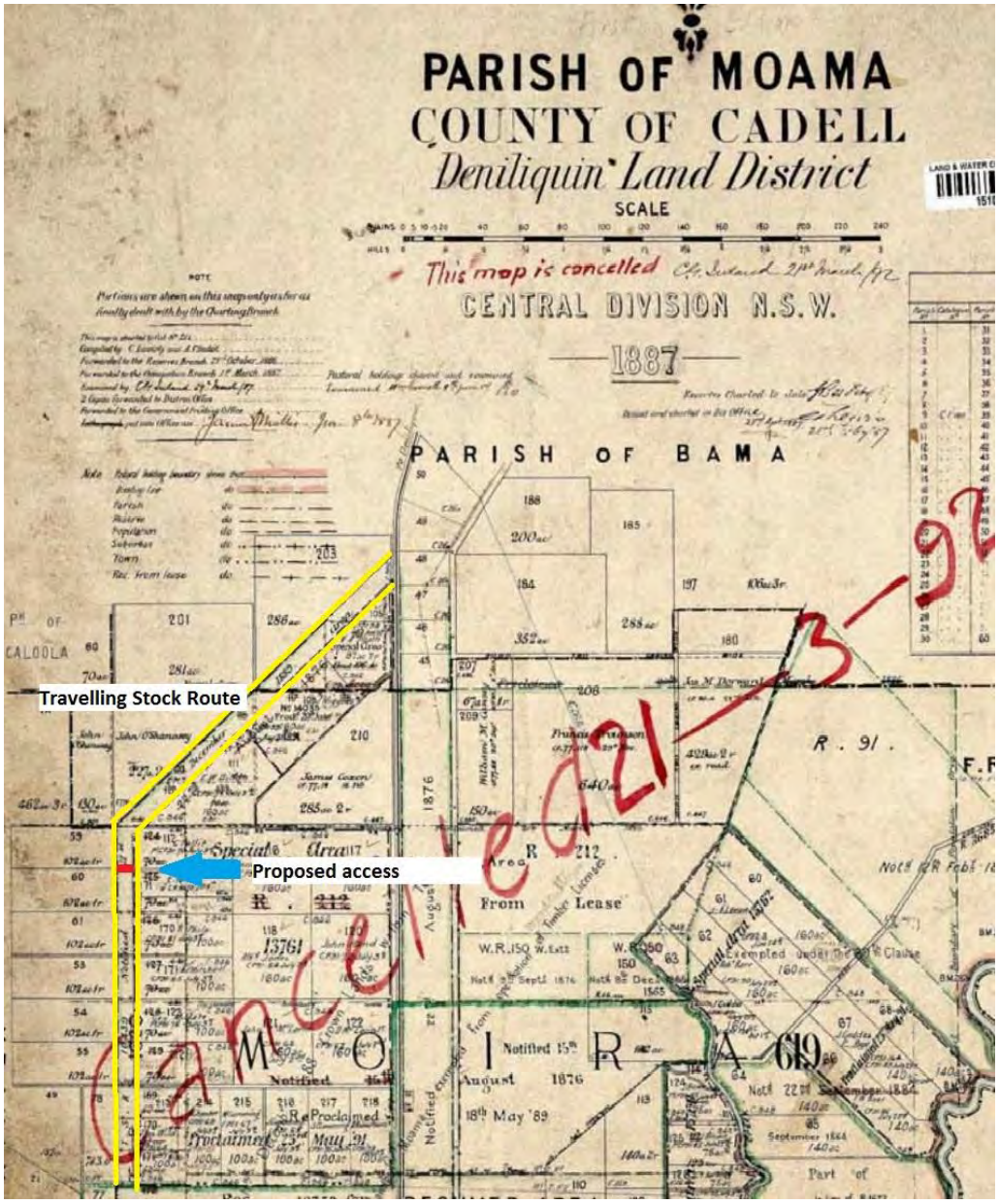
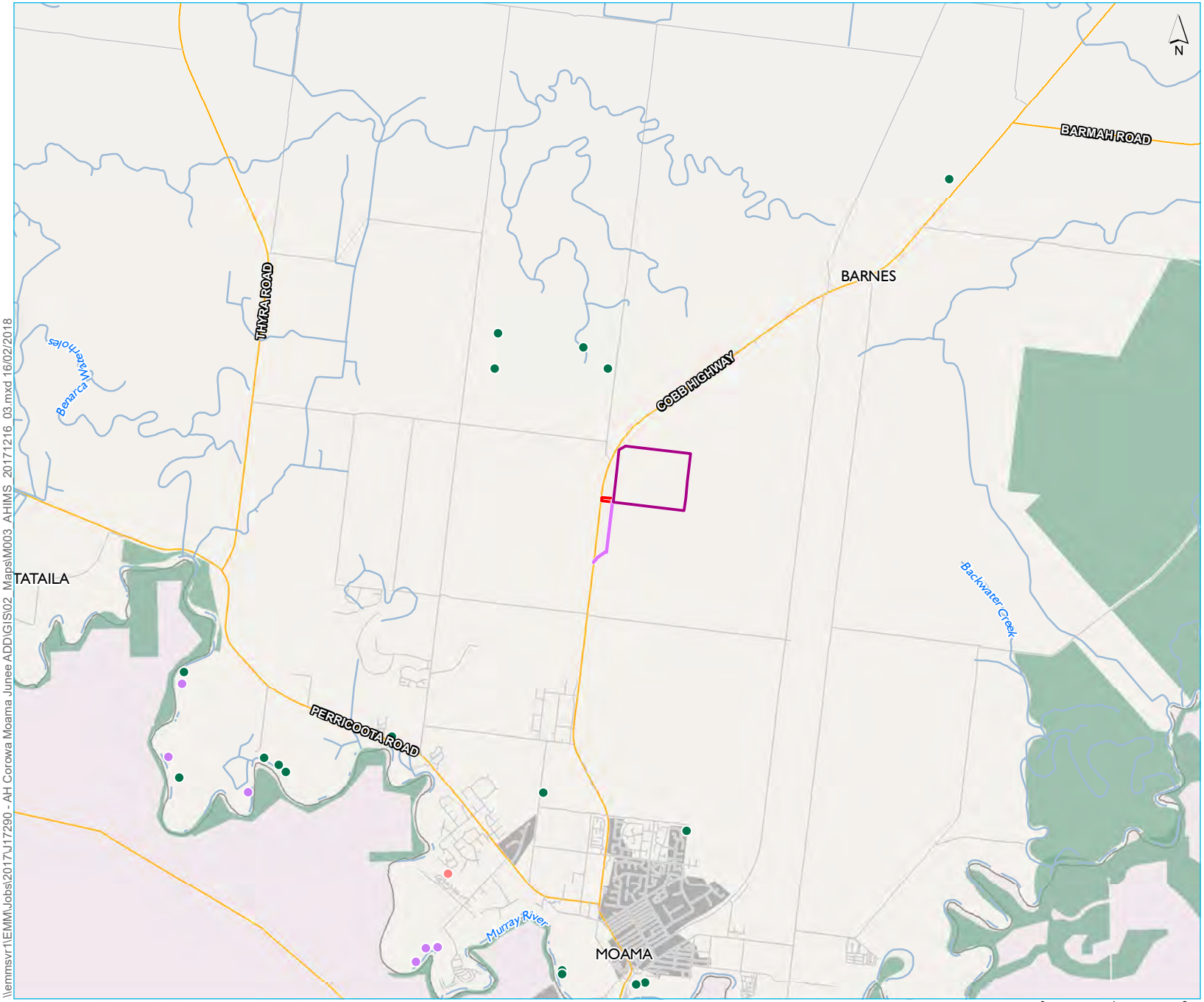


Plate 3.1 Travelling Stock Route (NSW Department of Lands Image 1887 Moama Parish)



\\emmsvr1\EMM\Jobs\2017\J117290 - AH Corowa Moama Junee ADD\GIS\02 Maps\M003 AHIMS 20171216 03.mxd 16/02/2018

Source: EMM (2017); DFSI (2017); DELWP (2001); OEH (2017)

AHIMS sites

Moama solar farm
Statement of environmental effects

Aboriginal due diligence assessment

Figure 3.1

EMM

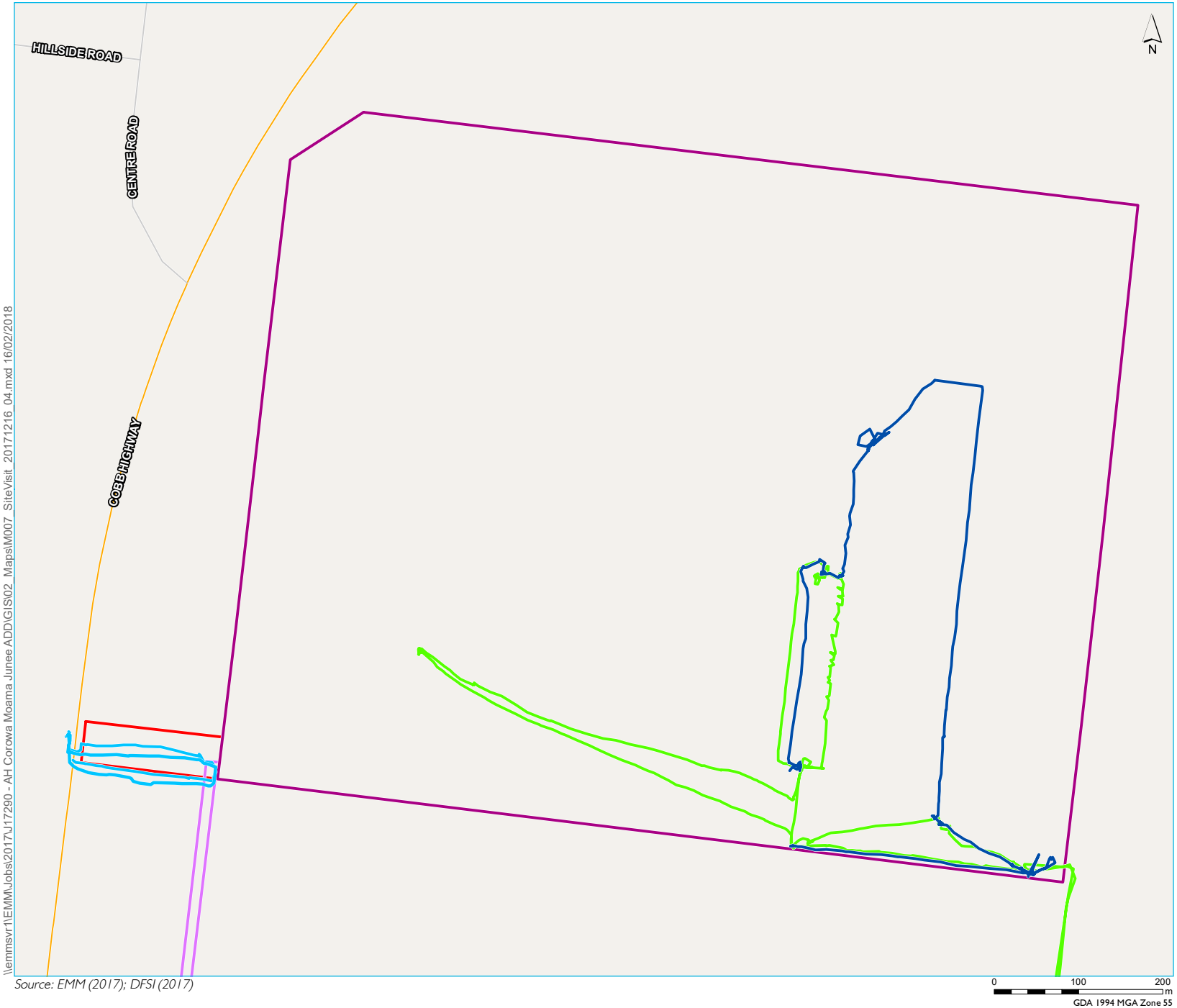
4 Site inspection

4.1 Overview

EMM archaeologists Kerryn Armstrong and Pamela Kottaras inspected the project area on 16 November 2017. This involved pedestrian survey across the paddock to record landscape information and target ground exposures for the presence of Aboriginal objects. As modified trees have been recorded in the region and occur in high numbers along the Murray River, a focus of the field inspection was on mature trees to identify cultural modifications. The main aims of the survey were to:

- identify Aboriginal sites or potential Aboriginal places; and
- characterise the landscape to aid predictions of subsurface archaeological potential.

The alignment was divided into three transects (Figure 4.1) which are described in the section below.



\\emmsvr1\EMM\Jobs\2017\J17290 - AH Corowa Moama Junee ADD\GIS\02_Maps\M007_SiteVisit_20171216_04.mxd 16/02/2018

Source: EMM (2017); DFSI (2017)

Survey record

Moama solar farm
Statement of environmental effects

Aboriginal due diligence assessment

Figure 4.1

EMM

4.1.1 Transect 1

Transect 1 (Plate 4.1) tracked north, the field was under wheat crop with visible plough lines (Plate 4.2). The flood plain was topped with black silty clay, and produced little to no lithic material. Transect 1 had two mature trees, both where examined for modification and showed none. A small dam (Plate 4.3) was present, under a line of young trees, this was possibly a result of being in the flood plain and likely dries up during warm or dry weather. Visibility was limited due to the approximately 60% of the field being under wheat.

No artefacts or areas of potential archaeological deposit were noted.

Plate 4.1 Transect 1. View north (photo ID: 20171116-000748)

Plate 4.2 Plough lines (photo ID: 20171116-001142)

Plate 4.3 Small dam along transect 1 (photo ID: 20171116-005405)

4.1.2 Transect 2

Transect 2 (Plate 4.4) covered highly disturbed terrain which has been repeatedly ploughed and planted for farm use and currently holds wheat. This transect included a few mature trees, all of which were examined and none of which had been culturally modified. The soil landscape is red silty clay with strong structure (Plate 4.5). Transect 2 showed very little stone or suitable knapping material, although the project area is still under crop so the visibility was low. Transect 2 also covered a row of planted trees that ran north in the middle of the project area (Plate 4.6), many of these trees were young trees however the few mature trees were examined for any possible cultural modification; none was present.

No artefacts or areas of potential archaeological deposit were noted.

Plate 4.4 Transect 2. View west (photo ID: 1460)

Plate 4.5 Example of red clay (photo ID: 1472)

Plate 4.6 Example of immature trees running north through the project area (photo ID: 1493)

4.1.3 Transect 3

Transect 3 (Plate 4.7) examined the preferred access area to the west of the project area. This segment of the survey begins at the edge of the Cobb highway in the south-west corner of the project area. This access area was approximately 165 m and crossed over a TSR (Plate 3.1), which travels 610 km along the Cobb highway. The area holds native vegetation the dominant types being, forb-rich Spear grass (*Austrostipa metatoris*), Windmill grass (*Chloris truncate*) and White Top grass (*Austrodanthonia caespitose*). This open tussock form of grassland is native to within the Riverina bioregion. Transect 3 has been used for heavy equipment related to the installation and maintenance of utility poles in the along the access area. There are no mature trees on transect 3 and visibility was low due to the extensive covering.

No artefacts or areas of potential archaeological deposit were noted

Plate 4.7 Transect 3. View east (photo ID: 1507)

Plate 4.8 Transect 3. Visibility (photo ID: 1508)

5 Discussion of archaeological potential

5.1 Preliminary assessment of archaeological potential

The project area is expressed as having nil, low, moderate or high archaeological potential. These terms refer to the likelihood of recovering subsurface Aboriginal objects and are defined as follows:

- **Nil potential:** Aboriginal objects cannot occur unless artificially imported – typically because of the artificial landform (eg ash dam fill);
- **low potential**: it is against expectation for Aboriginal objects to occur and no further investigation is warranted;
- **moderate potential**: Aboriginal objects could occur but in an uneven or highly clustered manner with gaps between sites and investigation would be warranted to determine if the potential development may impact sites; and
- **high potential**: Aboriginal objects almost certainly occur throughout the identified area and investigation would be warranted simply to confirm significance and management requirements.

Based on the discussion in Section 4 the project area is of low archaeological potential. The project area does not meet the known indicators expected for the presence of Aboriginal artefacts (Table 5.1). The high levels of disturbance through ploughing and harvesting, and the removal of native vegetation is likely to have destroyed any sites that may have existed.

An alternate access track has been nominated in addition to the preferred access track to the south west of the project area. This track can be viewed in all of the included figures; and has previously been subject to a heritage assessment by Navin Officer (2010). As noted in section 3.3.2 Navin Officer did not note any Aboriginal sites along this section and that work could proceed with caution without further assessment. The topography, soils, geology and distance to water make this area undesirable for habitation therefore the potential of this area for Aboriginal objects is low.

Table 5.1 Landscape indicator for Aboriginal sites

Landscape indicator	
Does the project area lie within 200 m of waters?	No
Is the project area within a sand dune system?	No
Is the project area located on a ridge top, ridge line or headland?	No
Is the project area located within 200 m below or above a cliff face?	No
Is the project area located within 20 m of a cave, or in a rock shelter or at a cave mouth and is on land that is not disturbed land?	No

6 Conclusion and recommendations

6.1 Conclusion

This Aboriginal due diligence assessment considers both background research and a visual inspection of the site; neither has produced any evidence to support the potential for Aboriginal artefacts to be present within the project area. Although background research of the regional area identified culturally modified trees in the regions, the project area includes very few mature trees, and those show no sign of culturally significant modifications. The area is low lying, and without a stable water source nearby, it is unlikely to have been a preferred area for occupation due to this.

6.2 Recommendations

The following recommendations have been prepared to respond to the site conditions and current legislation and guidelines protecting Aboriginal and historical heritage. The recommendations below are informed by the background research and fieldwork undertaken for the project.

They are:

- works may proceed with caution;
- in the unlikely event that sites are discovered work should immediately cease and archaeological advice sought; sites include modified trees as well as stone artefacts;
- In the event that known or suspected human skeletal remains are encountered during the activity, the following procedure will be followed:
    - all work in the immediate vicinity will cease and the find will be immediately reported to the work supervisor who will immediately advise the Environment Manager or other nominated senior staff member;
    - the Environment Manager or other nominated senior staff member will promptly notify the police and the state coroner (as required for all human remains discoveries);
    - the Environment Manager or other nominated senior staff member will contact OEH for advice on identification of the skeletal material;
    - if it is determined that the skeletal material is Aboriginal ancestral remains, the Local Aboriginal Land Council will be contacted and consultative arrangements will be made to discuss ongoing care of the remains; and
    - if it is determined that the skeletal material is not Aboriginal ancestral remains, further investigation will be conducted to determine if the remains represent a historical grave or if further involvement of the police is required.
- should the project areas be expanded, additional Aboriginal due diligence under the code should be undertaken.

References

Anonymous editorial, 1937 'Moama, gateway to the Southern Riverina', *Shepparton Advertiser,* 19 October, p. 43 1937, viewed 06 Nov 2017, http://nla.gov.au/nla.news-article171894045

Lance, A & Webb, S 1985, *An archaeological investigation of a sand dune on the murray river at moama, NSW,* prepared for National Parks and Wildlife Services by ANU Archaeological Consultancies

Lloyd, A 1993, *Archaeological survey of proposed moama sewerage treatment works moama, NSW*, prepared for Moama Shire Council by Annemaree Lloyd

Johnson, H 1997, *Report on aboriginal burial at moama, NSW*, prepared by National Parks and Wildlife Service, NSW

Bureau of meterology 2017, accessed 2 November 2017, produced by Australian Government http://www.bom.gov.au/climate/averages/tables/cw_080015.shtml

CSIRO 2009. Australian soil and land survey field handbook VIC, CSIRO Publishing.

Department of Environment and Energy 2017, *Australia's bioregions –maps*, prepared by Australian Government, ACT accessed 5 December 2017
http://www.environment.gov.au/land/nrs/science/ibra/australias-bioregions-maps

Discover Murray 2017, History of Echuca Moama on the Murray River from 1853, viewed on 2 November 2017, http://www.murrayriver.com.au/echuca/echuca-moama-history/

eSpade, NSW Soil and Land Information, accessed 2 November 2017, produced by Office of Environment and Heritage http://www.environment.nsw.gov.au/eSpade2WebApp

Geological Maps, NSW Geosciences Information, accessed 2 November 2017, produced by Planning and Environment https://www.resourcesandenergy.nsw.gov.au/miners-and-explorers/geoscience-information/products-and-data/maps/statewide-maps

Mulvaney, J & Kamminga, J 1999, Prehistory of Australia NSW Allen & Unwin

Navin Officer heritage consultants Pty Ltd 2009, *Deniliquin to Moama 132 kV Transmission Line Route Aboriginal and Historical Archaeological Assessment*, prepared for Sinclair Knight Merz

NSW Government Department of Planning (Heritage division) 2010, *RE: S139 Exception application for construction of Deniliquin to Moama 132 kV transmission line,* date sent 10 May 2010

Office of Environment and Heritage 2017, The Riverina Bioregion, accessed 5 December 2017, produced by NSW Government http://www.environment.nsw.gov.au/resources/nature/riverina.pdf

Yorta Yorta Nation Aboriginal Corporation 2017, accessed 2 November 2017, produced by Yorta Yorta Nation Aboriginal Corporation http://www.yynac.com.au/the-history-of-the-yynac

Appendix A

AHIMS results

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : J17266 - Moama

Client Service ID : 307288

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
59-2-0041	MR11	AGD	55	295080	6001111	Open site	Valid	Earth Mound : -, Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	D Rhodes					**Permits**		
59-2-0042	MR10	AGD	55	295240	6001140	Open site	Valid	Earth Mound : -, Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	D Rhodes					**Permits**		
59-2-0043	MR1	AGD	55	299962	5999379	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	D Rhodes					**Permits**		
59-2-0044	MR1	AGD	55	298177	6000629	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	D Rhodes					**Permits**		
59-2-0045	MR12	AGD	55	295245	6001126	Open site	Valid	Artefact : -, Earth Mound : -, Shell : -	Midden	
	Contact	**Recorders**	D Rhodes					**Permits**		
59-2-0046	LB1	AGD	55	298760	6002771	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	D Rhodes					**Permits**		
59-2-0001	Wharparilla North;Boora Boora Property;	GDA	55	291780	6005200	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Bill Thornhill					**Permits**		
59-2-0002	Big Tree Bend Midden, Moama	GDA	55	291750	6005030	Open site	Valid	Shell : -, Artefact : -	Midden	884
	Contact	**Recorders**	R.A Buchan					**Permits**		
59-2-0003	Big Tree Bend, Moama	GDA	55	292680	6003500	Open site	Valid	Hearth : -, Shell : -, Artefact : -	Midden	884
	Contact	**Recorders**	R.A Buchan					**Permits**		
59-5-0001	site one;	AGD	55	294600	6004100	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Ms.Vanessa Edmonds					**Permits**		
59-5-0002	Scarred tree 4;	AGD	55	293100	6003600	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Ms.Vanessa Edmonds					**Permits**		

Report generated by AHIMS Web Service on 17/10/2017 for Susan Macolino for the following area at Lat, Long From : -36.15, 144.69 - Lat, Long To : -36, 144.85 with a Buffer of 1000 meters.

Additional Info : Due diligence. Number of Aboriginal sites and Aboriginal objects found is 29

This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : J17266 - Moama

Client Service ID : 307288

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
59-5-0003	scarred tree 2;	AGD	55	293000	6003700	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Ms.Vanessa Edmonds					**Permits**		
59-5-0004	scarred tree 1;	AGD	55	292800	6003800	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Ms.Vanessa Edmonds					**Permits**		
59-5-0005	Scarred tree 3;	AGD	55	292800	6003800	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Ms.Vanessa Edmonds					**Permits**		
59-2-0004	Moama;Boora Boora;	GDA	55	291560	6004000	Open site	Valid	Shell : -, Artefact : -	Midden	884
	Contact	**Recorders**	T Negerevich,R.A Buchan					**Permits**		
59-2-0005	Boora Boora;Moama;	AGD	55	291599	6003525	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	884
	Contact	**Recorders**	ASRSYS					**Permits**		
59-2-0006	Moama Burials Griffith	AGD	55	300322	5999957	Open site	Valid	Burial : -	Burial/s	882
	Contact	**Recorders**	Michael Green					**Permits**		
59-2-0007	Site 1;Griffith;	AGD	55	297000	6000800	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Mr.Allan Lance					**Permits**		
59-2-0008	Site 2;Griffith;	AGD	55	297000	6000750	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Mr.Allan Lance					**Permits**		
59-2-0009	Site 3;Griffith;	AGD	55	298050	6000600	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Mr.Allan Lance					**Permits**		
59-2-0017	Moama 1;	AGD	55	297300	6009600	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	2874
	Contact	**Recorders**	Anne Lloyd					**Permits**		
59-2-0018	Moama 2;	AGD	55	296050	6009300	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	2874
	Contact	**Recorders**	Anne Lloyd					**Permits**		

Report generated by AHIMS Web Service on 17/10/2017 for Susan Macolino for the following area at Lat, Long From : -36.15, 144.69 - Lat, Long To : -36, 144.85 with a Buffer of 1000 meters.

Additional Info : Due diligence. Number of Aboriginal sites and Aboriginal objects found is 29

This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : J17266 - Moama

Client Service ID : 307288

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
59-2-0019	Moama 3;	AGD	55	296100	6009800	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	2874
	Contact	**Recorders**	Anne Lloyd					**Permits**		
59-2-0020	Moama 4;	AGD	55	297650	6009300	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	2874
	Contact	**Recorders**	Anne Lloyd					**Permits**		
59-2-0047	Merool Lane Burial, Moama	GDA	55	295506	6002350	Open site	Valid	Burial : 1		3996
	Contact	**Recorders**	Harvey Johnston					**Permits**		
59-2-0048	W1-7	AGD	55	296739	6003311	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact Searle	**Recorders**	Mr.David Rhodes					**Permits**		
59-2-0049	W1-6	AGD	55	294940	6000923	Open site	Valid	Shell : -		
	Contact Searle	**Recorders**	Mr.David Rhodes					**Permits**		
59-2-0050	MUNGABARINA-MM2	AGD	55	302466	6011972	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact Sarah Colley	**Recorders**	Philip Boot					**Permits**		
59-2-0076	Horseshoe Lagoon ST1	GDA	55	300305	5999654	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact	**Recorders**	Mr.John Gilding,OEH					**Permits**		

Report generated by AHIMS Web Service on 17/10/2017 for Susan Macolino for the following area at Lat, Long From : -36.15, 144.69 - Lat, Long To : -36, 144.85 with a Buffer of 1000 meters.
Additional Info : Due diligence. Number of Aboriginal sites and Aboriginal objects found is 29

This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.

Appendix B

BIODIVERSITY ASSESSMENT

Biodiversity Assessment
Moama Solar Farm

Prepared for Terrain Solar| February 2018

Biodiversity Assessment

Moama Solar Farm

Prepared for Terrain Solar | 20 February 2018

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065

T +61 2 9493 9500
F +61 2 9493 9599
E info@emmconsulting.com.au

www.emmconsulting.com.au

Biodiversity Assessment

Final

Report J17266RP1 | Prepared for Terrain Solar | 20 February 2018

Prepared by	**Katie Diver**	Approved by	**Nathan Garvey**
Position	Associate – Ecology Services Manager	Position	Associate Ecologist
Signature		Signature	
Date	20 February 2018	Date	20 February 2018

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

© Reproduction of this report for educational or other non-commercial purposes is authorised without prior written permission from EMM provided the source is fully acknowledged. Reproduction of this report for resale or other commercial purposes is prohibited without EMM's prior written permission.

Document Control

Version	Date	Prepared by	Reviewed by
1	20 February 2018	Katie Diver	Nathan Garvey

T +61 (0)2 9493 9500 | F +61 (0)2 9493 9599

Ground Floor | Suite 01 | 20 Chandos Street | St Leonards | New South Wales | 2065 | Australia

www.emmconsulting.com.au

Table of contents

Appendices

Appendices

Tables

Figures

Photographs

1 Introduction

1.1 Background

Geolyse is preparing a Statement of Environmental Effects (SEE) on behalf of Terrain Solar to support a development application (DA) for the proposed Moama Solar Farm (the project). The DA will be assessed and determined by Murray River Council under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The project is located in Moama, in central southern NSW, within the Murray Shire local government area (LGA) (Figure 1.1). The project area is zoned RU1 – Primary Production under the *Murray Local Environmental Plan 2011.* .

1.2 Project description

The project comprises the installation of piled solar panel supports with steel racking, inverter stations with associated electrical cabling and telecommunication equipment, a maintenance building, switching station and perimeter security fencing. The area where these will be located is collectively referred to in this report as Moama Solar Farm, and is approximately 81.2 ha in area (Figure 1.2).

Two options are proposed for access from the Cobb Highway (Figure 1.2). The preferred option would create a new access turning east from the Cobb Highway to enter the proposed solar farm at its south-western corner, and is approximately 0.8 ha in size. The alternate option would use an existing north-east facing access road off the Cobb Highway and existing north-facing access track that also enters the proposed solar farm at its south-western corner, and is approximately 1.1 ha in size. Both options require a maximum disturbance zone of 10 m to construct the access.

Moama Solar Farm and the two access options are collectively referred to in this report as the project area.

1.3 Biodiversity assessment pathway

The NSW *Biodiversity Conservation Act 2016* (BC Act) commenced on 25 August 2017, replacing the former NSW *Threatened Species Conservation Act 1995* (TSC Act). However, Clause 28(1) of the NSW *Biodiversity Conservation (Savings and Transitional) Regulation 2017* (the regulation) has delayed operation of the Biodiversity Offset Scheme (BOS) associated with Part 7 of the BC Act until 25 February 2018 for pending or interim planning applications. Pending or interim planning applications are defined under clause 27 (1) of the regulation, and include:

> (e) except in the case of State significant development—an application for development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* (or for the modification of such a development consent) made within 6 months after the commencement of the new Act...

The project satisfies the definition of a pending or interim planning application in accordance with clause 27(e) of the regulation, because a DA will be lodged for the project under Part 4 of the EP&A Act within six months of the commencement of the BC Act (ie the DA will be lodged prior to 25 February 2018).

Clause 28 of the regulation states:

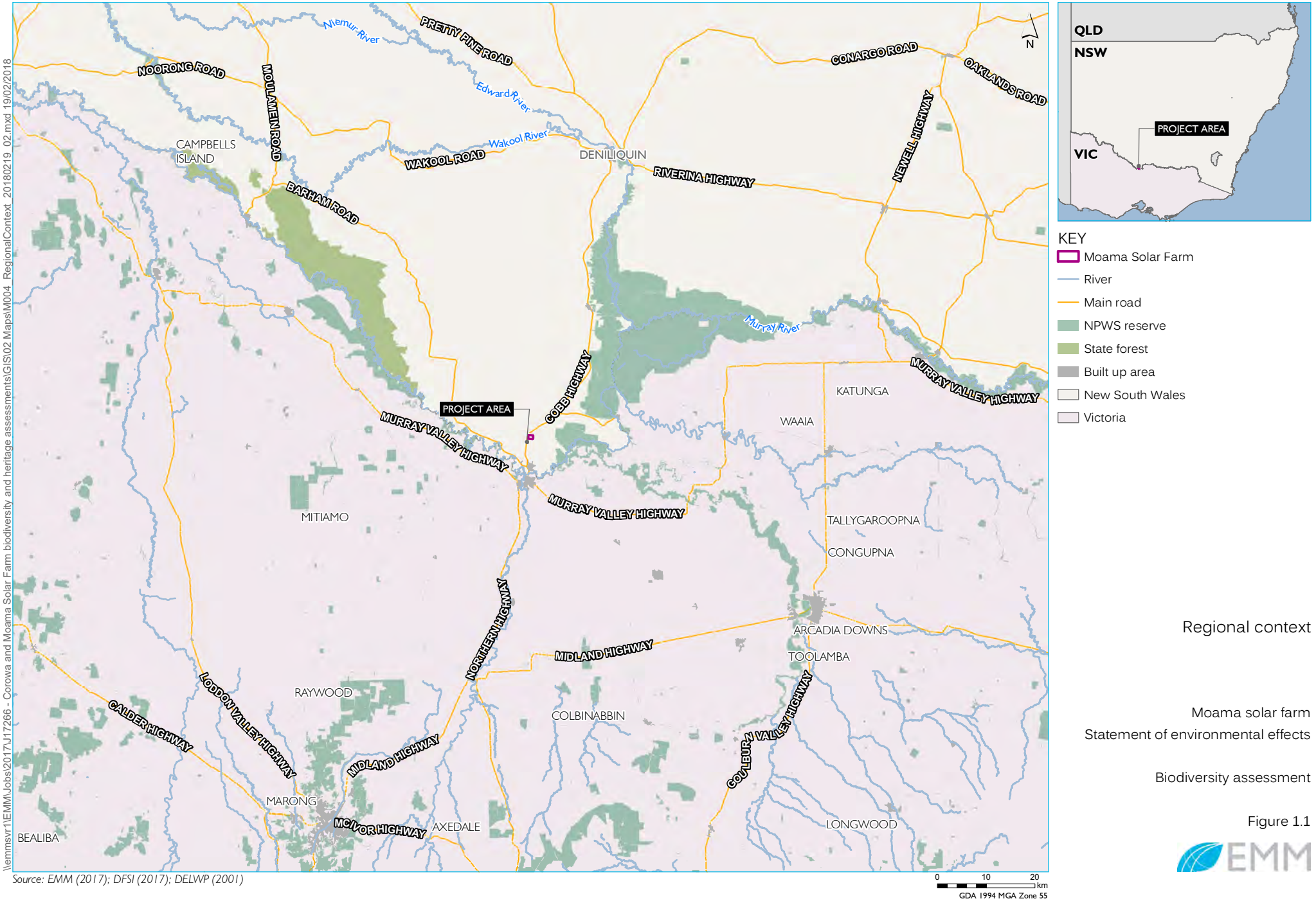
> (1) The former planning provisions continue to apply (and Part 7 of the new Act does not apply) to the determination of a pending or interim planning application.

(2) However, Part 7 of the new Act applies to the determination of a pending or interim planning application referred to in paragraph (b), (c) or (d) of the definition of pending or interim planning application in clause 27 (1) if the applicant or proponent and the planning approval body for the application agree in writing that Part 7 of the new Act is to apply to the determination of the application instead of the former planning provisions.

As the project is classified as a pending or interim planning application in accordance with clause 27(1)(e), the former planning provisions apply in accordance with clause 28(1) of the regulation.

Accordingly, this biodiversity assessment assesses the potential for species, populations and communities now listed under the BC Act (in accordance with clause 31 of the regulation) but uses the assessment of significance from the former provisions (ie section 5A of the EP&A Act) to determine the potential for significant impacts. Field methods have been based on the *Biodiversity Assessment Method* (BAM, OEH 2017a).

This biodiversity assessment also assesses the likelihood that threatened species and ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) would occur within the project area, and provides an assessment of significance in accordance with *Significant Impact Guidelines 1.1 EPBC Act* (DoE 2013) for species and communities recorded or predicted to occur.



Source: EMM (2017); DFSI (2017); DELWP (2001)

\\emmsvr1\EMM\Jobs\2017\J17266 - Corowa and Moama Solar Farm biodiversity and heritage assessments\GIS\02 Maps\M004_RegionalContext_20180219_02.mxd 19/02/2018

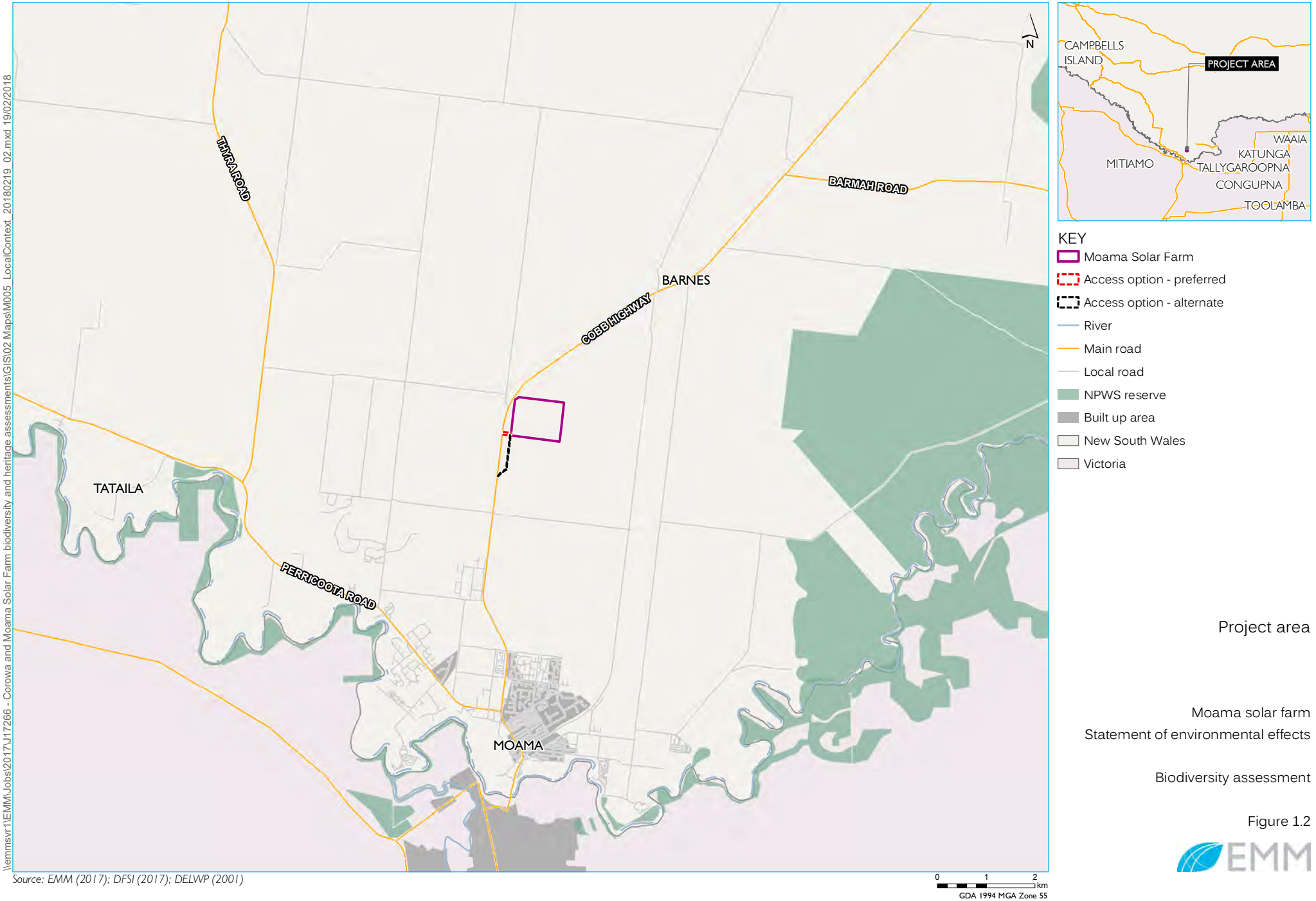
Regional context

Moama solar farm
Statement of environmental effects

Biodiversity assessment

Figure 1.1

EMM



\\emmsvr1\EMM\Jobs\2017\J17266 - Corowa and Moama Solar Farm biodiversity and heritage assessments\GIS\02 Maps\M005_LocalContext_20180219_02.mxd 19/02/2018

Source: EMM (2017); DFSI (2017); DELWP (2001)

Project area

Moama solar farm
Statement of environmental effects

Biodiversity assessment

Figure 1.2

EMM

2 Methods

2.1 Desktop assessment

A detailed desktop assessment was undertaken for the project area to identify any threatened species, populations or communities listed under the BC Act or EPBC Act. Several sources of information were reviewed to gather information on the landscape and ecological context of the project area, including:

- ArcMap aerial images for the project area and locality;
- *State Vegetation Type Map: Riverina Region Version 1.2 - VIS ID 4469* (OEH 2016a);
- *Map of Interim Biographic Regionalisation for Australia (IBRA) version 7 (IBRA7) bioregions and subregions* (DoEE 2017a);
- *Mitchell Landscapes NSW* v3 2011 map (OEH 2011);
- BioNet (OEH 2017b) resources to access the following:
    - Threatened Biodiversity Data Collection;
    - Threatened species profiles;
    - BioNet Atlas data; and
    - Vegetation Classification System.
- Protected Matters Search Tool (DoEE 2017b).

2.2 Field survey

Field surveys were undertaken by Katie Diver, Associate Ecologist with EMM Consulting Pty Ltd In November 2017.

Six floristic plots were completed within the project area, in accordance with the field methods described in the BAM (OEH 2017a). Plot locations are shown on Figure 2.1. Floristic plots were undertaken in both areas that had been cropped/cleared, as well as areas of native vegetation. All paddock trees within the project area were identified to species level and inspected for the presence of tree hollows.

Timed diurnal bird surveys were completed at the six plot locations for 20 minutes each to target threatened woodland birds, with the exception of the Swift Parrot and Superb Parrot. Surveys were completed to target potential woodland habitat for the Swift Parrot (*Lathamus discolor*) and Superb Parrot (*Polytelis swainsonii*), with surveys undertaken in accordance with the *Survey guidelines for Australia's threatened birds* (DEWHA 2010a).

Targeted searches were completed for the Turnip Copperburr (*Sclerolaena napiformis*) and Slender Darling Pea (*Swainsona murrayana*) in the two access option areas. Surveys were completed by inspecting the locations of previous records and walking parallel transects spaced at a maximum of 10 m in accordance with *NSW Guide to Surveying Threatened Plants* (OEH 2016b).

2.3 Expert report

To address the potential for *Prasophyllum* sp. Moama to occur within the project area, field surveys to support preparation of an expert report were completed by Dr Col Bower of FloraSearch. Field methods are contained in the expert report in Appendix D.

\\emmsvr1\EMMJobs\2017\J17266 - Corowa and Moama Solar Farm biodiversity and heritage assessments\GIS\02 Maps\M007 Plots 20180219 02.mxd 19/02/2018

Source: EMM (2017); DFSI (2017); DELWP (2001)

Methods

Moama solar farm
Statement of environmental effects

Biodiversity assessment

Figure 2.1

EMM

3 Existing environment

3.1 Landscape features

A summary of landscape features of the project area is summarised in Table 3.1, with further details provided in subsections below.

Table 3.1 Landscape features of the project area

Landscape feature	Description
IBRA Region	Riverina
IBRA Sub-region	Murray Fans
Aquatic habitat present	None
Wetlands present	None
Geological features (eg Karst, caves, crevices and areas of geological significance)	None
Areas of outstanding biodiversity value present	None

3.1.1 Rivers and streams

No rivers or streams are present within the project area. The project area is located at approximately 9 km to the west and 6 km to the north of the Murray River.

3.1.2 Wetlands

No wetlands are present within the project area, or within a 10 km radius. A shallow depression is present in the north-east of Moama Solar Farm. At the time of survey, it did not contain any water.

3.1.3 Connectivity features

The project area is within a rural landscape that has been extensively cleared. Native vegetation surrounding the project area is restricted to a grassy vegetated corridor in a travelling stock reserve to the west of the project area, and planted road verges to the north and east. These features act as a connective corridor for some species.

3.2 Native vegetation

3.2.1 Pre-existing vegetation mapping

A review of *State Vegetation Type Map: Riverina Region Version 1.2 - VIS ID 4469* (OEH 2016a) and aerial images indicated that the majority of the project area consisted of non-native vegetation, with two plant community types (PCTs) mapped within the project area. Table 3.2 shows the extent of each within the solar farm and the two access options.

Table 3.2 Vegetation extent predicted from pre-existing vegetation mapping

Plant community type	Moama Solar Farm (ha)	Preferred access option (ha)	Alternate access option (ha)
Non-native	76.4	0.1	0.7
PCT 44 Forb-rich Speargrass – Windmill Grass – White Top grassland of the Riverina Bioregion	0.6	0.7	0.4
PCT 237 Riverine Western Grey Box grassy woodland of the semi-arid (warm) climate zone	4.2	0	0
Total (ha)	81.2	0.8	1.1

3.2.2 Ground-truthed vegetation mapping

A total of 30 flora species were identified during plots undertaken in the project area, comprising 24 native and 6 exotic species. A further 25 native and four exotic plant species were identified in the project area during rapid assessments completed by FloraSearch (Appendix D). Accordingly, a total of 49 native and 10 exotic species were recorded in the project area during the two surveys. Data obtained from floristic plot is presented in Table C.1 in Appendix A.

The extent and condition of native vegetation predicted by the pre-existing vegetation mapping (Section 3.2.1) was found to be inconsistent with that observed during field surveys and was therefore refined. Consistent with the pre-existing mapping, the majority of the project area was found to support non-native vegetation with large areas cropped. Isolated paddock trees were recorded within areas of non-native vegetation. Three PCTs were mapped within the project area, predominantly to the west of the project area (in the travelling stock reserve) and two windrows in the east of the project area.

Table 3.3 Vegetation extent from ground-truthed vegetation mapping

Plant community type	Moama Solar Farm (ha)	Preferred access option (ha)	Alternate access option (ha)
Non-native and cleared	76.5	0	1
PCT 13 Black Box Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly in the Riverina Bioregion and Murray Darling Depression Bioregion)	4.6	0	0
PCT 44 Forb-rich Speargrass – Windmill Grass – White Top grassland of the Riverina Bioregion	0	0.8	0
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	0	0	0

Table 3.3 Vegetation extent from ground-truthed vegetation mapping

Plant community type	Moama Solar Farm (ha)	Preferred access option (ha)	Alternate access option (ha)
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions (Derived Native Grassland)	0	0	0.1
Total (ha)	81.2	0.8	1.1

A description of non-native vegetation and PCTs recorded in the project area is provided in the following sections. Vegetation mapping is shown on Figure 3.1.

i Non-native vegetation

Non-native vegetation in the project area comprises recently cropped Common Wheat (*Triticum aestivum*) (Photograph 3.1). The ground in these areas has been extensively ripped and no longer supports native vegetation communities. Four isolated Western Grey Box (*Eucalyptus microcarpa*)occur within areas of non-native vegetation, none of which contained hollows.

Photograph 3.1 Non-native vegetation

ii Cleared land

Cleared land comprises previously cleared access tracks and ploughed paddocks that do not contain any native vegetation. Cleared land occurs in the alternate access option.

iii Black Box Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly in the Riverina Bioregion and Murray Darling Depression Bioregion)

Black Box Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly in the Riverina Bioregion and Murray Darling Depression Bioregion) (PCT 13) (Photograph 3.2) is present within the proposed Moama Solar Farm. The community exists as windrows on the northern and eastern borders, connected by a north-south running windrow, as well as small areas of derived native grassland where trees have been previously removed, but a native and representative understorey remains. It is located in depressions.

The canopy comprises Black Box (*Eucalyptus largiflorens*) trees with a sparse understorey dominated by Lignum (*Duma florulenta*) and chenopods Creeping Saltbush (*Atriplex semibaccata*), Black Cottonbush (*Maireana decalvans*), Black Rolypoly (*Sclerolaena muricata*) and Spiny Saltbush (*Rhagodia spinescens*).

PCT 13 does not represent any threatened ecological community listed under the BC Act or EPBC Act known or predicted to occur in the locality.

Photograph 3.2 **Black Box Lignum woodland wetland of the inner floodplains in the semi arid (warm) climate zone (mainly in the Riverina Bioregion and Murray Darling Depression Bioregion)**

iv Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions

Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions (PCT 76) is present in the alternate access (Photograph 3.3). It comprises a tall woodland with Western Grey Box as the dominant canopy species. An understorey of native grasses and a few forbs are present, comprising Speargrass (*Austrostipa setacea*), Windmill Grass (*Chloris truncata*), Cotton Panic Grass (*Digitaria brownii*), Wheat Grass (*Anthosachne setacea*), Redleg Grass (*Bothriochloa macra*), Corrugated Sida (*Sida corrugata*) and the threatened Turnip Copperburr. The community occurs as a woodland and derived native grassland (ie where trees have been previously removed, however a native and representative understorey remains.

The woodland and derived native grassland forms of this vegetation community represents Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions listed as an endangered ecological community (EEC) under the BC Act. Both the woodland and derived native grassland satisfies the listing criteria in the final determination for the community (NSWSC 2011), as it is located in the Riverina bioregion, the canopy is dominated by Grey Box and it has a variable ground layer of grass and herbaceous species. The derived native grassland variant shares similar understorey species to the woodland form, however canopy trees have been removed.

The woodland form also represents Grey Box Grassy Woodlands and Derived Native Grassland of South-eastern Australia, listed as an EEC under the EPBC Act, satisfying criterion 1 of the condition thresholds in the Commonwealth listing advice (TSSC 2010). The derived native grasslands satisfy criterion 5a of the condition thresholds in the Commonwealth listing advice (TSSC 2010) as it is a derived native grassland with clear evidence that the site was formerly a woodland with a tree canopy dominated by Inland Grey Box and at least 50% of the vegetative cover in the ground layer is made up of perennial native species at any time of year; although only nine native groundcover species were recorded, it is reasonable to assume that during more favourable conditions, following wet weather, the understorey would contain 12 native understorey species. Potential impacts on this listed community and mitigation measures are provided in Chapter 4.

Photograph 3.3 **Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions**

v Forb-rich Speargrass – Windmill Grass – White Top grassland of the Riverina Bioregion

Forb-rich Speargrass – Windmill Grass – White Top grassland of the Riverina Bioregion (PCT 44) is present in the preferred access (Photograph 3.4). It comprises tall grassland with a variety of grasses, chenopods and forbs. These include Speargrass, Native Millet (*Panicum decompositum*), Wallaby Grass (*Rytidosperma duttonianum*), Cotton Panic Grass, Black Cottonbush, Spiny Saltbush, Woolly New Holland Daisy (*Vittadinia gracilis*), Billy Buttons (*Craspedia variabilis*), *Wurmbea dioica* and the threatened Turnip Copperburr.

PCT 44 represents Natural Grasslands of the Murray Valley Plains, listed as a critically endangered ecological community (CEEC) under the EPBC Act. The Commonwealth listing advice (TSSC 2012) recognises that PCT 44 represents the EPBC Act listed community.

Photograph 3.4 **Forb-rich Speargrass – Windmill Grass – White Top grassland of the Riverina Bioregions**

Source: EMM (2018); DFSI (2018)

0 100 200 m
GDA 1994 MGA Zone 55

KEY

- Moama Solar Farm
- Access option - preferred
- Access option - alternate

Plant community type

- Cleared
- Non-native
- Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions
- Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions - Derived Native Grassland
- Black Box Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
- Black Box Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) Derived Native Grassland
- Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
- Turnip Copperburr

Results: vegetation survey

Moama solar farm

Statement of environmental effects

Biodiversity assessment

Figure 3.1

EMM

\\emmsvr1\EMM\Jobs\2017\J17266 - Corowa and Moama Solar Farm biodiversity and heritage assessments\GIS\02 Maps\M003_VegToBeCleared_20180219_04.mxd 19/02/2018

3.3 Threatened species

3.3.1 Fauna habitats in the project area

Fauna habitat is limited across much of the project area, as native vegetation has been largely removed and replaced with cropped and cleared land. However, some habitat features remain, comprising woodland that may provide foraging and nesting habitat for woodland birds. No nests were observed in this area. No hollow trees were observed in the project area, and therefore hollow-dependent fauna would not occur.

3.3.2 Threatened species previously recorded within 10 km of the project area

Eleven threatened species listed under the BC Act and/or EPBC Act have previously been recorded within 10 km of the project area (Figure 3.2), comprising:

- threatened flora: Turnip Copperburr, Slender Darling Pea (*Swainsona plagiotropis*), *Pterostylis despectans* and *Prasophyllum sp.* Moama
- threatened birds: Brown Treecreeper (eastern subspecies, *Climacteris picumnus victoriae),* Bush Stone-curlew (*Burhinus grallarius*), Diamond Firetail (*Stictonetta naevosa*), Grey-crowned Babbler (*Pomatostomus temporalis temporalis*), Little Lorikeet (*Glossopsitta pusilla*) and Superb Parrot (*Polytelis swainsonii*); and
- threatened frog: Sloane's Froglet (*Crinia sloanei*).

In addition, the protected matters search (Appendix B) predicted that three threatened flora and 17 threatened fauna species may occur in the locality.

The likelihood that these species would occur in the project area is assessed in Table 3.3.

3.3.3 Threatened species likelihood of occurrence

The likelihood that threatened species previously recorded within 10 km of the project area (Section 3.3.1) may occur in the project area is assessed in Table 3.3.

One threatened flora species, Turnip Copperburr, was recorded during the survey. Given the presence of potentially suitable habitat and previous records in the locality, there is a moderate potential for *Prasophyllum sp.* Moama to occur in the preferred access route and for threatened woodland birds including the Diamond Firetail, Little Lorikeet, Superb Parrot and Swift Parrot to forage in the Western Grey Box Woodland These species are unlikely to breed as no nests or hollow-bearing trees were observed.

Potential impacts on these species and mitigation measures are provided in Chapter 4.

Table 3.4 Likelihood of occurrence for threatened species in the project area

Name	BC Act status	EPBC Act status	Habitat	Likelihood of occurrence
Flora				
Prasophyllum sp. Moama	CE	-	Forb-rich natural grasslands on flat alluvial plains with red clay loam soils. Only one population is known in NSW, north of Moama.	Moderate potential to occur in the preferred access, determined by expert report in Appendix D.
Turnip Copperburr *Sclerolaena napiformis*	E	E	Grows on light clay soils in grassland habitats.	Recorded in the preferred access and adjacent to the alternate access.
Pterostylis despectans	CE	E	Forb-rich natural grasslands on flat alluvial plains with red clay loam soils.	Moderate potential to occur in the preferred access.
River Swamp Wallaby Grass *Amphibromus fluitans*	V	V	Permanent swamps.	None. Suitable habitat is absent from the project area.
Slender Darling Pea *Swainsona murrayana*	V	V	Grows on clay-based soils in bladder saltbush, Black Box Woodland and grassland communities	Low. Targeted surveys in potentially suitable habitat failed to detect the species.
Birds				
Australian Painted Snipe *Rostratula australis*	E	E	Inhabit shallow terrestrial freshwater. They prefer the fringes of swamps, dams and nearby marshy areas, with covers of grasses, lignum, low scrub or open timber. Ground nests among tall vegetation, such as grasses or reeds.	None. Suitable habitat is absent.
Australasian Bittern *Botaurus poiciloptilus*	E	E	Favours permanent freshwater wetlands, with tall dense vegetation, particularly bullrushes (*Typha* sp) and spikerushes (*Eleacharis* sp). Nesting occurs in secluded areas with densely vegetated wetlands.	None. Suitable habitat is absent.
Brown Treecreeper *Climacteris picumnus victoriae*	V	-	Occurs in eucalypt woodlands of the Great Dividing Range dominated by Stringybarks, rough-barked Eucalypt and River Red Gum.	Low. While potentially suitable habitat is present in woodlands of the project area, this species was not recorded during targeted surveys. The Brown Treecreeper is a highly sedentary species and is likely to have been detected if present.
Bush Stone-curlew *Burhinus grallarius*	E	-	Open forests and woodlands with a grassy groundcover and fallen timber.	Low. Although open woodlands with a grassy groundcover are present in the access route, fallen timber is absent from this area.
Curlew Sandpiper *Callidris ferruginea*	E	CE	Occupies littoral and estuarine habitats. In NSW they generally occur in intertidal mudflats of sheltered coasts in non-tidal	None. Suitable habitat is absent.

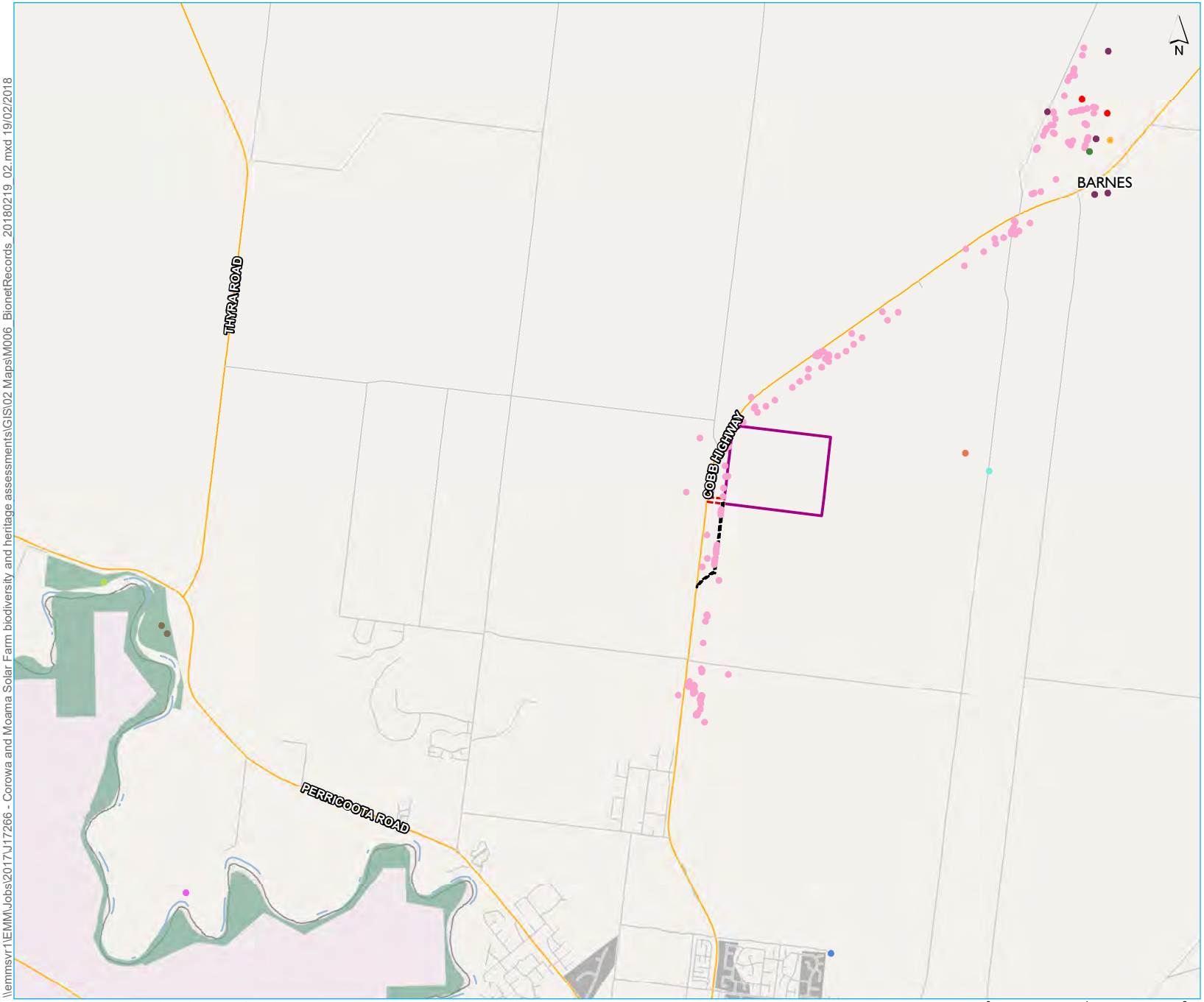
Table 3.4 Likelihood of occurrence for threatened species in the project area

Name	BC Act status	EPBC Act status	Habitat	Likelihood of occurrence
			swamps, lakes and lagoons.	
Diamond Firetail *Stagnopleura guttata*	V	-	Found in grassy eucalypt woodlands including Box Gum and Snow Gum, Natural Temperate Forest as well as riparian areas.	Moderate potential to forage in Western Grey Box Woodland. Not recorded during targeted surveys.
Eastern Curlew *Numenius minutus*	-	CE	Australia's largest shorebird and long-haul flyer. Take annual migratory flights to Russia and north-eastern China for breeding and arrive back on the shores of Australia in August to feed.	None. Suitable habitat is absent.
Grey-crowned Babbler *Pomatostomus temporalis temporalis*	V	-	Woodlands and Box-Cypress Pine and open Box Woodlands on alluvial plans.	Low. Although potentially suitable habitat is present in Western Grey Box Woodland, no individuals were detected during targeted surveys. This species is highly sedentary and would have been detected if present.
Little Lorikeet *Glossopsitta pusilla*	V	-	Occurs in eucalypt woodlands, roadside remnants and paddock trees. Favours riparian habitats.	Moderate potential to forage in Western Grey Box Woodland. However, no suitable nesting sites are present and the species was not recorded during targeted surveys.
Painted Honeyeater *Grantiella picta*	-	V	Boree/Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) Box-Gum Woodlands and Box-Ironbark Forest where it forages on mistletoe.	None. Suitable habitat is absent.
Plains Wanderer *Pedionomus torquatus*	E	CE	Semi-arid lowland grasslands on red clay soil. Require low grassland (approx 5 cm height) with approximately 50% bare ground and 50% grassland vegetation.	Low. Although grassland is present in the preferred access route, it is unsuitable as it is very dense and tall, with few bare patches.
Superb Parrot *Polytelis swainsonii*	V	V	Box Gum, Box-Cypress Pine, Boree Woodlands and River Red Gum Forests. In the Riverina, the species nests in the hollows of large trees in River Red Gum Forest.	Moderate potential to forage in Western Grey Box Woodland. However, no suitable nesting sites are present and the species was not recorded during targeted surveys.
Swift Parrot *Lathamus discolor*	E	CE	Found in areas where eucalypts are flowering or where there is an abundant lerp infestation. Favoured feed trees include Western Grey Box. Migrate to the Australian south-east mainland between March and October.	Moderate potential to forage in Western Grey Box Woodland. However, the species was not recorded during targeted surveys.
Mammals				
Corben's Long-eared Bat *Nyctophilus corbeni*	V	V	Most common in box, ironbark and cypress pine woodland on the western slopes and plains. They	Low. While the species may overfly the project area, and may forage in woodland areas, hollow-bearing

Table 3.4 Likelihood of occurrence for threatened species in the project area

Name	BC Act status	EPBC Act status	Habitat	Likelihood of occurrence
			roost in tree hollows, crevices and under loose bark.	trees were absent from woodlands.
Koala *Phascolarctos cinereus*	V	V	Inhabits eucalypt forest and woodlands.	None. The species is not known to occur in the area and suitable habitat is absent.
Grey-headed Flying Fox *Pteropus poliocephalus*	V	V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, as well as urban gardens and cultivated fruit crops.	None. The species is not known to occur in the area and suitable habitat is absent.
Reptiles				
Striped Legless Lizard *Delma impar*	V	V	Found in grasslands dominated by perennial, tussock-forming grasses such as Kangaroo Grass, spear-grasses (*Austrostipa* sp) and poa tussocks (*Poa* sp).	Low. Although potentially suitable habitat is present in the preferred access, the species is not known from the locality and the project area is well outside the species known distribution.
Frogs				
Sloane's Froglet *Crinia sloanei*	V	-	Periodically inundated grassland, woodland and disturbed habitats.	Low. Although a shallow depression is present, it did not contain any water during the survey and is considered unlikely to contain water often given its shallow depth and distance from the river (over 6km).
Southern Bell Frog *Litoria raniformis*	E	V	Permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys.	None. Suitable habitat is absent.
Fish				
Flathead Galaxias *Galaxias rostratus*	-	E	Slow flowing streams in the Lachlan, Murray and Murrumbidgee Catchments.	None. Suitable habitat is absent.
Murray Cod *Maccullochella peellii*	-	V	Clear rocky streams of the upper western slopes of NSW (including ACT), to slow flowing, turbid lowland rivers and billabongs.	None. Suitable habitat is absent.
Murray Hardyhead *Craterocephalus fluviatilis*	-	E	Murray River and saline lakes.	None. Suitable habitat is absent.
Macquarie Perch *Macquaria australasica*	-	E	Riverine, schooling species. Prefers clear water and deep, rocky holes with lots of cover such as large boulders, debris and overhanging banks. Spawning occurs just above shallow running water.	None. Suitable habitat is absent.

Notes: 1.V – vulnerable, E – endangered, CE – critically endangered



KEY

ATLAS bionet results

- Brown Treecreeper (eastern subspecies)
- Bush Stone-curlew
- Diamond Firetail
- Grey-crowned Babbler (eastern subspecies)
- Little Lorikeet
- Prasophyllum sp. Moama
- Pterostylis despectans
- Slender Darling Pea
- Sloane's Froglet
- Superb Parrot
- Turnip Copperburr
- Moama Solar Farm
- Access option - preferred
- Access option - alternate
- River
- Main road
- Local road
- NPWS reserve
- Built up area
- New South Wales
- Victoria

Source: EMM (2017); DFSI (2017); DELWP (2001)

\\emmsvr1\EMM\Jobs\2017\J17266 - Corowa and Moama Solar Farm biodiversity and heritage assessments\GIS\02 Maps\M006_BionetRecords_20180219_02.mxd 19/02/2018

Bionet records within 10km of the project area

Moama solar farm

Statement of environmental effects

Biodiversity assessment

Figure 3.2

EMM

4 Avoidance, minimisation, mitigation and residual impacts

4.1 Avoidance, minimisation and mitigation

Biodiversity constraints have been identified within the project area such that impacts would be avoided and/or minimised by the design. Direct biodiversity impacts have been largely avoided and minimised by locating the project in cleared areas.

Project activities with potential to impact biodiversity comprise the clearing of woodlands, native paddock trees in the project area and possible clearing for site access. Impacts are anticipated to be restricted to the construction phase, with no operational impacts expected.

Direct biodiversity impacts would be further avoided and/or minimised through implementation of the following measures:

- committing to no significant impact on *Prasophyllum sp.* Moama and *Pterostylis despectans*. The following process would be followed:
    - undertake a targeted pre-clearance survey for *Prasophyllum sp.* Moama in the preferred access route during the species optimal flowering season (September 2018);
    - undertake a targeted pre-clearance survey for *Pterostylis despectans* in the preferred access route during the species optimal flowering season (October to November 2018);
    - if the species are not recorded, the preferred access would be constructed;
    - if the species are recorded, evaluate if the 10 m wide construction zone impact for the access road can be constructed within the 50 m wide area surveyed as part of the biodiversity assessment without significant impact. If this is possible, the preferred access would be constructed; and
    - if the species are recorded and significant impacts cannot be avoided, the alternate access would be constructed.
- avoidance of clearing the two Turnip Copperburr plants in the preferred access (Figure 3.1) (should it be constructed);
- retention of Black Box Woodland on the northern and eastern boundaries of Moama Solar Farm; and
- if feasible, minimising the impact on the Western Grey Box Woodland to the lopping of branches overhanging the existing cleared track, should the alternate access be constructed.

Indirect biodiversity impacts would be mitigated through implementation of the following measures:

- development of a sediment and erosion control plan for implementation prior to and during construction of the project; and
- selection of a native or non-invasive cover crop (eg Wallaby Grass (*Rytidosperma duttonianum*), Native Millet (*Panicum decompositum*) and Wheat Grass (*Anthosachne scabra*)) for the Moama Solar Farm to minimise the potential for weed invasion into retained woodlands in the project area.

It is recommended that the above biodiversity management measures are incorporated into the Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan for the project.

4.2 Residual impacts

Direct and indirect impacts of the project are assessed in the following sections.

4.2.1 Direct impacts

Following the implementation of avoidance and minimisation measures (Section 4.1), the project would result in the direct residual impacts shown in Table 4.1. It should be noted that not all vegetation in the project area would be cleared. The patches of PCT 13 on the northern and eastern boundaries of Moama Solar Farm would be retained, and only a 10 m wide access of the 50 m wide area surveyed for the preferred access would be impacted (should the preferred option be constructed).

Table 4.1 Direct impacts

Plant community type	Moama Solar Farm (ha)	Preferred access option (ha)	Alternate access option (ha)
Non-native and cleared	76.5	0	1
PCT 13 Black Box Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly in the Riverina Bioregion and Murray Darling Depression Bioregion)	2.2	0	0
PCT 44 Forb-rich Speargrass – Windmill Grass – White Top grassland of the Riverina Bioregion	0	0.2	0
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	0	0	0
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions (Derived Native Grassland)	0	0	0.1
Total (ha)	78.7	0.2	1.1

4.2.2 Indirect impacts

No residual indirect impacts are expected following the implementation of mitigation measures (Section 4.1).

4.2.3 Impacts on threatened ecological communities

Threatened ecological communities are absent from Moama Solar Farm, and therefore would not be impacted. Both access options would have minor impacts on threatened ecological communities, comprising:

- removal of 0.2 ha of Natural Grasslands of the Murray Valley Plains listed under the EPBC Act for the preferred access; OR
- removal of 0.1 ha of Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions listed under the BC Act/ Grey Box Grassy Woodlands and Derived Native Grassland of South-eastern Australia for the alternate access.

An assessment of significance has been completed in accordance with Section 5A of the EP&A Act and significant impact criteria assessment in accordance with the EPBC Act Policy Statement 1.1 (DoE 2013) to assess the impact of vegetation removal on the above listed communities (Appendix C). The assessments concluded that the project would not result in significant impacts on the listed communities given the minor scale of disturbance.

4.2.4 Impacts on threatened species habitat

There is a moderate potential for *Prasophyllum sp.* Moama and *Pterostylis despectans* to occur in the preferred access. The removal of individuals from a population of *Prasophyllum sp.* Moama or *Pterostylis despectans* (if present) would likely be significant given that only one population of each species is known from north of Moama. Accordingly, the proponent has committed to no significant impact on the species by following the procedure outlined in Section 4.1. In addition, should the preferred access be constructed, impacts on the two Turnip Copperburr plants (Figure 3.1) would also be avoided. As impacts will be avoided, no further assessment has been conducted for these flora species.

There is a moderate potential for threatened woodland birds including the Diamond Firetail, Little Lorikeet, Superb Parrot and Swift Parrot to forage in the Western Grey Box Woodland in the alternate access. These species are unlikely to breed as no nests or hollow-bearing trees were observed. If constructed, the alternate access would remove 0.1 ha of potential foraging habitat for the above species.

Assessments of significance were completed for the above species in accordance with Section 5A of the EP&A Act for species listed under the BC Act and significant impact criteria assessment in accordance with the EPBC Act Policy Statement 1.1 (DoE 2013) for species listed under the EPBC Act. The assessment concluded that the alternate access would not result in significant impacts on the threatened species given the removal of an area that only represents potential foraging habitat and the minor scale of disturbance.

5 Conclusions

This biodiversity assessment has been completed to assess potential impacts of the project on species and communities listed under the BC Act and EPBC Act.

An ecological community listed under the EPBC Act, namely Natural Grasslands of the Murray Valley Plains occurs in the preferred access. An ecological community listed under the BC Act and EPBC Act, namely Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions listed under the BC Act and EPBC Act occurs in the alternate access. The project will result in only minor disturbance to these communities.

There is a moderate potential for *Prasophyllum sp.* Moama and *Pterostylis despectans* to occur in the preferred access, and two individuals of the Turnip Copperburr were recorded within the 50 m wide area surveyed. Impacts on these species will be avoided should the preferred access be constructed, and have therefore not been assessed further. The Diamond Firetail, Little Lorikeet, Superb Parrot and Swift Parrot were considered moderate likely to forage in the Western Grey Box Woodland in the alternate access.

Project activities with potential to impact biodiversity comprise the removal of four paddock trees, 2.2 ha of PCT 13 (a non-threatened ecological community) in Moama Solar Farm and small-scale vegetation removal for site access. Impacts are anticipated to be restricted to the construction phase, with no operational impacts expected.

Measures have been implemented to avoid and minimise direct and indirect biodiversity impacts. Following the implementation of avoidance and minimisation measures, the project would result in the following direct residual impacts:

- removal of 76.5 ha of non-native vegetation, four paddock trees and 2.2 ha of PCT 13 for Moama Solar Farm; and
- removal of 0.2 ha of PCT 44 (representing a listed community under the EPBC Act) for the preferred access; OR;
- removal of 1 ha of cleared and non-native vegetation and a maximum of 0.1 ha of PCT 76 (representing a listed community under the BC Act and EPBC Act) for the alternate access.

No indirect residual impacts are predicted.

Assessments of significance were completed in accordance with Section 5A of the EP&A Act and EPBC Act Policy Statement 1.1 (DoE 2013) for the listed community and species. The assessments concluded that the project would not result in significant impacts on these listed communities and species.

References

Baker-Gabb D 2011, *National Recovery Plan for the Superb Parrot,* viewed February 2018 from http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-superb-parrot-polytelis-swainsonii

DEWHA 2010a, *Survey guidelines for Australia's threatened birds,* Department of the Environment, Water, Heritage and the Arts, Canberra.

DoE 2013, EPBC Act Policy Statement 1.1, Department of the Environment, Canberra.

DoEE 2017a, Australia's Bioregons, Australian Government, Department of the Environment and Energy, viewed December 2017 http://www.environment.gov.au/land/nrs/science/ibra,.

DoEE 2017b, Protected Matters Search Tool, Australian Government, Department of the Environment and Energy, viewed December 2017http://www.environment.gov.au/epbc/protected-matters-search-tool.

NSWSC 2011, Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions, endangered ecological community listing, New South Wales Scientific Committee, viewed Feburary 2017, http://www.environment.nsw.gov.au/determinations/EucalyptusMicrocarpaEndCom.htm.

OEH 2011, *Mitchell Landscapes NSW* v3 map*,* NSW Office of Environment and Heritage, Sydney, viewed February 2018.

OEH 2016a, *State Vegetation Type Map: Riverina Region Version 1.2 - VIS ID 4469,* NSW Office of Environment and Heritage, Sydney, viewed February 2018.

OEH 2016b, *NSW Guide to Surveying Threatened Plants,* NSW Office of Environment and Heritage, Sydney

OEH 2017a, Biodiversity Assessment Method, NSW Office of the Environment and Heritage, Sydney South, NSW.

OEH 2017b BioNet, NSW Office of the Environment and Heritage, http://www.bionet.nsw.gov.au/, viewed December 2017.

Threatened Species Scientific Committeee (TSSC) 2012, Commonwealth listing advice on Natural Grasslands of the Murray Valley Plains, Threatened Species Scientific Committee, viewed February 2018, http://www.environment.gov.au/biodiversity/threatened/communities/pubs/117-listing-advice.pdf

TSSC 2010, Commonwealth listing advice on Grey Box Grassy Woodlands and Derived Native Grassland of South-eastern Australia, Threatened Species Scientific Committee, viewed February 2018 http://www.environment.gov.au/biodiversity/threatened/communities/pubs/86-listingadvice.pdf.

Appendix A

Plot data

Table 5.1 Plot data

				Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6	
Scientific name	**Common name**	**Growth Form**	**N, E or HTE**	**Cover**	**Abundance**	**Cover**	**Abundance**	**Cover**	**Abundance**	**Cover**	**Abundance**	**Cover**	**Abundance**	**Cover**	**Abundance**
Calotis scapigera	Tufted Burr-daisy	Forb	N					1	5						
Craspedia variabilis	Common Bilby Buttons	Forb	N							5	10				
Leiocarpa panaetioides	Woolly Buttons	Forb	N	0.5	10										
Sonchus asper	Prickly Sowthistle		E					0.5	1						
Vittadinia gracilis	Woolly New Holland Daisy	Forb	N					1	2	15	70				
Lepidium africanum	African Peppercress		E									0.5	1	0.5	3
Atriplex semibaccata	Creeping Saltbush	Forb	N	10	30			1	5						
Maireana decalvans	Black Cottonbush	Forb	N	15	80					1	5				
Rhagodia spinescens	Spiny Saltbush	Forb	N							1	3	0.5	2	1	5
Sclerolaena muricata	Black Rolypoly	Chenopod	N	1	10										
Sclerolaena napiformis	Turnip Copperburr	Chenopod	N							0.5	2				
Wurmbea dioica	Early Nancy	Forb	N							0.5	5				
Convolvulus angustissimus		Vine	N	0.5	3										
Trifolium angustifolium	Narrow-leaved Clover		E							1	5			1	5
Juncus sp.	-	Rush	N	1	1			1	2						
Duma florulenta	Lignum	Shrub	N	20	30			5	3						
Sida corrugata	Corrugated Sida	Forb	N									1	5	1	10
Eucalyptus largiflorens	Black Box	Tree	N	25	29			1	1						
Austrostipa densiflora	-	Tussock Grass	N					40	300						
Austrostipa setacea	Speargrass	Tussock Grass	N							5	10	20	100	30	200
Avena barbata	Bearded Oats		E					10	50	10	100	30	300	30	500
Chloris truncata	Windmill Grass	Tussock Grass	N					5	20			30	300	25	100
Panicum decompositum	Native Millet	Tussock Grass	N							5	5				
Lolium rigidum	Wimmera Ryegrass		E	5	100			5	50	10	100	5	50	20	200
Rytidosperma duttonianum	Wallaby Grass	Tussock Grass	N	40	100			15	20	45	500				
Triticum aestivum	Common Wheat		E			80	2000								

Table 5.1 Plot data

			Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6	
Scientific name	**Common name**	**Growth Form N, E or HTE**	**Cover**	**Abundance**	**Cover**	**Abundance**	**Cover**	**Abundance**	**Cover**	**Abundance**	**Cover**	**Abundance**	**Cover**	**Abundance**
Digitaria brownii	Cotton Panic Grass	Tussock Grass N							20	500	20	500	25	500
Anthosachne scabra	Wheat Grass	Tussock Grass N									15	100	5	50
Rytidosperma sp.	A Wallaby Grass	Tussock Grass N									30	100	20	200
Botriochloa macra	Redleg Grass	Tussock Grass N									1	5		

Notes 1. N – native, E – exotic, HTE – high threat weed

Appendix B

PMST results

Appendix C

Assessments of significance

C.1 BC Act assessments of significance

Assessments of significance in accordance with Section 5A of the EP&A Act are provided in the following sections for species and communities listed under the BC Act. Where species and communities occupy the same habitats, they have been grouped.

C.1.1 Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain Nandewar and Brigalow Belt South Bioregion and woodland birds (Diamond Firetail, Little Lorikeet, Superb Parrot and Swift Parrot)

N.B. This assessment of significance is relevant to the removal of native vegetation and fauna habitat in the alternate access, should it be constructed.

a) in the case of a threatened species, whether the action proposed 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;

Breeding habitat for threatened woodland birds is absent from the alternate access as large and/or hollow-bearing trees are absent. Therefore, only potential foraging habitat would be impacted. Accordingly, the action proposed would not adversely affect the life cycle of woodland bird species such that viable local populations of the species are placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i) 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, or

ii) 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.

Impacts on the listed community are restricted that required for the alternate access, should it be constructed. Approximately 0.1 ha of the listed community would be cleared, compared with a local occurrence of 3,189 ha within a 10 km buffer of the site according to *State Vegetation Type Map: Riverina Region Version 1.2 - VIS ID 4469* (OEH 2016a) (areas for PCT 76 and 237 combined, within a 10 km radius of the site). Accordingly, the project is unlikely to have an adverse effect on the listed community's local extent or substantially and adversely modify its composition.

d) in relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

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, population or ecological community in the locality.

Impacts on the listed community and threatened woodland habitat are restricted that required for the alternate access, should it be constructed. Approximately 0.2 ha of the listed community and species habitat will be cleared. Given the small scale of disturbance, fragmentation of existing patches will not occur and the small area to be removed is not important to the survival of the community or the species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

Critical habitat has not been declared for the community or species.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

Recovery and threat abatement plans for the listed community and species focus on their conservation and management. As the area of impact is very small (0.1 ha) when compared with the local occurrence, the project does not interfere with their recovery.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Thirty eight key threatening processes (KTPs) are listed under the BC Act. The action proposed does not represent any key threatening process or increase the impact of a key threatening process.

Conclusion: The project would not result in significant impacts on the listed community or species as only a small area (0.1 ha) would be disturbed for the alternate access compared with the local occurrence, if constructed.

C.2 EPBC Act assessments of significance

Assessments of significance in accordance with EPBC Act Policy Statement 1.1 (DoE 2013) are provided in the following sections for communities listed under the EPBC Act.

C.2.1 Natural Grasslands of the Murray Valley Plains

N.B. This assessment of significance is relevant to the removal of native vegetation in the preferred access, should it be constructed.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- reduce the extent of an ecological community;

Impacts on the listed community are restricted to the clearing of 0.2 ha for the preferred access, should it be constructed. A large and continuous patch of this ecological community (2,851 ha) occurs in a travelling stock reserve that extends far south and north of the site. Accordingly, the removal of this small area would not reduce the extent of the ecological community, if the preferred access is constructed.

- fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;

Impacts on the listed community are restricted to the clearing of 0.2 ha for the preferred access, if constructed. The preferred access comprises an access track with a maximum width of 10 m. Pollination of grasses and forbs would still be possible across this short distance. Accordingly, the project would not fragment the ecological community.

- adversely affect habitat critical to the survival of an ecological community;

Habitat critical to the survival of the community has not been specifically identified, as it does not have a recovery plan. As only 0.2 ha of the community would be removed in a large, contiguous patch that extends far north and south of the site, if critical habitat was present, it would not be adversely affected by the project.

- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;

Creation of the new access would disturb soil and the soil seedbank in 0.2 ha of the listed community's groundcover. This would prevent the community from re-establishing in this small area in the future.

- cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;

Creation of the new access will disturb soil and the soil seedbank in 0.2 ha of the listed community's groundcover. The disturbance of this small area would not cause a substantial change in species composition of the adjacent retained patches of the listed community.

- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

    - assisting invasive species, that are harmful to the listed ecological community, to become established; or

    - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or

Given the listed community's location in a linear travelling stock reserve, it is already subject to weed invasion, particularly from Bearded Oats. Soil disturbance for the project is not expected to increase weed invasion levels from existing levels.

- interfere with the recovery of an ecological community.

The proposed action would not interfere with the recovery of the ecological community as only a small area (0.2 ha) would be impacted for the preferred access (if constructed), while the remaining area of the community in the travelling stock reserve would remain intact.

Conclusion:

The project would not result in significant impacts on the listed community as only 0.2 ha would be removed, while the remaining grassland in the travelling stock reserve that extends far north and south of the site (ie 2,851 ha) would remain intact.

C.2.2 Swift Parrot

N.B. This assessment of significance is relevant to the removal of potential fauna habitat in the alternate access, should it be constructed.

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:

- lead to a long-term decrease in the size of a population;

The clearing of 0.2 ha of potential foraging habitat would not lead to a long-term decrease in the size of the population.

- reduce the area of occupancy of the species;

The clearing of 0.1 ha of potential foraging habitat would reduce the species area of occupancy.

- fragment an existing population into two or more populations;

The Swift Parrot occurs as a single population across its range. The removal of 0.1 ha of potential foraging habitat will not fragment the national population into two or more populations.

- adversely affect habitat critical to the survival of a species;

Critical habitat for the species comprises the species breeding habitat in Tasmania and key foraging areas identified in the National Recovery Plan for the Swift Parrot (Birds Australia 2011). Priority foraging areas that show high site fidelity have not been identified in NSW for the species. It has not been recorded in the locality, and therefore the potential habitat to be removed is unlikely to represent habitat critical to the survival of the species. In addition, the area to be removed is small, at 0.1 ha.

- disrupt the breeding cycle of a population;

The Swift Parrot breeds in Tasmania, and therefore the breeding cycle of the population will not be disrupted.

- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

Approximately 0.1 ha of potential Swift Parrot foraging habitat would be removed for the project. This would not decrease the availability or quality of habitat to the extent that the species would decline.

- result in invasive species that are harmful to a critically endangered or endangered species becoming established in their habitat;

Given the species habitat location adjacent to a road, it is already subject to weed invasion. Soil disturbance for the project is not expected to increase weed invasion levels from existing levels.

- introduce disease that may cause the species to decline; or

The Swift Parrot may be susceptible to Psittacine beak and feather disease (Birds Australia 2011). Disease outbreaks usually occur in wild animal populations where significant stresses arise. The clearance of potential habitat would not cause stress that would lead to a disease outbreak.

- interfere with the recovery of the species.

Recovery actions for the Swift Parrot focus on the species conservation and habitat management. The removal of 0.1 ha of potential habitat would not interfere with these recovery actions.

Conclusion: The project would not result in a significant impact on the Swift Parrot as the area to be removal only represents potential foraging habitat, and the scale of disturbance is small.

C.2.3 Superb Parrot

N.B. This assessment of significance is relevant to the removal of potential fauna habitat in the alternate access, should it be constructed.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of the species;

Important populations have not been defined in the recovery plan for the Superb Parrot (Baker-Gabb 2011). A single population of the species exists, and therefore the project cannot lead to the decrease of an important population.

- reduce the area of occupancy of an important population;

Important populations have not been defined in the recovery plan for the Superb Parrot (Baker-Gabb 2011). A single population of the species exists, and therefore the project cannot reduce the area of occupancy of an important population.

- fragment an existing important population into two or more populations;

Important populations have not been defined in the recovery plan for the Superb Parrot (Baker-Gabb 2011). A single population of the species exists, and therefore the project cannot fragment an important population.

- adversely affect habitat critical to the survival of the species;

Habitat critical to the survival of the species has been defined by the recovery plan (Baker-Gabb 2011) as breeding habitat that comprises riverine forests in the Riverina and Box Gum Woodlands on the tablelands and slopes and foraging habitat comprising Boree Woodlands between the Murrumbidgee and Murray Rivers, River Red Gum Forest, Box-Pine Woodland and White Cypress Pine Woodland. As breeding habitat is absent and only 0.1 ha of potential foraging habitat would be removed, the proposed action would not adversely affect habitat critical to the survival of the species.

- disrupt the breeding cycle of an important population;

Breeding habitat is absent from the area to be disturbed, and therefore the proposed action will not disrupt the breeding cycle of the population.

- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

Only 0.1 ha of potential Superb Parrot foraging habitat would be removed for the project. This would not decrease the availability or quality of habitat to the extent that the species would decline.

- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat;

Given the species habitat location adjacent to a road, it is already subject to weed invasion. Soil disturbance for the project is not expected to increase weed invasion levels from existing levels.

- introduce disease that may cause the species to decline; or

Superb Parrots may be susceptible to Beak and Feather disease. Disease outbreaks usually occur in wild animal populations where significant stresses arise. The clearance of potential habitat would not cause stress that would lead to a disease outbreak.

- interfere substantially with the recovery of the species.

Recovery actions for the Superb Parrot aim to determine population trends, increase knowledge of the species ecological requirements, develop and implement threat abatement strategies and increase community involvement and awareness of the recovery program (Baker-Gabb 2011). As recovery actions are focused on increasing knowledge of the species, the project will not interfere with recovery.

Conclusion: The project would not result in a significant impact on the Superb Parrot as the area to be removal only represents potential foraging habitat, and the scale of disturbance is small.

Appendix D

Expert report

Prasophyllum sp. 'Moama'

EXPERT REPORT

Prepared for Terrain Solar Pty. Ltd.

by C.C. Bower
Principal Consultant Ecologist

January 2018

FloraSearch

37 Kent Avenue, Orange, NSW 2800
PO Box 300, Orange, NSW 2800

Tel: 0263690252
Mob: 0428263274
E-mail: colbower@bigpond.net.au
ABN: 43060913622

INTRODUCTION

FloraSearch was commissioned by Terrain Solar Pty. Ltd. to prepare an Expert Report on the likelihood of the Critically Endangered and undescribed Leek Orchid, *Prasophyllum* sp. 'Moama', occurring on native grassland sites proposed for development at the Moama Solar Farm (MSF).

The proposed MSF is located approximately 6.5 km north of Moama Post Office on the eastern side of the Cobb Highway (Inset to Figure 1). The solar farm would be established in farm paddocks currently used for wheat cropping. The western boundary of the MSF adjoins a Travelling Stock Route (TSR) beside the Cobb Highway within which is a TransGrid high voltage overhead powerline in an easement parallel and close to the eastern boundary of the TSR (Figure 1).

The TSR adjacent to the MSF boundary comprises native grassland vegetation, identified by EMM Consulting (2017) as Plant Community Type 44, *Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion*, which is a known habitat of *Prasophyllum* sp. 'Moama' (NSW Scientific Committee, 2008).

Aims of this Report

This report aims to assess the likelihood that habitat suitable for *Prasophyllum* sp. 'Moama' occurs in the following locations:

- Potential access corridors between the Cobb Highway and the south-western corner of the proposed MSF (Figure 2), as follows;
    - Preferred access route (Figure 2), directly from the Cobb Highway to the south-west corner of the MSF.
    - Quarry access (Figure 2), along existing track from Cobb Highway onto existing powerline easement.
    - Milgate Road access (Figure 2), onto existing powerline easement from Milgate Road.
- Within grassland patches on a 2.5 km long MSF grid connection corridor that parallels the eastern boundary of the TSR between the south-western corner of the solar farm and the Essential Energy Moama electricity sub-station (Figure 1). The grid connection corridor may also serve as an access route to the MSF from the quarry track or Milgate Road.
- Within an area mapped as native grassland between the eastern and western wheat paddocks on the proposed MSF footprint (Figure 2).

Qualifications of Report Author

The relevant qualifications and experience of the author are given in Attachment 1. The author is a recognised expert on the native terrestrial orchids of NSW. He has conducted studies on terrestrial orchid pollination biology throughout south-eastern Australia and has published in national and international journals (Attachment 1). This included a detailed study of the pollination constraints on the Endangered Jervis Bay Leek Orchid, *Prasophyllum affine* (Attachment 1). The author is also highly experienced in biodiversity survey for environmental assessments (Attachment 1), has a Scientific Licence (SL100744), is an accredited BioBanking Assessor (No. 163) and is familiar with the role of Expert Reports in environmental assessment.

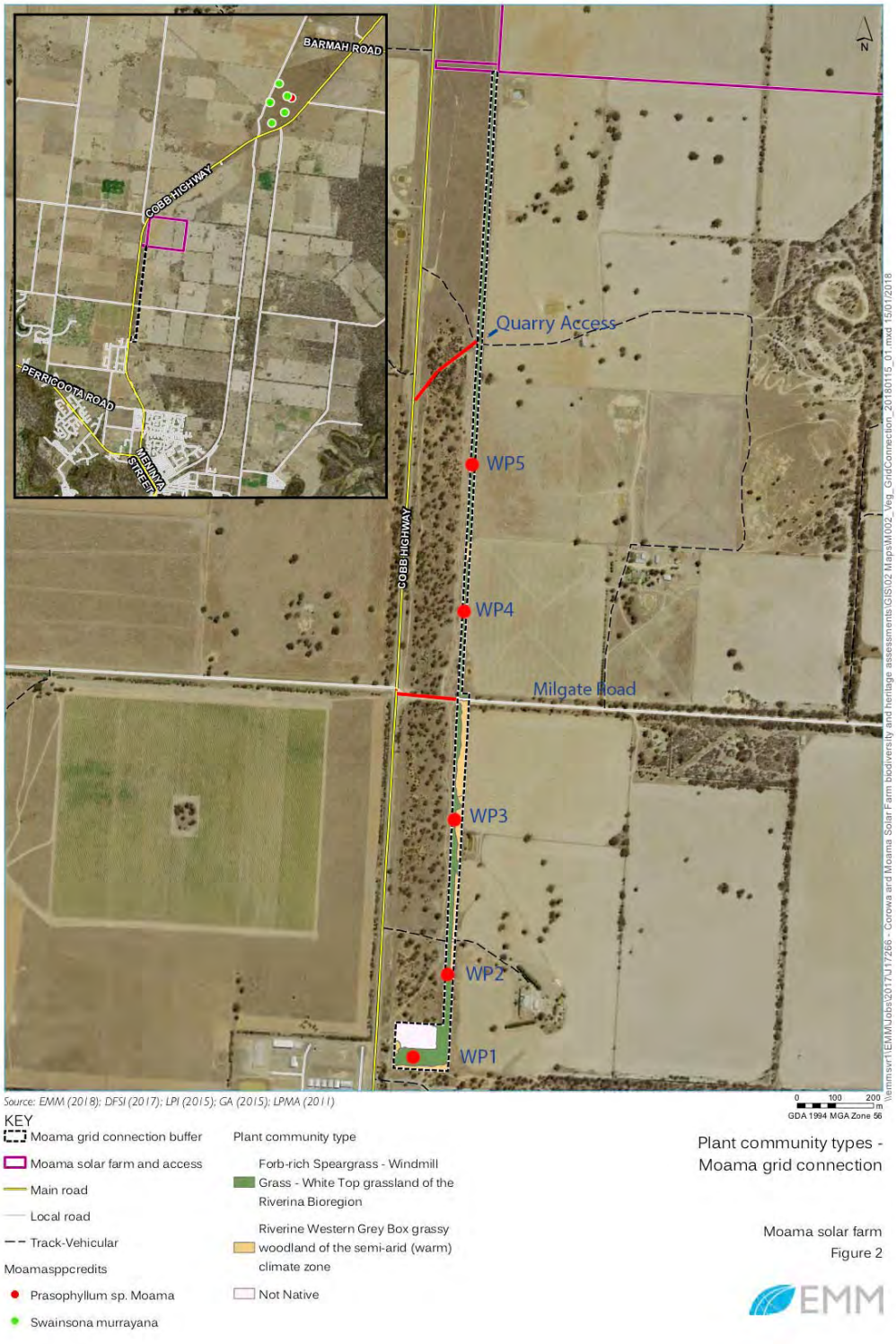


Figure 1. Locations of Moama Solar Farm (inset), Potential Access Routes and Sample Sites on Grid Connection / Access Route.

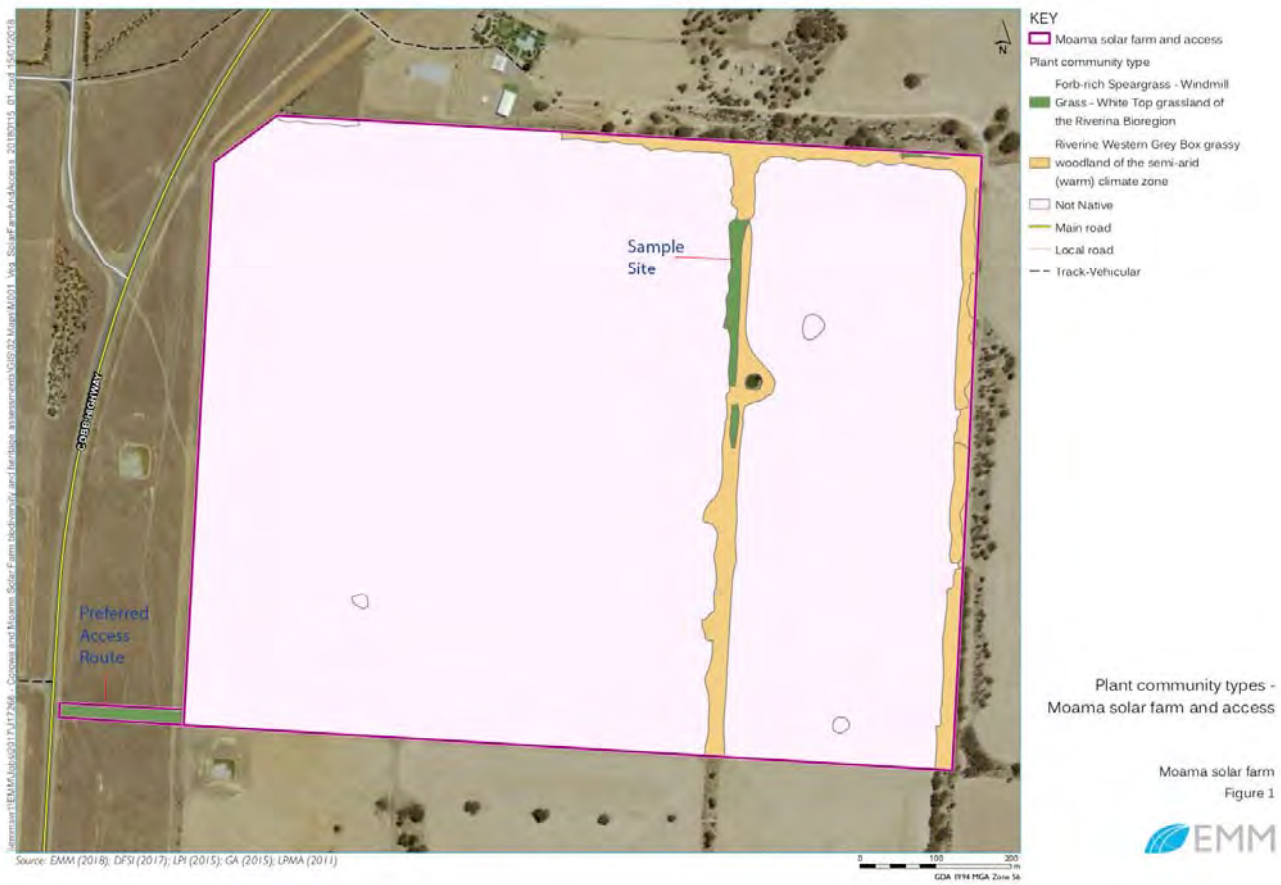


Figure 2. Moama Solar Farm showing areas of remnant native vegetation, grassland sample site and preferred access route.

Justification for Using an Expert Report

An expert report is required to assess the likelihood of occurrence of potential habitat for *Prasophyllum* sp. 'Moama' at the above three locations because:

- Targeted searches for threatened flora species on the MSF development footprint were not conducted at the optimum time (September-October) to detect flowering *Prasophyllum* sp. 'Moama'.

- Even if the searches were conducted at the most appropriate time, very dry seasonal conditions can result in poor flowering with the tubers of most individuals remaining dormant in the soil. That is, waiting to survey until next September may not definitively answer the question of presence or absence of the orchid if autumn and winter of 2018 are much drier than normal.

Habitat of *Prasophyllum* Sp. 'Moama'

Information on *Prasophyllum* sp. 'Moama' and its habitats is summarised in the Final Determination for listing the species as Critically Endangered in NSW (NSW Scientific Committee, 2008). The orchid is known from only one site in NSW, located about 4.5 km north east of the MSF. Accordingly, there is a high probability that it may once have occurred on or near the MSF if suitable habitat was present. The size of the known population has been estimated between several hundred and 10,000 plants depending on the observer and the season. The area of occupancy at Moama is approximately 20 ha. The species is also recorded from several locations in Victoria within 50 km of Echuca-Moama. In Victoria it is known as '*Prasophyllum sp. aff. suaveolens* Hunter' and is listed as Endangered on the Advisory List of Rare or Threatened Plants in Victoria under the name '*Prasophyllum aff. occidentale* D'.

All recorded locations of this species in NSW and Victoria are in similar high diversity natural forbland/grasslands. The habitat of the Moama population has been referred to as 'forb-rich grassland on flat alluvial plains'. There are no records associated with woodland or forest habitats. The soil at the Moama site is 'a reddish, probably calcareous clay-loam' (NSW Scientific Committee, 2008). The vegetation type is classified as Plant Community Type 44, *Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion* in the BioNet Vegetation Classification (OEH, 2018).

Habitat Relationships of Orchids

With few exceptions, native orchids are highly sensitive to changes in their habitats. For this reason, orchids are highly represented on lists of threatened species at the State and National levels. The underlying cause of the increasing rarity of orchids is likely to be disruption of the complex relationships they have with mycorrhizal fungi for seed germination and plant growth, and their often highly specific relationships with pollinators (Brundrett, 2007). Any disturbance of the environment that disfavours the mycorrhizae or pollinators on which orchids depend may lead to rapid population decline. Accordingly, orchids are characteristically found in undisturbed or minimally disturbed habitats and, except for a few colonising species, are unlikely to occur in highly disturbed or degraded environments.

The genus *Prasophyllum* (Leek Orchids) contains many species that favour open woodland and grassland habitats with deeper soils, or moist swampy sites with impeded drainage. Such

environments have been extensively cleared and modified historically for farming and grazing, which has led to marked declines in the populations of many Leek Orchids. At the same time, small less, modified areas, such as cemeteries, TSRs and railway easements, that often serve as refuges for orchids, are gradually succumbing to invasion by weeds or adverse management practices such as herbicide use.

The remarkable survival of a relatively large population of *Prasophyllum* sp. 'Moama' in the TSR north of the MSF site appears to reflect an unusual lack of historical disturbance to the site (NSW Scientific Committee, 2008). This is attributable to:

- The dedication of the site as Crown Land (TSR).
- The distance of the site from a major population centre, and its open nature which is unattractive to visitors.
- Relatively light grazing by stock, owing to a lack of water.
- Relatively little soil disturbance by infrastructure development, e.g. power and telephone lines, pipelines, tracks etc.
- Its relatively large size and small perimeter to area ratio, which limits edge effects such as weed encroachment and disturbance related to road maintenance etc.

METHODS

The approach taken in this report is to compare the habitats of the subject sites on the MSF footprint with that at the known *Prasophyllum* sp. 'Moama' population site. Given that the known *Prasophyllum* sp. 'Moama' site supports a relatively large and apparently sustainable population of the species, it can be assumed that the site meets its habitat requirements and can be regarded as a benchmark site for the species. The degree to which the other sites match the characteristics of the known site will help to determine the likelihood of the species occurring on the MSF footprint.

The known *Prasophyllum* sp. 'Moama' site and the three subject areas on the MSF footprint were examined on 18 January 2018. Each site was subjected to Rapid Site Assessments as follows:

- All vascular plant species were listed within an approximately 15 m radius of a central point at which GPS coordinates were taken.

- Each plant species was assigned an abundance rating on the following scale:

  a = abundant (> 40 individuals)
  c = common (10 to 40 individuals)
  o = occasional (5 to 10 individuals)
  u = uncommon (2 to 5 individuals)
  r = rare (1 or 2 individuals)

- Soil colour and texture were recorded.

- The dominant tree and shrub species in the immediate surrounds were recorded. This was important to assist in identifying the original vegetation type prior to European settlement for each site.

- The degree and kinds of disturbance to each site were noted.

A total of eight rapid assessment samples were conducted as follows; *Prasophyllum* sp. 'Moama' site (1), solar farm (1), preferred access route (1) and grid connection route (5).

Representative photographs of the study sites are given on the following pages.

Figure 3. Riverina Grassland at *Prasophyllum* sp. 'Moama' site.

Figure 4. Riverina Grassland at preferred access route.
[Looking along the access route from west (top) and east (bottom). Note ploughed firebreak in bottom photo.]

Figure 5. Solar Farm - Derived native grassland from Black Box Woodland.
[Looking south along the centre of the excavated drainage ditch with mound to the left. Note the presence of Lignum, a semi-aquatic species, and the line of Black Box trees.]

Figure 6. Grid Connection Corridor /Alternative Access.

[Top – North end looking south showing ploughed firebreak; Centre – Looking north from quarry access track showing south end of firebreak; Bottom – Looking south west from powerline easement along the quarry access track.]

Figure 7. Grid Connection Corridor / Alternative Access.
[Top - WP5 looking north; Centre – WP5 looking south; Bottom – WP4 looking north]

Figure 8. Grid Connection Corridor.
[Top – WP4 looking south; Centre – WP3 looking north; Bottom – WP3 looking south]

Figure 9. Grid Connection Corridor.
[Top – WP2 looking north; Centre – WP2 looking south; Bottom – Grassland south of Essential Energy substation]

RESULTS

Plant Communities

Ascertaining the suitability of the grassland vegetation on the MSF footprint and surrounds for *Prasophyllum* sp. 'Moama' depends on determining the likely original vegetation and its distribution pre-European settlement. The original vegetation types can be determined from the remnant overstorey trees in the immediate surrounds, if any, the composition of the understorey and the soil types associated with each patch of grassland. Table 1 gives the results for each of the study sites.

Solar Farm

The majority of the solar farm site is on alluvial grey clay soils associated with the outer floodplain of the Murray River. A small strip of yellowish to reddish soils occurs on slightly higher ground beside the TSR. Remnant trees along fence lines on the solar farm are all Black Box, *Eucalyptus largiflorens*, which is typical of outer floodplains in the Riverina. Accordingly, the former vegetation over most of the proposed solar farm was PCT13 [*Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)*]. This includes the small areas of derived native grassland on the fence line between the two wheat paddocks. *Prasophyllum* sp. 'Moama' has not been recorded in Black Box Woodlands or on grey clay floodplain soils which are prone to prolonged waterlogging.

Table 1. Plant Community Types (PCT) on Each Site.

Site	Soil Colour / Texture	Dominant Trees		PCT	
		Common Name	Scientific Name	Number and Formal Name	Common Name (this report)
Prasophyllum sp. 'Moama'	Red Clay Loam	N/A	-	44: *Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion*	Riverina Grassland
Access Route	Pale Yellow Clay	N/A	-	44: *Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion*	Riverina Grassland
Grid Connection Route / Alternative Access (north third)	Pale Yellow Clay	N/A	-	44: *Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion*	Riverina Grassland
Grid Connection Route / Alternative Access (south two thirds)	Red Brown Earth	Grey Box	*Eucalyptus microcarpa*	76: *Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions* Derived Native Grassland	Grey Box Woodland
Solar Farm	Grey Clay	Black Box	*Eucalyptus largiflorens*	13: *Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)* Derived Native Grassland	Black Box Woodland

Grid Connection Route / Alternative Access (south)

The grid connection route is 2.5 km long and traverses two vegetation types. There are many Inland Grey Box, *Eucalyptus microcarpa*, trees beside and in the surrounds of the southern two thirds of the route (approximately south of the quarry access track). The soils in this area are also largely Red-Brown Earths, the soil type favoured by Grey Box. Accordingly, the grassland along the power line easement is derived from the clearing of PCT76 [*Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions*]. *Prasophyllum* sp. 'Moama' has not been recorded in Grey Box Woodlands, a very widespread plant community, suggesting they are unsuitable for the orchid.

Preferred Access Route and Grid Connection Route / Alternative Access (north)

There are no remnant trees close to the preferred solar farm access route or to the northern third of the grid connection / alternative access route. The soil type is largely a pale yellowish clay which may be transitional between the alluvial grey clays to the east and the redder clay loams to the west. These areas are considered likely to have been native grasslands historically and represent examples of PCT44 [*Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion*].

Prasophyllum sp. 'Moama' site

This site with a high diversity of native forbs and grasses is considered to be a natural grassland (NSW Scientific Committee, 2008), although small patches of woodland dominated by Bulloak (*Allocasuarina luehmannii*) and/or Grey Box also occur. The soil type is a red clay loam. The site is representative of PCT44 [*Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion*] in close to pristine condition. Grasslands of this kind are the only habitats in which *Prasophyllum* sp. 'Moama' has been recorded.

Groundcover Diversity

A full list of the flora species recorded on each site is given in Attachment 2. The numbers and percentages of native and introduced species are given in Table 2.

Table 2. Numbers and Percentages of Native and Introduced Flora Species Recorded on Study Sites.

Site	No. of Samples	Native		Introduced		Total
		Number	%	Number	%	
Prasophyllum sp. 'Moama' site	1	28	90.3	3	9.7	31
Solar Farm	1	20	76.9	6	23.1	26
Preferred Access Route	1	26	86.7	4	13.3	30
Grid Connection Route / Alternative Access	5	15	57.7	11	42.3	26

The *Prasophyllum* sp. 'Moama' site had the highest number (28) and percentage (90.3%) of native groundcover species of all sites examined, followed closely by the preferred access route with 26 native species (86.7%) (Table 2). The lowest number (15) and percentage (57.7) of native species was

recorded across five sites associated with the southern two thirds of the grid connection route. The solar farm site was intermediate with 20 native species, or 76.9 percent of the total (26).

These data indicate that the preferred access route is in relatively good condition, supporting a similar diversity of native species as the *Prasophyllum* sp. 'Moama' benchmark site and with very few introduced species present (Table 2). By contrast, the southern two thirds of the grid connection / alternative access route is in poor condition supporting only half as many native species as the *Prasophyllum* sp. 'Moama' benchmark site and nearly four times as many introduced species. The solar farm is in moderate condition with intermediate native and introduced flora species diversity.

Disturbance

Degrees of disturbance vary greatly among the subject sites and may have a large influence on the likelihood of populations of *Prasophyllum* sp. 'Moama' surviving, if indeed they ever existed on these sites.

***Prasophyllum* sp. 'Moama' site**

As indicated above, this site is in close to pristine condition with a high diversity of native forbs, a low incidence of introduced species and very little disturbance, despite regular low intensity grazing. The high biological integrity of this site is why it is able to support a large, viable population of *Prasophyllum* sp. 'Moama', presumably including its mycorrhizal fungi and pollinators.

Preferred Access Route

The preferred access route traverses an area of Riverina Grassland that has undergone moderate disturbance historically. Disturbances include trenching for an underground telephone line, an easement with a high voltage power line and associated earthworks at a pole site, dumping of concrete waste and a 10m wide ploughed firebreak abutting the western boundary of the solar farm. The telephone line trench has allowed the establishment of the introduced Ox-tongue Daisy on the disturbed soil. Despite these disturbances the access route retains a good quality sample of Riverina Grassland.

The access route also differs from the *Prasophyllum* sp. 'Moama' benchmark site in being traversed by a shallow drainage line and associated low spots that pool water in wet seasons. These form small wetlands supporting an array of semi-aquatic species (Attachment 2).

Grid Connection Route / Alternative Access (north)

The northern third of the grid connection / alternative access route (north of the quarry access track) is a ploughed firebreak. At the time of the inspection, no live vegetation was present within the firebreak, which, according to the owner of the solar farm site, Peter McCallum, is regularly ploughed.

Grid Connection Route / Alternative Access (south)

The southern two thirds of the grid connection / alternative access route has been subject to a number of historical and ongoing disturbances. These include; clearing of Grey Box Woodland to establish the high voltage overhead power line, a buried telecommunications line, a regularly used

vehicle track along the whole length and large infestations of introduced weed species. This part of the grid connection route is highly degraded.

Solar Farm

The mapped areas of grassland on the solar farm are highly disturbed, being part of a drainage system designed to remove excessive moisture from the wheat paddocks in wet seasons. The system comprises an excavated linear drainage ditch and parallel mound made from the excavated material. The soil disturbance associated with these works would have been highly inimical to native orchids, if any were present originally.

DISCUSSION AND CONCLUSIONS

The above findings are summarised in Table 3 which presents an analysis of the likelihood that habitat of *Prasophyllum* sp. 'Moama' is present on the study sites.

Table 3. Analysis of the Likelihood that Habitat for *Prasophyllum* sp. 'Moama' Occurs on the Study Sites.

Site	Factor[1]			Likelihood of Occurrence
	Soil	PCT	Disturbance	
Prasophyllum sp. 'Moama' site	✓	✓	✓	Occurs
Solar Farm	X	X	X	Nil
Preferred Access Route	?	✓	✓	Moderate
Grid Connection Route / Alternative Access (north)	?	✓	X	Nil
Grid Connection Route / Alternative Access (south)	?	X	X	Highly unlikely
Quarry Access Track	?	X	X	Highly unlikely
Milgate Road	X	X	X	Nil

[1] ✓ = Site suitable, X = Site unsuitable ? = Status unknown

Solar Farm

The soils and vegetation community make it highly unlikely that *Prasophyllum* sp. 'Moama' habitat ever existed where there are currently derived grassland patches on the solar farm site (Table 3). In addition, the high degree of site disturbance would have eliminated any populations, if any were present historically. Overall, there is considered to be a nil likelihood of *Prasophyllum* sp. 'Moama' occurring on the solar farm grassland sites (Table 3).

Preferred Access Route

The vegetation on the preferred access route is similar to that at the benchmark site for *Prasophyllum* sp. 'Moama' and, although parts of the site have been disturbed, much of it remains in relatively good condition, indicating it is potential habitat for the orchid. However, the soil is a pale yellowish clay rather than the red clay-loam found on the benchmark site. This suggests the access route may be unsuitable for *Prasophyllum* sp. 'Moama', if soil type is of critical importance. As yet, there has been no research on the range of soil conditions tolerated by *Prasophyllum* sp. 'Moama', so the habitat cannot be deemed unsuitable on account of the soil. Accordingly, the access route is

considered to have a moderate likelihood of providing habitat for *Prasophyllum* sp. 'Moama' (Table 3). The site should not be disturbed without being surveyed for the orchid in September-October.

Grid Connection Route / Alternative Access (north)

The northern third of the grid connection / alternative access route is likely to have been Riverina Grassland, making it potential habitat for *Prasophyllum* sp. 'Moama'. However, it also has the same soil type as the preferred access route raising similar questions about habitat suitability. Most importantly, it has been ploughed periodically for a firebreak, which would have eliminated any population of *Prasophyllum* sp. 'Moama' that may have been present. It is considered that the likelihood of *Prasophyllum* sp. 'Moama' occurring on the northern third of the grid connection / alternative access route is nil (Table 3).

Grid Connection Route / Alternative Access (south)

The southern two thirds of the grid connection / alternative access route support areas of native grassland derived by clearing Grey Box Woodland. *Prasophyllum* sp. 'Moama' has not been recorded from Grey Box Woodland, or grasslands derived from it. In addition, the area has undergone multiple disturbances, has a very depauperate native flora and high weed levels. It is considered highly unlikely that habitat suitable for *Prasophyllum* sp. 'Moama' occurs there (Table 3).

Quarry Access Track

The quarry access track traverses an area of regenerating Grey Box Woodland (Figure 6). When the quarry to which it provides access was in use, the track would have been less encroached by trees and wide enough to accommodate large vehicles. The associated disturbance associated would have eliminated any *Prasophyllum* sp. 'Moama' that may have been present historically. In any event, it is highly unlikely that *Prasophyllum* sp. 'Moama' would have inhabited the original Grey Box Woodland. Accordingly, it is considered highly unlikely that habitat for *Prasophyllum* sp. 'Moama' occurs in the vicinity of the quarry access track (Table 3).

Milgate Road

Milgate Road is a wide unsealed rural road that is heavily used by B-double trucks accessing an active quarry. It would require little modification to enable access to the powerline easement. Given that the grid connection route at this point is highly unlikely to support *Prasophyllum* sp. 'Moama' (Table 3), it is considered there is a nil likelihood of impacting the orchid from this access.

REFERENCES

Brundrett, MC (2007). Scientific approaches to Australian temperate terrestrial orchid conservation. Australian Journal of Botany, 53: 293-307.

NSW Scientific Committee (2008). *Prasophyllum sp. 'Moama' – critically endangered listing.* Final Determination. NSW Office of environment and Heritage, Sydney.

OEH (2018). *BioNet Vegetation Classification*. Web Page: http://www.environment.nsw.gov.au/research/Visclassification.htm (Accessed: January 2018). NSW Office of Environment and Heritage, Sydney.

Attachment 1. Author's Curriculum Vitae

Name	Colin Charles Bower
Age	69 years **Date of birth** 29 August 1948
Postal Address	PO Box 300, Orange, NSW 2800
Phone	Work: 02 6369 0252 Mobile: 0428 263 274 Home: 02 6363 1513
E-mail	colbower@bigpond.net.au
Current employment	Consultant Ecologist
Qualifications	B.Sc. (Hons) (Zoology), University of Sydney (1969) Ph.D. (Zoology), University of Sydney (1975)

Professional history

1975-1992	Employed as a research entomologist by NSW Agriculture at:
1975	Biological and Chemical Research Institute, Rydalmere
1975-1980	Agricultural Research Station, Bathurst
1980-1992	Agricultural Research and Veterinary Centre, Orange
1992- Apr. 2003	Program Leader, Horticulture, NSW Agriculture, Head Office, Orange
Apr. 2003 - present	Full time ecological consultant (flora and fauna surveys, orchid pollination biology, scientific reviews)

University research history:

Undergraduate

1969 Honours thesis on the anatomy and physiology of colour patterns in the mouth breeding cichlid, *Tilapia mossambica.*

Postgraduate

1970-1974 Ph.D. thesis on the behaviour and ecology of the larvae of the Queensland fruitfly, *Dacus tryoni* Froggatt.

Award:

RD Fitzgerald Trophy (for significant contribution to knowledge of Australian orchids)

Current society memberships:

- Ecological Consultants Association of New South Wales
- Australian Entomological Society
- Entomological Society of New South Wales
- Australasian Native Orchid Society

Professional Committee:

1998-present Member of Research Committee of the Australian Orchid Foundation.

Licences:

Scientific Licence No. SL100744, NSW National Parks and Wildlife Service

Accreditation:

Accredited BioBanking Assessor (NSW Office of Environment and Heritage), No. 163

Insurances:

- Public Liability - $20m
- Professional Indemnity - $10m

Biodiversity surveys and entomological studies – major contract studies as a consultant ecologist / entomologist:

Year	Project and Client
1986	Junction Reefs Gold Mine proposal. Flora and fauna survey for Environmental Impact Statement (EIS). R.W. Corkery and Co. Pty. Ltd.
1987	Browns Creek Gold Mine proposal. Flora and fauna survey for EIS. R.W. Corkery and Co. Pty. Ltd.
1990	Prepared Statements of Significance for ten nature conservation areas. Australian Heritage Commission.
1995	Cadia Gold Mine proposal. Flora surveys for EIS with R. W. Medd and Orange Field Naturalist and Conservation Society. AGC Woodward-Clyde Pty. Limited
1996	Remnant vegetation survey and regeneration plan for the Lidster-Cargo-Cudal area west of Orange, NSW with J. Kenna and L. Kingham. Cudal and Lidster Landcare Groups.
1997	Flora survey of the Ophir Reserve, Orange with R.W. Medd and J.I. Kenna for Cabonne Shire Council. R.W. Corkery and Co. Pty. Limited.
1997	Member of expert panel to assess the potential long term environmental impact of a proposed gold mine on the shore of Lake Cowal in Central Western NSW. Resource Strategies Pty. Ltd.
1998	Lake Cowal Gold Mine EIS. Threatened species assessment (Eight Part Tests of Significance). Resource Strategies Pty. Ltd.
1998	Lake Cowal Gold Mine EIS. Targeted searches for the threatened plant species, *Lepidium hyssopifolium* and *Pilularia novae-hollandiae*. Resource Strategies Pty. Ltd.
1998	Survey of bushland remnants on the NSW Central Tablelands for populations of a rare undescribed greenhood orchid related to *Pterostylis longifolia*. Cadia Mines Pty. Limited
1998	Cadia-Ridgeway Gold Mine proposal. Flora survey, vegetation community mapping and targeted searches for threatened species with R.W. Medd and J.I. Kenna. Resource Strategies Pty. Ltd.
2000	Syerston Nickel-Cobalt Mine proposal, Fifield, NSW. Flora survey and targeted searches for threatened species on mine site and service corridors for EIS, with J.I. Kenna. Resource Strategies Pty. Ltd.
2001	Study of the pollination of the endangered Jervis Bay Leek Orchid, *Prasophyllum affine*, in order to develop a conservation strategy for this species compatible with a major shopping centre and residential development at Vincentia. NSW National Parks and Wildlife Service.
2001/02	Ginkgo Mineral Sand Mine proposal, Pooncarie, NSW. Flora survey of service corridors and targeted searches for threatened species for EIS. Resource Strategies Pty. Ltd.
2002	Cadia Gold Mine, Cadia, NSW. Establishment of permanent flora monitoring sites in the Wire Gully vegetation enhancement area. Resource Strategies Pty. Ltd.
2002	Ridgeway Gold Mine, Cadia, NSW. Flora survey, vegetation community mapping and targeted searches for threatened plant species on the 'Southern Remnant'. Resource Strategies Pty. Ltd.

Year	Project and Client
2002	Wambo Coal Mine Expansion Proposal, Warkworth, NSW. Flora survey, vegetation community mapping, targeted searches for threatened species for EIS, assessment of disturbance. Resource Strategies Pty. Ltd.
2003	Timbarra Gold Mine, Tenterfield, NSW. Assessment of ground cover of individual plant species by vegetation layer and assessment of plant health on long term monitoring plots. Resource Strategies Pty. Ltd.
Spring 2003	Continue study of the pollination of the endangered Jervis Bay Leek Orchid, *Prasophyllum affine*. Environmental Resources Management Australia.
2003/2004	Country Energy, Temora to Lake Cowal, NSW. Targeted searches for threatened plant species on the Electricity Transmission Line route. Resource Strategies Pty. Ltd.
2003/2004	Hydro Aluminium, Kurri Kurri, NSW. Flora survey, vegetation community mapping, plant species listing, targeted searches for threatened plant species, assessment of disturbance, recommendations for conservation and enhancement of the aluminium smelter's native vegetation buffer zone. Resource Strategies Pty. Ltd.
2004	Cadia Gold Mine, Cadia, NSW. Flora survey of proposed extension area for waste rock dump. Resource Strategies Pty. Ltd.
2004	Proposed Cadia East Gold Mine, Cadia, NSW. Flora survey, vegetation community mapping, plant species listing, targeted searches for threatened plant species. Resource Strategies Pty. Ltd.
2004	Warkworth Coal Mine, Singleton, NSW. Map all occurrences of the Warkworth Sands Endangered Ecological Community on land owned by the Warkworth and Wambo Coal Mines. Resource Strategies Pty. Ltd.
Spring 2004	Continue study of the pollination of the endangered Jervis Bay Leek Orchid. Environmental Resources Management Australia.
2004	Proposed Orange City Council residential subdivision, Ploughmans Creek, Orange, NSW. Flora survey, flora species listing, vegetation mapping, assessment of vegetation condition. Geolyse Pty. Ltd.
2004	Jenolan Caves, NSW. Weed survey of resort environs with recommendations for improved weed management. Jenolan Caves Resort Pty. Ltd.
2004/2005	Review Biosecurity Australia's 2004 draft Import Risk Assessment for the proposed importation of apples from New Zealand. Apple and Pear Australia Limited.
2004/2005	Proposed Wilpinjong Coal Mine, Wollar, NSW. Flora survey, vegetation community mapping, plant species listing, targeted searches for threatened plant species. Resource Strategies Pty. Ltd.
2005	Black Rock Ridge, Cargo, NSW. Flora survey, vegetation community mapping, plant species listing, targeted searches for threatened plant species. Assess value of area as an offset for proposed Cadia East Gold Mine. Resource Strategies Pty. Ltd.
2005	South Mullion Range, Orange, NSW. Flora survey, vegetation community mapping, plant species listing, targeted searches for threatened plant species. Community Biodiversity Survey, National Parks Association of NSW.
2005	Crown Lands, Ulan, NSW. Flora survey, vegetation community mapping, plant species listing, targeted searches for threatened plant species. Community Biodiversity Survey, National Parks Association of NSW.
2005	Hydro Aluminium Smelter, Kurri Kurri. Pre-control burn baseline vegetation survey. Resource Strategies Pty. Ltd.
2005	Duralie Coal Mine expansion, Stroud, NSW. Targeted searches for threatened species and communities; threatened community mapping. Resource Strategies Pty. Ltd.
2005	Orchid pollination workshop, Castlemaine, Vic. Prepare and run two hour workshop on pollination of threatened orchid species. Department of Sustainability and Environment.
2006	Review the entomological aspects of the 2005 draft of Biosecurity Australia's Import Risk Assessment for the Importation of New Zealand apples into Australia. Apple and Pear Australia Limited.
2006	Ulan to Wilpinjong Electricity Transmission Line. Targeted searches for threatened flora species, populations and communities. Wilpinjong Coal Pty. Ltd.

Year	Project and Client
2006	Contribute to the development of the Property Management Plan for the Hydro Aluminium Smelter, Kurri Kurri, particularly the flora monitoring, fire management, weed control and rehabilitation aspects. Resource Strategies Pty. Ltd. and Hydro Aluminium Kurri Kurri Pty. Ltd.
2006	Snapper Mineral Sands Project, Pooncarie, NSW. Baseline flora survey, threatened flora searches, vegetation community mapping. Bemax Resources N/L.
2006	Warkworth Coal Mine. Map former occurrences of the Warkworth Sands Woodland Endangered Ecological Community in the Warkworth area as potential offset and rehabilitation sites for the Warkworth Coal Mine expansion. Coal and Allied Pty. Ltd.
2006	Community Biodiversity Survey. Flora Team Leader for survey of remnant woodlands in the Parkes area, NSW. National Parks Association of NSW.
2006	Molong Electricity Substation. Preliminary flora survey: community identification, plant species list, threatened species search. TransGrid.
2006	Collection and identification of pollinators of eleven threatened orchid (*Caladenia*) species in South West Victoria. Determination of pollinator distribution and abundance. Department of Sustainability and the Environment, Victoria.
2006	Buffer zone of the Hydro Aluminium Smelter, Kurri Kurri. Monitor effects of planned autumn 2006 hazard reduction burn on five permanent quadrat sites and 14 species of tagged plants in spring 2006. Hydro Aluminium Kurri Kurri Pty Ltd.
2006	Buffer zone of the Hydro Aluminium Smelter, Kurri Kurri. Establish and perform baseline measurements on 28 long term flora quadrats as part of the approved Property Management Plan. Hydro Aluminium Kurri Kurri Pty Ltd.
2006	The Salt Lakes, SW of Pooncarie, NSW. Map vegetation communities and list plant species present along seven transects across The Salt Lakes on Kelleen Station. Bemax Resources N/L.
2006	Orchid Reintroduction Workshop, Melbourne, Vic. Present results of pollinator research on eleven threatened *Caladenia* species in South West Victoria with implications for potential reintroductions. Department of Sustainability and the Environment, Vic.
2007	Review Australian Pome Fruit Improvement Program (APFIP) in collaboration with another consultant. APFIP and Horticulture Australia Limited.
2007	Flora survey of proposed rural subdivision at Little Hartley, NSW.
2007	Survey habitat value of proposed offset for the Snapper Mineral Sands Mine using the NSW Department of Environment and Climate Change 'Biometric' tool. Bemax Resources N/L
2007	Second measurements of tagged plants and permanent quadrats in a long term monitoring study of the effects of a control burn on threatened flora and communities in the buffer zone of an aluminium smelter in the lower Hunter Valley, NSW. Hydro Aluminium Kurri Kurri.
2007	Inspections for the presence of significant flora on proposed water pipeline routes from the Icely Road Quarry and Gosling Creek Reservoir, Orange, to the Orange to Cadiangullong Dam water pipeline. Cadia Valley Operations Pty. Ltd.
2007	Flora and fauna survey, threatened species searches and impact assessment of proposed Dentistry School, Charles Sturt University, Orange Campus. Charles Sturt University.
2007	Mapping of vegetation communities on farming lands owned by Cadia Valley Operations, Cadia. Cadia Valley Operations Pty. Ltd.
2007	Survey and mapping of vegetation communities and threatened species searches on the Cadia to Blayney concentrate slurry pipeline. Cadia Valley Operations Pty. Ltd.
2007	Survey and mapping of vegetation communities and impact assessment on route of proposed borefield pipeline on Escort Way. Parkes Shire Council.
2007	Flora survey, vegetation community mapping, threatened species searches and impact assessment for proposed vegetation clearance below 33Kv power line through Turon National Park, Capertee. TransGrid.
2007	Flora and fauna survey and assessment for proposed Orange Private Hospital, Forest Road, Orange. Forest Road Syndicate Pty. Ltd.

Year	Project and Client
2007	Second season of pollinator collection and identification project on threatened orchid (*Caladenia*) species in Victoria. Determination of pollinator distribution and abundance. Department of Sustainability and the Environment, Victoria.
2007	Expert review of survey methodology and impact assessment of a threatened orchid species in a disputed Environmental Assessment for a housing subdivision at Dolphin Point on the NSW South Coast. NSW Department of Planning.
2007	Tagging and baseline measurement of 100 plants of each of three threatened species for long term monitoring under the Property Management Plan for the buffer zone of an aluminium smelter in the lower Hunter Valley. Hydro Aluminium Kurri Kurri.
2008	Baseline flora survey of section of Wentworth Swamp on 'Wangara' property, Kurri Kurri, NSW. Hydro Aluminium Kurri Kurri.
2008	Flora survey, targeted searches for threatened flora and vegetation mapping on the Woronora Plateau and Cumberland Plain for Illawarra Coal Bulli Seam Operations Environmental Assessment. A large ongoing project. BHP Billiton.
2008	Assessment of swamp condition and plant health in 27 Woronora Plateau upland swamps, including swamps over previous longwall mined areas and unmined areas. Helensburgh Coal.
2008	Flora survey and assessment for expansion of the E42 pit at the Lake Cowal Gold Mine. Barrick Australia Limited.
2008	Flora survey of powerline easement, Premer, NSW. Country Energy.
2008	Desktop review of flora and fauna issues for State Significant Site development on the Orange Agricultural Research, Forest Road, Orange. NSW Department of Primary Industries.
2008	Pre-disturbance inspection for threatened flora species of six proposed surface drill sites for groundwater monitoring bores with recommendations for relocation to avoid occurrences of the Prickly Bush-pea. Helensburgh Coal.
2008	Flora survey of the 'Southern Remnant' bushland area, Lake Cowal Gold Mine. Barrick Australia Limited.
2008	Targeted searches for threatened flora species and communities on proposed upgrade of culverts on Gradgery Lane, Macquarie Marshes, NSW. Warren Shire Council.
2008	Pre-clearance survey for threatened flora species and communities in the 'Southern Remnant', Cadia Valley, for expansion of a waste rock emplacement for the Cadia Gold Mine. Cadia Valley Operations.
2008	Participate in development of the Environmental Assessment for the Metropolitan Coal Project. Helensburgh Coal.
2008	Flora survey for Review of Environmental Factors at 'Big Cadia' ore deposit, Cadia, NSW. Cadia Valley Operations.
2008	Flora and fauna survey and assessment of site for student residential complex. Charles Sturt University, Orange.
2008	Flora survey and assessment of proposed stormwater harvesting project on Blackmans Swamp Creek. Orange City Council.
2008	Third season of pollinator studies on threatened Caladenia orchid species in Victoria. Department of Sustainability and the Environment, Vic.
2008	Ongoing monitoring of vegetation recovery (flora quadrats and tagged plant measurements) following hazard reduction burning in autumn 2006 of Blocks X and Y in the buffer zone of the Hydro Aluminium smelter, Kurri Kurri.
2008	Pre-burn baseline flora survey (flora quadrats and measurement of tagged plants of 3 threatened species) in blocks R and U in the buffer zone of the Hydro Aluminium smelter, Kurri Kurri, for a proposed hazard reduction burn in autumn 2009.
2008	Baseline flora survey and establishment of permanent monitoring quadrats for proposed vegetation offset for the Ginkgo and Snapper Mineral Sands Mines, Pooncarie, NSW. Bemax Minerals.
2009	Flora survey and assessment of a proposed power regulator site at Hermidale. Country Energy.

Year	Project and Client
2009	Completion of flora survey, targeted searches for threatened flora and vegetation mapping on the Woronora Plateau and Cumberland Plain and report preparation. Illawarra Coal Bulli Seam Operations Environmental Assessment. BHP Billiton.
2009	Four flora surveys and assessments of proposed monitoring borehole sites on the Woronora Plateau, Helensburgh. Metropolitan Coal.
2009	Threatened species searches and report at the Narrabri Coal Mine site. Whitehaven Coal.
2009	Metropolitan Coal Longwalls 20-22 Extraction Plan - Preparation of relevant flora components of the Biodiversity Management Plan, Metropolitan Coal, Helensburgh.
2009	Flora and fauna survey and assessment of three sub-catchments of Ploughmans Creek for the Orange Storm Water Harvesting Project. Orange City Council.
2009	Ongoing monitoring of vegetation recovery (flora quadrats and tagged plant measurements) following hazard reduction burning in the buffer zone of the Hydro Aluminium smelter, Kurri Kurri.
2010	Six separate threatened flora searches on disturbance areas for proposed monitoring borehole sites, access tracks and a car park on the Woronora Plateau, Helensburgh. Metropolitan Coal.
2010	Flora survey and assessment of a proposed extension to underground mining at the Wambo mine, Warkworth. Peabody Energy Australia.
2010	Targeted searches for *Persoonia hirsuta*, West Cliff Colliery. BHP Billiton.
2010	Pre controlled burn flora survey and establishment of permanent quadrats in Block N of the Hydro Aluminium Smelter, Kurri Kurri.
2010	Mapping of vegetation communities and threatened species searches at the site of the proposed Rocglen Coal Mine, Gunnedah. Whitehaven Coal.
2010	Flora survey and assessment of proposed saline water borefield, Barrick Cowal Gold Mine, West Wyalong. Barrick Gold Corporation.
2010	Flora survey and assessment of a proposed Curtilage open cut coal mine at the Wambo mine, Warkworth. Peabody Energy Australia.
2010	Threatened species searches at Holsworthy Army Base firing range for the Bulli Seam Project. BHP Billiton.
2010	Flora survey and assessment of proposed electricity transmission line from Orange to Cadia. Newcrest Mining Limited.
2010	Vegetation Management Plan for subdivision at Hartley Vale.
2010	Vegetation mapping on proposed mine sites at Gunnedah. Whitehaven Coal.
2010	Vegetation mapping on land owned by the Stratford coal mine. Gloucester Coal.
2010	Survey Point Danger Conservation Reserve, Portland, Vic., for pollinators of the endangered Mellblom's Spider Orchid and prepare an assessment of the potential impacts of wind turbines on the pollinator. Department of Sustainability and Environment, Victoria.
2010	Flora survey of a proposed extension to the Tarrawonga Coal Mine, Boggabri. Whitehaven Coal.
2010	Ongoing monitoring of vegetation recovery (flora quadrats and tagged plant measurements) following hazard reduction burning in the buffer zone of the Hydro Aluminium smelter, Kurri Kurri.
2011	Flora survey of additional areas affected by the Stratford Coal Mine expansion, including searches for habitat of the Glossy Black Cockatoo and refinement of vegetation mapping. Gloucester Coal.
2011	Continuation of flora survey of a proposed extension to the Tarrawonga Coal Mine, Boggabri. Whitehaven Coal.
2011	Biennial survey of freshwater wetlands in the buffer zone of the Hydro Aluminium Smelter, Kurri Kurri.
2011	Report and assessment on the distribution and significance of Box-Gum woodlands on the Tarrawonga Coal Mine site. Whitehaven Coal.
2011	Additional field survey of disturbance areas for the Stratford Coal Mine; survey of the vegetation in the surrounding district, preparation of a flora report and assessment of impact for a proposed expansion of the mine. Gloucester Coal.

Year	Project and Client
2011	Pre controlled burn flora survey and establishment of permanent quadrats in several blocks of the Hydro Aluminium Smelter buffer zone, Kurri Kurri.
2011	Flora survey and assessment of a proposed expansion of the Tarrawonga Coal Mine open cut, Boggabri. Whitehaven Coal.
2011	Four separate threatened flora searches on disturbance areas for proposed ground water monitoring borehole sites, access tracks and seismic lines on the Woronora Plateau, Helensburgh. Metropolitan Coal.
2011	Contribute to the NSW Office of Environment and Heritage' *Priority Action Statement* development process for certain threatened plant species.
2011	Flora survey of proposed offset area and report for the Tarrawonga Coal Project. Whitehaven Coal.
2011	Mapping of vegetation for Green and Golden Bellfrog compensatory habitat, Kooragang Island, Newcastle. Newcastle Coal and Infrastructure Group.
2011	Flora survey and assessment for the proposed North Wambo Underground Coal Mine, Warkworth. Peabody Energy Australia.
2011	Further flora survey and assessment of the Orange to Cadia electricity transmission line. Newcrest Mining Limited.
2011	Flora survey and report for the Crayfish Mineral Sands Mine, Pooncarie, NSW. Bemax Resources Ltd.
2011	Survey of reserves managed by Orange City Council to determine if any of them support endangered ecological communities. Orange City Council.
2012	Flora survey of drill sites, flora survey and vegetation mapping of whole exploration lease for the Spur Hill Underground Project, Denman, NSW.
2012	Biodiversity survey, report and assessment. Bathurst campus, Charles Sturt University.
2012	Two threatened flora searches on disturbance areas for proposed ground water monitoring borehole sites and GPS facility site on the Woronora Plateau, Helensburgh. Metropolitan Coal.
2012	Preliminary inspection of populations of the endangered Tuncurry Midge Orchid regarding pollination strategies. Landcom NSW.
2012	Additional survey and reporting for the Orange to Cadia electricity transmission line. Newcrest Mining Limited.
2012	Flora impact assessment for the proposed Montrose Dam, Wambo Coal Mine, Warkworth. Peabody Energy Australia.
2012	Flora survey for South Wambo Underground Project, Warkworth. Peabody Energy Australia.
2012	Biodiversity survey, report and assessment. Orange campus, Charles Sturt University.
2012	Additional flora survey and report amendments for the revisions of the Crayfish Mineral Sands Mine, Pooncarie, NSW. Bemax Resources Ltd.
2012	Flora survey and report for the proposed offset area for the Crayfish Mineral Sands Project. Bemax Resources Ltd.
2012	Further contribute to the NSW Office of Environment and Heritage' *Priority Action Statement* development process for certain threatened plant species.
2013	Assessment of impact of coal mine subsidence on threatened flora species in an upland swamp. Metropolitan Coal Pty Ltd., Helensburgh
2013	Prepare a Review of Environmental Factors report for exploration drilling for the Spur Hill Underground Coking Coal Mine, Denman
2013	Co-author research paper on conservation of orchids in the *Caladenia reticulata* complex.
2013	Field study on the pollination of the Tuncurry Midge Orchid. UrbanGrowth NSW
2013	Vegetation mapping and flora assessment of proposed constructed habitat ponds for Green and Golden Bell Frog on Kooragang Island. Newcastle Coal Infrastructure Group.
2013	Biodiversity survey, report and assessment. Dubbo campus, Charles Sturt University.
2013	Further flora survey and vegetation mapping of exploration lease for the Spur Hill Underground Coking Coal Project, Denman, NSW.

Year	Project and Client
2013	Flora survey of proposed Electricity Transmission Line for Barrick Cowal Gold Mine bore water pumping station, West Wyalong
2013	Metropolitan Coal Longwalls 23-27 Extraction Plan - Preparation of relevant flora components of the Biodiversity Management Plan, Metropolitan Coal, Helensburgh.
2013	Flora survey and report on proposed new haul road route, Tarrawonga Coal Mine. Whitehaven Coal, Gunnedah.
2013	Flora survey and report for rezoning land as industrial. Parkes Shire Council.
2013	Flora survey and report for proposed seismic survey lines. Metropolitan Coal Pty. Ltd., Helensburgh.
2013	Flora survey and report on proposed residential subdivision. Bathurst Diocese of the Catholic Church.
2013	Flora survey and assessment report for proposed new Parkes Public Hospital. Parkes Shire Council.
2013	Flora survey of offset area for Ginkgo Mineral Sands Mine, Pooncarie, NSW
2013	Targeted searches for threatened species and flora survey on the Spur Hill Underground Coking Coal Mine exploration lease. Denman.
2013	Flora survey and report for residential subdivision, Parkes. Geolyse Pty. Ltd.
2013	Flora survey and assessment on proposed residential subdivision, Bendick Murrell.
2013	Flora survey and assessment report for proposed new Parkes Southern Bypass Road. Parkes Shire Council.
2014	Prepare flora assessment for Gingko Mineral Sands Mine Modification Environmental Assessment.
2014	Flora survey and mapping proposed compensatory shorebird wetland area on Kooragang Island. Newcastle Coal Infrastructure Group.
2014	Threatened flora surveys of proposed seismic lines and borehole sites, Metropolitan Coal Pty. Ltd. Helensburgh.
2014	Flora survey and assessment of former RAAF Base site, Dubbo. Andorra Investments.
2014	Flora survey of the proposed infrastructure area for the Spur Hill Underground Coking Coal Mine. Denman.
2014	Flora survey and assessment of modification area for Duralie Coal Mine. Yancoal Pty. Ltd.
2014	Characterise the original vegetation along the route of the historic Cox's Road (1815) between Bathurst and Mount York. Bathurst Bicentennial Committee.
2014	Flora survey and assessment for Longwall 10a Modification, Wambo Coal Mine, Warkworth.
2014	Biodiversity survey on part of Weedallion Mountain, 'Panhandle', Bribbaree. Rinoldi Pasta.
2014	Flora survey and report on potential offset areas, Cadia Gold Mine, Orange.
2014	Flora survey and vegetation analysis of the 'Mayfield' property, Denman to meet new Office of Environment and Heritage 'Framework for Biodiversity Assessment' criteria for proposed offset area for the Spur Hill Underground Coking Coal Project..
2015	Flora survey and assessment for the South Bates Underground Coal Mine, Wambo Coal, Warkworth.
2015	Mapping of the distribution of noxious and environmental weeds on the West Willeroi Offset Area, Whitehaven Coal, Gunnedah.
2015	Flora survey and vegetation mapping of additional offset area, Atlas-Campaspe Mineral Sands Mine, Balranald.
2015	Flora survey, vegetation mapping and threatened species searches for the South Wambo Underground Coal Project, Wambo Coal, Warkworth.
2015	Consultant to the South Korean Educational Television Service for advice on pollination of the Western Australian Hammer Orchid, *Drakaea glyptodon* for filming of the nature documentary, *Green Animals*.
2015	Flora survey and assessment of an extension to the Ginkgo Mineral Sands Mine, Cristal Minerals, Pooncarie.
2015	Targeted surveys for the Pine Donkey Orchid, former Dubbo RAAF Base and South Dubbo Park, Andorra Investments.

Year	Project and Client
2015	Flora survey and assessment of the Vickery Coal Mine Extension Project (utilising the NSW Framework for Biodiversity Assessment), Whitehaven Coal, Boggabri.

Publications
(Scientific papers and major scientific reports since 1990 only)

Refereed Publications on Economic Entomology

Bower,C.C. (1992). Control of European earwig, *Forficula auricularia* L., in stone fruit orchards at Young, New South Wales. *General and Applied Entomology* **24**: 11-18.

Bower,C.C., L.J.Penrose and K.Dodds (1993). A practical approach to pesticide reduction on apple crops using supervised pest and disease control - preliminary results and problems. *Plant Protection Quarterly* **8**: 57-62.

Dodds,K.A., L.J.Penrose, C.C.Bower and H.Nicol (1994). The importance of pest and disease damage as a cause of downgrading of apple fruit. *Australian Journal of Experimental Agriculture* **34**: 431-434.

Penrose,L.J., C.C.Bower and H.I.Nicol (1996). Variability in pesticide use as a factor in measuring and bringing about reduction in pesticide usage in apple orchards. *Agriculture, Ecosystems and Environment* **59**: 97-105.

Penrose,L.J., W.G.Thwaite and C.C.Bower (1994). Rating index as a basis for decision making on pesticide use reduction and for accreditation of fruit produced under integrated pest management. *Crop Protection* **13**: 146-152.

Thwaite,W.G., C.C.Bower, A.M.Hately and D.Swist-Swirski (1996). Tebufenpyrad: Compatibility with integrated mite control on apples. *Experimental and Applied Acarology* **20**: 177-191.

Orchid Pollination Biology

Bower,C.C. (1992). The use of pollinators in the taxonomy of sexually deceptive orchids in the subtribe Caladeniinae (Orchidaceae). *The Orchadian* **10**: 331-338.

Bower,C.C. (1995). In defence of the New Taxonomy. *The Orchadian* **11**: 356-357.

Bower,C.C. (1996). Species concepts and the New Taxonomy. *The Orchadian* **11**: 556-557

Bower,C.C. (1996). Demonstration of pollinator-mediated reproductive isolation in sexually deceptive species of *Chiloglottis* (Orchidaceae: Caladeniinae). *The Australian Journal of Botany*. **44**: 15-33.

Bower, C. (2001). Pollination of the Elbow Orchid, *Arthrochilus huntianus* (F. Muell.) Blaxell subsp. *huntianus*. *The Orchadian*, **13**: 366-371.

Bower, C.C. (2001). Pollination (of 37 genera in the orchid subtribe Diurideae). *In* Pridgeon, A.M., Cribb, P.J. and Chase, M.W. (Eds.) *Genera Orchidacearum.* Volume 2 Orchidoideae (Part 1). Pages 64-213 (in parts). Oxford University Press, Oxford.

Bower, C.C. (2006). Specific pollinators reveal a cryptic taxon in the bird orchid, *Chiloglottis valida sensu lato* (Orchidaceae) in south-eastern Australia. *The Australian Journal of Botany*, **54**: 53-64.

Bower, C.C. (2006). Hybridisation between the Lemon Doubletail (*Diuris abbreviata*) and the Veined doubletail (*D. venosa*) at Barrington Tops. *The Orchadian*, **15**; 256-262.

Bower, C.C. (2007). The Wasp, Ant and Bird Orchids of the *Chiloglottis* Alliance – A general overview. *The Orchadian*, **15**; 402-416.

Bower, C.C. (2008). Serendipity and pollinators reveal a new cryptic orchid Spider Orchid species related to *Caladenia concinna* (Rupp) D Jones et M Clements. *The Orchadian*, **16**; 60-69.

Bower, C.C. (2008). Serendipity and pollinators reveal a new cryptic orchid Spider Orchid species related to *Caladenia concinna* (Rupp) D Jones et M Clements. *The Orchadian*, **16**; 60-69.

Bower, C.C. (2015). Pollinator sharing by the sexually deceptive Greencomb Spider Orchids, *Caladenia parva*, *C. phaeoclavia* and *C. villosissima* (Orchidaceae: Caladeniinae): taxonomic considerations. *Telopea* 18: 309–323.

Bower, C.C. and Branwhite, P. (1993). Observations on the pollination of *Calochilus campestris* R.Br. *The Orchadian* **11**: 68-71.

Bower, C.C. and Brown, G.R. (1997). Hidden biodiversity: Detection of cryptic Thynnine wasp species using sexually deceptive, female mimicking orchids. *Memoirs of the Museum of Victoria.* **56**: 461-466.

Bower, C.C. and Brown, G.R. (2009). Pollinator specificity, cryptic species and geographical patterns in pollinator responses to sexually deceptive orchids in the genus *Chiloglottis*: the *Chiloglottis gunnii* complex. *Australian Journal of Botany*, **57**: 37-55.

Bower, C.C. Towle, B. and Bickel, D. (2015). Reproductive success and pollination of the Tuncurry Midge Orchid (*Genoplesium littorale)* (Orchidaceae) by Chloropid Flies. *Telopea*, **18**: 43–55.

Mant, J., Bower, C.C., Weston, P.H and Peakall, R. (2005). Phylogeography of pollinator-specific sexually deceptive *Chiloglottis* taxa (Orchidaceae): evidence for sympatric divergence? *Molecular Ecology*, **14**: 3067-3076.

Peakall, R., Bower, C.C., Logan, A.E. and Nicol, H.I. (1997). Confirmation of the hybrid origin of *Chiloglottis* X *pescottiana* R.Rogers (Orchidaceae: Diurideae). 1. Genetic and morphometric evidence. *The Australian Journal of Botany*. **45**: 839-855.

Peakall, R., Jones, L. Bower, C.C. and Mackey, B.G. (2002). Bioclimatic assessment of the geographic limits to hybridisation in a sexually deceptive orchid system. *The Australian Journal of Botany*, **50**: 21-30.

Phillips, R.D., Faast, R., Bower, C.C., Brown, G.R. and Peakall, R. (2009). Implications of pollination by food and sexual deception for pollinator specificity, fruit set, population genetics and conservation of *Caladenia* (Orchidaceae). *Australian Journal of Botany*. **57**: 287-306.

Reiter, N., Vlcek, K., O'Brien, N., Gibson, M., Pitts, D., Brown, G.R., Bower, C.C. and Phillips, R. (2017). Pollinator rarity limits reintroduction sites in an endangered sexually deceptive orchid (*Caladenia hastata*): Implications for plants with specialized pollination systems. *Botanical Journal of the Linnean Society*, 184: 122-136.

Swarts, N.D., Clements, M.A., Bower C.C. and Miller, J.T. (2014). Defining conservation units in a complex of morphologically similar, sexually deceptive, highly endangered orchids. *Biological Conservation* **174**: 55-64.

Reports to the Australian Orchid Foundation (funding body)

Bower, C.C. (1993a). Determination of the pollinators of sexually deceptive terrestrial orchids in the subtribe Caladeniinae in New South Wales. Progress Report to the Australian Orchid Foundation. 9 pp.

Bower, C.C. (1993b). Determination of the pollinators of sexually deceptive terrestrial orchids in the subtribe Caladeniinae in New South Wales. 1992-93 Report to the Australian Orchid Foundation. 29 pp.

Bower, C.C. (1994). Report on the results of field investigations of the pollinators of the genus *Chiloglottis* (Orchidaceae: Caladeniinae) in 1993-94. Report to the Australian Orchid Foundation. 80 pp.

Bower, C.C. (1995). Determination of the pollinators of sexually deceptive orchids in the subtribe Caladeniinae. Australian Orchid Foundation. Progress Report, 1994-95. 60 pp.

Bower, C.C. (1996). Determination of the pollinators of sexually deceptive orchids in the subtribe Caladeniinae. Australian Orchid Foundation. Progress Report, 1995-96. 53 pp.

Bower, C.C. (2001). Determination of the pollinators of sexually deceptive orchids in the subtribes Drakaeinae and Caladeniinae. Technical Report, 1997-2000. 119 pp. Australian Orchid Foundation.

Bower, C. (2007). Pollinators of threatened sexually deceptive Spider Orchids (*Caladenia* subgenus *Calonema*) in south western Victoria. Report to the Australian Orchid Foundation. 20 pp.

Bower, C. (2008). Pollinators of sexually deceptive Spider Orchids (*Caladenia/Arachnorchis*) in Victoria. Report to the Australian Orchid Foundation. 18 pp.

Attachment 2. Flora Species Lists for Study Sites with Abundance Ratings.

Scientific Name	Common Name	*Prasophyllum* sp. 'Moama'	Solar Farm grassland	Preferred Access Route	Grid Connection Route / Alternative Access				
					Electricity Substation surrounds	WP2	WP3	WP4	WP5
CLASS FILICOPSIDA									
Marsileaceae									
Marsilea drummondii	Common Nardoo		r						
Pteridaceae									
Cheilanthes sieberi		r							
CLASS MAGNOLIOPSIDA									
SUBCLASS MAGNOLIIDAE									
Amaranthaceae									
Ptilotus nobilis subsp. *semilanatus*	Mulla Mulla	o							
Apiaceae									
Eryngium ovinum	Blue Devil	c							
Asteraceae									
Calocephalus citreus	Lemon Beauty-heads	a		c					
Calotis scapigera	Tufted Burr-daisy			u					
**Carthamus lanatus*	Saffron Thistle	c							
**Cirsium vulgare*	Spear Thistle						o		
Eclipta platyglossa			o	u					
**Helminthotheca echioides*	Ox-tongue			o					
**Lactuca serriola*	Prickly Lettuce		u					r	
Leiocarpa panaetioides	Woolly Buttons			u					
Pycnosorus globosus	Drumsticks			o					
Senecio quadridentatus	Cotton Fireweed	u							
Solenogyne bellioides		o							
**Sonchus oleraceus*	Common Sowthistle	o						u	
Vittadinia cuneata var. *hirsuta*	Fuzzweed	c		o					
Vittadinia gracilis	Woolly New Holland Daisy		u						
Vittadinia sp.					o	u	u	u	
Boraginaceae									
**Echium plantagineum*	Paterson's Curse			u					u
**Heliotropium europaeum*	Potato Weed		r		r				u
Brassicaceae									

Scientific Name	Common Name	*Prasophyllum* sp. 'Moama'	Solar Farm grassland	Preferred Access Route	Grid Connection Route / Alternative Access				
					Electricity Substation surrounds	WP2	WP3	WP4	WP5
**Lepidium africanum*			u					u	
Campanulaceae									
Wahlenbergia luteola		o							
Chenopodiaceae									
Atriplex leptocarpa	Slender-fruit Saltbush							r	
Atriplex semibaccata	Creeping Saltbush		o	o					
Enchylaena tomentosa	Ruby Saltbush		o			a	c	c	o
Maireana decalvans	Black Cotton Bush	o	u	u	r			u	o
Maireana humillima		u							
Rhagodia spinescens	Spiny Saltbush		u						
Salsola australis		u	u						
Sclerolaena muricata	Black Rolypoly				o		o	o	o
Sclerolaena napiformis	Turnip Copperburr	o		u					
Convolvulaceae									
Convolvulus angustissimus		o		o				r	
Euphorbiaceae									
Euphorbia drummondii	Caustic Weed		o	u				u	
Fabaceae: Faboideae									
Swainsona procumbens	Broughton Pea	c		r					
**Trifolium angustifolium*	Narrow-leaved Clover				u				
Fabaceae: Mimosoideae									
Acacia pycnantha	Golden Wattle						o		o
Gentianaceae									
Schenkia australis	Spike Centaury	c							
Goodeniaceae									
Goodenia fascicularis			o	u					
Lamiaceae									
**Marrubium vulgare*	White Horehound						o	u	c
Linaceae									
Linum marginale	Native Flax	r							
Lobeliaceae									
Pratia concolor	Poison Pratia		c	c					
Malvaceae									

Scientific Name	Common Name	*Prasophyllum* sp. 'Moama'	Solar Farm grassland	Preferred Access Route	Grid Connection Route / Alternative Access				
					Electricity Substation surrounds	WP2	WP3	WP4	WP5
Sida corrugata	Corrugated Sida		u		a	c	c	c	c
Sida trichopoda	Hairy Sida	c		c					
Myrtaceae									
Eucalyptus largiflorens	Black Box		c						
Eucalyptus microcarpa	Grey Box						u		
Oxalidaceae									
Oxalis perennans	A Woodsorrel	c		u					
Plantaginaceae									
Plantago gaudichaudii	Narrow plantain	o							
Polygonaceae									
Duma florulenta	Lignum		o						
**Polygonum arenastrum*	Wireweed		o						
Rubiaceae									
Asperula wimmerana		c		u					
Solanaceae									
Solanum esuriale	Quena		c						
SUBCLASS LILIIDAE									
Cyperaceae									
Carex inversa			a						
Eleocharis sp.				o					
Juncaceae									
Juncus subsecundus			o						
Juncus sp. (1)				o					
Juncus sp. (2)	(Globular Head)			r					
Lomandraceae									
Lomandra sp.		o							
Phormiaceae									
Dianella porracea	Riverine Flax-lily	u							
Poaceae									
Anthosachne scabra	Wheatgrass	o							
Austrostipa setacea	Corkscrew Grass	c		u					
Austrostipa sp.						u			
**Avena barbata*	Bearded Oats	a	o	c	a	c	c	a	a

Scientific Name	Common Name	*Prasophyllum* sp. 'Moama'	Solar Farm grassland	Preferred Access Route	Grid Connection Route / Alternative Access				
					Electricity Substation surrounds	WP2	WP3	WP4	WP5
Bothriochloa macra	Red Grass				c				
**Bromus diandrus*	Great Brome								c
Chloris truncata	Windmill Grass			o					
Digitaria brownii	Cotton Panic Grass			r					
Enteropogon acicularis		c	o	c	o	o	c	o	a
**Lolium rigidum*	Wimmera Ryegrass		o						
Panicum decompositum	Native Millet	c	u	c				r	o
Rytidosperma duttonianum			o						
Rytidosperma sp.		a		a	c	o	c	a	a
Themeda triandra	Kangaroo Grass	u							
**Vulpia* sp.				a			a	a	a
No. Native Species	**59**	28	20	26	15				
No. Introduced Species	**15**	3	6	4	11				
Total Species	**74**	31	26	30	26				

*Introduced Species

SYDNEY
Ground floor, Suite 01, 20 Chandos Street
St Leonards, New South Wales, 2065
T 02 9493 9500 F 02 9493 9599

NEWCASTLE
Level 1, Suite 6, 146 Hunter Street
Newcastle, New South Wales, 2300
T 02 4907 4800 F 02 4907 4899

BRISBANE
Level 4, Suite 01, 87 Wickham Terrace
Spring Hill, Queensland, 4000
T 07 3839 1800 F 07 3839 1866

Appendix C

NOISE AND VIBRATION ASSESSMENT

amg

Assured Monitoring Group

MOAMA SOLAR FARM: NOISE & VIBRATION IMPACT ASSESSMENT

GEOLYSE PTY LTD

Project ID. 10935

R_3

DATE OF RELEASE: 20/02/2018

Unit 7, 142Tennyson Memorial Avenue – Tennyson – Queensland - 4105

ABN: 87 604 851 078

Table 1: Document approval

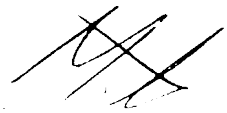
	Name	Position Title	Signature	Date
Author	Michelle Clifton	Senior Consultant		20/02/2018
Reviewer	Craig Beyers	Consulting Services Manager		20/02/2018
Approver	Craig Beyers	Consulting Services Manager		20/02/2018

Table 2: Revision register

Revision	Date	Name	Issued to	Comment
R_0	12/12/2017	C. Beyers	A. Brownlow	Formal report release
R_1	20/12/2017	C. Beyers	A. Brownlow	Revised to Address Comments
R_2	9/02/2018	C. Beyers	A. Brownlow	Formatting
R_3	20/02/2018	C. Beyers	A. Brownlow	Figure Updates

DISCLAIMER

Assured Monitoring Group acts in all professional matters as a faithful advisor to the Client and exercises all reasonable skill and care in the provision of its professional services.
Reports are commissioned by and prepared for the exclusive use of the Client. They are subject to and issued in accordance with the agreement between the Client and Assured Monitoring Group. Assured Monitoring Group is not responsible for any liability and accepts no responsibility whatsoever arising from the misapplication or misinterpretation by third parties of the contents of its reports.
Except where expressly stated, Assured Monitoring Group does not attempt to verify the accuracy, validity or comprehensiveness of any information supplied to Assured Monitoring Group for its reports.
Reports cannot be copied or reproduced in whole or part for any purpose without the prior written agreement of Assured Monitoring Group.
Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client or their nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Assured Monitoring Group is both complete and accurate. It is further assumed that normal activities were being undertaken at the site on the day of the site visit(s), unless explicitly stated otherwise.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 Scope of Assessment

The Assured Monitoring Group was appointed by Geolyse Pty Ltd to undertake a noise assessment for the proposed Moama Solar Farm project. The project involves construction and operation of a solar farm on three land parcels (Lots 71, 112 and 114 on DP751152), including grid connection to the Essential Energy substation to the south of the site.

The noise study has been undertaken to assess the potential impacts of the construction and operation of the proposed solar farm on nearby sensitive receptors in accordance with the following NSW policies and guidelines:

- NSW Environmental Protection Authority NSW Noise Policy for Industry (NPfI) (EPA, 2017).
- NSW Assessing Vibration: a technical guideline (DEC, 2006);
- NSW Road Noise Policy (DECCW, 2011); and
- Interim Construction Noise Guideline (DECCW, 2009).

In accordance with the requirements of the above guidelines, computational modelling and first principle calculations have been undertaken to support the assessment of the potential for adverse amenity impacts as a result of the development.

1.2 This Report

This report summarises the methodology, results and conclusions of the noise and vibration impact assessment. A glossary of terms is presented in Appendix A to assist the reader.

2 PROPOSED DEVELOPMENT SITE

2.1 Development Site

The proposed development site is located approximately 6 km north of Moama in southern New South Wales. Specifically, the proposed solar farm is to be constructed within the boundary of Lots 71, 112 and 114 on DP751152. Figure 1 presents the location of the site.

The area surrounding the proposed development includes a range of industrial, agricultural and rural uses with the Moama Golf Course located approximately 2.5 km to the south west of the subject site. To the north east of the site is Moama Waste Disposal Depot and sewage treatment plant.

2.2 Nearby Sensitive Receptors

The nearest off-site residential receptors to the proposed Solar Farm include 16 single existing dwellings located within 3 km of the proposed Solar Farm.

Table 3 and Figure 1 below provide a summary of the nearest sensitive uses to the proposed Moama Solar Farm development.

Table 3: Nearby Sensitive Receptors

Receptor ID	Description	Distance to Proposed Development Site
R1	Existing Dwelling	920 m
R2	Existing Dwelling	80 m
R3	Existing Dwelling	700 m
R4	Existing Dwelling	1,280 m
R5	Existing Dwelling	550 m
R6	Existing Dwelling	1,850 m
R7	Existing Dwelling	2,170 m
R8	Existing Dwelling	1,700 m
R9	Existing Dwelling	2,400 m
R10	Existing Dwelling	2,480 m
R11	Existing Dwelling	3,000 m
R12	Existing Dwelling	2,700 m
R13	Existing Dwelling	2,400 m
R14	Existing Dwelling	2,350 m
R15	Existing Dwelling	1,200 m
R16	Existing Dwelling	3,000 m
R17	Golf Course	2,800 m

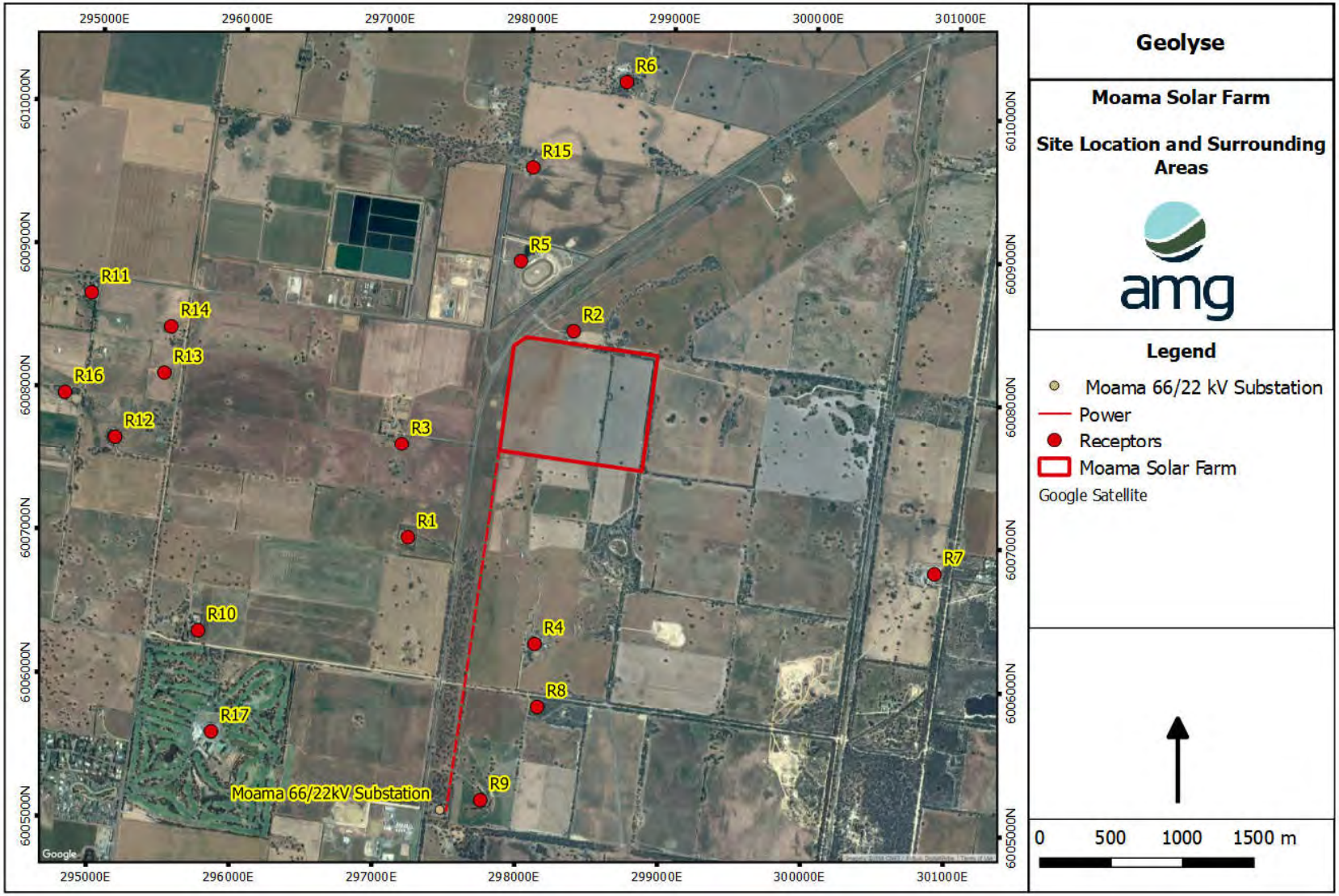


Figure 1: Site Location, Sensitive Receptors and Surrounding Land uses

2.3 Description of Development

The Moama Solar Farm is to consist of solar photovoltaic (PV) plant and associated infrastructure producing up to 30 Megawatts of electricity for supply into the grid. It is expected that, at completion, infrastructure installed on site will incorporate:

- a total of 101,562 solar panels;
- a switching station; and
- 10 solar inverters with integrated transformers.

The PV panels will be mounted onto fixed support structures by single axis tracking panels which track the suns movement across the day through the use of small motors which rotate the panel arc of the sun to maximise the solar effect.

Based on the size of the Moama Solar Farm it is estimated that 1,330 NexTracker tracking motors would be required. For the purposes of the assessment it is assumed that these tracking motors would be evenly distributed across the development area. Indicative placement of the inverters is shown in Figure 2

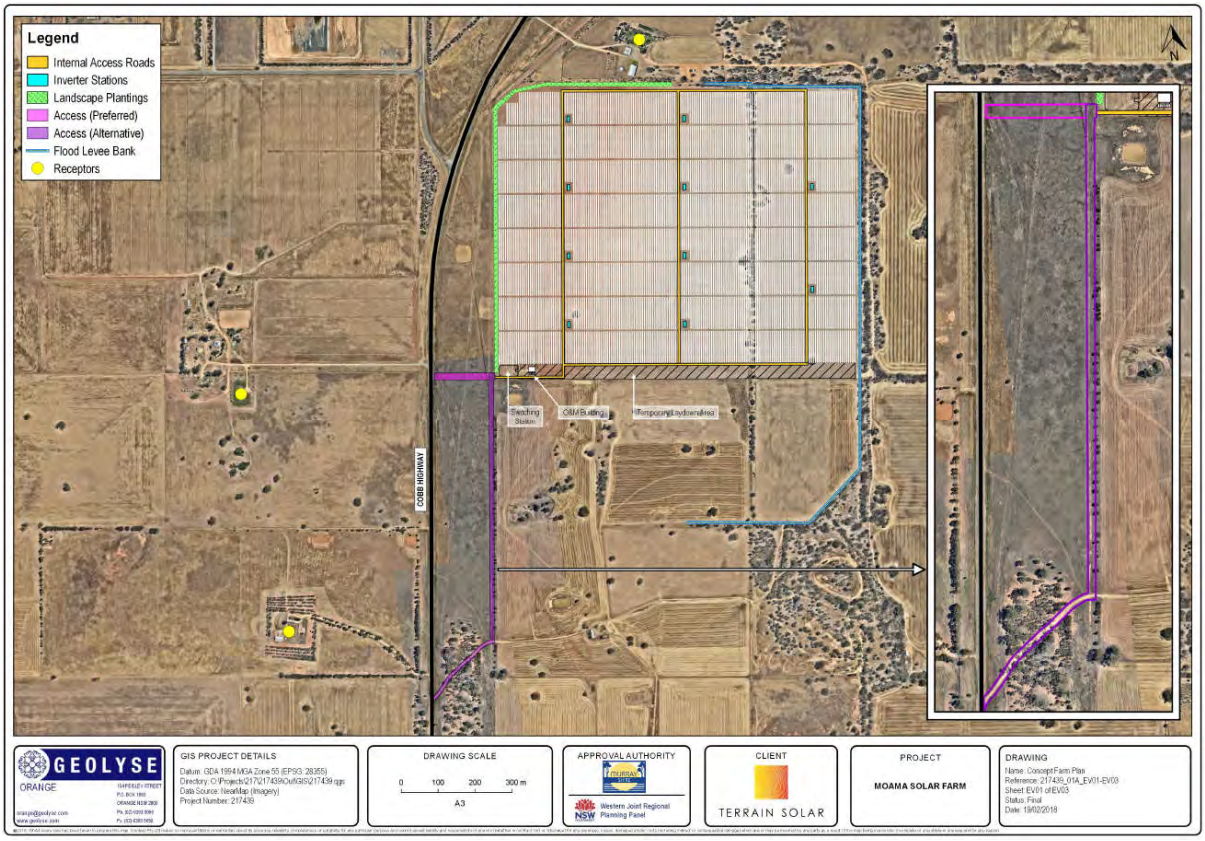


Figure 2: Concept Plan

Supply of electricity to the grid would be achieved via the nearby Essential Energy substation. In doing so, produced electricity will be transferred through an on-site switching station to the substation via a 22 kV underground line. As such, no transformer is required as part of the proposed solar farm development.

3 CONSTRUCTION NOISE ASSESSMENT

3.1 Duration of Construction Works

The construction of the Moama Solar Farm is expected to take approximately 12-months with a number of different activities undertaken over that time. Table 4 below presents an overview of each of the construction tasks along with their expected duration. It is noted that some of these tasks are likely to occur concurrently (e.g. site preparation and construction of the switching station is likely to be undertaken at the same time as installation of the solar PV modules and cabling).

Given the separation distance to the nearest existing sensitive receptors to the subject site there is potential for the duration of construction to be minimised through construction works outside standard hours (as described in Table 5 below). The assessment has therefore considered the potential for adverse amenity impacts associated with construction outside recommended standard hours.

Table 4: Construction Phases and Expected Duration

Construction Phase	Duration
Site clearing and preparation	3 months
Piling – installation of module mounting structures	3 months
Installation of solar PV modules & inverter assemblies and grid connection	5 months
Commissioning	3 months

3.2 Interim Construction Noise Guideline

Guidance on the assessment and management of construction noise in NSW is provided in the Interim Construction Noise Guideline 2009 (ICNG) published by the NSW EPA.

The main objectives of the Guideline are to:

- Promote a clear understanding of ways to identify and minimise noise from construction works;
- Focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts;
- Encourage construction to be undertaken only during the recommended standard hours, unless approval is given for works that cannot be undertaken during these hours;
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage;
- Provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts; and
- Provide guidelines for assessing noise generated during the construction phase of developments.

In achieving these objectives, the guideline provides a framework for the qualitative and quantitative assessment of potential construction noise impacts noting that, for major projects, a quantitative assessment is the preferred approach. Table 5 presents construction noise criteria outlined in the guideline. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

Table 5: NSW EPA Construction Noise Criteria – Residential Receivers

Time of Day	Management Level (Free-field)	How to Apply
Recommended standard hours: Monday to Friday, 7 am to 6 pm Saturday, 8 am to 1 pm No work on Sundays or public holidays	Noise affected 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 $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices 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 dB(A)	The highly noise affected 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 restricting the hours that the very noisy activities can occur, taking into account: • 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 • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected 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(A) above the noise affected level, the proponent should negotiate with the community.

Where nearby sensitive uses are predicted to be noise affected, the proponent of the project is required to apply reasonable and feasible noise mitigation measures noting that a noise

mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

For construction outside standard hours, the assessment criteria has been determined based on the minimum allowable RBL as provided in the NPfI. That is, for the purposes of the assessment it is assumed that the RBL is 30 dB(A) for night periods thereby resulting in a noise affected limit of 35 dB(A) for construction outside standard hours.

3.3 Construction Noise Sources

In terms of noise emissions, the site preparation activities and installation of the solar PV modules (specifically driving the support posts into the ground) are expected to represent those with the most significant potential for adverse impacts. The indicative project schedule has determined these two activities may occur concurrently. Therefore, for the purposes of the assessment, the impacts associated with these two elements have been assessed cumulatively.

It is noted that construction works are expected to progress across the site such that plant and equipment would only be in a single area for a short period of time. For example, each post takes approximately 25-30 seconds to drive into the ground thereby providing the ability to install a new pile approximately every 2.5 minutes. Given this, the potential for adverse impacts at any one receptor is expected to only occur for a short period of time. Table 6 below presents a summary of the plant and equipment likely to be required to complete the on-site construction works. The sound power levels presented have been sourced from published noise emission datasets and the library of source noise levels maintained by Assured Monitoring Group.

Table 6: Construction Phases and Expected Duration

Construction Phase	Plant Item	Number Required	Sound Power Level, dB(A)	Acoustical Usage Factor, % [e]
Site preparation and construction of site switching station [a]	Truck & Dog [b]	2	110	40
	Compactor	2	103	20
	Bulldozer	2	109	40
	Mulcher	1	116	20
	Grader [c]	2	108	40
	Water Cart (as required)	2	103	40
	Vibratory Roller	2	103	20
Installation of solar PV modules & inverter assemblies and grid connection	Post Pounding Machine [f]	2	112 - 124	20
	Franna Crane	2	107	16
	Trencher	2	97	40
	Loader	2	107	40
	Generator	1	73	50
	Trucks	20/day	108	40

Construction Phase	Plant Item	Number Required	Sound Power Level, dB(A)	Acoustical Usage Factor, % e)

a) Construction plant used intermittently as required. Continuous use not expected.

b) Truck movements associated with deliveries assumed to move through site at 10 km per hour as a moving point source.

c) Grader required for construction of access tracks, switching station, maintenance building, construction offices car park, minor earthworks and grading around the solar array area as required to meet structural tolerances for the tracker equipment.

d) Deliveries to site only to occur during standard construction hours.

e) The 'Acoustical Usage Factor' represents the percentage of time that a particular item of equipment is assumed to be running at full power while working on site.

f) Includes a correction for tonality.

It should be noted that the piling sound power level used in the model is 107 dB(A) (excluding tonality correction) as presented in Table 6.

3.4 Assessment of Impacts

For the purposes of predicting impacts associated with noise emissions from the development site on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (version 2018 build 161.4800) developed by DataKustik. Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors.

The model is utilised to assess the potential noise emissions from the site under a range of operating scenarios and meteorological conditions. In the event that non-compliance with the assessment criterion is predicted, the noise modelling also allows investigation of possible noise management solutions.

For the construction phase of the proposed project, predictive noise modelling has considered the range of potential impacts likely noting that noise generating activities will progressively move across the site over the duration of construction. As such, the highest noise levels would not be expected to be experienced at a single receptor for more than one day while construction equipment (e.g. piling drill rig) is at the closest point to the receptor.

Table 7 below presents predicted receptor noise levels during the construction phase of the proposed solar farm.

Table 7: Predicted Receptor Noise Levels - Construction Phase, dB(A)

Receptor	Description	Predicted Construction Noise Levels, $L_{Aeq, 15min}$	Noise Management Level		Comply (Y/N)
			Standard Hours	Outside Standard Hours	
R01	Existing receptor	40	40	35	Y [a]
R02	Existing receptor	40	40	35	Y [a]

Receptor	Description	Predicted Construction Noise Levels, $L_{Aeq, 15min}$	Noise Management Level		Comply (Y/N)
			Standard Hours	Outside Standard Hours	
R03	Existing receptor	39	40	35	Y [a]
R04	Existing receptor	37	40	35	Y [a]
R05	Existing receptor	29	40	35	Y
R06	Existing receptor	13	40	35	Y
R07	Existing receptor	<10	40	35	Y
R08	Existing receptor	33	40	35	Y
R09	Existing receptor	<10	40	35	Y
R10	Existing receptor	<10	40	35	Y
R11	Existing receptor	<10	40	35	Y
R12	Existing receptor	<10	40	35	Y
R13	Existing receptor	<10	40	35	Y
R14	Existing receptor	<10	40	35	Y
R15	Existing receptor	26	40	35	Y
R16	Existing receptor	<10	40	35	Y
R17	Golf course	<10	40	35	Y

a) Compliance predicted during standard construction hours only. Non-compliance outside standard construction hours likely for some construction activities.

Given the predicted compliance with the noise limits derived in accordance with the NPfI, no further noise mitigation is considered necessary.

Based on the results of the assessment, acceptable noise amenity impacts can be achieved throughout the construction works. Where appropriate management controls are implemented including:

- Using broad-band reversing alarms on all mobile plant and equipment where possible;
- Examining different types of machines that perform the same function and compare the noise level data to select the least noisy machine;
- Select quieter items of plant and equipment where feasible and reasonable.;
- Operating plant in a quiet and efficient manner;
- Reduce throttle setting and turn off equipment when not being used; and
- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.

Overall, given the size of the subject site, there is potential for construction works to be undertaken outside standard hours subject to the effective implementation of the above reasonable and feasible mitigation measures. Further, given the tendency for agricultural activities to be undertaken during evening and night periods (e.g. during harvest season etc.), construction during these periods, when undertaken concurrently with these agricultural activities is unlikely to represent a significant amenity impact for residences in the area.

4 OPERATIONAL PHASE NOISE ASSESSMENT

4.1 Operational Noise Criteria

4.1.1 Overview

The acoustic assessment has been completed in accordance with the procedure identified in the NSW NPfI. The NPfI establishes two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. These two criteria are then used to determine project triggers levels against which the proposed development will be assessed. The project noise trigger level is a level that, if exceeded, would indicate a potential noise impact on the community, and so 'trigger' a management response.

The derivation of the two sets of criteria are presented below. For residential dwellings, the noise criteria are assessed at the most-affected point (i.e. highest noise level) on or within the property boundary. Where the property boundary is more than 30 metres from the house, then the criteria applies at the most-affected point within 30 m of the house.

4.1.2 Intrusiveness Noise Criteria

The project intrusiveness noise level is intended to protect against significant changes in noise levels as a result of industrial development. To achieve this, the NPfI describes intrusive noise as noise that exceeds background noise levels (as defined by the Rating Background Level or RBL) by more than 5 dB.

For the purposes of the assessment, baseline noise levels have been assumed to be equivalent to the minimum background noise levels provided in the NPfI. At some receptors, where there is likely to be an influence during day periods from existing industrial activity in the area, this is considered to represent a conservative assumption. Table 8 presents the derivation of the intrusiveness criteria based on the minimum background noise level established by the NPfI.

Table 8: Derived Intrusiveness Noise Criteria

Receptor	Intrusiveness $L_{Aeq,15\text{-minute}}$ Criteria		
	Day	Evening	Night
All nearby residential receptors [a]	40 [b]	35 [b]	35 [b]

a) Receptor noise limit applied at a location 30 m from the dwelling façade.

b) Minimum background noise level established by the NPfI 2017 (35 dB(A)) for day periods and 30 dB(A) for evening and night periods + 5 dB.

4.1.3 Amenity Criteria

The project amenity noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Review of the surrounding area has identified that to the north west of the proposed solar farm, there is an industrial zone incorporating a landfill, sewage treatment plant and a scrap metal yard. Therefore, in accordance with the NPfI, the project amenity noise criteria are derived in Table 9 below for the uses in the area.

Table 9: NPfI Acceptable Noise Levels for Sensitive Receivers

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, (dB(A))	
			Total Industrial Noise	Project Specific
Residence	Rural	Day	50	45
		Evening	45	40
		Night	40	35
Recreational Area (golf course)	All	When in use	55	50

4.1.4 Project Trigger Levels

The project trigger level is the lower value of the project intrusiveness noise level and the project amenity level, after the conversion to $L_{Aeq,15min}$ dB(A) equivalent level. Table 10 presents the standardised intrusiveness noise level and the project amenity level as derived by adding 3 dB to each period of the day.

Table 10: Determining Project Trigger Levels

Type of Receiver	Time of Day	Standardised $L_{Aeq,\ 15\ min}$ Noise Level (dB)		
		Intrusiveness Criteria	Project Specific ANL	Project Trigger Level
Residential	Day	40	45 + 3 = 48	40
	Evening	35	40 + 3 = 43	35
	Night	35	35 + 3 = 38	35
Golf Course	When in Use	- [a]	50 + 3 = 53	53

a) Intrusive Nosie levels are only applied to residential receivers. For all other types ANL are used.

4.1.5 Sleep Disturbance

NSW EPA have identified a screening assessment for sleep disturbance based on the night-time noise levels at a residential location. Where noise levels at a residential location exceed:

- $L_{Aeq,\ 15\ min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is greater; and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 whichever is the greater,

a detailed maximum noise level event assessment should be undertaken.

For the operational phase of the project, loud impact noises associated with sleep disturbance are considered unlikely with all plant and equipment continuous or semi-continuous in its operations. Furthermore, the operation of plant and equipment on-site is

expected to only occur during daylight hours where solar energy is available with peak operations.

Given the lack of short-term impact noise sources on site consideration of sleep disturbance impacts for the operational phase of this project is considered unnecessary. Rather, where compliance can be demonstrated with the intrusive noise criteria established for the development, compliance with the sleep disturbance provisions would also be expected.

4.2 Noise Sources

As noted in Section 2.3, the Moama Solar Farm is to consist of an estimated:

- 101,562 solar panels with approximately 1330 NexTracker tracking motors; and
- 10 solar inverters with integrated transformers.

Noise emissions from the tracking motors are expected to occur for approximately one minute out of each 15-minute period (providing for up to five degrees' rotation per hour) during day periods.

Table 11 presents a summary of the source noise levels considered in the assessment. The sound power levels for the plant and equipment presented in the table below are as provided by the manufacturer or taken from information held in our library.

Table 11: Source Noise Levels

Source	Sound Power Level (dB(A))
NexTracker	60 (each)
Inverter [a)]	92 (each)
Light Vehicle	88

a) Based on previous experience with similar sources there is potential for tonal influences associated with this source. Therefore, in accordance with the NPfI, a +5 dB penalty has been applied to this source.

4.3 Noise Modelling Methodology

For the purposes of predicting impacts associated with noise emissions from the development site on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (version 2018 build 161.4800) developed by DataKustik. Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors.

The model is utilised to assess the potential noise emissions from the site under a range of operating scenarios and meteorological conditions. The noise modelling also allows investigation of possible noise management solutions, in the event that non-compliance with the assessment criterion is predicted.

4.4 Meteorology

The NSW Noise Policy for Industry (NPfI) presents guidelines for the consideration of meteorological effects on noise propagation. Specifically, temperature inversions and/or gradient winds should be modelled if each factor is a feature of the local environment. The following conditions for modelling temperature inversions or gradients winds are provided:

- temperature inversions:
  - use default parameters for temperature inversions and drainage-flow wind speed where inversions are present for at least 30 percent of the total night time during winter as specified; or
  - use parameters determined by direct measurement. Wind data should be collected at a 10-m height.
- gradient winds:
  - where there is 30 percent or more occurrence of wind speeds below 3 m/s (source-to-receiver component), then the highest wind speed (below 3 m/s) is used instead of the default.
  - where there is less than 30 percent occurrence of wind speeds of up to 3 m/s (source-to-receiver component), wind is not included in the noise prediction calculation.

Given the location of the site, the presence of temperature inversions is considered possible for night-periods. Therefore, in accordance with the requirements of the NPfI, the following scenarios have been considered:

- Day Periods - Source to receptor wind at 3 m/s representing a worst-case assessment of potential impacts for day-periods; and
- Night Periods - Moderate temperature inversion with light source to receptor winds representing a worst-case assessment of potential impacts for night periods.

4.5 Predicted Noise Levels

Table 12 below presents predicted receptor noise levels during the operational phase of the proposed solar farm. Review of the predicted noise levels confirms that compliance with the intrusive noise criteria established in accordance with the NPfI can be achieved for all receptors for both day and night periods under worst-case meteorological conditions.

Table 12: Predicted Receptor Noise Levels - Operational Phase, dB(A)

Receptor	Predicted Operational Noise Levels, $L_{Aeq, 15min}$		Day / Evening / Night Trigger Level Criteria	Comply (Y/N)
	Day Periods	Night Periods		
R1	25	26	40 / 35 / 35	Y
R2	29	35	40 / 35 / 35	Y
R3	26	28	40 / 35 / 35	Y
R4	23	23	40 / 35 / 35	Y
R5	18	26	40 / 35 / 35	Y
R6	<10	<10	40 / 35 / 35	Y
R7	<10	<10	40 / 35 / 35	Y

Receptor	Predicted Operational Noise Levels, $L_{Aeq, 15min}$		Day / Evening / Night Trigger Level Criteria	Comply (Y/N)
	Day Periods	Night Periods		
R8	16	16	40 / 35 / 35	Y
R9	<10	<10	40 / 35 / 35	Y
R10	<10	<10	40 / 35 / 35	Y
R11	<10	<10	40 / 35 / 35	Y
R12	<10	<10	40 / 35 / 35	Y
R13	<10	<10	40 / 35 / 35	Y
R14	<10	<10	40 / 35 / 35	Y
R15	11	19	40 / 35 / 35	Y
R16	<10	<10	40 / 35 / 35	Y
R17	<10	<10	53	Y

5 ROAD TRAFFIC NOISE ASSESSMENT

5.1 Introduction

Noise impacts associated with vehicle movements during the operational phase of the Moama Solar Farm project are expected to be negligible given the small number of movements expected (maximum of six per day for three permanent staff). During the construction phase of the project however, significantly higher traffic volumes are expected for the duration of the construction works.

Construction is expected to be completed over a 12-month period with an expected peak period of six months during which a range of construction tasks are concurrently undertaken. During this peak, it is anticipated that up to 100 workers would be on-site daily, dropping to 20 workers for the six-month shoulder periods.

While it is expected that the contractor would provide a shuttle bus service, for assessment purposes it is assumed that only 30% of the 100 workers would participate in some form of carpooling. Therefore, the modelling has assumed an estimated maximum of 70 private light vehicles travelling to and from the site daily for this peak period.

The infrastructure will be delivered to the site via the Cobb Highway and off-loaded within a designed lay-down area located at the south-western corner of the development site.

The maximum number of heavy vehicles accessing the site during the peak of the construction period is not expected to exceed 20 (i.e. generating a total of 40 heavy vehicle movements in a day).

Given this, the assessment has considered the potential impacts associated with noise emissions from the maximum expected 140 light and 40 heavy vehicle movements from the site entry onto the Cobb Highway as summarised in Table 13 below.

Table 13: Summary of Road Traffic Data

Road Segment	Vehicle Type	Vehicle Speed	Number of Movements	
			Day (7 am to 10 pm)	Night (Peak 1-hour)
Cobb Highway	Light	100 km/hr [b]	140	70
	Heavy	100 km/hr [b]	40	0

a) Assumes all truck deliveries to site occur during the hours of 7 am to 10 pm.

b) At the entry and approach to the site access vehicle speeds are expected to be significantly low than the sign-posted limits.

5.2 Assessment Criteria

The ICNG does not provide criteria for the assessment of construction road traffic during the project. Given this, reference is made to the noise criteria provided in the NSW Road Noise Policy (RNP). Based on the type of roadway, Table 14 below presents the applicable road traffic noise criteria for existing residences affected by traffic on existing roadways generated by land use developments.

Table 14: Applicable Road Traffic Noise Criteria

Road Category	Type of Project & Land Use	Assessment Criteria
Freeway / arterial / sub-arterial road	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	Day: $L_{Aeq,15\ hour}$ 60 dB(A) Night: $L_{Aeq,9\ hour}$ 55 dB(A) (external)

5.3 Noise Modelling Methodology

For the purposes of predicting impacts associated with road traffic noise emissions was completed using the proprietary software Cadna (version 2018 build 161.4800) developed by DataKustik. The model incorporates the influence of terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with Calculation of Road Traffic Noise (CRTN) methodology developed by the UK Department of Transport. In accordance with the requirements of the RNP, the predictive noise modelling incorporated the following assumptions:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CRTN methodology using the approximation $L_{Aeq,1\ hour} = L_{A10,1\ hour} - 3$.
- Noise source heights were set at 0.5 m above road level for cars, 1.5 m for heavy vehicle engines and 3.6 m for heavily vehicle exhausts.
- Noise from heavy vehicle exhausts is 8 dB lower than the steady continuous engine noise; and
- Corrections established for Australian conditions applied through a negative correction to the CRTN predations of -1.7 dB for façade-corrected levels (Samuels and Sauders, 1982).

Table 15 below presents predicted noise levels for the nearest potential receptor to the Cobb Highway assuming a minimum setback distance of 60 m[a]. It should be noted that this is considered to represent a conservative assumption with the majority of dwellings along the Cobb Highway noted to be setback more than 100 m from the roadway.

Review of the predicted noise level presented in Table 15 below confirms that compliance with the RNP is predicted by a considerable margin. As such, adverse amenity impacts due to peak traffic levels generated by the proposed construction works is considered unlikely.

Table 15: Predicted $L_{Aeq,15\ hour}$ Noise Levels - Road Traffic Noise

Receptor	Setback from Roadway	Period	Parameter	Criteria	Predicted Noise Level	Comply (Y/N)
Nearest to Cobb Highway	60 m	Day	$L_{Aeq,15\ hour}$	60 dB(A)	53	Y
		Night	$L_{Aeq,9\ hour}$	55 dB(A)	46	Y

[a] To represent the distance of sensitive receptors to Cobb Highway closer to Moama

6 VIBRATION ASSESSMENT

6.1 Introduction

A review of the proposal indicates there is potential for impacts as a result of vibration generated by plant and equipment during the construction phase. Given this, an assessment of the potential for vibration impacts has been undertaken. In particular, the assessment has considered the potential for impacts on both human comfort and structural damage for the nearest residence to the construction works.

6.2 Assessment Criteria

The vibration criteria presented in the Environmental Noise Management – Assessing Vibration: A Technical Guide (2006) published by the NSW Department of Environment Climate Change and Water (DECCW) have been adopted for the assessment. The technical guide provides vibration criteria associated with amenity impacts (human annoyance) for the three categories of vibration:

- Continuous vibration (e.g. road traffic, continuous construction activity);
- Impulsive vibration includes less than 3 distinct vibration events in an assessment period (e.g. occasional dropping of heavy equipment); and
- Intermittent vibration includes interrupted periods of continuous vibration (e.g. drilling), repeated periods of impulsive vibration (e.g. pile driving) or continuous vibration that varies significantly in amplitude.

Table 16 and Table 17 present the criteria for continuous and impulsive vibration and intermittent vibration, respectively.

Table 16: Continuous & Impulsive Vibration Criteria for Residences – Peak Velocity

Location	Vibration Type	Preferred Limit (mm/s)	Maximum Limit (mm/s)
Residences	Continuous	0.28	0.56
Residences	Impulsive	8.6	17

Table 17: Intermittent Vibration Criteria for Residences

Location	Assessment Period	Preferred Value ($m/s^{1.75}$)	Maximum Value ($m/s^{1.75}$)
Residences	Day-time	0.20	0.40

The above criteria are suitable for assessing human annoyance in response to vibration levels. In order to assess potential damage to buildings, reference has been made to British Standard BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration. Table 18 presents vibration criteria for assessing the potential for building damage.

Table 18: Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Particle Velocity (mm/s)	
	4 Hz to 15 Hz	15 Hz and above
Unreinforced or light framed structures – residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

6.3 Potential Vibration Sources

Table 19 identifies the vibration source levels for the equipment and likely to be used for the construction of the solar farm.

Table 19: Vibration Source levels – Peak Particle Velocity

Equipment Item	PPV at 10 metres (mm/s)	Source
Piling	1 – 2	Rockhill, D.J. et. al. [b)]
Roller	5 – 6	DECCW
7 tonne compactor	5 – 7	DECCW
Loaded trucks (rough surface)	5	USA DT [a)]
Loaded trucks (smooth surface)	1 – 2	USA DT [a)]
Excavator	2.5 – 4	DECCW

c) Transit Noise and Vibration Impact Assessment, US Department of Transportation, May 2006.

d) Rockhill, D.J., Bolton, M.D. & White, D.J. (2003) 'Ground-borne vibrations due to press-in piling operations'

6.4 Assessment of Potential Impacts

Based on the vibration source levels at 10 metres (presented in Table 19), peak particle velocities have been predicted at various separation distances. The NSW DECCW indicates that in predicting vibration levels, it can be assumed that the vibration level is inversely proportional to distance (with the relationship varying between $d^{-0.8}$ to $d^{-1.6}$ based on field data).

The US Department of Transportation's Transit Noise and Vibration Impact Assessment (May 2006) presents the following construction vibration propagation formula assuming an inverse relationship:

$$PPV@d_2 = PPV@d_1 \times (d_1/d_2)^{1.5}$$

where: d_1 = distance 1 (reference distance for source data) (m)
d_2 = distance 2 (separation distance for predicted PPV) (m)
PPV = peak particle velocity (mm/s)

The above formula has been considered for predicted PPVs at various distances from construction equipment. Based on the above information, Table 20 presents PPV predictions for the various construction equipment.

Table 20: Predicted Peak Particle Velocity at Sensitive Receptors (mm/s)

Distance from Source (m)	Predicted Peak Particle Velocity (mm/s)					
	Roller	7 tonne compactor	Excavator	Piling	Loaded trucks (rough surfaces)	Loaded trucks (smooth surfaces)
10	6.00	7.00	4.00	0.35 - 0.71	5.00	1 – 2
20	2.12	2.47	1.41	0.19 - 0.38	1.77	0.35 – 0.71
30	1.15	1.35	0.77	0.13 - 0.25	0.96	0.19 – 0.38
40	0.75	0.88	0.50	0.09 - 0.18	0.63	0.13 – 0.25
50	0.54	0.63	0.36	0.07 - 0.14	0.45	0.09 – 0.18
60	0.41	0.48	0.27	0.05 - 0.11	0.34	0.07 – 0.14
70	0.32	0.38	0.22	0.04 - 0.09	0.27	0.06 – 0.11
80	0.27	0.31	0.18	0.04 - 0.07	0.22	0.05 – 0.09
90	0.22	0.26	0.15	0.03 - 0.06	0.19	0.04 – 0.07
100	0.19	0.22	0.13	0.02 - 0.03	0.16	0.03 – 0.06
150	0.1	0.12	0.07	0.35 - 0.71	0.09	0.02 – 0.03
Type	Continuous	Continuous	Continuous	Intermittent	Intermittent	Intermittent
Nuisance Criteria	Residential 0.28 (preferred) / 0.56 (max) School 0.56 (preferred) / 1.1 (max)					
Building Criteria	Residential 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above					

The predicted vibration levels presented in Table 20 indicate compliance with the continuous preferred vibration nuisance criteria for locations at a separation distance of 50-60 metres. Compliance with the building damage criteria is predicted at 10 metres from construction for each source.

For intermittent vibration associated with haul vehicles and piling, it is difficult to provide an appropriate comparison with the relevant criteria (which is presented as a Vibration Dose Value (VDV) in $m/s^{1.75}$). The calculation of a VDV requires both the overall weighted RMS (root mean square) acceleration (m/s^2) typically obtained from on-site measurements and the estimated time period for vibration events.

It is noted, however, that the piling PPV at distances of 220 m (the distance to the nearest sensitive receptor from potential piling) is predicted to be within the maximum continuous criteria of 0.56 mm/s. This comparison with the continuous criteria (as a conservative approach) indicates that vibration levels associated with piling are not considered to be significant (which is expected given the significant separation distances).

7 CONCLUSIONS AND RECOMMENDATIONS

Terrain Solar propose to construct a solar farm (to be known as the Moama Solar Farm) on three land parcels (Lots 71, 112 and 114 on DP751152). The area surrounding the proposed development is sparsely populated with dominant activities including a range of agricultural and rural uses.

The impact assessment has considered the potential for adverse impacts resulting from noise (construction, road traffic and operational) and vibration (construction) emissions on nearby residential uses.

The impact assessment has considered the potential for adverse impacts resulting from noise (site clearing and installation construction phases and operational) and vibration (construction) emissions on nearby residential uses.

The assessment of potential noise impacts has considered construction during standard construction hours. Based on the results of the assessment, acceptable noise amenity impacts can be achieved throughout the construction works. where appropriate management controls are implemented including:

- Using broad-band reversing alarms on all mobile plant and equipment where possible;
- Examining different types of machines that perform the same function and compare the noise level data to select the least noisy machine;
- Select quieter items of plant and equipment where feasible and reasonable.;
- Operating plant in a quiet and efficient manner;
- Reduce throttle setting and turn off equipment when not being used; and
- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.

For the operational phase of the project, adverse amenity impacts are considered unlikely with compliance with the project noise limits predicted for all receptors by a significant margin.

Overall, based on the results of the assessment, the risk of adverse impacts as a result of the proposed Moama Solar Farm is considered to be low and complies with all applicable criteria. Hence, from an acoustic perspective, the proposed development site is considered acceptable for the proposed use.

APPENDIX A: GLOSSARY OF TERMS

A-Weighting	A response provided by an electronic circuit which modifies sound in such a way that the resulting level is similar to that perceived by the human ear.
dB (decibel)	This is the scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and the reference pressure (0.00002 N/m^2).
dB(A) or dBA	This is a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Free-field	Refers to a sound pressure level determined at a point away from reflective surfaces other than the ground with no significant contribution due to sound from other reflective surfaces; generally, as measured outside and away from buildings.
L_{Aeq}	This is the equivalent steady sound level in dB(A) containing the same acoustic energy as the actual fluctuating sound level over the given period. Noise levels often fluctuate over a wide range with time. Therefore, when a noise varies over time, the L_{Aeq} is the equivalent continuous sound which would contain the same sound energy as the time varying sound. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.

Appendix D

GLARE ASSESSMENT

GlareGauge Glare Analysis Results

Site Configuration: Moama Solar Farm

Project site configuration details and results.

Created Feb. 5, 2018 11:46 p.m.
Updated Feb. 6, 2018 4:32 p.m.
DNI varies and peaks at 1,000.0 W/m^2
Analyze every 1 minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Site Configuration ID: 14659.2348

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)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 8.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 60.0 deg
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	-36.055151	144.755511	99.45	2.60	102.05
2	-36.048652	144.756648	97.70	2.60	100.30
3	-36.048110	144.757597	98.46	2.60	101.06
4	-36.049411	144.767447	98.70	2.60	101.30
5	-36.056411	144.766331	98.01	2.60	100.61

Flight Path Receptor(s)

Name: Approach from North
Description:
Threshold height: 15 m
Direction: 173.2 deg
Glide slope: 3.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 120.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	-36.071658	144.764209	98.27	15.24	113.51
2-mile point	-36.042949	144.759969	98.35	183.85	282.19

Name: Approach from South
Description:
Threshold height: 15 m
Direction: 353.2 deg
Glide slope: 3.0 deg
Pilot view restricted? Yes
Vertical view restriction: 30.0 deg
Azimuthal view restriction: 120.0 deg

Point	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	-36.079714	144.765129	100.66	15.24	115.90
2-mile point	-36.108423	144.769370	101.00	183.58	284.58

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	-36.047512	144.761315	98.05	1.80	99.85
OP 2	-36.054668	144.747899	99.94	1.80	101.74
OP 3	-36.060548	144.748435	99.79	1.80	101.59
OP 4	-36.067209	144.758220	101.38	1.80	103.18
OP 5	-36.071129	144.758456	98.61	1.80	100.41
OP 6	-36.037136	144.758155	101.07	1.80	102.87
OP 7	-36.031740	144.765451	102.00	1.80	103.80
OP 8	-36.047173	144.729960	99.77	1.80	101.57
OP 9	-36.050114	144.729413	97.00	1.80	98.80
OP 10	-36.052326	144.725443	99.60	1.80	101.40
OP 11	-36.058857	144.729788	99.50	1.80	101.30
OP 12	-36.066337	144.732020	101.88	1.80	103.68
OP 13	-36.044566	144.724101	100.78	1.80	102.58
OP 14	-36.051372	144.721726	97.30	1.80	99.10
OP 15	-36.062847	144.789318	98.79	1.80	100.59
OP 16	-36.077008	144.753993	101.41	1.80	103.21
OP 17	-36.073037	144.732728	100.86	1.80	102.66
OP 18	-36.043790	144.758434	97.57	1.80	99.37
OP 19	-36.044146	144.753649	98.10	1.80	99.90
OP 20	-36.045126	144.744991	99.00	1.80	100.80
OP 21	-36.078664	144.748564	99.19	1.80	100.99
OP 22	-36.057842	144.753070	100.00	1.30	101.30
OP 23	-36.054780	144.753596	99.75	1.30	101.05
OP 24	-36.052178	144.754186	99.79	1.30	101.09
OP 25	-36.049888	144.755216	98.57	1.30	99.87
OP 26	-36.047390	144.757093	98.04	1.30	99.34
OP 27	-36.045117	144.759711	98.91	1.30	100.21

PV Array Results

PV array 1

Component	Green glare (min)	Yellow glare (min)
FP: Approach from North	0	0
FP: Approach from South	0	0
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

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.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.
- 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.

Appendix E

CONSIDERATION OF DCP

The *Murray Development Control Plan 2012* supports the *Murray Local Environmental Plan 2011* by providing additional controls and objectives. It is a policy document.

Each section of the DCP identifies Design Principles, which are an expression of Council's expectations. Development Application are to be consistent with these principles.

Whilst all developments should aim to satisfy all controls within the DCP, it is acknowledged that there may be circumstances where it may not be possible to achieve strict compliance. In exceptional circumstances Council may consider a variance to a development control but only where the applicant has comprehensively demonstrated in writing and/or with other plans that the objective can still be achieved.

The relevant provisions of the DCP are considered in **Table 20.1.**

Table 20.1 – DCP Compliance

Section	Requirement	Assessment	Compliance
RESIDENTIAL DEVELOPMENT			
Section 2	This section of the DCP applies to all forms of residential development in the Shire for which a development application is required.	The solar farm is not a residential development	N/A
INDUSTRIAL DEVELOPMENT			
Section 3	This section of the DCP applies to all forms of industrial development in the Shire for which a development application is required.	The solar farm is infrastructure and not, by definition, industrial development. The development site is not located on land zoned IN1 or IN2. Notwithstanding, commentary against the Objectives and Controls is provided below.	
Appearance	Buildings on sites fronting the Cobb Highway to be designed to a high control and make a positive contribution to the northern entrance to Moama.	Landscape screen planting along the western boundary is proposed.	Yes
Landscaping	A landscape buffer between industrial developments and adjoining or nearby non industrial land uses.	Landscape screen planting along the western half of the northern boundary, and the along the western boundary is proposed. Existing stands of native vegetation to the east provide an existing buffer. The planting will be 5 m wide and species associated with the Black Box Lignum woodland community present in the area.	Yes
Building setbacks		All buildings will have a minimum 10 metre setback from the property boundary.	Yes
Parking and Access	Sufficient on-site parking for employees and visitors.	Post construction five (5) car parking spaces will be provided. Three staff are proposed. A temporary laydown area during construction will provide sufficient space for car parking.	Yes
Outdoor Areas	Screen outdoor storage and work areas as seen from public land and non-industrial land uses.	Post construction no outdoor storage areas are proposed.	N/A

Table 20.1 – DCP Compliance

Section	Requirement	Assessment	Compliance
Amenity	Locating industrial activities in locations that minimise detrimental offsite impacts. Minimise amenity impacts on residential and future residential areas.	The MSF is not a potentially hazardous or offensive development and will not cause amenity impacts on residential or future residential areas.	Yes
Signage	Signage that is of a high professional control. Signage that does not detrimentally affect the streetscape or highway corridor. Signage to the minimal extent necessary.	Signage will be restricted to providing contact details for the owner of the MSF and will be maintained in good condition at all times.	Yes
COMMERCIAL DEVELOPMENT			
Section 4	This section of the DCP applies to all forms of commercial development in the Shire for which a development application is required.	The solar farm is not a commercial development and is not located in the central business area, local and neighbourhood centres, neighbourhood shops and Business Development Zone.	N/A
TOURIST ACCOMMODATION			
Section 5	This section of the DCP applies to tourist accommodation in the Shire for which a development application is required.	The solar farm does not provide tourist accommodation.	N/A
STRATEGIC LAND USE PLAN			
Section 6	This section of the DCP relates to the application of the Councils Strategic Land use Plan (SLUP). The overall purpose of the SLUP is to guide future development and use of land within the Shire, more specifically to assist in the following:		
	Maintaining in production agricultural land not required for urban expansion.	The development of the site would not result in any significant reduction in the overall agricultural productivity of the district and the land can be readily returned to agricultural use if the solar farm is decommissioned in 30 years.	No
	Protecting the riverine environment from use and development detrimental to it.	The MSF will have no impact on the riverine environment.	N/A
	Separating incompatible land uses	As detailed in **Section 5**, the MSF is not an incompatible land use at the site proposed.	Yes
	Reducing development speculation	The solar farm will not contribute to development speculation.	N/A
	Considering tourist development proposals	The solar farm is not a tourist development	N/A

Table 20.1 – DCP Compliance

Section	Requirement	Assessment	Compliance
	Discouraging development on flood prone land	As detailed in Section 11, whilst the development site is located on flood prone land, it is a low hazard flood storage area and the MSF will not exacerbate any flooding impacts.	Noted
	Moama Structure Plan	The development site is not located on land mapped on the Moama Structure Plan	N/A
SUBDIVISION			
Section 7	Section 7 contains the controls for the subdivision of land.	The solar farm Development Application does not include subdivision.	N/A
URBAN RELEASE AREAS			
Section 8	This section of the DCP applies to land shown on the Urban Release Area (URA) Map of the Murray LEP. This land is essentially the 'greenfield' development area to accommodate the future growth of Moama over the next 15 to 20 years.	The solar farm development is not located on lands mapped as Urban Release Area.	N/A
VEGETATION REMOVAL			
Section 9		Refer **Appendix B**	Yes
WATERCOURSES AND RIPARIAN LAND			
Section 10	This section of the DCP provides controls for development to minimise environmental impacts on land within or adjacent to a watercourse.	The development is not located on or adjacent to a mapped watercourse or riparian land. No aquatic or riparian habitats and ecosystems will be impacted.	N/A
FLOOD PRONE LAND			
Section 11	This section of the DCP applies to land use and development on flood prone land within the Shire. Proposed developments will be considered on their merits in terms of flooding impacts.	Refer Section 11.	Yes
NOTIFICATION POLICY			
Section 12	This section of the DCP outlines Councils notification and exhibition requirements for development matters.		Noted