ESSENTIAL ECONOMICS

Pallamana Solar Farm Project

Economic Impact Assessment

FINAL

Prepared for

RES Australia

by

Essential Economics Pty Ltd

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Authorship

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EXECUTIVE SUMMARY

RES Australia Pty Ltd (RES) have commissioned Essential Economics Pty Ltd to prepare an Economic Impact Assessment (EIA) for the proposed 176 Mega Watt (MW) Pallamana Solar Farm development to be located 75km south east of Adelaide and 5km north of Murray Bridge in South Australia.

The solar farm facility, which is subject to planning approval from State Government under a Crown Sponsorship (Section 49) application process, will be located across a 730ha site, with construction anticipated to start in late 2018. Subject to planning approval and financing, the Pallamana Solar Farm facility is expected to be operational by mid-2020.

The main findings of this EIA are summarised as follows.

Regional Economic Context

1 The Study Area (which includes the Local Government Areas of Mount Barker, Mid Murray and Murray Bridge) has a resident population of around 64,000 persons (2016), which is expected to reach approximately 76,400 persons by 2031, representing annual growth of 1.2% pa over the period which is higher than the forecast State growth of 0.8% pa over the 15 years. However, the Mid Murray Council area is projected to decline in population at a rate of -0.5% pa over the coming 15 years, and therefore new infrastructure projects which provide local economic stimulus should be welcomed.

2 The Study Area currently has an unemployment rate of 7.0%, which is above the unemployment rate for South Australia of 6.7% and includes 2,330 persons who are unemployed. In this regard, construction of the Pallamana Solar Farm provides new short-term employment opportunities for the region’s labour force participants, with a small amount of ongoing employment also supported once the facility is operational.

3 The Study Area’s occupational and business structures indicate a good base exists to service the needs of the solar farm project, including approximately 10,300 construction-related workers (based on occupation) and 830 construction and transport businesses.

4 Mount Barker, Murray Bridge and Mannum, given their relatively close proximity to the subject site, will underpin most project needs in view of their supply of labour, commercial accommodation (300+ rooms), trade supplies and transport services, machinery hire and repairs, retail services, emergency services and so on.

Economic Impact Assessment

5 The Pallamana Solar Farm project will involve approximately $200 million in investment during the construction phase and will support 200 direct and 320 indirect positions over the 12-month construction period. Once operational, 4 direct and 12 indirect jobs will be supported by the facility on an ongoing basis.

6 Accessing adequate labour supply should not present a major issue for the project, noting the peak local employment requirement for the project (140 workers) represents only 1% of workers occupied in construction-related activities in the Study Area (10,260 workers).

7 The project will provide significant participation opportunities for businesses and workers located in the Study Area, having regard for the good match of skills and resources available. In this regard, the proponent and organisations such as the Industry Capability Network might be involved in ensuring maximum local inputs are secured.

8 The 'external' project labour requirement is expected to generate an accommodation need for 60 project workers at the peak of the project. This represents 18% of total commercial accommodation rooms (hotels and motels) in the Study Area and would provide a boost to local accommodation operators, noting room occupancy rates were just 56% during the June Quarter, 2016. Other providers such as houseboat owners, caravan parks operators etc may also benefit in terms of increased accommodation revenues.

9 Construction workers are expected to inject approximately $2.7 million in additional spending into the regional economy over the construction phase, supporting around 13-14 jobs in the service sector in the Study Area.

10 Approximately 730ha of productive agricultural land will be lost to accommodate the solar farm. However, this is negligible in a regional context (4.3 million ha) and noting the land can potentially be used for agricultural purposes at the end of the solar farm's lifecycle.

11 Ongoing economic stimulus associated with new local wage spending and returns to the host landowner are estimated at $22.9 million over 25 years (adjusted for CPI).

12 Council rates revenue associated with the solar farm will be subject to negotiations between Murray Bridge Council and the operator; however, based on preliminary figures, rates revenue to Council is estimated at $290,000 over the 25-year project lifecycle (including CPI adjustment) based on the exiting Capital Improved Value (CIV) of the site. However, CIV will increase significantly through the development of the solar farm, and a corresponding uplift in CIV and Council rates can be expected.

13 The proposed Community Fund would contribute to new community infrastructure and programs.

14 The project has the capacity to supply sufficient clean energy to power approximately 82,000 homes and, in the process, to reduce C02 emissions by 140,000 tonnes per year.

15 Once operational, the Pallamana Solar Farm will present a new environmental experience for the region, which could potentially support small-scale tourism and educational opportunities in the future.

INTRODUCTION

Background

RES Australia Pty Ltd (RES) have commissioned Essential Economics Pty Ltd to prepare an Economic Impact Assessment (EIA) for the proposed Pallamana Solar Farm development to be located 75km south east of Adelaide in South Australia. The solar farm site falls under the Local Government Area (LGA) of Murray Bridge.

The proposed development will be situated on a 730ha site which involves a single farming landholding. The solar farm will have an installed capacity of 176 MW powered by photovoltaic panels. Construction of the Pallamana Solar Farm, subject to planning approval and financing, is anticipated to start in late 2018 with the facility fully operational by mid-2020.

Objectives

The objectives of this project are:

- To highlight likely local and regional economic benefits arising from the project
- To identify potential impacts associated with the project.

This Report

This report contains the following chapters:

Chapter 1: **Project Context**
Presents a description of site location, project components, policy context and definition of Study Area.

Chapter 2: **Regional Economic Profile**
Presents an overview of population, labour force, occupational structure, industry structure, business structure and township services, including an audit of available commercial accommodation in the Study Area.

Chapter 3: **Economic Impact Assessment of Proposed Project**
Presents an assessment of the economic impacts of the proposed development, including investment, employment, business participation, local wage stimulus, impact on accommodation, impact on agricultural activities, local economic stimulus, financial returns to Council and community, and environmental benefits.

1 PROJECT CONTEXT

1.1 Site Location

The proposed Pallamana Solar Farm will be developed on a site located 5km north of the Murray Bridge township, approximately 75km south east of Adelaide.

The site is within a 10 minute drive from Murray Bridge, with Mt Barker located 35km to the west of the site. It is anticipated both Murray Bridge and Mount Barker will play important roles in servicing the project, including the provision of labour and accommodation.

The site which is shown in Figure 1.1 is approximately 730 hectares (ha) in area and located on Pallamana Road, making construction access relatively easy.

The site will be leased from the existing landowner and the land will be utilised for solar farm infrastructure.

A range of technical studies are currently underway – including ecology, landscape and visual, noise, cultural heritage, bushfire risk, access and transport, and drainage and storm water. Planning approval will be sought from the State Government under a Crown Sponsorship (Section 49) application process to facilitate the project.

Figure 1.1: Pallamana Solar Farm Site

1.2 Project Description

The project will consist of a Solar Photovoltaics (PV) facility arranged as either a series of fixed or tracker arrays.

The arrays consist of PV panels mounted on steel or aluminum racking. The PV modules for a fixed array are arranged to face north; however, for a tracker array, the modules are arranged north to south, with the panels tilting around a centre rail to follow the sun's trajectory throughout the day.

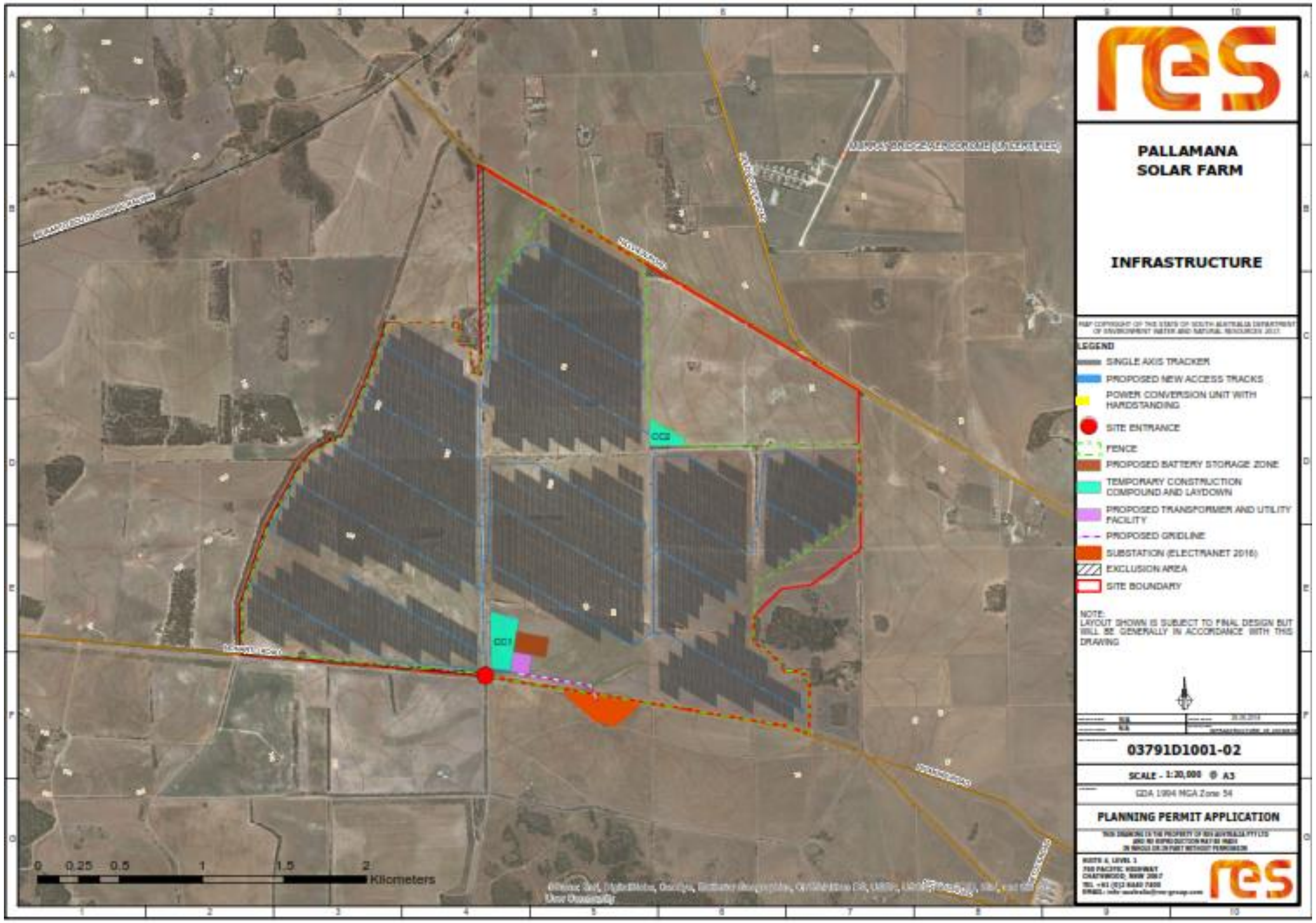
A number of graded tracks across the site will allow all-weather access for construction and operational maintenance. These tracks will vary in size from 2.0m to 6.0m.

An operations and maintenance building with associated carparking will be constructed to service the solar farm. Other on-site infrastructure includes access tracks, security fencing and CCTV.

The solar farm will be connected to the National Grid via a nearby substation located at the South Australia Water site.

The preliminary site layout is shown in Figure 1.2.

Figure 1.2: Pallamana Solar Farm – Preliminary Site Layout



Source: RES Australia

1.3 Study Area

The Study Area for the project is defined as the Local Government Areas of Mid Murray Council, Mount Barker Council and the Rural City of Murray Bridge, and includes the following townships located within 40km from the subject site (listed in order of distance from the subject site):

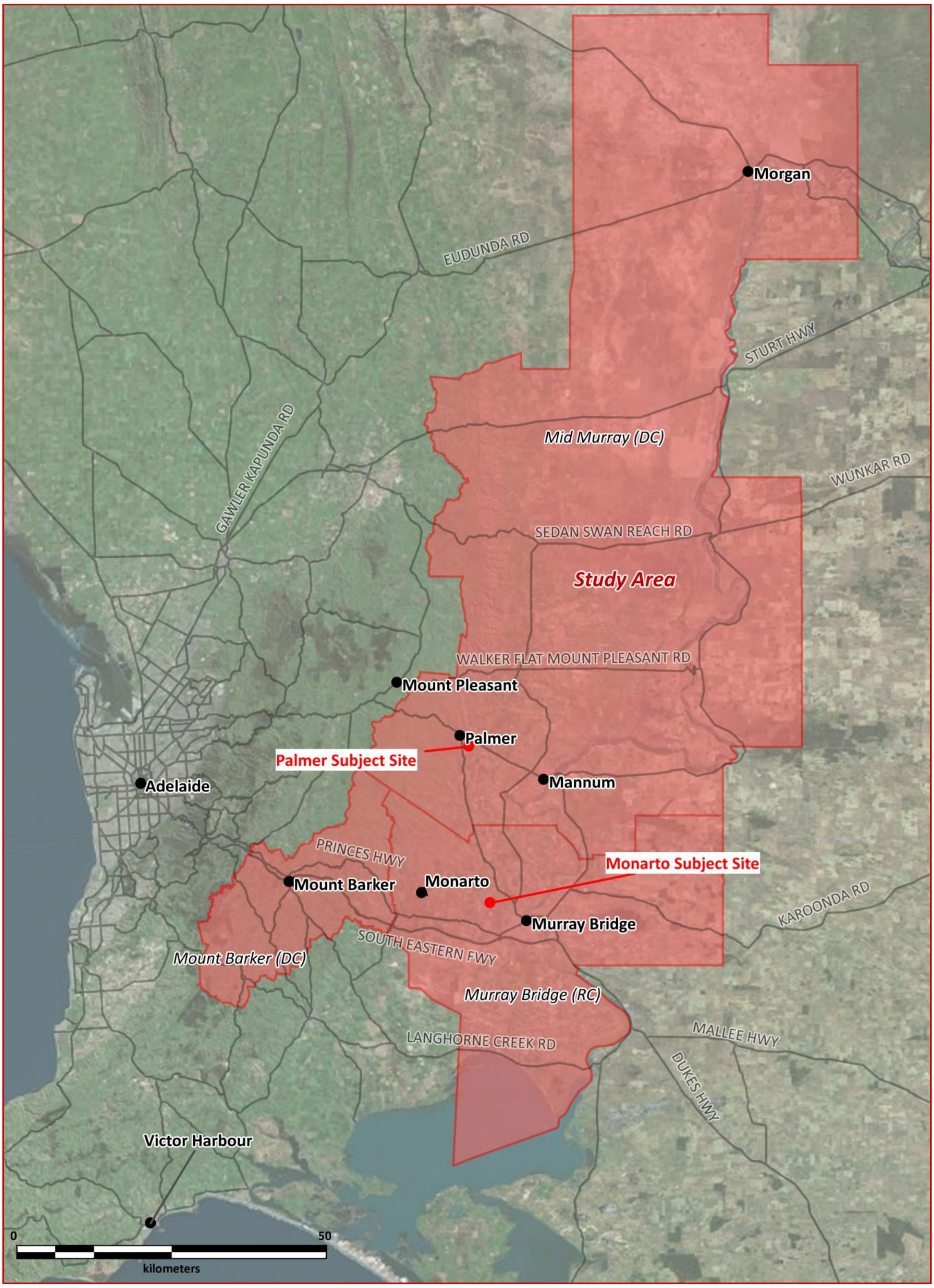
- Murray Bridge (5km)
- Pallamana (15km)
- Mannum (25km)
- Mount Barker (35km)

These townships, to differing extents, all have the potential to contribute to the project and derive economic benefits from both the construction and ongoing phases of the project.

This Study Area is illustrated in Figure 1.3.

Some construction components and specialist labour will be sourced from outside the Study Area and this will include Adelaide, interstate and overseas (solar panels). The impacts of these factors are considered in the EIA.

Figure 1.3: Pallamana Solar Farm – Study Area



Source: Essential Economics, using MapInfo

1.4 Policy Context

International agreements and Federal and State policy settings are important factors in influencing demand and investment in the renewable energy sector, as noted below.

Paris Climate Accord

The Paris Accord is a comprehensive international climate agreement to which Australia is a party. The Accord provides a framework for participating nations to set themselves nationally-determined contributions (NDCs), beginning in 2020 with review at five-year intervals. The agreement sets out a global consensus to limit temperature increases to below two degrees Celsius when compared to pre-industrial levels; an additional goal is to maintain this increase at less than one and a half degrees Celsius. NDCs do not have any set lower limit but are required to progress over time (beginning with the intended NDC pledged during the Paris conference), and to be 'ambitious'. Australia's current targets are a reduction of emissions by five percent from 2000 levels by 2020, and by 26-28 percent below 2005 levels by 2030.

Federal Renewable Energy Target

The Renewable Energy Target (RET) is an Australian Government scheme designed to reduce emissions of greenhouse gases in the electricity sector and encourage the additional generation of electricity from sustainable and renewable sources.

The RET works by allowing both large-scale power stations and the owners of small-scale systems to create certificates for every megawatt hour of power they generate. Certificates are then purchased by electricity retailers who sell the electricity to householders and businesses. These electricity retailers also have legal obligations under the RET to surrender certificates to the Clean Energy Regulator, in percentages set by regulation each year. This creates a market which provides financial incentives to both large-scale renewable energy power stations and the owners of small-scale renewable energy systems.

In June 2015, the Australian Parliament passed the Renewable Energy (Electricity) Amendment Bill 2015. As part of the amendment bill, the large-scale RET was reduced from 41,000 GWh to 33,000 GWh in 2020, with interim and post-2020 targets adjusted accordingly.

Finkel Report

The Independent Review into the Future Security of the National Electricity Market, released in June 2017, is a report commissioned by the Federal Government in order to establish a framework for the development the Australian energy sector. Also known as the Finkel Report, it recommends the use of a Clean Energy Target (CET) scheme to stimulate renewable energy production throughout the National Electricity Market (NEM). This would likely replace the present Federal RET scheme due to expire in 2020, and would result in a more technology-neutral allocation of renewable energy generation certificates; any generator producing energy at a level of pollution below a benchmark rate would be eligible as opposed to only specific technologies as with the RET scheme. The report modelled outcomes utilising this type of scheme to achieve the trajectory committed to by the Federal Government by 2030 and determined that renewable energy would constitute approximately 42% of the NEM at this time. Other policies including an Emissions Intensity Scheme and lifetime limits on coal-powered generation were considered, with the report deeming CET the most effective based on their model.

The Federal Government recently signalled its response to the Finkel Report, which does not include a CET. The Federal Government's proposal is based on a National Energy Guarantee scheme, involving the following main components:

- No subsidies for renewable or any other kind of energy generators
- Power companies will be forced to guarantee on-demand electricity from coal, gas, hydro or batteries that store renewable energy
- Power companies will also be forced to keep carbon dioxide emissions below a certain level, through the purchase of low emissions generated energy.

Implementation of the proposed National Energy Guarantee scheme will likely require Federal parliamentary legislation and will need the agreement of States and Territories.

South Australian Renewable Energy Target

South Australia is the leading jurisdiction in Australia in terms of renewable energy generation, through proactive policy and investment initiatives.

In 2009, the South Australian Government set a renewable energy target of 33% by 2020; however, this target was met six years ahead of schedule in 2014.

In 2014, a new target of 50% by 2025 was set, subject to national renewable energy policy being retained. South Australia exceeded its 50%renewable energy target in 2016, nearly a decade ahead of schedule – with an estimated 53% of energy derived from renewable wind and solar sources at that time.

1.5 Summary

1. RES Australia is proposing the construction of a 176 MW Solar Farm just north of the Murray Bridge township in South Australia.
2. The solar farm facility will be located across a single property which is 730ha in area.
3. The project is in the process of obtaining planning approval from the State Government. Subject to planning approval, it is anticipated construction of the solar farm could start by late 2018 and the facility may be operational by mid-2020.
4. In the past 18 months, Federal and State governments have updated long-term renewable energy targets and this should provide greater investment certainly within the sector in the short-term (ie 2020). The National Energy Plan is currently being formulated by the Federal Government and at this stage it is unclear as to the eventual impact on the renewable energy sector, noting the proposed Clean Energy Target (Finkel Report) is unlikely to feature in the Plan. Importantly, South Australia is the national

leader in the provision of renewable energy, with over 50% of the State's electricity generation now derived from wind and solar sources.

5 This Economic Impact Assessment will provide an understanding of potential economic benefits arising for the local and regional economies and communities through the construction and operational stages of the Pallamana Solar Farm project.

2 REGIONAL ECONOMIC PROFILE

2.1 Population

The population of the Study Area totalled approximately 64,090 persons as of June 2016 (ABS Estimated Resident Population).

Over the period 2016-2031 population growth in the Study Area is expected to be relatively strong at +1.2% pa (or +12,270 persons over 15 years), which is above the growth rate forecast for South Australia (+0.9% pa) over the period.

Of particular note is the projected population contraction in the Mid Murray Council area of -640 persons over the period, representing a decline in population of -0.5% pa over 15 years.

This projected population decline highlights economic trends experienced in many rural areas over recent years, especially those with a high reliance on the agricultural sector and which have been negatively impacted variously by drought, an uncompetitive exchange rate, and an ageing labour force.

In this context the proposed Pallamana Solar Farm (and the proposed nearby Palmer Solar Farm) will provide alternative drought-proofed, guaranteed income to the host farms for 25 years. In addition the construction and operational phases of these projects will provide an economic stimulus (jobs, project contracts, new spending etc) to small towns and rural settlements in the immediate region.

Population estimates, which are included in Table 2.1, are based on official population forecasts prepared by the State Government (based on the medium growth scenario).

Table 2.1: Population Projections – Study Area, 2016-2036

Area	2016[1]	2031[2]	Change 2016-31	AAGR 2016-31
Mid Murray (DC)	8,800	8,160	-640	-0.5%
Mount Barker (DC)	33,810	43,560	9,750	1.7%
Murray Bridge (RC)	21,490	24,640	3,150	0.9%
Study Area	**64,090**	**76,360**	**12,270**	**1.2%**
South Australia	**1,713,050**	**1,936,810**	**25,170**	**0.8%**

Sources: [1]ABS, 3218.0 Regional Population Growth; Australia; [2]South Australian Government (Department of Planning, Transport and Infrastructure) population projections (medium series), 2016 edition

Notes: AAGR = Annual Average Growth Rate
Figures rounded

2.2 Labour Force

As of June 2017 (latest available) the Study Area had an unemployment rate of 7.0%, which is slightly above South Australia's unemployment rate of 6.7%.

As Table 2.2 shows, in June 2017 the Study Area's labour force totalled 33,320 persons, including 2,330 persons who were unemployed.

The Pallamana Solar Farm project is likely to require200 workers (at peak), with many of these likely to be sourced locally (70% or 140 positions). The project therefore provides new short-term employment opportunities for labour force participants, including existing unemployed persons, subject to appropriate skills match.

These labour supply factors are further explored in Chapter 3.

Table 2.2: Labour Force – Study Area, June 2017

Municipality / Area	Employed No. of Persons	Unemployed No. of Persons	Total No. of Persons	Unemployment Rate
Mid Murray (DC)	3,780	240	4,010	6.0%
Mount Barker (DC)	18,220	1,300	19,530	6.7%
Murray Bridge (RC)	8,990	800	9,790	8.2%
Study Area	**30,990**	**2,330**	**33,320**	**7.0%**
South Australia	**817,200**	**58,800**	**876,000**	**6.7%**

Source: Australian Government Department of Employment, *Small Area Labour Markets – June Quarter 2017*
Note: Figures rounded

2.3 Occupational Structure

The skills base of the Study Area is reflected in its occupational structure, as shown in Table 2.3. ABS Census data for 2016 shows 36.5% of Study Area workers were occupied in activities generally associated with the types of skills required for the construction of a solar farm. These include technicians and trades workers, machinery operators & drivers, and labourers.

The Study Area's representation in these occupations is well above the State average of 30.6%, indicating a generally suitable occupational base for the proposed project.

In total numbers, approximately 10,260 workers in the Study Area are occupied in construction-related activities, highlighting the strong worker base available to support the project.

Table 2.3: Occupational Structure – Study Area, 2016

	Study Area		South Australia
Occupation	***No.***	***Share***	***Share***
Professionals	**4,260**	**15.1%**	**20.3%**
Technicians and Trades Workers	**4,100**	**14.6%**	**13.4%**
Managers	3,720	13.2%	12.6%
Clerical and Administrative Workers	3,280	11.7%	13.3%
Labourers	**4,350**	**15.5%**	**11.1%**
Community and Personal Service Workers	3,370	12.0%	12.0%
Sales Workers	2,840	10.1%	9.6%
Machinery Operators and Drivers	**1,810**	**6.4%**	**6.1%**
Inadequately described / not stated	420	1.5%	1.5%
Total	**28,160**	**100.0%**	**100.0%**

Source: ABS Census of Population and Housing 2016

2.4 Business Structure

One of the more tangible benefits of a major investment project, such as the proposed Pallamana Solar Farm, is the extent to which local businesses can participate in the project through project contracts and other service provision.

ABS Business Count data for 2016 (latest available) shows the Study Area includes approximately 625 construction businesses, plus approximately 205 businesses associated with transport, postal and warehousing services, with these two sectors contributing 830 businesses or 21.4% of all businesses located in the Study Area and this compares to 20.4% for these sectors across South Australia.

This data, which is included in Table 2.4, indicates a strong presence in the Study Area of the types of firms that are likely to be well-placed to service aspects of the project. This opportunity is explored in more detail in the following Chapter.

Table 2.4: Business Structure – Study Area, 2016

	Study Area		South Australia
Sector	**No.**	**%**	**%**
Agriculture, Forestry and Fishing	834	21.4%	12.4%
Mining	23	0.6%	0.4%
Manufacturing	194	5.0%	4.3%
Electricity, Gas, Water and Waste Services	23	0.6%	0.3%
Construction	625	16.1%	14.8%
Wholesale Trade	84	2.2%	2.8%
Retail Trade	282	7.3%	6.1%
Accommodation and Food Services	130	3.3%	4.0%
Transport, Postal and Warehousing	206	5.3%	5.6%
Information Media and Telecommunications	10	0.3%	0.6%
Financial and Insurance Services	223	5.7%	10.5%
Rental, Hiring and Real Estate Services	377	9.7%	11.6%
Professional, Scientific and Technical Services	310	8.0%	9.4%
Administrative and Support Services	122	3.1%	3.4%
Public Administration and Safety	16	0.4%	0.3%
Education and Training	18	0.5%	1.0%
Health Care and Social Assistance	130	3.3%	5.9%
Arts and Recreation Services	42	1.1%	1.0%
Other Services	204	5.2%	4.2%
Industry not classified	36	0.9%	1.3%
Total Business	**3,889**	**100.0%**	**100.0%**

Source: ABS Counts of Australian Businesses, including Entries and Exits, June 2012 to June 2016

2.5 Township Services Capacity

Commercial Accommodation

The ability to accommodate non-local workers (ie those who are not resident in the Study Area or not living within a daily commutable distance) is a key consideration for major construction projects.

As Table 2.5 highlights, the Adelaide Hills and Murraylands tourism regions (which include Mount Barker, Murray Bridge and Mannum) and provide the 'best fit 'for the Study Area have a reasonable supply of commercial accommodation as measured by the ABS Tourism Accommodation series for the June Quarter 2016 (latest available).

This data – which identifies supply for hotels, motels and apartments with 15 rooms or more – shows these tourism regions include 12 establishments and approximately 340 rooms and 1,000 beds.

In the June 2016 Quarter, room and bed occupancy rates across the Adelaide Hills and Murraylands tourism regions were approximately 56% and 32% respectively.

These relatively low room and bed occupancy rates in the Study Area indicate the solar farm project will boost the commercial accommodation sector, especially during off-peak periods. This factor is further discussed in section 3.5.

Table 2.5: Hotel, Motel and Apartments Accommodation (with 15 Rooms or more) – Adelaide Hills and Murraylands Tourism Regions, June Quarter 2016

Location	Establishments No.	Rooms No.	Beds No.	Room Occupancy Rate	Bed Occupancy Rate %
Adelaide Hills Tourism Region	5	177	520	56%	32%
Murraylands Tourism Region	7	165	480	56%	30%
Study Area	**12**	**342**	**1,000**	**56%**	**31%**

Source: ABS Tourism Accommodation, Australia 2015-16 – June Quarter, 2016.

In addition to commercial accommodation outlined above, the Study Area also provides a range of additional low cost options close to the subject site which might be used for project accommodation, including the following:

- Caravan/ Holiday parks providing cabins, such as:
  - White Sands Riverfront Caravan Park, Murray Bridge
  - Murray Bridge Marina Camping and Caravan Park
  - Murray Bridge Tourist Park
  - Avoca Dell Caravan Park, Murray Bridge
  - Mannum Riverside Caravan Park

  - Mount Barker Caravan & Tourist Park
- House boats (especially in Mannum)
- Bed and Breakfast
- Guest houses.

Private Accommodation

Private accommodation is often used to support construction worker needs and this could be through the leasing of holiday homes and investment properties, either privately or through real estate agents. ABS Census data for 2016 indicates the Study Area has an above-average level of unoccupied dwellings, especially in the Mid Murray Council area, where almost one in two dwellings (45.4%) or 2,905 dwellings are unoccupied reflecting the high level of holiday homes and tourism associated with the area. Neighbouring Murray Bridge Council has 1,245 unoccupied dwellings, or 13.6% of total dwelling stock.

As Table 2.6 shows, 17.8% of Study Area dwellings were unoccupied at the 2016 Census, and this is well above the average for South Australia of 12.6%.

Shared private housing accommodation is one potential option for the solar farm project workers, and this is further explored in section 3.5.

Table 2.6: Unoccupied Dwellings – Study Area, June 2016

	Occupied Dwellings No.	Unoccupied Dwellings No.	Total Dwellings No.	Unoccupied Dwelling Share
Mid Murray (DC)	3,500	2,905	6,405	45.4%
Mount Barker (DC)	12,010	910	12,920	7.0%
Murray Bridge (RC)	7,925	1,245	9,170	13.6%
Study Area	**23,435**	**5,060**	**28,495**	**17.8%**
South Australia	**638,780**	**92,240**	**736,495**	**12.6%**

Source: ABS Census of Population and Housing, 2016
Note: Figures rounded

Township Services

In addition to accommodation, workers temporarily locating to the Study Area will require a wide range of other convenience services, and the project will also need to source trade and other services from businesses located in the immediate region. The following paragraphs provide an overview of the services located in settlements and townships in the Study Area, which are likely support the project in some capacity and in doing so, generate economic benefits for their communities. Township services are described in order of proximity to the subject site.

Murray Bridge

Murray Bridge is a major rural town located on the banks of the Murray River, with a population of approximately 17,560 persons (ABS Census 2016). The town is approximately an hour's drive from the Adelaide CBD and is approximately 5km to the south (or a 10 minute drive) from the proposed Pallamana Solar Farm site.

Murray Bridge is the primary activity centres for the mid Murray Region, and provides many of the key services likely to be required to support a major infrastructure project such as the proposed solar farm project.

Murray Bridge's key services include:

- Freight and transport services (Bocca Transport, Gunn Freight)
- Auto mechanics (various)
- Steel fabricators (Jacksons Australia, Southern Steel Supplies, Bridge Building Supplies
- Construction firms (Mobbs constructions, SPRY Earthmovers, Nigro Earthmovers)
- Concreters
- Engineering services (Moore Engineering, Miegel Engineering, Newell Composites)
- Trade Suppliers (Bunnings, Mitre 10)
- Fuel supplies
- Commercial and private accommodation (see above Tables and commentary)
- Full range of retail services – (2 Coles, 2 Woolworths, BIG W, Target)
- Cafes and restaurants
- Entertainment (hotels, clubs, sports and recreational facilities)
- Major banks and financial institutions
- Real estate agents
- Postal services
- Employment agencies (MADEC, Job Prospects)
- Medical and emergency services including:
  - Murray Bridge Soldiers Memorial Hospital. with a 24 hour emergency department
  - Murray Bridge Ambulance Station
  - SA MFS Fire & Rescue Service
  - Murray Bridge Police Station

- Medical centres and health services.

Images of Murray Bridge are shown in Figure 2.1

Figure 2.1: Images of Murray Bridge

Source: www.google.com

Mannum

Mannum, with a population of approximately 6,180 persons (ABS Census 2016), is a medium sized tourist town which offers a range of services likely to be required during the construction phase.

Mannum is located approximately 25km to the north of the solar farm site, or a 30 minute drive, and has a large amount of existing visitor accommodation (including many house boats) due to its tourist trade, and therefore represents an ideal base for the accommodation of non-local project workers.

Mannum's key services include:

- Auto mechanics (various)
- Fuel supplies (BP, Caltex, Shell)
- Commercial and private accommodation (see above Tables and commentary)
- Retail services - including Mannum Green, Foodland supermarket and speciality stores
- Cafes and restaurants
- Entertainment (hotels, clubs, and recreational facilities)
- Postal services and banks
- Real estate agents (Mannum Real Estate, First National Real Estate, CE Property Group)
- Medical and Hospital services
- Some Freight transport services
- Some engineering and construction services

Images of Mannum are shown in Figure 2.2

Figure 2.2: Images of Mannum

Source: www.google.com

Mount Barker

Mt Barker is a major regional town of approximately 17,370 people (ABS Census 2016) that lies on the eastern side of the Adelaide Hills approximately an hour's drive from the Adelaide CBD. The town is located 35km west of the solar farm site, approximately 30 minutes' drive time. Mount Barker is the main service centre for broader region and provides a full range of key services likely to be required to support a major infrastructure project such as the proposed solar farm.

- Freight and transport services (various)
- Auto mechanics (various)
- Steel fabricators (Mt Barker Steel)
- Construction firms (Mobbs constructions, SPRY Earthmovers, Nigro Earthmovers)
- Concreters
- Engineering services (Steriline Engineering, Unox Engineering, Engineering Options)
- Trade Suppliers (Bunnings, Mitre 10, Tradelink)
- Fuel supplies
- Commercial and private accommodation
- Full range of retail services – (Coles, Woolworths, Foodland, Kmart, BIG W, Target)
- Cafes and restaurants
- Entertainment (hotels, clubs, sports and recreational facilities)
- Major banks and financial institutions
- Real estate agents

- Postal services
- Employment agencies (Maxima, Madec, Jobs Statewide)
- Medical and emergency services including:
  - Mount Barker Districts Soldiers' Memorial Hospital, with a 24 hour emergency department
  - Mount Barker Ambulance Station
  - SA MFS Fire & Rescue Service
  - Mount Barker Police Station
  - Medical centres and health services.

Images of Mount Barker are shown in Figure 2.3

Figure 2.3: Images of Mount Barker

2.6 Conclusions

The key findings of this Regional Economic Profile are as follows:

1 The Study Area has a resident population of around 64,000 persons (2016), which is expected to reach approximately 76,400 persons by 2031, representing annual growth of 1.2% pa over the period which is higher than the forecast State growth of 0.8% pa over the 15 years. However, the Mid Murray Council area is projected to decline in population at a rate of -0.5% pa over the coming 15 years, and therefore new infrastructure projects which provide local economic stimulus should be welcomed.

2 The Study Area currently has an unemployment rate of 7.0%, which is above the unemployment rate for South Australia of 6.7%. The Study Area currently has 2,330 persons who are unemployed. In this regard, construction of the Pallamana Solar Farm provides new short-term employment opportunities for the region's labour force participants, with a small amount of ongoing employment also supported once the facility is operational.

3 The Study Area's occupational and business structures indicate a good base exists to service the needs of the solar farm project, including approximately 10,300 construction-related workers (based on occupation) and 830 construction and transport businesses.

4 Mount Barker, Murray Bridge and Mannum, given their relatively close proximity to the subject site, will underpin most project needs in view of its supply of commercial accommodation (300+ rooms), trade supplies and transport services, machinery hire and repairs, retail services, emergency services and so on.

3 ECONOMIC IMPACT ASSESSMENT

3.1 Project Investment

The total construction cost for the Pallamana Solar Farm project is estimated to be approximately $200 million, according to information provided by RES. The major investment cost is associated with the purchase of PV panels and associated equipment, although significant investment is also required for civil, electrical and grid connection works. Additional investment will be required with regard to project management, financing, insurance and other project costs.

3.2 Project Employment

Construction Phase

Project employment is assessed in terms of **Direct** jobs (ie, site-related) and **Indirect** (or flow-on) jobs in the local and wider economies (ie, jobs that are generated by the employment multiplier as funds circulate around the economy between various industry sectors).

Direct Construction Employment

RES have indicated that 200 jobs will be generated during construction of the Pallamana Solar Farm, which is expected to occur over a 16-month period. These jobs include full time, part-time and casual labour employed on the project.

Construction-related jobs are expected to be associated with a wide-range of on and off-site activities, including:

- Installation of PV support structures
- Fabrication
- Vehicle and equipment hire
- Earthworks
- Foundations
- Engineering services
- Roads and access tracks
- Transport and logistics
- Assembly and installation of PV panels
- Electrical works (cabling and connections)

- Installation of monitoring equipment
- Fencing
- Landscaping
- Trade services
- Fuel supplies
- Security
- Waste disposal
- Business, finance and administrative services.

As indicated in Chapter 2, the business structure of the Study Area indicates that a good mix of these types of services is available, principally in nearby Murray Bridge and the major regional centre of Mount Barker. It is reasonable to expect, therefore, that local and regional businesses will be well-positioned to secure contracts during the construction phase of the project.

Indirect Construction Employment

In addition to direct employment, significant employment will be generated indirectly through the employment multiplier effect. By applying an industry-standard multiplier for the construction industry of 2.6 (based on ABS Input-Output tables), the project is estimated to generate an additional 320 jobs over the construction period.

Indirect or flow-on jobs (which capture industry and consumption effects) include those supported locally and in the wider economy (including in other states), as the economic effects of the capital investment flow through the economy. Indirect employment creation within the region would include jobs supported through catering, accommodation, trade supplies, fuel supplies, transportation, food and drink and the like.

Total Construction Employment

In summary, approximately 520 jobs (200 direct jobs and 320 indirect jobs) are expected to be generated by the Pallamana Solar Farm project during the 16-month construction phase.

The amount of local employment required at the peak of the project is estimated by the proponent to be approximately 140 jobs. This represents only 1.4% of the Study Area's labour force who are occupied in construction-related activities (10,260 persons) and therefore this should not present a constraint to labour supply for the project.

Operational Phase

Direct Operational Employment

RES Australia indicate that 4 jobs will be supported on an ongoing basis through the operation and maintenance of the Pallamana Solar Farm, including employment supported in the Study Area (eg maintenance) and positions supported centrally at Head Office (eg administration).

Indirect Operational Employment

A number of additional jobs will also be supported indirectly through the employment multiplier effect. By applying an industry-standard multiplier for the electricity industry of 3.9 (based on ABS Input-Output tables) to the direct operational and maintenance jobs, a further 12 permanent jobs (rounded) would be generated in the wider State and national economies, but some of these jobs would be generated locally through existing supply chains.

Operational-related employment is for the lifetime of the project (ie, at least 25 years); therefore, while job creation is relatively small, it represents new long-term employment opportunities at a local, regional and state-wide level.

For the purposes of this assessment it is assumed 75% of direct jobs and 25% of indirect jobs are created in the Study Area. This equates to approximately 6 ongoing new positions created in the Study Area through the Pallamana Solar Farm project.

Total Operational Employment

In summary, approximately 16 jobs (4 direct and 12 indirect) are expected to be generated by the Pallamana Solar Farm project through its ongoing operations, including 6 positions that are expected to be created locally.

3.3 Concurrent Infrastructure Projects and other Activities in the Study Area

The Pallamana Solar Farm project may to need compete for labour and resources with other infrastructure projects that include the Palmer Wind Farm and the Palmer Solar Farm projects (both subject to planning approval) and Council infrastructure works, as well as seasonal agricultural and tourism activities.

However, the relatively small workforce requirement for the project (140 local positions over 16 months) makes it unlikely any project labour supply issues will occur, recognising the significant construction-related labour force available in the Study Area, especially in Murray Bridge and Mount Barker. Additionally, the Study Area currently has 2,330 labour force participants who are unemployed, some of whom may gain project employment (subject to suitable skills match).

3.4 Industry and Business Participation Opportunities

In terms of cost efficiencies (lower transport, equipment hire, labour costs etc), many large construction projects located in regional areas are (where possible) serviced from within the same region.

As identified above, the Study Area comprises 625 construction firms and many other businesses associated with activities likely to be required for the project, such as transport operators, trade suppliers, vehicle and machinery hire, auto mechanics etc.

Within the Study Area, Mount Barker and Murray Bridge have firms of sufficient scale/expertise to compete for contracts or provide services and equipment to the project.

In order to maximise local business participation, a number of strategies might be considered, such as widespread advertising of contract opportunities in local media and directly through the RES website etc.

The Industry Capability Network (ICN) is another organisation that often plays an important business facilitation role for major infrastructure projects, such as the proposed solar farm. The ICN is an independent, non-profit organisation funded by the Federal Government to support business opportunities, including linking suppliers to project contracts at a local level through its ICN Gateway website where details of work packages are advertised.

3.5 Housing and Commercial Accommodation Sector Impacts

Information supplied by RES Australia indicates that up to 60 non-local staff may need to be accommodated in the region at the project's peak. These staff will include occupations such as general management, project management and supervising engineers. Contract lengths will vary. This highlights the need for a number of types of accommodation which would be expected to range from higher-end options for professional staff on longer contracts, to convenient low-cost options for those on short-term contracts.

As highlighted in Chapter 2, the Study Area has a capacity of around 340 rooms and equivalent to approximately 1,000 bed spaces in commercial accommodation establishment (hotels, motels and apartments with 15 rooms or more). Assuming each non-local worker requires individual accommodation, only approximately 18% of the Study Area's total accommodation stock would be required at peak times to service the project. This requirement is likely to be even lower as some workers may be choose to be accommodated on House Boats (Mannum), Caravan Parks (cabins), B&Bs, private rentals (holiday homes) or with family or friends – none of these categories are included in the commercial accommodation audit. Additionally, some workers may share motel rooms or cabins to reduce personal costs.

ABS Tourism Accommodation data for the June Quarter 2016 (refer to Table 2.5) shows the Study Area had a room occupancy rate of 56% and a bed occupancy rate of 32% for its hotels, motels and serviced apartments (with 15 rooms or more).

This data indicates that adequate capacity exists in the Study Area to accommodate the relatively small numbers of non-local workers expected at the peak of the solar farm project.

Importantly, the influx of project workers will support higher occupancy rates and revenues for local accommodation operators over the construction period, particularly during off-peak periods.

3.6 Local Wage Spending Stimulus

RES estimate that 30% of the 200 jobs in construction (60 jobs) are likely to be sourced from outside the Study Area, particularly specialist and management positions.

This level of employment would equate to $4.8 million in wages (2017 dollars) on the basis that each non-local worker is employed for 12-months (on average) over the 16-monrh construction phase and earns the average construction wage of $80,000 pa including on-costs (source: ABS, *Average Weekly Earnings 6302.0*, May 2017).

A considerable portion of these wages would be spent in the Study Area where the workers will be based. An estimated $2.7 million in wages (2017 dollars) would likely be directed to local and regional businesses and service providers during the construction period. This estimate is based on reference to the ABS *Household Expenditure Survey* which indicates that approximately 75% of post-tax wages are likely to be spent by workers in the regional economy in view of the wide range of goods and services available in Murray Bridge and Mount Barker (refer to section 2.5). This spending would include the following:

- <u>Housing expenditure</u>, including spending on accommodation at hotels, motels, caravan/holiday parks, B&Bs, and private rental dwellings
- <u>Retail expenditure</u>, including spending on supermarket items, clothing, books, homewares etc
- <u>Recreation spending</u> associated with day trips and excursions, gaming (lottery, sports betting, etc), purchases in pubs and clubs (although noting that expenditures at restaurants is included in the retail category)
- <u>Personal, medical and other services</u>, such as local prescriptions and GP fees, fuel, vehicle maintenance and so on.

This level of personal spending would support approximately 13-14 jobs in the services sector (based on 1 job allocated for every $200,000 of induced spending), supporting jobs in the Study Area associated with retail, accommodation, trade supplies, cafes and restaurants etc. These jobs are included in the 'indirect employment' estimates outlined in Section 3.2 above.

3.7 Impact on Agricultural Land

The potential impact of the Pallamana Solar Farm on agricultural activity is noted as follows:

- Approximately 730ha of productive farming land might be unusable for agricultural purposes during the lifetime of the solar farm. However, RES are examining the possibility of accommodating continued sheep grazing across part of the site.

- This will affect land used principally for grazing, with the site being extensively grazed over many years.
- ABS Agricultural Commodities for South Australia 2015/16 shows the South Australia – South East region (in which the subject site is located) has 4.3 million hectares of agricultural land; therefore, agricultural land lost to the solar farm project is negligible in a regional context.
- The property owner will be compensated for the loss of this agricultural land through annual lease payments for hosting the solar farm.
- The land can potentially be rehabilitated to its original condition at the end of the project when all above ground infrastructure is removed, allowing agricultural activities to recommence.

3.8 Ongoing Economic Stimulus

As noted, the proponent will pay the landowner annual lease payments to host the Pallamana Solar Farm project. These payments (the details of which are subject to confidentiality) are likely to be significantly above the long-term agricultural returns generated from the land, and in this regard will support the financial sustainability of this particular farming operation.

Additionally, an estimated 6 permanent jobs will be created through the project in the Study Area (refer to section 3.2), and wage spending associated by these jobs will benefit local businesses and communities.

Based on data provided by RES relating to potential host landowner returns and the consultant's calculations of new wage spending, the Study Area's economy will receive an estimated stimulus of $22.9 million over 25 years (adjusted for CPI) through these effects.

3.9 Returns to Council

Council Rates Revenue

Unlike other states (such as Victoria), South Australia does not currently have in place a legislative framework to guide rates payable for electricity generating facilities. Revenues payable to Murray Bridge Council associated with the operation of the Pallamana Solar Farm, therefore, will be subject to negotiation between Council and the operator.

The operator will be liable for Council rates and other taxes, such as the Natural Resource Management Levy (NRML), over the lifetime of the Solar Farm (25 years). Currently the rateable value of the site is in the order of $8,510 pa which is based on the existing Capital Improved Value (CIV) and estimated NRML payment. Assuming $8,510 pa is payable by the operator on an annual basis, an estimated $290,000 would be generated in Council rates over 25 years (includes CPI adjustment).

However, this calculation is based on the existing site CIV. Once the solar farm has been completed it is likely the CIV of the site will increase significantly, resulting in a corresponding uplift in rates and taxes payable to Council.

Community Fund

The proponent is committed to providing a Community Fund associated with the Pallamana Solar Farm facility. The Community Fund could be used to support a range of projects including environmental and local community projects.

3.10 National Grid Supply Benefits

The Pallamana Solar Farm has the potential to provide sufficient renewable energy to support the annual electricity needs of approximately 82,000 South Australian households. This calculation is based on:

- 420,000 MWh per year / by average household energy use of 5,145 kwh (Source: ACIL Allen Consulting, AER electricity distributer data).

The Study Area currently contains approximately 28,500 dwellings (ABS Census 2016); therefore, the Solar Farm has the potential to provide 2.9 times the annual electricity needs of the Study Area, highlighting the importance of the facility from a clean energy generation perspective.

3.11 Environmental Benefits

Once fully-operational, the Pallamana Solar Farm will result in the reduction of an estimated 140,000 tonnes (rounded) in carbon dioxide (CO_2) emissions on an annual basis compared to the same level of electricity generation using fossil fuels. This calculation is based on:

- 420,000 MWh x 0.33372 tonnes/MWh =140,160 tonnes saved per year (assuming generation would otherwise be sourced from brown coal with a carbon factor = 0.33372 tonnes per MWh (Source: Department of the Environment National Inventory Report).

This reduction on CO_2 emissions is the equivalent of taking approximately 50,000 cars off the road annually, based on an average of 14,000km travelled with CO_2 emissions of 200g/km (or 2.8 tonnes of CO_2 emissions per car pa).

3.12 Tourism Opportunities

In the longer-term, the Pallamana Solar Farm could provide opportunities to attract new visitors to the area, if suitable arrangements can be put in place regarding access to the site.

Potential visitor types include:

- Environmentalists
- Researchers

- Eco-tourists
- School and educational groups.

Benefits of attracting new visitors to the region include increased expenditures on local accommodation, food and beverage, fuel, retail, entertainment etc, all of which will support businesses and employment, especially in nearby Murray Bridge.

3.13 Conclusions

1 The Pallamana Solar Farm project will involve approximately $200 million in investment during the construction phase and will support 200 direct and 320 indirect positions over the 12-month construction period. Once operational, 4 direct and 12 indirect jobs will be supported by the facility.

2 Accessing adequate labour supply should not present a major issue for the project, noting the peak local employment requirement for the project (140 workers) represents only 1% of workers occupied in construction-related activities in the Study Area (10,260 workers).

3 The project will provide significant participation opportunities for businesses and workers located in the Study Area, having regard for the good match of skills and resources available. In this regard, the proponent and organisations such as the Industry Capability Network might be involved in ensuring maximum local inputs are secured.

4 The 'external' project labour requirement is expected to generate an accommodation need for 60 project workers at the peak of the project. This represents 18% of total commercial accommodation rooms (hotels and motels) in the Study Area and would provide a boost to local accommodation operators, noting room occupancy rates were just 56% during the June Quarter, 2016. Other providers such as houseboat owners, caravan parks operators etc may also benefit in terms of increased accommodation revenues.

5 Construction workers are expected to inject approximately $2.7 million in additional spending into the regional economy over the construction phase, supporting around 13-14 jobs in the service sector in the Study Area.

6 Approximately 730ha of productive agricultural land will be lost to accommodate the solar farm. However, this is negligible in a regional context (4.3 million ha of agricultural land exist) and noting the land can potentially be used for agricultural purposes at the end of the solar farm's lifecycle.

7 Ongoing economic stimulus associated with new local wage spending and returns to the host landowner are estimated at $22.9 million over 25 years (adjusted for CPI).

8 Council rates revenue associated with the solar farm will be subject to negotiations between Murray Bridge Council and the operator (who will be responsible for payments). Rates revenue to Council is estimated at $290,000 over the 25-year project lifecycle (including CPI adjustment) based on the exiting Capital Improved Value (CIV) of

the site. However, the site's CIV will increase significantly through the development of the solar farm, and a corresponding uplift in Council rates can be expected.

9 The proposed Community Fund can be directed to new community infrastructure and programs.

10 The project has the capacity to supply sufficient clean energy to power approximately 82,000 homes and, in the process, to reduce C02 emissions by 140,000 tonnes per year.

11 Once operational, the Pallamana Solar Farm will present a new environmental experience for the region, which could potentially support small-scale tourism and educational opportunities in the future.

Pallamana Solar Array and Battery Storage Project

Ecological Assessment

Pallamana Solar Array and Battery Storage Project Ecological Assessment

31 July 2018

Version 4

Prepared by EBS Ecology (Matt Launer, Andrew Sinel and Mark Laws, all NVC Accredited Consultants) for Masterplan SA Pty Ltd

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Cover photograph: Scattered tree, *Eucalyptus odorata* (Peppermint Box) within the Project area.

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GLOSSARY AND ABBREVIATION OF TERMS

ALA	Atlas of Living Australia
BAM	Bushland Assessment Method
BDBSA	Biological Database of South Australia (maintained by DEWNR)
BOM	Bureau of Meteorology
CP	Conservation Park
DEW	Department of Environment and Water (formerly known as DEWNR: Department of Environment, Water and Natural Resources
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
DotEE	Department of the Environment and Energy
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
HA	Heritage agreement
IBRA	Interim Biogeographical Regionalisation of Australia
NPW Act	*National Parks and Wildlife Act 1972*
NPWSA	National Parks and Wildlife South Australia
NV Act	*Native Vegetation Act 1991*
NVC	Native Vegetation Council
PMST	Protected Matters Search Tool (under the EPBC Act, maintained by DotEE)
Project area	the area within the perimeter boundary as shown in Figure 1
RES	RES Australia Pty Ltd
SEB	Significant Environmental Benefit
STAM	Scattered Tree Assessment Method
TEC	Threatened Ecological Community

EXECUTIVE SUMMARY

EBS Ecology (EBS) was contracted by Masterplan SA Pty Ltd acting for RES Australia Pty Ltd (RES) to conduct a vegetation survey and fauna assessment to inform planning and development for the Pallamana Solar Array and Battery Storage Project. The field survey was performed on 16 August 2017 and 5 July 2018. The vegetation survey included the Bushland Assessment Method (BAM) and Scattered Tree Assessment Method (STAM) devised by the Department of Environment and Water (NVC 2017).

The desktop assessment utilised data from the Protects Matters Search Tool (PMST) to determine the potential presence of Threatened Ecological Communities (TEC's), threatened or migratory species listed under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act), and the Biological Database of South Australia (BDBSA) to obtain records of species listed as threatened under the *National Parks and Wildlife Act 1972* (NPW Act). The likelihood of occurrence for each TEC and threatened species identified as potentially occurring in each database was then deliberated based on habitat availability in the Project area, date of last record and the conspicuousness of the species.

The Project area is located approximately 5 km from Murray Bridge, South Australia. The Project area is 791.35 ha and contains approximately 18.85 ha of remnant vegetation and 772.50 ha of agricultural land and areas devoid of native vegetation (vehicle tracks etc.). The remnant vegetation is restricted to relatively small patches, totalling 18.85 ha. The majority of the remnant vegetation is in very poor condition due to a range a factors including weed invasion, over grazing, soil disturbance, firewood removal and rubbish dumping.

There were three vegetation associations and 51 scattered trees recorded within the Project area. The vegetation associations were:

1. *Eucalyptus odorata* Low Woodland over Exotic grass and herbaceous sp.;
2. *Eucalyptus socialis +/- E. dumosa* Mixed Mallee over Chenopod shrubs; and
3. *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *M. lanceolata*.

A total of 44 flora species were recorded within the Project area, including 22 native and 22 introduced species. No flora species with a conservation rating under the *EPBC Act* were recorded. *Maireana excavata* (Bottle Bluebush) which has a conservation rating of Vulnerable under the NPW Act was recorded within BAM Quadrat 3a, within vegetation associtation *Eucalyptus odorata* Low Woodland over Exotic grass and herbaceous sp.. Five of the weed species recorded are listed declared species under the NRM Act:

1. *Lycium ferocissimum* (African Boxthorn);
2. *Marrubium vulgare* (Horehound);
3. *Echium plantagineum* (Salvation Jane);
4. *Emex australis* (Three-corner Jack); and
5. *Asparagus asparagoides f. asparagoides* (Bridal Creeper).

There were 26 bird species and three mammal species detected within the Project area during the field survey. Two of the bird species recorded are introduced, these were; House Sparrow (*Passer domesticus*) and Common Starling (*Sturnus vulgaris*). No fauna species with a conservation rating under the *EPBC Act* or *NPW Act* were recorded during the survey.

The majority of the native vegetation within the Project area will be avoided and thus retained due to the adjustment of the infrastructure footprint during the early stages of planning. It is estimated that the clearance of native vegetation required for the construction of the Project will be limited to 3.68 ha of *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *Melaleuca lanceolate*. A total of 34 out of the 51 scattered trees will require removal. It is understood that the clearance footprint may be further reduced during the final stages of planning and micro-siting of infrastructure.

Clearance Summary: The total Significant Environmental Benefit (SEB) points required for the clearance of the remnant patches of vegetation (3.68 ha) is 96.13 and the total SEB hectares required is 12.02. The total SEB points required for the clearance of the 34 scattered trees is 111.58 and the total SEB hectares required is 13.95. The combined total scores for clearance of 3.68 ha of remnant of vegetation and 34 scattered trees equates to 207.71 SEB points or 15.70 ha. The form of the SEB offset will be determined during the Native Vegetation Clearance application.

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1 PROJECT DETAILS

A summary of details for the Pallamana Solar Array and Battery Storage Project is provided in Table 1.

Table 1. Summary of Project details for the proposed Pallamana Solar Array and Battery Storage Project.

Applicant:	RES Australia Pty Ltd		
Key contact:	Phone: 0415 426 181 Email: chris.gosling@res-group.com Address: Suite 4, Level 1, 760 Pacific Highway Chatswood NSW 2067		
Landowner:	Kuchel		
Site address:	Refer below		
Local Government Area:	Rural City of Murray Bridge	Hundred:	Mobilong
Certificate of title:	Volume 5858 Folio 257 Volume 5487 Folio 88 Volume 5858 Folio 259 Volume 5858 Folio 258 Volume 5858 Folio 256 Volume 5802 Folio 294	Section/Allotment:	Section 196N Section 166 Section 197 Section 193 & 196S Section 192 Section 285
Summary of proposed clearance			
Proposed clearance area:	The clearance involves the removal of 8 patches of remnant vegetation totalling 3.68 ha and 34 scattered trees.		
Applicable regulation and purpose of the clearance:	Division 5 of the *Native Vegetation Regulations 2017*, which allows for the clearance of native vegetation in relation to specific activities as set out in Schedule 1, Parts 4, 5 or 6. This project fits within Part 6, section 34 (1) (b). The purpose of the clearance is to facilitate the establishment of a Solar Array and Battery Storage project.		
Level of risk:	3		

2 INTRODUCTION

EBS Ecology (EBS) was contracted by Masterplan SA Pty Ltd to conduct an ecological assessment for the proposed solar array and battery storage project located at Pallamana ('the Project'). Pallamana is located in the Murray Basin approximately 5 km from Murray Bridge, South Australia. The ecological assement included a deskop assessment and two field surveys. The field surveys were conducted on 16 August 2017 and 5 July 2018 and included a vegetation survey following the Bushland Assessment Method (BAM) and Scattered Tree Assessment Method (STAM) devised by the Department of Environment and Water (DEW) in July 2017 (NVC 2017).

The desktop assessment involved searching Commonwealth and State databases to identify threatened species potentially occurring in and surrounding the proposed development site, as well as relevant matters of national environmental significance and other matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *National Parks and Wildlife Act 1972* (NPW Act).

2.1 Objectives

The objectives of this study were to:

- Identify any threatened flora and fauna species and threatened ecological communities listed under State and Federal legislation that are present or have been historically recorded in the vicinity of the Project area.
- Determine the type, condition and species composition of vegetation in the Project area.
- Identify fauna species and suitable habitat present in the Project area.
- Determine if the proposed works will likely impact any state and federally listed species to inform decisions on EPBC referral.
- Identify any introduced flora and fauna species, including plant diseases, in the Project area that may require control during the works.
- Determine Significant Environmental Benefit (SEB) offset requirements for a future Native Vegetation Clearance application
- Provide recommendations to help avoid, minimise or mitigate impacts, should the Project be approved.

2.2 Project area

The Pallamana Project area is located approximately 5 km from Murray Bridge, South Australia (Figure 1). The Project area is 791.35 ha and contains approximately 18.85 ha of remnant vegetation and 772.50 ha of agricultural land and areas devoid of native vegetation (vehicle tracks etc.).

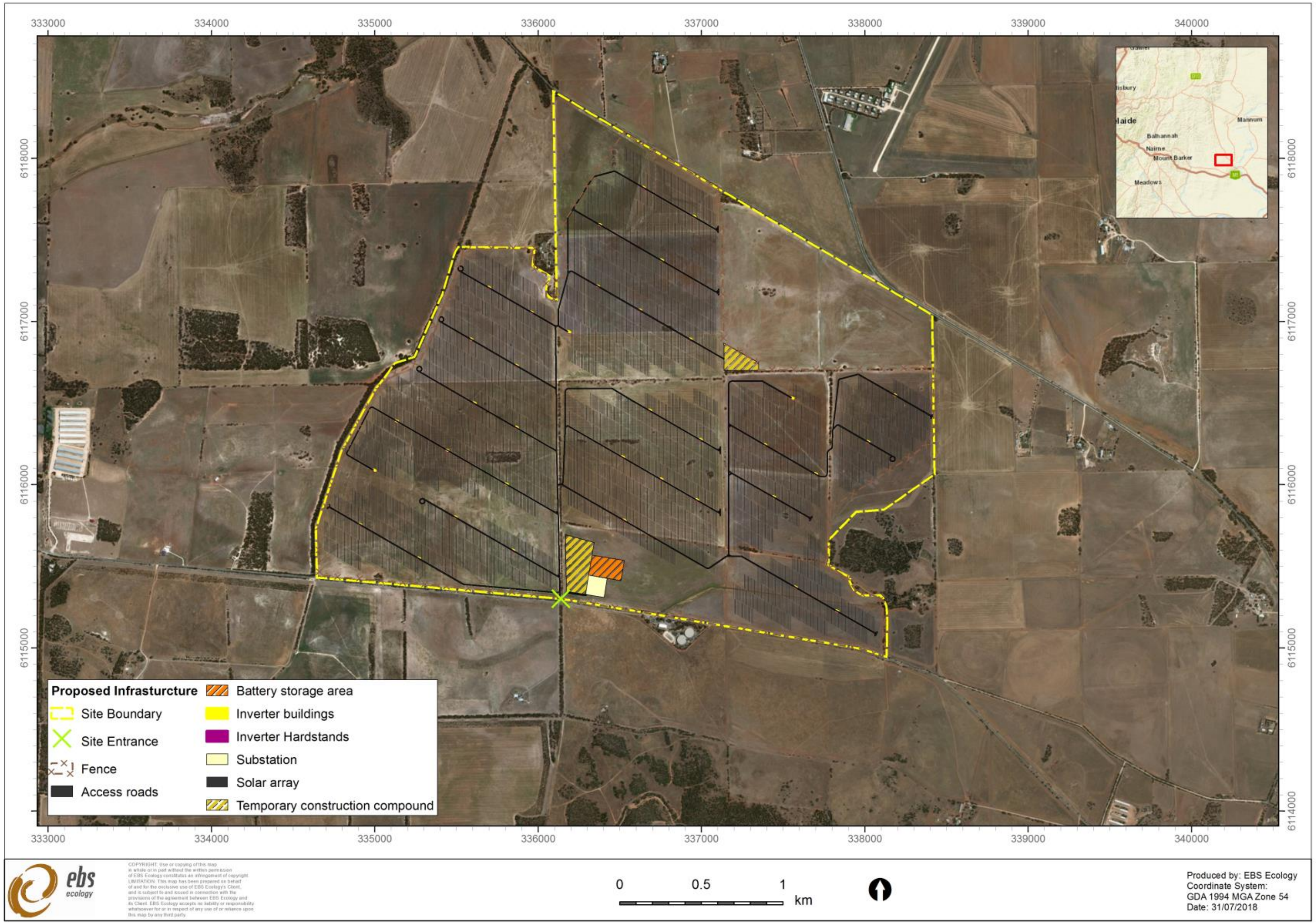


Figure 1. Location of the Pallamana Project area and the infrastructure footprint, in South Australia.

3 COMPLIANCE AND LEGISLATIVE SUMMARY

3.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act and the *Environment Protection and Biodiversity Conservation Regulations 2000* provide a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – defined in the Act as ‘matters of national environmental significance’. The nine matters of national environmental significance protected under the Act are:

1. World Heritage properties
2. National Heritage places
3. Wetlands of international importance (listed under the RAMSAR Convention)
4. Listed threatened species and ecological communities
5. Migratory species protected under international agreements
6. Commonwealth marine areas
7. The Great Barrier Reef Marine Park
8. Nuclear actions (including uranium mines
9. A water resource, in relation to coal seam gas development and large coal mining development

Any action that has, will have, or is likely to have a significant impact on matters of national environmental significance requires referral under the EPBC Act. Substantial penalties apply for undertaking an action that has, will have or is likely to have significant impact on a matter of national environmental significance without approval.

The EPBC Act Significant Impact Guidelines provide overarching guidance on determining whether an action is likely to have a significant impact on a matter of national environmental significance. In terms of nationally threatened species, the guidelines define an action as likely to have a significant impact if there is a real chance or possibility that it will:

- Lead to a long term decrease in the population
- Reduce the area of occupancy of the species
- Fragment an existing population
- Adversely affect critical habitat
- Disrupt breeding cycles
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in the establishment of invasive species that are harmful to the species
- Introduce disease that may cause the species to decline
- Interfere with the recovery of the species.

3.2 Native Vegetation Act 1991

The Project area is located in the Rural City of Murray Bridge Council area, which is subject to the NV Act. Native vegetation within the Project area is protected under the NV Act and *Native Vegetation Regulations 2017*. Any proposed clearance of native vegetation in South Australia (unless exempt under the *Native Vegetation Regulations 2017*) is to be assessed against the NV Act Principles of Clearance, and requires approval from the Native Vegetation Council (NVC). A net environmental benefit is generally conditional on an approval being granted.

Native vegetation refers to any naturally occurring local plant species that are indigenous to South Australia, from small ground covers and native grasses to large trees and water plants.

“Clearance", in relation to native vegetation, means:

- The killing or destruction of native vegetation
- The removal of native vegetation
- The severing of branches, limbs, stems or trunks of native vegetation
- The burning of native vegetation
- Any other substantial damage to native vegetation, and includes the draining or flooding of land, or any other act or activity, that causes the killing or destruction of native vegetation, the severing of branches, limbs, stems or trunks of native vegetation or any other substantial damage to native vegetation

Approval must be obtained before performing any activity that could cause substantial damage to native plants. This also applies to dead trees that may provide habitat for animals. These activities include but are not limited to:

- The cutting down, destruction or removal of whole plants
- The removal of branches, limbs, stems or trunks (including brush cutting and woodcutting)
- Burning
- Poisoning
- Slashing of understorey
- Drainage and reclamation of wetlands
- Grazing by animals (in some circumstances).

Under the NV Act, the NVC considers applications to clear native vegetation under ten principles. Native vegetation should not be cleared if it is significantly at odds with these principles:

- It contains a high level of diversity of plant species
- It is an important wildlife habitat
- It includes rare, vulnerable or endangered plant species
- The vegetation comprises a plant community that is rare, vulnerable or endangered
- It is a remnant of vegetation in an area which has been extensively cleared
- It is growing in, or association with, a wetland environment

- It contributes to the amenity of the area
- The clearance of vegetation is likely to contribute to soil erosion, salinity, or flooding
- The clearance of vegetation is likely to cause deterioration in the quality of surface or underground water
- After clearance, the land is to be used for a purpose which is unsustainable

The principles apply in all cases, except where the vegetation has been considered exempt under the *Native Vegetation Regulations 2017* or can be classified as an 'intact stratum'. 'Intact stratum' means that applications will usually be denied when the vegetation has not been seriously degraded by human activity within the last 20 years.

All approved vegetation clearance must also be conditional on achieving a SEB to offset the clearance. The requirement for a SEB also applies to several of the exemptions. Potential SEB offsets include:

- The establishment and management of a set-aside area to encourage the natural regeneration of native vegetation
- The protection and management of an established area of native vegetation
- Entering into a Heritage Agreement on land where native vegetation is already established to further preserve or enhance the area in perpetuity
- A payment to the Native Vegetation Fund

An assessment against the Native Vegetation Clearance Principles is not required as the clearance associated with the project is in accordance with Division 5 of the *Native Vegetation Regulations 2017*, which allows for the clearance of native vegetation in relation to specific activities as set out in Schedule 1, Parts 4, 5 or 6. This project fits within Part 6, section 34 (1) (b):

34 - Infrastructure

(1) Clearance of vegetation—

(a) incidental to the construction or expansion of a building or infrastructure where the Minister has, by instrument in writing, declared that the Minister is satisfied that the clearance is in the public interest; or

(b) required in connection with the provision of infrastructure or services to a building or proposed building, or to any place, provided that any development authorisation required by or under the *Development Act 1993* has been obtained.

3.3 National Parks and Wildlife Act 1972

Native plants and animals in South Australia are protected under the NPW Act. It is an offence to take a native plant or protected animal without approval. Threatened plant and animal species are listed in Schedules 7 (endangered species), 8 (vulnerable species) and 9 (rare species) of the Act. Persons must not:

- Take a native plant on a reserve, wilderness protection area, wilderness protection zone, land reserved for public purposes, a forest reserve or any other Crown land

- Take a native plant of a prescribed species on private land
- Take a native plant on private land without the consent of the owner (such plants may also be covered by the NV Act)
- Take a protected animal or the eggs of a protected animal without approval
- Keep protected animals unless authorised to do so
- Use poison to kill a protected animal without approval

Conservation rated flora and fauna species listed on Schedules 7, 8, or 9 of the NPW Act are known to or may occur within the Project area. Persons must comply with the conditions imposed upon permits and approvals.

3.4 Natural Resources Management Act 2004

Under the *Natural Resources Management Act 2004* (NRM Act) landholders have a legal responsibility to manage declared pest plants and animals and prevent land and water degradation.

Key components under the Act include the establishment of regional Natural Resource Management (NRM) Boards and development of regional NRM Plans; the ability to control water use through prescription, allocations and restrictions; requirement to control pest plants and animals and activities that might result in land degradation.

A ‘duty of care’ is a fundamental component of this Act, i.e. ensuring one’s environmental and civil obligation by taking reasonable steps to prevent land and water degradation. Persons can be prosecuted if they are considered negligent in meeting their obligations.

4 BACKGROUND INFORMATION

4.1 Administrative boundaries

The Project area is located within the South Australian Murray-Darling Basin Natural Resource Management (NRM) Region, the Sturt County, the Mobilong Hundred and the Rural City of Murray Bridge Council area.

4.2 Environmental setting

4.2.1 IBRA

The Interim Biogeographical Regionalisation of Australia (IBRA) identifies geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. The bioregions are further refined into subregions and environmental associations (DEW 2011). The Project area is located within the Murray Darling Depression IBRA Bioregion, the Murray Mallee IBRA Subregion and Sandergrove and Pallamana IBRA Environmental Associations.

Native vegetation remnancy figures for IBRA subregions and environmental associations are useful for setting regional landscape targets. Approximately 21% (444,401 ha) of the Murray Mallee IBRA Subregion is mapped as remnant vegetation, of which 17% (76,180 ha) is formally conserved and protected within National Parks and Wildlife reserves and private Heritage Agreements under the NV Act. A full summary is provided below in Table 2.

Table 2. IBRA bioregion, subregion, and environmental association environmental landscape summary.

Murray Darling Depression IBRA bioregion	
An extensive gently undulating sand and clay plain of Tertiary and Quaternary age frequently overlain by aeolian dunes. Vegetation consists of semi-arid woodlands of Black Oak / Belah, Bullock Bush/ Rosewood and Acacia spp., mallee shrublands and heathlands and savanna woodlands.	
Murray Mallee IBRA subregion	
Extensive calcreted plains overlain by a series of sand dunes The calcreted ridges which form the undulating plain have a distinct west-north-westerly trend. The soils are shallow reddish sands on the plains and deep yellowish sands on the dunes. Fans bordering the Mt Lofty Ranges with low isolated hills rising above them have red duplex soils and calcareous earths subject to sheet erosion. Mallee is the dominant vegetation of the subregion. Its species composition reflects the diminishing coastal influence towards the north, especially in the understorey: broombush gives way here to saltbush and bluebush (*Atriplex* and Maireana spp.) and hummock grass (Triodia irritans). Blue gum (*E. leucoxylon*) and peppermint box (E. odorata) are characteristic species in the west of the region. Although tracts of mallee still occur, most of the original vegetation has been cleared for agriculture.	
Remnant vegetation	Approximately 21% (444401 ha) of the subregion is mapped as remnant native vegetation, of which 17% (76180 ha) is formally conserved.
Landform	Very gently undulating to flat aeolian sand covered depositional plain of the central-southern Murray Basin.
Geology	East-west linear dunes, regularly spaced with cusp-like crests which are consistently steeper on the southern side. Up to four buried paleo sols within the dune. Dunes composed of pale to dark reddish-brown calcareous sand with some clay fraction.

Soil	Brown calcareous earths and highly calcareous brown loamy earths, Hard setting loamy soils with red clayey subsoils, Cracking clays.
Vegetation	Mallee heath and shrublands.
Conservation significance	101 species of threatened fauna, 136 species of threatened flora. 9 wetlands of national significance.
Sandergrove IBRA environmental association	
Remnant vegetation	Approximately 11% (6037 ha) of the association is mapped as remnant native vegetation, of which 26% (1560ha) is formally conserved.
Landform	Undulating plain on tillite with areas of calcrete merging into alluvial fans.
Geology	Calcrete, tillite and alluvium.
Soil	Sandy pedal mottled-yellow duplex soils, hard pedal red duplex soils and reddish dense loams.
Vegetation	Open woodland of peppermint box, open scrub of mallee and Broombush, low open forest of brown Stringybark sometimes with pink gum and open scrub of cup gum and desert banksia.
Conservation significance	52 species of threatened fauna, 130 species of threatened flora. 2 wetlands of national significance.
Pallamana IBRA environmental association	
Remnant vegetation	Approximately 6% (564 ha) of the association is mapped as remnant native vegetation, of which 19% (107 ha) is formally conserved.
Landform	Undulating plain on calcrete with a thin veneer of sand.
Geology	Limestone overlain with aeolian sand.
Soil	Grey calcareous earths and sandy apedal yellow duplex soils.
Vegetation	Open parkland of pink gum and mallee.
Conservation significance	21 species of threatened fauna, 13 species of threatened flora. 0 wetlands of national significance.

4.2.2 Climate

The closest weather station to the Project area is located at Murray Bridge. This weather station is located approximately 10 km south-east of the Project area. The annual average rainfall is 350.4 mm. The majority of the rainfall occurs during winter with the highest falls in June (average 38.1 mm) (Figure 2). The mean minimum temperature ranges from 5.4°C (July) to 14.7°C (January and February) and the mean maximum temperature ranges from 16.2°C (July) to 29.4°C (February).

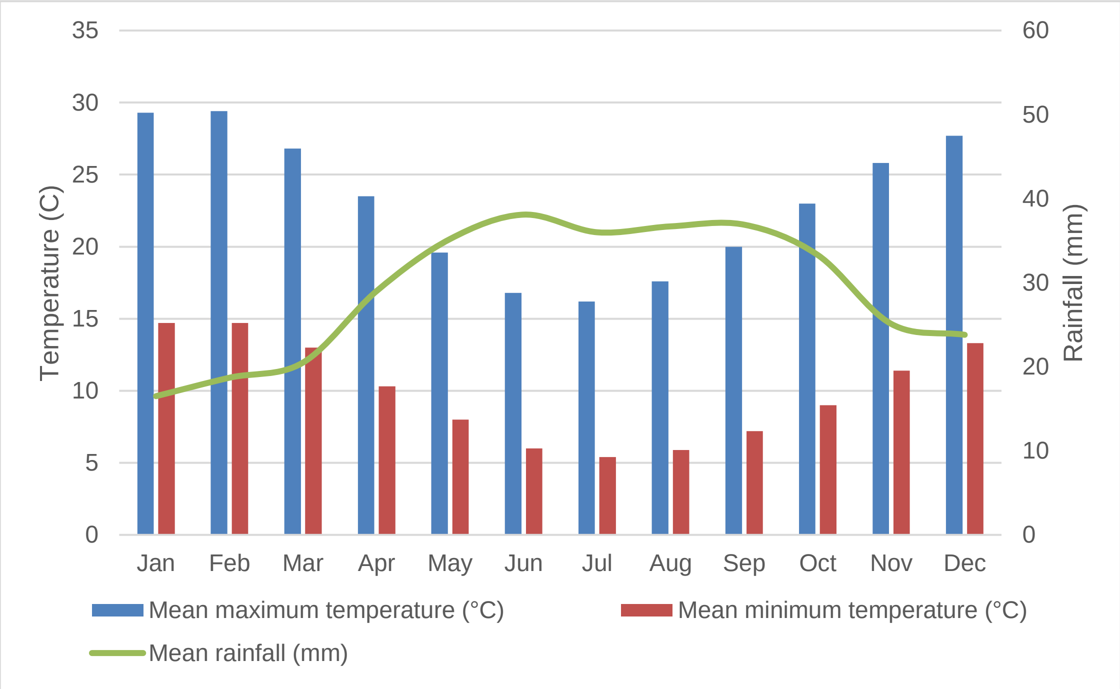


Figure 2. Mean monthly rainfall and temperature data for Murray Bridge (station no. 024521) (BOM 2017).

5 METHODS

5.1 Desktop assessment

An initial desktop assessment was conducted to assess the potential for any threatened species (both Commonwealth and State listed) to occur within the Project area. This was achieved by undertaking database searches with a 10 km buffer of the Project area.

5.1.1 Protected Matters Search Tool (PMST) – EPBC Act

A Protected Matters Search Tool (PMST) report was generated on 31 July 2017 to identify matters of national environmental significance under the EPBC Act (DotEE 2017). An additional PMST report was generated on 30 July 2018 to identify any possible updates in results. No new results were highlighted in the 30 July 2018 PMST report.

The PMST is maintained by the Department of the Environment and Energy (DotEE) and was used to identify flora and fauna species or ecological communities of national environmental significance that may occur or have suitable habitat within the Project area.

5.1.2 Biological Database of South Australia (BDBSA) – NPW Act

Species listed under South Australia's NPW Act were assessed using the Biological Databases of South Australia (BDBSA). The dataset was obtained on 01 August 2017 and used to identify threatened species that have been recorded within the 10 km buffer of the Project area (DEW 2017). An additional search utulising the Atlas of Living Australia (ALA) was generated on 30 July 2018 to identify any possible updates in results. No new results were highlighted in the 30 July 2018 ALA report.

5.1.3 Assessment of the likelihood of occurrence

The likelihood of each threatened flora and fauna species occurring within the Project area was assessed. A likelihood of occurrence rating (Highly Likely/Known, Likely, Possible, Unlikely, Impossible) was assigned to each threatened species identified in the desktop database searches. The ratings take the following criteria into consideration:

- Date of the most recent record (taking into consideration the date of the last surveys conducted in the area) (DEW 2017).
- Proximity of the records (i.e. distance to the Project area).
- Landscape, vegetation remnancy and vegetation type of the record location (taking into consideration the landscape, vegetation remnancy and vegetation type of the Project area, with higher likelihood assigned to species that were found in similar locations/condition/vegetation associations).
- Knowledge of the species habitat preferences, causes of its decline, and local population trends.

A summary of the likelihood criteria is shown below in Table 3.

Table 3. Likelihood criteria for the occurrence of threatened species.

Likelihood	Criteria
Impossible	• Species cannot occur in Project area (e.g. it is impossible for a marine mammal to occur in a terrestrial Project area).
Unlikely	• No records despite survey effort considered adequate, or • No records and survey effort is considered not adequate, and no suitable habitat is known to occur in the area, or • No records and survey effort is not considered adequate, and no suitable is known to occur in the area, and species of similar habitat needs have no records either.
Possible	• No records, survey effort is considered not adequate, suitable habitat does occur (or isn't known if it does occur) and species of similar habitat needs have been recorded in the area, or • Records within the last 40 years, and the area is not largely intact, or • Records in the last 10 years, the species does not have highly specific needs, and habitat is largely intact.
Likely	• Records in the last 10 years, the species does not have highly specific habitat needs and the habitat is largely intact, or • Records in the last 10 years, the species does have highly specific habitat needs and these needs occur in the area.
Highly likely/known	• Records in the last 10 years, the species does not have highly specific needs, and the habitat is largely intact.

5.2 Field survey

The field surveys were conducted on 16 August 2017 and 5 July 2018 and included a vegetation survey and fauna assessment.

5.2.1 Vegetation survey

Bushland Assessment

The vegetation survey was performed in accordance with the (Bushland Assessment Method) BAM manual, by NVC accredited ecologists (NVC 2017a). The NVC BAM is suitable for assessing vegetation that is located within the agricultural region of South Australia. This includes the following NRM Board Regions:

- Adelaide and Mount Lofty Ranges
- Eyre Peninsula
- Kangaroo Island
- Northern and Yorke
- South Australian Murray-Darling Basin
- South East

The BAM uses biodiversity 'surrogates' or 'indicators' to measure biodiversity value against benchmark communities. Each area to be assessed is termed an application area ('Block'), within which different vegetation associations ('sites') are identified and compared to the Nature Conservation Society of South

Australia's 'benchmark' vegetation communities. A representative 1 hectare 'Quadrat' is surveyed for each site (NVC 2017a).

For the NVC BAM, three components of the biodiversity value of the site are measured and scored (Table 4).

- Vegetation condition
- Conservation value
- Landscape context

These three component scores are combined to provide a 'Unit Biodiversity Score' (per ha) and then multiplied by the size (hectares) of the site to provide a 'Total Biodiversity Score' for the site. This is used to calculate an SEB area and value for payment in to the Native Vegetation Fund derived from the clearance of native vegetation (NVC 2017a).

Table 4. Components of the biodiversity value of a site that are measured in the Bushland Assessment Method.

Parameter	Factors
Vegetation condition	• Native species diversity • Number of native lifeforms and their cover • Number of regenerating species • Weed cover and the level of invasiveness of dominant species • Cover of bare ground, fallen timber, exotic species in the understorey • Tree health and the number of individuals supporting hollows
Conservation value	• The presence of federal or state listed threatened ecological communities, and their conservation rating. • Number of threatened plant species recorded at the site, and their conservation rating • Number of threatened fauna species for potential habitat occurs within the site, and their conservation rating.
Landscape context	• Percentage vegetation cover within 5 km • Block shape • Distance to remnant of > 50 ha • Remnancy of IBRA Association • Percentage of vegetation protected within the IBRA Association • The presence of riparian vegetation, swamps or wetlands
Mean annual rainfall	The mean annual rainfall for the assessment area.
Area of clearance	The area of native vegetation (ha) to be cleared for the project.

Scattered Tree Assessment

The assessment of scattered trees was performed in accordance with the Scattered Tree Assessment Method (STAM) devised by the NVC (2017a). The STAM was suitable in this instance since the Project area contains individual scattered trees and clumps of trees that are <0.1 ha surrounded by introduced pasture or crops. Not all scattered tree species are available in the STAM scoresheet due to the recent establishment of the STAM. Therefore, species of similar growth habit and life form were selected based on consultation with the NVC (Adam Schutz pers. comm. 11 May 2018) and 'Appendix 5 Life Forms' in the Bushland Assessment Manual (NVC 2017a) (Table 5).

Table 5. Scattered tree species substitutions applied in the STAM scoresheet as per consultation with the NVC (Adam Schutz pers. comm. 11 May 2018) and 'Appendix 5 Life Forms' in the Bushland Assessment Manual (NVC 2017a).

Species observed	Substitute species in scoresheet
Eucalyptus dumosa (White Mallee)	*Eucalyptus phenax spp. phenax* (White Mallee)
Eucalyptus oleosa (Red Mallee)	*Eucalyptus socialis* (Beaked Red Mallee)
Melaleuca uncinata (Broombush)	*Melaleuca brevifolia* (Short-leaf Honey-myrtle)

5.2.2 Fauna assessment

The areas containing remnant vegetation within Project area were traversed on foot. All fauna species, signs of species and potential habitat for fauna was recorded. Bird species in particular were targeted. The value of habitat for the threated fauna species identified in the desktop assessment was also determined when searching each area.

5.3 Limitations

The content of the desktop assessment was derived from existing datasets and references from a range of sources. EBS has not attempted to verify the accuracy of any such information.

Flora and fauna records were sourced from the PMST and BDBSA. The BDBSA only includes verified flora and fauna records submitted to DEW or partner organisations. It is recognised that knowledge is poorly captured and it is possible that significant species occur that are not reflected by database records. Although much of the BDBSA data has been through a variety of validation processes, the lists may contain errors and should be used with caution. DEW gives no warranty that the data is accurate or fit for any particular purpose of the user or any person to whom the user discloses the information.

The reliability of the BDBSA data ranges from 100 m to over 100 km. Fauna species, in particular birds, also have the ability to traverse distances in excess of 20 km. It is also acknowledged that the presence of species may not be adequately represented by database records. Hence the PMST and BDBSA results may not highlight all potential threatened flora and fauna species that may occur in the area, within a 10 km radius.

The fauna assessment was performed to determine the likelihood of presence for threatened fauna species. In addition to this, all fauna species observed were recorded. The compiled list of fauna observations does not represent all species expected to occur within the Project area.

The findings and conclusions expressed by EBS are based solely upon information in existence at the time of the assessment. The combination of database records and background research have provided a solid foundation for determining the flora and fauna that are likely to, or are known to, occur within the Project area.

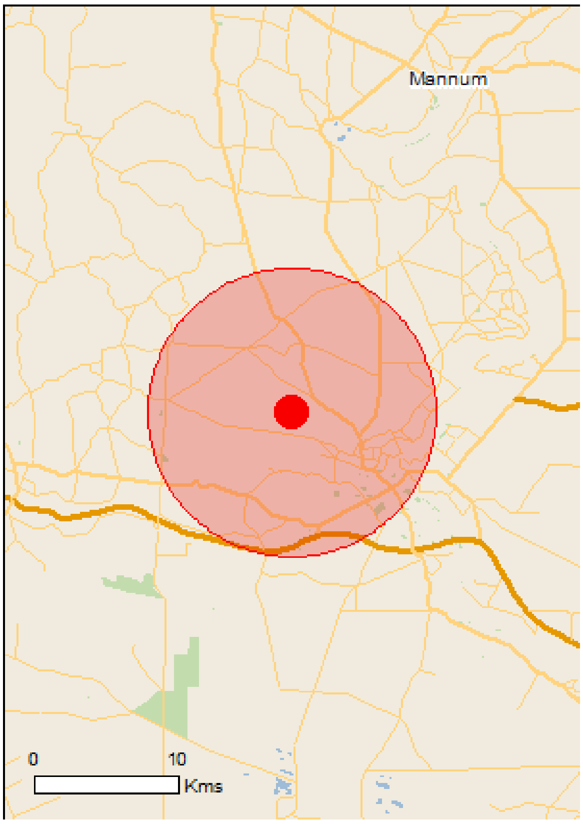
6 DESKTOP ASSESSMENT RESULTS

6.1 Matters of national and state significance

One Wetland of International Significance, four threatened ecological communities (TECs), 28 threatened species and 12 migratory species were identified in the PMST as potentially occurring or having suitable habitat potentially occurring within 10 km of the Project area. The results of the EPBC Act PMST report are summarised in Table 6.

The relevant matters of national environmental significance, other matters protected under the EPBC Act, and threatened species listed under the NPW Act are discussed in detail below. Listed aquatic dependent species (i.e. fish, Platypus) are included in Table 6 but are not relevant and therefore not discussed, as the Project area and potential impacts are confined to the terrestrial environment.

Table 6. Summary of the results of the EPBC Act Protected Matters Search Tool report.

Search area (10 km buffer)	**Matters of National Environment Significance under the *EPBC Act 1999***	**Identified within the search area**
	World Heritage Properties	None
	National Heritage Properties	None
	Wetlands of International Significance	1
	Great Barrier Reef Marine Park	None
	Commonwealth Marine Areas	None
	Threatened Ecological Communities	4
	Threatened Species	28
	Migratory Species	12
	Commonwealth Lands	3
	Commonwealth Heritage Places	None
	Listed Marine Species	17
	Whales and other Cetaceans	None
	Critical Habitats	None
	Commonwealth Reserves	None
	State and Territory Reserves	76
	Regional Forest Agreements	None
	Invasive Species	33
	Nationally Important Wetlands	1

6.1.1 Wetlands of national importance

The Coorong and Lakes Alexandrina and Albert Ramsar site is located at the downstream end of the Murray River, in south-east South Australia. The Project area is located approximately 25 km north of the Ramsar listed wetland. The Project will therefore have no impact on the listed wetland.

6.1.2 Threatened ecological communities

Four TECs were identified in the PMST as potentially occurring within 10 km of the Project area. A summary of these TECs and comment regarding their likelihood of occurrence in the Project area are provided in Table 7. None of the four TEC's were identified within the Project area during the field surveys.

Table 7. The threatened ecological communities identified in the PMST and their likelihood of presence within the Project area.

Threatened Ecological Community	EPBC status	Likelihood of occurrence in the Project area
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	E	Unlikely
Iron-grass Natural Temperate Grassland of South Australia	CE	Unlikely
Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia	CE	Unlikely
River Murray and associated wetlands, floodplains and groundwater systems, from the junction with the Darling River to the sea	Approval Disallowed	Unlikely

Conservation status
Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare.

6.1.3 Nationally threatened flora

Twelve flora species listed as threatened under the EPBC Act were identified in the PMST as potentially occurring or having suitable habitat potentially occurring within 10 km of the Project area (Table 8). Five of these species were also identified in the 10 km BDBSA search. Furthermore, one additional EPBC Act listed species that was not identified in the PMST was identified in the BDBSA search. This was *Caladenia concolor* (Crimson Spider-orchid). The distribution of all nationally listed species identified in the BDBSA search are shown in Figure 3.

None of the EPBC Act listed species are likely to occur within the Project area.

6.1.4 State threatened flora

Forty-four flora species listed as threatened under the NPW Act were identified in the BDBSA search as being previously recorded within 10 km of the Project area (Table 8). Seven of these species are also nationally threatened. Two of the NPW Act listed species could potentially occur within the Project area (Table 8), these are; *Bothriochloa macra* (Red-leg Grass) (SA:R) and *Maireana rohrlachii* (Rohrlach's Bluebush) (SA:R).

The distribution of all nationally and state threatened species identified in the BDBSA search are shown in (Figure 3). The complete list of flora species identified in the 10 km BDBSA search is provided in Appendix 1.

Table 8. Threatened flora species listed under the EPBC Act and NPW Act identified in the PMST (Source 1) and BDBSA (Source 2) database searches within 10 km of the Project area.

Scientific name	Common name	Conservation status		Source	BDBSA last record (year)	Likelihood of occurrence within Project area
		Aus	SA			
Acacia iteaphylla	Flinders Ranges Wattle		R	2	19/07/2012	Unlikely
Acacia lineata	Streaked Wattle		R	2	17/06/1988	Unlikely
Acacia menzelii	Menzel's Wattle	VU	V	1, 2	10/11/2014	Unlikely
Acacia montana	Mallee Wattle		R	2	10/11/2014	Unlikely
Acacia pinguifolia	Fat-leaved Wattle	EN	E	1		Unlikely
Acacia rhetinocarpa	Resin Wattle	VU	V	1, 2	22/09/2012	Unlikely
Acacia rhigiophylla	Dagger-leaf Wattle		R	2	3/11/2012	Unlikely
Acacia simmonsiana	Hall's Wattle		R	2	12/09/1982	Unlikely
Acacia trineura	Three-nerve Wattle		E	2	22/10/2004	Unlikely
Atriplex australasica			R	2	19/04/1977	Unlikely
Austrostipa densiflora	Fox-tail Spear-grass		R	2	4/11/2014	Unlikely
Austrostipa tuckeri	Tucker's Spear-grass		R	2	8/05/1992	Unlikely
Bothriochloa macra	Red-leg Grass		R	2	1/05/1939	Possible
Brachyscome paludicola	Swamp Daisy		R	2	1/01/1991	Unlikely
Caladenia argocalla	White-beauty Spider-orchid	EN	E	1		Unlikely
Caladenia colorata	Coloured Spider-orchid	EN	E	1, 2	1/09/1942	Unlikely
Caladenia concolor	Crimson Spider-orchid	VU	E	2	1/09/1942	Unlikely
Caladenia macroclavia	Large-club Spider-Orchid	EN	E	1		Unlikely
Caladenia sp. Monarto South (H.Goldsack 163 AD97708605A)			E	2	26/09/1936	Unlikely
Caladenia stellata	Star Spider-orchid		R	2	0/01/1900	Unlikely
Caladenia tensa	Greencomb Spider-orchid	EN		1		Unlikely
Calocephalus sonderi	Pale Beauty-heads		R	2	0/01/1900	Unlikely
Calotis scapigera	Tufted Burr-daisy		R	2	20/06/1941	Unlikely
Ceratophyllum demersum	Hornwort		R	2	1/11/2005	Unlikely
Crassula peduncularis	Purple Crassula		R	2	17/05/1977	Unlikely
Crassula sieberiana	Sieber's Crassula		E	2	30/07/1974	Unlikely
Daviesia benthamii ssp. humilis (NC)	Mallee Bitter-pea		R	2	29/10/2004	Unlikely
Diuris behrii	Behr's Cowslip Orchid		V	2	1/09/1978	Unlikely
Eragrostis lacunaria	Purple Love-grass		R	2	25/03/1946	Unlikely
Eremophila gibbifolia	Coccid Emubush		R	2	12/10/1995	Unlikely
Eucalyptus fasciculosa	Pink Gum		R	2	7/05/1992	Unlikely
Eucalyptus leucoxylon ssp. megalocarpa	Large-fruit Blue Gum		R	2	5/05/1992	Unlikely
Hydrilla verticillata	Waterthyme		R	2	1/01/1991	Unlikely
Leptorhynchos elongatus	Lanky Buttons		R	2	29/09/1961	Unlikely
Maireana rohrlachii	Rohrlach's Bluebush		R	2	10/11/2014	Possible
Montia australasica	White Purslane		R	2	0/01/1900	Unlikely
Myriophyllum papillosum	Robust Milfoil		R	2	18/03/1990	Unlikely
Olearia pannosa ssp. pannosa	Silver Daisy-bush	VU	V	1, 2	9/11/2014	Unlikely
Olearia passerinoides ssp. glutescens	Sticky Daisy-bush		R	2	9/07/1984	Unlikely
Olearia picridifolia	Rasp Daisy-bush		R	2	24/09/2013	Unlikely

Scientific name	Common name	Conservation status		Source	BDBSA last record (year)	Likelihood of occurrence within Project area
		Aus	SA			
Philotheca angustifolia ssp. angustifolia	Narrow-leaf Wax-flower		R	2		Unlikely
Poa drummondiana	Knotted Poa		R	2	0/01/1900	Unlikely
Podolepis jaceoides	Showy Copper-wire Daisy		R	2	4/11/2004	Unlikely
Potamogeton ochreatus	Blunt Pondweed		R	2	0/01/1900	Unlikely
Prostanthera chlorantha	Green Mintbush		R	2	1/06/1925	Unlikely
Prostanthera eurybioides	Monarto Mintbush	EN	E	1, 2	4/09/2012	Unlikely
Pterostylis arenicola	Sandhill Greenhood Orchid	VU	V	1		Unlikely
Pterostylis sp. Hale (R.Bates 21725)	Hale Dwarf Greenhood	EN	V	1		Unlikely
Stellaria palustris var. tenella	Swamp Starwort		R	2	20/10/1907	Unlikely
Thelymitra epipactoides	Metallic Sun-orchid	EN	E	1, 2	21/09/1912	Unlikely
Zieria veronicea ssp. veronicea	Pink Zieria		R	2	1/10/1964	Unlikely

Conservation status
Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare.

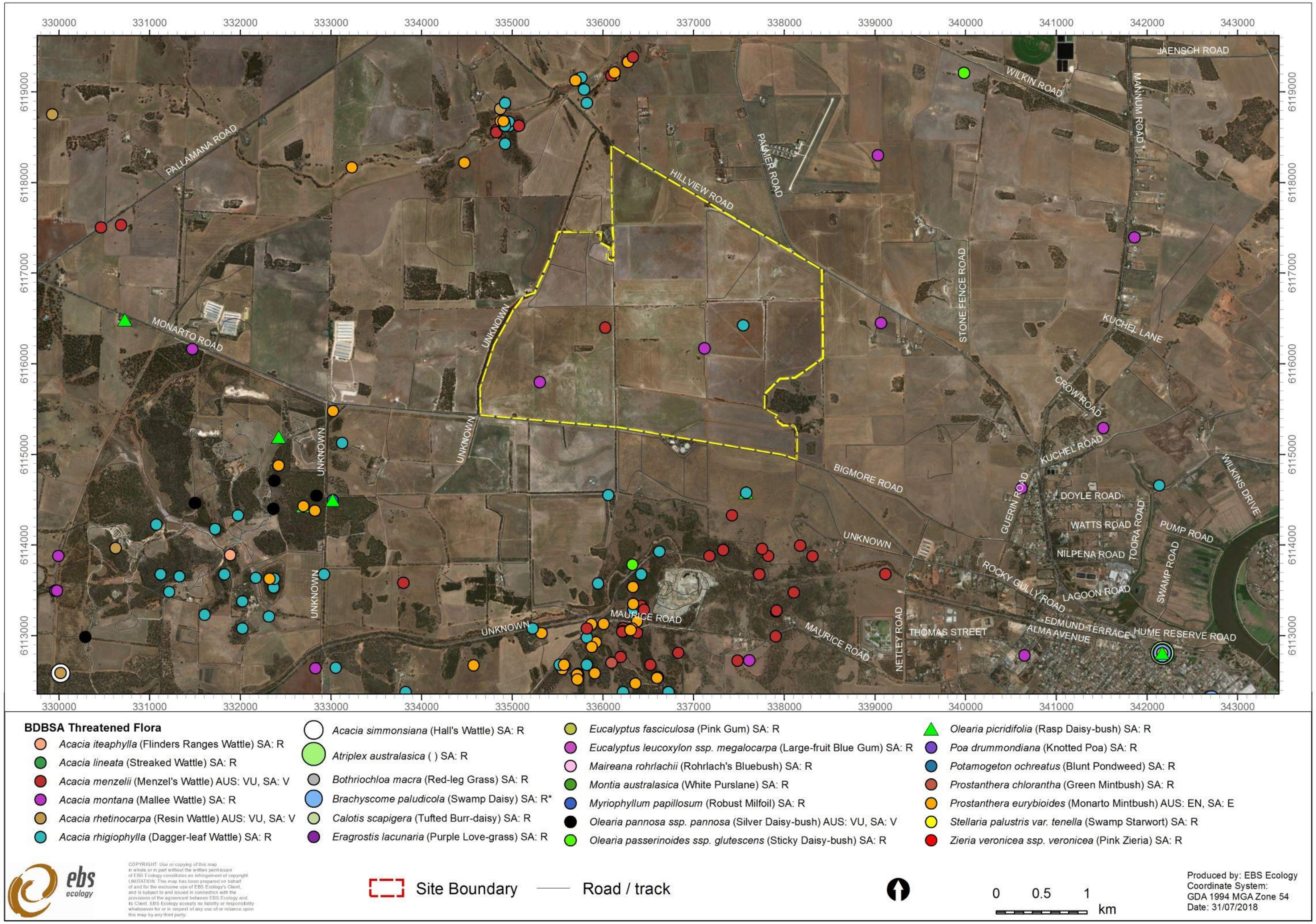


Figure 3. National and state threatened flora species identified within 10 km of the Project area in the BDBSA search (DEW 2017).

6.1.5 Nationally threatened fauna

Thirteen fauna species (excluding fish) listed as threatened under the EPBC Act were identified in the PMST as potentially occurring or having suitable habitat potentially occurring within 10 km of the Project area Table 9. The nationally vulnerable Southern Bell Frog (*Litoria raniformis*) and Malleefowl (*Leipoa ocellata*) were also identified in the 10 km BDBSA search. Neither of these two species is likely to occur within the Project area due to a lack of preferred habitat.

One additional EPBC Act listed species was not identified in the PMST was identified in the BDBSA search. This was the nationally vulnerable Australian Fairy Tern (*Sternula nereis nereis*). The Australian Fairy Tern is unlikely to occur within the Project area due to a lack of preferred habitat.

No fauna species with a conservation rating under the EPBC Act were recorded during the survey. None of the 13 threatened fauna species identified in the PMST are likely to occur within the Project area due to species distributions and a lack of preferred habitat. The distribution of all nationally listed species identified in the BDBSA search is shown in Figure 4.

6.1.6 State threatened fauna

Thirty-seven fauna species (excluding fish and Platypus) listed as threatened under the NPW Act were identified in the BDBSA search as being previously recorded within 10 km of the Project area (Table 9). This included 39 birds, one mammal, one amphibian and one reptile. Three of the bird species, Common Sandpiper (*Actitis hypoleucos*), Cattle Egret (*Ardea ibis*) and Latham's Snipe (*Gallinago hardwickii*) are also listed as migratory and marine species under the EPBC Act. The distribution of all nationally and state threatened species identified in the BDBSA search are shown in (Figure 4).

Five of the NPW Act listed bird species could possibly occur within the Project area based on species distributions and available habitat. These are: White-winged Chough (*Corcorax melanorhamphos*) (SA:R), Peregrine Falcon (*Falco peregrinus*) (SA:R), Purple-gaped Honeyeater (mainland SA) (*Lichenostomus cratitius occidentalis occidentalis*) (SA:R), Black-chinned Honeyeater (*Melithreptus gularis*) (SA: V) and Elegant Parrot (*Neophema elegans*) (SA:R).

The Common Brushtail Possum (*Trichosurus vulpecula*) (SA:R) could also occur within the Project area based on species distribution. The complete list of fauna species identified in the 10 km BDBSA search is provided in Appendix 2.

Table 9. Threatened and migratory fauna species listed under the EPBC Act and NPW Act identified in the PMST (Source 1) and BDBSA (Source 2) database searches within 10 km of the Project area.

Scientific name	Common name	Conservation status		Source	BDBSA last record (year)	Likelihood of occurrence within Project area
		Aus	SA			
ACTINOPTERI						
Craterocephalus fluviatilis	Murray Hardyhead	VU		1, 2	9/10/2015	Impossible
Galaxias rostratus	Flathead Galaxias	CE		1		Impossible
Maccullochella peelii	Murray Cod	VU		1		Impossible
AMPHIBIA						
Litoria raniformis	Southern Bell Frog	VU	V	1, 2	10/09/2005	Unlikely
AVES						
Actitis hypoleucos	Common Sandpiper	Mi (W), Ma	R	1, 2	28/10/2005	Unlikely
Amytornis striatus	Striated Grasswren		R	2	23/08/1980	Unlikely
Anas rhynchotis rhynchotis	Australasian Shoveler		R	2	31/05/2015	Unlikely
Anhinga novaehollandiae	Australasian Darter		R	2	9/10/2015	Unlikely
Apus pacificus	Fork-tailed Swift	Mi (M), Ma		1		Possible
Ardea alba	Great Egret	Ma		1		Unlikely
Ardea ibis	Cattle Egret	Ma	R	1, 2	21/06/2004	Unlikely
Ardea intermedia	Intermediate Egret		R	2	11/12/2002	Unlikely
Ardeotis australis	Australian Bustard		V	2	16/08/2004	Unlikely
Biziura lobata	Musk Duck		R	2	7/03/1987	Unlikely
Botaurus poiciloptilus	Australasian Bittern	EN	V	1		Unlikely
Burhinus grallarius	Bush Stonecurlew		R	2	1/11/2013	Unlikely
Calamanthus (Hylacola) cautus	Shy Heathwren		R	2	3/07/2000	Unlikely
Calidris acuminata	Sharp-tailed Sandpiper	Mi (W), Ma		1		Unlikely
Calidris ferruginea	Curlew Sandpiper	CE, Mi (W), Ma		1		Unlikely
Calidris melanotos	Pectoral Sandpiper	Mi (W), Ma	R	1		Unlikely
Cinclosoma punctatum anachoreta	Mt Lofty Ranges Spotted Quail-thrush	CE	E	1		Unlikely
Corcorax melanorhamphos	White-winged Chough		R	2	25/10/2016	Possible
Egretta garzetta	Little Egret		R	2	26/02/2001	Unlikely
Falco peregrinus	Peregrine Falcon		R	2	18/04/2005	Possible
Falcunculus frontatus frontatus frontatus	Eastern Shriketit		R	2	1/07/2000	Unlikely
Gallinago hardwickii	Latham's Snipe	Mi (W), Ma	R	1, 2	12/12/1976	Unlikely
Grantiella picta	Painted Honeyeater	VU	R	1		Unlikely
Haliaeetus leucogaster	White-bellied Sea-eagle	Ma	E	1		Unlikely
Leipoa ocellata	Malleefowl	VU	V	1, 2	20/12/2009	Unlikely
Lewinia pectoralis	Lewin's Rail		V	2	28/10/2005	Unlikely
Lichenostomus cratitius occidentalis occidentalis	Purple-gaped Honeyeater (mainland SA)		R	2	24/11/1991	Possible
**Melanodryas cucullata cucullata cucullata*	Hooded Robin (SE, MM, MLR, AP, YP, MN)		R	2	25/10/2016	Unlikely
Melithreptus gularis	Black-chinned Honeyeater		V	2	4/08/2008	Possible

Scientific name	Common name	Conservation status		Source	BDBSA last record (year)	Likelihood of occurrence within Project area
		Aus	SA			
Merops ornatus	Rainbow Bee-eater	Ma		1		Possible
Motacilla cinerea	Grey Wagtail	Mi (T), Ma		1		Unlikely
Motacilla flava	Yellow Wagtail	Mi (T), Ma		1		Unlikely
Myiagra cyanoleuca	Satin Flycatcher	Mi (T)		1		Unlikely
**Myiagra inquieta*	Restless Flycatcher		R	2	15/04/2014	Unlikely
Neophema elegans	Elegant Parrot		R	2	28/10/2012	Possible
Numenius madagascariensis	Eastern Curlew	CE, Mi (W), Ma	V	1		Unlikely
Oxyura australis	Blue-billed Duck		R	2	1/01/1900	Unlikely
Pachycephala inornata	Gilbert's Whistler		R	2	19/06/2003	Unlikely
Pandion haliaetus	Osprey	Mi (W), Ma	E	1		Unlikely
Pedionomus torquatus	Plains-wanderer	CE	E	1		Unlikely
Petroica boodang boodang boodang	Scarlet Robin		R	2	23/05/1983	Unlikely
Petroica phoenicea	Flame Robin		V	2	9/05/1999	Unlikely
Pezoporus occidentalis	Night Parrot	EN	E	1		Unlikely
Plectorhyncha lanceolata	Striped Honeyeater		R	2	19/07/2003	Unlikely
Podiceps cristatus	Great Crested Grebe		R	2	28/11/2004	Unlikely
Porzana tabuensis	Spotless Crake		R	2	28/10/2005	Unlikely
Rostratula australis	Australian Painted Snipe	EN, Ma	V	1		Unlikely
**Stagonopleura guttata*	Diamond Firetail		V	2	25/10/2016	Unlikely
Sternula albifrons	Little Tern		E	2	12/07/2003	Unlikely
Sternula nereis	Fairy Tern	VU	E	2	9/05/1997	Unlikely
Tringa glareola	Wood Sandpiper		R	2	1/12/1998	Unlikely
Tringa nebularia	Common Greenshank	Mi (W), Ma		1		Unlikely
Turnix pyrrhothorax	Red-chested Buttonquail		R	2	5/01/1975	Unlikely
MAMMALIA						
Nyctophilus corbeni	Corben's Long-eared Bat	VU	V	1		Unlikely
Ornithorhynchus anatinus	Platypus		E	2	0/01/1900	Impossible
Pteropus poliocephalus	Grey-headed Flying-fox	VU	R	1		Unlikely
Trichosurus vulpecula	Common Brushtail Possum		R	2	18/11/2015	Possible
REPTILIA						
Emydura macquarii	Macquarie Tortoise		V	2	18/02/2016	Unlikely
Tiliqua adelaidensis	Pygmy Blue-tongue Lizard	EN	E	1		Unlikely

Conservation status
Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. ssp.: the conservation status applies at the sub-species level. Mi: Migratory species. (W): Wetland migratory species. (M): Marine migratory species. (T): Terrestrial migratory species. Ma: Marine species.

*** = These species may occur within the Project area on a very infrequent basis.**

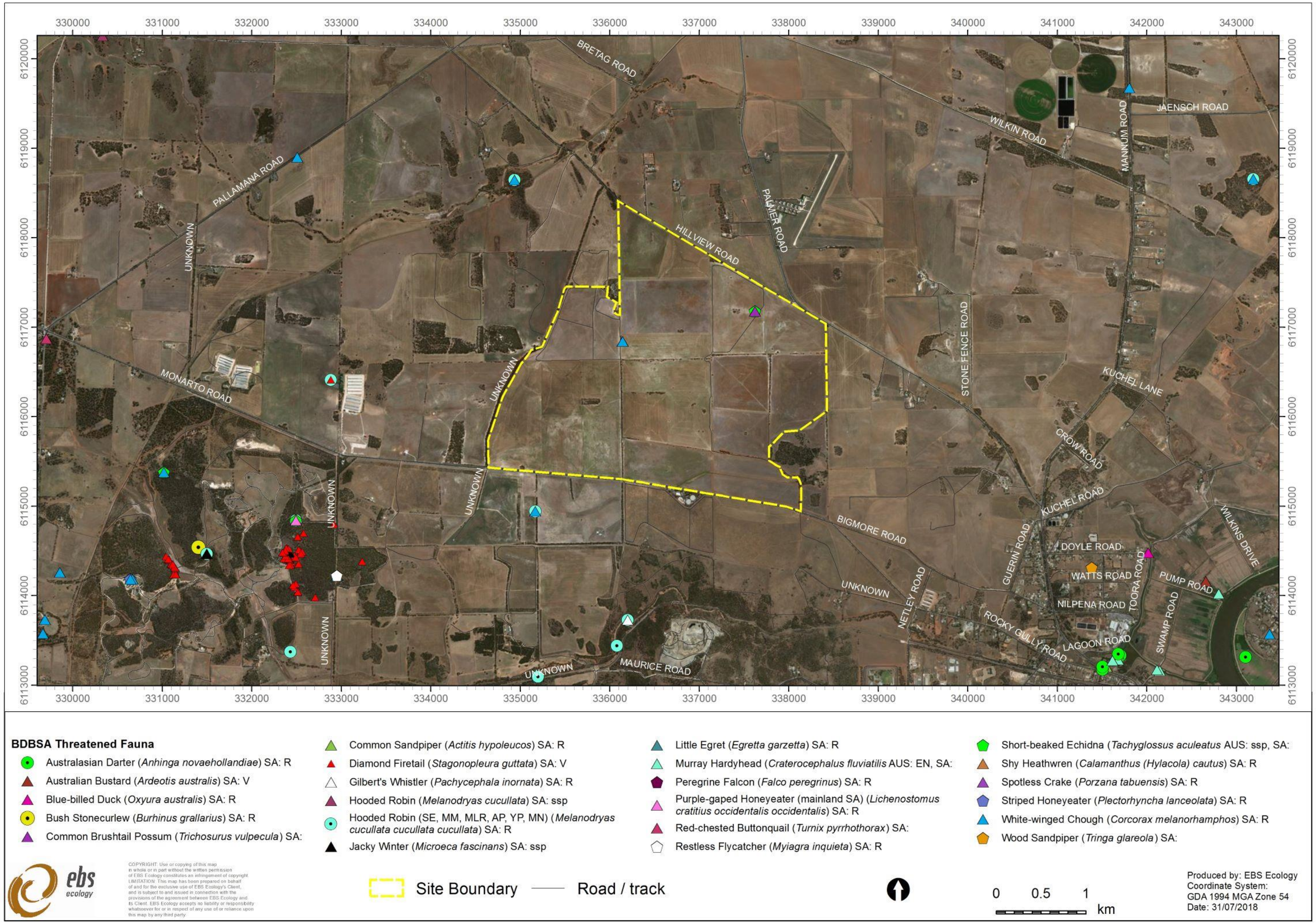


Figure 4. National and state threatened fauna species identified within 10 km of the Project area in the BDBSA search (DEW 2017).

6.1.7 Nationally listed migratory fauna

Twelve fauna species listed as migratory under the EPBC Act were identified in the PMST as potentially occurring or having suitable habitat potentially occurring within 10 km of the Project area (Table 9). All twelve are bird species. The Fork-tailed Swift (*Apus pacificus*) could potentially occur within the Project area.

6.1.8 Nationally listed marine species

Seventeen fauna species listed as marine under the EPBC Act were identified in the PMST as potentially occurring or having suitable habitat potentially occurring within 10 km of the Project area (Table 9). All seventeen are bird species. The Rainbow Bee-eater (*Merops ornatus)* and Fork-tailed Swift (*Apus pacificus*) could potentially occur within the Project area.

6.1.9 State and territory reserves

Seventy-six Heritage Agreements (HA) were identified in the PMST as occurring within 10 km of the Project area. One expired Heritage Agreement did occur within the Project area. The HA was proclaimed in 1982 and occurred as three separate parcels (HA 9045.1, HA 9045.3 and HA 9045.5). These covered an area of 171.9 ha, 80.69 ha and 214.7 ha respectively (Figure 5).

Kinchina Conservation Park (CP) is located less than 1 km from the southern boundary of the Project area and approximately 5 km west of Murray Bridge (Figure 5). Kinchina CP covers an area of 414.3 ha.

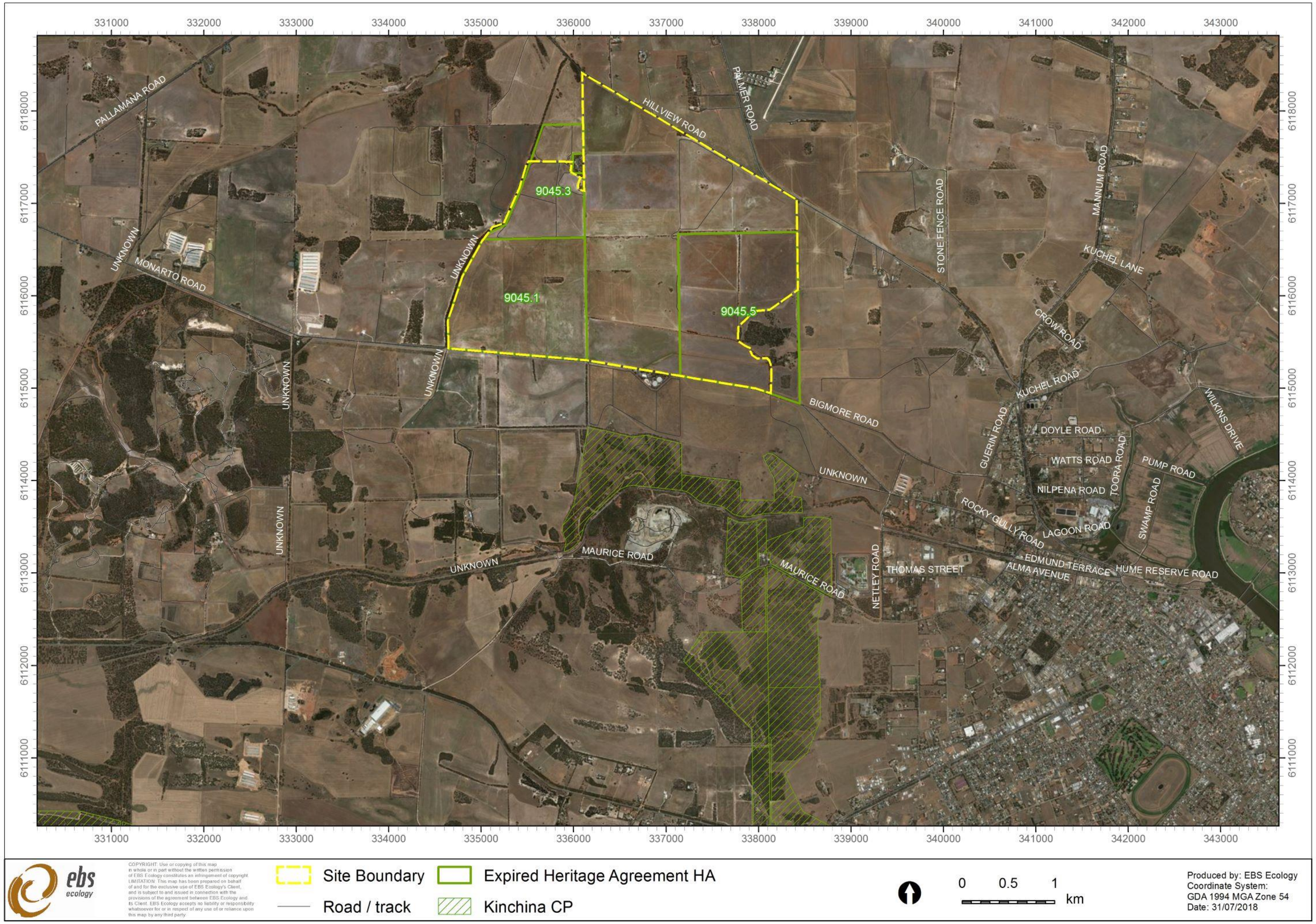


Figure 5. Location of the expired Heritage Agreement and Kinchina CP in relation to the Project area.

6.1.10 Invasive species

Nine exotic bird, nine exotic mammal and 15 exotic plant species were identified in the PMST as potentially occurring or having suitable habitat potentially occurring within 10 km of the Project are. These are summarised below in Table 10. Six of the species identified in the PMST were recorded during the field survey. This included two birds, two mammals and two plant species (Table 10).

The BDBSA search identified four exotic fish, 11 exotic bird, nine exotic mammal and 302 exotic plant species recorded within 10 km of the Project area. These are listed in Appendix 1 and Appendix 2.

Table 10. Invasive species potentially occurring within 10 km of the Project area identified using the PMST (DotEE 2017).

Scientific name	Common name	Likelihood of occurrence within Project area
Birds		
Alauda arvensis	Skylark	Possible
Anas platyrhynchos	Mallard	Unlikely
Carduelis carduelis	European Goldfinch	Unlikely
Columba livia	Domestic Pigeon	Likely
Passer domesticus	House Sparrow	Known (recorded during the survey)
Pycnonotus jocosus	Red-whiskered Bulbul	Unlikely
Streptopelia chinensis	Spotted Turtle-dove	Possible
Sturnus vulgaris	Common Starling	Known (recorded during the survey)
Turdus merula	Common Blackbird	Likely
Mammals		
Bos taurus	Domestic Cattle	Unlikely
Canis lupus familiaris	Domestic Dog	Likely
Capra hircus	Goat	Unlikely
Felis catus	Cat	Likely
Lepus capensis	Brown Hare	Known (recorded during the survey)
Mus musculus	House Mouse	Likely
Oryctolagus cuniculus	European Rabbit	Known (recorded during the survey)
Rattus rattus	Black Rat	Likely
Vulpes vulpes	European Red Fox	Likely
Plants		
Asparagus asparagoides	Bridal Creeper	Known (recorded during the survey)
Austrocylindropuntia spp.	Prickly Pears	Possible
Carrichtera annua	Ward's Weed	Possible
Chrysanthemoides monilifera	Boneseed	Possible
Chrysanthemoides monilifera subsp. monilifera	Boneseed	Possible
Cytisus scoparius	Broom	Possible
Lycium ferocissimum	African Boxthorn	Known (recorded during the survey)
Olea europaea	Olive	Possible
Opuntia spp.	Prickly Pears	Possible

Scientific name	Common name	Likelihood of occurrence within Project area
Pinus radiata	Radiata Pine	Possible
Rubus fruticosus aggregate	European Blackberry	Unlikely
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii	Willows	Unlikely
Solanum elaeagnifolium	Silver Nightshade,	Possible
Tamarix aphylla	Athel Pine,	Unlikely
Ulex europaeus	Gorse	Unlikely

7 FIELD SURVEY RESULTS

7.1 Vegetation

There were three vegetation associations recorded within the Project area, these were: *Eucalyptus odorata* Low Woodland over Exotic grass and herbaceous sp., *Eucalyptus socialis* +/- *E. dumosa* Mixed Mallee over Chenopod shrubs and *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *Melaleuca lanceolata* (Table 11 and Figure 6 to Figure 9). The majority of the Project area contains agricultural cropping land and associated access tracks (approximately 772.50 ha of a total 795.05 ha).

The remnant vegetation is restricted to relatively small patches, totalling 18.86 ha and 51 scattered trees where the soil type was generally not conducive to cropping activities. The majority of the remnant vegetation is in very poor condition due to a range a factors including weed invasion, over grazing, soil disturbance, firewood removal and rubbish dumping. All strata within the vegetation patches have been impacted. The majority of the midstorey and understorey layers of vegetation have been severely impacted with some areas containing only an understorey of introduced species and highly disturbance resistant native species such as *Enchylaena tomentosa* (Ruby saltbush) and *Maireana brevifolia* (Bluebush).

Maireana excavata (Bottle Bluebush) which has a conservation rating of vulnerable under the NPW Act was recorded within BAM quadrat 3a (*Eucalyptus odorata* Low Woodland over Exotic grass and herbaceous sp.).

Twenty-two weed species were recorded within the Project area (Appendix 3), including five species which are listed declared species under the NRM Act. These were; *Lycium ferocissimum* (African Boxthorn), *Marrubium vulgare* (Horehound), *Echium plantagineum* (Salvation Jane), *Emex australis* (Three-corner Jack) and *Asparagus asparagoides f. asparagoides* (Bridal Creeper).

Seven BAM quadrats were surveyed across the three vegetation associations. Five of these BAM quadrats (1a, 1b, 1c, 1d, 1e) were established within the *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *Melaleuca lanceolata* vegetation association due to the varying condition throughout the Project area. The remaining two BAM quadrats were established within the *Eucalyptus socialis* +/- *E. dumosa* Mixed Mallee over Chenopod shrubs (2a) and *Eucalyptus odorata* Low Woodland over Exotic grass and herbaceous sp. (3a).

BAM scoresheets for a further six sites were established after the field survey following updates of the construction footprint of the project. The scores from the established BAM quadrats were utilised for these six sites (1b-1, 1b-2, 1b-3, 1c-1, 1d-1, and 1d-2).

The majority of the native vegetation within the Project area was able to be retained due to the adjustment of the infrastructure footprint during the early stages of planning. It is estimated that the clearance of native vegetation required for the construction of the Project will be limited to 3.68 ha of *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *Melaleuca lanceolata* and 34 scattered trees.

Each of the three vegetation associations, correlating BAM quadrats and scattered trees are discussed further below.

Table 11. Summary of vegetation associations within the Project area.

Vegetation community	BAM quadrat	Total hectares within the Project area	Proposed clearance of native vegetation within the Project area (ha)	Percentage of vegetation association clearance
Cropping land and areas devoid of vegetation	N/A	772.50	N/A	N/A
Eucalyptus odorata Low Woodland over Exotic grass and herbaceous sp.	3a	1.55	0	0
Eucalyptus socialis +/- *E. dumosa* Mixed Mallee over Chenopod shrubs	2a	0.55	0	0
Eucalyptus socialis, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *Melaleuca lanceolata*	1a, 1b, 1b-1, 1b-2, 1c, 1c-1, 1d, 1d-1, 1d-2, 1e	16.76	3.69	22.01
Total		**795.05**		

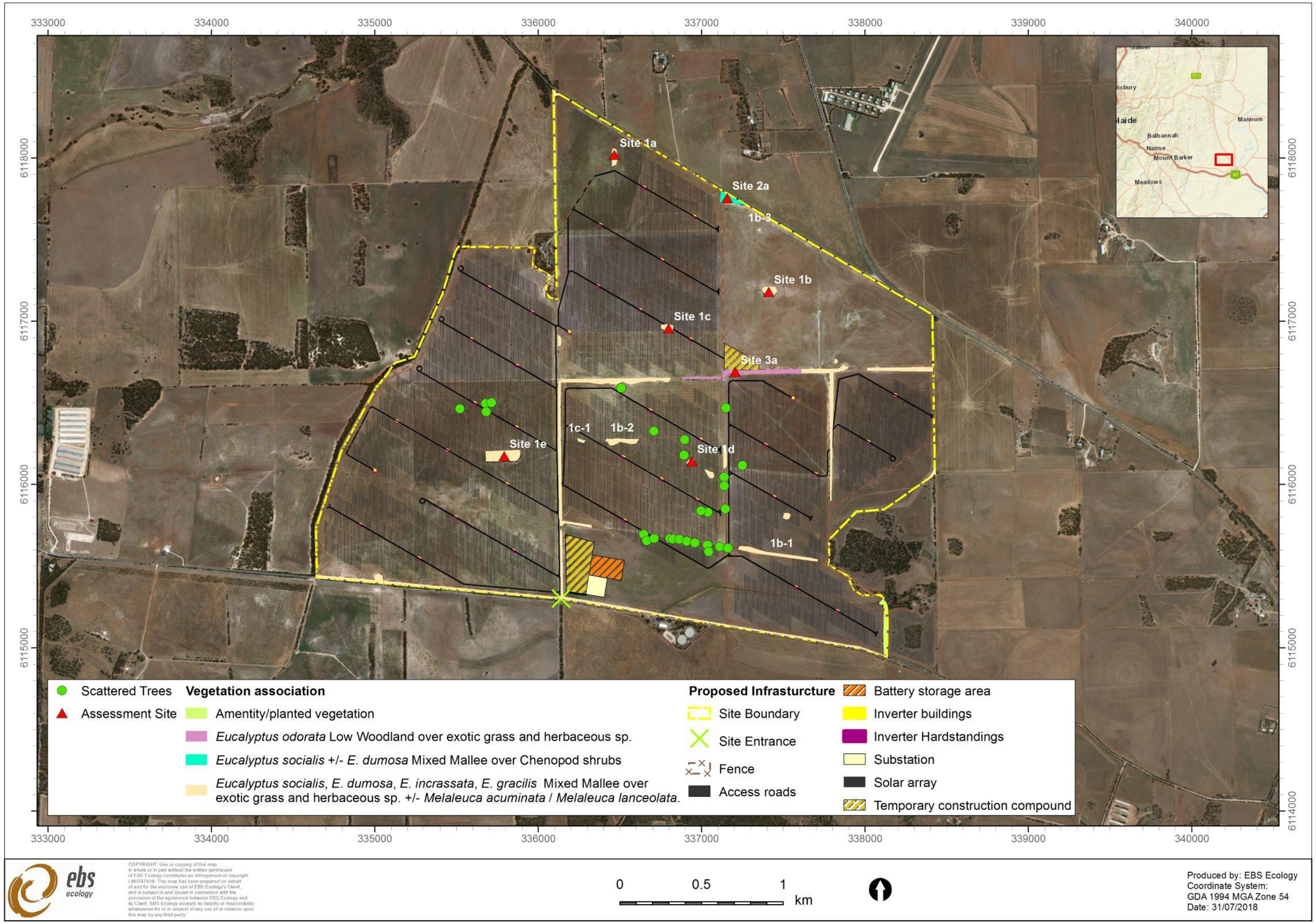


Figure 6. Vegetation associations, scattered trees and BAM sites within the Project area.

Figure 7. Location of scattered trees (map 1 of 3).

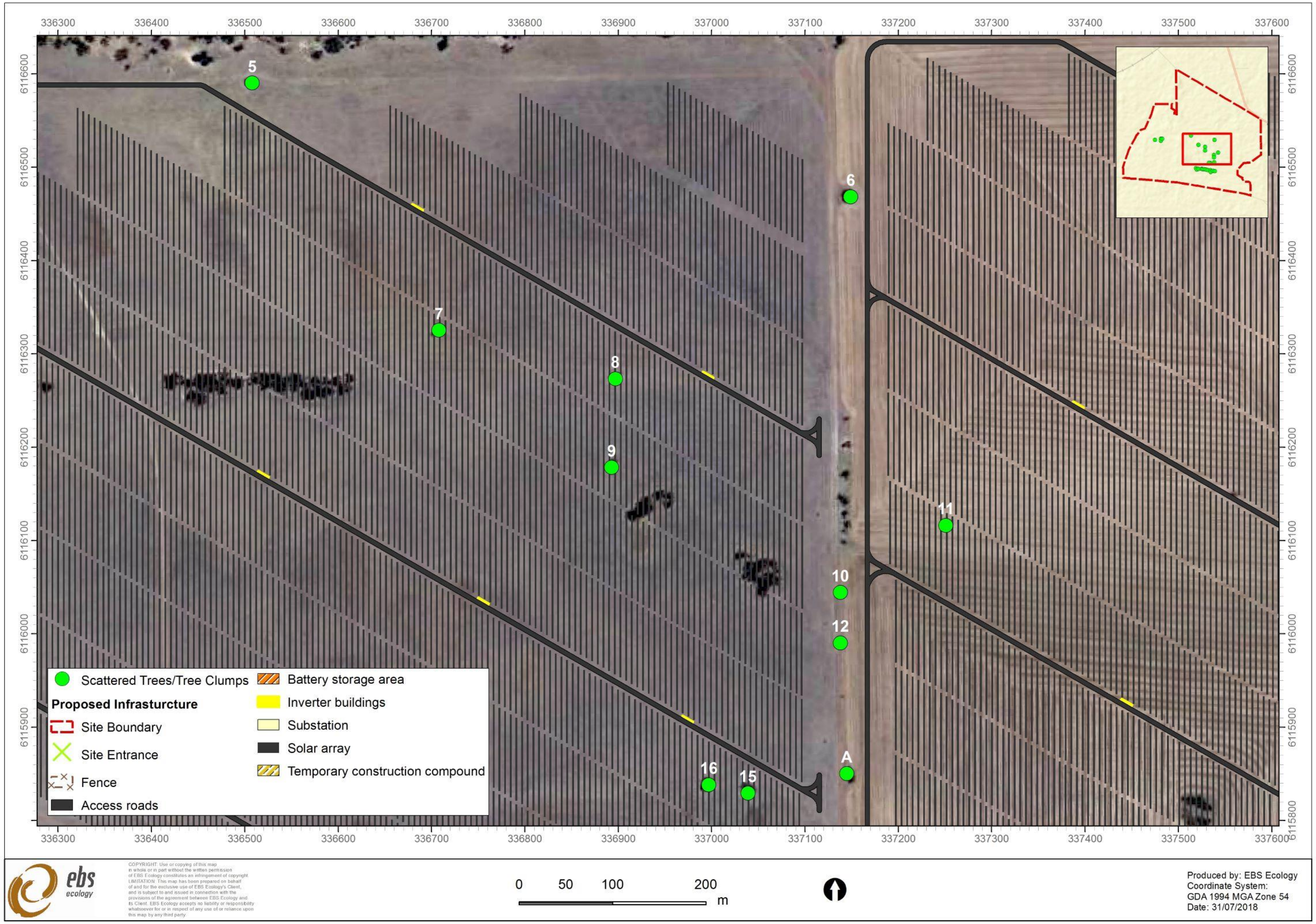


Figure 8. Location of scattered trees (map 2 of 3).

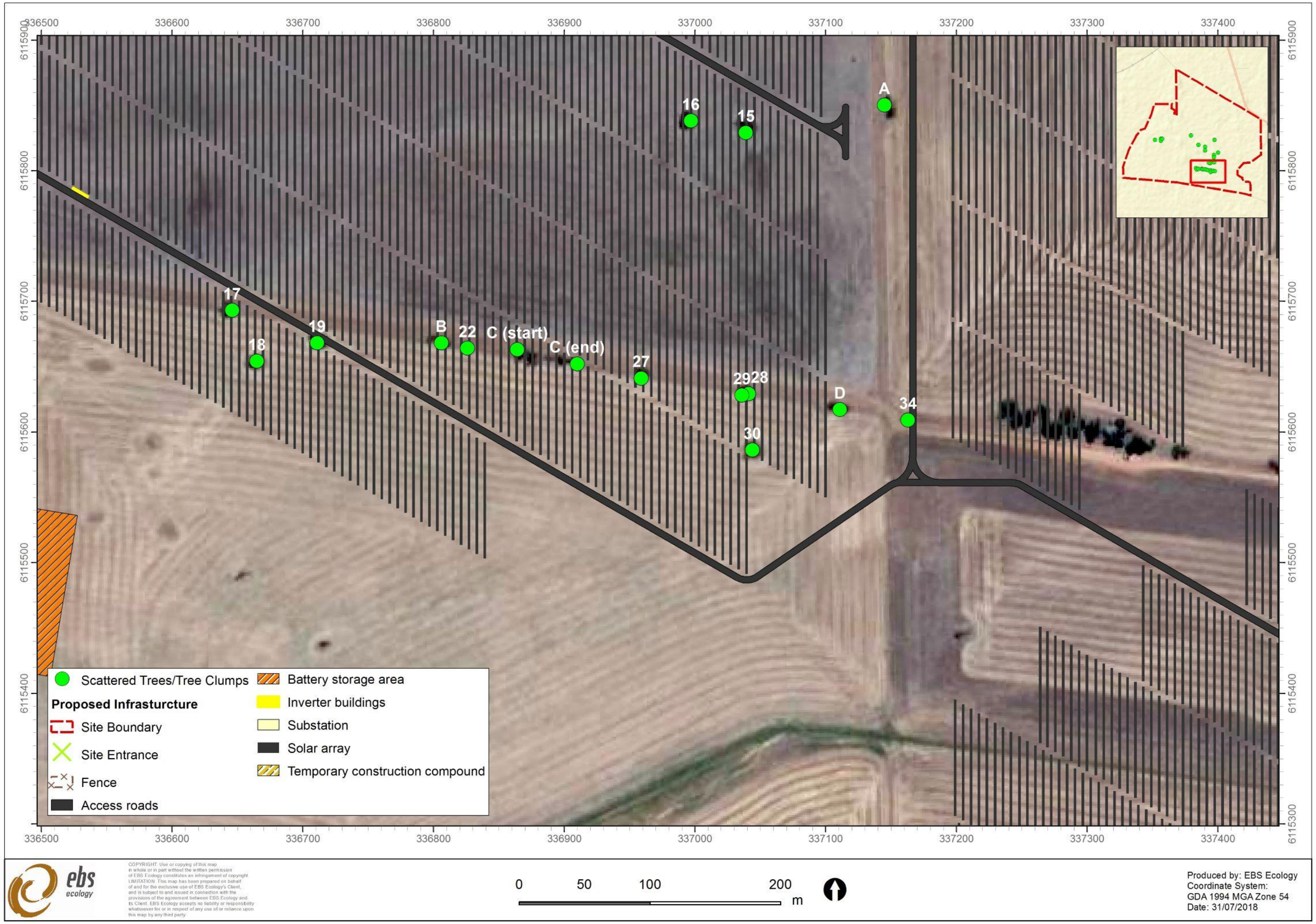


Figure 9. Location of scattered trees (map 3 of 3).

7.1.1 Vegetation associations

Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *M. lanceolata

The *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *Melaleuca lanceolata* vegetation association covers an area of approximately 16.76 ha. There were five BAM quadrats established due to the highly variable condition of the vegetation association within the Project area. There were 16 flora species recorded within the vegetation association which included 10 native and 16 weed species (Appendix 3). No conservation rated flora species were recorded. Three of the weeds recorded, *Lycium ferocissimum* (African Boxthorn), *Marrubium vulgare* (Horehound) and *Echium plantagineum* (Salvation Jane).are listed as declared species under the NRM Act.

This association was in generally very poor condition with an almost complete absence of native understorey. The few redeeming features of these patches of vegetation were that the overstorey was generally intact although evidence of significant die back in previous. Hollow bearing limbs were relatively prevalent which gave these patches some habitat value.

The vegetation condition score ranged from a low of 19.84 recorded at both BAM Quadrats 1a and 1c to a high of 21.56 at Quadrat 1d. The unit biodiversity score ranged from 20.83 at Quadrat 1a to 24.45 at Quadrat 1d. Each of the BAM quadrats are summarised below in Table 12 to Table 17. A representative photo of each of the BAM quadrats is provided in Figure 10 to Figure 14.

As previously mentioned, BAM scoresheets for a further six sites within this association were established after the field survey following updates of the construction footprint of the project. The scores from these six scoresheets (1b-1, 1b-2, 1b-3, 1c-1, 1d-1, and 1d-2) are provided in Table 13.

Eight patches of the *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *M. lanceolata*, totalling 3.68 ha will require clearance for the construction of the Project. The patches or sites proposed for clearance are 1b-1, 1b-2, 1c, 1c-1, 1d, 1d-1, 1d-2 and 1e).

Table 12. Summary of assessment Quadrat 1a.

BCM benchmark community	MDBSA 5.2 Mallee with Very Sparse Sclerophyll Shrub Understorey on Clay/Clay loam Flats
Size of site (ha)	0.309
Overstorey species	*Eucalyptus incrassata* (Ridge-fruited Mallee)
Midstorey species	None recorded
Understorey species	None recorded
Conservation rated species	None recorded
Declared weed species	*Lycium ferocissimum* (African Boxthorn)
Landscape context score	1.05
Vegetation condition score	19.84
Conservation significance score	1.00
Unit biodiversity score	20.83
Total biodiversity score	6.44

Table 13. Score summary for 1b-1, 1b-2, 1b-3, 1c-1, 1d-1 and 1d-2).

	1b-1	1b-2	1b-3	1c-1	1d-1	1d-2
Size of site (ha)	1.018	0.572	0.023	0.089	0.146	0.167
Landscape context score	1.07	1.07	1.05	1.05	1.05	1.05
Vegetation condition score	22.49	22.49	23.72	19.84	21.56	21.56
Conservation significance score	1.08	1.08	1.08	1.08	1.08	1.08
Unit biodiversity score	25.99	25.99	26.90	22.50	24.45	24.45
Total biodiversity score	26.46	14.87	0.62	2.00	3.57	4.08

Figure 10. Representative photo of assessment Quadrat 1a.

Table 14. Summary of assessment Quadrat 1b.

BCM benchmark community	MDBSA 5.2 Mallee with Very Sparse Sclerophyll Shrub Understorey on Clay/Clay loam Flats
Size of site (ha)	0.433
Overstorey species	*Eucalyptus incrassata* (Ridge-fruited Mallee), *E. gracilis* (Yorrell)
Midstorey species	None recorded
Understorey species	*Enchylaena tomentosa var.* (Ruby saltbush)
Conservation rated species	None recorded
Declared weed species	*Lycium ferocissimum* (African Boxthorn)
Landscape context score	1.05
Vegetation condition score	23.72
Conservation significance score	1.08
Unit biodiversity score	26.90
Total biodiversity score	11.65

Figure 11. Representative photo of assessment Quadrat 1b.

Table 15. Summary of assessment Quadrat 1c.

BCM benchmark community	MDBSA 5.2 Mallee with Very Sparse Sclerophyll Shrub Understorey on Clay/Clay loam Flats
Size of site (ha)	0.255
Overstorey species	*Eucalyptus incrassata* (Ridge-fruited Mallee)
Midstorey species	None recorded
Understorey species	None recorded
Conservation rated species	None recorded
Declared weed species	*Lycium ferocissimum* (African Boxthorn)
Landscape context score	1.05
Vegetation condition score	19.84
Conservation significance score	1.08
Unit biodiversity score	22.50
Total biodiversity score	5.74

Figure 12. Representative photo of assessment Quadrat 1c.

Table 16. Summary of assessment Quadrat 1d.

BCM benchmark community	MDBSA 5.2 Mallee with Very Sparse Sclerophyll Shrub Understorey on Clay/Clay loam Flats
Size of site (ha)	0.096
Overstorey species	*Eucalyptus incrassata* (Ridge-fruited Mallee), *E. gracilis* (Yorrell)
Midstorey species	None recorded
Understorey species	*Lomandra effusa* (Scented mat-rush), *Gahnia deusta* (Limestone Saw-sedge)
Conservation rated species	None recorded
Declared weed species	*Lycium ferocissimum* (African Boxthorn), *Marrubium vulgare* (Horehound)
Landscape context score	1.05
Vegetation condition score	21.56
Conservation significance score	1.08
Unit biodiversity score	24.45
Total biodiversity score	2.35

Figure 13. Representative photo of assessment Quadrat 1d.

Table 17. Summary of assessment Quadrat 1e.

BCM benchmark community	MDBSA 5.2 Mallee with Very Sparse Sclerophyll Shrub Understorey on Clay/Clay loam Flats
Size of site (ha)	1.344
Overstorey species	*Eucalyptus gracilis* (Yorrell), *E. phenax ssp. phenax* (White Mallee), *E. odorata* (Peppermint Box)
Midstorey species	*Melaleuca lanceolata* (Dryland Tea-tree)
Understorey species	None recorded
Conservation rated species	None recorded
Declared weed species	*Lycium ferocissimum* (African Boxthorn), *Marrubium vulgare* (Horehound), *Echium plantagineum* (Salvation Jane)
Landscape context score	1.07
Vegetation condition score	20.93
Conservation significance score	1.08
Unit biodiversity score	24.18
Total biodiversity score	32.50

Figure 14. Representative photo of assessment Quadrat 1e.

***Eucalyptus socialis* +/- *E. dumosa* Mixed Mallee over Chenopod shrubs**

The *Eucalyptus socialis* +/- *E. dumosa* Mixed Mallee over Chenopod shrubs vegetation association was recorded on the northern boundary of the Project area (Figure 6). The 0.55 ha patch of vegetation contained 13 flora species including 11 native and two weed species.

Some areas of vegetation had remnant understorey of disturbance resistant species such as *Enchylaena tomentosa* (Ruby saltbush) and *Maireana brevifolia* (Bluebush). Other understorey was dominated by annual grasses, emergent exotic herbaceous species such as *Mesembryanthemum* (Iceplant), *Rumex* (Dock), *Oxalis pes-capre* (Soursob), *Asparagus asparagoides* (Bridal Creeper) and woody exotic shrubs such as *Lycium ferocissimum* (Boxthorn).

Within these areas, habitat value was high with hollows present in most (if not all) trees with openings from 50-200mm prevalent. There were numerous examples of fallen timber of sizes from branches right through to entire trees. Litter cover was present in combination with stone outcropping which provided some stability to the soil surface.

The vegetation condition score for the vegetation association was 32.34 and the unit biodiversity score was 37.73 (Table 18). A representative photo of the vegetation is provided in Figure 15. There is no vegetation clearance required within the 0.55 ha patch of *Eucalyptus socialis* +/- *E. dumosa* Mixed Mallee over Chenopod shrubs vegetation association under the current project infrastructure footprint.

Table 18. Summary of assessment Quadrat 2a.

BCM benchmark community	MDBSA 3.1 Mallee with Very Open Sclerophyll / Chenopod Shrub Understorey
Size of site (ha)	0.555
Overstorey species	*Eucalyptus socialis ssp. socialis* (Red Beaked Mallee), *E. calycogona ssp.* (Square Fruit Mallee), *E. dumosa* (White Mallee)
Midstorey species	None recorded
Understorey species	*Enchylaena tomentosa var.* (Ruby saltbush), *Maireana brevifolia* (Short-leaf Bluebush), *Atriplex sp.* (Saltbush), *Sclerolaena diacantha* (Grey Bindyi)
Conservation rated species	None recorded
Declared weed species	None recorded
Landscape context score	1.07
Vegetation condition score	32.34
Conservation significance score	1.08
Unit biodiversity score	37.73
Total biodiversity score	20.74

Figure 15. Representative photo of assessment Quadrat 2a.

Eucalyptus odorata Low Woodland over Exotic grass and herbaceous sp.

The *Eucalyptus odorata* Low Woodland over Exotic grass and herbaceous sp. vegetation association covered an area of 1.55 ha. The patch of vegetation, located in the centre of the Project area is very linear as it borders a fence line (Figure 6). The structure of the overtorey is representative of an intact strata however the understorey layer was largely absent other than the highly disturbance resistant native species *Enchylaena tomentosa* (Ruby saltbush) and *Maireana brevifolia* (Bluebush).

The vegetation association contained 19 flora species, including eight native and 11 weed species. One conservation rated species was recorded within the vegetation association. This was *Maireana excavata* (Bottle Fissure-plant) (SA:V). Two of the weeds *Emex australis* (Three-corner Jack), *Lycium ferocissimum* (African Boxthorn) are listed as declared species under the NRM Act.

The vegetation condition score for the vegetation association was 19.53 and the unit biodiversity score was 23.4 (Table 19). A representative photo of the vegetation is provided in Figure 16. There is no vegetation clearance required within the *Eucalyptus odorata* Low Woodland over Exotic grass and herbaceous sp. vegetation association under the current project infrastructure footprint.

Table 19. Summary of assessment Quadrat 3a.

BCM benchmark community	MDBSA 9.1 Woodlands with an Open Grassy Understorey
Size of site (ha)	1.55
Overstorey species	*Eucalyptus odorata* (Peppermint Box), *E. phenax ssp. phenax* (White Mallee)
Midstorey species	None recorded
Understorey species	*Enchylaena tomentosa var.* (Ruby saltbush), *Lomandra effusa* (Scented (Mat Rush), *Lomandra leucocephala* (Woolly Mat Rush), *Maireana brevifolia* (Short-leaf Bluebush)
Conservation rated species	*Maireana excavata* (Bottle Fissure-plant) (SA:V)
Declared weed species	*Emex australis* (Three-corner Jack), *Lycium ferocissimum* (African Boxthorn)
Landscape context score	1.07
Vegetation condition score	19.53
Conservation significance score	1.12
Unit biodiversity score	23.4
Total biodiversity score	36.15

Figure 16. Representative photo of assessment Quadrat 3a.

7.1.5 Scattered trees

There are 34 scattered trees which will require clearance under the current project infrastructure footprint (Table 20). The locations of the scattered trees are shown in Figure 7 to Figure 9 and the coordinates are provided in Appendix 4. Data and photos of each of the 34 scattered trees are provided in Appendix 5.

Table 20. Summary of scattered trees within the Project area.

Species name	Common name	Quantity
Eucalyptus dumosa	White Mallee	10
Eucalyptus incrassata	Ridge-fruited Mallee	1
Eucalyptus leptophylla	Narrow-leaf Red Mallee	2
Eucalyptus odorata	Peppermint Box	10
Eucalyptus oleosa ssp	Red Mallee	10
Melaleuca uncinata	Broombush	1

7.2 Fauna

There were 26 bird species and three mammal species detected within the Project area (Table 21). Two of the bird species recorded are introduced, these were; House Sparrow (*Passer domesticus*) and Common Starling (*Sturnus vulgaris*).

A small mob of Western Grey Kangaroos (*Macropus fuliginosus*) was observed grazing within paddock near BAM quadrat 1b-1. Signs (scat, diggings and buckheaps) of the introduced European Brown Hare (*Lepus europaeus*) and Rabbit European Rabbit (*Oryctolagus cuniculus*) were sparely distributed in the majority of areas containing remnant vegetation. One European Brown Hare was recorded in the *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *Melaleuca lanceolata* vegetation association (BAM Quadrat 1d).

Table 21. Fauna species recorded within the Project area.

	Class	Family name	Species name	Common name	Conservation status	
					Aus	SA
	AVES	ACANTHIZIDAE	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill		
	AVES	ARTAMIDAE	*Artamus cinereus*	Black-faced Woodswallow		
	AVES	ARTAMIDAE	*Artamus cyanopterus*	Dusky Woodswallow		
	AVES	ARTAMIDAE	*Gymnorhina tibicen*	Australian Magpie		
	AVES	CACATUIDAE	*Eolophus roseicapilla*	Galah		
	AVES	CAMPEPHAGIDAE	*Coracina novaehollandiae*	Black-faced Cuckooshrike		
	AVES	CHARADRIIDAE	*Vanellus miles*	Masked Lapwing		
	AVES	COLUMBIDAE	*Ocyphaps lophotes*	Crested Pigeon		
	AVES	CORVIDAE	*Corvus coronoides*	Australian Raven		
	AVES	FALCONIDAE	*Falco berigora*	Brown Falcon		
	AVES	FALCONIDAE	*Falco cenchroides*	Nankeen Kestrel		
	AVES	HIRUNDINIDAE	*Hirundo neoxena*	Welcome Swallow		
	AVES	HIRUNDINIDAE	*Petrochelidon nigricans*	Tree Martin		
	AVES	MELIPHAGIDAE	*Gavicalis virescens*	Singing Honeyeater		
	AVES	MELIPHAGIDAE	*Manorina flavigula*	Yellow-throated Miner		
	AVES	MELIPHAGIDAE	*Ptilotula penicillata*	White-plumed Honeyeater		
	AVES	PACHYCEPHALIDAE	*Colluricincla harmonica*	Grey Shrikethrush		
*	AVES	PASSERIDAE	**Passer domesticus*	House Sparrow		
	AVES	POMATOSTOMIDAE	*Pomatostomus superciliosus*	White-browed Babbler		
	AVES	PSITTACIDAE	*Barnardius zonarius*	Australian Ringneck		
	AVES	PSITTACIDAE	*Glossopsitta concinna*	Musk Lorikeet		
	AVES	PSITTACIDAE	*Northiella haematogaster*	Bluebonnet		
	AVES	PSITTACIDAE	*Platycercus elegans*	Crimson Rosella		
	AVES	PSITTACIDAE	*Psephotus haematonotus*	Red-rumped Parrot		
	AVES	RHIPIDURIDAE	*Rhipidura leucophrys*	Willie Wagtail		
*	AVES	STURNIDAE	**Sturnus vulgaris*	Common Starling		
*	MAMMALIA	LEPORIDAE	**Lepus europaeus*	European Brown Hare		
*	MAMMALIA	LEPORIDAE	**Oryctolagus cuniculus*	Rabbit (European Rabbit)		
	MAMMALIA	MACROPODIDAE	*Macropus fuliginosus*	Western Grey Kangaroo		

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. *: INTRODUCED.

8 VEGETATION CLEARANCE SUMMARY

Eight patches of remnant vegetation totalling 3.68 ha (Table 22) and 34 scattered trees (Table 23) will require clearance for the construction of the Solar Array and Battery Storage Project. The eight patches of vegetation contain *Eucalyptus socialis*, *E. dumosa*, *E. incrassata*, *E. gracilis* Mixed Mallee over exotic grass and herbaceous sp. +/- *Melaleuca acuminata* / *Melaleuca lanceolata*. The patch size ranges from 0.08 ha (Site 1c-1) to 1.34 ha (1e). The total SEB points required for the clearance of the remnant patches (3.68 ha) of vegetation is 96.13 and the total SEB hectares required is 12.02 (Table 22).

The total SEB points required for the clearance of the 34 scattered trees is 111.58 and the total SEB hectares required is 13.95 (Table 23). The grand total for the clearance of the remnant patches of vegetation and scattered trees equates to 207.71 SEB points and 25.97 SEB hectares.

Table 22. Clearance impact summary for remnant patches of vegetation.

Site (area of proposed vegetation clearance)	Area (ha)	SEB points required	Hectares required
1b-1	1.018	27.78	3.47
1b-2	0.572	15.61	1.95
1c	0.255	6.02	0.75
1c-1	0.089	2.10	0.26
1d	0.096	2.46	0.31
1d-1	0.146	3.75	0.47
1d-2	0.167	4.29	0.54
1e	1.344	34.12	4.27
Total	**3.687**	**96.13**	**12.02**

Table 23. Clearance impact summary for scattered trees.

Species name	Common name	Number of trees	SEB points required	Hectares required
Eucalyptus dumosa	White Mallee	10	22.57	2.82
Eucalyptus incrassata	Ridge-fruited Mallee	1	2.44	0.31
Eucalyptus leptophylla	Narrow-leaf Red Mallee	2	8.88	1.11
Eucalyptus odorata	Peppermint Box	10	31.51	3.94
Eucalyptus oleosa ssp.	Red Mallee	10	45.08	5.64
Melaleuca uncinata	Broombush	1	1.09	0.14
Total		**34**	**111.58**	**13.95**

8.1 Mitigation hierarchy

For clearances under Division 5 of the Regulations, proponents must demonstrate how they have complied with the Mitigation Hierarchy. The NVC will consider if the proponent has taken sufficient measures to avoid and minimise clearance as far as practicable. The NVC must be satisfied that there is no other practicable alternative that involves less clearance, or clearance of less significant vegetation, or clearance of vegetation that has been degraded to a greater extent than the vegetation proposed to be cleared.

The mitigation principles are as follows:

(a) Avoidance — measures should be taken to avoid clearance of native vegetation wherever possible.

> Demonstrating avoidance is the key objective of any proposed clearance activity. Doing this early in the planning process will provide the flexibility required to inform decision making or make adjustments to the location or design of the impact (this includes any incidental clearance such as by moving machinery to obtain access to the site).

(b) Minimisation — if clearance of native vegetation cannot be avoided, measures should be taken to minimise the extent, duration and intensity of impacts of the clearance on biological diversity to the fullest possible extent (whether the impact is direct, indirect or cumulative).

> If avoidance is not possible, the applicant must consider ways to alter the location, design or construction method of the activity so as to minimise the clearance. Direct impacts are caused by an activity and occur at the same time and place of the development. Indirect impacts are caused by the action but occur at a later point in time or affect a different location. Cumulative impacts result from the incremental impact of past, present and future activities.

(c) Rehabilitation or restoration — measures should be taken to rehabilitate ecosystems that will be degraded, and to restore ecosystems that will be destroyed, due to impacts of clearance that cannot be avoided or minimised.

> Measures for on-site restoration activities should be identified. The aim should be to achieve the following:
>
> - Limiting impacts as far as possible to allow the vegetation to naturally re-establish once the impact has ceased
> - Re-instating the vegetation as much as possible through restoration activities once the impact has ceased.

(d) Offset — any adverse impact on native vegetation or ecosystems that cannot be avoided or minimised should be offset by implementing an SEB that outweighs that impact.

> Biodiversity offsets address any residual impacts after prevention and mitigation measures have been implemented.

The NVC will only approve clearances if these steps have been fulfilled. Offsetting is only considered by the NVC when a proponent has identified and documented appropriate measures to avoid and minimise negative impacts (direct or indirect) on biodiversity. Biodiversity offsets are only appropriate for projects that have rigorously applied the Mitigation Hierarchy to the fullest extent. Offsets must never be used to circumvent responsibilities to avoid and minimise damage to biodiversity and the NVC will consider this when determining whether the clearance can proceed (NVC 2017b).

8.1.2 Avoidance

The current land use in the Project is agricultural cropping. Every effort has been made by RES to avoid the unnecessary clearance of vegetation to construct the proposed Project. This has included three modifications to the infrastructure footprint since the initial stages of planning and consultation with EBS.

8.1.3 Minimisation

The Project has seen three updates to the infrastructure footprint since EBS conducted the initial vegetation survey. The Project area contains approximately 18.86 ha of remnant vegetation and 51 scattered trees. The clearance footprint has been reduced to just 3.69 ha of remnant vegetation and 34 scattered trees. RES, at the time of writing, have indicated that the clearance footprint may be reduced further during the final stages of planning.

8.1.4 Rehabilitation or restoration

Rehabilitation or restoration is not appropriate in area within the solar design layout since the proposed solar infrastructure will be permanent. There is however the opportunity for restoration in areas surrounding solar design layout. This includes planting screening vegetation and restoring understorey vegetation within native vegetation patches which are highly degraded.

Hollows, coarse woody debris and litter should be translocated into the native vegetation patches within the Project area as trees and shrubs are removed. Mounting branch/trunk sections containing hollows in trees can reduce habitat loss for the hollow using species in the Project area. The addition of coarse woody debris and litter to the native vegetation patches in the Project area, which have been degraded, will create structural diversity and niche habitats for small vertebrates and invertebrates, as well as benefitting nutrient cycling.

8.1.5 Offset

Any adverse impact on native vegetation or ecosystems that cannot be avoided or minimised should be offset by implementing an SEB that outweighs that impact. Biodiversity offsets address any residual impacts after prevention and mitigation measures have been implemented.

The NVC will only approve clearances if these steps have been fulfilled. Offsetting is only considered by the NVC when a proponent has identified and documented appropriate measures to avoid and minimise negative impacts (direct or indirect) on biodiversity. Biodiversity offsets are only appropriate for projects that have rigorously applied the Mitigation Hierarchy to the fullest extent. Offsets must never be used to circumvent responsibilities to avoid and minimise damage to biodiversity and the NVC will consider this when determining whether the clearance can proceed.

9 DISCUSSION

The remnant vegetation is restricted to relatively small and isolated patches within the Project area. The majority of the remnant vegetation is in very poor condition due to a range a factors including weed invasion, over grazing, soil disturbance, firewood removal and rubbish dumping. All strata within the vegetation patches have been impacted. The majority of the midstorey and understorey layers of vegetation have been severely impacted with some areas containing only an understorey of introduced species and highly disturbance resistant native species such as *Enchylaena tomentosa* (Ruby saltbush) and *Maireana brevifolia* (Bluebush).

The desktop analysis and site assessment determined that two flora species listed under the NPW Act have the potential to occur within the Project area. These are: *Bothriochloa macra* (Red-leg Grass) and *Maireana rohrlachii* (Rohrlach's Bluebush). Both species have a conservation rating of rare under the NPW Act. One conservation rated species, *Maireana excavata* (Bottle Bluebush) (NPW Act – vulnerable) was recorded within the *Eucalyptus odorata* Low Woodland. The 1.55 ha of *Eucalyptus odorata* Low Woodland containing the *M. excavata* will not require any clearance. No Threatened Ecological Communities (TEC) or flora species protected under the *EPBC Act* were recorded within, or are expected to occur within the Project area.

There were 26 bird species and three mammal species detected within the Project area. Two of the bird species recorded are introduced, these were; House Sparrow (*Passer domesticus*) and Common Starling (*Sturnus vulgaris*). The mammals species recorded were, Western Grey Kangaroo (*Macropus fuliginosus*) and the introduced European Brown Hare (*Lepus europaeus*) and Rabbit European Rabbit (*Oryctolagus cuniculus*). The compiled list of fauna observations does not represent all species expected to occur within the Project area.

The desktop analysis and site assessment determined that six fauna species (five bird species and one mammal species) listed under the NPW Act have the potential to occur within the Project area. No threatened fauna species protected under the EPBC Act were recorded within, or are expected to occur within the Project area. The bird species listed under the NPW Act which could potentially occur within the Project area are: White-winged Chough (*Corcorax melanorhamphos*) (SA:R), Peregrine Falcon (*Falco peregrinus*) (SA:R), Purple-gaped Honeyeater (mainland SA) (*Lichenostomus cratitius occidentalis occidentalis*) (SA:R), Black-chinned Honeyeater (*Melithreptus gularis*) (SA:V) and Elegant Parrot (*Neophema elegans*) (SA:R). The Common Brushtail Possum (*Trichosurus vulpecula*) (SA:R) could also occur within the Project area.

Two of the 17 listed migratory and/or marine bird species; the Fork-tailed Swift (*Apus pacificus*) (listed as a migratory species under the EPBC Act) and Rainbow Bee-eater (*Merops ornatus*) (listed as a marine species under the EPBC Act) were determined to potentially occur within the Project area as occasional visitors. Neither of these species were detected during the two field surveys. The Fork-tailed Swift is a non-breeding visitor to Australia, migrating from its breeding grounds which extend from northern India to western Russia. The species is more common in coastal and sub-coastal areas; however, regularly occurs in inland Australia. Fork-tailed Swifts are nearly exclusively aerial in Australia, and fly over a wide range of habitats, including open plains, forests and cities (Pizzey and Knight 2014; DotEE 2018). Therefore, it is possible that the species can occur flying over the Project area.

The Rainbow Bee-eater is a migratory species within Australia. The species is a breeding resident in northern Australia; however, a portion of the population will migrate south to breed from September to April (Pizzey and Knight 2014). Rainbow Bee-eaters inhabit a wide range of habitats, including open forest and woodland, scrubland, and other lightly wooded areas, as such suitable habitat exists within the Project area (Pizzey and Knight 2014). The species is commonly observed in southern Australia from September to April, and therefore, it is possible that Rainbow Bee-eaters could potentially occur within the Project area.

The relatively small size of the remnants of vegetation within the Project area and relative isolation (>5 km) from large remnants (>50 ha) means that the habitat present is likely to be non-preferable for a range of bird species that are moderately or highly sensitive to remnant size and isolation.

The threatened species most likely to be present are those which are highly mobile, such as the Purple-gaped Honeyeater (*Lichenostomus cratitius*) and Elegant Parrot. The Elegant Parrot is considered to be partly nomadic (Pizzey and Knight 2009), while the Purple-gaped Honeyeater moves in response to the availability of nectar resources (Ford 1977). Therefore, these species would only be present temporarily.

Hollows, coarse woody debris and litter should be translocated into the remaining native vegetation patches within the Project area as trees and shrubs are removed. Mounting branch/trunk sections containing hollows in trees can reduce habitat loss for the hollow using species in the Project area. The addition of coarse woody debris and litter to the native vegetation patches in the Project area, which have been degraded, will create structural diversity and niche habitats for small vertebrates and invertebrates.

10 RECOMMENDATIONS

10.1 Legislative approvals

10.1.1 Seek Native Vegetation Council approval for required vegetation clearance

Any native vegetation clearance that may be required needs approval under the *Native Vegetation Act 1991*. The provision of an SEB can be undertaken in several forms including managing and conserving areas of native vegetation, undertaking native vegetation restoration activities or making a payment into the Native Vegetation Fund.

10.1.2 EPBC referral

No threatened species, threatened ecological communities or migratory or marine species listed under the EPBC Act were recorded within the Project area during the survey.

It is considered based on this assessment that the development of the Pallamana Solar Array and Battery Storage Project is not likely to have any significant impact on any matter protected by the EPBC Act. Accordingly, there is no requirement to refer the project under the EPBC Act.

10.2 General

- A site representative or equivalent should be on site when vegetation clearance occurs, or alternatively a site induction session with clearance contractors should be arranged whereby the Project area is defined and areas designated for clearance are delineated. The purpose of the site induction would be to ensure clearance occurs in accordance with the controls contained in all approvals and in any construction or other environmental management plans.
- Native fauna disturbed during vegetation clearance/construction should if possible be relocated to suitable habitat nearby.
- Ensure that construction machinery is clean and free from soil pathogens and any weed seed materials before entering/exiting the area. This includes performing appropriate hygiene measures when leaving the subject site to avoid potential spread.
- Any soil/material brought to site should be certified clean and free of weed propagules and soil pathogens.
- Vegetative material removed from the site must be managed appropriately.
- Stockpile sites, vehicle / machinery parking areas and general construction laydown areas should be located away from any native vegetation to the extent practicable.
- Weed management strategies (including weed hygiene procedures) should be implemented to ensure that weed species are not introduced to the construction area or spread throughout the construction area.

11 REFERENCES

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12 APPENDICES

Appendix 1. Flora species recorded in the BDBSA within 10 km of the Project area (DEW 2017).

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
	ADIANTACEAE	*Cheilanthes austrotenuifolia*	Annual Rock-fern			9/10/2012
		Cheilanthes distans	Bristly Cloak-fern			3/11/2012
		Cheilanthes lasiophylla	Woolly Cloak-fern			3/11/2012
	AGARICACEAE	*Agaricus campestris*				8/06/1926
*	AGAVACEAE	*Agave americana*	Century Plant			9/11/2014
	AIZOACEAE	*Carpobrotus modestus*	Inland Pigface			27/02/2015
		Carpobrotus rossii	Native Pigface			1/06/2012
		Carpobrotus rossii (NC)	Native Pigface			22/11/2002
		Carpobrotus sp. Short calyx (S.T.Blake 20451)	Native Pigface			10/08/1971
*		*Cleretum papulosum ssp. papulosum*				5/08/1980
		Disphyma crassifolium ssp. clavellatum	Round-leaf Pigface			1/06/2012
*		*Galenia pubescens var. pubescens*	Coastal Galenia			3/09/2008
*		*Galenia secunda*	Galenia			27/02/2015
*		*Galenia sp.*	Galenia			11/11/2014
		Glinus lotoides	Hairy Carpet-weed			1/03/1910
		Glinus oppositifolius	Slender Carpet-weed			1/03/1910
*		*Mesembryanthemum aitonis*	Angled Iceplant			25/01/1977
*		*Mesembryanthemum crystallinum*	Common Iceplant			3/11/2012
*		*Mesembryanthemum nodiflorum*	Slender Iceplant			1/07/1999
		Sarcozona praecox	Sarcozona			28/08/1985
		Tetragonia tetragonoides	New Zealand Spinach			1/11/2005
	AMANITACEAE	*Amanita angustispora*				1/08/1925
		Amanita austrostraminea				8/06/1926
		Amanita bambra				1/08/1925
		Amanita conicobulbosa				10/10/1925
		Amanita subalbida				8/06/1925
*	AMARANTHACEAE	*Alternanthera pungens*	Khaki Weed			16/03/1977
*		*Amaranthus caudatus*	Love-lies-bleeding			1/04/2005
		Ptilotus seminudus	Rabbit-tails			3/11/2012
		Ptilotus sp.	Mulla Mulla			4/11/2004
		Ptilotus spathulatus	Pussy-tails			10/11/2014
	AMARYLLIDACEAE	*Calostemma purpureum*	Pink Garland-lily			5/11/2014
*	ANACARDIACEAE	*Schinus molle*	Pepper-tree			5/11/2014
*	APOCYNACEAE	*Vinca major*	Blue Periwinkle			30/05/1977
*	ARACEAE	*Zantedeschia aethiopica*	White Arum Lily			26/07/2012
*	ASCLEPIADACEAE	*Gomphocarpus cancellatus*	Broad-leaf Cotton-bush			10/11/2014
*		*Gomphocarpus fruticosus*	Narrow-leaf Cotton-bush			3/02/1977

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
	ASPLENIACEAE	*Pleurosorus rutifolius*	Blanket Fern			26/07/1974
	AZOLLACEAE	*Azolla sp.*	Azolla			1/01/1991
	BLECHNACEAE	*Blechnum sp.*	Water-fern			1/06/2012
*	BORAGINACEAE	*Buglossoides arvensis*	Sheepweed			30/07/1974
		Cynoglossum suaveolens	Sweet Hound's-tongue			19/10/2004
*		*Echium italicum*	Italian Bugloss			31/05/1977
*		*Echium plantagineum*	Salvation Jane			10/11/2014
		Halgania andromedifolia	Scented Blue-flower			11/12/2001
		Halgania cyanea	Rough Blue-flower			3/04/2012
*		*Heliotropium curassavicum*	Smooth Heliotrope			14/11/2002
*		*Heliotropium supinum*	Creeping Heliotrope			26/03/1921
*		*Neatostema apulum*	Hairy Sheepweed			5/11/2014
	BRYACEAE	*Bryum pachytheca*				10/07/1963
*	CACTACEAE	*Austrocylindropuntia cylindrica*	Cane Cactus			8/05/2014
*		*Opuntia monacantha*	Drooping Prickly Pear			9/07/2009
*		*Opuntia sp.*				9/11/2014
*		*Opuntia stricta*	Erect Prickly Pear			10/04/2014
	CAMPANULACEAE	*Wahlenbergia communis*	Tufted Bluebell			17/03/1976
		Wahlenbergia gracilenta	Annual Bluebell			20/10/1974
		Wahlenbergia luteola	Yellow-wash Bluebell			6/11/2014
		Wahlenbergia sp.	Native Bluebell			3/11/2012
		Wahlenbergia stricta ssp. stricta	Tall Bluebell			9/11/2014
*	CANNABACEAE	*Cannabis sativa*	Indian Hemp			7/05/1992
*	CARYOPHYLLACEAE	*Arenaria leptoclados*	Lesser Thyme-leaved Sandwort			26/11/1974
*		*Herniaria cinerea*	Rupturewort			10/09/1978
*		*Moenchia erecta*	Erect Chickweed			21/09/1978
*		*Petrorhagia dubia*	Velvet Pink			9/11/2014
*		*Petrorhagia nanteuilii*				16/09/1991
*		*Polycarpon tetraphyllum*	Four-leaf Allseed			20/01/1976
*		*Sagina apetala*	Annual Pearlwort			21/10/1930
*		*Silene apetala*	Sand Catchfly			26/07/2012
*		*Silene gallica var.*	French Catchfly			8/05/1992
*		*Silene gallica var. gallica*	French Catchfly			2/10/1974
*		*Silene nocturna*	Mediterranean Catchfly			1/07/1999
*		*Silene tridentata*				28/08/1985
*		*Spergularia bocconei*	Red Sand-spurrey			8/11/1924
*		*Spergularia diandra*	Lesser Sand-spurrey			25/10/1975
		Spergularia marina	Salt Sand-spurrey			6/11/2014
*		*Spergularia marina (NC)*	Salt Sand-spurrey			14/11/2002
*		*Spergularia rubra*	Red Sand-spurrey			9/11/1974
		Spergularia tasmanica	Coast Sand-spurrey			17/02/1982
		Stellaria filiformis	Thread Starwort			
		Stellaria palustris var. tenella	Swamp Starwort		R	20/10/1907

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
	CASUARINACEAE	*Allocasuarina muelleriana ssp. muelleriana*	Common Oak-bush			1/09/1997
		Allocasuarina pusilla	Dwarf Oak-bush			1/10/1953
		Allocasuarina verticillata	Drooping Sheoak			10/11/2014
*		*Casuarina glauca*	Grey Buloak			27/02/2015
	CENTROLEPIDACEAE	*Centrolepis aristata*	Pointed Centrolepis			16/09/1974
		Centrolepis polygyna	Wiry Centrolepis			2/10/1974
		Centrolepis strigosa ssp. strigosa	Hairy Centrolepis			2/10/1974
	CERATOPHYLLACEAE	*Ceratophyllum demersum*	Hornwort		R	1/11/2005
	CHENOPODIACEAE	*Atriplex acutibractea ssp.*	Pointed Saltbush			11/11/2014
		Atriplex acutibractea ssp. karoniensis	Pointed Saltbush			7/05/1992
		Atriplex australasica			R	19/04/1977
		Atriplex holocarpa	Pop Saltbush			0/01/1900
		Atriplex leptocarpa	Slender-fruit Saltbush			14/11/2002
		Atriplex nummularia ssp.	Old-man Saltbush			1/11/2005
*		*Atriplex prostrata*	Creeping Saltbush			4/02/1976
		Atriplex semibaccata	Berry Saltbush			2/04/2013
		Atriplex sp.	Saltbush			1/11/2005
		Atriplex stipitata	Bitter Saltbush			7/02/1980
		Atriplex suberecta	Lagoon Saltbush			18/03/1976
*		*Chenopodium album*	Fat Hen			27/04/1983
		Chenopodium auricomum	Golden Goosefoot			31/03/1939
		Chenopodium curvispicatum	Cottony Goosefoot			3/11/2012
		Chenopodium desertorum ssp.	Desert Goosefoot			7/05/1992
		Chenopodium desertorum ssp. desertorum	Frosted Goosefoot			18/05/1992
		Chenopodium desertorum ssp. microphyllum	Small-leaf Goosefoot			10/11/2014
*		*Chenopodium murale*	Nettle-leaf Goosefoot			10/11/2014
		Dissocarpus paradoxus	Ball Bindyi			16/04/2013
		Dysphania pumilio	Small Crumbweed			1/11/2005
		Einadia nutans ssp.	Climbing Saltbush			2/11/2004
		Einadia nutans ssp. nutans	Climbing Saltbush			10/11/2014
		Enchylaena tomentosa var.	Ruby Saltbush			27/02/2015
		Enchylaena tomentosa var. tomentosa	Ruby Saltbush			10/11/2014
		Halosarcia sp. (NC)	Samphire			11/12/2001
		Maireana brevifolia	Short-leaf Bluebush			11/11/2014
		Maireana enchylaenoides	Wingless Fissure-plant			10/11/2014
		Maireana erioclada	Rosy Bluebush			15/09/2013
		Maireana microcarpa	Swamp Bluebush			1/11/2005
		Maireana rohrlachii	Rohrlach's Bluebush		R	10/11/2014
		Maireana trichoptera	Hairy-fruit Bluebush			3/11/2012
		Rhagodia candolleana ssp.	Sea-berry Saltbush			22/10/2004

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Rhagodia candolleana ssp. candolleana	Sea-berry Saltbush			9/11/2014
		Rhagodia crassifolia	Fleshy Saltbush			27/02/2015
		Rhagodia parabolica	Mealy Saltbush			12/12/2001
		Rhagodia sp.	Saltbush			2/11/2004
		Salsola australis	Buckbush			11/11/2014
		Sarcocornia blackiana	Thick-head Samphire			27/02/2015
		Sarcocornia quinqueflora	Beaded Samphire			27/02/2015
		Sclerolaena diacantha	Grey Bindyi			3/11/2012
		Sclerolaena muricata var. muricata	Five-spine Bindyi			1/02/1952
		Sclerolaena parviflora	Small-flower Bindyi			7/05/1992
		Sclerolaena uniflora	Small-spine Bindyi			13/08/2013
		Suaeda australis	Austral Seablite			27/02/2015
		Tecticornia indica ssp. bidens	Brown-head Samphire			1/03/1951
		Tecticornia indica ssp. leiostachya	Brown-head Samphire			14/11/2002
		Tecticornia pergranulata ssp. pergranulata	Black-seed Samphire			1/11/2005
	CLADONIACEAE	*Cladia aggregata*				8/09/1974
*	COMPOSITAE	*Achillea millefolium*	Yarrow			14/01/1987
		Actinobole uliginosum	Flannel Cudweed			6/11/2014
*		*Ambrosia psilostachya*	Perennial Ragweed			16/08/1943
		Angianthus preissianus	Salt Angianthus			1/10/1974
*		*Arctotheca calendula*	Cape Weed			11/11/2014
		Argentipallium blandowskianum	Woolly Everlasting			27/05/1921
		Argentipallium obtusifolium	Blunt Everlasting			25/10/1970
		Blennospora drummondii	Dwarf Button-flower			1/07/1999
		Brachyscome ciliaris var.	Variable Daisy			7/05/1992
		Brachyscome ciliaris var. ciliaris	Variable Daisy			3/11/2012
		Brachyscome debilis	Weak Daisy			30/09/1974
		Brachyscome dentata	Lobe-seed Daisy			11/09/1974
		Brachyscome exilis	Slender Daisy			9/11/1974
		Brachyscome goniocarpa	Dwarf Daisy			1/07/1999
		Brachyscome lineariloba	Hard-head Daisy			1/07/1999
		Brachyscome paludicola	Swamp Daisy		R*	1/01/1991
		Brachyscome perpusilla	Tiny Daisy			21/09/1974
		Calocephalus citreus	Lemon Beauty-heads			0/01/1900
		Calocephalus sonderi	Pale Beauty-heads		R	0/01/1900
		Calotis hispidula	Hairy Burr-daisy			8/09/1974
		Calotis scapigera	Tufted Burr-daisy		R	20/06/1941
*		*Carduus tenuiflorus*	Slender Thistle			1/10/1974
*		*Carthamus lanatus*	Saffron Thistle			8/02/1977
		Cassinia arcuata	Drooping Cassinia			6/11/2014
		Cassinia complanata	Sticky Cassinia			3/11/2012

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Cassinia laevis	Curry Bush			4/04/2013
		Cassinia uncata (NC)	Sticky Cassinia			18/05/1992
*		*Centaurea calcitrapa*	Star Thistle			6/06/2005
*		*Centaurea melitensis*	Malta Thistle			20/11/1964
*		*Chondrilla juncea*	Skeleton Weed			10/12/2015
*		*Chrysanthemoides monilifera ssp. monilifera*	Boneseed			1/09/1997
		Chrysocephalum apiculatum	Common Everlasting			10/11/2014
		Chrysocephalum apiculatum (NC)	Common Everlasting			4/11/2004
		Chrysocephalum baxteri	White Everlasting			21/10/1973
		Chrysocephalum semipapposum	Clustered Everlasting			6/11/2014
		Chthonocephalus pseudevax	Ground-heads			9/09/1983
*		*Cichorium intybus*	Chicory			11/01/1977
*		*Cirsium vulgare*	Spear Thistle			11/11/2003
*		*Conyza bonariensis*	Flax-leaf Fleabane			26/07/1974
		Cotula australis	Common Cotula			26/07/1974
*		*Cotula coronopifolia*	Water Buttons			1/11/2005
		Craspedia variabilis	Billy-buttons			23/09/2013
*		*Cynara cardunculus ssp. flavescens*	Artichoke Thistle			9/11/2014
*		*Dittrichia graveolens*	Stinkweed			27/04/1983
		Euchiton sphaericus	Annual Cudweed			1/10/1974
*		*Euryops abrotanifolius*	Euryops			12/05/1917
*		*Gazania linearis*	Gazania			26/07/2012
*		*Gazania sp.*	Gazania			3/11/2012
		Gnaphalium indutum ssp. indutum	Tiny Cudweed			9/09/1983
		Helichrysum leucopsideum	Satin Everlasting			10/11/2014
		Hyalosperma demissum	Dwarf Sunray			29/09/2002
		Hyalosperma glutinosum ssp. glutinosum	Golden Sunray			17/09/1978
		Hyalosperma semisterile	Orange Sunray			10/11/2014
*		*Hypochaeris glabra*	Smooth Cat's Ear			10/11/2014
*		*Hypochaeris radicata*	Rough Cat's Ear			10/11/2014
		Isoetopsis graminifolia	Grass Cushion			13/10/1976
		Ixodia achillaeoides ssp. alata	Hills Daisy			0/01/1900
*		*Lactuca saligna*	Willow-leaf Lettuce			1/11/2005
*		*Lactuca serriola f. integrifolia*	Prickly Lettuce			7/03/1941
*		*Lactuca serriola f. serriola*	Prickly Lettuce			20/01/1976
*		*Lactuca sp.*	Lettuce			1/11/2005
		Lagenophora huegelii	Coarse Bottle-daisy			2/11/2004
		Leptorhynchos elongatus	Lanky Buttons		R	29/09/1961
		Leptorhynchos squamatus ssp. squamatus	Scaly Buttons			15/12/1993
		Leptorhynchos tetrachaetus	Little Buttons			1/09/1997

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
*		*Mauranthemum paludosum*	Ox-eye Daisy			19/08/1988
		Microseris lanceolata	Yam Daisy			14/09/2013
		Millotia muelleri	Common Bow-flower			10/10/1984
		Millotia myosotidifolia	Broad-leaf Millotia			20/10/1974
		Millotia tenuifolia var.	Soft Millotia			23/09/2013
		Millotia tenuifolia var. tenuifolia	Soft Millotia			10/11/2014
		Minuria leptophylla	Minnie Daisy			15/09/2013
		Olearia brachyphylla	Short-leaf Daisy-bush			24/07/1999
		Olearia ciliata var. ciliata	Fringed Daisy-bush			1/09/1997
		Olearia decurrens	Winged Daisy-bush			7/05/1992
		Olearia floribunda	Heath Daisy-bush			8/05/1992
		Olearia lanuginosa	Woolly Daisy-bush			15/04/2013
		Olearia lepidophylla	Clubmoss Daisy-bush			7/04/2013
		Olearia magniflora	Splendid Daisy-bush			12/09/2013
		Olearia minor	Heath Daisy-bush			8/09/1974
		Olearia muelleri	Mueller's Daisy-bush			7/05/1992
		Olearia pannosa ssp.	Silver Daisy-bush			8/05/1992
		Olearia pannosa ssp. pannosa	Silver Daisy-bush	VU	V	9/11/2014
		Olearia passerinoides ssp. glutescens	Sticky Daisy-bush		R	9/07/1984
		Olearia picridifolia	Rasp Daisy-bush		R	24/09/2013
		Olearia ramulosa	Twiggy Daisy-bush			8/05/1992
		Olearia tubuliflora	Rayless Daisy-bush			29/05/1926
*		*Oncosiphon suffruticosum*	Calomba Daisy			8/11/2011
*		*Onopordum acaulon*	Horse Thistle			6/11/2014
		Ozothamnus decurrens	Ridged Bush-everlasting			11/09/1971
		Ozothamnus retusus	Notched Bush-everlasting			14/12/1975
*		*Picnomon acarna*	Soldier Thistle			14/10/1976
		Podolepis canescens	Grey Copper-wire Daisy			1/10/1911
		Podolepis jaceoides	Showy Copper-wire Daisy		R	4/11/2004
		Podolepis rugata ssp. glabrata	Pleated Podolepis			7/11/1989
		Podolepis tepperi	Delicate Copper-wire Daisy			1/07/1999
		Podotheca angustifolia	Sticky Long-heads			11/10/2013
		Pogonolepis muelleriana	Stiff Cup-flower			6/11/2014
		Polycalymma stuartii	Poached-egg Daisy			28/08/1985
*		*Reichardia tingitana*	False Sowthistle			6/11/2014
*		*Rhaponticum repens*	Creeping Knapweed			30/03/1967
		Rhodanthe corymbiflora	Paper Everlasting			5/10/1906
		Rhodanthe laevis	Smooth Daisy			17/09/1978
		Rhodanthe moschata	Musk Daisy			28/10/1911
		Rhodanthe pygmaea	Pigmy Daisy			16/09/1991

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Senecio cunninghamii var. cunninghamii	Shrubby Groundsel			20/06/1918
		Senecio cunninghamii var. cunninghamii (NC)	Shrubby Groundsel			11/11/2003
		Senecio dolichocephalus	Woodland Groundsel			3/11/2012
		Senecio glossanthus	Annual Groundsel			9/09/1983
		Senecio glossanthus (NC)	Annual Groundsel			1/07/1999
		Senecio magnificus	Showy Groundsel			26/09/1963
		Senecio odoratus	Scented Groundsel			8/06/1925
		Senecio picridioides	Purple-leaf Groundsel			26/11/1974
		Senecio pilosicristus				24/06/1984
		Senecio pinnatifolius (NC)	Variable Groundsel			1/07/1999
		Senecio pinnatifolius group	Variable Groundsel			20/07/2012
*		*Senecio pterophorus*	African Daisy			8/05/2014
		Senecio quadridentatus	Cotton Groundsel			1/07/1999
		Senecio sp.	Groundsel			1/09/1997
		Senecio spanomerus				6/11/2014
		Siloxerus multiflorus	Small Wrinklewort			10/10/1925
*		*Sonchus asper ssp. asper*	Rough Sow-thistle			31/03/1976
		Sonchus hydrophilus	Native Sow-thistle			20/07/1968
*		*Sonchus oleraceus*	Common Sow-thistle			9/11/2014
		Sphaeromorphaea littoralis	Spreading Nut-heads			26/03/1921
*		*Symphyotrichum subulatum*	Aster-weed			27/02/2015
*		*Taraxacum sp.*	Dandelion			11/12/2001
		Triptilodiscus pygmaeus	Small Yellow-heads			29/09/2002
*		*Urospermum picroides*	False Hawkbit			10/11/1925
		Vittadinia australasica var. australasica	Sticky New Holland Daisy			24/11/1993
		Vittadinia blackii	Narrow-leaf New Holland Daisy			9/11/2014
		Vittadinia cervicularis var. cervicularis	Waisted New Holland Daisy			3/11/2012
		Vittadinia cuneata var.	Fuzzy New Holland Daisy			4/11/2004
		Vittadinia cuneata var. cuneata	Fuzzy New Holland Daisy			10/11/2014
		Vittadinia dissecta var. hirta	Dissected New Holland Daisy			5/05/1992
		Vittadinia eremaea	Desert New Holland Daisy			25/09/1976
		Vittadinia gracilis	Woolly New Holland Daisy			10/11/2014
		Vittadinia megacephala	Giant New Holland Daisy			16/10/1977
		Vittadinia sp.	New Holland Daisy			3/11/2012
		Waitzia acuminata var. acuminata	Orange Immortelle			13/10/1939
*		*Xanthium spinosum*	Bathurst Burr			25/03/1976
	CONVOLVULACEAE	*Calystegia sepium (NC)*	Large Bindweed			11/11/2003

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Convolvulus angustissimus ssp. angustissimus	Narrow-leaf Bindweed			10/11/2014
		Convolvulus angustissimus ssp. peninsularum	Narrow-leaf Bindweed			3/11/2012
*		*Convolvulus arvensis*	Field Bindweed			1/11/2005
		Convolvulus crispifolius	Silver Bindweed			30/07/1984
		Convolvulus erubescens (NC)	Australian Bindweed			26/10/2004
		Convolvulus microsepalus	Small-flower Bindweed			11/01/1977
		Convolvulus remotus	Grassy Bindweed			7/05/1992
*		*Cuscuta campestris*	Golden Dodder			1/06/2012
*		*Ipomoea indica*	Purple Morning-glory			1/11/2005
	CORTINARIACEAE	*Cortinarius fiveashianus*				1/08/1925
		Cortinarius sinapicolor				7/07/1923
		Inocybe imbricata				8/06/1925
	CRASSULACEAE	*Crassula closiana*	Stalked Crassula			8/09/1974
		Crassula colligata ssp. colligata				2/10/1974
		Crassula colligata ssp. lamprosperma				13/10/1976
		Crassula colorata var.	Dense Crassula			2/11/2004
		Crassula colorata var. acuminata	Dense Crassula			1/07/1999
		Crassula colorata var. colorata	Dense Crassula			27/10/1976
		Crassula decumbens var. decumbens	Spreading Crassula			13/10/1976
		Crassula helmsii	Swamp Crassula			13/05/1985
*		*Crassula natans var. minus*	Water Crassula			16/08/1975
		Crassula peduncularis	Purple Crassula		R	17/05/1977
		Crassula sieberiana	Sieber's Crassula		E	30/07/1974
		Crassula sieberiana ssp. tetramera (NC)	Australian Stonecrop			16/09/1991
		Crassula sp.	Crassula/Stonecrop			9/11/2014
		Crassula tetramera	Australian Stonecrop			1/10/1974
*		*Sedum praealtum*	Green Cockscomb			29/09/1961
	CREPIDOTACEAE	*Tubaria fiveashiana*				29/07/1922
		Tubaria rufofulva				8/06/1925
*	CRUCIFERAE	*Alyssum linifolium*	Flax-leaf Alyssum			24/08/1980
*		*Brassica oleracea*	Cabbage			2/08/2012
*		*Brassica sp.*				1/09/1997
*		*Brassica tournefortii*	Wild Turnip			11/11/2014
*		*Capsella bursa-pastoris*	Shepherd's Purse			29/09/1976
*		*Carrichtera annua*	Ward's Weed			26/07/2012
		Cruciferae sp.	Cress Family			1/11/2005
*		*Diplotaxis muralis*	Wall Rocket			17/03/1976
*		*Diplotaxis tenuifolia*	Lincoln Weed			2/08/2012
		Geococcus pusillus	Earth Cress			29/06/1936

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Harmsiodoxa brevipes var. brevipes	Short Cress			1/08/1925
*		*Hirschfeldia incana*	Hoary Mustard			11/07/1945
*		*Hornungia procumbens*	Oval Purse			0/01/1900
*		*Lepidium africanum*	Common Peppercress			17/01/2012
*		*Lepidium didymum*	Lesser Swine's-cress			20/11/1964
*		*Lobularia maritima*	Sweet Alyssum			15/06/2011
*		*Matthiola incana*	Common Stock			1/10/1911
		Pachymitus cardaminoides	Sand Cress			2/08/1974
*		*Raphanus raphanistrum*	Wild Radish			3/12/1968
*		*Raphanus sativus*	Radish			3/09/2008
*		*Rorippa nasturtium-aquaticum*	Watercress			1/11/2005
*		*Rorippa palustris*	Yellow Marsh-cress			11/11/2003
*		*Sisymbrium erysimoides*	Smooth Mustard			26/07/2012
*		*Sisymbrium irio*	London Mustard			2/08/2012
*		*Sisymbrium orientale*	Indian Hedge Mustard			2/08/2012
		Stenopetalum lineare	Narrow Thread-petal			3/11/2012
		Stenopetalum lineare (NC)	Narrow Thread-petal			7/05/1992
		Stenopetalum sphaerocarpum	Round-fruit Thread-petal			7/05/1992
	CUCURBITACEAE	*Austrobryonia micrantha*	Desert Cucumber			26/03/1921
*		*Citrullus lanatus*	Bitter Melon			17/03/1976
*		*Cucumis myriocarpus*	Paddy Melon			22/11/2002
*		*Ecballium elaterium*	Squirting Cucumber			20/04/1983
	CUPRESSACEAE	*Callitris canescens*	Scrubby Cypress Pine			17/02/1982
		Callitris gracilis	Southern Cypress Pine			27/02/2015
		Callitris verrucosa	Scrub Cypress Pine			24/05/1975
	CYPERACEAE	*Baumea juncea*	Bare Twig-rush			1/09/1997
		Bolboschoenus caldwellii	Salt Club-rush			27/02/2015
		Carex breviculmis	Short-stem Sedge			9/09/1975
		Carex gaudichaudiana	Fen Sedge			1/01/1991
		Cyperus exaltatus	Splendid Flat-sedge			1/11/2005
		Cyperus gymnocaulos	Spiny Flat-sedge			9/11/2014
		Eleocharis acuta	Common Spike-rush			1/11/2005
		Eleocharis sphacelata	Tall Spike-rush			1/11/2005
		Gahnia deusta	Limestone Saw-sedge			13/10/1993
		Gahnia lanigera	Black Grass Saw-sedge			3/11/2012
		Gahnia sp.	Saw-sedge			1/11/2005
*		*Isolepis marginata*	Little Club-rush			21/09/1974
		Lepidosperma carphoides	Black Rapier-sedge			1/09/1997
		Lepidosperma concavum	Spreading Sword-sedge			7/04/1974
		Lepidosperma concavum/congestum/laterale	Sword-sedge			1/09/1997
		Lepidosperma congestum				3/07/1975

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				Aus	SA	
		Lepidosperma congestum (NC)	Clustered Sword-sedge			8/05/1992
		Lepidosperma viscidum	Sticky Sword-sedge			9/11/2014
		Schoenoplectus pungens	Spiky Club-rush			16/12/1976
		Schoenoplectus validus	River Club-rush			1/11/2005
		Schoenus apogon	Common Bog-rush			27/10/1978
		Schoenus breviculmis	Matted Bog-rush			8/05/1992
		Schoenus deformis	Small Bog-rush			29/11/1949
		Schoenus nanus	Little Bog-rush			2/10/1974
	DILLENIACEAE	*Hibbertia australis*	Stalked Guinea-flower			0/01/1900
		Hibbertia crinita	Velvet-leaf Guinea-flower			1/07/1999
		Hibbertia riparia	Bristly Guinea-flower			23/09/2012
		Hibbertia riparia (NC)	Guinea-flower			1/09/1997
		Hibbertia sericea	Silky Guinea-flower			12/08/2012
		Hibbertia sp.	Guinea-flower			1/09/1997
		Hibbertia virgata	Twiggy Guinea-flower			4/11/2004
*	DIPSACACEAE	*Scabiosa atropurpurea*	Pincushion			27/02/2015
	DROSERACEAE	*Drosera glanduligera*	Scarlet Sundew			3/09/2012
		Drosera macrantha ssp. planchonii	Climbing Sundew			4/11/2004
		Drosera sp.	Sundew			1/09/1997
		Drosera whittakeri	Scented Sundew			9/09/2012
		Drosera whittakeri (NC)	Scented Sundew			8/05/1992
		Drosera whittakeri ssp. (NC)				1/09/1997
	EPACRIDACEAE	*Acrotriche affinis*	Ridged Ground-berry			10/09/1966
		Acrotriche cordata	Blunt-leaf Ground-berry			27/10/1976
		Acrotriche depressa	Native Currant			10/07/1990
		Acrotriche patula	Prickly Ground-berry			25/09/1976
		Acrotriche serrulata	Cushion Ground-berry			1/09/1997
		Astroloma conostephioides	Flame Heath			1/09/1997
		Astroloma humifusum	Cranberry Heath			9/11/2014
		Brachyloma ericoides ssp. ericoides	Brush Heath			1/09/1997
		Leucopogon cordifolius	Heart-leaf Beard-heath			25/07/1968
		Leucopogon costatus	Twiggy Beard-heath			9/10/1953
		Leucopogon rufus	Ruddy Beard-heath			10/10/1925
		Lissanthe strigosa ssp. subulata	Peach Heath			1/06/1925
		Styphelia exarrhena	Desert Heath			15/05/1938
	EUPHORBIACEAE	*Adriana klotzschii (NC)*	Coast Bitter-bush			22/11/2002
		Adriana quadripartita	Coast Bitter-bush			26/11/1974
		Bertya tasmanica ssp. vestita	Mitchell's Bertya			5/09/1990
		Beyeria lechenaultii	Pale Turpentine Bush			10/11/2014
		Euphorbia dallachyana	Caustic Weed			11/03/1976
		Euphorbia drummondii (NC)				6/11/2014
*		*Euphorbia maculata*	Eyebane			1/02/2008

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
*		*Euphorbia peplus*	Petty Spurge			20/01/1976
*		*Euphorbia terracina*	False Caper			26/07/2012
		Poranthera microphylla	Small Poranthera			3/12/1974
		Poranthera microphylla (NC)	Small Poranthera			29/09/2002
		Poranthera triandra	Three-petal Poranthera			8/09/1974
*		*Ricinus communis*	Castor Oil Plant			3/09/1984
*	GENTIANACEAE	*Centaurium pulchellum*	Branched Centaury			26/11/1974
*		*Centaurium tenuiflorum*	Branched Centaury			30/11/1963
		Schenkia australis	Spike Centaury			30/11/1963
		Sebaea ovata	Yellow Sebaea			1/10/1974
*	GERANIACEAE	*Erodium botrys*	Long Heron's-bill			10/11/2014
*		*Erodium cicutarium*	Cut-leaf Heron's-bill			1/07/1999
		Erodium crinitum	Blue Heron's-bill			29/09/2002
*		*Erodium moschatum*	Musky Herons-bill			3/09/2008
		Geranium sp.	Geranium			1/09/1997
	GOODENIACEAE	*Dampiera dysantha*	Shrubby Dampiera			9/11/2014
		Dampiera marifolia	Velvet Dampiera			27/10/1976
		Dampiera rosmarinifolia	Rosemary Dampiera			4/11/2004
		Goodenia geniculata	Bent Goodenia			1/09/1997
		Goodenia pinnatifida	Cut-leaf Goodenia			6/11/2014
		Goodenia pusilliflora	Small-flower Goodenia			16/09/1991
		Goodenia robusta	Woolly Goodenia			1/07/1999
		Goodenia sp.	Goodenia			1/09/1997
		Goodenia varia	Sticky Goodenia			25/09/2012
		Goodenia willisiana	Silver Goodenia			3/11/2012
		Scaevola aemula	Fairy Fanflower			15/10/1974
		Velleia arguta	Toothed Velleia			23/09/2012
		Velleia paradoxa	Spur Velleia			10/11/2014
*	GRAMINEAE	*Aira cupaniana*	Small Hair-grass			29/09/2002
*		*Aira sp.*	Hair-grass			11/11/2014
		Amphipogon caricinus var. caricinus	Long Grey-beard Grass			9/11/2014
		Amphipogon sp.	Grey-beard Grass			1/09/1997
		Anthosachne scabra	Native Wheat-grass			9/11/2014
		Aristida behriana	Brush Wire-grass			10/11/2014
		Aristida contorta	Curly Wire-grass			3/11/2012
		Austrodanthonia sp. (NC)				3/09/2008
		Austrostipa acrociliata	Graceful Spear-grass			3/11/2012
		Austrostipa blackii	Crested Spear-grass			2/11/2004
		Austrostipa densiflora	Fox-tail Spear-grass		R	4/11/2014
		Austrostipa drummondii	Cottony Spear-grass			3/11/2012
		Austrostipa elegantissima	Feather Spear-grass			9/11/2014
		Austrostipa eremophila	Rusty Spear-grass			9/11/2014
		Austrostipa exilis	Heath Spear-grass			26/10/1986
		Austrostipa flavescens	Coast Spear-grass			14/10/1949
		Austrostipa hemipogon	Half-beard Spear-grass			4/11/2014

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Austrostipa mollis	Soft Spear-grass			3/11/2012
		Austrostipa mollis group	Soft Spear-grass			8/05/1992
		Austrostipa nitida	Balcarra Spear-grass			3/11/2012
		Austrostipa nodosa	Tall Spear-grass			9/11/2014
		Austrostipa platychaeta	Flat-awn Spear-grass			20/09/1982
		Austrostipa puberula	Fine-hairy Spear-grass			19/10/2004
		Austrostipa scabra group	Falcate-awn Spear-grass			8/05/1992
		Austrostipa scabra ssp.	Rough Spear-grass			2/11/2004
		Austrostipa scabra ssp. falcata	Slender Spear-grass			3/11/2012
		Austrostipa scabra ssp. scabra	Rough Spear-grass			
		Austrostipa setacea	Corkscrew Spear-grass			3/11/2012
		Austrostipa sp.	Spear-grass			27/02/2015
		Austrostipa trichophylla				3/11/2012
		Austrostipa tuckeri	Tucker's Spear-grass		R	8/05/1992
*		*Avellinia michelii*	Avellinia			16/08/1974
*		*Avena barbata*	Bearded Oat			27/02/2015
*		*Avena fatua*	Wild Oat			5/05/1992
*		*Avena sp.*	Oat			11/11/2014
		Bothriochloa macra	Red-leg Grass		R	1/05/1939
*		*Brachypodium distachyon*	False Brome			20/11/1964
*		*Briza maxima*	Large Quaking-grass			9/11/2014
*		*Bromus catharticus*	Prairie Grass			1/11/2005
*		*Bromus diandrus*	Great Brome			10/11/2014
*		*Bromus diandrus (NC)*	Great Brome			3/09/2008
*		*Bromus madritensis*	Compact Brome			26/09/1959
*		*Bromus rubens*	Red Brome			27/02/2015
		Bromus sp.	Brome			9/11/2014
*		*Catapodium rigidum*	Rigid Fescue			8/05/1992
*		*Cenchrus clandestinus*	Kikuyu			26/07/2012
*		*Cenchrus longispinus*	Spiny Burr-grass			20/03/1946
		Chloris truncata	Windmill Grass			9/11/2014
*		*Cynodon dactylon (NC)*	Couch			6/06/2005
*		*Cynodon dactylon var. dactylon*	Couch			20/01/1976
*		*Cynodon sp.*	Couch			1/11/2005
		Danthonia sp. (NC)	Wallaby-grass			22/11/2002
		Dichelachne crinita	Long-hair Plume-grass			23/09/1922
*		*Digitaria sanguinalis*	Crab Grass			20/01/1976
		Distichlis distichophylla	Emu-grass			1/11/2005
*		*Echinochloa esculenta*	Japanese Millet			30/04/2005
*		*Ehrharta calycina*	Perennial Veldt Grass			27/02/2015
*		*Ehrharta erecta*	Panic Veldt Grass			15/06/2011
*		*Ehrharta longiflora*	Annual Veldt Grass			10/11/2014
*		*Ehrharta villosa var. maxima*	Pyp Grass			30/01/1939

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Enneapogon nigricans	Black-head Grass			10/11/2014
		Enteropogon acicularis	Umbrella Grass			28/03/1974
		Eragrostis australasica	Cane-grass			1/11/2005
*		*Eragrostis barrelieri*	Pitted Love-grass			15/04/2015
		Eragrostis brownii	Bentham's Love-grass			0/01/1900
*		*Eragrostis cilianensis*	Stink Grass			15/06/2011
*		*Eragrostis curvula*	African Love-grass			15/04/2015
		Eragrostis dielsii	Mulka			2/09/1989
		Eragrostis elongata	Clustered Love-grass			1/04/1940
		Eragrostis lacunaria	Purple Love-grass		R	25/03/1946
*		*Eragrostis minor*	Small Stink-grass			12/03/1992
		Eragrostis parviflora	Weeping Love-grass			16/05/1985
*		*Festuca rubra*	Red Fescue			30/10/1992
		Glyceria australis	Australian Sweet-grass			
		Gramineae sp.	Grass Family			12/11/2002
*		*Holcus lanatus*	Yorkshire Fog			22/12/1916
*		*Hordeum glaucum*	Blue Barley-grass			16/09/1991
*		*Hordeum leporinum*	Wall Barley-grass			10/10/2012
*		*Hordeum marinum*	Sea Barley-grass			1/11/2005
*		*Hordeum sp.*	Barley-grass			11/11/2014
		Lachnagrostis aemula	Blown-grass			8/11/1924
		Lachnagrostis filiformis	Common Blown-grass			8/01/1971
*		*Lagurus ovatus*	Hare's Tail Grass			9/11/2014
*		*Lamarckia aurea*	Toothbrush Grass			11/11/2014
*		*Lolium loliaceum*	Stiff Ryegrass			8/11/1924
*		*Lolium perenne*	Perennial Ryegrass			3/09/2008
*		*Lolium rigidum*	Wimmera Ryegrass			2/08/2012
*		*Lolium sp.*	Ryegrass			1/11/2005
		Neurachne alopecuroidea	Fox-tail Mulga-grass			1/07/1999
		Neurachne sp.	Mulga-grass			2/11/2004
*		*Panicum capillare var. brevifolium*	Witch-grass			11/12/2001
		Panicum effusum var. effusum	Hairy Panic			15/11/1996
*		*Panicum hillmanii*	Witch-grass			15/06/2011
*		*Parapholis incurva*	Curly Ryegrass			27/10/1976
*		*Paspalum dilatatum*	Paspalum			1/11/2005
*		*Paspalum distichum*	Water Couch			1/11/2005
*		*Paspalum vaginatum*	Salt-water Couch			11/11/2003
*		*Pentameris airoides ssp. airoides*	False Hair-grass			8/05/1992
*		*Pentameris pallida*	Pussy Tail			9/11/2014
*		*Phalaris aquatica*	Phalaris			6/06/2005
*		*Phalaris minor*	Lesser Canary-grass			1/11/2005
		Phragmites australis	Common Reed			1/11/2005
*		*Piptatherum miliaceum*	Rice Millet			3/09/2008
*		*Poa annua*	Winter Grass			26/07/2012

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Poa crassicaudex	Thick-stem Tussock-grass			2/10/1974
		Poa drummondiana	Knotted Poa		R	0/01/1900
		Poa labillardieri var. labillardieri	Common Tussock-grass			12/11/1992
		Poa sp.	Meadow-grass/Tussock-grass			8/05/1992
*		*Polypogon monspeliensis*	Annual Beard-grass			27/02/2015
		Pseudoraphis spinescens	Spiny Mud-grass			1/03/1910
*		*Puccinellia fasciculata*	Borrer's Saltmarsh-grass			15/12/1996
		Puccinellia stricta	Australian Saltmarsh-grass			27/10/1976
*		*Rostraria cristata*	Annual Cat's-tail			9/11/2014
*		*Rostraria pumila*	Tiny Bristle-grass			9/10/1926
		Rytidosperma caespitosum	Common Wallaby-grass			10/11/2014
		Rytidosperma erianthum	Hill Wallaby-grass			10/11/2014
		Rytidosperma pilosum	Velvet Wallaby-grass			24/10/1930
		Rytidosperma setaceum	Small-flower Wallaby-grass			9/11/2014
		Rytidosperma sp.	Wallaby-grass			19/10/2004
*		*Schismus barbatus*	Arabian Grass			3/11/2012
		Setaria clementii	Clement's Paspalidium			11/01/1977
		Setaria constricta	Knotty-butt Paspalidium			9/11/2014
*		*Setaria italica*	Fox-tail Millet			1/04/2005
		Setaria jubiflora	Warrego Summer-grass			1/03/1910
*		*Setaria pumila ssp. pumila*	Pale Pigeon-grass			18/02/1931
*		*Setaria verticillata*	Whorled Pigeon-grass			30/03/1977
*		*Sorghum halepense*	Johnson Grass			16/03/1977
		Sporobolus virginicus	Salt Couch			4/12/1975
		Stipa nitida group (NC)	Spear-grass			8/05/1992
		Themeda triandra	Kangaroo Grass			27/02/2015
		Tragus australianus	Small Burr-grass			15/04/2015
		Triodia compacta	Spinifex			25/11/1953
		Triodia irritans	Spinifex			18/05/1992
		Triodia irritans var. (NC)				7/05/1992
		Triodia scariosa	Spinifex			3/11/2012
		Triodia scariosa ssp. (NC)	Spinifex			22/11/2002
		Triodia sp.	Spinifex			6/06/2005
*		*Triticum aestivum*	Wheat			2/08/2012
*		*Vulpia bromoides*	Squirrel-tail Fescue			16/09/1991
*		*Vulpia ciliata*	Fringed Fescue			9/11/1974
*		*Vulpia muralis*	Wall Fescue			20/11/1930
*		*Vulpia myuros f. megalura*	Fox-tail Fescue			2/10/1974
*		*Vulpia myuros f. myuros*	Rat's-tail Fescue			15/06/2011
*		*Vulpia sp.*	Fescue			11/11/2014

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Walwhalleya proluta	Rigid Panic			3/11/2012
*	GUTTIFERAE	*Hypericum perforatum*	St John's Wort			20/05/1977
	GYROSTEMONACEAE	*Gyrostemon australasicus*	Buckbush Wheel-fruit			2/10/1971
		Gyrostemon thesioides	Broom Wheel-fruit			16/08/1975
	HALORAGACEAE	*Glischrocaryon behrii*	Golden Pennants			4/11/2004
		Gonocarpus elatus	Hill Raspwort			10/11/2014
		Gonocarpus tetragynus	Small-leaf Raspwort			1/09/1997
		Haloragis acutangula f. acutangula	Smooth Raspwort			14/12/1975
		Haloragis aspera	Rough Raspwort			4/02/1937
*		*Myriophyllum aquaticum*				7/11/2003
		Myriophyllum caput-medusae	Coarse Milfoil			31/12/1972
		Myriophyllum papillosum	Robust Milfoil		R	18/03/1990
		Myriophyllum simulans	Amphibious Milfoil			18/12/1916
	HYDROCHARITACEAE	*Hydrilla verticillata*	Waterthyme		R	1/01/1991
	HYPOXIDACEAE	*Pauridia glabella var. glabella*	Tiny Star			1/07/1999
*	IRIDACEAE	*Freesia cultivar*	Freesia			8/05/1992
*		*Gladiolus undulatus*	Wild Gladiolus			18/12/1946
*		*Moraea setifolia*	Thread Iris			29/09/2002
*		*Romulea minutiflora*	Small-flower Onion-grass			29/09/2002
*		*Romulea sp.*	Onion-grass			9/11/2014
*		*Sparaxis sp.*	Sparaxis			8/05/1992
*	JUNCACEAE	*Juncus acutus*	Sharp Rush			27/02/2015
		Juncus aridicola	Inland Rush			0/01/1900
*		*Juncus capitatus*	Dwarf Rush			16/09/1974
		Juncus holoschoenus	Joint-leaf Rush			0/01/1900
		Juncus kraussii	Sea Rush			27/02/2015
		Juncus subsecundus	Finger Rush			25/04/1924
*		*Juncus usitatus*	Common Rush			1/11/2005
		Luzula meridionalis	Common Wood-rush			9/09/1975
	JUNCAGINACEAE	*Triglochin procera*	Water-ribbons			1/11/2005
		Triglochin striata	Streaked Arrowgrass			1/11/2005
	LABIATAE	*Lycopus australis*	Australian Gipsywort			11/11/2003
*		*Marrubium vulgare*	Horehound			10/11/2014
		Mentha australis	River Mint			22/12/1965
*		*Mentha pulegium*	Pennyroyal			25/12/1909
		Prostanthera aspalathoides	Scarlet Mintbush			4/09/2012
		Prostanthera behriana	Downy Mintbush			14/09/2013
		Prostanthera chlorantha	Green Mintbush		R	1/06/1925
		Prostanthera eurybioides	Monarto Mintbush	EN	E	4/09/2012
		Prostanthera serpyllifolia ssp. microphylla	Small-leaf Mintbush			17/05/1992
*		*Salvia verbenaca var.*	Wild Sage			9/11/2014
*		*Salvia verbenaca var. verbenaca*	Wild Sage			18/05/1992

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Teucrium racemosum	Grey Germander			26/03/1951
		Teucrium sessiliflorum	Mallee Germander			3/12/1974
		Westringia eremicola	Slender Westringia			5/09/1990
		Westringia rigida	Stiff Westringia			3/11/2012
	LAURACEAE	*Cassytha glabella f. dispar*	Slender Dodder-laurel			28/10/1973
		Cassytha melantha	Coarse Dodder-laurel			11/11/2014
		Cassytha pubescens	Downy Dodder-laurel			22/08/2012
	LEGUMINOSAE	*Acacia acinacea*	Wreath Wattle			9/11/2014
		Acacia aff. menzelii (NC)				14/01/1987
		Acacia ancistrophylla/sclerophylla				16/09/1991
		Acacia argyrophylla	Silver Mulga-bush			9/11/2014
		Acacia brachybotrya	Grey Mulga-bush			10/11/2014
		Acacia calamifolia	Wallowa			13/08/2012
		Acacia calamifolia (NC)	Wallowa			4/11/2004
		Acacia continua	Thorn Wattle			0/01/1900
		Acacia cupularis	Cup Wattle			22/09/2012
		Acacia euthycarpa	Wallowa			10/04/2014
		Acacia farinosa	Mealy Wattle			1/09/1980
		Acacia hakeoides	Hakea Wattle			22/11/2002
		Acacia halliana	Hall's Wattle			18/07/1985
		Acacia halliana/microcarpa				22/11/2002
		Acacia iteaphylla	Flinders Ranges Wattle		R	19/07/2012
		Acacia ligulata	Umbrella Bush			22/11/2002
		Acacia ligulata (NC)	Umbrella Bush			8/05/1992
		Acacia lineata	Streaked Wattle		R	17/06/1988
		Acacia menzelii	Menzel's Wattle	VU	V	10/11/2014
		Acacia microcarpa	Manna Wattle			21/06/2012
		Acacia montana	Mallee Wattle		R	10/11/2014
		Acacia notabilis	Notable Wattle			22/09/2012
		Acacia oswaldii	Umbrella Wattle			26/03/1921
		Acacia paradoxa	Kangaroo Thorn			3/11/2012
		Acacia pycnantha	Golden Wattle			10/11/2014
		Acacia retinodes	Wirilda			9/11/2014
		Acacia rhetinocarpa	Resin Wattle	VU	V	22/09/2012
		Acacia rhigiophylla	Dagger-leaf Wattle		R	3/11/2012
		Acacia rigens	Nealie			8/05/1992
		Acacia rupicola	Rock Wattle			22/11/2002
		Acacia sclerophylla var. sclerophylla	Hard-leaf Wattle			23/08/2012
		Acacia simmonsiana	Hall's Wattle		R	12/09/1982
		Acacia sp.	Wattle			3/09/2008
		Acacia spinescens	Spiny Wattle			4/09/2012
		Acacia trineura	Three-nerve Wattle		E	22/10/2004
		Acacia triquetra	Mallee Wreath Wattle			22/11/2002
		Acacia verniciflua	Varnish Wattle			20/08/1939

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Acacia wilhelmiana	Dwarf Nealie			3/11/2012
		Aotus subspinescens	Mallee Aotus			1/10/1964
		Cullen australasicum	Tall Scurf-pea			9/11/2014
		Cullen pallidum	White Scurf-pea			26/03/1921
		Daviesia arenaria	Sand Bitter-pea			18/07/1985
		Daviesia benthamii ssp. humilis (NC)	Mallee Bitter-pea		R	29/10/2004
		Daviesia brevifolia	Leafless Bitter-pea			12/09/1968
		Dillwynia hispida	Red Parrot-pea			20/10/1974
		Dillwynia uncinata	Silky Parrot-pea			23/10/1973
		Eutaxia diffusa	Large-leaf Eutaxia			9/09/2003
		Eutaxia microphylla	Common Eutaxia			10/11/2014
		Eutaxia sp.	Eutaxia			8/05/1992
*		*Genista monspessulana*	Montpellier Broom			6/06/2005
		Glycine clandestina var. (NC)	Twining Glycine			29/09/2002
		Glycine rubiginosa	Twining Glycine			9/11/2014
		Hardenbergia violacea	Native Lilac			16/08/1974
		Lotus australis	Austral Trefoil			29/09/1977
*		*Medicago lupulina*	Black Medic			6/12/1939
*		*Medicago minima var. minima*	Little Medic			1/07/1999
*		*Medicago polymorpha var. polymorpha*	Burr-medic			16/09/1991
*		*Medicago praecox*	Small-leaf Burr-medic			6/10/1918
*		*Medicago sativa*	Lucerne			30/03/1977
*		*Medicago sp.*	Medic			1/11/2005
*		*Medicago truncatula*	Barrel Medic			20/05/1977
*		*Melilotus indicus*	King Island Melilot			15/06/2011
		Phyllota remota	Slender Phyllota			14/04/1969
		Pultenaea densifolia	Dense Bush-pea			29/10/2004
		Pultenaea tenuifolia	Narrow-leaf Bush-pea			15/09/1917
		Senna artemisioides ssp.	Desert Senna			1/06/2012
		Senna artemisioides ssp. artemisioides x ssp. coriacea	Desert Senna			5/11/2014
		Senna artemisioides ssp. filifolia	Fine-leaf Desert Senna			9/11/2014
		Senna artemisioides ssp. petiolaris				10/11/2014
		Senna artemisioides ssp. petiolaris (NC)	Flat-stalk Senna			5/05/1992
		Senna artemisioides ssp. X artemisioides	Silver Senna			23/06/2012
		Senna artemisioides ssp. X coriacea	Broad-leaf Desert Senna			9/11/2014
		Senna artemisioides ssp. X sturtii	Grey Senna			18/07/2012
		Senna sp.	Senna			17/12/1998
		Swainsona lessertiifolia	Coast Swainson-pea			12/09/2012

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Swainsona microphylla	Small-leaf Swainson-pea			13/10/1994
*		*Trifolium angustifolium*	Narrow-leaf Clover			5/11/2014
*		*Trifolium arvense var. arvense*	Hare's-foot Clover			9/11/2014
*		*Trifolium campestre*	Hop Clover			5/11/2014
*		*Trifolium glomeratum*	Cluster Clover			20/11/1964
*		*Trifolium repens*	White Clover			1/10/1911
*		*Trifolium sp.*	Clover			1/07/1999
*		*Trifolium strictum*				27/02/2015
*		*Trifolium suffocatum*	Suffocated Clover			1/10/1927
*		*Trifolium tomentosum*	Woolly Clover			13/10/1976
*		*Vicia monantha ssp. triflora*				15/06/2011
*		*Vicia sativa ssp.*	Common Vetch			18/05/1992
	LEMNACEAE	*Spirodela punctata*	Thin Duckweed			26/12/1909
	LILIACEAE	*Arthropodium fimbriatum*	Nodding Vanilla-lily			9/11/2014
		Arthropodium minus	Small Vanilla-lily			21/09/1974
		Arthropodium sp.	Vanilla-lily			16/09/1991
		Arthropodium strictum	Common Vanilla-lily			3/11/2012
*		*Asparagus asparagoides (NC)*	Bridal Creeper			6/06/2005
*		*Asparagus asparagoides f.*	Bridal Creeper			3/11/2012
*		*Asparagus asparagoides f. asparagoides*	Bridal Creeper			9/11/2014
*		*Asparagus officinalis*	Asparagus			22/11/2002
*		*Asphodelus fistulosus*	Onion Weed			3/09/2008
		Bulbine bulbosa	Bulbine-lily			26/10/2004
		Bulbine semibarbata	Small Leek-lily			24/10/1930
		Caesia calliantha	Blue Grass-lily			14/09/2012
		Chamaescilla corymbosa var. corymbosa	Blue Squill			16/09/1974
		Dianella brevicaulis	Short-stem Flax-lily			18/05/1992
		Dianella revoluta var.				27/02/2015
		Dianella revoluta var. revoluta	Black-anther Flax-lily			9/11/2014
		Laxmannia orientalis	Dwarf Wire-lily			12/09/1968
		Lomandra collina	Sand Mat-rush			3/11/2012
		Lomandra densiflora	Soft Tussock Mat-rush			10/11/2014
		Lomandra effusa	Scented Mat-rush			27/02/2015
		Lomandra juncea	Desert Mat-rush			1/09/1997
		Lomandra leucocephala ssp. robusta	Woolly Mat-rush			29/10/2004
		Lomandra micrantha ssp.	Small-flower Mat-rush			8/05/1992
		Lomandra micrantha ssp. micrantha	Small-flower Mat-rush			29/09/2002
		Lomandra multiflora ssp. dura	Hard Mat-rush			10/11/2014
		Lomandra sororia	Sword Mat-rush			13/10/1971
		Lomandra sp.	Mat-rush			22/11/2002

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
*		*Ornithogalum umbellatum*	Star Of Bethlehem			13/10/1976
		Thysanotus baueri	Mallee Fringe-lily			9/11/2014
		Thysanotus patersonii	Twining Fringe-lily			26/09/2013
		Tricoryne tenella	Tufted Yellow Rush-lily			3/11/2012
		Wurmbea dioica ssp. brevifolia	Early Nancy			16/08/1974
		Wurmbea dioica ssp. dioica	Early Nancy			28/08/1919
		Wurmbea dioica ssp. dioica (NC)	Early Nancy			1/07/1999
*	LIMONIACEAE	*Limonium companyonis*	Sea-lavender			8/05/2014
*		*Limonium hyblaeum*				21/01/1978
*		*Limonium lobatum*	Winged Sea-lavender			12/12/2001
*		*Limonium sinuatum*	Notch-leaf Sea-lavender			6/11/2014
*		*Limonium sp.*	Sea-lavender			27/02/2015
	LINACEAE	*Linum marginale*	Native Flax			9/10/2012
	LOGANIACEAE	*Logania linifolia*	Flax-leaf Logania			20/09/1971
		Phyllangium divergens	Wiry Mitrewort			21/09/1974
	LORANTHACEAE	*Amyema miquelii*	Box Mistletoe			10/11/2014
		Amyema miraculosa ssp. boormanii	Fleshy Mistletoe			25/10/1975
		Amyema preissii	Wire-leaf Mistletoe			10/11/2014
		Lysiana exocarpi ssp. exocarpi	Harlequin Mistletoe			10/11/2014
	LYCOPERDACEAE	*Bovista verrucosa*				20/09/2003
	LYTHRACEAE	*Ammannia multiflora*	Jerry-jerry			15/03/1997
		Lythrum hyssopifolia	Lesser Loosestrife			16/12/1976
*	MALVACEAE	*Alcea rosea*	Hollyhock			11/02/1967
		Lawrencia glomerata	Clustered Lawrencia			26/11/1974
		Lawrencia squamata	Thorny Lawrencia			10/08/2012
*		*Malva parviflora*	Small-flower Marshmallow			11/11/2014
		Malva preissiana	Australian Hollyhock			15/06/2011
		Malva weinmanniana	Australian Hollyhock			26/07/2012
	MARSILEACEAE	*Marsilea drummondii*	Common Nardoo			
*	MELIANTHACEAE	*Melianthus major*	Cape Honey-flower			21/06/1977
	MYOPORACEAE	*Eremophila crassifolia*	Thick-leaf Emubush			7/11/1989
		Eremophila deserti	Turkey-bush			10/11/2014
		Eremophila gibbifolia	Coccid Emubush		R	12/10/1995
		Eremophila glabra ssp.	Tar Bush			26/09/2012
		Eremophila glabra ssp. glabra	Tar Bush			20/11/1989
		Eremophila longifolia	Weeping Emubush			9/11/2014
		Myoporum brevipes	Warty Boobialla			1/10/1911
		Myoporum insulare	Common Boobialla			19/09/1954
		Myoporum montanum	Native Myrtle			1/01/1991
		Myoporum platycarpum (NC)	False Sandalwood			7/05/1992
		Myoporum platycarpum ssp.	False Sandalwood			1/06/2012

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Myoporum platycarpum ssp. perbellum	Mallee Sandalwood			31/01/1988
		Myoporum platycarpum ssp. platycarpum	False Sandalwood			9/11/2014
	MYRTACEAE	*Babingtonia behrii*	Silver Broombush			9/10/2012
		Baeckea crassifolia	Desert Baeckea			25/09/2012
		Callistemon rugulosus	Scarlet Bottlebrush			5/09/1990
		Callistemon sp.	Bottlebrush			3/09/2008
		Callistemon teretifolius	Needle Bottlebrush			20/11/1939
		Calytrix tetragona	Common Fringe-myrtle			1/09/1985
		Eucalyptus brachycalyx	Gilja			12/12/2001
		Eucalyptus calycogona ssp.	Square-fruit Mallee			7/08/2012
		Eucalyptus calycogona ssp. calycogona	Square-fruit Mallee			10/08/1975
		Eucalyptus calycogona ssp. trachybasis	Square-fruit Mallee			8/08/1991
		Eucalyptus camaldulensis ssp.	River Red Gum			1/11/2005
		Eucalyptus camaldulensis var. camaldulensis (NC)	River Red Gum			1/01/1991
*		*Eucalyptus campaspe*	Silver Gimlet			5/11/1996
		Eucalyptus cladocalyx (NC)	Sugar Gum			3/09/2008
		Eucalyptus cyanophylla	Blue-leaf Mallee			8/06/1925
		Eucalyptus diversifolia ssp. diversifolia	Coastal White Mallee			8/08/1965
		Eucalyptus dumosa	White Mallee			8/08/1991
*		*Eucalyptus dumosa X Eucalyptus odorata (NC)*	Hybrid Mallee			1/03/2005
		Eucalyptus fasciculosa	Pink Gum		R	7/05/1992
		Eucalyptus gracilis	Yorrell			14/08/2013
		Eucalyptus incrassata	Ridge-fruited Mallee			3/09/2008
		Eucalyptus largiflorens	River Box			26/03/1921
		Eucalyptus leptophylla	Narrow-leaf Red Mallee			1/06/2012
		Eucalyptus leptophylla (NC)	Narrow-leaf Red Mallee			3/11/2012
		Eucalyptus leucoxylon ssp.	South Australian Blue Gum			1/06/2012
		Eucalyptus leucoxylon ssp. leucoxylon	South Australian Blue Gum			10/11/2014
		Eucalyptus leucoxylon ssp. leucoxylon X Eucalyptus porosa	SA Blue Gum - Mallee Box Hybrid			3/11/2012
		Eucalyptus leucoxylon ssp. megalocarpa	Large-fruit Blue Gum		R	5/05/1992
		Eucalyptus leucoxylon ssp. pruinosa	Inland South Australian Blue Gum			26/11/1974
		Eucalyptus odorata	Peppermint Box			9/11/2014
		Eucalyptus odorata (NC)	Peppermint Box			6/06/2005
		Eucalyptus oleosa (NC)	Red Mallee			8/05/1992
		Eucalyptus oleosa ssp.				1/06/2012

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Eucalyptus oleosa ssp. oleosa	Red Mallee			11/10/1952
		Eucalyptus phenax (NC)	Sessile-fruit White Mallee			22/11/2002
		Eucalyptus phenax ssp.				1/06/2012
		Eucalyptus phenax ssp. phenax	White Mallee			6/11/2014
		Eucalyptus porosa	Mallee Box			11/11/2014
		Eucalyptus rugosa	Coastal White Mallee			1/05/1973
		Eucalyptus socialis (NC)	Beaked Red Mallee			27/10/2004
		Eucalyptus socialis ssp.	Beaked Red Mallee			1/06/2012
		Eucalyptus socialis ssp. socialis	Beaked Red Mallee			3/11/2012
		Eucalyptus socialis ssp. viridans	Beaked Red Mallee			5/09/1990
		Eucalyptus sp.				3/09/2008
		Eucalyptus yalatensis	Yalata Mallee			27/04/2006
		Kunzea pomifera	Muntries			1/09/1997
		Leptospermum coriaceum	Dune Tea-tree			9/10/2012
		Leptospermum lanigerum	Silky Tea-tree			24/10/2012
		Leptospermum myrsinoides	Heath Tea-tree			9/10/1953
		Melaleuca acuminata ssp. acuminata	Mallee Honey-myrtle			3/11/2012
		Melaleuca brevifolia	Short-leaf Honey-myrtle			1/05/1976
		Melaleuca halmaturorum	Swamp Paper-bark			1/11/2005
		Melaleuca lanceolata	Dryland Tea-tree			9/11/2014
		Melaleuca lanceolata ssp. lanceolata (NC)	Dryland Tea-tree			22/11/2002
		Melaleuca uncinata	Broombush			3/11/2012
		Melaleuca uncinata (NC)	Broombush			22/11/2002
*	OLEACEAE	*Olea europaea ssp. europaea*	Olive			23/05/2014
	ONAGRACEAE	*Epilobium pallidiflorum*	Showy Willow-herb			11/11/2003
*		*Ludwigia peploides ssp. montevidensis*	Water Primrose			1/11/2005
*		*Oenothera stricta ssp. stricta*	Common Evening Primrose			17/12/1998
	OPHIOGLOSSACEAE	*Ophioglossum lusitanicum*	Austral Adder's-tongue			1/07/1999
	ORCHIDACEAE	*Acianthus pusillus*	Mosquito Orchid			15/06/2010
		Caladenia capillata	Wispy Spider-orchid			4/09/1974
		Caladenia cardiochila	Heart-lip Spider-orchid			15/09/1956
		Caladenia colorata	Coloured Spider-orchid	EN	E	1/09/1942
		Caladenia concolor	Crimson Spider-orchid	VU	E*	1/09/1942
		Caladenia fuscata	Dusky Caladenia			16/09/1974
		Caladenia sp.	Spider-orchid			1/07/1999
		Caladenia sp. Monarto South (H.Goldsack 163 AD97708605A)			E	26/09/1936
		Caladenia stellata	Star Spider-orchid		R	0/01/1900

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Caladenia stricta	Upright Caladenia			2/10/1974
		Caladenia tensa	Inland Green-comb Spider-orchid	EN		1/10/1992
		Caladenia verrucosa	Yellow-club Spider-orchid			21/09/1974
		Cyrtostylis robusta	Robust Gnat-orchid			1/07/1999
		Diuris behrii	Behr's Cowslip Orchid		V	1/09/1978
		Eriochilus cucullatus	Parson's Bands			14/04/1969
		Genoplesium nigricans	Black Midge-orchid			8/05/1992
		Microtis frutetorum				1/10/1992
		Microtis sp.	Onion-orchid			1/07/1999
		Microtis unifolia				5/05/1992
		Microtis unifolia (NC)	Common Onion-orchid			6/05/1992
		Pheladenia deformis	Bluebeard Orchid			30/07/1974
		Prasophyllum occidentale	Plains Leek-orchid			20/09/1977
		Prasophyllum odoratum	Scented Leek-orchid			1/10/1993
		Pterostylis biseta	Two-bristle Greenhood			10/11/2010
		Pterostylis biseta (NC)	Two-bristle Greenhood			26/10/2004
		Pterostylis cycnocephala	Swan-head Greenhood			1/07/1999
		Pterostylis cycnocephala/mutica	Greenhood			5/05/1992
		Pterostylis dolichochila	Mallee Shell-orchid			29/07/1996
		Pterostylis mutica	Midget Greenhood			15/09/1956
		Pterostylis nana	Dwarf Greenhood			30/07/1974
		Pterostylis pusilla	Small Rusty-hood			17/10/1927
		Pterostylis robusta	Large Shell-orchid			15/06/2010
		Pterostylis sp.	Greenhood			1/09/1997
		Pyrorchis nigricans	Black Fire-orchid			29/08/1964
		Thelymitra alcockiae	Scented Sun-orchid			30/09/1974
		Thelymitra antennifera	Lemon Sun-orchid			4/10/1958
		Thelymitra azurea	Azure Sun-orchid			1/11/1956
		Thelymitra epipactoides	Metallic Sun-orchid	EN	E	21/09/1912
		Thelymitra luteocilium	Yellow-tuft Sun Orchid			23/09/1922
		Thelymitra megcalyptra	Scented Sun-orchid			26/09/1936
		Thelymitra nuda				21/09/1974
		Thelymitra sp.	Sun-orchid			1/07/1999
*	OXALIDACEAE	*Oxalis corniculata ssp. corniculata*	Creeping Wood-sorrel			16/09/1991
*		*Oxalis flava*	Finger-leaf Oxalis			28/04/1977
*		*Oxalis hirta*	Hairy Wood-sorrel			28/04/1977
		Oxalis perennans	Native Sorrel			8/10/2012
		Oxalis perennans (NC)	Native Sorrel			26/10/2004
*		*Oxalis pes-caprae*	Soursob			9/11/2014
*		*Oxalis purpurea*	One-o'clock			28/04/1977
		Oxalis radicosa	Downy Native Sorrel			9/11/2014
*	PAPAVERACEAE	*Fumaria bastardii*	Bastard Fumitory			1/11/2005
*		*Fumaria capreolata*	White-flower Fumitory			15/06/2011

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
*		*Glaucium corniculatum*	Bristly Horned-poppy			17/09/1992
*		*Papaver aculeatum*	Bristle Poppy			10/10/1925
*		*Papaver hybridum*	Rough Poppy			29/09/1976
*		*Papaver rhoeas*	Field Poppy			10/10/1925
	PARMELIACEAE	*Flavoparmelia rutidota*				27/01/1975
		Parmelia sp.				28/03/1975
		Xanthoparmelia conspersa				27/01/1975
	PHYSCIACEAE	*Physcia sp.*				7/02/1980
*	PINACEAE	*Pinus halepensis*	Aleppo Pine			3/09/2008
	PITTOSPORACEAE	*Billardiera cymosa (NC)*	Sweet Apple-berry			18/05/1992
		Billardiera cymosa ssp. cymosa	Sweet Apple-berry			3/11/2012
		Billardiera sp.	Apple-berry			1/09/1997
		Billardiera versicolor	Yellow-flower Apple-berry			1/06/2012
		Bursaria spinosa ssp.	Bursaria			1/06/2012
		Bursaria spinosa ssp. lasiophylla	Downy Bursaria			10/11/2014
		Bursaria spinosa ssp. spinosa	Sweet Bursaria			26/10/2004
		Cheiranthera alternifolia	Hand-flower			18/10/1955
		Marianthus bignoniaceus	Orange Bell-climber			29/12/1971
		Pittosporum angustifolium	Native Apricot			10/11/2014
*	PLANTAGINACEAE	*Plantago bellardii*	Hairy Plantain			10/11/2014
*		*Plantago coronopus ssp.*	Bucks-horn Plantain			1/11/2005
*		*Plantago coronopus ssp. commutata*	Bucks-horn Plantain			27/10/1976
*		*Plantago coronopus ssp. coronopus*	Bucks-horn Plantain			15/06/2011
		Plantago gaudichaudii	Narrow-leaf Plantain			12/09/1927
		Plantago hispida	Hairy Plantain			16/10/1930
*		*Plantago lanceolata var.*	Ribwort			1/11/2005
*		*Plantago lanceolata var. lanceolata*	Ribwort			5/11/2014
		Plantago turrifera	Crowned Plantain			1/11/2005
	POLYGALACEAE	*Comesperma calymega*	Blue-spike Milkwort			1/11/1972
		Comesperma volubile	Love Creeper			25/09/2012
*	POLYGONACEAE	*Acetosa vesicaria*	Rosy Dock			1/01/1939
*		*Acetosella vulgaris*	Sorrel			21/06/1977
		Duma florulenta	Lignum			1/11/2005
*		*Emex australis*	Three-corner Jack			20/01/1976
		Muehlenbeckia adpressa	Climbing Lignum			5/09/1990
		Persicaria decipiens	Slender Knotweed			14/02/1955
		Persicaria decipiens (NC)	Slender Knotweed			11/11/2003
		Persicaria lapathifolia	Pale Knotweed			1/11/2005
		Persicaria prostrata	Creeping Knotweed			1/01/1913
*		*Polygonum aviculare*	Wireweed			6/06/2005
		Rumex bidens	Mud Dock			1/11/2005

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Rumex brownii	Slender Dock			2/10/1974
*		*Rumex conglomeratus*	Clustered Dock			11/11/2003
*		*Rumex crispus*	Curled Dock			18/02/1916
		Rumex tenax	Shiny Dock			28/09/1976
	PORTULACACEAE	*Calandrinia calyptrata*	Pink Purslane			9/09/1983
		Calandrinia eremaea	Dryland Purslane			19/10/2004
		Calandrinia sp.	Purslane/Parakeelya			1/07/1999
		Calandrinia volubilis	Twining Purslane			
		Montia australasica	White Purslane		R	0/01/1900
	POTAMOGETONACEAE	*Potamogeton crispus*	Curly Pondweed			1/11/2005
		Potamogeton ochreatus	Blunt Pondweed		R	0/01/1900
		Ruppia megacarpa	Widgeon Grass			1/11/2005
	POTTIACEAE	*Microbryum starckeanum*				10/07/1963
		Tetrapterum cylindricum				3/10/1987
*	PRIMULACEAE	*Anagallis arvensis*	Pimpernel			2/10/1974
*		*Asterolinon linum-stellatum*	Asterolinon			1/10/1926
	PROTEACEAE	*Adenanthos terminalis*	Yellow Gland-flower			12/09/1968
		Banksia ornata	Desert Banksia			14/01/1977
		Conospermum patens	Slender Smoke-bush			29/07/1984
		Grevillea huegelii	Comb Grevillea			1/12/1922
		Grevillea ilicifolia ssp. ilicifolia	Holly-leaf Grevillea			9/07/1984
		Grevillea lavandulacea ssp. lavandulacea	Spider-flower			24/05/1975
		Grevillea lavandulacea var. (NC)	Spider-flower			1/09/1997
		Hakea leucoptera ssp. leucoptera	Silver Needlewood			1/09/1997
		Hakea mitchellii	Heath Needlebush			1/09/1997
		Hakea rugosa	Dwarf Hakea			1/09/1946
		Isopogon ceratophyllus	Horny Cone-bush			1/09/1997
	PSORACEAE	*Psora crenata*				27/01/1975
	RAMALINACEAE	*Ramalina celastri ssp. ovalis*				19/04/1975
		Ramalina inflata				27/01/1975
		Ramalina inflata ssp. australis				27/01/1975
	RANUNCULACEAE	*Clematis microphylla*	Old Man's Beard			9/11/2014
		Clematis microphylla var. microphylla (NC)	Old Man's Beard			2/11/2004
		Ranunculus amphitrichus	Small River Buttercup			11/11/2003
		Ranunculus pachycarpus	Thick-fruit Buttercup			18/09/1972
*		*Ranunculus trilobus*	Three-lobed Buttercup			16/10/1910
*	RESEDACEAE	*Reseda lutea*	Cut-leaf Mignonette			17/03/1976
	RESTIONACEAE	*Hypolaena fastigiata*	Tassel Rope-rush			1/09/1997
	RHAMNACEAE	*Cryptandra amara (NC)*				18/05/1992
		Cryptandra amara var. (NC)	Cryptandra			4/11/2004
		Cryptandra amara var. amara (NC)	Spiny Cryptandra			8/05/1992

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Cryptandra sp. Floriferous (W.R.Barker 4131)	Pretty Cryptandra			28/08/1985
		Cryptandra tomentosa	Heath Cryptandra			24/07/1999
		Cryptandra tomentosa (NC)	Heath Cryptandra			24/07/1999
		Pomaderris obcordata	Wedge-leaf Pomaderris			11/09/1971
		Pomaderris paniculosa ssp.				1/06/2012
		Pomaderris paniculosa ssp. paniculosa	Mallee Pomaderris			18/12/2003
		Pomaderris paniculosa ssp. paralia	Coast Pomaderris			20/11/1964
		Spyridium eriocephalum var.	Heath Spyridium			10/10/2012
		Spyridium eriocephalum var. eriocephalum	Heath Spyridium			18/07/1985
		Spyridium parvifolium	Dusty Miller			29/08/1919
		Spyridium sp.	Spyridium			4/11/2004
		Spyridium subochreatum	Velvet Spyridium			19/08/1971
		Stenanthemum leucophractum	White Cryptandra			1/06/2012
	ROSACEAE	*Acaena echinata*	Sheep's Burr			22/10/1975
		Acaena novae-zelandiae	Biddy-biddy			8/04/1980
*		*Rosa rubiginosa*	Sweet Briar			14/04/1977
*		*Rubus ulmifolius var. anoplothyrsus*	Thornless Blackberry			16/03/1977
*		*Sanguisorba minor ssp. muricata*	Sheep's Burnet			25/01/1977
	RUBIACEAE	*Asperula conferta*	Common Woodruff			10/10/1925
		Asperula gemella	Twin-leaf Bedstraw			1/11/2005
		Galium compactum	Compact Bedstraw			26/11/1974
*		*Galium divaricatum*	Slender Bedstraw			5/11/1924
		Galium gaudichaudii (NC)	Rough Bedstraw			6/05/1992
		Opercularia turpis	Twiggy Stinkweed			1/07/1999
	RUTACEAE	*Boronia coerulescens ssp. coerulescens*	Blue Boronia			1/09/1997
		Boronia inornata ssp. leptophylla	Dryland Boronia			8/08/1991
		Correa glabra (NC)	Rock Correa			1/07/1999
		Correa glabra var.				22/08/2012
		Correa glabra var. turnbullii	Smooth Correa			5/09/1986
		Correa reflexa (NC)	Common Correa			1/09/1997
		Microcybe pauciflora ssp. pauciflora	Yellow Microcybe			7/11/1989
		Phebalium bullatum	Silvery Phebalium			1/09/1997
		Philotheca angustifolia ssp. angustifolia	Narrow-leaf Wax-flower		R	
		Philotheca pungens	Prickly Wax-flower			28/08/1919
		Zieria veronicea ssp. veronicea	Pink Zieria		R	1/10/1964
*	SALICACEAE	*Salix babylonica*	Weeping Willow			1/11/2005
*		*Salix sp.*	Willow			1/11/2005

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
	SANTALACEAE	*Exocarpos sparteus*	Slender Cherry			24/09/2012
		Leptomeria aphylla	Leafless Current-bush			8/05/1992
		Santalum acuminatum	Quandong			9/11/2014
		Santalum murrayanum	Bitter Quandong			10/04/1939
	SAPINDACEAE	*Dodonaea baueri*	Crinkled Hop-bush			9/10/2012
		Dodonaea bursariifolia	Small Hop-bush			21/03/1978
		Dodonaea hexandra	Horned Hop-bush			23/06/2012
		Dodonaea humilis	Dwarf Hop-bush			2/07/1975
		Dodonaea lobulata	Lobed-leaf Hop-bush			1/09/1954
		Dodonaea stenozyga	Desert Hop-bush			8/05/1992
		Dodonaea tepperi	Streaked Hop-bush			20/11/1989
		Dodonaea viscosa ssp.	Sticky Hop-bush			27/02/2015
		Dodonaea viscosa ssp. angustissima	Narrow-leaf Hop-bush			3/09/2008
		Dodonaea viscosa ssp. cuneata	Wedge-leaf Hop-bush			3/11/2012
		Dodonaea viscosa ssp. mucronata	Northern Hop-bush			27/08/2012
		Dodonaea viscosa ssp. spatulata	Sticky Hop-bush			9/11/2014
	SCROPHULARIACEAE	*Gratiola peruviana*	Austral Brooklime			1/01/1991
*		*Kickxia elatine ssp. crinita*	Twining Toadflax			16/12/1976
*		*Kickxia elatine ssp. elatine*	Woolly Toadflax			6/11/2014
*		*Parentucellia latifolia*	Red Bartsia			5/05/1992
		Stemodia florulenta	Bluerod			6/04/1982
		Thyridia repens	Creeping Monkey-flower			1/11/2005
		Veronica hillebrandii	Rigid Speedwell			17/10/1974
*		*Zaluzianskya divaricata*	Spreading Night-phlox			1/07/1999
*	SOLANACEAE	*Hyoscyamus niger*	Henbane			1/01/1927
		Lycium australe	Australian Boxthorn			12/05/1977
*		*Lycium ferocissimum*	African Boxthorn			11/11/2014
*		*Nicotiana glauca*	Tree Tobacco			1/11/2005
		Nicotiana goodspeedii	Small-flower Tobacco			26/07/2012
		Nicotiana maritima	Coast Tobacco			3/11/2012
		Nicotiana velutina	Velvet Tobacco			
*		*Solanum elaeagnifolium*	Silver-leaf Nightshade			15/04/2015
		Solanum esuriale	Quena			9/12/1964
		Solanum laciniatum	Cut-leaf Kangaroo-apple			11/09/2012
*		*Solanum linnaeanum*	Apple Of Sodom			14/04/1977
*		*Solanum nigrum*	Black Nightshade			3/11/2012
*		*Solanum rostratum*	Buffalo Burr			1/02/1921
		Solanum simile	Kangaroo Apple			14/01/1977
*		*Solanum triflorum*	Three-flower Nightshade			13/12/2010
	STACKHOUSIACEAE	*Stackhousia aspericocca ssp.*	Bushy Candles			24/09/2012

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Stackhousia monogyna (NC)	Creamy Candles			9/11/2014
		Stackhousia subterranea	Creamy Candles			20/09/1977
	STERCULIACEAE	*Lasiopetalum baueri*	Slender Velvet-bush			4/11/2004
		Lasiopetalum behrii	Pink Velvet-bush			1/06/2012
		Thomasia petalocalyx	Paper-flower			1/10/1953
	STYLIDIACEAE	*Levenhookia dubia*	Hairy Stylewort			2/10/1974
*	TAMARICACEAE	*Tamarix aphylla*	Athel Pine			3/09/2008
	TELOSCHISTACEAE	*Teloschistes chrysophthalmus*				23/10/1979
		Teloschistes sieberianus				9/07/1977
		Xanthoria ligulata				19/04/1975
		Xanthoria parietina				4/12/1975
	THYMELAEACEAE	*Pimelea flava ssp.*	Diosma Riceflower			23/09/2012
		Pimelea flava ssp. dichotoma	Diosma Riceflower			3/11/2012
		Pimelea glauca	Smooth Riceflower			8/05/1992
		Pimelea micrantha	Silky Riceflower			3/11/2012
		Pimelea octophylla	Woolly Riceflower			24/10/1930
		Pimelea serpyllifolia ssp. serpyllifolia	Thyme Riceflower			5/09/2012
		Pimelea stricta	Erect Riceflower			10/11/2014
*		*Thymelaea passerina*	Thymelaea			12/03/1981
	TYPHACEAE	*Typha domingensis*	Narrow-leaf Bulrush			31/12/1972
		Typha orientalis	Broad-leaf Bulrush			11/11/2003
		Typha sp.	Bulrush			1/11/2005
*	UMBELLIFERAE	*Apium graveolens*	Celery			1/11/2005
*		*Berula erecta*	Water Parsnip			11/11/2003
*		*Bupleurum semicompositum*	Hare's Ear			7/05/1992
		Centella asiatica	Asian Centella			11/11/2003
*		*Coriandrum sativum*	Coriander			25/10/1989
		Daucus glochidiatus	Native Carrot			9/11/2014
*		*Foeniculum vulgare*	Fennel			6/06/2005
		Hydrocotyle callicarpa	Tiny Pennywort			24/10/1930
		Hydrocotyle capillaris	Thread Pennywort			23/09/1922
		Hydrocotyle pilifera var. glabrata	Buttercup Pennywort			1/07/1999
		Hydrocotyle rugulosa	Mallee Pennywort			9/09/1983
		Hydrocotyle verticillata	Shield Pennywort			1/11/2005
		Trachymene cyanopetala	Purple Trachymene			24/10/1930
		Trachymene pilosa	Dwarf Trachymene			2/10/1974
	URTICACEAE	*Parietaria debilis*	Smooth-nettle			1/10/1974
		Urtica incisa	Scrub Nettle			24/09/2014
*		*Urtica urens*	Small Nettle			26/07/2012
	USNEACEAE	*Usnea scabrida*				27/01/1975
*	VERBENACEAE	*Phyla canescens*	Lippia			31/12/1972
	VIOLACEAE	*Hybanthus floribundus ssp. floribundus*	Shrub Violet			1/09/1997

*	Family name	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
	ZANNICHELLIACEAE	*Lepilaena patentifolia*	Spreading Water-mat			0/01/1900
*	ZYGOPHYLLACEAE	*Tribulus terrestris*	Caltrop			11/01/1977
		Zygophyllum apiculatum	Pointed Twinleaf			26/03/1921
		Zygophyllum aurantiacum ssp. aurantiacum	Shrubby Twinleaf			5/10/1906
		Zygophyllum crenatum	Notched Twinleaf			26/08/1978
		Zygophyllum glaucum	Pale Twinleaf			28/08/1983

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. *: Introduced.

Appendix 2. Fauna species recorded in the BDBSA within 10 km of the Project area (DEW 2017).

*	Class	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
	ACTINOPTERI	*Atherinosoma microstoma*	Smallmouth Hardyhead			11/11/2011
*		*Carassius auratus*	Goldfish			11/11/2011
		Craterocephalus fluviatilis	Murray Hardyhead	EN		9/10/2015
		Craterocephalus fulvus	Unspecked Hardyhead			18/02/2016
		Craterocephalus stercusmuscarum (NC)	Fly-specked Hardyhead			10/11/2010
*		*Cyprinus carpio*	European Carp			18/02/2016
		Galaxias maculatus	Common Galaxias			18/02/2016
*		*Gambusia holbrooki*	Eastern Gambusia			23/04/2013
		Hypseleotris sp.				10/11/2010
		Hypseleotris spp. (complex)	N/A			18/02/2016
		Macquaria ambigua ambigua	Murray-Darling Golden Perch			9/10/2015
		Melanotaenia fluviatilis	Crimson-spotted Rainbow Fish			18/02/2016
		Nematalosa erebi	Bony Bream			18/02/2016
*		*Perca fluviatilis*	Redfin Perch			21/04/2012
		Philypnodon grandiceps	Big-headed Gudgeon			23/04/2013
		Philypnodon macrostomus	Dwarf Flathead Gudgeon			18/02/2016
		Philypnodon sp.				10/11/2010
		Pseudaphritis urvillii	Congolli			9/10/2015
		Pseudogobius olorum	Swan River Goby			10/11/2008
		Retropinna semoni	Australian Smelt			9/10/2015
		Tandanus tandanus	Freshwater Catfish			29/07/2015
		Tasmanogobius lasti	Lagoon Goby			10/11/2008
	AMPHIBIA	*Crinia parinsignifera*	Murray Valley Froglet			25/07/1989
		Crinia signifera	Common Froglet			17/09/2015
		Limnodynastes dumerilii	Banjo Frog			17/09/2015
		Limnodynastes fletcheri	Long-thumbed Frog			2/04/2015
		Limnodynastes tasmaniensis	Spotted Marsh Frog			25/10/2016
		Litoria ewingii	Brown Tree Frog			17/09/2015
		Litoria peronii	Peron's Tree Frog			26/11/2013
		Litoria raniformis	Southern Bell Frog	VU	V	10/09/2005
		Neobatrachus pictus	Burrowing Frog			15/10/2012
	AVES	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater			25/10/2016
		Acanthiza apicalis	Inland Thornbill			29/11/1991
		Acanthiza chrysorrhoa	Yellow-rumped Thornbill			25/10/2016
		Acanthiza lineata clelandi clelandi	Striated Thornbill (MLR, SE)			6/05/2002
		Acanthiza nana	Yellow Thornbill			10/11/2014
		Acanthiza reguloides	Buff-rumped Thornbill			15/04/2014
		Acanthiza uropygialis	Chestnut-rumped Thornbill			10/11/2014
		Acanthorhynchus tenuirostris	Eastern Spinebill			19/08/2005
		Accipiter cirrocephalus	Collared Sparrowhawk			12/01/2003
		Accipiter fasciatus	Brown Goshawk			1/06/2016

*	Class	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Acrocephalus australis	Australian Reed Warbler			9/10/2015
		Acrocephalus stentoreus	Clamorous Reedwarbler			28/10/2005
		Actitis hypoleucos	Common Sandpiper		R	28/10/2005
		Aegotheles cristatus	Australian Owlet-nightjar			22/10/2012
*		*Alauda arvensis*	Eurasian Skylark			7/10/2000
		Amytornis striatus	Striated Grasswren		R	23/08/1980
		Anas castanea	Chestnut Teal			30/05/2015
		Anas gracilis	Grey Teal			31/05/2015
*		*Anas platyrhynchos*	Mallard (Northern Mallard)			6/06/2005
		Anas rhynchotis rhynchotis	Australasian Shoveler		R	31/05/2015
		Anas superciliosa	Pacific Black Duck			9/10/2015
		Anas superciliosa x anas platyrhynchos	Pacific Black Duck/Mallard Hybrid			12/10/1987
		Anhinga novaehollandiae	Australasian Darter		R	9/10/2015
		Anthochaera carunculata	Red Wattlebird			9/10/2015
		Anthus australis	Australian Pipit			6/11/2014
		Aphelocephala leucopsis	Southern Whiteface			25/10/2016
		Apus pacificus	Pacific Swift (Fork-tailed Swift)			22/02/2000
		Aquila audax	Wedge-tailed Eagle			6/11/2014
		Ardea alba	Great Egret			9/10/2015
		Ardea ibis	Cattle Egret		R	21/06/2004
		Ardea intermedia	Intermediate Egret		R	11/12/2002
		Ardea pacifica	White-necked Heron			24/09/2015
		Ardeotis australis	Australian Bustard		V	16/08/2004
		Artamus cinereus	Black-faced Woodswallow			1/06/2016
		Artamus cyanopterus	Dusky Woodswallow			25/10/2016
		Artamus personatus	Masked Woodswallow			14/12/2013
		Artamus superciliosus	White-browed Woodswallow			10/11/2014
		Aythya australis	Hardhead			30/01/2005
		Barnardius zonarius	Australian Ringneck			25/10/2016
		Biziura lobata	Musk Duck		R	7/03/1987
		Burhinus grallarius	Bush Stonecurlew		R	1/11/2013
		Cacatua sanguinea	Little Corella			31/05/2015
		Cacatua sp.				23/07/2002
		Cacomantis flabelliformis	Fan-tailed Cuckoo			1/07/2000
		Cacomantis pallidus	Pallid Cuckoo			22/10/2012
		Calamanthus (Hylacola) cautus	Shy Heathwren		R	3/07/2000
		Calidris acuminata	Sharp-tailed Sandpiper			24/10/1999
		Calidris ruficollis	Red-necked Stint			30/12/2002
		Caligavis chrysops	Yellow-faced Honeyeater			25/06/2000
*		*Carduelis carduelis*	European Goldfinch			22/10/2012
		Chalcites basalis	Horsfield's Bronze Cuckoo			28/10/2012
		Chalcites lucidus	Shining Bronze Cuckoo			15/03/1987
		Chalcites osculans	Black-eared Cuckoo			31/10/2012
		Charadrius ruficapillus	Red-capped Plover			26/03/2000

*	Class	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Chenonetta jubata	Maned Duck			19/01/2004
		Chlidonias hybrida	Whiskered Tern			9/10/2015
*		*Chloris chloris*	European (Common) Greenfinch			21/11/2005
		Chroicocephalus novaehollandiae	Silver Gull			9/10/2015
		Cincloramphus cruralis	Brown Songlark			6/06/2005
		Cincloramphus mathewsi	Rufous Songlark			25/10/2016
		Circus approximans	Swamp Harrier			21/10/2005
		Circus assimilis	Spotted Harrier			22/10/2012
		Cisticola exilis exilis exilis	Golden-headed Cisticola			30/08/2004
		Climacteris picumnus	Brown Treecreeper			25/10/2016
		Colluricincla harmonica	Grey Shrikethrush			25/10/2016
*		*Columba livia*	Feral Pigeon [Rock Dove]			23/06/2005
		Coracina novaehollandiae	Black-faced Cuckooshrike			15/04/2014
		Corcorax melanorhamphos	White-winged Chough		R	25/10/2016
		Corvus bennetti	Little Crow			25/11/1922
		Corvus coronoides	Australian Raven			1/06/2016
		Corvus mellori	Little Raven			25/10/2016
		Corvus sp.				28/11/2004
		Coturnix pectoralis	Stubble Quail			21/06/2001
		Cracticus torquatus	Grey Butcherbird			28/10/2012
		Cygnus atratus	Black Swan			9/10/2015
		Dacelo novaeguineae	Laughing Kookaburra			30/08/2015
		Daphoenositta chrysoptera	Varied Sittella			5/11/2014
		Dicaeum hirundinaceum	Mistletoebird			10/11/2014
		Dromaius novaehollandiae	Emu			20/06/2001
		Drymodes brunneopygia	Southern Scrub Robin			1/03/2005
		Egretta garzetta	Little Egret		R	26/02/2001
		Egretta novaehollandiae	White-faced Heron			9/10/2015
		Elanus axillaris	Black-shouldered Kite			6/06/2005
		Elseyornis melanops	Black-fronted Dotterel			23/06/2005
		Eolophus roseicapilla	Galah			25/10/2016
		Eopsaltria australis	Eastern Yellow Robin			16/01/1994
		Epthianura albifrons	White-fronted Chat			25/10/2016
		Erythrogonys cinctus	Red-kneed Dotterel			26/12/2005
		Eurostopodus argus	Spotted Nightjar			1/06/2005
		Falco berigora	Brown Falcon			25/10/2016
		Falco cenchroides	Nankeen Kestrel			30/08/2015
		Falco longipennis	Australian Hobby			28/10/2012
		Falco peregrinus	Peregrine Falcon		R	18/04/2005
		Falco subniger	Black Falcon			25/10/2012
		Falcunculus frontatus frontatus frontatus	Eastern Shriketit		R	1/07/2000
		Fulica atra	Eurasian Coot			9/10/2015
		Gallinago hardwickii	Latham's Snipe		R	12/12/1976
		Gallinula tenebrosa	Dusky Moorhen			31/05/2015

*	Class	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Gavicalis virescens	Singing Honeyeater			25/10/2016
		Geopelia placida	Peaceful Dove			12/10/2016
		Gliciphila melanops	Tawny-crowned Honeyeater			3/07/2000
		Glossopsitta concinna	Musk Lorikeet			15/04/2014
		Grallina cyanoleuca	Magpielark			9/10/2015
		Gymnorhina tibicen	Australian Magpie			25/10/2016
		Haliastur sphenurus	Whistling Kite			9/10/2015
		Hieraaetus morphnoides	Little Eagle			1/06/2016
		Himantopus leucocephalus	White-headed Stilt			31/05/2015
		Hirundo neoxena	Welcome Swallow			1/06/2016
		Hydroprogne caspia	Caspian Tern			31/05/2015
		Lalage tricolor	White-winged Triller			25/10/2012
		Leipoa ocellata	Malleefowl	VU	V	20/12/2009
		Lewinia pectoralis	Lewin's Rail		V	28/10/2005
		Lichenostomus cratitius	Purple-gaped Honeyeater		R	5/10/1985
		Lichenostomus cratitius occidentalis occidentalis	Purple-gaped Honeyeater (mainland SA)		R	24/11/1991
		Malacorhynchus membranaceus	Pink-eared Duck			21/11/2004
		Malurus cyaneus	Superb Fairywren			25/10/2016
		Malurus lamberti	Variegated Fairywren			10/11/2014
		Manorina flavigula	Yellow-throated Miner			25/10/2016
		Manorina melanocephala	Noisy Miner			31/05/2015
		Megalurus gramineus	Little Grassbird			31/05/2015
		Melanodryas cucullata	Hooded Robin		R	25/10/2016
		Melanodryas cucullata cucullata cucullata	Hooded Robin (SE, MM, MLR, AP, YP, MN)		R	10/11/2014
		Melithreptus brevirostris	Brown-headed Honeyeater			10/11/2014
		Melithreptus gularis	Black-chinned Honeyeater		V	4/08/2008
		Melithreptus lunatus	White-naped Honeyeater			9/10/2015
		Melopsittacus undulatus	Budgerigar			22/10/2012
		Merops ornatus	Rainbow Bee-eater			25/10/2016
		Microcarbo melanoleucos	Little Pied Cormorant			9/10/2015
		Microeca fascinans	Jacky Winter			25/10/2016
		Microeca fascinans fascinans fascinans	Jacky Winter (SE, MLR)		R	5/11/2014
		Milvus migrans	Black Kite			25/10/2016
		Mirafra javanica	Horsfield's Bush Lark			1/12/1985
		Myiagra inquieta	Restless Flycatcher		R	15/04/2014
		Neophema elegans	Elegant Parrot		R	28/10/2012
		Neophema sp.				5/11/2014
		Nesoptilotis leucotis	White-eared Honeyeater			28/11/1991
		Ninox boobook	Southern Boobook			6/02/2015
		Northiella haematogaster	Bluebonnet			6/10/2002
		Northiella haematogaster haematogaster (NC)	Yellow-vented Bluebonnet			19/06/1996
*		*Numida meleagris*	Helmeted Guineafowl			31/05/2015

*	Class	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Nycticorax caledonicus	Nankeen Night Heron			15/04/2002
		Nymphicus hollandicus	Cockatiel			22/10/2012
		Ocyphaps lophotes	Crested Pigeon			25/10/2016
		Oreoica gutturalis	Crested Bellbird			12/10/2001
		Oxyura australis	Blue-billed Duck		R	1/01/1900
		Pachycephala inornata	Gilbert's Whistler		R	19/06/2003
		Pachycephala pectoralis	Australian Golden Whistler (Golden Whistler)			14/12/2013
		Pachycephala rufiventris	Rufous Whistler			25/10/2016
		Pardalotus punctatus	Spotted Pardalote			29/06/2015
		Pardalotus striatus	Striated Pardalote			25/10/2016
		Parvipsitta porphyrocephala	Purple-crowned Lorikeet			10/11/2014
*		*Passer domesticus*	House Sparrow			25/10/2016
		Pelecanus conspicillatus	Australian Pelican			9/10/2015
		Petrochelidon ariel	Fairy Martin			2/05/2005
		Petrochelidon nigricans	Tree Martin			25/10/2016
		Petroica boodang boodang boodang	Scarlet Robin		R	23/05/1983
		Petroica goodenovii	Red-capped Robin			10/11/2014
		Petroica phoenicea	Flame Robin		V	9/05/1999
		Petroica rosea	Rose Robin			6/08/2000
		Phalacrocorax carbo	Great Cormorant			9/10/2015
		Phalacrocorax sulcirostris	Little Black Cormorant			9/10/2015
		Phalacrocorax varius	[Australian] Pied Cormorant			13/09/2015
		Phaps chalcoptera	Common Bronzewing			25/10/2016
		Phylidonyris novaehollandiae	New Holland Honeyeater			9/10/2015
		Platalea flavipes	Yellow-billed Spoonbill			9/10/2015
		Platalea regia	Royal Spoonbill			10/03/2005
		Platycercus elegans	Crimson Rosella			25/10/2016
		Platycercus eximius	Eastern Rosella			12/03/2000
		Plectorhyncha lanceolata	Striped Honeyeater		R	19/07/2003
		Podargus strigoides	Tawny Frogmouth			27/08/2005
		Podiceps cristatus	Great Crested Grebe		R	28/11/2004
		Poliocephalus poliocephalus	Hoary-headed Grebe			8/12/2003
		Pomatostomus superciliosus	White-browed Babbler			25/10/2016
		Porphyrio porphyrio	Purple Swamphen			9/10/2015
		Porzana fluminea	Australian Crake (Australian Spotted Crake)			10/12/2001
		Porzana tabuensis	Spotless Crake		R	28/10/2005
		Psephotellus varius	Mulga Parrot			26/11/1991
		Psephotus haematonotus	Red-rumped Parrot			25/10/2016
		Pterodroma lessonii	White-headed Petrel			18/02/1988
		Ptilotula ornata	Yellow-plumed Honeyeater			15/04/2014
		Ptilotula penicillata	White-plumed Honeyeater			25/10/2016
		Purnella albifrons	White-fronted Honeyeater			21/11/2002

*	Class	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
*		*Pycnonotus jocosus*	Red-whiskered Bulbul			1/07/1983
		Recurvirostra novaehollandiae	Red-necked Avocet			31/05/2015
		Rhipidura albiscapa	Grey Fantail			15/04/2014
		Rhipidura leucophrys	Willie Wagtail			25/10/2016
		Smicrornis brevirostris	Weebill			25/10/2016
*		*Spilopelia chinensis*	Spotted Dove			9/10/2015
		Stagonopleura guttata	Diamond Firetail		V	25/10/2016
		Sternula albifrons	Little Tern		E	12/07/2003
		Sternula nereis	Fairy Tern	VU	E	9/05/1997
		Strepera versicolor	Grey Currawong			31/05/2016
		Strepera versicolor melanoptera melanoptera	Black-winged Currawong (SE, MLR, MM)			6/11/2014
*		*Sturnus vulgaris*	Common Starling			25/10/2016
		Sugomel niger	Black Honeyeater			18/11/1995
		Tachybaptus novaehollandiae	Australasian Grebe			9/10/2015
		Tadorna tadornoides	Australian Shelduck			2/08/2004
		Taeniopygia guttata	Zebra Finch			14/04/2003
		Thalasseus bergii	Greater Crested Tern			26/08/2004
		Threskiornis moluccus	Australian White Ibis			9/10/2015
		Threskiornis spinicollis	Straw-necked Ibis			9/10/2015
		Todiramphus pyrrhopygius	Red-backed Kingfisher			24/10/1988
		Todiramphus sanctus	Sacred Kingfisher			18/04/2015
		Tribonyx ventralis	Black-tailed Nativehen			31/05/2015
		Trichoglossus haematodus	Rainbow Lorikeet			27/10/2012
		Tringa glareola	Wood Sandpiper		R	1/12/1998
		Tringa nebularia	Common Greenshank			22/03/2004
		Tringa stagnatilis	Marsh Sandpiper			11/12/2002
*		*Turdus merula*	Common Blackbird			9/10/2015
		Turnix pyrrhothorax	Red-chested Buttonquail		R	5/01/1975
		Turnix velox	Little Buttonquail			5/09/2001
		Tyto delicatula	Eastern Barn Owl			6/10/2002
		Vanellus miles	Masked Lapwing			30/08/2015
		Vanellus tricolor	Banded Lapwing			8/03/1985
		Zosterops lateralis	Silvereye			31/05/2015
	MAMMALIA	*Austronomus australis*	White-striped Free-tailed Bat			23/11/2004
*		*Bos taurus*	Cattle (European Cattle)			1/10/2002
		Cercartetus concinnus	Western Pygmy-possum			14/10/2012
		Chalinolobus morio	Chocolate Wattled Bat			23/11/2004
*		*Equus caballus*	Horse (Brumby)			25/08/2004
*		*Felis catus*	Domestic Cat (Feral Cat)			29/10/1991
		Hydromys chrysogaster	Water Rat			27/08/2004
*		*Lepus europaeus*	European Brown Hare			31/05/2016
		Macropus fuliginosus	Western Grey Kangaroo			25/10/2016
		Macropus robustus	Euro			1/06/2016
		Macropus rufus	Red Kangaroo			6/11/2014

*	Class	Scientific name	Common name	Conservation status		Last sighting (year)
				Aus	SA	
		Mormopterus planiceps	Southern Free-tailed Bat			12/04/1988
		Mormopterus sp.				23/11/2004
*		*Mus musculus*	House Mouse			20/11/2015
		Nyctophilus geoffroyi	Lesser Long-eared Bat			23/11/2004
		Ornithorhynchus anatinus	Platypus		E	0/01/1900
*		*Oryctolagus cuniculus*	Rabbit (European Rabbit)			31/10/2012
*		*Ovis aries*	Sheep (Feral Sheep)			1/10/2002
*		*Rattus rattus*	Black Rat (Ship Rat, Roof Rat)			29/11/1991
		Tachyglossus aculeatus	Short-beaked Echidna			31/05/2016
		Trichosurus vulpecula	Common Brushtail Possum		R	18/11/2015
		Vespadelus regulus	Southern Forest Bat			23/11/2004
*		*Vulpes vulpes*	Fox (Red Fox)			25/10/2016
	REPTILIA	*Anilios bicolor*	Southern Blind Snake			21/11/2015
		Anilios bituberculatus	Rough-nosed Blind Snake			19/02/2007
		Brachyurophis australis	Coral Snake			1/01/1950
		Chelodina longicollis	Common Long-necked Tortoise			18/02/2016
		Christinus marmoratus	Marbled Gecko			2/10/2002
		Ctenophorus pictus	Painted Dragon			23/10/1978
		Ctenotus orientalis	Spotted Ctenotus			29/08/2016
		Ctenotus spaldingi	Eastern Striped Skink			17/11/2015
		Delma molleri	Adelaide Snake-lizard			29/08/2016
		Delma sp.				29/10/1991
		Demansia psammophis	Yellow-faced Whipsnake			30/10/1991
		Diplodactylus furcosus	Ranges Stone Gecko			2/10/2002
		Emydura macquarii	Macquarie Tortoise		V	18/02/2016
		Gehyra lazelli	Southern Rock Dtella			16/11/2015
		Gehyra sp.				31/10/1991
		Hemiergis peronii	Four-toed Earless Skink			29/08/2016
		Lampropholis guichenoti	Garden Skink			1/01/1950
		Lerista bougainvillii	Bougainville's Skink			20/11/2015
		Lerista dorsalis	Southern Four-toed Slider			12/10/2012
		Menetia greyii	Dwarf Skink			29/08/2016
		Morethia boulengeri	Common Snake-eye			29/08/2016
		Morethia obscura	Mallee Snake-eye			29/11/1995
		Parasuta nigriceps	Mitchell's Short-tailed Snake			29/08/2016
		Pogona barbata	Eastern Bearded Dragon			25/10/2016
		Pseudonaja textilis	Eastern Brown Snake			17/11/2015
		Tiliqua occipitalis	Western Bluetongue			1/01/1950
		Tiliqua rugosa	Sleepy Lizard			25/10/2016
		Tiliqua scincoides	Eastern Bluetongue			30/10/1991
		Tympanocryptis lineata	Five-lined Earless Dragon			28/08/2004
		Underwoodisaurus milii	Common Barking Gecko			29/08/2016
		Varanus gouldii	Sand Goanna			17/11/2015
		Varanus sp.	Goanna			1/01/2009

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. *: Introduced.

Appendix 3. Flora species observed within the Project area during the field survey.

	Family	Species name	Common name	Conservation status		BAM quadrat						
				Aus	SA	1a	1b	1c	1d	1e	2a	3a
*	AIZOACEAE	*Galenia pubescens var. pubescens*	Coastal Galenia									✓
*	AIZOACEAE	*Mesembryanthemum sp.*	Iceplant				✓					✓
*	BORAGINACEAE	*Echium plantagineum*	Salvation Jane							✓		
	CHENOPODIACEAE	*Atriplex sp.*	Saltbush								✓	
	CHENOPODIACEAE	*Einadia nutans ssp.*	Climbing Saltbush									✓
	CHENOPODIACEAE	*Enchylaena tomentosa var. tomentosa*	Ruby Saltbush				✓				✓	✓
	CHENOPODIACEAE	*Maireana brevifolia*	Short-leaf Bluebush								✓	✓
	CHENOPODIACEAE	*Maireana erioclada*	Rosy Bluebush								✓	
	CHENOPODIACEAE	*Maireana excavata*	Bottle Fissure-plant	V								✓
	CHENOPODIACEAE	*Salsola australis*	Buckbush								✓	
	CHENOPODIACEAE	*Sclerolaena diacantha*	Grey Bindyi								✓	
*	COMPOSITAE	*Arctotheca sp.*				✓	✓			✓		✓
*	COMPOSITAE	*Cirsium vulgare*	Spear Thistle						✓			
*	COMPOSITAE	*Gazania sp.*	Gazania				✓					
	COMPOSITAE	*Sonchus sp.*	Sow-thistle				✓					
*	CRUCIFERAE	*Brassica sp.*				✓	✓	✓				
*	CRUCIFERAE	*Brassica tournefortii*	Wild Turnip						✓			✓
*	CRUCIFERAE	*Sisymbrium sp.*	Wild Mustard						✓			
*	CUCURBITACEAE	*Citrullus sp.*	Wild Melon				✓		✓			✓
*	CUCURBITACEAE	*Cucumis myriocarpus*	Paddy Melon									✓
	CYPERACEAE	*Gahnia deusta*	Limestone Saw-sedge						✓			
	EUPHORBIACEAE	*Euphorbia ferdinandi var. ferdinandi*									✓	
*	GRAMINEAE	*Aira Cupaniana*	Hair-grass				✓					
	GRAMINEAE	*Austrostipa scabra ssp.*	Rough Spear-grass								✓	
*	GRAMINEAE	*Avena sp.*	Oat				✓	✓	✓	✓		
*	GRAMINEAE	*Hordeum vulgare*	Barley			✓	✓	✓		✓		

	Family	Species name	Common name	Conservation status		BAM quadrat						
				Aus	SA	1a	1b	1c	1d	1e	2a	3a
*	GRAMINEAE	*Vulpia sp.*	Fescue							✓		✓
*	LABIATAE	*Marrubium vulgare*	Horehound						✓	✓		
*	LILIACEAE	*Asphodelus fistulosus*	Onion Weed								✓	✓
	LILIACEAE	*Dianella revoluta var.*										✓
	LILIACEAE	*Lomandra effusa*	Scented Mat-rush						✓			
	LILIACEAE	*Lomandra leucocephala ssp. robusta*	Woolly Mat-rush									✓
	MYRTACEAE	*Eucalyptus calycogona ssp.*	Square-fruit Mallee								✓	
	MYRTACEAE	*Eucalyptus dumosa*	White Mallee								✓	
	MYRTACEAE	*Eucalyptus gracilis*	Yorrell				✓		✓	✓		
	MYRTACEAE	*Eucalyptus incrassata*	Ridge-fruited Mallee			✓	✓	✓	✓			
	MYRTACEAE	*Eucalyptus odorata*	Peppermint Box							✓		✓
	MYRTACEAE	*Eucalyptus phenax ssp. phenax*	White Mallee							✓		✓
	MYRTACEAE	*Eucalyptus socialis ssp. socialis*	Beaked Red Mallee								✓	
	MYRTACEAE	*Melaleuca lanceolata*	Dryland Tea-tree							✓		
*	OXALIDACEAE	*Oxalis pes-caprae*	Soursob			✓	✓			✓	✓	
*	POLYGONACEAE	*Acetosella vulgaris*	Sorrel									✓
*	POLYGONACEAE	*Emex australis*	Three-corner Jack									✓
*	SOLANACEAE	*Lycium ferocissimum*	African Boxthorn			✓	✓	✓	✓	✓		✓

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. *: Introduced.

Appendix 4. Location data for scattered trees.

Tree or tree clump	Number of trees	Species name	Location	
			Easting	Northing
1	1	*Eucalyptus oleosa ssp.*	335679	6116495
2	1	*Eucalyptus oleosa ssp.*	335521	6116463
3	1	*Eucalyptus oleosa ssp.*	335682	6116443
4	1	*Melaleuca uncinata*	335715	6116499
5	1	*Eucalyptus incrassata*	336508	6116590
6	1	*Eucalyptus odorata*	337149	6116468
7	1	*Eucalyptus oleosa ssp.*	336708	6116325
8	1	*Eucalyptus oleosa ssp.*	336897	6116273
9	1	*Eucalyptus leptophylla*	336893	6116178
10	1	*Eucalyptus dumosa*	337138	6116044
11	1	*Eucalyptus oleosa ssp.*	337251	6116116
12	1	*Eucalyptus leptophylla*	337138	6115990
A 13-14	2	*Eucalyptus oleosa ssp.*	337145	6115850
15	1	*Eucalyptus odorata*	337039	6115829
16	1	*Eucalyptus odorata*	336997	6115838
17	1	*Eucalyptus odorata*	336646	6115693
1	1	*Eucalyptus oleosa ssp.*	336665	6115654
2	1	*Eucalyptus oleosa ssp.*	336711	6115668
3	1	*Eucalyptus oleosa ssp.*	336806	6115668
4	1	*Melaleuca uncinata*	336826	6115664
5	1	*Eucalyptus incrassata*	336864	6115663
6	1	*Eucalyptus odorata*	336910	6115652
7	1	*Eucalyptus oleosa ssp.*	336959	6115641
8	1	*Eucalyptus oleosa ssp.*	337041	6115629
9	1	*Eucalyptus leptophylla*	337036	6115628
10	1	*Eucalyptus dumosa*	337044	6115586
11	1	*Eucalyptus socialis*	337111	6115617
12	1	*Eucalyptus leptophylla*	337163	6115609
A 13-14	2	*Eucalyptus oleosa ssp.*	335679	6116495
15	1	*Eucalyptus odorata*	335521	6116463
16	1	*Eucalyptus odorata*	335682	6116443
17	1	*Eucalyptus odorata*	335715	6116499
1	1	*Eucalyptus oleosa ssp.*	336508	6116590
2	1	*Eucalyptus oleosa ssp.*	337149	6116468
3	1	*Eucalyptus oleosa ssp.*	336708	6116325
4	1	*Melaleuca uncinata*	336897	6116273
5	1	*Eucalyptus incrassata*	336893	6116178

Appendix 5. Scattered tree data and photos.

Tree 1: *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
9.2	50	15	6	4	0	1	700	68.4	6.57	6.90

Tree 2: *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
5.2	30	20	4	0	0	1	600	33.0	2.11	2.22

Tree 3: *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
8.8	30	20	2	3	0	1	730	57.6	4.61	4.84

Tree 4: *Melaleuca uncinata*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
4.5	25	50	0	0	0	1	740	21.7	1.04	1.09

Tree 5: *Eucalyptus incrassata.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
6.0	30	10	0	0	0	2	1500	36.3	2.33	2.44

Tree 6: *Eucalyptus odorata*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
7.0	25	10	1	0	0	1	1100	36.3	2.33	2.44

Tree 7: *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
6.0	40	25	3	1	0	1	1100	55.3	4.42	4.65

Tree 8: *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
8.2	30	20	2	1	0	1	1400	57.6	4.61	4.84

Tree 9: *Eucalyptus leptophylla*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
5.0	30	10	1	1	0	2	1150	67.5	6.48	6.81

Tree 10: *Eucalyptus dumosa.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
4.0	15	0	0	0	0	1	850	30.9	1.98	2.07

Tree 11: *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
5.0	30	15	3	2	0	1	800	48.2	3.86	4.05

Tree 12: *Eucalyptus leptophylla*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
4.5	15	0	0	0	0	1	850	30.9	1.98	2.07

Clump A (Trees 13-14) - *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
5.0	30	15	2	1	0	1	800	48.2	3.86	4.05

Tree 15: *Eucalyptus odorata*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
10.0	45	50	1	1	0	1	875	44.7	3.57	3.75

Tree 16: *Eucalyptus odorata.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
11.0	50	30	1	4	0	1	925	60.8	4.86	5.11

Tree 17: *Eucalyptus odorata.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
6.0	5	95	0	0	0	2	1250	7.7	0.24	0.26

Tree 18: *Eucalyptus odorata.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
8.6	25	50	0	0	0	2	1225	17.9	0.57	0.60

Tree 19: *Eucalyptus odorata.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
6.4	40	20	1	0	0	2	1175	36.3	2.33	2.44

Clump B (Trees 20-21) - *Eucalyptus dumosa.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
5.0	20	5	0	0	0	2	1075	38.1	2.44	2.56

Tree 22: *Eucalyptus dumosa*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
5.0	15	5	0	0	0	2	1050	32.5	2.08	2.18

Clump C (Trees 23-26) - *Eucalyptus odorata*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
8.0	30	30	2	0	1	3	975	50.3	4.03	4.23

Tree 27: *Eucalyptus dumosa*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
6.0	25	5	0	0	0	1	900	34.6	2.22	2.33

Tree 28: *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
10	40	20	0	2	1	1	825	57.6	4.61	4.84

Tree 29: *Eucalyptus dumosa*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
3.0	10	5	0	0	0	1	825	22.2	1.06	1.12

Tree 30: *Eucalyptus oleosa ssp.*

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
8.0	40	25	9	3	1	1	825	55.3	4.42	4.65

Clump D (Trees 31-33) - *Eucalyptus dumosa*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
6.0	20	15	0	0	0	4	750	38.1	2.44	2.56

Tree 34: *Eucalyptus dumosa*.

Height (m)	Trunk diameter (cm)	Dieback (%)	Hollows			Density	Proximity to other veg.(m)	Individual Tree Score	Total Tree Score	SEB points req.
			S	M	L					
4.0	15	0	0	0	0	1	700	30.9	1.98	2.07

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Landscape Character and Probable Visual Effect Assessment

Pallamana Solar and Energy Storage Facility

Prepared for RES Australia Pty Ltd

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6 August 2018

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E	**06/08/2018**	**BG/WK/KP**	**WK**
D	**13/07/2018**	**BG/WK/KP**	**WK**
C	**15/05/2018**	**BG/WK/KP**	**WK**
B	**14/02/2018**	**BG/WK/CS**	**WK**
A	**15/11/2017**	**BG/WK/CS**	**CS/BG/WK**
A	**05/11/2017**	**BG/WK/CS**	**CS/WK**
A	**11/10/2017**	**BG/WK/CS**	**CS**
A	**01/09/2017**	**BG/WK/CS**	**CS**

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01 Scope of Assessment

1.0 Scope of Assessment

1.1 Introduction

This report has been prepared by Warwick Keates of WAX Design in association with Dr Brett Grimm of Brett Grimm Landscape Architect for RES Australia to assess the potential visual impact of the proposed Pallamana Solar and Energy Storage Facility project (the Project). This report aims to evaluate the existing landscape character, identify the potential viewpoints for the final visual impact assessment and provide a discussion around the degree of visual change that is likely to result from the introduction of the proposed solar and energy storage facility and associated infrastructure into the existing landscape character of the locality.

The Landscape and Visual Impact Assessment (LVIA) comprises of two separate assessments, a landscape character assessment and a visual impact assessment; these are interrelated processes as described in the Guidelines for Landscape and Visual Impact Assessment[1]. The landscape character assessment described in this report considers the existing character of the landscape and the site locality. The site locality is considered as the areas around the Project from which the solar arrays and associated infrastructure are likely to be visible in the landscape as described in section 1.3 below. The visual impact assessment considers the likely effect of the proposed development on the physical landscape which may give rise to changes in its character and the resultant effects on visual amenity.

The potential visual impact will be assessed using the Grimke matrix methodology that involves on-site assessments, GIS modelling, consultation with relevant stakeholders and interested parties through RES Australia, the preparation of photomontages and a detailed visual impact assessment to illustrate the predicted visual effect of the Project within the defined locality. The visual impact assessment forms the second stage of the LVIA process.

1.2 Project Description

The Project is located along Monarto Road approximately 4 kilometres from Murray Bridge within the Rural City of Murray Bridge in South Australia. The main entrance to the site is along the southern boundary, Monarto Road, approximately 500 metres west of the SA Water pumping station. Reedy Creek Road and Hillview Road forms the northern boundary to the site

The project is a large-scale solar energy production facility and storage facilities. The solar collectors are arranged in rows running north west-south east with panels facing north in clustered groups across the site. The single axis tracking solar panels will move from facing the east in the morning to facing west in the afternoon.

The proposed solar and energy storage facility will consist of the following components:

- The proposed solar panels are Poly-Crystalline which are designed to maximise absorption of the sun's light by direct conversion to electricity. The modules used in this development will absorb approximately 82-90% of the light received and have been designed using two anti-reflective coatings.
- Solar collectors arranged across the site with single-axis tracking, generating up to 176MW in solar and 66MW in battery storage.
- Single axis tracking solar array with a maximum height of 4metres and width of 2 metres
- On-site substation with a connection to existing transmission corridor that traverses the site
- Battery storage facility located adjacent to a substation on the southern edge of the site
- Site office located adjacent to battery storage facility

1Swanwick, C. (2013). *Guidelines for Landscape and Visual Impact Assessment*. 3rd ed. United Kingdom: Landscape Institute and Institute of Environmental Management and Assessment.

01 Scope of Assessment

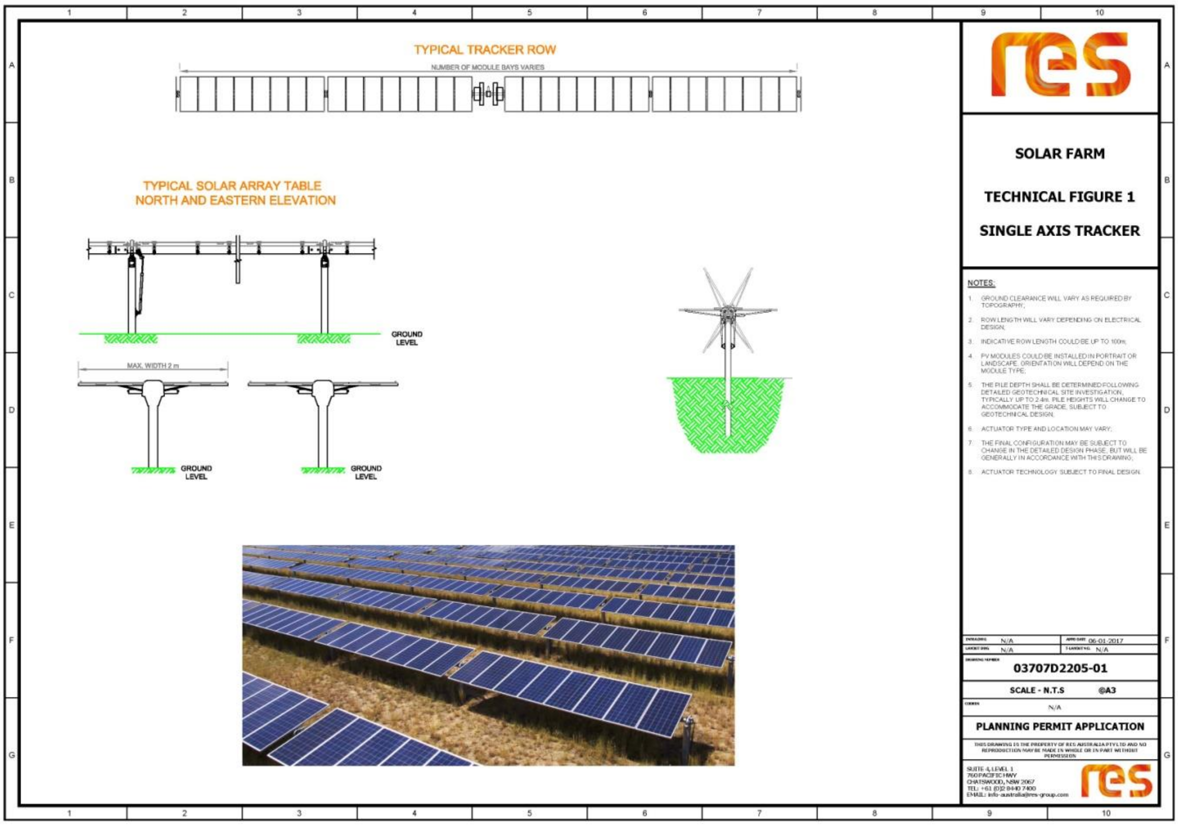

Figure 1: Technical Figure of Single Axis Tracker Solar Array

1.3 Site Locality

A 10km site locality around the project has been defined for assessment purposes and is based on research and previous experience in defining thresholds for scale and identification of visual effect. Most notably the Thomas matrix[2] and Bishop (2002)[3] has provided guidance on this matter for wind farms. However solar farms are of considerably less vertical scale which has been taken into account during the assessment process. Also, the extent of the site locality has been reviewed against the Zone of Theoretical Visual Influence (ZTVI) mapping. This mapping provides a reference of the extent to which the Project is likely to be visible in the landscape and defines the viewshed resulting from the local topography (excluding vegetation and built form screening).

The landscape character assessment of the proposed wind farm consists of written descriptions and photographic surveys of the surrounding locality to articulate the character of the existing landscape that surrounds the site in relation to the local (0-3km), sub-regional (3-10km) and regional (>10km) landscapes. This is followed by a discussion of the probable visual effect that is anticipated to occur across the regional landscape as well as within the infrastructure corridors associated with the proposed project. The landscape character and visual assessment provide the basis on which to measure the suitability of the development in relation to the visual impact within the regional area (10km) and in regards to the relevant provisions of the Murray Bridge Council Development Plan (consolidated 23 January 2018).

Recognition of the potential visual impact of a layout design is implicit in the design process. This includes early reference to development plan provisions and relevant guidance reports

2Sinclair, G. (2001). The Potential Visual Impact of Wind Turbines in relation to distance: An approach to the environmental assessment of planning proposals. E.I.Services

3 Bishop, I. (2003). Determination of thresholds of visual impact: the case of the wind turbines: Environment and Planning B: Planning and Design: 707-718

01 Scope of Assessment

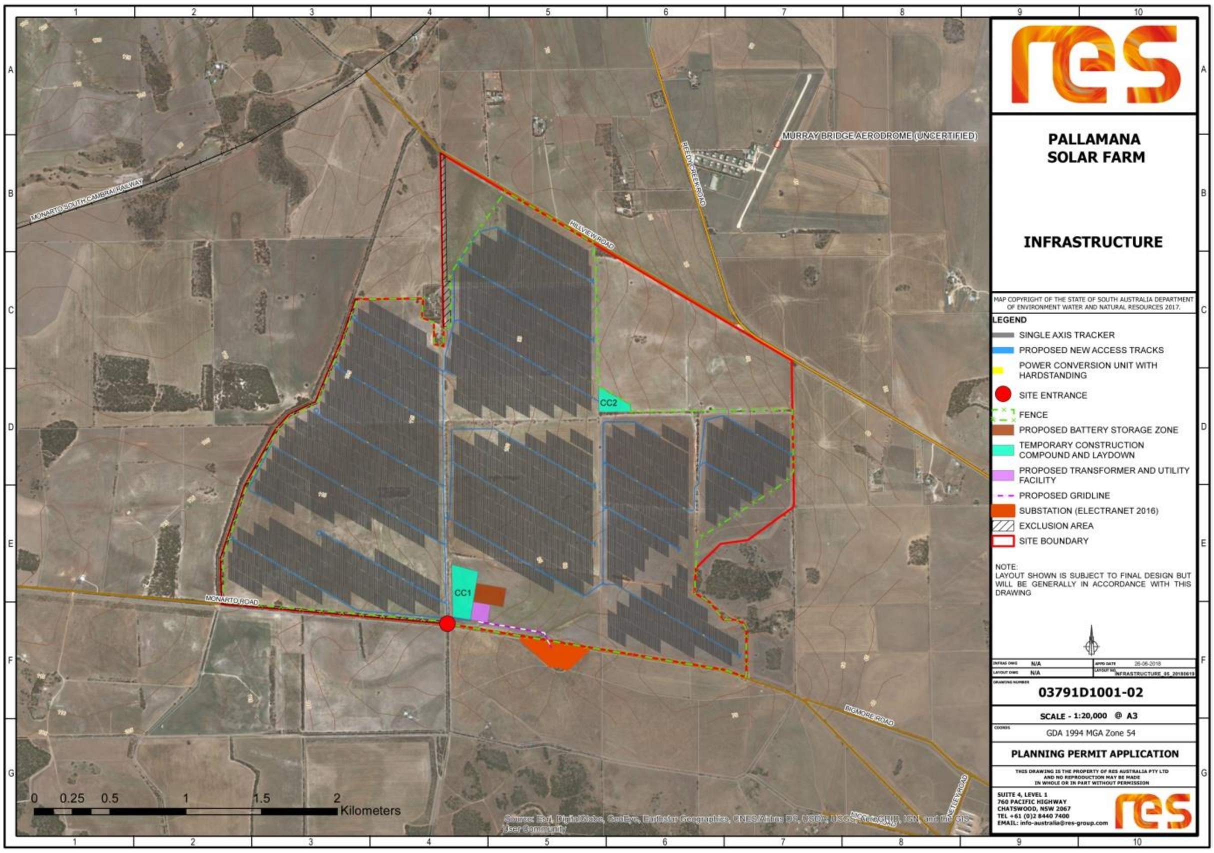

Figure 2: Proposed layout for the Pallamana Solar and Energy Storage Facility

Figure 3: Visualisation of Pallamana Solar and Energy Storage Facility

02 Introduction

2.0 Introduction

2.1 Visual Assessment Approach

The aim of the LVIA methodology is to provide an objective, reliable, credible, replicable and measurable analysis of the potential visual impact when considered against the existing landscape character.

The process for the visual assessment is based on the recommendations of John Ginivanand Planning SA (2002)[4] and considers the visual assessment regarding the Primary Landscape Character Assessment and Detailed Visual Effect Assessment (excluding Qualitative Subjective Assessment).

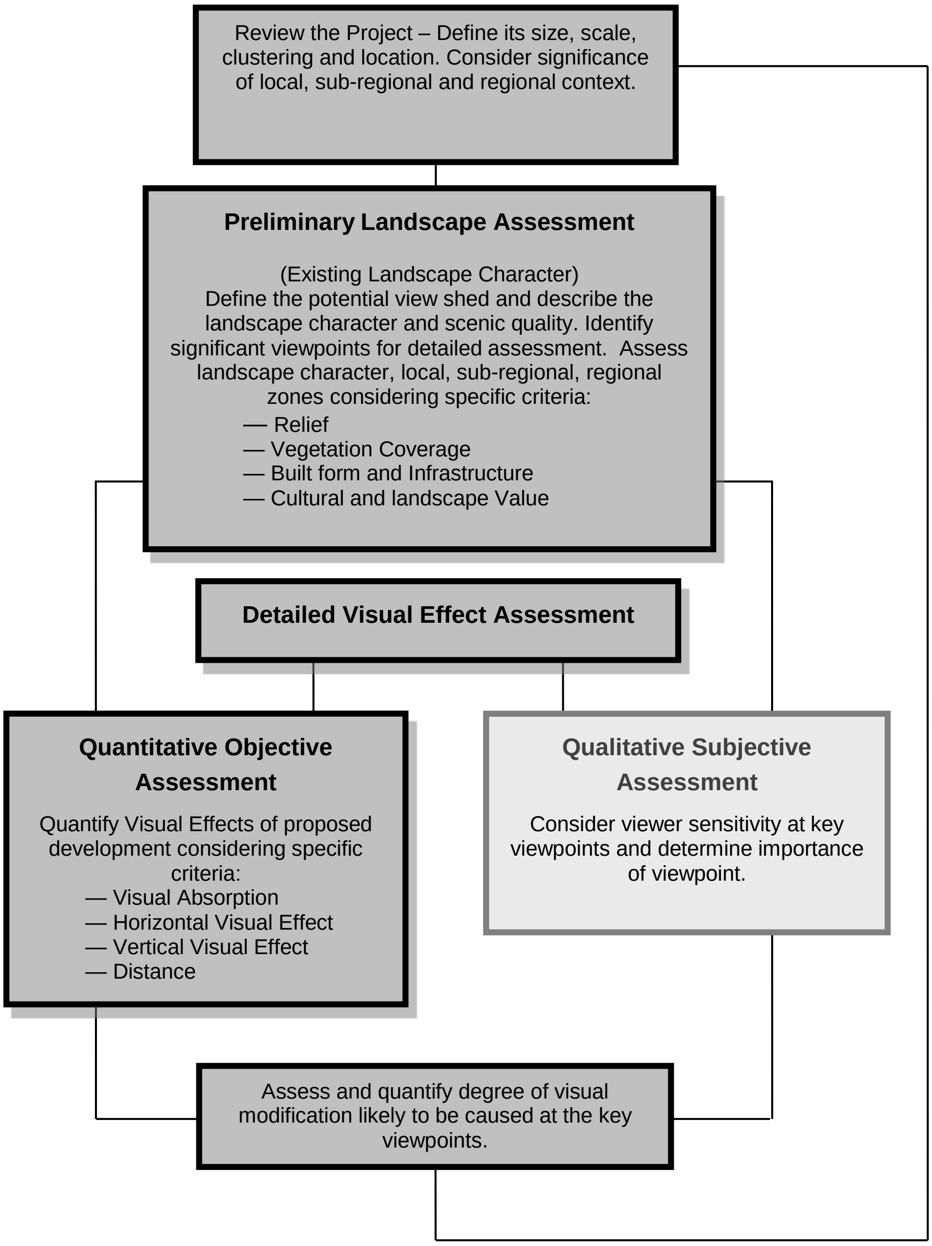

Figure 4: Detailed Visual Assessment Process

4 *Planning South Australia (2002). Advisory Notice Planning- Draft for Consultation 21 Wind Farms. S.A Adelaide*

02 Introduction

2.2 Guidance and Best Practice

Currently, there is no formalised standard visual assessment methodology at local, state or federal government levels. While various guidelines and frameworks have been produced, they do not provide a definitive methodology or technique to be applied. Frameworks have more recently been developed and applied to wind farms. The same process adopted for visual assessment can be applied to solar farms. For the visual assessment of the Pallamana Solar and Energy Storage Facility to follow a ‘best practice’ approach, the assessment methodology has been defined with reference to the following documents:

- Guidelines for Landscape and Visual Impact Assessment (Third edition) (2013), Landscape Institute;
- Grimm, B (2009). Quantifying the Visual Effects of Wind Farms; A Theoretical Process in an Evolving Australian Visual Landscape. PhD Thesis Adelaide University;
- Australian Wind Energy Association and the Australian Council of National Trusts (2007) Wind Farms and Landscape Values: National Assessment Framework;
- Visual Landscape Planning in Western Australia. (2007).A manual for evaluation, assessment, siting and design, Western Australian Planning Commission;
- Best Practice Guidelines for the Implementation of Wind Energy Projects in Australia (2006);
- Lothian, A. (2008). Scenic perceptions of the visual effects of wind farms on South Australian landscapes. Geographical Research, 46:2, 196 – 207;
- Swanwick, C. (2013). Guidelines for Landscape and Visual Impact Assessment. 3rd ed. United Kingdom: Landscape Institute and Institute of Environmental Management and Assessment;
- Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (2002);
- South Australian Wind Farms Planning Bulletin (2002); and
- Lothian, A. (2000). Landscape Quality Assessment of South Australia. PhD Thesis Adelaide University.

2.3 Methodology

The approach used for the LVIA is based on two assessment stages with reference to the Guidelines for Landscape and Visual Impact Assessment and set out in Figure 5.Stage 1; Landscape character assessment is concerned with identifying and assessing the importance of landscape characteristics and the existing landscape quality. Stage 2; The visual assessment aims to quantify the extent to which the development is visible as well as defining the degree of visual change and the associated visual impacts using the Grimke Matrix.

The completed landscape character assessment and visual impact assessment are used to draw a number of conclusions about the magnitude of the visual effects of the proposed development on the site locality.

The LVIA includes two assessment stages and associated tasks as seen in Figure 5. The following table outlines a detailed description of each process conducted within the methodology.

02 Introduction

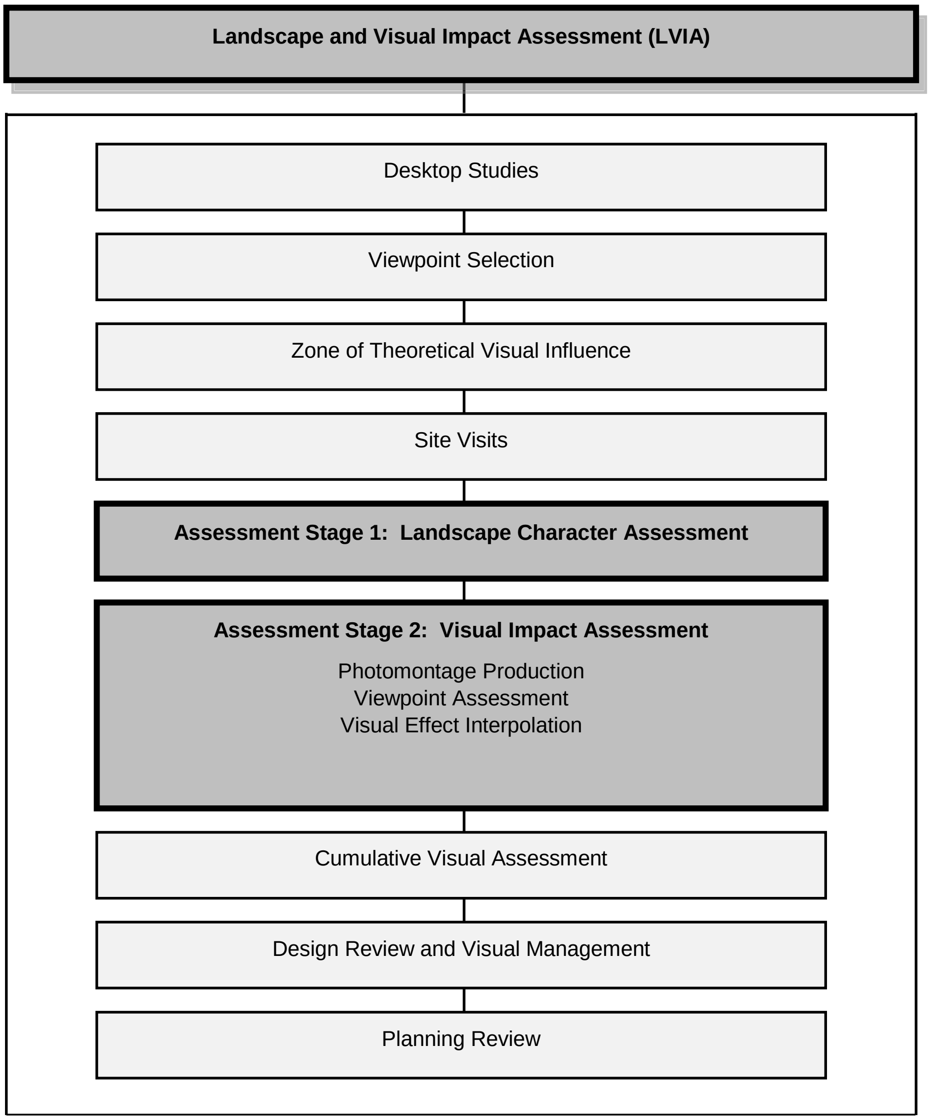

Figure 5: LVIA – Two Assessment Stages and Associated Tasks.

Desktop Studies

The Landscape Character Assessment for the project includes reviews of the project documentation, the proposed development location and infrastructure associated with the proposed development. Analysis of GIS maps, landscape photography, aerial photographs and supporting literature was also reviewed to establish a broad comprehension of the scope of the proposed solar and energy storage facility and the existing landscape character.

02 Introduction

Viewpoint Selection

Viewpoint selection was conducted by WAX Design and BGLA as part of an initial site visit on the 18 September 2017 and during subsequent desktop analysis. The selection of the viewpoints provides locations from which a detailed visual assessment of the potential visual effect can be made as part of the stage 2 assessment. The locations are also selected on the basis of being representative of the locality, public locations and viewpoints where a large proportion of the solar and energy storage facility is visible.

A total of four (4) viewpoints were selected surrounding the project during this site visit to provide an understanding of the likely visual effect.

Viewpoint locations were identified using a preliminary ZTVI map which illustrates the likely degree of visibility in accordance with the topography. The site assessment certified the evaluation of the ZTVIwith reference to vegetation screening and local landforms not depicted in the ZTVI.

Two viewpoints represent a typical location where the greatest probable degree of visual change that will be experienced as a result of the proposed development within the existing landscape. Two additional viewpoints were selected to ensure that the potential visual effect was assessed from each direction around the proposed development and key locations within the regional area reflecting the ZTVI potential visibility. However, the onsite assessment concluded that vegetation screened any potential views from these two viewpoint localities. The four viewpoints were confirmed by RES Australia before the final stage of visual impact assessment.

02 Introduction

Figure 6: Viewpoint Locations

02 Introduction

Zone of Theoretical Visual Influence

To gain an appreciation of where the project will be visible from; Zone of Theoretical Visual Influence (ZTVI) maps have been produced. The mapping provides an illustrative depiction of where the development may be seen within the landscape. The maps quantify the extent to which the solar arrays are likely to be seen considering a maximum development height of the solar panels of 4 metres, the extent of the solar arrays within the subject land and any other associated infrastructure such as battery storage facilities.

The analysis uses a digital terrain model, and computer-generated models of the solar arrays to illustrate the potential visibility from any location around the solar and energy storage facility. It should be noted that the ZTVI does not take into account the impact of local vegetation, buildings or localised landforms as it is based on a 10m contour data set. This means that theoretically, the visual impact of the proposed development is evaluated within a landscape devoid of any screening vegetation or other features and as such represents a 'worst case' scenario.

Assessment Stage 1: Landscape Character Assessment

The assessment includes the identification and description of landscape character units (areas of defined quality determined by topographic form, land use, vegetation association including patterning, colouration and textural relief). Also, special landscape features are identified. Mapping and photographic surveys are undertaken in addition to written commentary to describe the locality and existing landscape character of the site locality.

As part of the landscape character assessment, the selection of viewpoints was confirmed, and the base photography was taken for photomontage production.

The assessment was undertaken on the 18 September 2017 and 3 November 2017to enable the project team to develop a detailed understanding of the existing landscape character. Weather conditions on the 18 September 2017 were overcast with scattered showers and on 3 November 2017were clear with visibility extending over several tens of kilometres. There was some low cloud cover and atmospheric interference in relation to visibility at distances exceeding several hundred kilometres.

Assessment Stage 2: Visual Impact Assessment

The assessment of the visual impact includes the production of photomontages to assist in the quantification and qualification of the potential visual effect. The viewpoints identified as part of the preliminary assessment stages were measured using a series of landscape and visual criteria. The assessment results were then mapped to demonstrate the likely visual impact of the project.

The Stage 2 assessment was undertaken on the 3 November 2017 with fair weather conditions, sunny with winds and sporadic cloud cover throughout the day, ensuring clear visibility extending across the regional landscape character zone.

Assessment Stage 2: Photomontage Production

Photomontages of the proposed development from each viewpoint were produced by Convergen. The photomontages represent 120-degree horizontal field of view with a 50mm lens digital equivalent photo capture. This has been proven to represent the human binocular field of view best. Details of the methodology used to produce the photomontages are described in Appendix B and represents a best practice approach with reference to 'Photography and photomontage in landscape and visual impact assessment' (2011) Landscape Institute (advice note 01/11).

WAX and BGLA validated the accuracy of the photomontages during a site visit on the 3 November 2017. The combination of a photomontage assessment and an on-site review ensures issues typically associated with photographic simulations such as image compression and distortion are mitigated by assessing and measuring the visual effect in-situ using GPS and a bearing compass.

This enables the photomontages to be ground-truthed for positional correctness and scale. Any minor distortion to the edge of the 120 degrees provided by the horizontal field extent and two-dimensional image representations are reflected relatively in the simulated modelling overlay.

The photomontage images were used to inform the detailed viewpoint assessment.

Assessment Stage 2: Viewpoint Impact Assessment

The viewpoint assessment of the project uses a combination of visual assessment measurements and descriptive text. This comprises site observations with reference to prepared photomontages and a detailed assessment of the baseline landscape character and visual impact.

Initially, the baseline landscape character for each viewpoint was assessed regarding:

- Relief (the complexity of the land that exists as part of the underlying landscape character);
- Vegetation Cover (the extent to which vegetation is present and its potential to screen and filter views);
- Infrastructure and Built Form (the impact of development on the landscape and visual character); and
- Cultural Sensitivity(existing cultural overlays, planning designations and any identified listing of heritage items and or local sensitivities to landscape such as scenic drives, the frequency of potential views and viewpoints).

A value was generated for the existing landscape relative to each viewpoint. This value formed the baseline assessment value. It is this baseline value that is modified by the impact of the development on the landscape, which in turn informs the degree of visual effect.

Following the landscape character assessment, each viewpoint was then assessed on the following visual effects:

- Percent of landscape absorption (the landscape's ability to absorb and screen the development form);
- Horizontal visual effect (percentage spread of the development in the field of view);
- Vertical visual effect (vertical scale of the development as a percentage of the existing landscape scale within the field of view); and
- Distance of visual effect (distance between viewpoint and development).

The landscape character and visual effect measurements were combined to produce a quantified value for the degree of visual change that resulted from the project at each viewpoint (refer to Appendix D for detailed assessment criteria and matrix methodology).

Assessment Stage 2: Visual Effect Interpolation

The findings of the visual impact assessment for each viewpoint were used to provide a percentage value to the degree of visual change. Each viewpoint was cartographically mapped in GIS, and the visual effect values expressed as a weighted interpolation. The ZTVI was overlayed onto the visual effect interpolation map to define the extent of visibility. The combination of Visual Effect Interpolation and ZTVI provided a map of the likely visual impacts experienced in the site locality as a result of the proposed project. This map provides relativity to the likely experience of visual effect within the regional locality.

Design Review and Visual Management

During the design development of the project, there have been adjustments to the layout and scope of the project in response to various assessments. These changes in the design layout and scope have been considered as part of the visual impact assessment.

02 Introduction

Planning Review

A review of the landscape and visual impacts of the development from a planning context was also undertaken. The planning review included a review of the Murray Bridge Council Development Plan (consolidated 23 January 2018).

These documents provided a range of recommendations that influenced the development assessment of the Project proposal. In particular, the potential visual impact of the development has been reviewed and discussed against the relevant desired character statements with specific reference to landscape and visual considerations resulting from the development of the Project.

03 Landscape Character Assessment

3.0 Landscape Character Assessment

3.1 The Site Locality

The project (as shown in Figure 9)is approximately four kilometres from the outskirts of Murray Bridge which is located southeast of Adelaide on the Murray Plains. The boundary of the site is defined by Monarto Road and Reedy Creek Road to the south and north respectively. The main entrance to the site is along the southern boundary, Monarto Road, approximately 500 metres west of the SA Water pumping station. The southern boundary is located close to the northeastern corner of the Monarto Zoological Park.

The subject land and the immediate locality to the north are formed by an undulating tableland with numerous local ridges and creeks. The underlying land cover is predominantly cropped agriculture. This rural landscape is punctuated by shelter belts of trees and woodland areas that form defined vegetated elements in the landscape. Four transmission lines run through the site, which reflects existing infrastructure elements within the locality.

The topographic variation in combination with the existing areas of vegetation create a visually enclosed landscape character with a degree of visual complexity that results in pockets of landscape with contained views extending for a few kilometres before being the surrounding ridgelines, and vegetation belts contain the visual character forming defined viewsheds.

The site extends across an elevated plateau that forms the highest point of the Monarto tablelands between Murray Bridge and the Bremer River corridor. The site is defined by several local undulations that form localised basins and depressions that limit the degree of visibility within the wider locality.

Extensive revegetation and conservation parks associated with Monarto zoological park and Kinchina provide substantial screening, scale and visual enclosure to the sub-regional character.

The combination of vegetation and landform creates an enclosed visual character to the site with fragmented views towards the subject land between existing tree groups. To the east, the site slopes gently towards the residential edge of Murray Bridge. The orientation of the slope offers a greater degree of visibility over part of the subject land.

Figure 7: View of the land use and land forms typical for the locality, photo taken along Reedy Creek Road

Figure 8: View of the SA Water pumping station along Monarto Road

03 Landscape Character Assessment

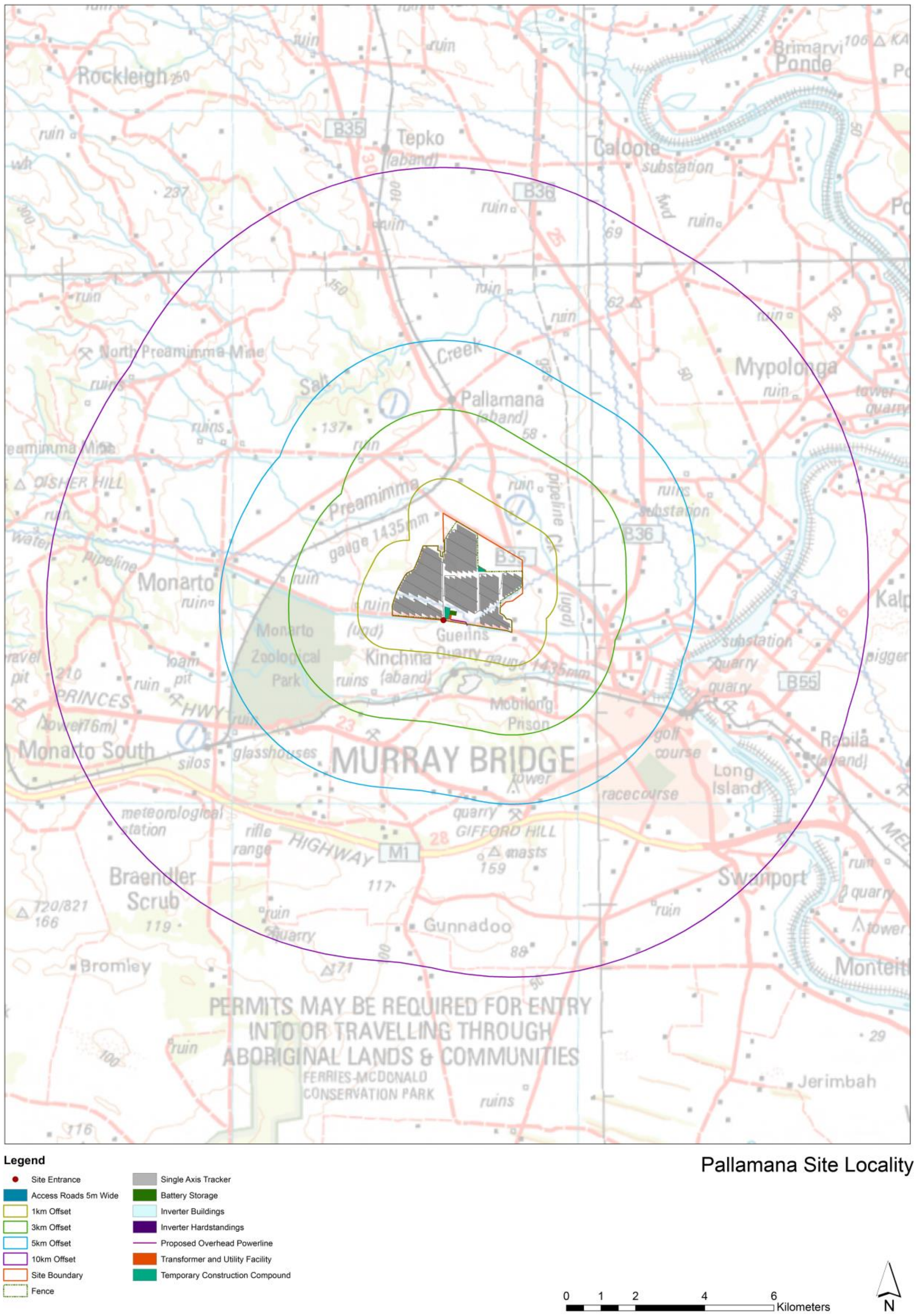

Figure 9: Proposed site location

3.2 Land Use and Land Cover

The land use and land cover across the proposed development site and the immediate locality (<3km) of the proposed solar and energy storage facility are defined by a mixture of large open paddocks, vegetation belts, isolated tree groups and some areas of revegetation. Cropping is the dominant land use with occasional residential properties, isolated farming buildings and Pallamana airfield located in the surrounding regional landscape. The land cover and associated infrastructure is representative of the Murray Plains and creates a distinctly agricultural landscape character.

The land use of the local, sub-regional and regional landscape is predominately agricultural, this underlying agricultural character changes as it transitions into the adjacent regional urban settlement of Murray Bridge, the Kinchina Conservation Park, Monarto Zoological Park and Murray River Basin.

3.3 Landform and Geomorphology

The underlying topography of the locality is defined by a number of distinct landforms and topographic features. These include the escarpment of the Murray River floodplain to the east which forms a defined elevation change. To the south, are a series of defined ridgelines that are formed by the Narrinyeri Hills, White Hill and Gifford Hill. The orientation of the ridgelines extends west from the Southern Mount Lofty Ranges.

To the west and north are the undulating tablelands of the Southern Mount Lofty Ranges. The tablelands extend between the Murray River and the Bremer River and are punctuated by numerous local landforms and creeks including Preamimma Creek and Rocky Gully.

3.4 Landscape Character Units

To understand how and to what degree the proposed development will produce a visual effect in the existing landscape, an assessment to identify landscape character units has been undertaken as is shown in Figure 10. This assessment identified a number of landscape character areas within the site locality that contain similar landscape qualities in relation to land use, topography, vegetation, visual patterning, texture, landscape scale and containment of views.

The landscape character is broadly defined by the Murray River corridor and river escarpment that forms an agricultural floodplain to the east; the urban settlement of Murray Bridge; the western ridgeline and the Monarto tablelands to the northwest and the agricultural plains to the northeast. Within these defined landscape character areas are some specific landscape elements including; Monarto Zoological Park, a quarry, Kinchina Conservation Park and a number of local ridgelines formed by the Southern Mount Lofty Ranges.

The regional landscape context surrounding the project contains four (4) landscape character areas which are;

1. Agricultural Tablelands
2. Agricultural Plains
3. Agricultural Flood Plains
4. Urban Settlement (Murray Bridge)

03 Landscape Character Assessment

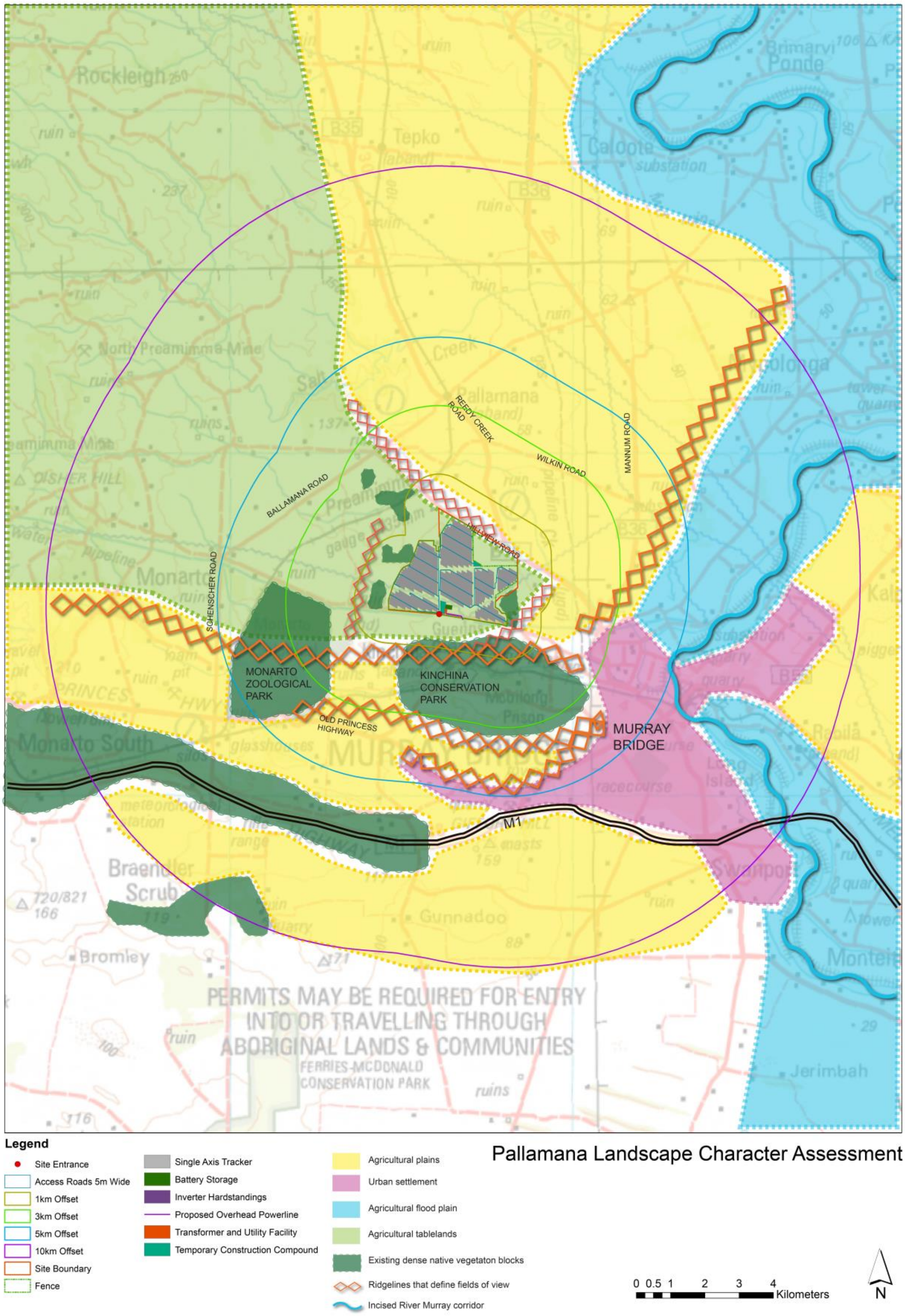

Figure 10: Landscape character units

03 Landscape Character Assessment

3.4.1 Agricultural Tablelands

The agricultural tablelands extend from the base of the Southern Mount Lofty Ranges and transition into the Murray Plains and Murray Basin further east. There is a number of rolling local hills and landforms across the tablelands running southwest which create defined viewsheds. The proposed development site is located on the eastern edge of the tablelands as it transitions to the agricultural plains.

The tablelands are predominately defined by large agricultural properties mainly used for cropping, grazing and some horse agistment with scattered dwellings and associated agricultural storage and processing facilities. Established belts of vegetation line road corridors and cadastral boundaries and there are some larger remnant and re-vegetation areas across the tablelands.

The vegetation pattern coupled with undulating topographic form fragments and contains views to distances of less than 1 kilometre, the landscape character of the agricultural tablelands provides substantial visual absorption properties.

Figure 11: Agricultural Tablelands; Pallamana Road looking east towards the proposed development site

3.4.2 Agricultural Plains

The agricultural plains landscape character area is very similar in land use and land cover to the agricultural tablelands. The key variation is the lower lying elevation of the landscape character unit as it transitions towards the Murray River as well as a slight reduction in tree clusters.

The local landforms create a gently rolling landscape before a further drop in elevation to the Murray River floodplain. The field sizes reduce across the agricultural plains as the rural land use changes into more urban settlements. At the same time, land use remains agricultural.

Immediately south of the proposed development site is the Kinchina Conservation Park and Monarto Zoological Park. These areas are defined by densely vegetated landscapes, with limited development. The undulating topography associated with Rocky Gully which becomes more complex to the south and is punctuated with rocky outcrops and the incised gullies of the Narrinyeri Hills. These areas form distinct local landscape features within the wider landscape character area of the Agricultural Plains.

Figure 12: Agricultural Plains; Reedy Creek Road looking north west towards the Southern Mount Lofty Ranges

3.4.3 Agricultural Flood Plains

The Agricultural Flood Plains include the Murray River corridor and the immediate area surrounding the watercourse. This area includes areas which flood when the river has a season of high flow. Within this area are a number of agricultural cropping properties as well as rural townships scattered along the banks of the Murray River.

The river edge varies with some areas having gentle slopes towards the water and other areas having a steep slope or cliff face which alters the visual character of the area.

Figure 13: Agricultural Flood Plains, adjacent ferry landing in Murray Bridge

3.4.4 Urban Settlement (Murray Bridge)

Murray Bridge is located on the edges of the Murray River and forms a large urban settlement which services the wider regional area. The residential edge of the city is defined by single-storey standalone dwellings on larger allotments. Around the northern and western edges of the city are a number of light industrial and agricultural processing properties. These land uses reinforce the peri-urban edge of the city. To the west of Murray Bridge is the Mobilong Prison which is integrated to the fringe of Kinchina Conservation Park.

The local ridgelines along the western edge of the city restrict views to the wider landscape area. Views within the city are contained due to the surrounding development and the shallow slope of the underlying topography towards the Murray River. The main centre of the town is close to the banks of the Murray River with a concentration of development linear to the main street, which aligns east-west perpendicular to the River Murray.

Figure 14: Murray Bridge, eastern end of Bridge Street looking towards the River Murray

04 Zone of Theoretical Visual Influence

4.0 Zone of Theoretical Visual Influence

4.1 Zone of Theoretical Visual Influence (ZTVI)

The Zone of Theoretical Visual Influence (ZTVI) mapping illustrates where the proposed solar and energy storage facility is likely to be seen in the landscape. The mapping quantifies the extent to which the Pallamana Solar and Energy Storage Facility is likely to be seen within the wider landscape.

The ZTVI mapping is developed in GIS using 10m contour data that has been provided within a 10km radius of the project site. The ZTVI represents a ‘worst case’ scenario as it does not incorporate vegetation, built form or localised screening effects, which are assessed as part of the landscape character and visual impact assessment.

The ZTVI mapping used information provided through the site layout and detail cross sections drawings to develop a representation of the proposed development extent and anticipated maximum height of 4 metres above ground level. Although the solar panels will track along their axis and change the maximum height over the course of the sunlight hours the maximum height was modelled to indicate the worst case scenario. Associated infrastructure and storage sheds were included based on the information provided.

The ZTVI mapping illustrates the viewshed that results from the surrounding landforms within the locality. To the south and west the ridgelines associated with Monarto tablelands, Narrinyeri Hills and White Hill limit the visibility of the proposed development and beyond one or two kilometres views of the solar panels would be negligible. In combination with the dense woodland cover, the visibility is likely to be completely removed from distances more than two kilometres.

To the north, the potential visibility illustrated by the ZTVI increases and extends beyond five kilometres. As previously discussed, the combination of local landforms and the presence of existing vegetation reduce the visibility of the proposed development. The proposed development is seen screened by tree and belts of vegetation creating a fragmented visual effect.

From locations adjacent to the proposed development the absences of screening vegetation or topography are likely to increase the potential visual effect.

04 Zone of Theoretical Visual Influence

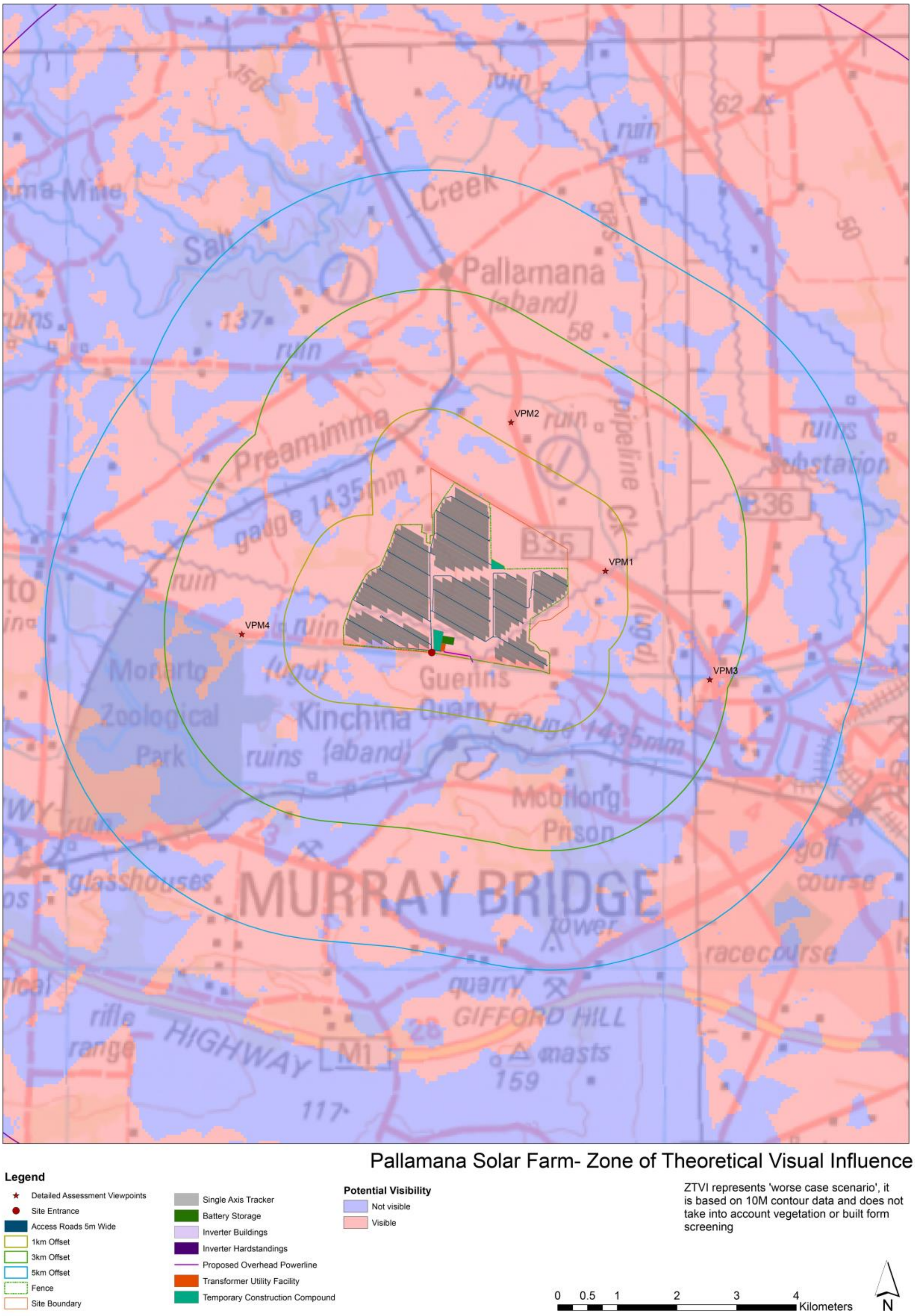

Figure 15: ZTVI map for the Pallamana Solar and Energy Storage Facility based on layout provided

05 Visual Impact Assessment

5.0 Visual Impact Assessment

5.1 Visual Assessment Scope

The visual impact assessment was based on single-axis tracking solar panels with a maximum height of 4 metres, arranged across the site in groups to maximise the solar collection potential and the site locality as described in the landscape character assessment to a radius of 10km of the proposed development.

The visual impact assessment considered key aspects of the existing landscape such as topography, vegetation, built form and infrastructure elements; as well as cultural and scenic landscape values from each of the four selected viewpoints. Key landscape and visual aspects associated with each viewpoint were scored out of 5 to produce an assessment value out of 20. This enabled a baseline landscape value to be calculated from which the visual effect was measured in relation to the degree of visual change that is likely to occur as a result of the introduction of the proposed development into the existing landscape character.

The visual effect was assessed using a set of criteria that considered factors such as the degree of landscape absorption, horizontal and vertical effects and distance to the development from each viewpoint.

The visual effect was then expressed as a coefficient and applied to the baseline landscape value to produce a measurement of the likely degree of visual change, that is to say, the extent to which the Project is predicted to alter the existing landscape.

Photomontages and wireline simulators were developed for each of the viewpoints to facilitate landscape absorption assessment and to illustrate the likely visual change.

5.2 Visual Impact Assessment

Using the visual assessment matrix as described in Appendix D, the potential degree of visual change and resulting visual impact of each viewpoint was measured and evaluated against the following criteria:

- Baseline Landscape Value is expressed as a value between 4 and 20;
- Visual Assessment Value is expressed as a value between 4 and 20;
- Coefficient of Visual Impact is calculated as decimal fraction of the visual assessment value;
- Relative Value of Visual Impact is calculated as the baseline landscape character multiplied by the coefficient; and
- Degree of Visual Change is expressed as the visual impact divided by the landscape character assessment range represented as a percentage.

The visual assessment also includes a description of the viewpoint context in relation to the landscape character that surrounds the viewpoint and the potential visual impact. This assessment is supported by the photomontages of the development and wireframe illustrations of the relative solar arrays positions.

For clarity and legibility of the report all reference images, maps and photomontages have been included in Appendix A and C and reproduced at A3 to enable them to be studied while reviewing the associated text for each viewpoint.

05 Visual Impact Assessment

The viewpoints selected for the visual impact assessment as shown in Table 1are:

VP01 Near the intersection of Reedy Creek Road and Hillview Road (Looking North-North-West - Local)

VP02 Reedy Creek Road (Looking South - Local)

VP03 Intersection of Guerin Road and Mannum Road (Looking West - Local)

VP04 Monarto Road (Looking East - Local)

Ref.	Viewpoint	Longitude	Latitude	Distance to development	View Direction
VP01	**Near the intersection of Reedy Creek Road and Hillview Road**	**339049**	**6116673**	**0.714km**	**NNW**
VP02	**Reedy Creek Road**	**337467**	**6119163**	**1.41km**	**S**
VP03	**Intersection of Guerin Road and Mannum Road**	**340798**	**6114852**	**2.8km**	**W**
VP04	**Monarto Road**	**332955**	**6115612**	**1.72km**	**E**

Table 1: Summary of Viewpoint locations

05 Visual Impact Assessment

Figure 16: Viewpoint locations and Infrastructure Identification

5.3 Viewpoint 1: Near the intersection of Reedy Creek Road and Hillview Road

<u>Viewpoint Context</u>

Viewpoint 1 is located along Reedy Creek Road within one kilometre of the northeastern corner of the proposed development site. The viewpoint is representative of the anticipated visual effect that will occur to the northeast particularly in relation to the adjacent residential properties along Reedy Creek Road.

This viewpoint is located within the agricultural plains landscape character area looking west over the site and towards the agricultural tablelands. The rising topography of the site towards the western boundary results in a more significant view across the site from this location and an increased potential visual effect.

The surrounding land use is one of a modified agricultural landscape with scattered dwellings and buildings associated with farm storage and processing. The locality of the viewpoint also includes an existing transmission corridor.

There are dense stands of trees along the cadastral boundaries and surrounding most dwellings. The undulating landform creates a defined visual envelop to the south with views extending over a few kilometres to local ridgelines. Views to the north are more extensive with distant views of the Southern Mount Lofty Ranges to the northwest.

Figure 17: Viewpoint 1: Reedy Creek Road, near the intersection with Hillview Road

Figure 18: Digital Overlay showing all solar arraysViewpoint 1

05 Visual Impact Assessment

Figure 19: Photomontage of Viewpoint 1 illustrating the degree of absorption

Viewpoint Assessment

Assessment	Value	Description
Relief	**2**	The topography provides local to sub-regional visual relief with the ridgelines associated to the tablelands landscape that are aligned north-south and east-west to the south and east of the proposed site.
Vegetation Coverage	**3**	Moderate vegetation coverage with substantial cadastral plantings in blocks surrounding the west and east of the site with sporadic copse to the south
Infrastructure and Built Form	**2**	Isolated dwellings associated with farming and rural residential, transmission lines and road infrastructure
Cultural and Landscape Value	**2**	Reedy Creek Road is an arterial road that connects Murray Bridge to Palmer providing a high frequency of use visual experience.
Baseline Landscape	**9**	
Landscape Absorption	**3**	Moderate absorption. The development is noticeable along the local ridge of the locality; however through vegetation and topography the landscape fragments and filters views of the development.
Horizontal	**4**	The horizontal visual effect is substantial occupying 72% of the field of view. The visual mass of the development extends across the landscape and increases in elevation towards Reedy Creek Road
Vertical	**1**	Due to the low lying nature of the development form. The scale of the solar panels and associated infrastructure on the landscape provides insignificant vertical visual effect
Distance	**5**	The viewpoint is located approximately 715m to the southeastern

		corner of the solar panels
Visual Effect	**13**	
Coefficient	**0.65**	
Degree of Visual Change	**29%**	9x0.65= 5.85 Landscape visual effect 5.85/20= Degree of visual change

Description of potential visual impact

The proposed development will be visible extending across the undulating landscape to the southwest. The proposed development is seen as a narrow horizontal band of infrastructure extending across the undulating agricultural landscape. The vegetation associated with the Monarto Road corridor to the south of the development provides a degree of back screening to this section of the proposed development from this viewpoint.

To the north, the proposed development will appear more prominent due to the proximity of the panels to the viewpoint due to the elevation of the ridgeline, resulting in a more of the solar arrays being visible. The absence of vegetation to the top of the plateau increases the visibility and potential visual impact.

When travelling along Reedy Creek Road towards Palmer, the visual effect is likely to increase due to the proximity and oblique angle of views towards the solar panels. However, when travelling towards Murray Bridge, the existing northern vegetation buffer along the road corridor will fragment the view of the development, limiting or completely screening the potential visual effect.

The most prominent visual effect produced by the proposed development will be experienced from this viewpoint looking south due to the topography of the site and the absence of roadside vegetation. However, suitable management and the adoption of landscape treatments to the site boundary would significantly reduce this visual effect and increase the vegetation cover that surrounds the development site.

5.4 Viewpoint 2: Reedy Creek Road

Viewpoint Context

Viewpoint 2is located to the north of the proposed development site along Reedy Creek Road within the agricultural plains just north of the agricultural tablelands. The location is representative of the visual effect that is anticipated when travelling north/south between Palmer and Murray Bridge and adjacent dwellings.

The landscape character is typical of the wider locality with cropped fields and extensive belts of vegetation forming a defined agricultural landscape. The elevated plateau of the tablelands and the south facing slope limit the visibility to the west and southwest. To the east and north, there are views across the undulating topography which extend over several kilometres with distant views of the Southern Mount Lofty Ranges. Views towards the southern Mount Lofty Ranges will not be impacted by the proposed development.

Surrounding the viewpoint area number of residential dwellings associated with agricultural land uses within this locality. The dwellings are typically oriented towards the more panoramic views of the plains and Murray River. There are a number of established stands of trees surrounding these dwellings which reduce the potential for views towards the proposed development site.

Figure 20: Viewpoint 2: Reedy Creek Road

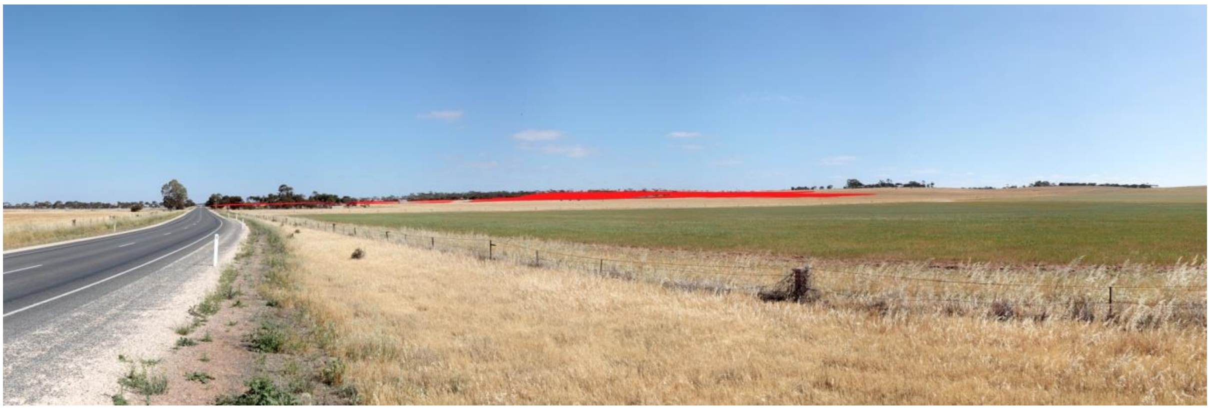

Figure 21: Digital Overlay showing all solar arrays Viewpoint 2

Figure 22: Photomontage of Viewpoint 2 illustrating the degree of absorption

05 Visual Impact Assessment

Viewpoint Assessment

Assessment	Value	Description
Relief	2	The topography provides local to sub-regional visual relief with the ridgelines associated to the tablelands landscape that are aligned north-south and east-west to the south and east of the proposed site.
Vegetation Coverage	3	Moderate vegetation coverage with substantial cadastral plantings in blocks surrounding the west and east of the site particularly surrounding residential properties
Infrastructure and Built Form	3	Isolated dwellings associated with farming, rural residential properties, transmission lines, an airfield and road infrastructure
Cultural and Landscape Value	3	Reedy Creek Road is an arterial road that connects Murray Bridge to Palmer providing a high frequency of use visual experience.
Baseline Landscape	**11**	
Landscape Absorption	1	Substantial landscape absorption capacity. The landscape possesses sufficient vegetation and topography to screen any effect of the development, maintaining the visual character
Horizontal	3	The extent of the horizontal field of view occupied by the development is 65%. This is described as increasing visual effect. A large proportion of the active field of view is affected.
Vertical	1	Due to the low lying nature of the development form. The scale of the solar panels and associated infrastructure on the landscape provides insignificant vertical visual effect with
Distance	5	The distance of the visual effect is within 1.4km this increases the potential visual impact on the locality.
Visual Effect	**10**	
Coefficient	**0.5**	
Degree of Visual Change	**28%**	11x0.5= 5.5 Landscape visual effect 5.5/20= Degree of visual change

Description of potential visual impact

From this viewpoint, the local ridgeline of the tablelands limits views towards the development. Also, existing vegetation screening is provided along Hillview Road to the north of the development. There is a potential for the solar panels to be seen as glimpsed elements through the existing vegetation screen.

The proposed colouration and scale of the solar panels will be similar to existing vegetation that extends along the northern boundary of the site. The height and colour of the solar panels are likely to become recessive elements set behind the canopy layer. The shadowing of the trees will further add to the visual screening of the proposed development with the existing vegetation increasing the potential mitigation of the visual effect.

5.5 Viewpoint 3: Intersection of Guerin Road and Mannum Road

Viewpoint Context

Viewpoint 3 is located at the intersection of Guerin Road and Mannum Road. This viewpoint represents the peri-urban edge of the Rural City of Murray Bridge and the main approach into the city from Mannum. The viewpoint represents the anticipated visual effect from the outskirt of the township.

The viewpoint is located where the agricultural plains transition into the outer residential edge of the city. There is an increase in built form and infrastructure elements associated with this transition point.

The underlying topography is a series of undulating hills which continues to reduce in elevation as the topography meets the Murray River. There are extended views across the agricultural plains to the north. However, the local landforms and urban edge contain views towards the south, west and east.

From this locality there will be limited to no visual change due to the local ridgelines and vegetation, providing sufficient visual absorption. The low lying characteristics of the proposed development mitigate the potential for visual change.

Figure 23: Viewpoint 3: Intersection of Guerin Road and Mannum Road

Figure 24: Digital Overlay showing all solar arrays Viewpoint 3

Figure 25: Absorption Capacity Calculations: Viewpoint 3

Viewpoint Assessment

Assessment	Value	Description
Relief	**2**	Limited local to sub-regional topographic form contains views to the north, west and east. The topography also defines the landscape character associated with the transitional floodplains, agricultural plains and tablelands
Vegetation Coverage	**3**	Dense mallee plantings surrounding the peri-urban fringe of Murray Bridge and tablelands landscape to the north.
Infrastructure and Built Form	**2**	Peri-urban setting with residential properties and infrastructure associated with water pumping and electricity substation
Cultural and Landscape Value	**3**	Mannum to Murray bridge arterial Rd and intersection with Reedy Creek Rd. This provides a high frequency of visitation and potential views.
Landscape Character	**10**	
Landscape Absorption	**1**	The development is entirely screened from view by the local ridgeline to the south of the site
Horizontal	**1**	The horizontal extent of the development is 30% of a potential horizontal field of view. However, the development is screened by vegetation and a local ridgeline to the foreground.
Vertical	**1**	The development is entirely screened from view. Due to the low lying nature of the development form, the scale of the solar panels and associated infrastructure on the landscape provides insignificant vertical visual effect
Distance	**4**	The proposed development is 2.4km from the viewpoint.
Visual Effect	**7**	

Coefficient	**0.35**	
Degree of Visual Change	**18%**	10x0.35= 4 Landscape visual effect 3.5/20= Degree of visual change

Description of potential visual impact

From this viewpoint, the development will not be visible. It is anticipated, that due to the surrounding topography, the pattern of vegetation cover and distance to the development, the visual effect from viewpoint 3 will be typical for most of the western edge of Murray Bridge.

5.6 Viewpoint 4: Monarto Road

Viewpoint Context

Viewpoint 4is located along the Monarto Road close to the northeastern corner of the Monarto Zoological Park. This viewpoint is located on the agricultural tablelands with views to the north towards cropped agricultural properties and large stands of vegetation.

Views to the south are contained due to the existing Murray Bridge to Onkaparinga water pipeline as well as the densely planted landscape of Monarto Zoological Park. The pipeline and dense vegetation continue along the Monarto Road corridor.

There is an existing Electranet substation located along the southern side of Monarto Road. This infrastructure has been co-located with a pumping station for the Murray Bridge to Onkaparinga pipeline. The infrastructure elements associated with the substation and pump station are located at a low point in the local topography and are surrounded by established vegetation which minimises the visibility of the infrastructure.

The 132kV transmission line connects to the substation and then traverses the proposed development site. This results in a concentration of infrastructure elements at this location.

This viewpoint is representative of the typical visual effect experienced to the southwest of the proposed development, including from the surrounding dwellings and the northern edge of the Monarto Zoological Park.

Figure 26: Viewpoint 4: Monarto Road

Figure 27: Digital Overlay showing all solar arrays Viewpoint 4

Figure 28: Absorption Capacity Calculations: Viewpoint 4

Viewpoint Assessment

Assessment	Value	Description
Relief	**3**	From this locality, the topography provides additional containment of views with east-west rolling ridgelines. The variety in scale enhances the complexity to the north of the site as to the surrounds of Monarto Zoological Park and Kinchina Conservation Park.
Vegetation Coverage	**3**	Dense vegetation blocks are located to the north of the site and the west associated with revegetation conservation sites in addition to Monarto Zoological Park and Kinchina Conservation Park
Infrastructure and Built Form	**3**	Scattered residential dwellings are located adjacent to the road corridor
Cultural and Landscape Value	**1**	Local road corridor with limited frequency of views
Landscape Character	**10**	

Landscape Absorption	**1**	The development is entirely screened from view by the local ridgeline and dense vegetation to the north of the site
Horizontal	**1**	The horizontal extent of the development is 35% of a potential horizontal field of view. However, the development is screened by vegetation and a local ridgeline to the foreground.
Vertical	**1**	The development is entirely screened from view. Due to the low lying nature of the development form, the scale of the solar panels and associated infrastructure on the landscape provides insignificant vertical visual effect.
Distance	**5**	The proposed development is 1.7km from the viewpoint.
Visual Effect	**8**	
Coefficient	**0.40**	
Degree of Visual Change	**20%**	10x0.4= 4 Landscape visual effect 4/20= Degree of visual change

<u>Description of potential visual impact</u>

There will be no visual effect experienced from the viewpoint. Views towards the proposed development site are removed due to local landforms and existing densely planted stands of vegetation.

The northern boundary of the Monarto Zoological Park is framed by the existing Murray Bridge to Onkaparinga water pipeline; this forms a defined infrastructure edge to the zoological park. The northern edge of the Monarto Zoological Park is densely vegetated which forms a buffer between the existing infrastructure. It is anticipated that there will be very little visual change experienced from within the park due to this existing edge and vegetation.

5.7 Summary of Visual Impacts

The visual assessment of the four (4) viewpoints demonstrates that a variety of visual impacts will be experienced within the local, sub-regional and regional landscapes that surround the proposed solar and energy storage facility. Typically, the visual effect associated with the solar and energy storage facility will occur within a few kilometres of the proposed site.

The two tables below illustrate and describe the degree of visual change recorded at each of the viewpoints and classification of the potential visual impacts which reflects the immediate surrounds. Of note are the key factors that will affect the visual impact which occurs at each viewpoint and in the wider landscape. They include:

- Underlying topography
- Existing boundary vegetation
- Screening of the proposed development

These visual elements can either screen the proposed development, or fragment the views depending on the receptors perspective.

As shown in Table 2 below, there is a slight to moderate visual effect.

Viewpoints	Relief	Vegetation Coverage	Infrastructure	Cultural/Landscape Value	Landscape Character	Landscape Absorption	Horizontal	Vertical	Distance	Visual Assessment	Degree of Visual Change
Viewpoint 1	2	3	2	2	**9**	3	4	1	5	**13**	**29%**
Viewpoint 2	2	3	3	3	**11**	1	3	1	5	**10**	**28%**
Viewpoint 3	2	3	2	3	**10**	1	1	1	4	**7**	**18%**
Viewpoint 4	3	3	3	1	**10**	1	1	1	5	**8**	**20%**

Table 2: Summary of Visual Impacts

05 Visual Impact Assessment

The following Table 3 is a summary of the classifications described in the GrimKe matrix which provides additional information on the potential visual impact used to describe each viewpoint.

Percentage of Visual Change	**Descriptive of Visual Impact**	**Descriptors – appearance in central vision field**	**Comments**
80-100%	**Extreme**	*Commanding, controlling the view*	*Extreme change in view: change very prominent involving total obstruction of existing view or change in character and composition of the landscape and view through loss of key elements or addition of new or uncharacteristic elements which significantly alter underlying landscape visual character and amenity. The sensitivity of the underlying landscape character to change is unable to accommodate or mitigate the introduction of development, and the visual effect is highly adverse.*
60-80%	**Severe**	*Standing out, striking, sharp, unmistakable, easily seen*	*Severe change in view involving the obstruction of existing views or alteration to underlying landscape visual character through the introduction of new elements. Change may be different in scale and character from the surroundings and the wider setting or a severe change in the context of the existing landscape character. Resulting in a perceived adverse visual effect and an increase in a proportional change to the underlying landscape visual character.*
40-60%	**Substantial**	*Noticeable, distinct, catching the eye or attention, clearly visible, well defined*	*Substantial change in view: which may involve partial obstruction of existing view or alteration of underlying landscape visual character and composition through the introduction of new elements. Composition of the view will alter however the sensitivity of the underlying landscape character to change is low, and it provides opportunities for mitigation, management and absorptions of the visual effect. View character may be partially changed through the introduction of features.*
20-40%	**Moderate**	*Visible, evident, obvious*	*Moderate change in view: change will be distinguishable from the surroundings while the composition and underlying landscape visual character will be retained. The sensitivity of the existing landscape to change is low.*
0-20%	**Slight**	*Lacking sharpness of definition, not obvious, indistinct, not clear, obscure, blurred, indefinite*	*Very slight change in view: change barely distinguishable from the surroundings. Composition and character of view substantially unaltered.*

Table 3: Classification of Visual Impacts

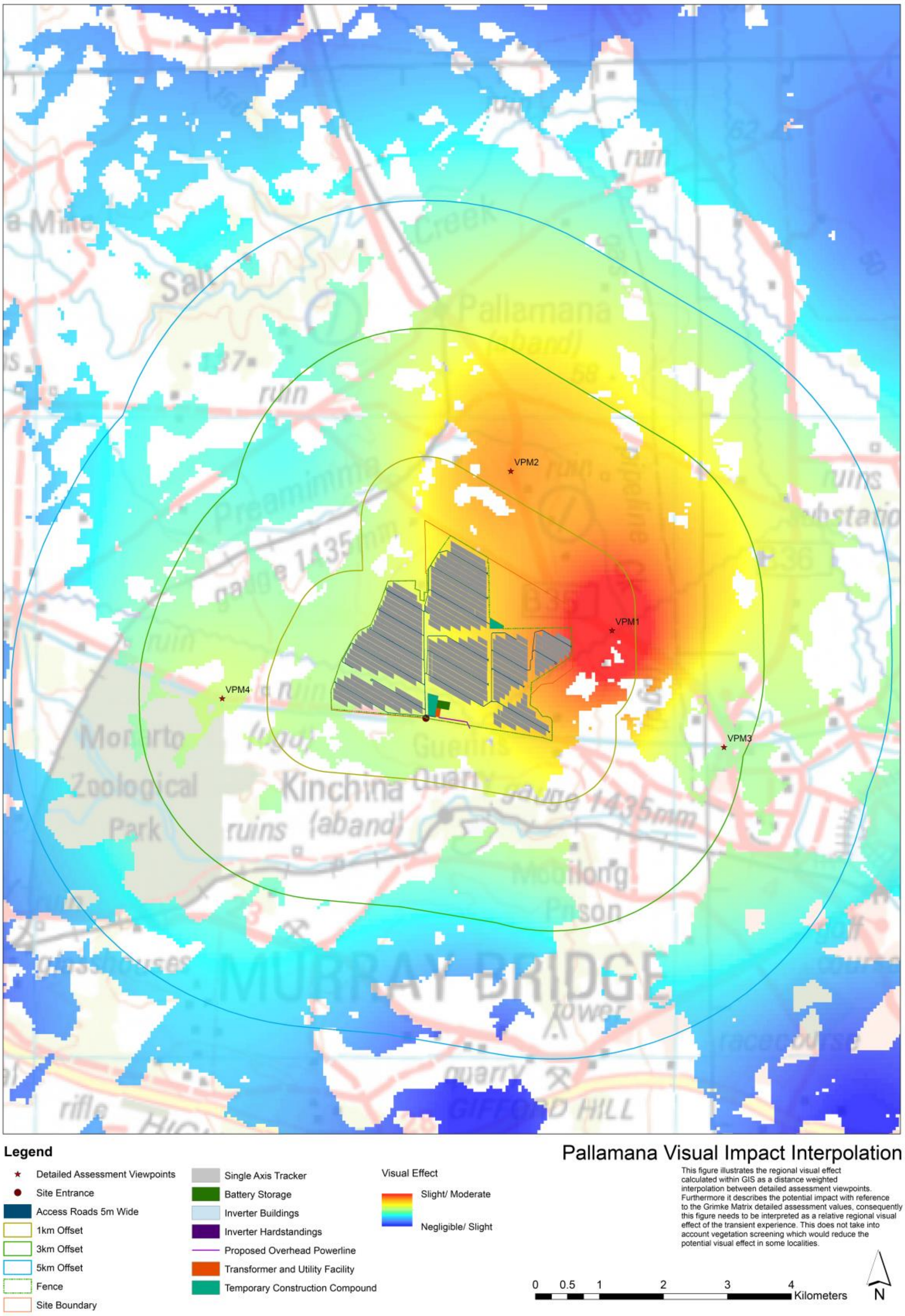

Figure 29: Summary of viewpoint visual effect

5.8 Design Review and Visual Management

The management of the visual effect is a result of the site selection, the existing characteristics of the proposed development site and opportunities to increase landscape treatments to the boundary of the site. Consideration has also been given to the relevant provisions of the Development Plan to guide the landscape planning and resulting visual management.

The elevated plateau associated with the underlying topography of the site removes the potential for views across the proposed development. The solar panels are typically viewed as narrow horizontal bands of infrastructure in the existing rural landscape.

The retention of the established vegetation across the site will aid in visual fragmentation of the development reducing the potential visual effect, particularly, when viewed from the north, west and south. The retention of other areas of vegetation to the perimeter of the proposed site further fragments the potential visual effect.

Other opportunities exist to increase tree planting along road corridors or to establish a second band of vegetation 5-10 metres within the site boundary. These landscape treatments will establish a layered vegetation buffer which will provide a denser screen of vegetation, reducing potential visual impact longer term.

Existing vegetation demonstrates that a screening height of 9-12 metres can be achieved with the local Mallee species. The establishment of screening vegetation to this height along with appropriate development buffers would significantly reduce and fragment the views towards the development, and any visual mass imposed in particular from viewpoint 1.

Material selection and finishes, such as colourbond zincalum finish should be considered for service buildings and other infrastructure to provide a contextual reference within the agricultural building with the rural landscape. Materiality and colour finishes should be selected that are consistent with the surrounding agricultural landscape character to provide additional visual management and enhancement and integration of the proposed development.

It is suggested that the following recommendations and new landscape treatments are implemented to the site boundaries, and other locations to increase the visual management. These include;

- Establish landscape buffers, particularly along the Reedy Creek Road corridor and the Monarto Road boundary of the site. This will fragment the visual mass and bulk of the development.
- Use local plant species to encourage maximum growth heights are achieved. Established trees in the locality suggest that screening trees could reach a height of approximately 15 metres over 10-20 years.
- Consider mounding with swale combination to increase stormwater collection and increase potential visual screening. The planting will then create a layered vegetation screen.
- Landscaping within the existing transmission line corridors should be consistent with access and electricity generation requirements.
- Landscape proposals immediately surrounding the development should be consistent with bushfire risk mitigation requirements.

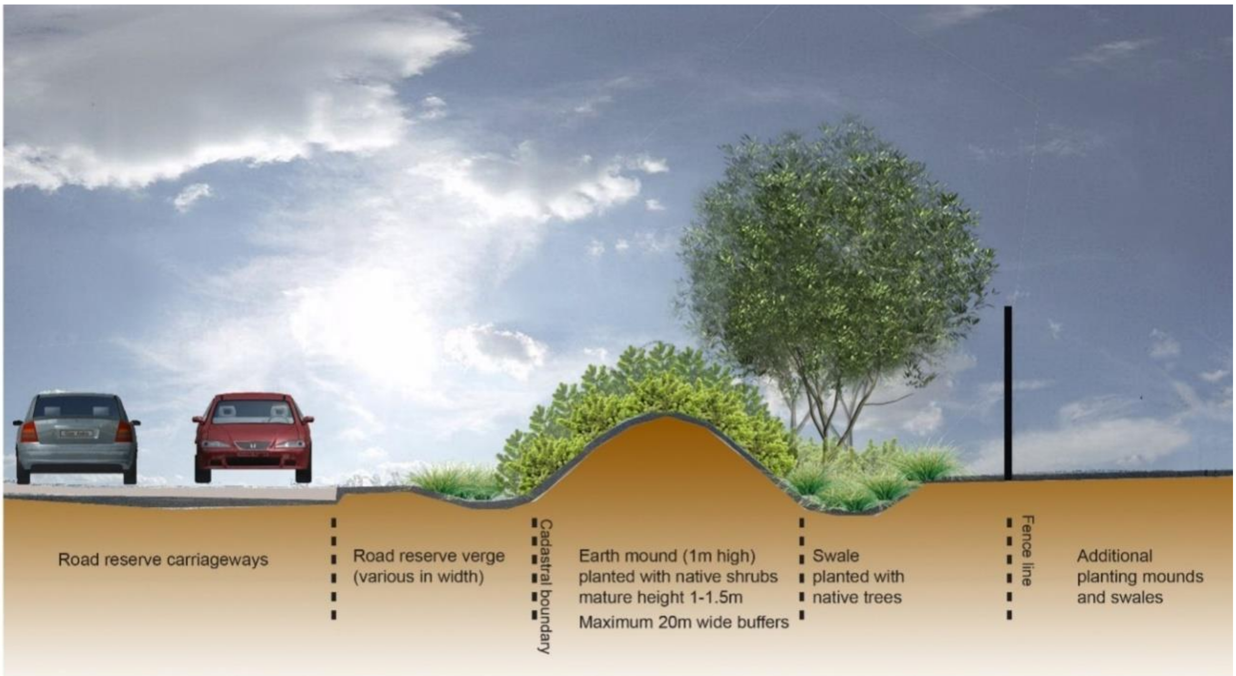

Figure 30: Typical planting buffer detail (not to scale)

5.9 Visual Effect Assessment for Associated Infrastructure

In addition to the visual effect of the solar arrays, an assessment was undertaken to understand the anticipated visual effect of any associated infrastructure including the collector substation, proposed battery storage facility, and site office.

For clarity and legibility of the report all reference images, maps and photomontages have been extracted to Appendix A and C and reproduced at A3 to enable them to be studied while reviewing the associated text for each viewpoint.

5.10 Utility Zone, Collector Station, Substation and Control Room

The proposed main entrance to the site is located along Monarto Road along the southern boundary approximately 500 metres west of the SA Water pumping station. The utility zone is located close to the main entrance and includes a collector substation and battery storage facility. The site office and control room will be co-located with these other infrastructure elements. The collector substation will cut into the existing 132kV transmission line; there will be no increase in transmission lines running through the site.

It is anticipated that the collector substation will be relatively small with a cut in tower similar in scale and development form to the existing transmission towers. The location of an existing substation along the southern side of Monarto Road ensures that this additional collector substation will be seen as an increase in existing infrastructure within the locality.

Buildings to house the batteries are to be constructed as corrugated sheds which will fit into the wider agricultural context regarding scale, colouration and form.

The proposed height of associated infrastructure including the Control Room, Storage Shed, Substation and On-site Collector Station will be approximately 3 to 4 metres in height. Also, these infrastructure elements are set within the solar arrays. With the solar arrays surrounding these elements, the utility zone and substation, battery units will be seen as part of the larger development rather than individual elements in the landscape.

The existing belts of vegetation to the north and west and the existing roadside vegetation along most of Monarto Road will reduce the visibility of these pieces of infrastructure from the road corridor and other areas to the south.

There are two lay-down areas which will be used during the construction phase of the development; once this phase is complete, these elements will be clear of any structures. It is anticipated that over time these areas will be subjected to weathering and revegetation with the surrounding grass species which will remove any associated visual effect.

As described previously, the visual mitigation provided by local landforms and existing vegetation will mitigate the visual effect with glimpsed views likely to be experienced along Monarto Road.

5.11 Access tracks

As part of the proposed development, a series of compacted gravel tracks will be required across the site to access the solar arrays for maintenance. It is anticipated that these access tracks will be approximately 3-4m width. The form, materiality and colour of the new tracks will be in keeping with other tracks and roads in the area.

While the proposed tracks will appear as new development, post construction they will not appear out of character within the wider rural landscape. The track surface will be crushed rock sourced either on-site or from a local supplier. Over time, the track material is likely to weather and will be subject to the revegetation to the track edges which will further reduce the associated visual effect.

Finally, the visibility of the tracks needs to be assessed relative to the other development forms associated with the solar farm proposal. The proportional effect of the tracks will always be a secondary or partial visual element when considered against the degree of visual change produced by the low lying development form of the solar arrays. In this regard, the visual effect of the track is described as negligible and will progressively diminish over time.

06 Review of Development Plan

6.0 Review of Development Plan

6.1 Introduction

The Murray Bridge Council Development Plan (consolidated 23 January 2018) provisions, zones and policy areas have been considered in relation to the potential visual effect of the Pallamana Solar and Energy Storage Facility and associated infrastructure.

Consideration has been given to the Primary Production Zone provisions and North Central Policy Area 5 as well as the General Provisions in relation to Renewable Energy Facilities and Siting and Visibility. The review intends to provide clarity as to the relevance and consistency with particular provisions in relation to the proposed solar and energy storage facility and associated infrastructure, visual impacts, and the effects on the landscape character and amenity.

While it is acknowledged that under the Development Act 1993 a solar farm is defined as development as a building or structure, consideration has been given to the relevance and applicability of numerous provisions of the Development Plan to a solar farm. To assess whether a provision applies to this form of development the following considerations have been applied:

- The context in which the provision applies, or the intent behind the provision, including what form of development the provision refers to and in what situation it would apply.
- Whether the provision is relevant to a solar farm development, and whether said provision appears to have been written with solar farms or renewable energy production in mind.
- Whether the provision is a realistic expectation in relation to a solar farm development.

  For example, where provisions refer to walls, verandahs or windows, the associated provisions have not been considered relevant or realistic when applied to a solar array specifically or a solar farm in general

(The Objectives and Principles that are considered relevant to management and mitigation of visual impacts have been underlined for clarity).

Primary Production Zone

OBJECTIVES

1 *The long term continuation of primary production.*

2 *Economically productive, efficient and environmentally sustainable primary production.*

3 *Allotments of a size and configuration that promote the efficient use of land for primary production.*

<u>4 *Protection of primary production from encroachment by incompatible land uses and protection of scenic qualities of rural landscapes.*</u>

5 *Accommodation of wind farms and ancillary development.*

<u>6 *Development that contributes to the desired character of the zone.*</u>

DESIRED CHARACTER

This zone covers the majority of the rural area throughout the Rural City of Murray Bridge. The zone will incorporate environmentally sustainable rural activities and maintain a rural character.

<u>*Development will be undertaken in a manner that minimises adverse impacts on water resources, biodiversity or the visual and scenic quality of the environment, and does not result in air and land pollution, weed infestation, vermin proliferation or the uneconomic provision of infrastructure.*</u>

Wind farms and ancillary development such as substations, maintenance sheds, access roads and connecting power-lines (including to the National Electricity Grid) are envisaged within the zone and constitute a component of the zone's desired character. These facilities will need to be located in areas where they can take advantage of the natural resource upon which they rely and, as a consequence, components (particularly turbines) may need to be:

- *located in visually prominent locations such as ridgelines*
- *visible from scenic routes and valuable scenic and environmental areas*
- *located closer to roads than envisaged by generic setback policy.*

This, coupled with the large scale of these facilities (in terms of both height and spread of components), renders it difficult to mitigate the visual impacts of wind farms to the degree expected of other types of development. Subject to implementation of management techniques set out by general/council wide policy regarding renewable energy facilities, these visual impacts are to be accepted in pursuit of benefits derived from the increased generation of renewable energy.

PRINCIPLES OF DEVELOPMENT CONTROL

14 Buildings should primarily be limited to farm buildings (including storage and implement sheds, pump sheds and the like), a detached dwelling associated with primary production on the allotment and residential outbuildings that are:

(a) grouped together on the allotment and set back from allotment boundaries to minimise the visual impact of buildings on the landscape as viewed from public roads

(b) screened from public roads and adjacent land by existing vegetation or landscaped buffers.

18 Buildings should be set back a minimum of 50 metres from every public road, other than adjacent to the South Eastern Freeway and the Old Princes Highway where the setback should be a minimum of 100 metres.

Renewable Energy Facilities

OBJECTIVES

1 Development of renewable energy facilities that benefit the environment, the community and the state.

2 The development of renewable energy facilities, such as wind farms and ancillary development, in areas that provide an opportunity to harvest natural resources for the efficient generation of electricity.

3 Location, siting, design and operation of renewable energy facilities to avoid or minimise adverse impacts on the natural environment and other land uses.

PRINCIPLES OF DEVELOPMENT CONTROL

1 Renewable energy facilities, including wind farms and ancillary development, should be:

(a) located in areas that maximise efficient generation and supply of electricity; and

(b) designed and sited so as not to impact on the safety of water or air transport and the operation of ports, airfields and designated landing strips.

06 Review of Development Plan

Siting and Visibility

OBJECTIVES

1 *Protection of scenically attractive areas, particularly natural and rural landscapes.*

PRINCIPLES OF DEVELOPMENT CONTROL

1 *Development should be sited and designed to minimise its visual impact on:*

(a) the natural, rural or heritage character of the area

(b) areas of high visual or scenic value, particularly rural areas

(c) views from the River Murray, public reserves, tourist routes and walking trails.

2 *Buildings should be sited in unobtrusive locations and, in particular, should:*

(a) be grouped together

(b) where possible be located in such a way as to be screened by existing vegetation when viewed from public roads.

4 *Buildings outside of urban areas and in undulating landscapes should be sited in unobtrusive locations and in particular, should be:*

(a) sited below the ridgeline

(b) sited within valleys or behind spurs

(c) sited in such a way as to not be visible against the skyline when viewed from public roads

(d) set well back from public roads, particularly when the allotment is on the high side of the road.

8 *Development should be screened through the establishment of landscaping using locally indigenous plant species:*

(a) around buildings and earthworks to provide a visual screen as well as shade in summer, and protection from prevailing winds

(b) along allotment boundaries to provide permanent screening of buildings and structures when viewed from adjoining properties and public roads

(c) along the verges of new roads and access tracks to provide screening and minimise erosion.

Discussion

The Primary Production Zone does not specify a solar energy production facility and battery storage facility as an anticipated form of development within this zone. The Development Plan is also silent on solar developments and the potential or required visual management of these types of developments. Consequently, for the purposes of this assessment the Objectives and Principles of Development Control (PDC) which consider visual impact including, setbacks and screening are considered relevant and are discussed.

Structural elements of the development typically have a setback exceeding 50 metres, which satisfies the intent of PDC 18. This substantially satisfies the intent of PDC 15. Within this setback are established stands of trees as well as a transmission line along the southern site boundary. The project layout has identified the retention of all established stands of trees along the road corridors and areas along some of the internal cadastral boundaries. The retention of this vegetation will aid in

reducing and fragmenting the visual effect of the development satisfying PDC 14b as well as providing visual management of the proposed development in the existing landscape.
Also, the relative elevation and local topographic features associated with the site produce visually contained location which means that the visual effects produced by the solar farm extend over a relatively short distance and the visibility of the proposed development is contained within a defined viewshed that extends to a maximum distance of 3-5 kilometres.

The proposed site selection meets Objective 3 of the Renewable Energy Facilities provisions by minimising adverse impacts on the natural environment, and other land uses specifically visual impacts. Similarly, Objective 1 and PDC 1, 2 and 4 of the Siting and Visibility CW provisions are substantially met due to the limited visual effect produced by the Pallamana Solar and Energy Storage Facility and the screening that the existing landscape character provides. These factors help to protect the rural landscape.

Any visual effects on the wider landscape are contained within few kilometres of the development and are described as slight with an isolated area of moderate visual impact to the east of the proposed site. Beyond two kilometres the topography and existing belts of vegetation provide increased levels of screening. At a distance exceeding seven kilometres, the proposed development is almost completely screened, contained by the defined viewshed associated with the surrounding landforms and extensive tree cover associated with the rural landscape.

In this regard, the combination of site selection, siting and landscape screening of the Pallamana Solar and Energy Storage Facility manage the potential visual effect to the degree that meets the intent of the Primary Production Zone and the General Provisions.

The potential for further landscape mitigation has been expanded in paragraph 5.8 of the report. The development of new vegetation belts and landform mounds throughout the development will reduce the homogenous visual mass and screen sections of the development from visually sensitive areas such as the Reedy Creek Road and Hillview Road as well as Monarto Road and surrounding properties.

The development of a landscape framework to manage the visual effect meets the intent of PDC 8 of the Siting and Visibility CW provisions in relation to screening through the establishment of landscaping using locally indigenous plant species

7.0 Viewer Sensitivity

The preceding assessment considers the visual effect of the solar and energy storage facility from various locations having regard to the existing landscape quality and the degree of visual change in the existing environment. It does not measure the extent to which a viewer's response or sensitivity to landscape changes and how this influences the perception of visual effect.

The viewer's sensitivity is the degree to which visual change is perceived or experienced and whether this is seen as a positive or negative visual effect. Therefore, it is likely that local residents, who are most familiar with the landscape, will experience a greater degree of change than perhaps occasional visitors to the area. However, whether the change is perceived as positive or negative will depend on the viewer's opinions.

By contrast, the majority of tourists may perceive no change and see the solar farm as part of the existing visual environment.

The truth may be that within all user groups, be they locals, tourists, walkers or weekenders, a spectrum of opinions can be expected based on differing views on the receiving landscape, the visual appeal of renewable energy. The final level of viewer sensitivity becomes the personal preference of the viewer as to whether the visual change is positive or negative, as an assessment of social or demographic groups can only be subjective, it does not form part of this discussion.

08 Conclusion

8.0 Conclusion

The existing landscape that surrounds the proposed Pallamana Solar and Energy Storage Facility has a modified rural character that is defined by the tablelands and undulating landscapes of the Southern Mount Lofty Ranges. The proposed solar farm is located in an area of elevated land to the northwest of Murray Bridge. The combination of localised topographic variations, and significant belts of vegetation results in a visual effect that is contained to 2-3 kilometres.

The topography of the site and the continuous sloped elevation towards the Murray River ensures that there are limited opportunities within the locality for the proposed development to be seen from elevated locations.

The detailed visual impact assessment describes the visual effect as slight with isolated areas of moderate, with a degree of visual change that ranges from 20% to 29%. The variation in the degree of visual change results from variations in the landscape character and the amount of visual absorption provided by existing landscape elements, particularly in relation to local landforms and vegetation associated with the Monarto Tablelands. The visual effect produced by the proposed development in the existing landscape character produces three distinct visual effects to the northwest, east and south.

To the northwest, the existing landscape character is defined by the undulating topography of the Southern Mount Lofty Ranges. Numerous ridgelines and valleys, in combination with extensive areas of vegetation, create visual screens across the landscape restricting views to the proposed site. From the northwest, the Pallamana Solar and Energy Storage Facility is not visible in the landscape, and no visual effect is produced.

The Monarto Zoological Park forms a densely vegetated landscape character to the south. The existing vegetation and recent re-vegetation of the park increase the landscape screening and amenity to the edges of the zoological park. The potential for any visual impact between the two sites is minimised due to the extent of vegetation and surrounding ridgelines to the north.

South of the proposed solar and energy storage facility, the underlying landform of the Kinchina and Narrinyeri Hills result in a series of pronounced topographic variations that define the visual character of the landscape, creating a contained visual character. The combination of topography and vegetation cover in the form of the Kinchina Conservation Park produces significant screening, and no visual effect is produced.

Further south, Gifford Hill provides an elevated location from which potential visual effects may be experienced. However, at distances of five to seven kilometres, the narrow profile and colouration of the solar panels will produce a similar visual effect to the existing belts of evergreen trees that are present in the locality. The similarity in form and colour reduces the visual contrast of the proposed development within the existing landscape character, and the degree of visual change is likely to be considered as negligible when viewed from regional and sub-regional locations.

Along Reedy Creek Road to the southeast, the arrangement of the solar panels, orientation of the underlying topography and a reduction in screening vegetation results in Pallamana Solar and Energy Storage Facility being visible in the existing rural landscape. From viewpoint 1, a distinct section of the proposed development is visible and produces a visual effect that is described as moderate. The proximity of the viewpoint to the solar and energy storage facility and the significance of the adjacent road corridor on which the viewpoint is located, increase the visual effect.

From locations further to the south and north, the inter-relationship of vegetation and the rising topography on which the development is sited reduces the visibility of the solar and energy storage facility. The solar panels are visible as a narrow horizontal band of development, set behind the boundary vegetation of the site. The elevation of the solar panels on the site restricts potential views over or across the proposed development limiting the visual effect. This is demonstrated in viewpoint 2 and reflected in the degree of visual change which is measured at 28%.

08 Conclusion

The existing topography and vegetation cover associated with Pallamana Solar and Energy Storage Facility results in an enclosed visual character with few locations where a significant proportion of the proposed development is visible. From the south, northwest and areas on the edge of Murray Bridge, the proposed development is screened, and no visual effect occurs. To the northeast and east, along Reedy Creek Road and the adjoining agricultural landscape, the solar panels and associated infrastructure will be visible. The location of the solar panels on the east facing slope of the site increases the visibility of the proposed development with the visual effect extending out across the landscape to a maximum of three kilometres. Beyond this distance, the visibility of the proposed development will be limited.

The visual management techniques described in paragraph 5.8, aim to reduce the visual effect and the inclusion of earth mounding along the cadastral boundaries, planted with native shrubs and small mallee trees will provide additional screening. This integrated planning and landscape design approach will further limit the visual effect of the proposed solar farm, particularly to the northeast and east, particularly along Reedy Creek Road.

Based on the visual assessment, this report concludes that the degree of visual change that will result from the development of the Pallamana Solar and Energy Storage Facility will be slight with isolated areas of moderate impact. In addition, the existing landscape has the capacity to accommodate the proposed development. It is our interpretation and evaluation that the degree of visual change associated with the proposed development will be acceptable retaining the existing regional rural character, defined by the development plan principles.

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Landscape Character and Probable Visual Effect Assessment

Monarto Solar and Energy Storage Facility

Prepared for RES Australia Pty Ltd

By Warwick Charles Digby Keates and Brett Grimm

6 August 2018

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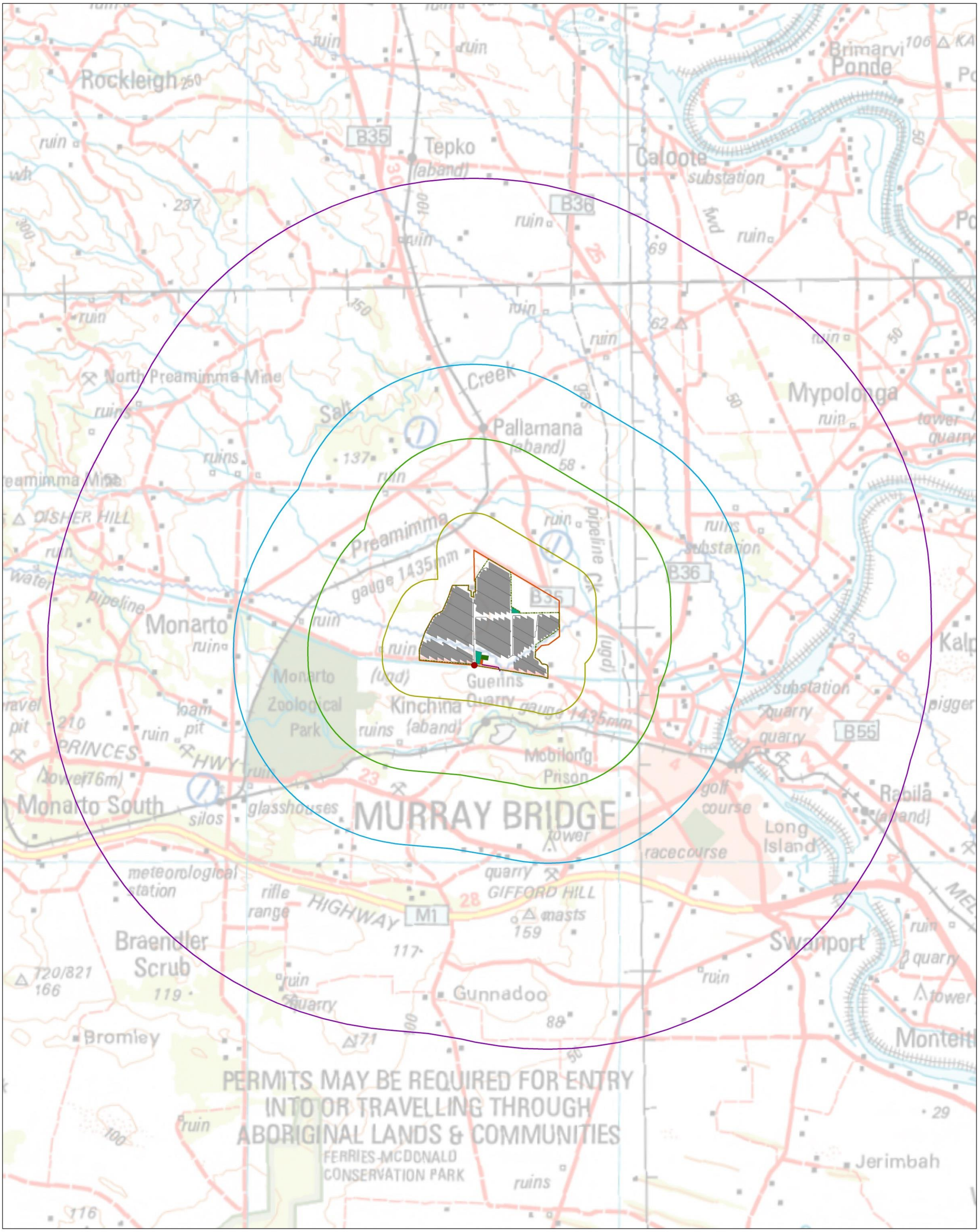
REVISION	DATE	AUTHOR	REVIEWER
C	6 August 2018	KP	WK
B	13 July 2018	WK	WK
A	14 February 18	WK	WK

Appendix A
Assessment Mapping



Legend

- Site Entrance
- Access Roads 5m Wide
- 1km Offset
- 3km Offset
- 5km Offset
- 10km Offset
- Site Boundary
- Fence
- Single Axis Tracker
- Battery Storage
- Inverter Buildings
- Inverter Hardstandings
- Proposed Overhead Powerline
- Transformer and Utility Facility
- Temporary Construction Compound

Pallamana Site Locality

0 1 2 4 6 Kilometers

N

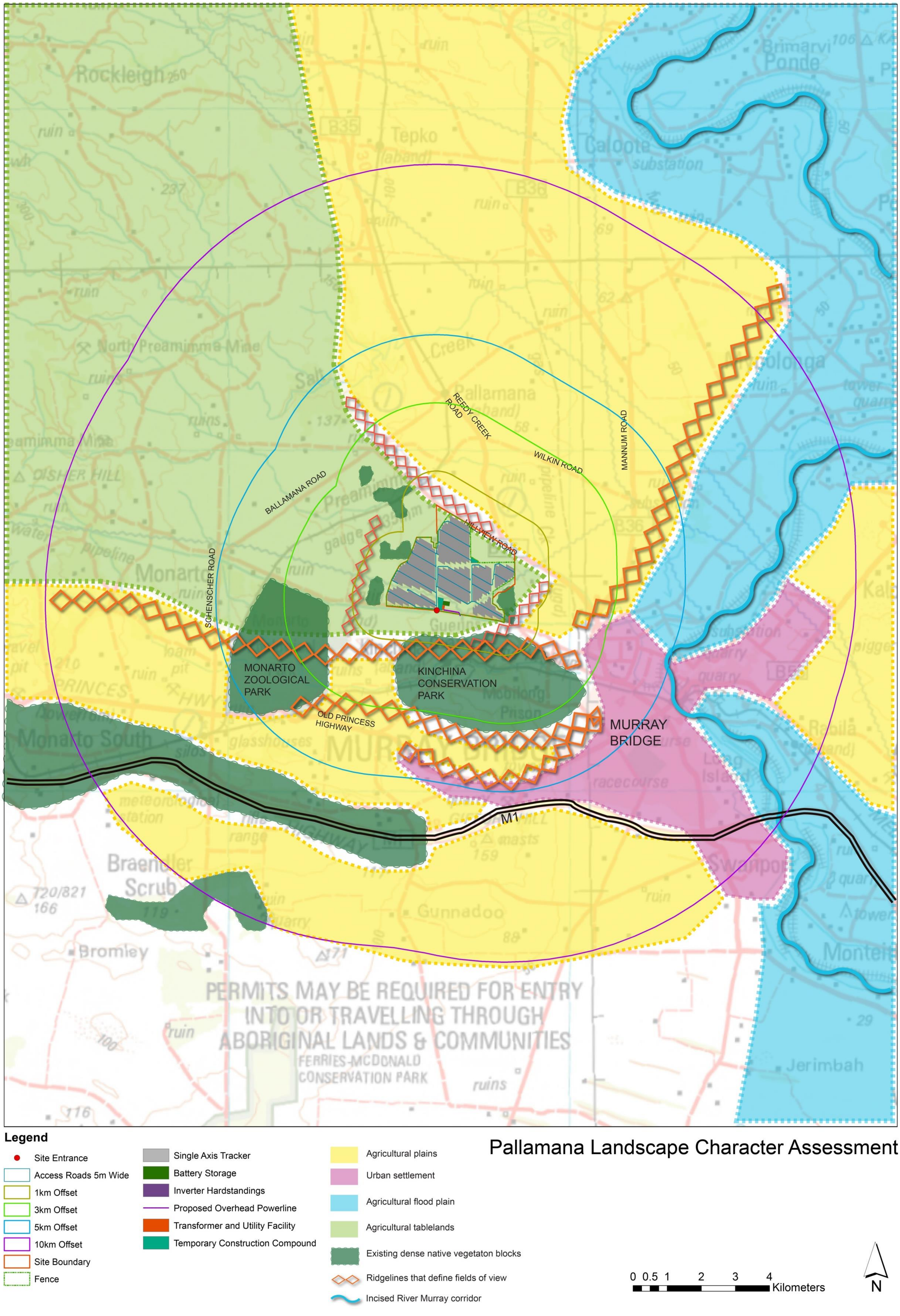
Legend

- Site Entrance
- Access Roads 5m Wide
- 1km Offset
- 3km Offset
- 5km Offset
- Fence
- Site Boundary
- Single Axis Tracker
- Battery Storage
- Access Roads 5m Wide
- Inverter Buildings
- Inverter Hardstandings
- Overhead Powerline
- Transformer and Utility Facility
- Temporary Construction Compound

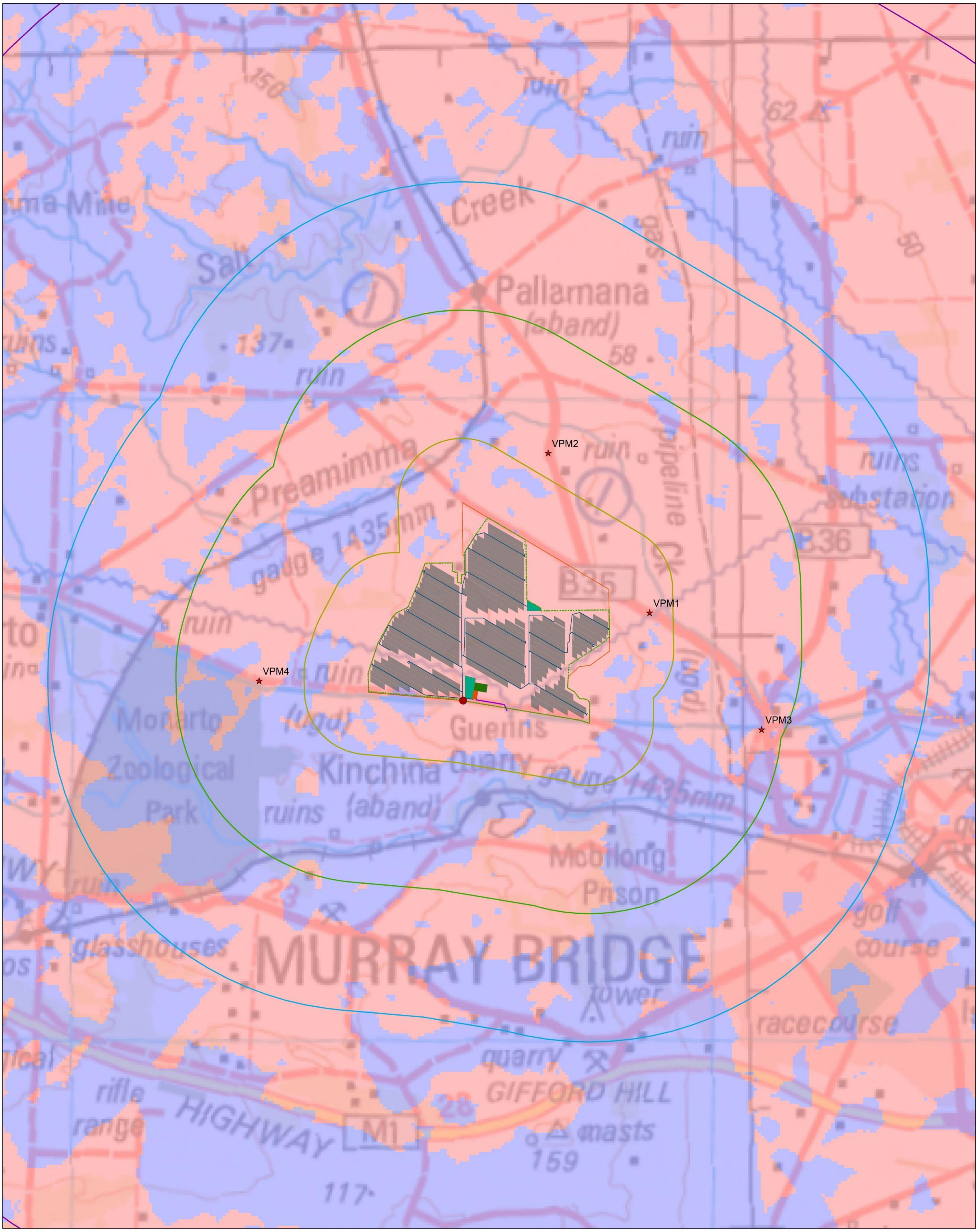
Pallamana Topography

0 0.5 1 2 3 4 Kilometers

N



Pallamana Landscape Character Assessment



Pallamana Solar Farm- Zone of Theoretical Visual Influence

Legend

- Detailed Assessment Viewpoints
- Site Entrance
- Access Roads 5m Wide
- 1km Offset
- 3km Offset
- 5km Offset
- Fence
- Site Boundary
- Single Axis Tracker
- Battery Storage
- Inverter Buildings
- Inverter Hardstandings
- Proposed Overhead Powerline
- Transformer Utility Facility
- Temporary Construction Compound

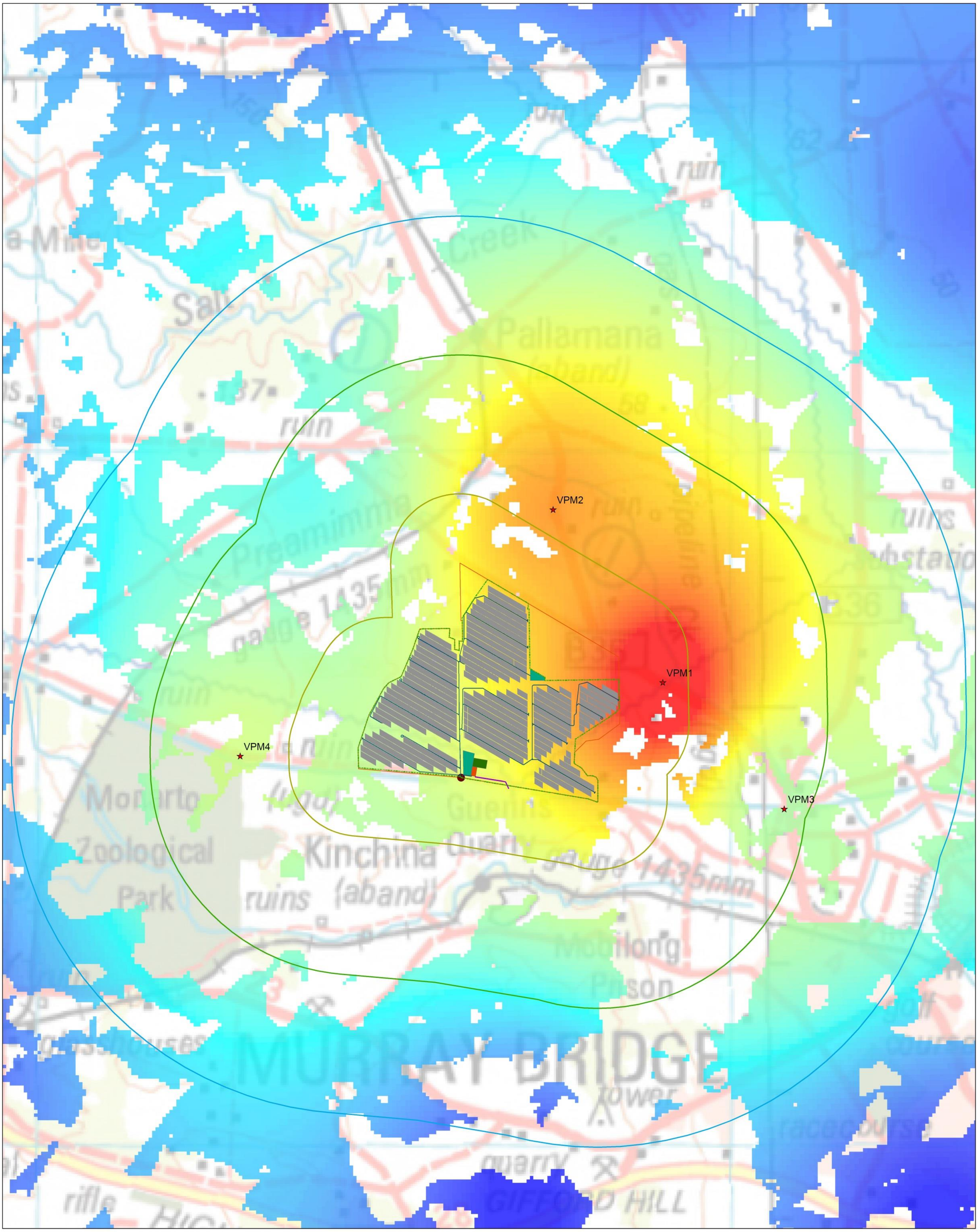
Potential Visibility

- Not visible
- Visible

ZTVI represents 'worse case scenario', it is based on 10M contour data and does not take into account vegetation or built form screening

0 0.5 1 2 3 4 Kilometers

N



Pallamana Visual Impact Interpolation

This figure illustrates the regional visual effect calculated within GIS as a distance weighted interpolation between detailed assessment viewpoints. Furthermore it describes the potential impact with reference to the Grimke Matrix detailed assessment values, consequently this figure needs to be interpreted as a relative regional visual effect of the transient experience. This does not take into account vegetation screening which would reduce the potential visual effect in some localities.

Legend

- Detailed Assessment Viewpoints
- Site Entrance
- Access Roads 5m Wide
- 1km Offset
- 3km Offset
- 5km Offset
- Fence
- Site Boundary
- Single Axis Tracker
- Battery Storage
- Inverter Buildings
- Inverter Hardstandings
- Proposed Overhead Powerline
- Transformer and Utility Facility
- Temporary Construction Compound

Visual Effect

Slight/ Moderate

Negligible/ Slight

0 0.5 1 2 3 4 Kilometers

N

Appendix B

Photographic Methodology (produced by Convergen)

The method consists of 6 stages. The following summarises the stages;

1. Viewpoints are identified using a Zone of Theoretical Visibility map, site assessment and in consultation with the client and residents in the area. The viewpoints are selected to represent the worse case scenario i.e. the maximum number of turbines visible within the field of view. The locations of viewpoints are typically representative of the regional landscape character units or identified by residents. The locations represent a diverse range of views from around the wind farm at a variety of directions and distances.

2. Photos are taken onsite using a 32mm lens digital SLR camera (50mm equivalent analogue). Numerous research papers have concluded that this is most representative of the human eye for depth of field. Photos are taken on a mounted tripod and the height recorded to eye level. In addition the elevation of the viewpoint is recorded Above Sea Level (ASL) using the barometric measure on a handheld GPS device. The weather and time of day are also recorded to enable computer model rectification in stage 4 and 6 of the process.

3. The centre of the field of view is equated onsite using a bearing compass and GPS to the projected centre of the development. A field of view of 60 degrees to either side of centre is established onsite to provide the full 120 degrees. The extent of the field of view is recorded and evaluated onsite using the GPS and bearing compass. 6 photos are taken for each viewpoint with 1/3 overlap of each to enable photo stitching. The bearing to centre of each photo is recorded to enable cross reference to the next phase of developing a computer model. During the site photography numerous fixed known visual markers are recorded with a GPS location and bearing from the viewpoint. These markers provide reference points within the computer modelling for due diligence.

4. To generate the panoramic photographs the individual photographs are stitched together using PTGui software.

5. The next stage of the process involves the computer generation of a wire frame perspective view of the wind farm, which incorporates the topography from each viewpoint. Using the Wind Farmer™ software the wire frame is produced using a digital terrain model with 10 metre contour intervals. This creates the topography and positions the turbines at the correct coordinates and elevation within the wire frame. The correct field of view is established by matching the viewing centre of the view angle to the camera and lens used for the photography with the wire frame. This ensures that the image size and angle of view of the wire linematches the photos taken. The wire line is then superimposed on the stitched panoramic photograph and matched in accordance to reference markers and landscape features.

6. A second site visit is conducted with the preliminary wire lines to certify the correct locations of the turbines using a GPS and bearing compass. Minor alterations are marked up on the drafts to mitigate the effects of photographic warping to the periphery of the stitched panorama. Ground truthing the turbine locations, provides rigour to the process. Typically if any amendments are required they are within 1-5 degrees.

7. Once the wire frame and photograph have been lined up the rendered image of the turbines are created. The rendered model is created in Wind Farmer™ using the correct sun angle for the date and time of the day that the photograph was taken. The rendered model is exported to Photoshop™ for final matching with the photograph. The rendered image is edited, masking

turbines or parts their off that are screened by vegetation and other elements to the foreground. Additional visual effects are applied to match the lighting effects of shadow imposed by vegetation etc.

Viewing of Photomontages

Given that the objectives of photography and photomontage are to produce printed images of a size and resolution sufficient for use in assessment work in the field, the exact dimensions of these images will depend on the characteristics of the field of view.

All photographs, whether printed or digitally displayed, have a unique, correct viewing distance - that is, the distance at which the perspective in the photograph correctly reconstructs the perspective seen from the point at which the photograph was taken. The correct viewing distance is stated for all printed or digitally displayed photographs and photomontages, together with the size at which they should be printed.

The viewing distance and the horizontal field of view together determine the overall printed image size.
Photographs and photomontages should be printed or published digitally at an appropriate scale for comfortable viewing at the correct distance, noting the limitations of the printing process particularly with regards to colour and resolution. Guidance is provided on viewing the image in order to best represent how the proposal would appear if constructed, such as the required viewing distance between the eye and the printed image. Panoramic images should be curved so that peripheral parts of the image are viewed at the same intended viewing distance. The 'before' photograph and the 'after' photomontage should be presented on the same page and/or at the same scale to allow comparison if practicable.

References

Landscape Institute Photography and photomontage in landscape and visual impact assessment (March 2011)

Landscape Institute and IEMA (2002) Guidelines for landscape and visual impact assessment (2nd ed). London: Spon.

Scottish Natural Heritage (2006) Visual representation of windfarms: good practice guidance. Inverness: Scottish Natural Heritage. SNH report no. FO3 AA 308/2

Appendix C

Photomontages

Viewpoint 1 with red overlay

Viewpoint 1 Photomontages

Viewpoint 2 with red overlay

Viewpoint 2 Photomontages

Viewpoint 3 with red overlay

Viewpoint 4 with red overlay

Appendix D
GrimKe Assessment Matrix

The GRIMKE Matrix has been based on the WAX (2006) and HASSELL Matrix (2005), and with reference to The Visual Management System (VMS) produced by Litton (1968) primarily used for the U.S. Forest Service (1973) and the US Bureau of Land Management (1980). These models are based on a professional consultant (Landscape Architect) quantifying potential changes to landscape composition through "forms, lines, colours and textures and their interrelationships"1. Other factors such as compositional qualities, dominance, variety, animation and sensitivity to potential receptors are also considered.

The extent of visual impact was identified on site, using a GPS with a Wide Area Augmentation System (WAAS) that provides positional accuracy to within 3 metres.i Using the GPS, the location and extent of the development was plotted as 'waypoints', using longitude and latitude, elevation and distances to provide geographic referenced data. The surrounding area was then surveyed with the GPS and a SILVAii bearing compass to calculate the bearing and distance between the viewpoint and the subject area. This methodology was used to assess where the development is in the landscape and whether it is visible.

The GrimKe Matrix considers two key aspects in terms of understanding visual impact and the resulting visual assessment. The initial assessment is a quasi-objective measurement, where a landscape architect considers the landscape character of the site and particularly in relation of this landscape to the viewpoints that have been selected as part of the assessment criteria. Each viewpoint is then assessedin terms of:

- Relief (the complexity of the land that exists as part of the underlying landscape character)
- Vegetation Cover (the extent to which vegetation is present and its potential to screen and filter views)
- Infrastructure and Built Form (the impact of development on landscape and visual character)
- Cultural and Landscape Value (quantification of recognised planning overlays)

Assessing each viewpoint and the regional context (cultural and landscape value) a quantified value is generated for landscape character. This value then forms the baseline assessment value, which will be modified by the impact of the development within the landscape, which in turn will be measured as part of the visual assessment.

This two-tiered assessment methodology ensures the degree of visual impact is assessed against a quantified landscape character value enabling, the GrimKe Matrix to accurately quantify the degree of visual impact that is experienced as a result of implementing the development.

The assessment considers the landscape as three distinct zones based on the distance from the proposed development. The three zones were defined as; local (0-1km), sub-regional (1-5km) and regional (5-30km). (Planning South Australia, 2002). Specific landscape characters are also identified to provide a complete assessment of the landscape context.

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[1] *Daniel, T C & Vining, J (1980) p49*

1. Landscape Character Assessment

1.1 Relief

This is an assessment of the landscape complexity in terms of the underlying topography. The relationship of relief assists in defining the landscape and the visual character of an area. This is relevant in terms of the position and elevation of a proposed development within the landscape and the viewpoint.

The topography is assessed both on site (from each viewpoint) and as part of a desktop review (topography mapping). The assessment considers the topographical complexity in terms of local, sub-regional and regional. Within each zone an assessment is made of the topography and the complexity of landscape features.

The assessment is concerned with landscape complexity and how it impacts on the visual character. The assessment considers landform patterns, dominant elements and other distinguishing topographical features that will impact on the visual context.

Relief (expressed as percentage)	Value	Description of Landscape Relief
80-100%	5	Substantial landscape relief. The landscape possesses significant topographic variations, features and prominent elements creating a dynamic landscape context.
60-79%	4	Increasing relief. Due to the scale of the topography and frequency of features.
40-59%	3	Moderate relief. Medium level of change to the landscape. Occasional landscape features and topographic variation.
20-39%	2	Limited relief. Small amount of topographic variation in the landscape.
0-19%	1	No or minor relief within the landscape. The landscape is considered feature less, without noticeable elements or patterns.

1.2 Vegetation Coverage

Vegetation coverage is a measurement of the extent, character and frequency of vegetation that exists at each viewpoint and within the local, sub-regional and regional zones. The extent of vegetation provides the potential for screening and to reduce the visual effect of development. Conversely, a lack of vegetation results in an increase in the visual significance of a development.

This measurement responds to the potential visual absorption of the landscape as measured by the visual matrix. Again, this assessment considers the dominant vegetation patterns within each zone and in relation to each viewpoint.

Vegetation Coverage (expressed as percentage)	Value	Description of Vegetation Coverage
80-100%	5	Natural or non-harvested commercial forests. Significant areas of treed vegetation creating an arboreal landscape.
60-79%	4	Bushland or woodlands. Major areas of vegetation that define the landscape character of an area
40-59%	3	Tree groups, copse, screens, shelter belts. Defined areas of vegetation creating a layered landscape character.
20-39%	2	Sporadic trees producing a punctuated vegetation character.
0-19%	1	No trees scrub or low ground cover. Limited vegetation cover.

1.3 Infrastructure and Built Form

This assessment considers the interrelationship of landscape character and human development. The assessment considers how development and infrastructure can create a counterpoint to the existing landscape character (vegetation and topography). Alternatively, development within the landscape may assist with the assimilation of development.

Infrastructure and Built Form (expressed as percentage)	Value	Description of Infrastructure and Built Form
0-19%	5	No objects within the landscape. The landscape has a high natural or remote rural character.
20-39%	4	Isolated objects in the landscape. Single elements with limited visual impact on the landscape. Small farm building, telephone towers or houses.
40-59%	3	Small clusters of development. Increasing presence of development within the landscape.
60-79%	2	Medium scale linear infrastructure or development. More significant development within the landscape. Minor roads, culverts, warehouses, transmission lines and residential areas.
80-100%	1	Large scale infrastructure. The landscape is significantly affected by development. Freeways, power stations and opencast mining

1.4 Cultural Sensitivity Value

The cultural and landscape value assessment is a survey of the regional area around the development up to 20 kilometres. The measurement considers the recognised cultural, heritage, natural and social overlays that exist within the landscape. This assessment is predominantly a desktop survey and only measures recognised designations.

The measurement is then represented as a percentage based of the area of designation compare to the area occupied by the regional zone.

The landscape value is the aggregate value from each of the assessment criteria. Either, as a value for each viewpoint or as a baseline value for the landscape surrounding the development. This Landscape Value in then used to assess the percentage of visual change created by the introduction of development within the landscape.

Cultural and Landscape (expressed as percentage)	Value	Description of Cultural and Landscape Value
80-100%	5	Majority of regional zone is affected by planning designations or overlays. Highly valued culture, natural and social landscape.
60-79%	4	Planning designations impacts a significant area of the regional zone.Valued culture, natural and social landscape
40-59%	3	Moderate impact from planning designations. Valued community or social landscape
20-39%	2	Limited effect
0-19%	1	None to negligible effect of planning designations

1.5 Landscape Character Assessment

The aggregate of relief, vegetation, infrastructure and cultural sensitivity values determines the base line landscape character value. The following table summarises the definition of Landscape Character Values

Landscape Character Value	Value	Description of Landscape Relief
16-20	High	Landscape quality is of high value with significant areas of scenic quality provided by varied topography, large areas of natural beauty and obvious presence of cultural sensitivity to change.
12-16	Moderate to increasing	Moderate to increasing landscape character value experienced through a layered landscape of natural

		qualities, scenic beauty and cultural sensitivity.
8-12	Moderate	Moderate landscape character value experienced by small clusters of natural landscape and cultural sensitivity.
4-8	Limited	Limited landscape character value experienced. The landscape is monotonous with little visual interest through topography or vegetation and heavily modified.

2. Visual Assessment

Each viewpoint was then assessedwith respect to the following aspects of visual effect

- Percent of landscape absorption (the landscape's ability to absorb and screen the development form).
- Horizontal visual effect (percentage spread of the development in the field of view).
- Vertical visual effect (height of the development as a percentage of the field of view).
- Distance of visual effect (distance between viewpoint and development).

Using the following GRIMKE matrixformula, the development was quantified and aggregated to provide an assessment of the visual effect for each viewpoint.

2.1 Percent of Visual Absorption (PVA)

This is an assessment of the landscape's ability to absorb or screen the visual effect. Due to the comprehension of the landscape and wind farm development being holistic, the area that is visually affected includes the space between the turbines.

Using photomontages of the proposed development and Adobe Photoshop™ the amount to which the landscape screens the development is described as a percent of pixel absorption. Foreground contrasting pixels are selected within the vertical and horizontal extents of the development (area A), figure 6. This area is divided by the total area occupied by the development within the active field of view (area B) and expressed as a percentage of visual absorption. The assessment takes into consideration, visual sky lining and screening from existing vegetation and other physical forms.

Figure 1 Photo with wire line model draped on top. Courtesy Wind Farm Developments (2004)

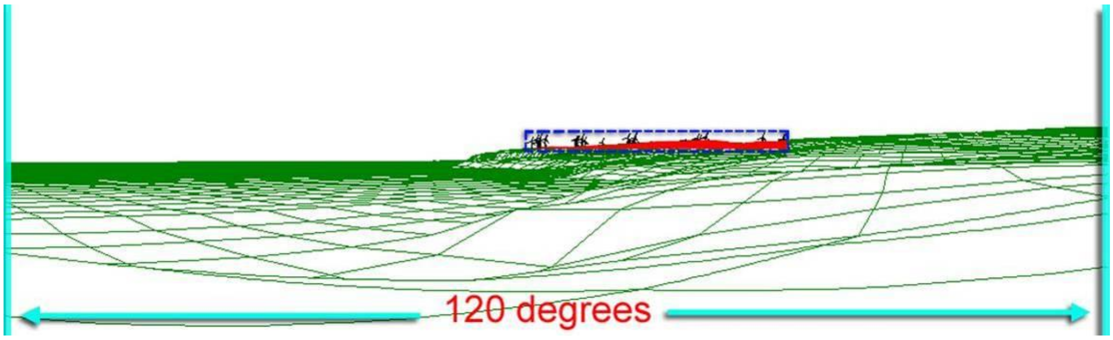


Figure 2 Wire line of showing extent of photomontage. Adapted from Wind Farm Development (2004)

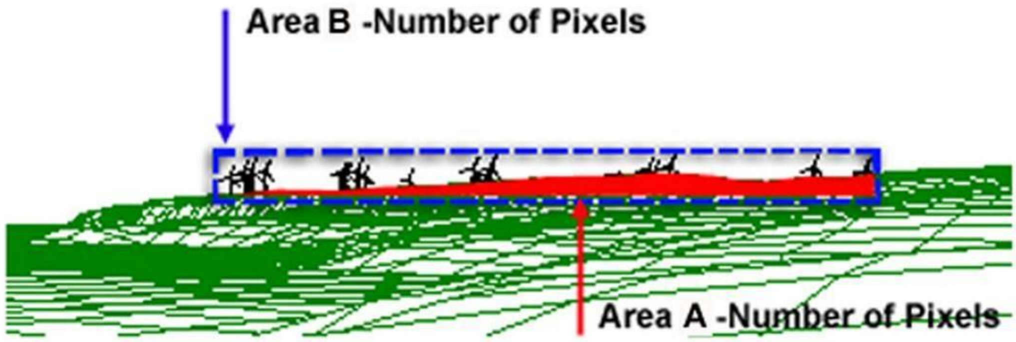


Figure 3 Detailed view of the landscape absorption (area A) and development extents (area B). Adapted from Wind Farm Development (2004)

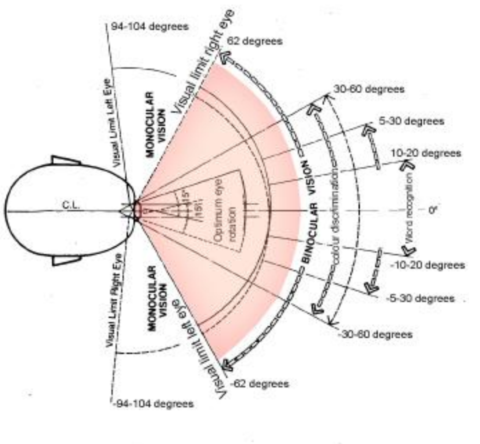
Percent of Visual Absorption (expressed as percentage of change)	Value	Description of Visual Absorption
80-100%	1	Substantial landscape absorption capacity. The landscape possesses sufficient vegetation and topography to screen any effect of the development,

		maintaining the visual character.
60-79%	2	Increasing absorption capacity. Due to the scale of the topography and density of vegetation the landscape is able to screen the development.
40-59%	3	Moderate absorption capacity. Medium level of change to the landscape. The landscape is less able to absorb change due to the scale, distance and extent of the development.
20-39%	4	Limited absorption. The development is noticeable within the landscape; however through vegetation and topography the landscape fragments and filters views of the development.
0-19%	5	No or minor absorption within the landscape. The development is considered to be prominent within the visual landscape.

2.3 Horizontal Visual Effect (HVE)

The field of vision (FOV) experienced by the human eye is described as an angle of 200-208 degrees horizontallyiii. This field of view includes the peripheral (monocular) vision, which is described as 40 degrees to each eye; within this zone colour and depth of field are not registered. For the purposes of the assessment the angle of peripheral vision has been subtracted from the field of view producing a binocular, ‘active field of view’ of 120 degrees.

Using this fixed visual reference, an assessment of the possible impact of development within this measurable area is undertaken. The centre of the development is established and an angle of 60 degrees each side is defined. The overall assessment is made of the entire development, rather than of the individual objects that may form the proposal. The angle is measured using a GPS and a bearing compass with known waypoints (geographic coordinates). Using GPS the extent of the horizontal visual field is calculated by the difference in bearing between the widest waypoints from a particular viewpoint. This measurement of effect is then described as a percentage of the 120 degrees active field of view



VISUAL FIELD IN HORIZONTAL PLANE

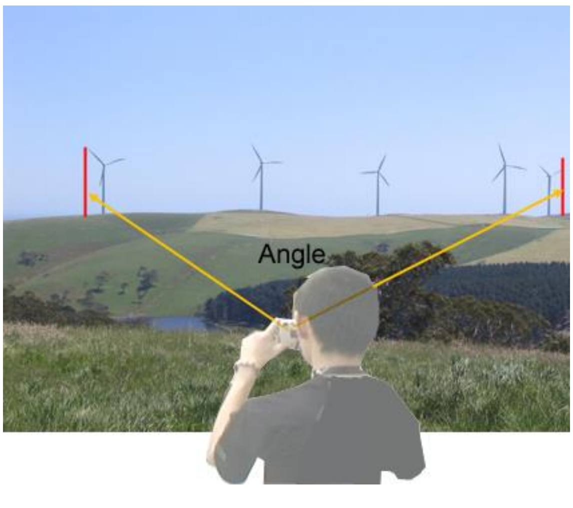


Figure 4 Active field of view is defined as the binocular field equating to 120-124 degreesiv. On the right is an illustration of horizontal measured angle as percent of active field 120 degrees. Photo Brett Grimm

Degree of Horizontal Visual Impact (expressed as an angle of impact and percentage of change)	Value	Description of Visual Modification
80-100% of the panorama measure at 120˚FOV)	5	Substantial horizontal visual impact. Visual impact throughout the entire active field of view.
60-80% of the panorama measure at 120˚FOV)	4	Increasing visual effect. A large proportion of the active field of view is affected.
40-60% of the panorama Measure at 120˚FOV	3	Moderate visual effect.
20-40% of the panorama measure at 120˚FOV)	2	Limited effect. The visual impact is a small part of the active field of view.
0-20% of the panorama measure at 120˚FOV)	1	No or minor visual effect.

2.4 Vertical Visual Effect (VVE)

The vertical visual effect evaluates the proportional scale of the development with reference to the vertical character of the existing landscape, as seen within the field of view of the assessed viewpoints.

The process of assessment is undertaken in 3 stages:

Stage 1:

The first stage of the process is to determine the vertical scale of the existing landscape. The baseline landscape scale is calculated using the photomontage viewpoint elevation (A) as a known reference height. The elevation of the viewpoint is recorded using a GPS. Using contour data, a second value (B) is recorded representing the highest topographic elevation within the field of view. Finally, the horizontal distance (C) between the viewpoint and the highest topographic feature is recorded. The vertical angle of view α_1 is then given as:

$\alpha_1 = \tan^{-1}((B-A)/C)$

as shown in Figure 6 below.

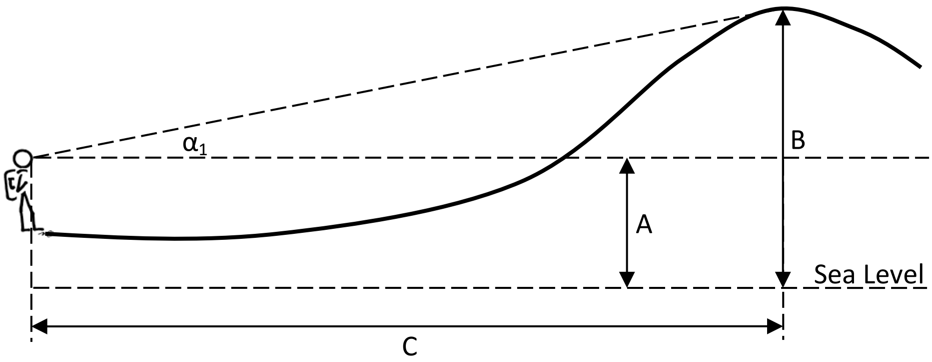


Figure 6: Vertical Scale of Existing Landscape

Stage 2:

The second stage of the process is to determine the vertical scale of the landscape modification, namely that of the apparent maximum turbine tip height as viewed from the viewpoint. Using the known turbine height (E), ground elevation (F) and its distance from the viewpoint (G), the vertical angle of view α_2 is then given by:

$\alpha_2 = \tan^{-1}((E+F - A)/G)$

as shown in Figure 7 below.

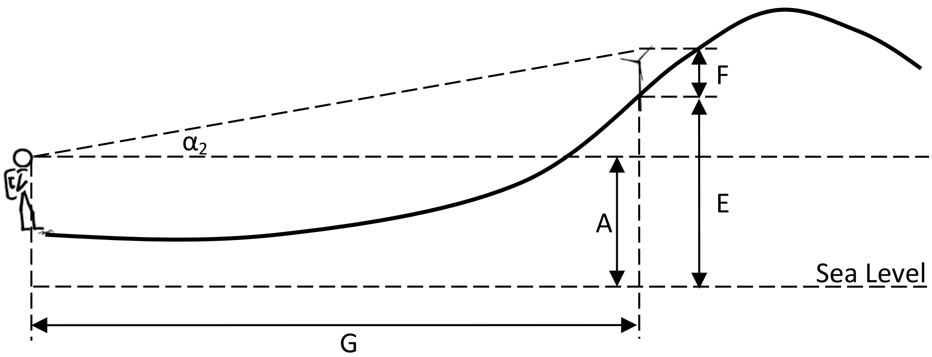


Figure 7: Vertical Scale of Landscape Modification

Stage 3:

The final stage of the process is to determine the overall proportion of the vertical scale of the development with reference to the existing landscape scale by taking the ratio of the two angles α_2 and α_1. Depending on the relative size of the vertical angles of view occupied by the existing and modified landscapes respectively, the ratio α_2 / α_1 will determine the nature and scale of the visual impact.

Depending on the relative scale of the angle of view occupied by the landscape and/or the development, the two vertical angles will depict whether there will be an increase in vertical visual impact created by the development ($\alpha_2 / \alpha_1 > 1$) or conversely the visual effect will be experienced as a vertical visual effect relative to the existing landscape scale ($\alpha_2 / \alpha_1 < 1$).

The vertical visual effect assessment will result in one of the following conditions:

- an increase in the overall vertical visual effect experienced from the viewpoint as a result of the combined vertical visual effect of the existing landscape character and the proposed development, or;

- a limited vertical visual effect as a result of the scale of the development being less than the existing landscape vertical scale when assessed from a viewpoint. This may be created by backdrop landforms or large ravines, valleys depicting a scale that within the field of view is greater than the development.

Either, the turbines or parts of the turbines are seen above ridgelines or landforms within the field of view and the effect will result in an increase in vertical visual effect, or the viewpoint contains large escarpments or deep valleys within the field of view and the vertical scale of the proposed wind turbines are likely to be seen as a proportion of the existing landscape scale resulting in a limited vertical visual effect.

In the first case (i.e. where $\alpha_2 / \alpha_1 > 1$), the proportional vertical visual impact should be assessed using Table 1 below. In the second case, the proportional vertical visual impact is considered minor and is assigned a value of 1.

Table 1 Proportional Vertical Visual Effect in existing landscape scale ($\alpha_2 / \alpha_1 > 1$)

Vertical Visual Impact (expressed as percentage increase (α_2 / α_1 - 1) x 100)	Value	Description of Visual Modification
80-100%	5	Substantial visual impact.
60-80%	4	Increasing visual impact
40-60%	3	Moderate visual impact.
20-40%	2	Limited impact
0-20%	1	No or minor visual impact within the landscape.

2.5 Distance of Visual Effect

This is a measurement of how visual impact is modified by distance. The effect of scale, topography, vegetation and weather, changes with distance, and in turn changes the degree of visual effect. The distance to the development from each viewpoint is recorded using the GPS. Standing onsite at each viewpoint the exact distance can be calculated by selecting the closest waypoint function (all the turbine locations are stored as waypoints in the GPS).

The distance categories outlined in the table below have been based on empirical research University of Newcastle (2002), Sinclair (2001), Bishop (2002).

Location of Development (from viewpoint)v	Value	Description
0 to 4 km (80-100%)	5	Adjacent: Dominant impact due to large scale, movement, proximity and number
4 to 8 km (60-80%)	4	Foreground: Major impact due to proximity: capable of dominating landscape
8 to 13 km (40-60%)	3	Middle ground: Clearly visible with moderate impact: potentially intrusive
13 to 18 km (20-40%)	2	Distant middle ground: Clearly visible with moderate impact becoming less distinct
18 km and greater (0-20%)	1	Background: Less distinct: size much reduced

2.6 Landscape Absorption Assessment

The aggregate of landscape absorption, horizontal and vertical effects and distance values determines the base visual impact value form the viewpoint. The following table summarises the definition of Visual Impact values

Visual Impact Value	Value	Description of Landscape Relief
16-20	High	High visual impact within the field of view
12-16	Moderate to increasing	Moderate to increasing visual impact within the field of view
8-12	Moderate	Moderate visual impact within the field of view
5-8	Limited	Limited visual impact within the field of view

3. Degree of Visual Impact (Percentage of Visual Change)

Degree of Visual Impact

The degree of Visual Impact is expressed as a coefficient of visual change to the baseline Landscape Value (general or viewpoint specific). This calculation directly expresses the effect of the development on the landscape, the change to the visual character and the reciprocal visual impact.

- Baseline Landscape Character : express as a value between 4 and 20)
- Coefficient of Visual Impact : calculated as the 20 divided by visual assessment value

Calculation of degree of Visual Impact

Coefficient x landscape character value expressed as a percentage = Visual Impact on Landscape Character

Example:

(a) *Visual Impact Assessment*

Horizontal visual effect	3
Vertical visual effect	1
Absorption capacity	3
Distance	2
Total visual effect	9 (0.45)

*9/20 equated to a coefficient of **0.45***

(b) *Landscape Character Assessment*

Relief	3
Vegetation coverage	3
Infrastructure built form	2
Cultural landscape overlays	2
Total landscape character	10

(c) *10 x 0.45 = 4.5*

(d) *4.5/20 = 0.225*

(e) *0.225 x 100 = 22.5% Visual Change to the Landscape*

3.1 Final Aggregated Visual Effect

Percentage Value of Visual Change	Descriptive Qualification of Visual Effect	Comments
80-100%	Extreme	Extreme change in view: change very prominent involving total obstruction of existing view or change in character and composition of view through loss of key elements or addition of new or uncharacteristic elements which significantly alter underlying landscape visual character and amenity
60-80%	Severe	Severe change in view involving the obstruction of existing views or alteration to character through the introduction of new elements. Change may be different in scale and character from the surroundings and the wider setting. Resulting in a perceived increase in proportional change to the underlying landscape visual character.
40-60%	Substantial	Substantial change in view: which may involve partial obstruction of existing view or alteration of character and composition through the introduction of new elements.Composition of the view will alter. View character may be partially changed through the introduction of features.
20-40%	Moderate	Moderate change in view: change will be distinguishable from the surroundings whilst composition and underlying landscape visual character will be retained.
0-20%	Slight	Very slight change in view: change barely distinguishable from the surroundings. Composition and character of view substantially unaltered.

Appendix E

Glossary[2]

[2] *Visual Analysis of Windfarms Good Practice Guidance, Scottish Natural Heritage (2005)*

Active Field of View:	The field of view excluding peripheral vision, which is described as 40° to each eye, within this zone colour, shapes and forms are not registered. The active field of view removes the angle of peripheral vision from the field of view producing an angle of 120 - 160°
Assessment (landscape):	An umbrella term for description, classification and analysis of landscape.
Depth of Field:	The distance between the nearest point (viewpoint) and farthest objects (visual envelope) which is visible within the field of view.
Element:	A component part of the landscape or visual composition.
Effect (landscape or visual):	These occur as a broad culmination of one or more impacts, incorporating professional judgement to extrapolate and/or generalise on the nature of these.
Horizontal Visual Effect:	This term is used to describe the field of view occupied by the visible part of a wind farm.
Impact (landscape or visual):	Impacts occur to a particular element of the environment and they can be described factually by the nature and degree of change.
Landscape:	Human perception of the land conditioned by knowledge and identity with a place.
Landscape character:	The distinct and recognizable pattern of elements that occurs consistently in a particular type of landscape, and how people perceive this. It reflects particular combinations of geology, landform, soils, vegetation, land use and human settlement. It creates the particular sense of place of different areas of the landscape.
Landscape feature:	A prominent eye-catching element, for example, wooded hilltop, isolated trees or grain silo.
Mitigation:	Measures, including any process, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual impacts of a development project.
Panorama:	A view, covering a wide field of view.
Photomontage:	A visualisation based on the superimposition of an image onto a photograph for the purpose of creating a realistic representation of proposed or potential changes to a view. These are now mainly generated using computer software.
Sensitivity:	The extent to which a landscape or visual composition can accommodate of a particular type and scale without adverse effects on its character or value.
Visual Amenity:	The value of a particular area or view in terms of what is seen.
Visual Envelope:	Extent of potential visibility to or from a specific area, viewpoint or feature.

Appendix F
Endnotes

[i] The GPS used was a Garmin X12 which differential-ready 12 parallel channel receiver continuously tracks and uses up to twelve satellites to compute and update a position

[ii]The SILVA precision M80 with a parallax free prismatic magnification-bearing compass.A magnetic bearing compass with a ± 0.5° from true magnetic course.

[iii]Pirenne, M.H. (1967). Vision and the Eye.London: Chapman and Hall

[iv]Panero, J. &Zelnik, M. (1979) Human Dimension & Interior Space- A source Book of Design Reference Standards. The Architectural Press Ltd. London.

[v] The distance zones have been developed Sinclair Thomas Matrix, which has cited field observations of the visual extents. The classification zones have been based on projected 90-100m high turbines.

JULY 2018

PALLAMANA SOLAR FARM

AERONAUTICAL IMPACT ASSESSMENT

Prepared for RES Australia Pty Ltd

AVIATION PROJECTS

DOCUMENT CONTROL

Document Title: Pallamana Solar Farm – Aeronautical Impact Assessment

Reference: 101807-01

Release Date: 18 April 2018

Prepared by: P Davidyuk

Reviewed by: K Tonkin

Released by: K Tonkin

Revision History: Release

Revision History

Version	*Description*	*Transmitted*	*Reviewed by*	*Date*
0.1	First Draft	06 April 2018	RES	18 April 2018
1.0	Final	18 April 2018	RES	26 April 2018
1.1	Revised Final	26 April 2018		
1.2	Revised layout	10 July 2018	RES	16 July 2018
1.3	Revised layout	17 July 2018		

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LIST OF FIGURES

ACRONYMS

AGL	above ground level
AHD	Australian Height Datum
AIP	Aeronautical Information Package
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
ATSB	Australian Transport Safety Bureau
CAR	Civil Aviation Regulation (1988)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (1998)
CFIT	controlled flight into terrain
ERSA	En Route Supplement Australia
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
MOS	Manual of Standards
MSA	minimum sector altitude
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
RPT	regular public transport
VFR	visual flight rules
VMC	visual meteorological conditions

UNITS OF MEASUREMENT

ft	feet	(1 ft = 0.3048 m)
km	kilometres	(1 km = 0.5399 nm)
m	metres	(1 m = 3.281 ft)
nm	nautical miles	(1 nm = 1.852 km)

EXECUTIVE SUMMARY

Introduction

RES Australia Pty Ltd (RES Australia) is preparing a planning application for the development of the Pallamana Solar Farm, located approximately 6 km to the north west of the city of Murray Bridge in South Australia, and just to the south of Pallamana Aerodrome (Murray Bridge, YMBD).

RES Australia engaged Aviation Projects to visit the site and meet with the owner of Murray Bridge aerodrome to discuss the proposed solar farm development and potential aviation safety implications, and produce an Aeronautical Impact Assessment.

Conclusions

Aviation Impact Statement

- The proposed Pallamana Solar Farm:
    - will not penetrate any OLS surfaces;
    - will not affect any instrument procedures;
    - will not impact on nearby designated air routes;
    - will not have an impact on designated airspace;
    - is wholly contained within Class G airspace; and
    - is outside the clearance zones associated with aviation navigation aids and communication facilities.

Aircraft operations

- The operator of Murray Bridge aerodrome has identified concerns in relation to an aircraft suffering a loss of power on departure from runway 19 and having no ability to avoid landing on or into the solar panel array, would suffer much more serious consequences than in the current circumstances.
- As a result, although not a mandatory obligation, RES has modified the proposed solar farm layout to incorporate a forced landing area that mitigates this risk.

Solar glare analysis

- A solar glare analysis using the ForgeSolar application found that
    - Analysis time interval and eye characteristics used are acceptable; and
    - Flight path receptor(s) do not receive yellow (unacceptable) glare.
- The proposed use of an anti-reflective coating will serve to further reduce any potential glare issues.

Summary

- Subject to implementation of the proposed recommendations, the proposed Pallamana Solar Farm will not have an adverse impact on aviation safety.

Recommendations

Recommended actions resulting from the conduct of this assessment are provided below.

Aircraft safety

1. The proponent should consider the incorporation of a 'forced landing area' in the overall layout, generally aligned with runway 01/19 but avoiding vertical obstructions like trees and power lines, as per the indicative concept provided.
2. The proponent should ensure that an anti-reflective coating is applied to the solar panels to further reduce any potential glare issues.

1. INTRODUCTION

1.1. Situation

RES Australia Pty Ltd (RES Australia) is preparing a planning application for the development of the Pallamana Solar Farm (the Project).

The proposed Pallamana Solar Farm is located approximately 6 km to the north west of the city of Murray Bridge in South Australia. It is also located just to the south of Pallamana Aerodrome (Murray Bridge, YMBD).

An Aeronautical Impact Assessment was prepared in 2017 by Landrum & Brown (L&B). Since the original L&B assessment, there have been minor changes to the proposed layout, and the maximum height of the panels has been increased from 3 m to 4 m.

RES Australia engaged Aviation Projects to visit the site and meet with the nominated representative of the operator of Murray Bridge aerodrome to discuss the project. During the discussions concerns were expressed by the representative, which has resulted in this supplementary Aeronautical Impact Assessment and amendments to the project layout to accommodate a forced landing area.

1.2. Scope

The scope of work for this engagement was defined as:

1. Preparation of an Aeronautical Impact Assessment to identify any potential aviation impacts and suggested mitigations, sufficient to support a planning application; and
2. Attendance at a site visit to consult with local aviation stakeholders at Murray Bridge aerodrome.

1.3. Methodology

In performing this task, the following activities were undertaken:

1. Confirm scope, requirements and administration arrangements;
2. Review background material, including the report prepared by Landrum and Brown titled *Aeronautical Impact Assessment Monarto Solar Farm* dated October 2017;
3. Attend a site visit at Murray Bridge aerodrome to consult with stakeholders as agreed with RES;
4. Prepare a draft report for client review, that includes consideration of aerodrome safeguarding issues and a review of solar glare analysis using the ForgeSolar glare analysis tool; and
5. Prepare a final report for client acceptance.

1.4. Report structure

This report is structured around the following areas of consideration:

- Introduction;
- Background;

- Aviation Impact Statement
- Aircraft operations;
- Glare analysis;
- Conclusions; and
- Recommendations.

1.5. Stakeholders

Direct consultation was undertaken with the following party:

- A representative of the operator of Murray Bridge aerodrome.

RES Australia conducted consultation and received input from a number of interested parties. Their responses are summarised in Section 3.

Other parties were considered but not consulted as they had no active interests in the area:

- Aerial Agricultural Association of Australia;
- Airservices Australia;
- Civil Aviation Safety Authority;
- Country Fire Service
- Department of Defence;
- Royal Flying Doctor Service; and
- other stakeholders where noted.

1.6. Material reviewed

Material provided by the Proponent for preparation of this assessment included:

- RES Australia, Monarto.kmz, received 01 March 2018;
- RES Australia, Monarto Solar Farm, Revised Layout, Infrastructure.pdf, 27 June 2018;
- RES Australia, Monarto Solar Farm, Crown Sponsorship Application, 20 December 2017;
- RES Australia, Monarto Solar Farm, Site Layout and Constraints – Axis Tracker, Issue 2, 160418; and
- Landrum & Brown, Aeronautical Impact Assessment, Monarto Solar Farm, v002, 12 October 2017.

1.7. References

References used or consulted in the preparation of this report include:

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures, and En Route Supplement Australia effective 24 May 2018;
- Civil Aviation Safety Authority, *Civil Aviation Regulations 1998 (CAR)*, as amended;
- Civil Aviation Safety Authority, *Civil Aviation Safety Regulations 1998 (CASR)*, as amended;
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 92-1(1): Guidelines for aeroplane landing areas, dated July 1992;
- Civil Aviation Safety Authority, Civil Aviation Advisory Publication (CAAP) 166-1(3): Operations in the vicinity of non-controlled aerodromes, v4.1, File Ref D17/87576 dated April 2017;
- Civil Aviation Safety Authority, *Manual of Standards Part 139 – Aerodromes*, version 1.14: dated January 2017;
- Civil Aviation Safety Authority, Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design, version 1.5, dated March 2016;
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS);
- ICAO Standards and Recommended Practices, *Annex 14—Aerodromes*;
- OzRunways, dated 01 March 2018; and
- other references as noted.

1.8. Triggers for review

This assessment has been based on the material reviewed and references nominated herein.

Triggers for review of the assessment, if a significant period of time passes between the report being finalised and serving its intended purpose, are as follows:

1. following any significant changes to the context in which the assessment was prepared, including the regulatory framework; and
2. following any near miss, incident or accident associated with operations considered in this assessment.

2. BACKGROUND

2.1. Site overview

The proposed Pallamana Solar Farm is located approximately 6 km to the north west of the city of Murray Bridge in South Australia. It is also located just to the south of Pallamana Aerodrome (Murray Bridge, YMBD).

An overview of the proposed Pallamana Solar Farm site boundary is provided in Figure 1 (source: RES Australia, Google Earth).

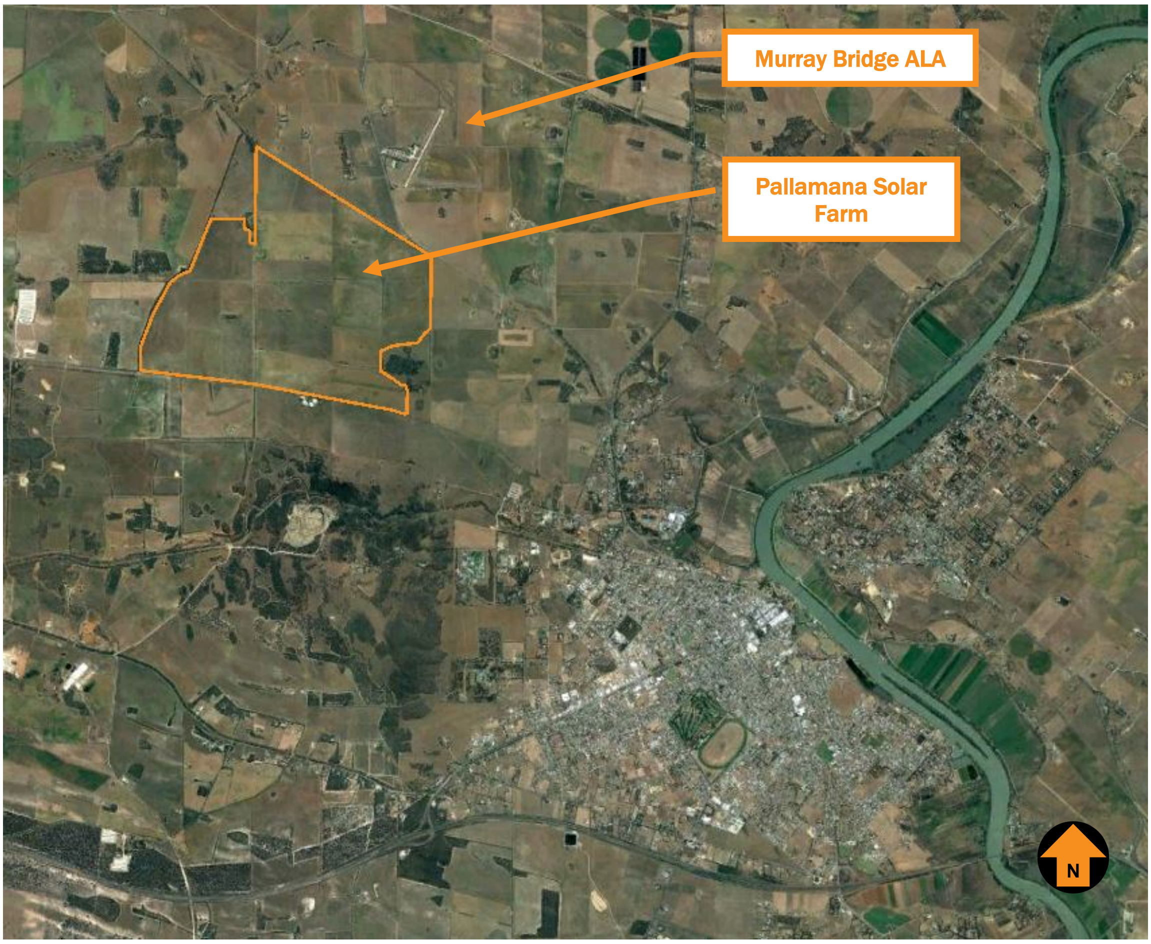


Figure 1 Proposed Pallamana Solar Farm site overview

2.2. Project description

The project involves construction of a solar farm within the site boundaries, connecting to existing overhead electricity transmission lines.

The solar photovoltaic (PV) panels will be single axis tracking installations up to 4 m above ground level at the maximum point of travel.

Refer to Figure 2 for the current proposed layout and site project envelope (source: RES).

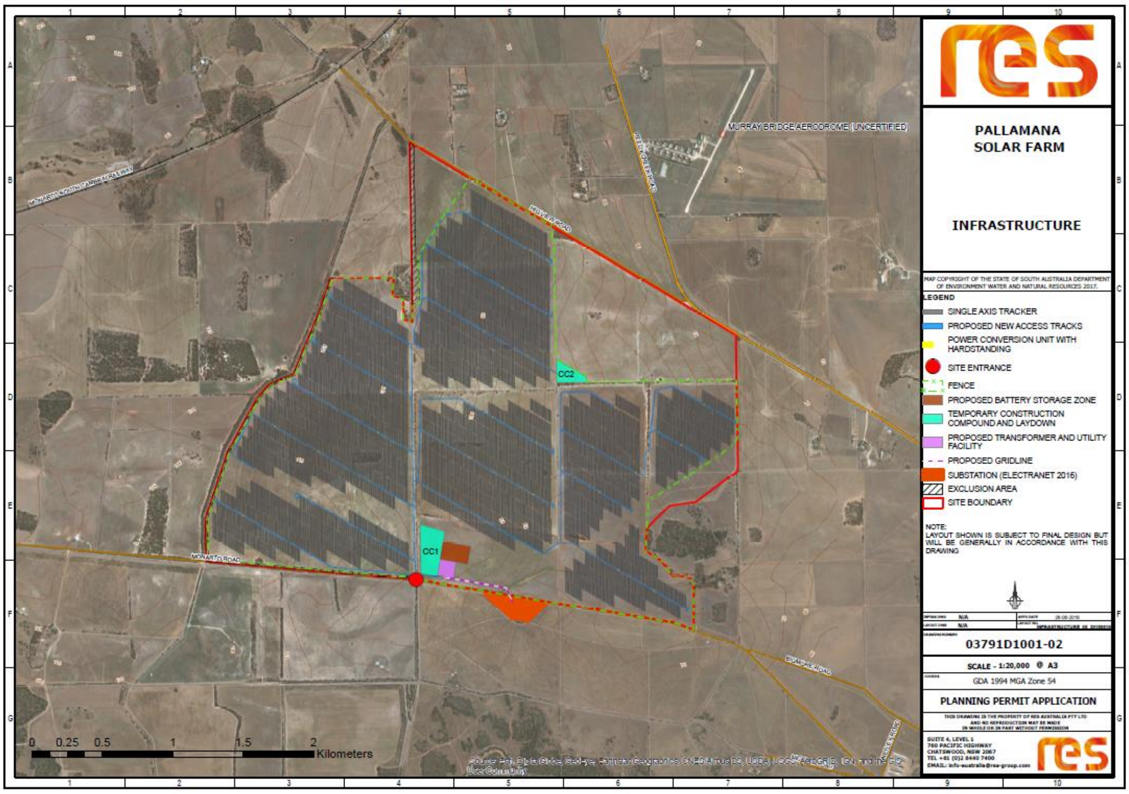


Figure 2 Proposed Pallamana Solar Farm Site Layout and Constraints

3. COMMUNITY CONSULTATION

Details of community concerns in relation to aviation aspects associated with the proposed Pallamana Solar Farm Project site location are provided in Table 1. The plan of the proposal considered as part of the community consultation was that based on a forced landing corridor, as shown in Figure 11 of this report.

Table 1 Community consultation details

Respondent	*Concern Details*	*Action Proposed*
Response 1	Respondent 1 has safety concerns in relation to the proposed Pallamana Solar Farm Project site and its relative location to Murray Bridge aerodrome.	Incorporation of a 'forced landing area' in the overall layout.
Response 2	Respondent 2 raises concerns regarding the proposed Pallamana Solar Farm Project site location and that the Project site would use the land that has being utilized in the event of emergency.	Incorporation of a 'forced landing area' in the overall layout.
Response 3	Respondent 3 expressed great concern regarding the actual location of the proposed farm. The placement of the proposed solar farm will place pilots in jeopardy should they sustain an engine failure.	Incorporation of a 'forced landing area' in the overall layout. A glare analysis was prepared and showed an acceptable level of glare.
Response 4	Respondent 4 believes that the proposed Pallamana Solar Farm Project site is located in close proximity to Murray Bridge aerodrome and dangerous to aircraft operations.	Incorporation of a 'forced landing area' in the overall layout.
Response 5	Respondent 5 believes that proposed site is exactly the emergency landing area in the event of an engine failure on take-off to the south. The respondent also raises concerns in relation to the glare from the panels at certain angles which may result in blinding pilots.	Incorporation of a 'forced landing area' in the overall layout. A glare analysis was prepared and showed an acceptable level of glare.
Response 6	Respondent 6 is in favour of the development of renewable energy but objects the proposed Pallamana Solar Farm Project construction without any explanation provided.	Incorporation of a 'forced landing area' in the overall layout.
Response 7	Respondent 7 provided irrelevant comment to the project.	N/A
Response 8	Respondent 8 has concerns in relation to the proposed Pallamana Solar Farm Project site location relative to Murray Bridge aerodrome. The respondent is also concerned about glare effects.	Incorporation of a 'forced landing area' in the overall layout. A glare analysis was prepared and showed an acceptable level of glare.

Respondent	Concern Details	Action Proposed
Response 9	Respondent 9 says that there is no provision is made for a safe arrival and departure flight from the southern end of the airfield.	Incorporation of a 'forced landing area' in the overall layout.
Response 10	Respondent 10 is concerned by the danger posed to those aircraft operating in and around the nearby airport.	Incorporation of a 'forced landing area' in the overall layout.
Response 11	Respondent 11 asks whether or not RES Australia proposes some area for aircraft with an engine failure departed from Murray Bridge aerodrome to land safely.	Incorporation of a 'forced landing area' in the overall layout.
Response 12	Respondent 12 expresses his disappointment on the State Planning authority decision to grand an approval for the Pallamana Solar Farm Project development.	N/A
Response 13	Respondent 13 supports the solar concept but concerns about the safety aspect. The respondent is also concerned by sunlight reflection and radiated heat causing thermal turbulence affecting aircraft in the crucial landing or take-off stages of flight.	Incorporation of a 'forced landing area' in the overall layout. A glare analysis was prepared and showed an acceptable level of glare.
Response 14	Respondent 14 expressed concern about obstructing the southern end of the main runway with glass panels.	Incorporation of a 'forced landing area' in the overall layout.
Response 15	Respondent 15 requested copies of the aviation specific impact study and any other documentation related to the proposed solar farm and any impacts on flight operations and safety at Murray Bridge aerodrome.	AIA to be provided.
Response 16	Respondent 16 believes that the proposed solar farm increases risk to all aircraft using the main runway at the Murray Bridge aerodrome	Incorporation of a 'forced landing area' in the overall layout.
Response 17	Respondent 17 believes that the proposed Pallamana Solar Farm poses a serious hazard and safety risk to aviators and the public who fly in aircraft that land and take off from Murray Bridge aerodrome. The respondent is also concerned about glare and reflection from the glass panels on a sunny day.	Incorporation of a 'forced landing area' in the overall layout.

3.1. Key issues raised

The following two key issues in relation to the Project site location were raised during community engagement:

- close proximity of the Project site to Murray Bridge aerodrome and potential obstruction of the southern end of runway 19;

- glare and reflection from the solar farm; and
- thermal turbulence.

3.1.1. Close proximity of the Project site

The departure end of runway 19 end is located approximately 550 m north east from the proposed Pallamana Solar Farm Project site.

The Aviation Impact Statement (Section 4) confirms that Murray Bridge aerodrome will not be impacted by the proposed Pallamana Solar Farm Project.

The Project will not affect any obstacle limitation surfaces at Murray Bridge aerodrome or any other aerodromes.

Murray Bridge aerodrome is not equipped with instrument procedures and as a result will not be affected by the Project.

3.1.2. Obstruction of a forced landing area

There is no regulatory requirement for an aircraft landing area (ALA) to have a forced landing area. RES Australia has proposed and included an indicative concept of the forced landing area in the overall layout of the proposed Pallamana Solar Farm Project site.

3.1.3. Glare and reflection

Following incorporation of the forced landing area within the overall site, the solar glare analysis determined that neither flight path caused green or yellow glare.

In terms of adherence to the FAA policy, it was found that:

1. Analysis time interval and eye characteristics used are acceptable; and
2. Flight path receptor(s) do not receive yellow glare.

A full copy of the glare analysis report is provided at Annexure 1.

3.1.4. Thermal turbulence

There have not been any recorded impacts at other operating aerodromes in close proximity to utility scale solar projects.

4. AVIATION IMPACT STATEMENT

4.1. Nearby aerodromes

There are no registered or certified aerodromes in close proximity to the Project.

The nearest aerodrome is Murray Bridge aerodrome, an aircraft landing area (ALA), just to the north of the site, as shown in Figure 3 (source: OzRunways, Hybrid VFR overlay) and Figure 4 (source: OzRunways, WAC overlay).

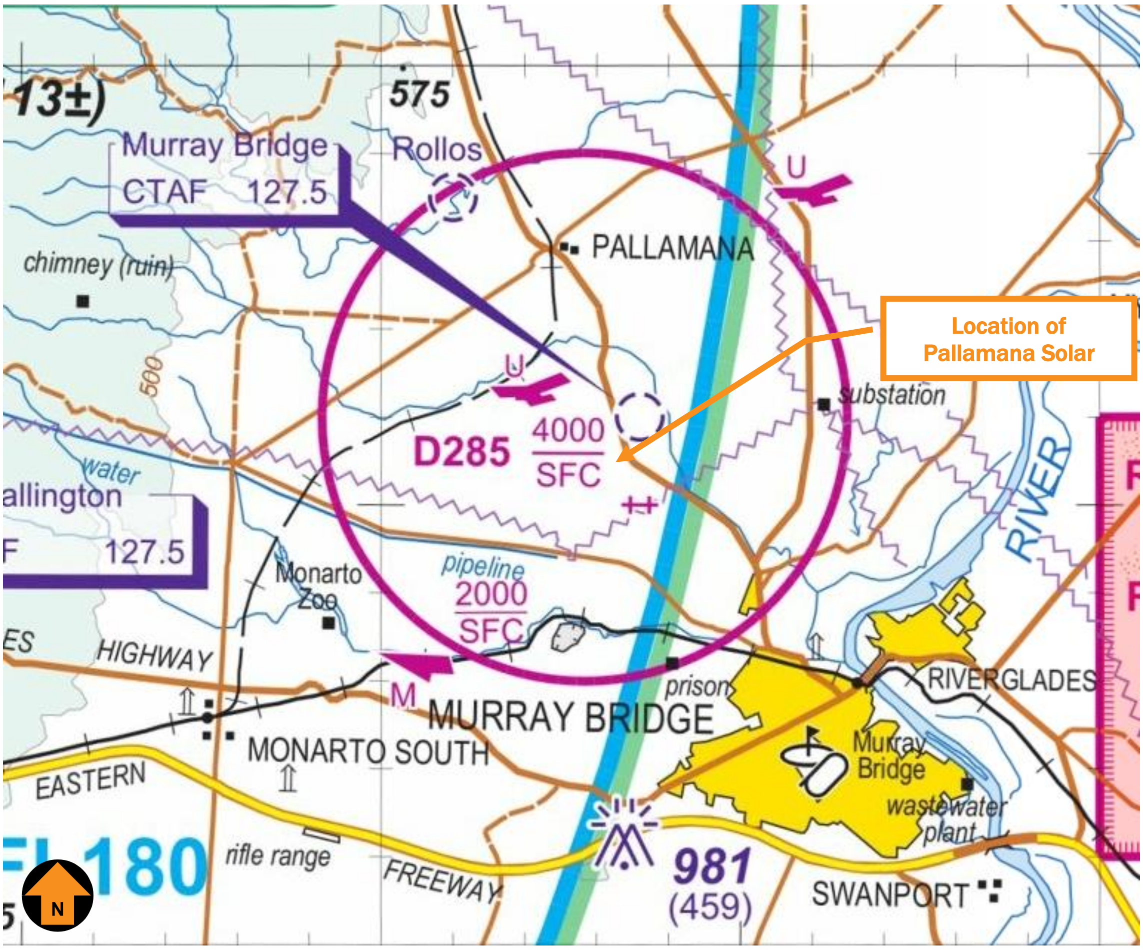


Figure 3 Location of site in relation to Murray Bridge aerodrome

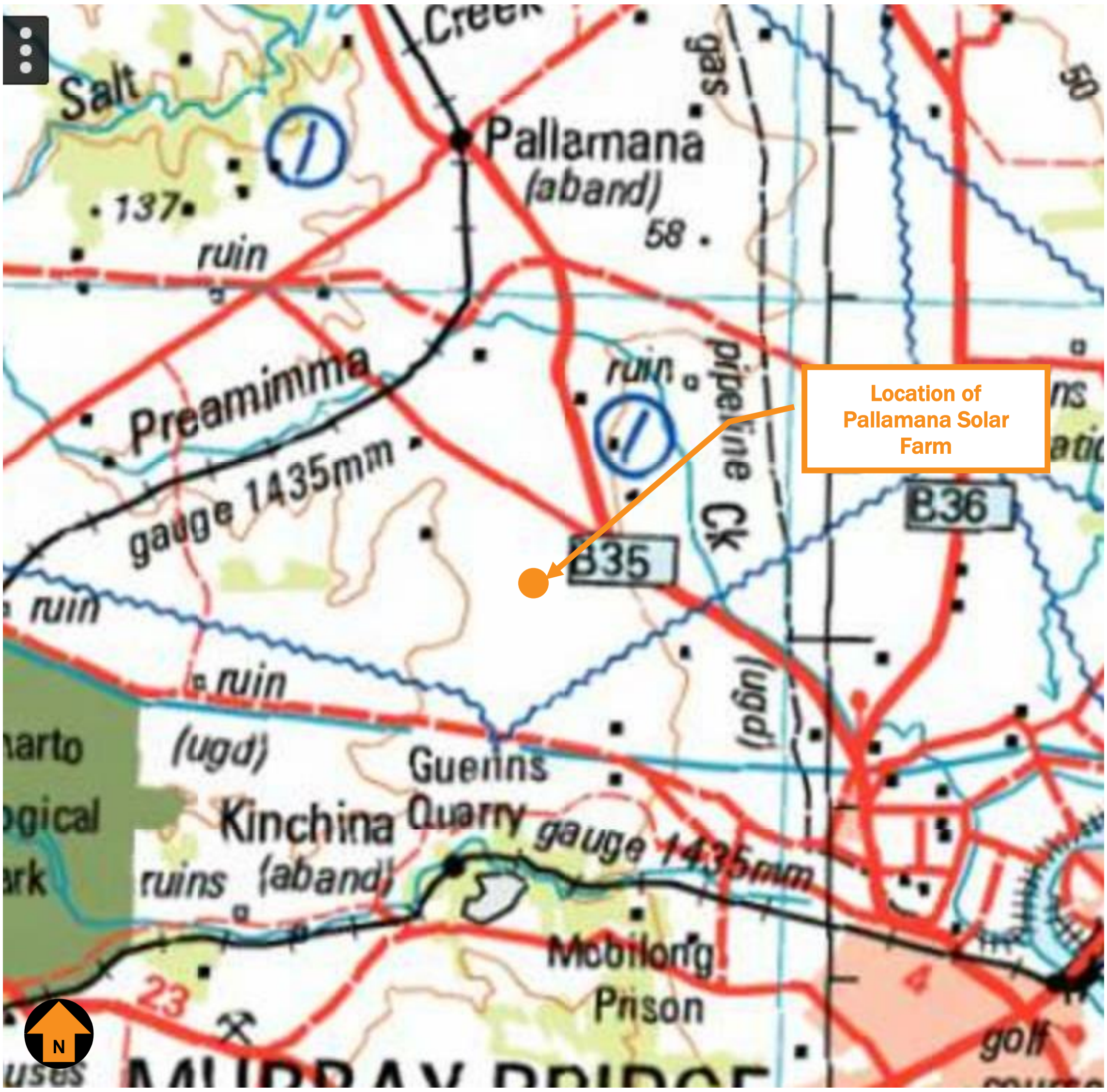


Figure 4 Site overview - World Aeronautical Chart

4.2. Instrument procedures

Murray Bridge aerodrome is not equipped with instrument procedures, and in any case, the Project will not affect instrument procedures if they are implemented at Murray Bridge aerodrome in the future.

4.3. Obstacle limitation surfaces

The Project will not affect any obstacle limitation surfaces at Murray Bridge aerodrome or any other aerodromes.

4.4. Airspace

The Project is located within Danger area D285, active during daylight hours from surface to 4000 ft AMSL, for the purposes of aerobatic flying operations at Murray Bridge aerodrome.

The Project is located outside controlled airspace (wholly within Class G airspace).

4.5. Air routes and LSALT

The Project will not affect air routes or grid lowest safe altitudes. Refer to Figure 5 (source: OzRunways, ERC L7 SA overlay).

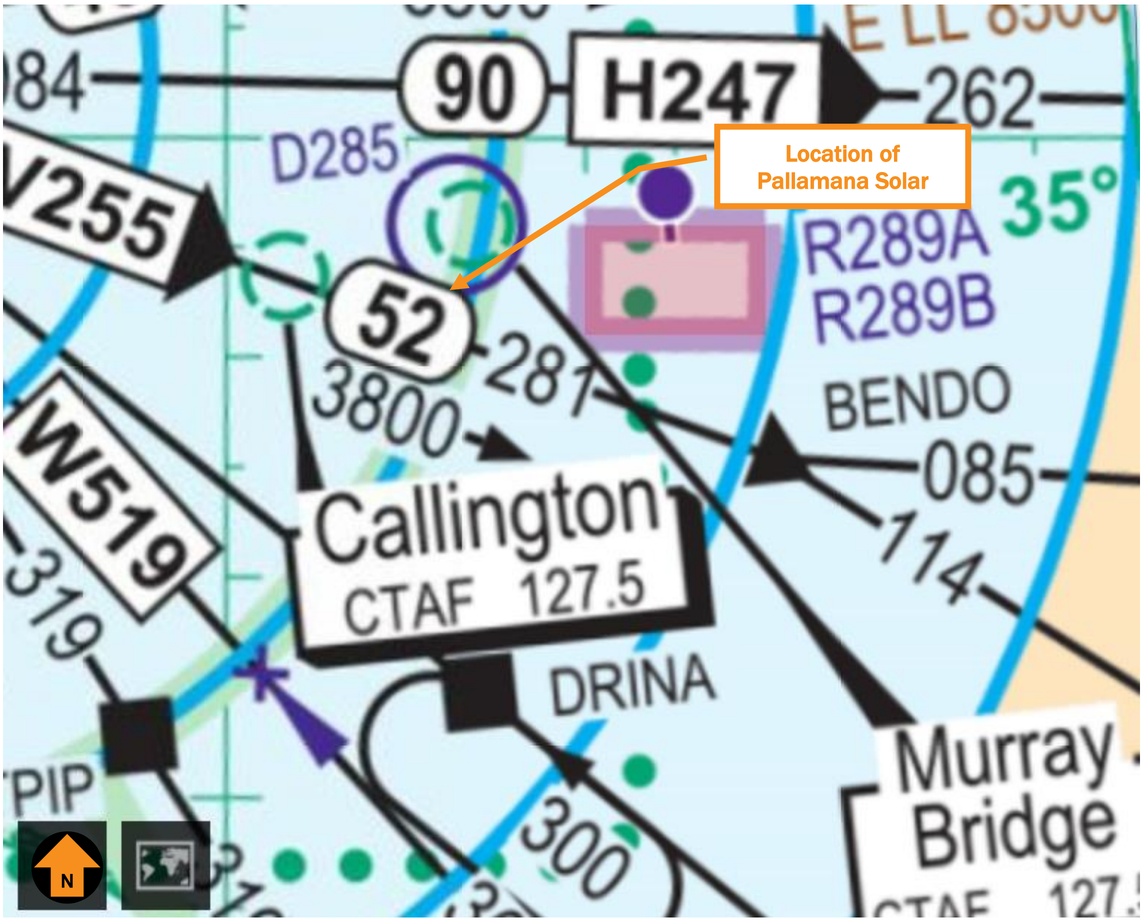


Figure 5 Enroute Chart overlay

4.6. Aviation facilities

The Project will not interfere with any aviation facilities.

4.7. Radar

The Project will not interfere with any aviation radar facilities.

4.8. Summary

The proposed Pallamana Solar Farm:

- will not penetrate any OLS surfaces;
- will not affect any instrument procedures;
- will not impact on nearby designated air routes;
- will not have an impact on designated airspace;
- is wholly contained within Class G airspace; and
- is outside the clearance zones associated with aviation navigation aids and communication facilities.

5. AIRCRAFT OPERATIONS

5.1. Operations at Murray Bridge aerodrome

Murray Bridge aerodrome is an uncertified aerodrome, meaning that it is not regulated by the Civil Aviation Safety Authority (CASA). The aerodrome features two runways, 01/19 and 09/27. Runway 01/19 is the main runway and is used approximately 80% of the time in equal amounts in each direction. Runway 09/27 is less frequently used, mainly in the 27 direction.

The aerodrome is equipped with solar night lighting for occasional night operations and a Bureau of Meteorology automatic weather station but does not have instrument procedures.

A meeting was conducted with Mr Antel, the nominated representative of the operator of Murray Bridge aerodrome, during a site visit on 23 March 2018. He provided a detailed description of aircraft operations that are conducted at the aerodrome, commensurate with its uncertified status:

- private and flying training operations using VH-registered and recreational aviation (ultralight) aircraft;
- passenger transport (charter);
- aerobatics;
- parachute jumping;
- gliding;
- aeromedical retrieval; and
- aerial fire-fighting by the Country Fire Service.

A photo of the passenger terminal is provided at Figure 6.

Figure 6 Murray Bridge (Pallamana) aerodrome passenger terminal

A photo taken from runway 19 looking south is provided at Figure 7.

Figure 7 Runway 19 looking south

A photo taken from Hillview Rd to the south of Murray Bridge aerodrome looking north along the extended runway centreline of runway 01 is provided at Figure 8.

Figure 8 Hillview Rd looking along runway 01 to the north

A photo taken from the same location but looking south along the extended runway 19 centreline towards the solar farm site is provided at Figure 9.

Figure 9 Hillview Rd looking along runway 19 centreline towards the solar farm site

5.2. Proposed forced landing area – extended concept

Mr Antel discussed a number of accidents (one fatal) and incidents that had occurred at or in the vicinity of the aerodrome over the last 20-30 years, and specifically identified a number of occasions when aircraft had suffered a loss of power and conducted a forced landing in paddocks in the vicinity of the aerodrome. These loss of power incidents are not recorded on the online Australian Transport Safety Bureau Aviation Safety Investigations and Reports Database.

Mr Antel expressed concern that an aircraft suffering a loss of power on departure from runway 19 and having no ability to avoid landing on or into the solar panel array, would suffer much more serious consequences than in the current circumstances. He suggested that the provision of a 'forced landing area', generally aligned with the runway but avoiding vertical obstructions like trees and power lines, would serve to mitigate this risk to an acceptable level, and provided an indicative diagram to illustrate his concept.

This concept has been developed in consideration of requests of Murray Bridge aerodrome operator and following local community consultation. The forced landing area as now proposed has been included by RES in the overall layout as shown in Figure 10 (source RES). The forced landing area is shown as a yellow-coloured trapezium approximately 720 m long and 1276 m wide.

This concept provides the area to perform a forced landing for aircraft suffering an engine failure on departure from runway 19. The area is also aligned with the approach to runway 01/departure from runway 19.

It should also be noted that the proposed forced landing area is not required by any aviation legislation.

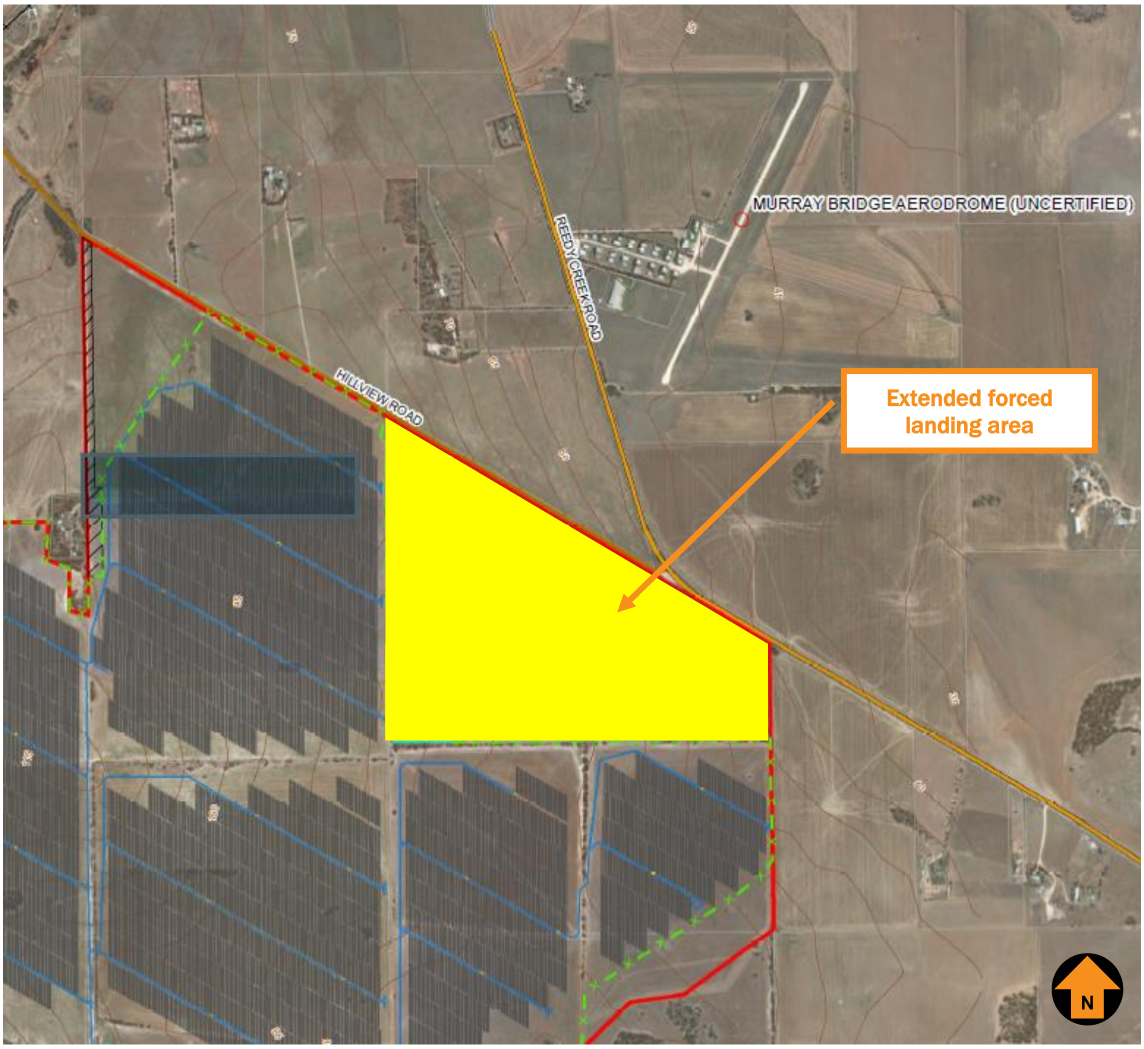


Figure 10 Proposed forced landing area (yellow trapezium)

5.3. Proposed forced landing area – initial concept

RES Australia previously proposed an indicative concept of a 'forced landing area' as an extended magenta-coloured rectangle approximately 750 m long as shown in Figure 11 (source: RES).

Note that other paths more closely aligned with the runway centreline were considered, but these would be shortened by the line of remnant vegetation.

Following community consultation the initial concept was expanded to provide an extended forced landing area.

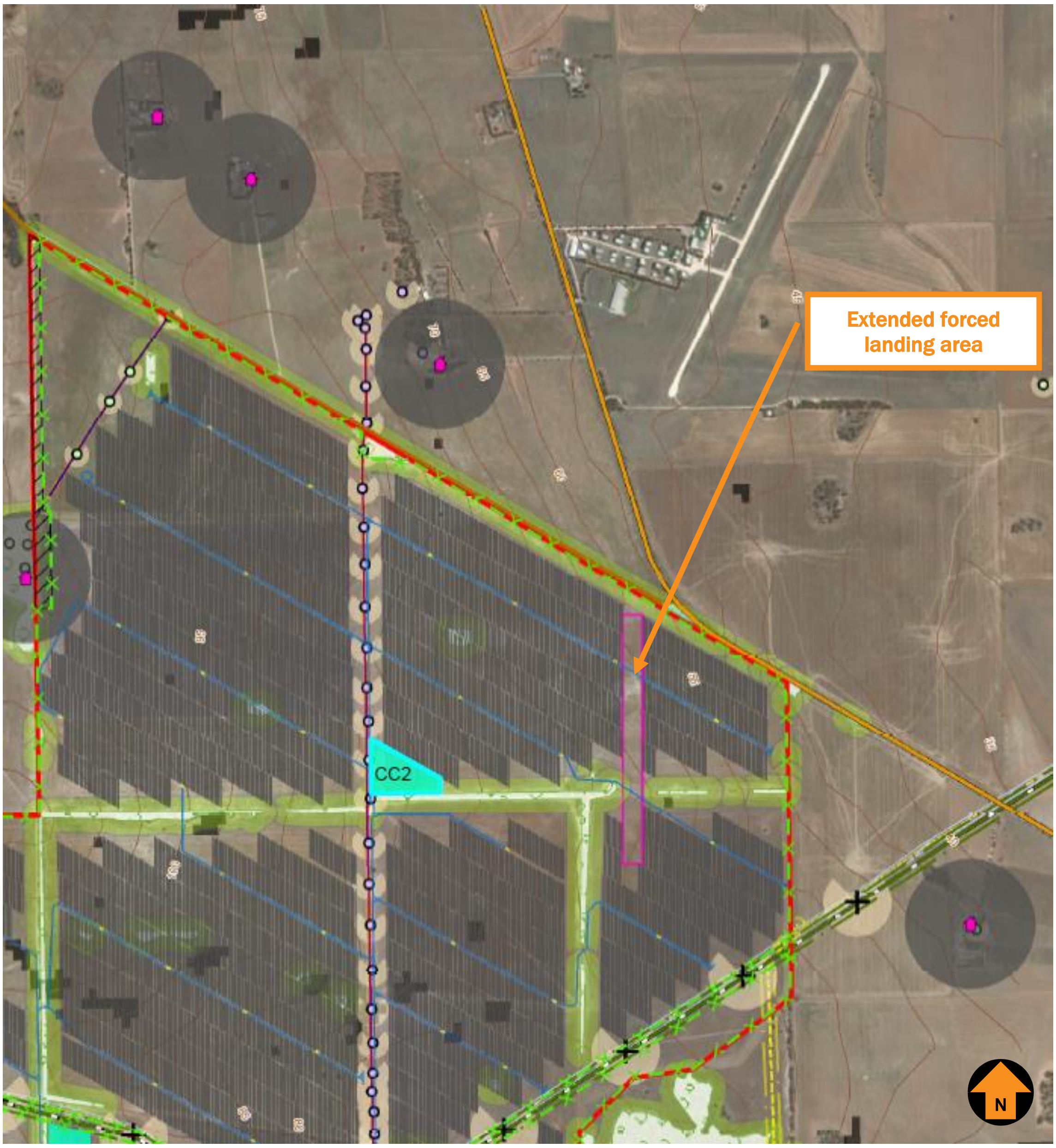


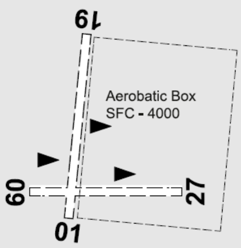
Figure 11 Initial proposed extended forced landing area

5.4. En Route Supplement Australia for Murray Bridge aerodrome

For ease of reference, a copy of the En Route Supplement Australia (ERSA) entry for Murray Bridge aerodrome is provided at Figure 12 (source: Airservices Australia, ERSA 01 March 2018). This entry shows aeronautical data applicable to the aerodrome, including the type of aerodrome, hours of operation and information for pilots about the facilities and equipment available and aircraft operations generally.

AIP Australia 01 MAR 2018 FAC YMBD - 1

MURRAY BRIDGE **ELEV 180**
AVFAX CODE 5019 **FULL NOTAM SERVICE NOT AVBL**



SA		UTC +9:30	YMBD
S 35 04.0	E 139 13.6	VAR 8 DEG E	UNCR

AD OPR Comak Pty Ltd, PO Box 88, Aldgate, SA, 5154. Email: bantel@internode.on.net. PH 0408 841 066.

REMARKS

1. PPR - AD HR: 2330-0700.
2. After AD HR - Some lighting AVBL. Contact ARO.
3. No straight-in approaches when other circuit traffic.
4. D285 applies to this area. Assume the Aerobatic Box is active and exercise caution.
5. Aerobatic Box to E of and adjacent RWY 01/19 SFC-4000 1,000M x 1,000M. Use of the Aerobatic Box requires prior approval FM the OPR. The Aerobatic Box will be ACT by radio FREQ CTAF 127.50 for periods up to 20MIN only. During activation of the Aerobatic Box no crosswind joins will be permitted and RWY 09/27 will not be available.

HANDLING SERVICES AND FACILITIES

H24 PN. Fuel by prior arrangement outside AD HR - Phone 0422 755 831.

METEOROLOGICAL INFORMATION PROVIDED

METAR/SPECI.

PHYSICAL CHARACTERISTICS

RWY 01/19 gravel 1,065M.
RWY 09/27 grass 910M with 2% upward slope to W.

ATS COMMUNICATIONS FACILITIES

FIA ADELAIDE CENTRE 130.45 Circuit Area

CTAF 127.5

ADDITIONAL INFORMATION

1. PJE 3NM NW.
2. Glider OPS at AD.
3. ACFT taking off RWY 27 are not visible from THR RWY 19.
4. Northern hold point/exit along RWY 01/19 referred to as “Alpha” and Southern hold point/ exit referred to as “Bravo”.
5. CAUTION: Blasting 1030-1500 LMT at Kanmantoo Mine 11NM west of AD.

CHARTS RELATED TO THE AERODROME

WAC 3458.

Figure 12 Murray Bridge ERSA entry

6. SOLAR GLARE ACCIDENT STATISTIC

A search has been conducted in the online aircraft accident database of the Australian Transport Safety Bureau (ATSB) Reports Database for accidents in which 'solar glare' was cited as a factor in the period from 1986 to 2018.

6.1. Accident results

The ATSB Reports Database contains 66 cases in which ‘solar glare’ was cited as a contributing factor in aircraft accidents.

Following a detailed analysis, there were no cases in the ATSB Report Database found in which ‘solar glare’ from a solar farm was cited as a factor.

The following incidents are examples in which the glare of other light sources was cited as a contributing factor to aircraft incident:

- Robinson R22 tail rotor impacts branch in Queensland, 28 May 2018;
- Robinson R22 collision with terrain in Queensland, 28 May 2015;
- Boeing 737 near Renmark in South Australia, 07 November 2014;
- Piper PA-28 and a Skyfox CA25N with separation issue near Roma Airport in Queensland, 03 July 2014;
- Piper PA34 controlled flight into terrain at Denmark (ALA) in Western Australia, 13 March 2014;
- Grob G-115C2 at Merredin (ALA) in Western Australia, 11 October 2013;
- Cessna 210N, VH-WPD, Urapunga (ALA), Northern Territory, 23 August 2012; and
- Robinson R22 crash into Lake Marradibbadibba in South Australia, 31 October 2012.

7. SIMILAR SOLAR FARM PROJECTS

Numerous airports around the world have solar farms located on their premises.

7.1. Projects in Australia

Among those in Australia where solar farms have been constructed are Darwin International Airport (NT), Karratha Airport (WA) and Ballarat Airport VIC).

Figure 13 illustrates the location of the solar farm relative to Karratha Airport runway 08/26 which located approximately 1110 m north west of runway 26 threshold (source: Google Earth).

Figure 13 Karratha Airport and solar farm

Figure 14 shows the location of the solar farm located approximately 189 m north east of runway 29 centreline at Darwin International Airport (source: Google Earth).

Figure 14 Darwin International Airport and solar farm

Figure 15 shows the location of the solar farm located approximately 188 m south west runway 05 threshold at Ballarat Airport (source: Google Earth).

Figure 15 Ballarat Airport and solar farm

7.2. International projects

Internationally, solar farms have been installed at or near airports in Singapore, UK, USA, Germany and Canada.

Figure 16 illustrates the location of the solar farm at Neuhardenberg Airport (Germany) around runway 08/26.

Figure 16 Neuhardenberg Airport and solar farm

Figure 17 illustrates the location of the solar farm at Fresno Yosemite International Airport (CA, USA) which is located approximately 742 m south east of runway 29R threshold and approximately 1100 m south east from runway 29R centreline extension.

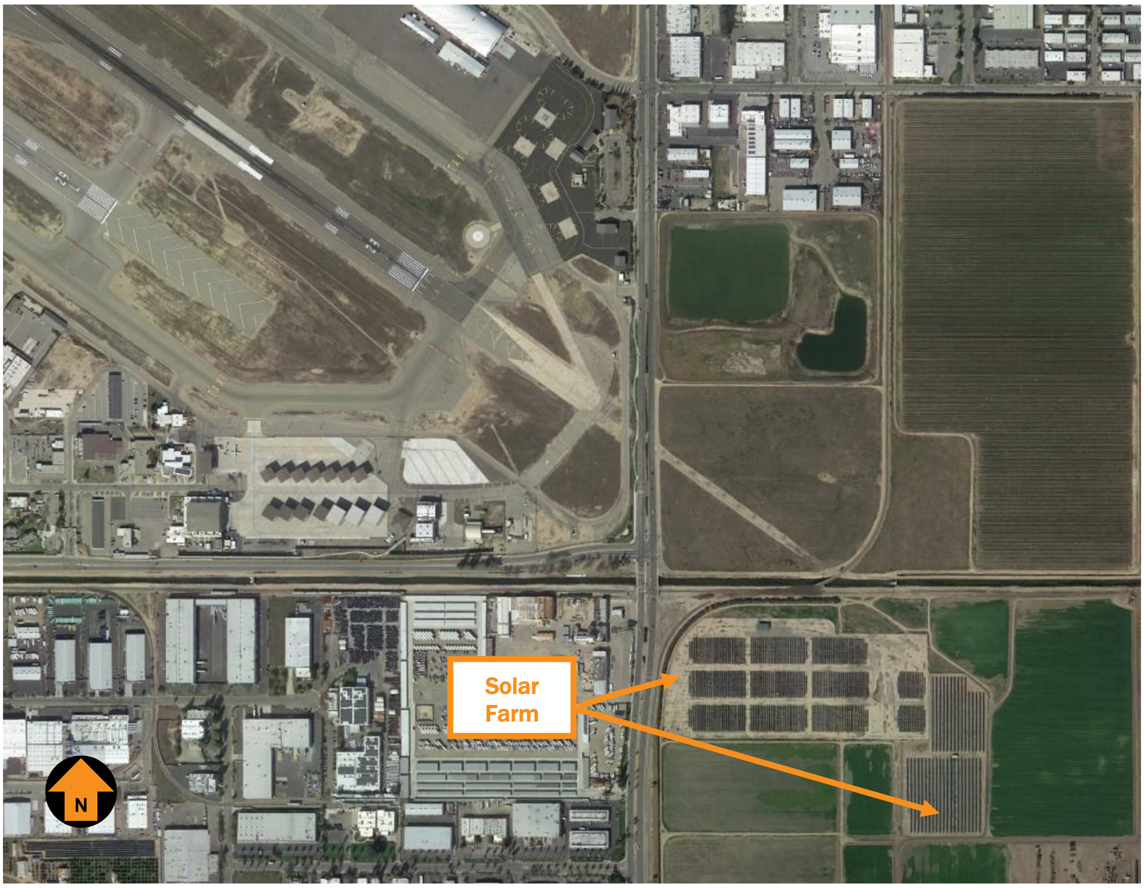


Figure 17 Fresno Yosemite International Airport and solar farm

Figure 18 shows the location of the solar farm relative to runway 05L and runway 05R thresholds and which is located approximately 920 m south east from runway 05R threshold.

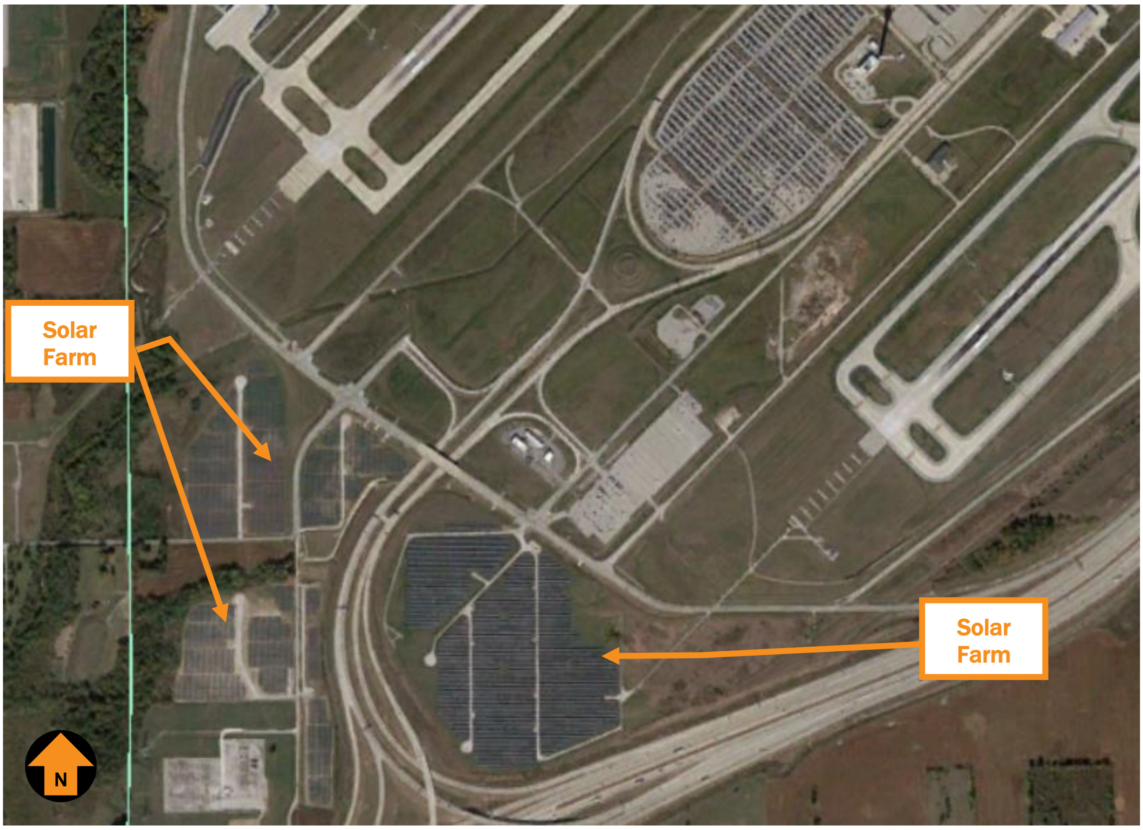


Figure 18 Indianapolis International Airport and solar farm

7.3. Summary

No evidence could be found from existing solar energy projects around the world of any reported problems of glare affecting pilots. This includes many projects in Australia and worldwide.

8. SIMILAR GA AIRPORTS

8.1. Parafield Airport

Parafield Airport is a certified airport located in South Australia.

A check of Airservices Australia's Aeronautical Information Package (AIP) shows that Parafield Airport (YPPF) has four runways:

- runway 08L/26R is a sealed runway that is 958 m in length and 18 m in width;
- runway 08R/26L is sealed runway that is 992 m in length and 18 m in width;
- runway 03L/21R is sealed runway that is 1350 m in length and 18 m in width; and
- runway 03R/21L is sealed runway that is 1279 m in length and 18 m in width.

8.1.1. Airport location

Parafield Airport is surrounded by the edge of the residential suburbs of Parafield Gardens, Mawson Lakes, Para Hills West, Salisbury (including East and Down) and located approximately 18 km (11 nm) north of the Adelaide city centre. Figure 19 shows the location of Parafield Airport relative to the neighbouring suburbs.

Parafield Airport runways has limited cleared area available in the approach to runways 08L, 08R and 21L.

Figure 19 Parafield Airport

8.1.2. Airport movement statistic

A check of the Airservices Australia's statistics presented in the Australian Airports Movements report for the Financial Year 2018 revealed that there were 152,942 general aviation (GA) aircraft movements at Parafield Airport.

8.2. Moorabbin Airport

Moorabbin Airport is a certified airport located in Victoria.

A check of Airservices Australia's Aeronautical Information Package (AIP) shows that Moorabbin Airport (YMMB) has five runways:

- runway 04/22 is an asphalt runway that is 571 m in length and 18 m in width;
- runway 13L/31R is an asphalt runway that is 1149 m in length and 30 m in width;
- runway 13R/31L is an asphalt runway that is 1060 m in length and 18 m in width;
- runway 17L/35R is an asphalt runway that is 1335 m in length and 30 m in width; and
- runway 17R/35L is an asphalt runway that is 1240 m in length and 18 m in width.

8.2.1. Airport location

Moorabbin Airport is surrounded by the edge of the residential suburbs of Mentone and Parkdale from south west, Heatherton from the north, Dingley Village from the east and Braeside from the south. Figure 20 shows the location of Moorabbin Airport relative to the neighbouring suburbs.

Moorabbin Airport has limited cleared area available in the approach to all five runways.

Figure 20 Moorabbin Airport

8.2.1. Airport movement statistic

A check of the Airservices Australia's statistics presented in the Australian Airports Movements report for the Financial Year 2018 revealed that there were 175,366 movements of GA aircraft at Moorabbin Airport.

8.3. Archerfield Airport

Archerfield Airport is a certified airport located in Queensland.

A check of Airservices Australia's Aeronautical Information Package (AIP) shows that Archerfield Airport (YBAF) has four runways:

- runway 04L/22R is a dirt runway that is 1245 m in length and 30 m in width;
- runway 04R/22L is a dirt runway that is 1100 m in length and 30 m in width;
- runway 10L/28R is an asphalt runway that is 1471 m in length and 30 m in width; and
- runway 10R/28L is a sealed runway that is 1100 m in length and 30 m in width.

8.3.1. Airport location

Archerfield Airport is surrounded by the edge of the residential suburbs of Rocklea and Salisbury from the north, Archerfield from the east, Acacia Ridge from the south and Durack from the west. Figure 21 shows the location of Archerfield Airport relative to the neighbouring suburbs.

Archerfield Airport has limited cleared area available in the approach to all four runways.

Figure 21 Archerfield Airport

8.3.2. Airport movement statistic

A check of the Airservices Australia's statistics presented in the Australian Airports Movements report for the Financial Year 2018 revealed that there were 84,124 movements of GA aircraft at Archerfield Airport.

9. SOLAR GLARE ANALYSIS

Solar photovoltaic panels can produce glint (a momentary flash of bright light) and glare (a continuous source of bright light), which could result in an ocular impact to pilots.

During consultation, this was raised as a concern to pilots operating at Murray Bridge aerodrome.

9.1. Civil Aviation Safety Authority

The Civil Aviation Safety Authority (CASA) regulates aviation safety outcomes in Australia. CASA has not published any formal direction in relation to the consideration of solar glare.

The National Airport Safeguarding Framework provides guidance on the potential risk of distractions to pilots of aircraft from lighting and light fixtures near airports but does not specifically address solar glare.

9.2. Federal Aviation Administration (USA)

The Federal Aviation Administration (FAA) provided a free tool called So*lar Glare Hazard Analysis Tool* (SGHAT) and supporting Interim Policy 78 FR 63276 for the assessment of solar glare.

The assessment requirement specified:

> *No potential for glare or "low potential for after-image" along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath.*

SGHAT was withdrawn from public access in 2017. The ForgeSolar glare analysis tool is recommended instead for non-military/government users.

9.3. ForgeSolar analysis

A revised glare analysis was prepared using the ForgeSolar application.

Following incorporation of the forced landing area within the overall site, the solar glare analysis determined that neither flight path caused green or yellow glare.

In terms of adherence to the FAA policy, it was found that:

1. Analysis time interval and eye characteristics used are acceptable; and
2. Flight path receptor(s) do not receive yellow glare.

The analysis was prepared on the basis that there is no anti-reflective coating on the solar panels. Incorporation of an anti-reflective coating may serve to further reduce any potential glare issues.

A full copy of the glare analysis report is provided at Annexure 1.

10. CONCLUSIONS

The results of this study are summarised as follows:

10.1. Project description

- The proposed Pallamana Solar Farm involves construction of a solar farm to the south of Murray Bridge aerodrome, connecting to existing overhead electricity transmission lines. The solar photovoltaic (PV) panels will be single axis tracking installations up to 4 m above ground level at the maximum point of travel.

10.2. Aviation Impact Statement

- The proposed Pallamana Solar Farm:
    - will not penetrate any OLS surfaces;
    - will not affect any instrument procedures;
    - will not impact on nearby designated air routes;
    - will not have an impact on designated airspace;
    - is wholly contained within Class G airspace; and
    - is outside the clearance zones associated with aviation navigation aids and communication facilities.

10.3. Aircraft operations

- The operator of Murray Bridge aerodrome has identified concerns in relation to an aircraft suffering a loss of power on departure from runway 19 and having no ability to avoid landing on or into the solar panel array, would suffer much more serious consequences than in the current circumstances.
- As a result, although not a mandatory obligation, RES has modified the proposed solar farm layout to incorporate a forced landing area that mitigates this risk.

10.4. Solar glare analysis

A solar glare analysis using the ForgeSolar application found that

- Analysis time interval and eye characteristics used are acceptable; and
- Flight path receptor(s) do not receive yellow (unacceptable) glare.

- The proposed use of an anti-reflective coating will serve to further reduce any potential glare issues.

10.5. Summary

- Subject to implementation of the proposed recommendations, the proposed Pallamana Solar Farm will not have an adverse impact on aviation safety.

11. RECOMMENDATIONS

Recommended actions resulting from the conduct of this assessment are provided below.

Aircraft safety

1. The proponent should consider the incorporation of a ‘forced landing area’ in the overall layout, generally aligned with runway 01/19 but avoiding vertical obstructions like trees and power lines, as per the indicative concepts provided.

2. The proponent should ensure that an anti-reflective coating is applied to the solar panels to further reduce any potential glare issues.

ANNEXURE

1. ForgeSolar Glare Analysis

FORGESOLAR GLARE ANALYSIS

Project: **Pallamana Solar Farm**

Proposed site south of Murray Bridge Aerodrome

Site configuration: **V1_3 Forced landing**

Analysis conducted by Keith Tonkin (ktonkin@aviationprojects.com.au) at 00:04 on 17 Jul, 2018.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis and observer eye characteristics are as follows:

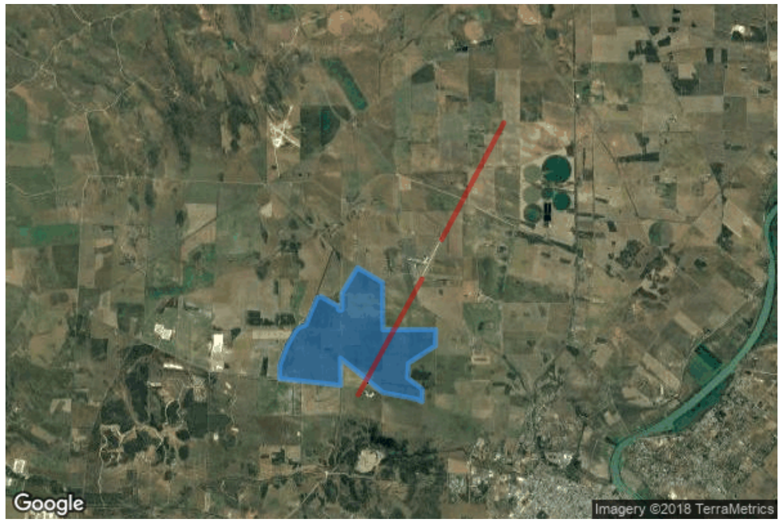
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

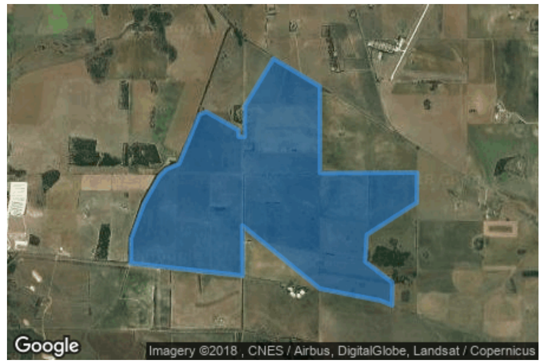
Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 19786.2657



PV Array(s)

Name: PV array 1
Description: Layout with forced landing area
Axis tracking: Single-axis rotation
Tracking axis orientation: 30.0°
Tracking axis tilt: 90.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 60.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	-35.066051	139.206756	285.95	13.10	299.05
2	-35.071636	139.202593	327.45	13.10	340.55
3	-35.075294	139.202578	335.08	13.10	348.18
4	-35.075276	139.201687	340.34	13.10	353.44
5	-35.074521	139.201676	338.28	13.10	351.38
6	-35.072353	139.197031	332.66	13.10	345.76
7	-35.072634	139.196012	326.54	13.10	339.64
8	-35.078495	139.193027	327.56	13.10	340.66
9	-35.079162	139.191160	330.50	13.10	343.60
10	-35.080022	139.190152	334.36	13.10	347.46
11	-35.083183	139.187963	347.25	13.10	360.35
12	-35.087362	139.186032	360.40	13.10	373.50
13	-35.090277	139.185989	368.90	13.10	382.00
14	-35.091752	139.202297	302.22	13.10	315.32
15	-35.085817	139.202254	304.06	13.10	317.16
16	-35.093297	139.213498	249.88	13.10	262.98
17	-35.094701	139.222295	205.53	13.10	218.63
18	-35.095263	139.224012	213.81	13.10	226.91
19	-35.092559	139.224055	183.58	13.10	196.68
20	-35.090101	139.220107	195.28	13.10	208.38
21	-35.086906	139.220321	216.08	13.10	229.18
22	-35.083113	139.227574	181.00	13.10	194.10
23	-35.079531	139.227617	157.21	13.10	170.31
24	-35.079601	139.213541	262.25	13.10	275.35
25	-35.069345	139.213498	273.84	13.10	286.94

Flight Path Receptor(s)

Name: FP 1
Description:
Threshold height: 50 ft
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	-35.068467	139.223979	161.91	50.00	211.92
Two-mile	-35.093818	139.206974	258.48	506.89	765.37

Name: FP 2
Description:
Threshold height: 50 ft
Direction: °
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	-35.059949	139.229221	143.32	50.00	193.32
Two-mile	-35.034418	139.245818	148.18	598.60	746.78

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array 1	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 1	0	0
FP 2	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
FP 1	0	0
FP 2	0	0

Flight Path: FP 1

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 2

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
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 based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

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Aeronautical Impact Assessment

Monarto Solar Farm

For

RES Australia Pty Ltd

Document details

Project	Client	Contract No.	Version No.	Author
Aeronautical Impact Assessment Monarto Solar Farm	RES Australia Pty Ltd	LB00097	002	Ian Jennings

VERSION NO.	BASIS OF ISSUE	DATE	REVIEWERS
001	Draft report for submission	12 Oct 2017	
002	Final Report Monarto Solar Farm	16 Oct 2017	B Slingo

Contents

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Executive Summary

RES Australia Pty Ltd engaged Landrum and Brown Worldwide Australia Pty Ltd to prepare an Aeronautical Impact Assessment for Solar Power Generation facilities proposed at Monarto, to the east of Adelaide between the ranges and the Murray River in South Australia. The proposed large-scale facility will utilise photovoltaic panels mounted on single axis tracking mounts.

The proposed Monarto facility is sufficiently distant from any Military, Certified or Registered aerodromes to have no impact on their operation, however it is 1km south of the Murray Bridge uncertified aerodrome. The height of the single axis tracking solar panels, at 3m above ground level, is considered to have no impact on the flight paths for the two runways.

The location of the solar panels in relation to the flight path for take-off and landing on Runway 19, that is, to the south, may cause short periods of “green glare” with a low potential to cause temporary after image. The solar glare analysis conducted indicates that the potential impact on aircraft operations at Murray Bridge is low.

The Monarto solar facility will have no impact on Controlled Airspace, Air Routes, published Instrument Approach Procedures or Restricted Airspace. Neither will it impact on aviation Communications, Navigation or Surveillance installations.

1. Introduction

RES Australia Pty Ltd has engaged Landrum and Brown Worldwide Services Pty. Ltd. to prepare an Aeronautical Impact Assessment for Solar Power Generation facilities at Monarto in South Australia.

1.1. Location

The proposed solar farm site is located to the east of Adelaide between the ranges and the Murray River. The nearest town is Murray Bridge.

The Monarto site is located south of the Hillview Road with the northern boundary approximately 1km south of the Murray Bridge aerodrome. See Figure 1.1.1 below.

Figure 1.1 – Monarto Solar Farm Site Location.

1.2. Aerodromes and Airstrips

Aerodromes fall into four categories:

- Military or Joint User (combined military and civilian);
- Certified;
- Registered; and
- Uncertified or Aeroplane Landing Areas

A Military aerodrome is operated by the Department of Defence and is suitable for the operation of military aircraft. A Joint User aerodrome is a Military aerodrome used by both military and civilian aircraft, for example Darwin International and Townsville International Airports.

A Certified Aerodrome, certified under Civil Aviation Safety Regulation (CASR) 139.040, is available for Regular Public Transport and Charter operations and has a runway suitable for use by an aircraft having a maximum carrying capacity of more than 3,400kg or a passenger seating capacity of more than 30 seats, for example Adelaide International Airport, Mount Gambier Airport and Whyalla Airport.

A Registered Aerodrome, registered under CASR 139.260, is one to which CASR 139.040 does not apply and the operator has applied to the Civil Aviation Safety Authority (CASA) to have it registered, for example Renmark and Port Pirie Airports.

An Uncertified Aerodrome is any other aerodrome or airstrip and is referred to as an Aeroplane Landing Area (ALA). These range in capability and size from having a sealed runway with lighting capable of accommodating corporate jet aircraft to a grass paddock that is smooth enough to land a single engine light aircraft or a purpose built aerial agricultural aircraft.

Military, Joint User, Certified and Registered aerodromes are listed in the Aeronautical Information Publication[1] (AIP) and are subject to a NOTAM[2] service that provides the aviation industry with current information on the status of the aerodrome facilities. This information is held in the public domain, is available through aeronautical publications and charts and is kept current by mandatory reporting requirements.

Uncertified aerodromes (ALA) are not required to be listed in the AIP so information about them is not held in the public domain, is not available through aeronautical publications and charts and is not required to be reported. Where ALA information is published in the AIP it is clearly annotated that it is not kept current. Consequently, ALA can come into use and fall out of use without any formal notification to CASA or any other authority. Airstrips that appear on survey maps often no longer exist; others exist but do not feature on maps. Similarly, a grass paddock used as an ALA is not usually discernable on satellite mapping services such as Google Earth.

Military, Joint User, Certified and Registered aerodromes usually have Obstacle Limitation Surfaces (OLS) and Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) surfaces prescribed to protect the airspace associated with published instrument approach and landing procedures. An uncertified aerodrome or ALA cannot have a published instrument approach and landing procedure so cannot have associated prescribed airspace protected by OLS or PANS-OPS. All operations into ALA therefore, must be conducted in accordance with the Visual Flight Rules (VFR) and in Visual Meteorological Conditions (VMC).

1.3. Aerodromes in the Area

There are no military, joint user, certified or registered aerodromes within 30nm (56km) of the Monarto site.

There is a substantial ALA at Murray Bridge (YMBD) immediately 0.54nm (1km) to the north of the site.

1 AIP; a mandatory worldwide distribution system for the promulgation of aviation rules, procedures and information
2 NOTAM (Notice to Airmen); a mandatory reporting service to keep aerodrome and airways information current and available to the aviation industry world wide

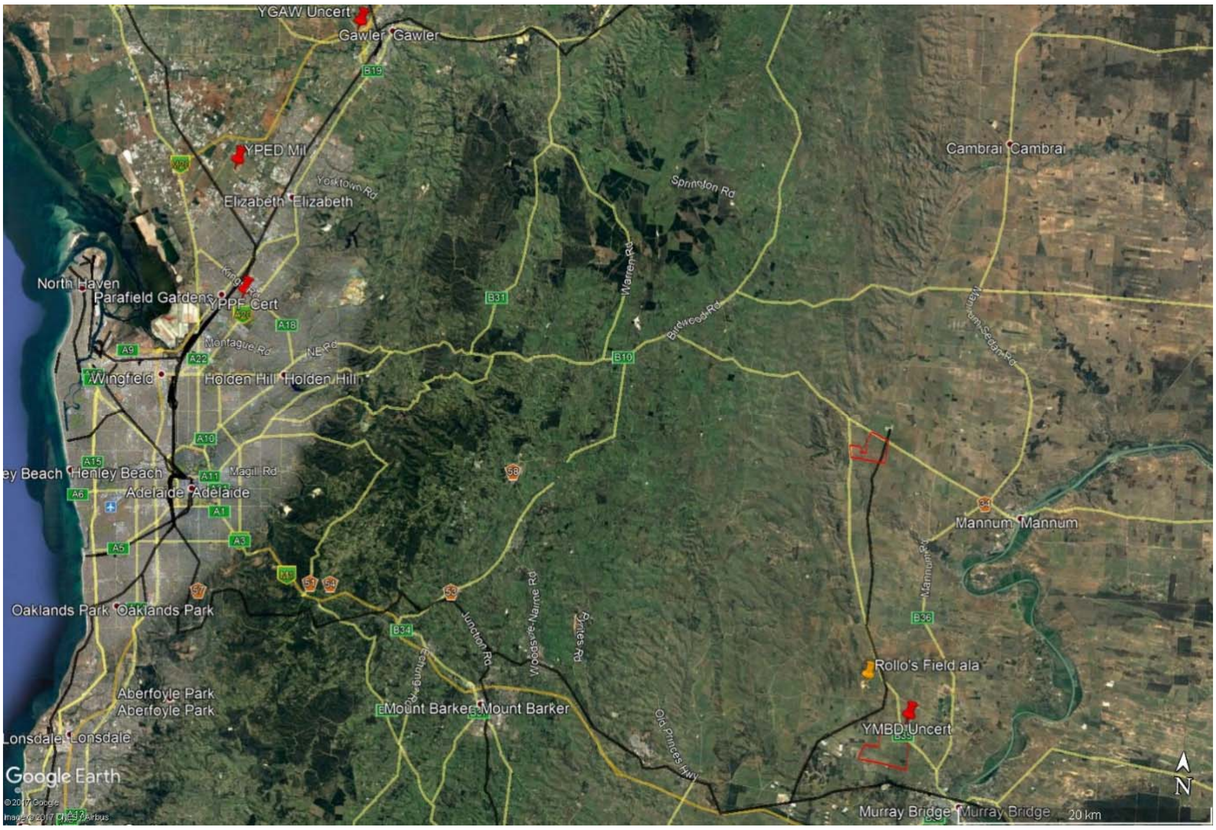


Figure 1.2 – Aerodromes within 30nm

1.4. Airspace

The airspace surrounding the site is Class G airspace.

There is a Danger Area D285 of 3nm radius surface to 4000ft centred on YMBD used for aerobatics, which sits over the Monarto site.

There are two military Restricted Areas, R289A surface to 2500ft and R289B 2500ft to 7000ft approximately 5.5nm (11km) to the east of the Monarto site.

2. Scope

To meet the requirements of RES the study required L&B to examine the proposed developments and undertake the following tasks.

- Specify all Military, Joint User, Certified and Registered aerodromes within 30nm (56km):
  - Nominate all instrument approach and landing procedures
  - Confirm that the obstacles do not penetrate the Annex 14 OLS
  - Confirm that the obstacles do not penetrate the PANS-OPS
- Confirm that glare and sun reflection does not create a distraction for pilots.

Details of aerodromes, OLS and PANS-OPS procedures Lowest Safe Altitudes, Navigation and Airspace Surveillance facilities were obtained from the Australian Aeronautical Information Publication (AIP), Airservices Australia (AsA) sources and Civil Aviation Safety Authority (CASA) publications.

3. Methodology

To meet the requirements of an Aeronautical Impact Assessment the following methodology was used: -

- The AIP was reviewed to determine;
  - All military/registered/certified aerodromes located within 30nm (55.6km) of the solar farms
  - Any associated Instrument Departure and Approach Procedures (DAP);
  - The extent of the OLS and PANS-OPS surfaces for the identified DAP;
  - Published air routes located over or near the solar farm;
  - The classification of the airspace surrounding the solar farm;
- Ascertain the locations of CNS facilities that may be impacted and analyse the impact on;
  - Communications facilities;
  - Navigation facilities;
  - Surveillance facilities (in accordance with EUROCONTROL Guidelines);
- The location of the sites was plotted on Google Earth to ascertain their location in relation to military/registered/certified aerodromes and any significant uncertified (ALA) within 30nm.
- A glare assessment was undertaken, using an FAA approved tool, to ascertain the likelihood of the solar panels creating a glare hazard or pilot distraction for nearby aerodromes.

4. Aeronautical Impact Assessment

The Solar PV panels proposed for use in the Monarto installation are single axis tracking installations that will be 3m Above Ground Level (AGL) at the maximum point of travel. They are not considered tall structures and therefore will not be an obstacle to aircraft flight.

4.1 Location

The location of the Monarto solar farm site is shown in Figures 1.1 above.

4.2 Aerodromes within 30nm

As noted in 1.3 above, there are no military, joint user, certified or registered aerodromes within 30nm of the Monarto site.

The Monarto solar farm does not penetrate any Obstacle Limitation Surfaces (OLS) or Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) surfaces associated with any Instrument Approach Procedures (IAP) at these aerodromes.

There is an uncertified aerodrome, Murray Bridge (YMBD), immediately north of the solar farm. YMBD[3] has one gravel and one grass runway and no instrument approach procedures. The gravel runway is 1065m long and aligned 01/19, i.e. north south with the grass runway being 910m long and aligned 09/27, i.e. east west. The aerodrome is available for use with prior permission required from 2330-0700 Universal Time Coordinated (UTC) [0900 to 1630 CST] daily. There is limited runway lighting available with prior arrangement.

From previous work undertaken by the author, YMBD is used for Recreational Aviation Australia (RA-Aus) registered Ultra-light aircraft flying training as well as General Aviation Flying training. There are multiple aircraft hangars on site and there appears to be a sizeable number of aircraft, both ultra-light and general aviation light aircraft based at the aerodrome. Murray Bridge is also used by glider aircraft.

It can be considered that the main runway is 01/19 and is the one used predominantly for General Aviation light aircraft, both single and twin engine. A light aircraft is defined as one having a maximum take-off weight (MTOW) of 5700kg or less. It can be considered that the aircraft that regularly use YMBD will be smaller types with a typical MTOW of 1200 to 3000kg. The RA-Aus registered ultralight aircraft are limited to 600kg MTOW.

When using runway 19 (RWY 19), that is taking off or landing to the south, aircraft will be tracking directly toward the Monarto solar installation. The first line of solar panels is approximately 650m from the end of RWY19. At a maximum height of 3m Above Ground Level (AGL) the proposed single axis tracker panels are sufficiently below the normal take-off and landing paths used by aircraft and are therefore not considered to be an obstacle.

There are existing 33kv and 132kv power transmission lines in the vicinity of YMBD.

There is a Danger Area D285 of 3nm radius, surface to 4000ft, centred on YMBD used for aerobatics, which sits over the Monarto site. However, the nature of the use of D285 for aerobatics indicates that the proposed solar farm will not impact on its intended use.

[3] AIP ERSA, FAC YMBD-1, 17 August 2017.

Rollo's Field is another ALA located 3.4km to the North West. This ALA has been used for parachute jumping activity. Its current use is not known. It is sufficiently distant from the Monarto site to be unaffected by the solar farm installation.

4.3 Airspace

Given that the solar farm is no more than 3m AGL, except for power transmission line structures, it will have no impact on any overlying Controlled Airspace.

The solar facility will not impact on any Air Routes or Lowest Safe Altitudes (LSALT) in the vicinity.

The Monarto site will not impact on Restricted Areas R289A & B, situated 5.5nm (11km) to the east.

Danger Area D285 of 3nm radius surface to 4000ft is centred on YMBD and used for aerobatics. This Danger Area sits over the Monarto site, however its purpose indicates that the proposed solar farm will not impact on its intended use for aerobatics.

4.4 Communications, Navigation and Surveillance Facilities

There are no identified civil of military Communications, Navigation or Surveillance (CNS) facilities in the area. The Monarto solar farm site will not have any impact on CNS facilities.

4.5 Solar Glare Assessment

The nature of photovoltaic (PV) panels is such that they may create sun glare as a result of reflection from the outer covering of the panel. At close range this glare may pose a hazard to aircraft safety. This is particularly so for solar PV installations within direct line and close to runways where glare may distract an aircraft pilot at a critical phase of flight.

The solar glare analysis was conducted using the ForgeSolar[4] tools which are used throughout the world by consultants, PV installers and researchers to predict and plan for glare. ForgeSolar use SGHAT[5] technology to offer a suite of glare analysis tools that meet all United States Federal Aviation Administration (FAA) standards.

A solar glare assessment was carried out for the Monarto site due to its proximity to YMBD.

The ForgeSolar glare analysis was undertaken for runways RWY01 and RWY19. The RWY19 flight path is the most likely to be affected by glare. Glare is defined as a continuous source of excessive brightness with possible after image or temporary loss of vision. Glint is defined as a momentary flash of light. The results of the analysis are shown at Appendix A.

The results show that for Flight Path 2 (FP 2) which is a take-off or landing to the south using RWY 19 there is a low potential for glare causing a temporary after image. This potential glare is of short duration and is visible within approximately 0.3nm (0.48km) of the runway threshold. The nature of the glare is termed "green glare" and as such has a low potential to cause a temporary after image; that is there is no lingering effect from the glare.

The results indicate short duration glare periods that total 39 minutes over a 12 month period and vary in duration throughout the year.

4 The ForgeSolar tools are available at https://www.forgesolar.com/
5 Solar Glare Hazard Analysis Tool developed by Sandia National Laboratories https://share.sandia.gov/phlux

These results are for PV panels using smooth glass without an anti-reflective coating which is considered to be a "worst case" scenario. Using anti-reflective materials will reduce the glare from the panels.

Overall the impact of the Monarto solar farm on aviation safety at YMBD is considered to be low.

4.6 Conclusions

The conclusions drawn from this Aeronautical Impact Assessment for the Monarto solar farm are that:-

- It will not impact on LSALT's, OLS nor PANS-OPS prescribed airspace;
- It will not impact on CNS facilities; and
- It will have a low impact on aviation operations at the Murray Bridge aerodrome through short duration periods of "green glare" being visible from the Runway 19 flight path within 0.3nm of the runway threshold.

Appendix A

ForgeSolar Analysis Results

GlareGauge Glare Analysis Results

Site Configuration: Monarto

Project site configuration details and results.

Created **Oct. 8, 2017 8:04 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 ft pupil diameter
0.017 ft eye focal length
9.3 mrad sun subtended angle
Site Configuration ID: 10456.1833

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

PV name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	90.0	30.0	39	0	-

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 30.0 deg
Tracking axis tilt: 90.0 deg
Tracking axis panel offset: 0.0 deg
Limit tracking rotation? Yes
Maximum tracking 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	ft	ft	ft
1	-35.063866	139.202614	301.85	0.00	301.85
2	-35.076721	139.227934	146.43	0.00	146.43
3	-35.096386	139.227591	211.73	0.00	211.73
4	-35.091822	139.202442	306.10	0.00	306.10
5	-35.090487	139.186563	379.84	0.00	379.84
6	-35.083885	139.187937	364.03	0.00	364.03
7	-35.079460	139.192657	341.77	0.00	341.77
8	-35.079601	139.202528	379.82	0.00	379.82

Flight Path Receptor(s)

Name: FP 1
Description:
Threshold height: 50 ft
Direction: 203.0 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	ft	ft	ft
Threshold	-35.068291	139.224072	170.20	50.00	220.20
2-mile point	-35.094906	139.210253	277.41	496.25	773.66

10/9/2017 Monarto Site Config | ForgeSolar

Name: FP 2
Description:
Threshold height: 50 ft
Direction: 28.0 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	ft	ft	ft
Threshold	-35.059439	139.229307	154.19	50.00	204.20
2-mile point	-35.033911	139.245909	156.54	601.11	757.65

https://www.forgesolar.com/projects/1833/configs/10456/ 2/4

10/9/2017 Monarto Site Config | ForgeSolar

PV Array Results

PV array 1 low potential for temporary after-image

Component	Green glare (min)	Yellow glare (min)
FP: FP 1	0	0
FP: FP 2	39	0

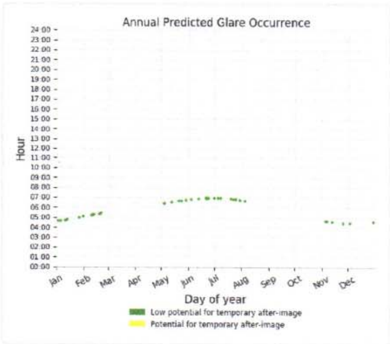
PV array 1 - Flight Path Receptor (FP 1)

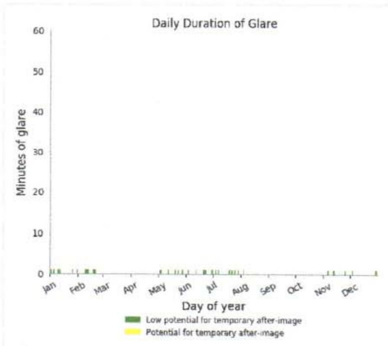
No glare found

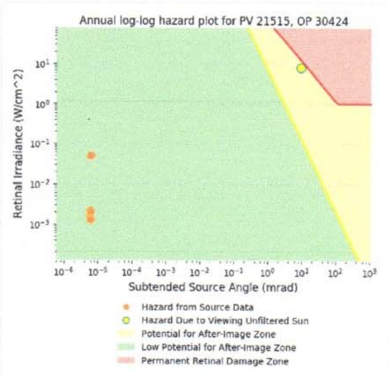
PV array 1 - Flight Path Receptor (FP 2)

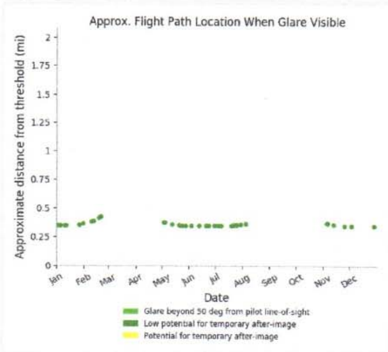
PV array is expected to produce the following glare for observers on this flight path:

- 39 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.









https://www.forgesolar.com/projects/1833/configs/10456/ 3/4

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.

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RES Australia Pty Ltd
11-Jul-2018

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Pallamana Solar Farm

Geology, Topography and Soils

Pallamana Solar Farm

Geology, Topography and Soils

Client: RES Australia Pty Ltd

ABN: 55 106 637 754

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AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document Pallamana Solar Farm

Ref 60577009

Date 11-Jul-2018

Prepared by Kylie Schmidt

Reviewed by James Rusk

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Rev	Revision Date	Details	Authorised	
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A	02-May-2018	Draft For Review	Kylie Schmidt Project Manager	KRSchmidt
B	21-May-2018	Draft For Issue	Kylie Schmidt Project Manager	KRSchmidt
C	11-Jul-2018	Final Issue	Kylie Schmidt Project Manager	

Table of Contents

Executive Summary

This report addresses the desktop geology, topography and a soil review, and identifies issues including the potential for erosion and sedimentation through construction and operational phases of the solar farm. It also identifies potential geotechnical issues with anticipated ground conditions.

This report is based on a desktop assessment of the geological conditions of the Pallamana Solar Farm which will be further considered in future stages of the Project. The recommended mitigation measures include the preparation of a construction environmental management plan and a geotechnical site investigation.

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was commissioned by RES Australia Pty Ltd (RES) to provide engineering consulting services to support the planning application for the proposed solar farm in the area named Pallamana, Monarto Road, Murray Bridge, South Australia 5254. The site covers an area of 758 hectares.

This report has been prepared to provide a preliminary assessment of the geology, topography and soils at the proposed solar farm located on Monarto Road approximately 7 km north west of Murray Bridge, SA.

The purpose of the preliminary geology, topography and soils assessment is to provide a baseline assessment of features that may be impacted by the Project or that may impact the design of the Project.

The scope of works included the following:

- Site visit by a civil engineer to observe the project site and its features including surface soils and geological features, topographical features and landforms
- Desktop review of geological, topographic and soil information for the site to identify any site conditions that may impact on the project.
- Review of SA regulatory framework relevant to geology, topography and soil impacts to inform any requirements or constraints for the site.

2.0 Project Description

RES Australia Pty Ltd (RES Australia) proposes to develop the Pallamana Solar Farm development in an area named Pallamana. The site of the proposed solar farm is approximately 7 km north west of Murray Bridge, SA.

RES is one of the world's leading independent renewable energy companies, with the expertise to develop, engineer, construct, finance, and operate projects around the globe. RES Australia has been developing renewable energy projects in Australia since 2004.

2.1 Project Overview

The proposed solar farm will consist of the following components:

- Up to 7890 solar arrays (84 panels per array)
- Access road
- Battery storage area
- Temporary construction facilities
- Connection infrastructure

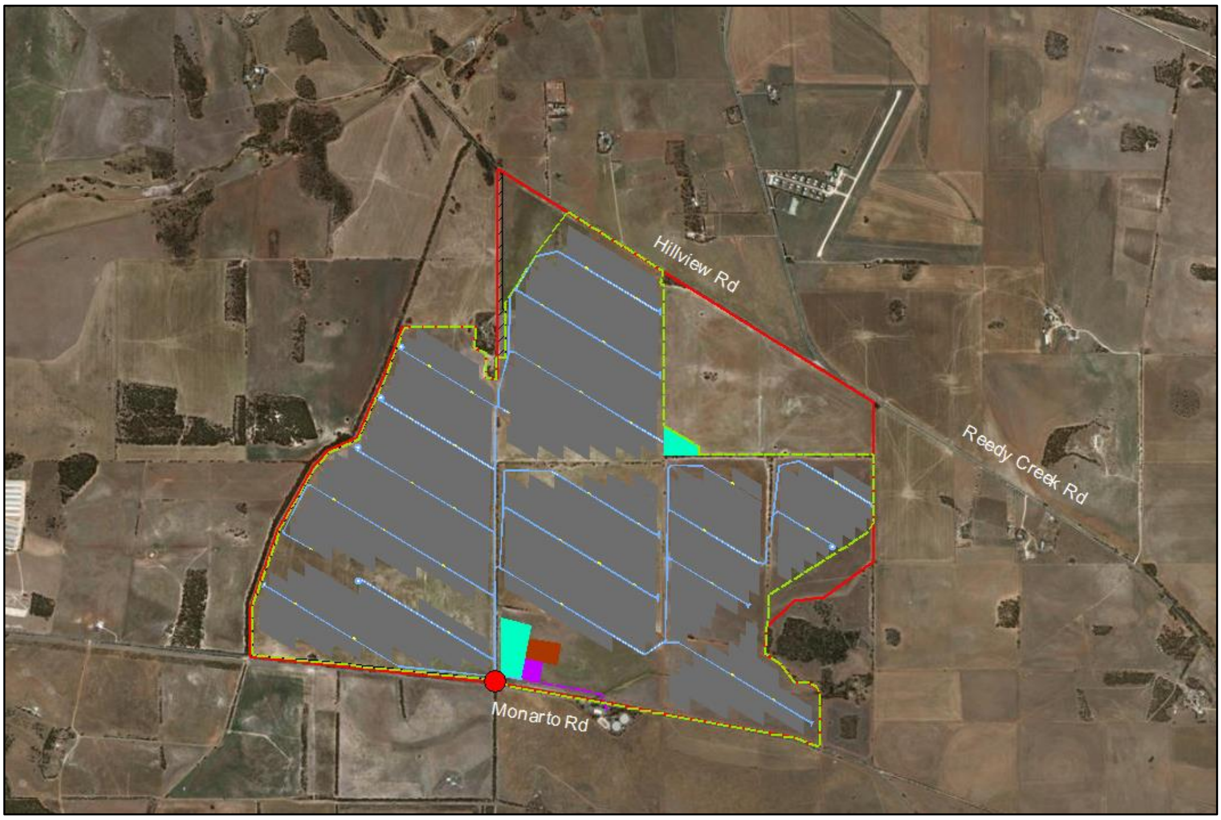
3.0 Project Siting/Locality Description

RES proposes to develop the Pallamana Solar Farm within the south east area of South Australia. The site of the proposed solar farm is approximately 7 km north west of Murray Bridge and 60 km south east of Adelaide.

The site layout in relation to the surrounding road network is shown in Figure 1 below.

The proposed site and area surrounding the site is predominantly agricultural land with some pockets of vegetation.

Figure 1 Site layout



4.0 Regulatory Framework

4.1 SA Murray Darling Basin Regional NRM Plan

The *Natural Resources Management Act 2004* creates a regulatory framework for the management of water, soil and biological assets in the region. The SA MDB Regional NRM Plan aims to support ecologically sustainable development in the region and achieve a balance between environmental, social, economic and cultural outcomes through the use of natural resources.

The strategic plan has a vision of sustainable production landscapes, with a target of protecting and improving soil and land to support the productive capacity and natural resources of the region by 2030. Major threats to the land listed relevant to the proposed development include wind and water erosion, pest plants and animals, inappropriate land management, dryland salinity, soil acidity, acid sulphate soils, declining soil physical condition, water repellence, other nutrient deficiencies or toxicities.

4.2 Murray Bridge Council Development Plan

The Murray Bridge Council Development Plan (referred to as the 'Development Plan') sets out several objectives for the management of hazards as outlined below:

1. Maintenance of the natural environment and systems by limiting development in areas susceptible to natural hazard risk.

7. The environmental values and ecological health of receiving waterways and marine environments protected from the release of acid water resulting from the disturbance of acid sulfate soils.

10. Minimisation of harm to life, property and the environment through appropriate location of development and appropriate storage, containment and handling of hazardous materials.

Relevant principles of development control relating to specific hazards are outlined below:

Salinity

18. Development should not increase the potential for, or result in an increase in soil and water salinity.

Acid Sulfate Soils

21. Development and activities, including excavation and filling of land, that may lead to the disturbance of potential or actual acid sulfate soils should be avoided unless such disturbances are managed in a way that effectively avoids the potential for harm or damage to any of the following:
    a. The marine or estuarine environment
    b. Natural water bodies and wetlands
    c. Agricultural or aquaculture activities
    d. Buildings, structures and infrastructure
    e. Public health.

Containment of Chemical and Hazardous Materials

24. Hazardous materials should be stored and contained in a manner that minimises the risk to public health and safety and the potential for water, land or air contamination.

Landslip

26. Land identified at risk from landslip as shown on the *Overlay Maps – Development Constraints* should not be developed.

The following principles of development control are highlighted as part of the natural resources section of the Development Plan:

Soil Conservation

41. Development should not have an adverse impact on the natural, physical, chemical or biological quality and characteristics of soil resources.
42. Development should be designed and sited to prevent erosion.
43. Development should take place in a manner that will minimise alteration to the existing landform.
44. Development should minimise the loss of soil from a site through soil erosion or siltation during the construction phase of any development and following the commencement of an activity.

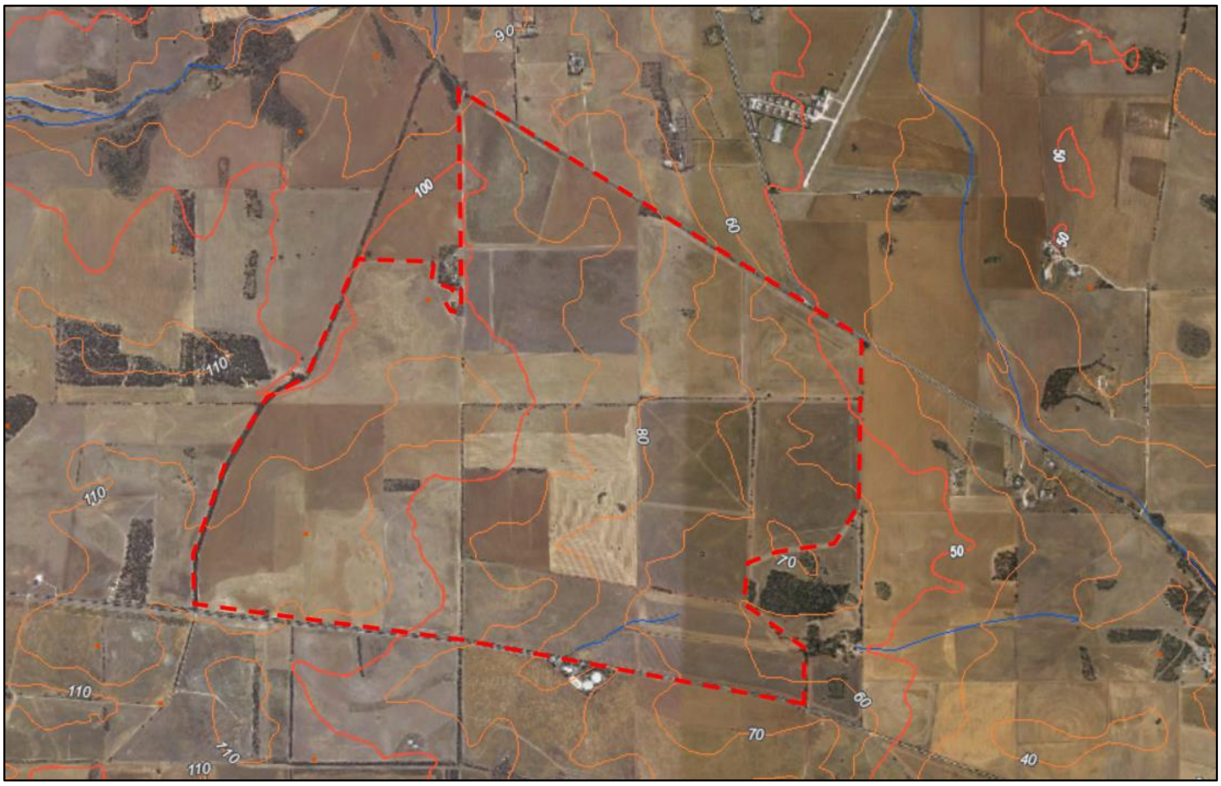
5.0 Desktop Review of Topography, Geology and Soils

5.1 Topography and Landforms

The proposed solar farm layout extends approximately 4.3 km in the west-east direction and 3.5 km in the north south direction.

The topography of the site is hilly. The hills are generally rounded and the site generally slopes from west to east down towards the River Murray. The elevation of the site varies from approximately 100 mAHD on the western site boundary to approximately 60 to 70 mAHD on the eastern site boundary.

Figure 2 Site topography



At the time of the site visit, vegetation typically comprised of low grass pastures with clusters of mature trees south east of the site boundary.

An overland drainage line is present from near the centre of the southern boundary (Figure 3), which discharges from the adjacent SA Water Pumping/Transfer station, under Monarto Road and then drains across the south eastern corner of the site and appears to discharge on the south eastern boundary of the site (Figure 4). This is a tributary and within the Preamimma Creek catchment.

Figure 3 Drainage swale culvert

Figure 4 Drainage swale watercourse (N-E facing)

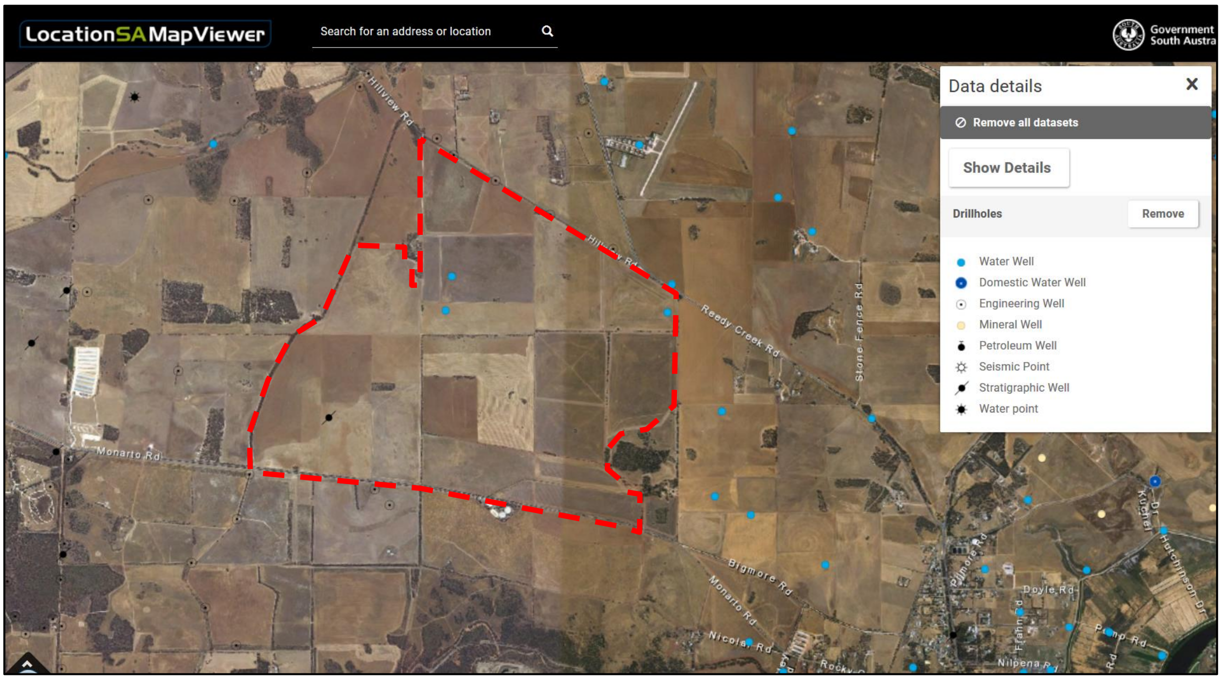
5.2 Groundwater

The site is located within the Eastern Mount Lofty Ranges Prescribed Water Resource Area, which covers groundwater, water courses and surface water.

The proposed solar farm is located on top of both a fractured rock aquifer in Cambrian and Precambrian rocks (western portion of the site) and a sedimentary rock aquifer in limestone, sandstone, sand shale and clay (eastern portion of site). It is important to note that aquifers in limestone are often cavernous.

Four registered wells are located within the site boundary; 6727-607, 6727-608, 6727-450 and 6727-611, however there is no available information on groundwater quality. A reduced standing water level of 44.84 m AHD has been reported for well number 6727-611.

Figure 5 Well locations



5.3 Soils

Soils observed during the site visit were consistent with the expected Quaternary deposits of sands and clays (Figure 6). Some calcrete gravels were observed (Figure 7) that could be consistent with the Bakara calcrete cap unit. These may have been brought to the surface by the cultivation of the soils for cropping.

Figure 6 Soil observations

Figure 7 Calcrete observations

A review of Location SA (refer to Figure 8) identified the following soil classes as sourced from *The Soils of Southern South Australia*:

- D5 – Hard loamy sand over red clay in the south eastern corner of the site
- A2 – calcareous loam on rock over the eastern portion of the site
- G4 – sand over poorly structured clay over the western portion of the site

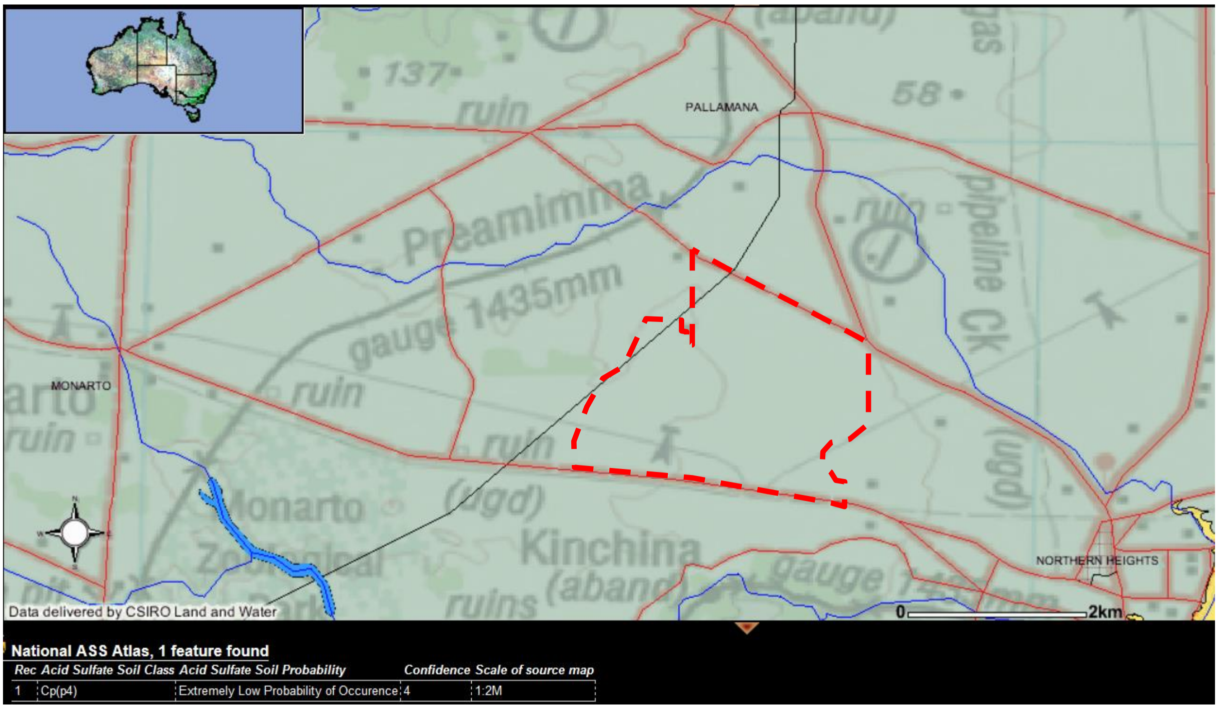
While not on the site, it is noted on the eastern site boundary where the vegetated area exists the soil class is identified as shallow calcareous loam on calcrete.

These soils are consistent with the Quaternary aged deposits expected to be present at surface across the site and Bakara calcrete as identified in the geology section.

Figure 8 Location SA soil subgroup map

A review of the Australian Soil Resource Information System (ASRIS) for acid sulfate soils, indicates the site is located in an area of extremely low probability of occurrence, as expected by the distance from water courses (refer to Figure 9).

Figure 9 Australian Soil resource Information System map



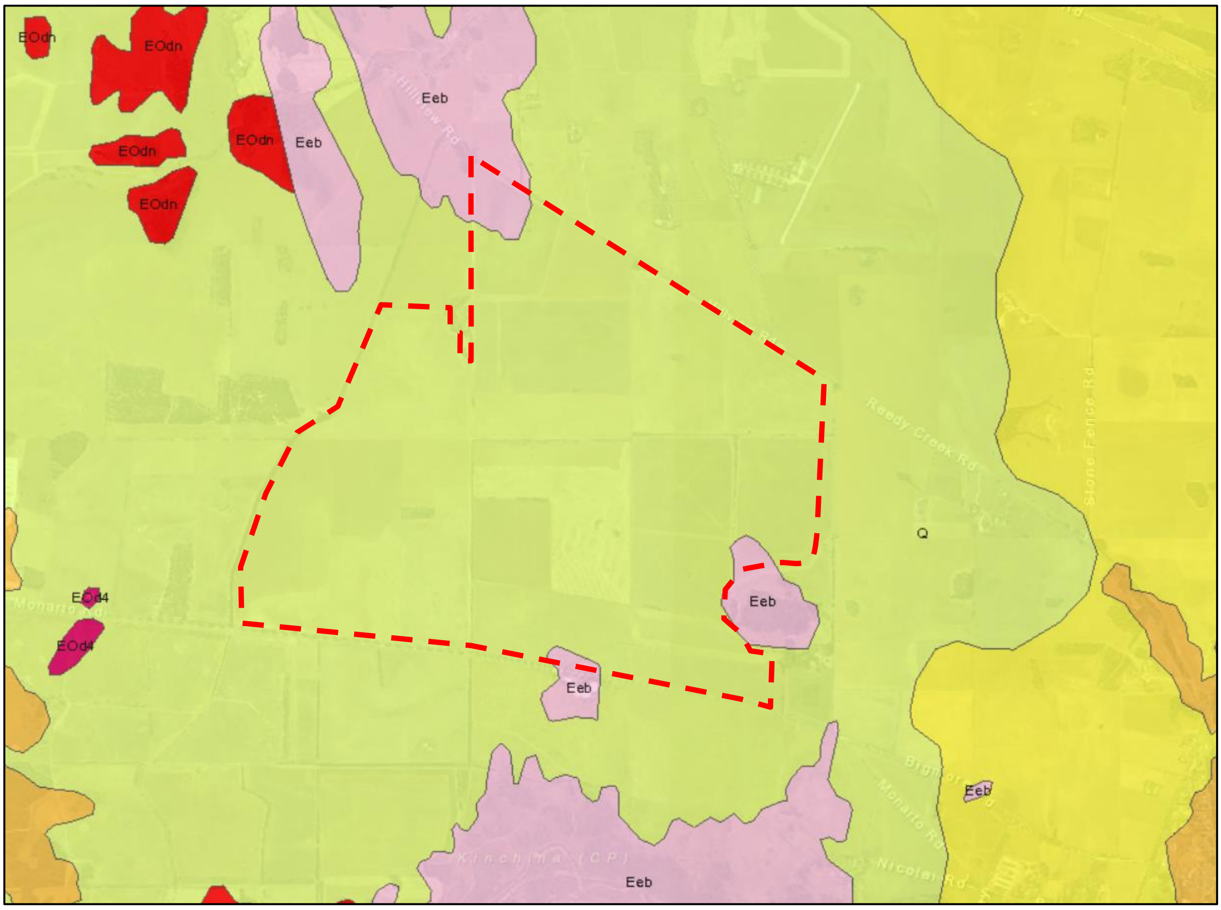
5.4 Geology

Information on the regional geology was reviewed from the 1:50,000 Monarto and 1:250,000 Barker sheet of Geology of South Australia and also reference to the SARIG geology database.

The geology database indicates that for the main wind farm site:

- The majority of the site is underlain by Quaternary aged alluvial flat deposits (refer to Figure 10)
- Portions of the site near the centre of the southern boundary and along the eastern boundary are underlain by the Palaeozoic Mid-Cambrian aged Kanmantoo group (Backstairs Passage formation).

Figure 10 SARIG geology map

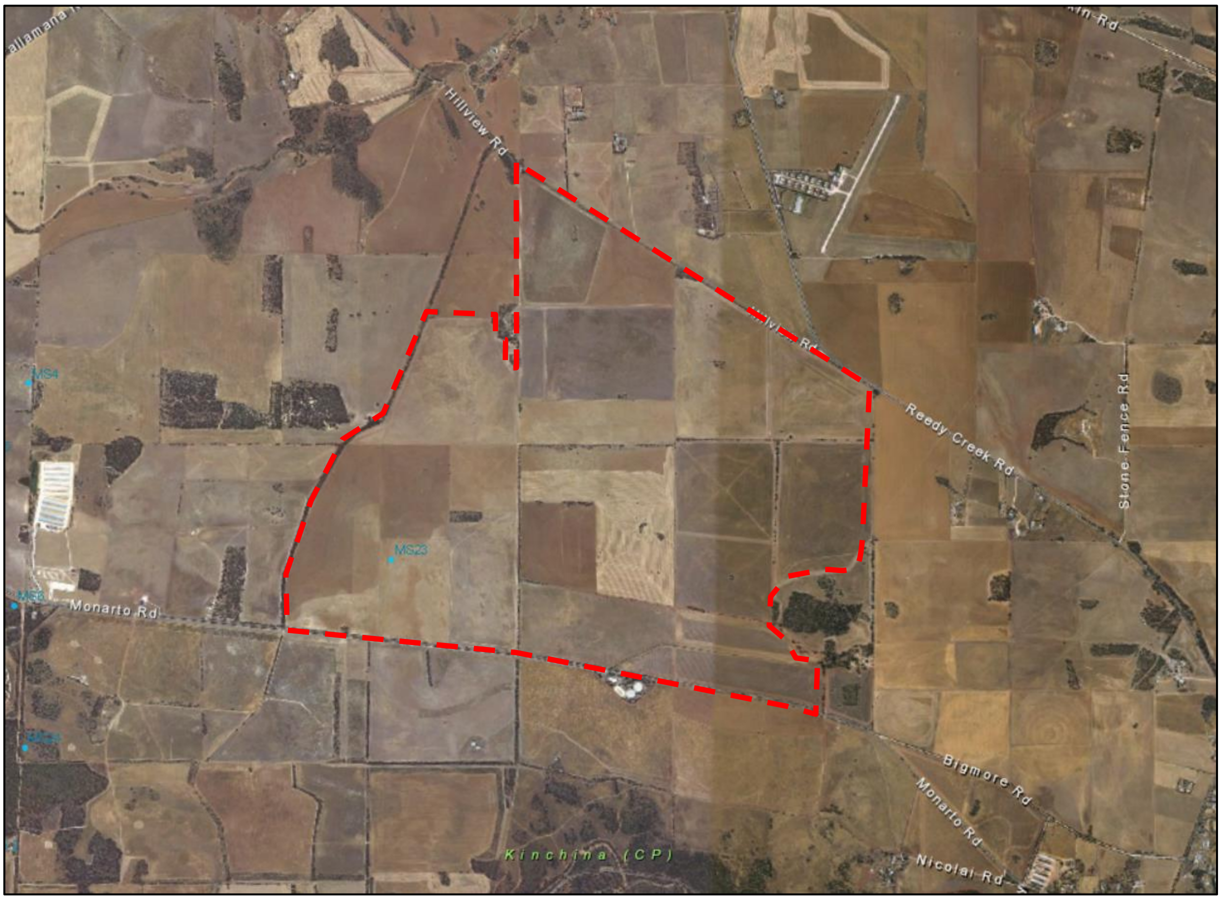


A review of the SARIG geology database identified a drillhole that had been historically drilled in the south western portion of the site (MS23) as part of the 1976 investigation on the 'Stratigraphy and Engineering Geology of the Monarto Designated Area' (refer to Figure 11).

A review of the MS23 stratigraphic log identified the following ground conditions:

- Shallow clayey sand to 0.5 m
- Quaternary aged Bakara soils included a weakly cemented calcrete cap over stiff highly calcareous clays to 1.2 m
- Dense sands over clays of the Tertiary aged fluvial Parilla sand formation to 4 m
- Moderately weathered, medium strength schists of the Cambrian aged Brukunga formation to 6.9 m depth and end of the hole.
- No groundwater was struck.

Figure 11 MS23 location



Other information noted from a review of SARIG is the proximity of the site to numerous current and historical mineral tenements, mines, deposits and quarries, with the closest being located immediately south of the site.

6.0 Potential Impacts

The construction of the solar farm is expected to involve clearing and associated earthworks for the solar panel, substation, battery storage, access roads and other ancillary works. During operation, land management considerations will include ongoing erosion and sedimentation controls and storage.

Potential impacts identified as a result of the development include:

- Increased risk of erosion and sedimentation due to ground disturbance, potential lack of vegetative cover, and areas of concentrated flow.
- Exposure of soils to wind and rain erosion during construction and/or operation with potential for impacts to water quality, sedimentation and air quality impacts from airborne dust.
- Soil transport off site through construction vehicles
- Physical impacts to soil structure due to compaction from earthworks equipment
- Soil contamination from chemical spills
- Land degradation in the event that subsurface saline or sodic soils (if present) are exposed to form the new ground surface

All of the above issues should be included in the construction environment management plan.

Potential geotechnical issues that should be reviewed through site investigations include:

- Presence of at surface or near surface calcareous materials that can lose strength upon wetting
- Presence of near surface calcrete that present excavatability issues
- Presence of clays that can be susceptible to high shrink swell

7.0 Mitigation Measures

The following management measures are proposed to mitigate the soil impacts listed in Section 6.0 and should be incorporated into the construction environmental management plan (CEMP).

The CEMP should consider sediment, erosion control and management regarding management of soils on the site.

Reference should be made to the SA EPA construction guidelines regarding sedimentation and erosion control measures. The CEMP should also reference the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and relevant Stormwater Pollution Prevention codes of practice.

7.1 Erosion and Sediment Control

Erosion and sediment control measures should be developed for the Project prior to construction and should consider the following:

7.1.1 Construction Phase

- Minimising the construction footprint to reduce the impact on the surrounding environment.
- Minimising earthworks during intense rainfall events.
- Installation of sediment / silt fences downhill of disturbed areas that are likely to generate runoff.
- Dust suppression methods to avoid wind dispersion of sediments into creeks.
- Scour protection in temporary drainage infrastructure.
- Regular inspection of site during construction for signs of erosion (particularly after large storm events).

7.1.2 Operations Phase

- Erosion protection at the base of solar panels to reduce the risk of erosion (e.g. planting and maintenance of vegetation at the base of solar panels).
- Scour protection in open drains and around culvert headwalls (if required).
- Gravel covering of highly trafficked areas.

7.2 Site Geotechnical Investigations

Site geotechnical investigations will be required for the design stage of the project and should include a series of boreholes across the site, targeting the solar panel areas, the substation and access tracks. In areas where rock or calcrete are identified, test pitting should be conducted to gain an appreciation of excavatability.

Soil layers to be disturbed or exposed during construction and upon operation should also be characterised to determine whether they have any detrimental properties (saline, sodic/ dispersive) which could lead to land degradation.

Any material proposed to be reused off-site will also need to be chemically characterised to determine its suitability for reuse as ‘waste derived fill’.

8.0 Conclusion

The construction of the solar farm is expected to involve clearing and associated earthworks for the construction of site infrastructure. During operation, land management considerations will include ongoing erosion and sedimentation controls and storage. The existing geology and soils are not expected to have an unacceptable impact on construction and excavations at the Project site with the inclusion of mitigation measures highlighted in Section 7.0.

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Pallamana Solar Farm
RES Australia Pty Ltd
11-Jul-2018

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Pallamana Solar Farm

Surface Water and Hydrology

Pallamana Solar Farm

Surface Water and Hydrology

Client: RES Australia Pty Ltd

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Document Pallamana Solar Farm

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Reviewed by Kylie Schmidt

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	30-Apr-2018	Draft for Review	Kylie Schmidt Project Manager	
B	21-May-2018	Draft for Issue	Kylie Schmidt Project Manager	
C	11-Jul-2018	Revised Draft for Review (Site Layout Changes)	Kylie Schmidt Project Manager	

Table of Contents

Executive Summary

This report addresses the desktop hydrology and hydrogeology review, and identifies issues including the increased potential for erosion and sedimentation through the design, construction and operational phases of the solar farm.

This report is based on a desktop assessment and the hydrological and hydrogeological conditions of the proposed solar farm which will be further considered in future stages of the project. The recommended mitigation measures include the preparation of a construction environmental management plan and the bunding / containment of any fuels and contaminants stored on-site.

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was commissioned by RES Australia Pty Ltd (RES) to provide engineering services for the proposed solar farm in the area named Pallamana, Monarto Road, Murray Bridge, South Australia 5254. The site covers an area of 786 hectares.

RES is one of the world's leading independent renewable energy companies, with the expertise to develop, engineer, construct, finance and operate projects around the globe. RES has been developing renewable energy projects in Australia since 2004.

This report has been prepared to provide a preliminary assessment of the hydrological conditions at the proposed solar farm located on Monarto Road approximately 7 km north west of Murray Bridge, SA. The purpose of the preliminary hydrology assessment is to provide a baseline assessment of features that may be impacted by the Project or that may impact the design of the Project.

The methods used to document the existing environment, construction and operation impacts and likely mitigation measures included:

- A review of the existing South Australian regulatory framework relevant to surface water and hydrology and identification of the applicable environmental values to inform any requirements or constraints for the site;
- Desktop review of publically available hydrological information, including topographical information and aerial photography;
- Review of data from Bureau of Meteorology Stations (precipitation, evaporation and seasonality);
- Review of government and groundwater databases;
- Review of water quality and hazard mapping to identify existing hydrological constraints;
- A site visit (conducted on 26/04/2018) to confirm drainage features identified through aerial imagery and topographic data and make visual observations of erosion and sedimentation baseline conditions
- Consideration of the potential impacts of construction and operational activity on the hydrological features of the site; and
- The identification of relevant management and mitigation measures concerning the treatment of wastewater (during construction and surface water runoff / stormwater across the site).

The following publically available data sources were utilised to determine the hydrological features in the vicinity of the Project area:

- Google aerial imagery;
- Bureau of Meteorology (BOM) rainfall and climate data;
- Watercourses in South Australia (Department for Environment and Water, 2016);
- Surface Water Catchments (Department for Environment and Water, 2016);
- Land Use Generalised 2017 (Department of Planning, Transport and Infrastructure, 2017);
- Location SA Map Viewer (Government of South Australia, 2018); and
- NatureMaps Map Viewer (Enviro Data SA, 2018).
- WaterConnect Groundwater Data (Government of South Australia, 2018).

2.0 Project Description

RES Australia Pty Ltd (RES Australia) proposes to develop the Pallamana Solar Farm development in an area named Pallamana. The site of the proposed solar farm is approximately 7 km north west of Murray Bridge, SA.

RES is one of the world's leading independent renewable energy companies, with the expertise to develop, engineer, construct, finance, and operate projects around the globe. RES Australia has been developing renewable energy projects in Australia since 2004.

2.1 Project Overview

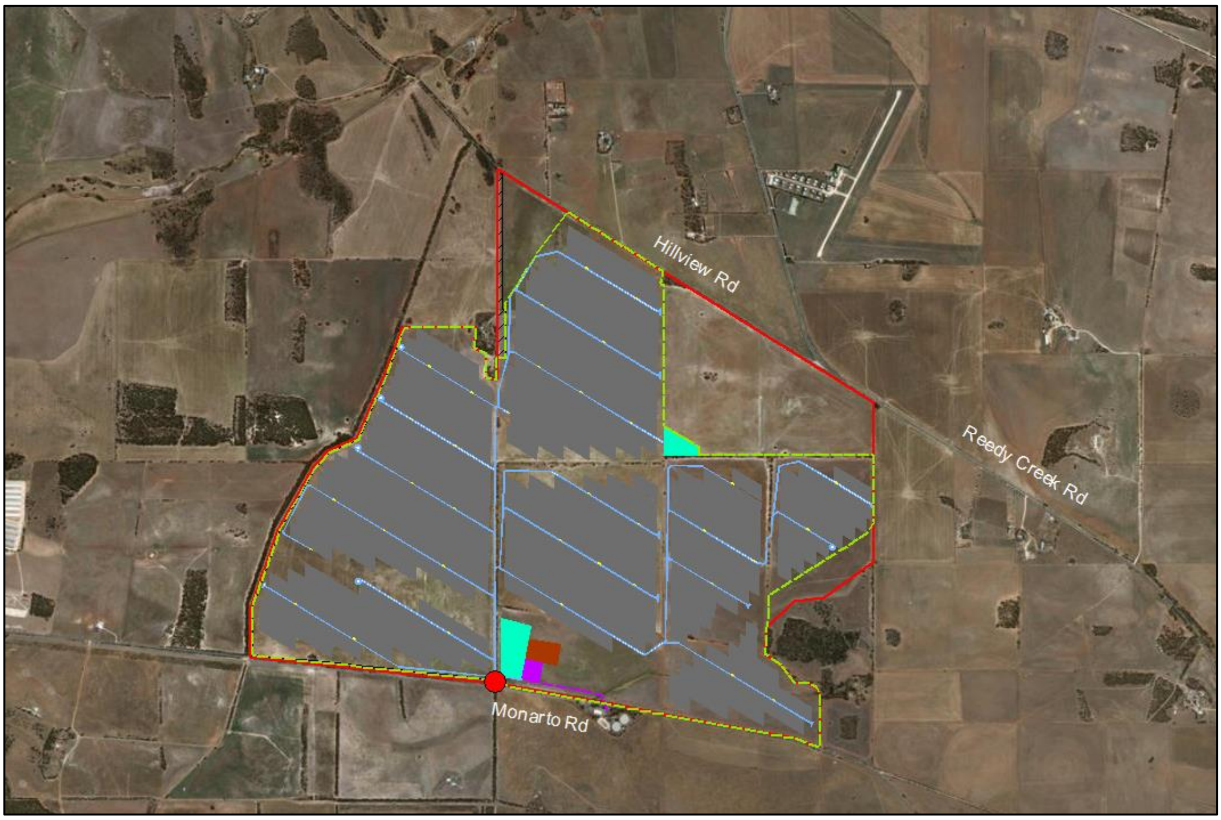
The proposed solar farm will consist of the following components:

- Up to 7890 solar arrays (84 panels per array)
- Access roads
- Battery storage area
- Temporary construction facilities
- Connection infrastructure

3.0 Project Siting / Locality Description

RES proposed to develop the Pallamana Solar Farm within the south east area of South Australia. The site of the proposed solar farm is approximately 7 km north west of Murray Bridge and 60 km south east of Adelaide. The site layout in relation to the surrounding road network is shown in Figure 1 below.

Figure 1 Site layout



Surrounding the Project site, the landscape is dominated by grazing with open paddocks defined by fence boundaries

4.0 Regulatory Framework

4.1 Environmental Protection (Water Quality) Policy 2015

The Environmental Protection Agency (EPA) is responsible for the control of stormwater pollution through the Environmental Protection Act 1993 (The Act). It provides the regulatory framework to protect the South Australian environment and is supported through other regulations including the Environmental Protection (Water Quality) Policy 2015 (the Water Quality Policy).

The Act places a general obligation to take all reasonable and practicable measures to minimise environmental harm caused by pollution and promotes ecologically sustainable development.

The Water Quality Policy is second-level legislation and offers more specific protection for South Australia's waters. It prohibits the pollution of the stormwater system and natural waters. The policy has general obligations which every person, business and industry must comply with as well as specific obligations for particular activities.

Clauses 10 and 11 of the Water Quality Policy state that a person must not discharge pollutants listed in Schedules 2 and 3 of the Policy into any waters. Also, those pollutants known as Class 1 and listed in Schedule 2 must not be deposited onto land where they are likely to enter waters.

These clauses apply to the stormwater system. This means that the above pollutants cannot be placed on land or such that they may enter the stormwater system.

The Stormwater Pollution Codes of Practice look more specifically at preventing stormwater pollutions. These are linked to the Water Quality Policy and are enforceable under The Act.

Part of complying with the Policy is the protection of environmental values as described within the Policy. Schedule 1 of the Policy provides the environmental values for waters in South Australia shown in Table 1 below:

Table 1 Environmental values of waters - default values

Waters	Aquatic ecosystem	Recreation and aesthetics	Drinking water for human consumption	Primary industries – Irrigation and general water uses	Primary industries – livestock drinking water	Primary industries – aquaculture and human consumption of aquatic foods
Inland surface waters	X	X		X	X	X

4.2 SA Murray Darling Basin Regional Natural Resources Management Plan

The Natural Resources Management Act 2004 creates a regulatory framework for the management of water, soil and biological assets in the region. The SA MDB Regional NRM Plan aims to support ecologically sustainable development in the region and achieve a balance between environmental, social, economic and cultural outcomes through the use of natural recourses.

The plan has a vision of sustainable production landscapes, with a target of protecting and improving soil and land to support the productive capacity and natural resources of the region by 2030. Major threats to the land listed relevant to the proposed development include wind and water erosion, pest plants and animals, inappropriate land management, dryland salinity, soil acidity, acid sulphate soils, declining soil physical condition, water repellence, other nutrient deficiencies or toxicities.

4.3 Rural City of Murray Bridge Strategic Plan (2016 – 2020)

The Rural City of Murray Bridge Strategic Plan (2016 – 2020) (referred to as the 'Strategic Plan') sets out a number of principles for water resource management. A major component of the Strategic Plan is the promotion of increased stormwater reuse to reduce the area's dependence on the River Murray.

The Project will need to consider the quality of stormwater runoff and ensure that it complies with all regulatory standard and guidelines.

4.4 Murray Bridge Council Development Plan

The Murray Bridge Council Development Plan (referred to as the 'Development Plan') sets out several objectives and principles for developments relating to natural resources and surface water. General principles of development control discussed in the Natural Resources section of the Development Plan are provided below:

1. Development should be undertaken with minimum impact on the natural environment, including air and water quality, land, soil, biodiversity, and scenically attractive areas.
2. Development should ensure that South Australia's natural assets, such as biodiversity, water and soil, are protected and enhanced.
3. Development should not significantly obstruct or adversely affect sensitive ecological areas such as creeks, wetlands, estuaries and significant seagrass and mangrove communities.
4. Development should not:

   a. Significantly obstruct or adversely affect sensitive ecological areas such as creeks, the River Murray and wetlands
   b. Compromise the utilisation, conservation or quality of surface and groundwater resources, especially the River Murray and Lake Alexandrina
   c. Compromise the capacity for natural systems to restore or maintain water quality.

5. Development should be appropriate to land capability and the protection and conservation of water resources and biodiversity.

The Project area is not identified on a flood hazard overlay in the development plan and is not located within the 1956 flood levels.

5.0 Hydrology and Hydrology Review

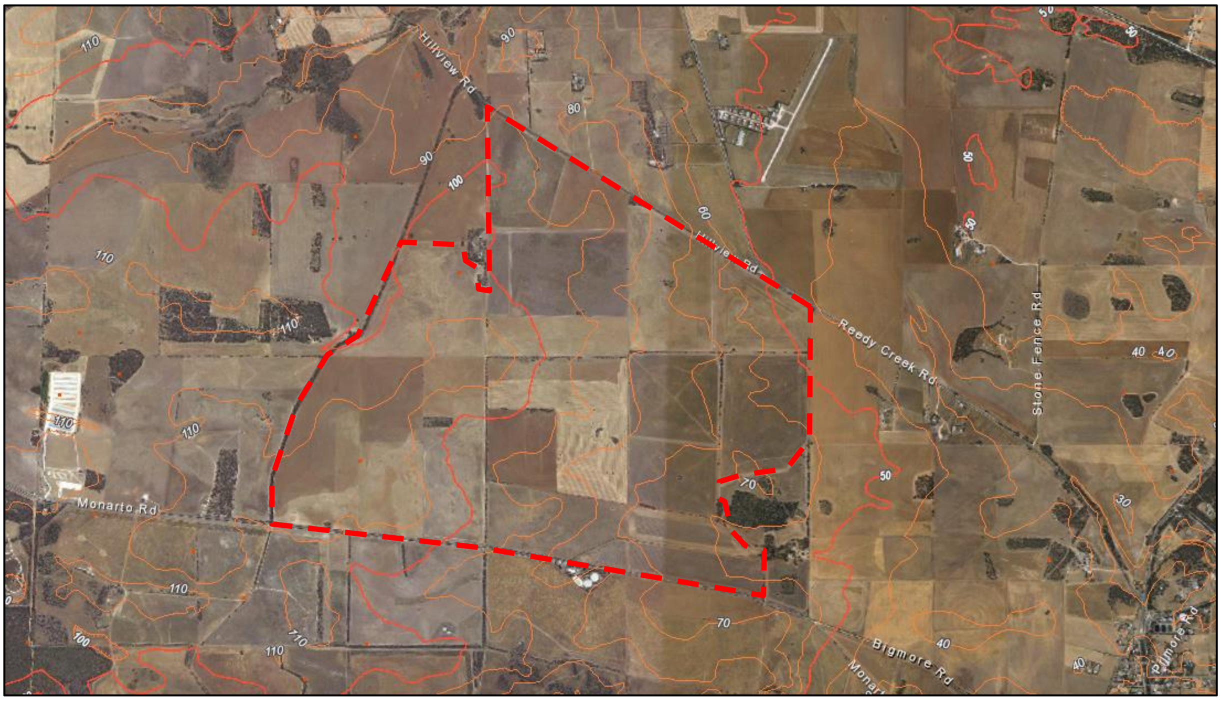
5.1 Surface Features

The proposed solar farm layout extends approximately 4.3 km in the west-east direction and 3.5 km in the north south direction.

The topography of the site is hilly, although there are no significant watercourses that run through the site other than a drainage swale used by the nearby SA Water Pumping Station.

The hills are generally rounded and the site generally drains from west to east towards the River Murray. The elevation of the site varies from approximately 100 m AHD on the western site boundary to approximately 60 to 70 m AHD on the eastern site boundary (Figure 2).

Figure 2 Site surface topography



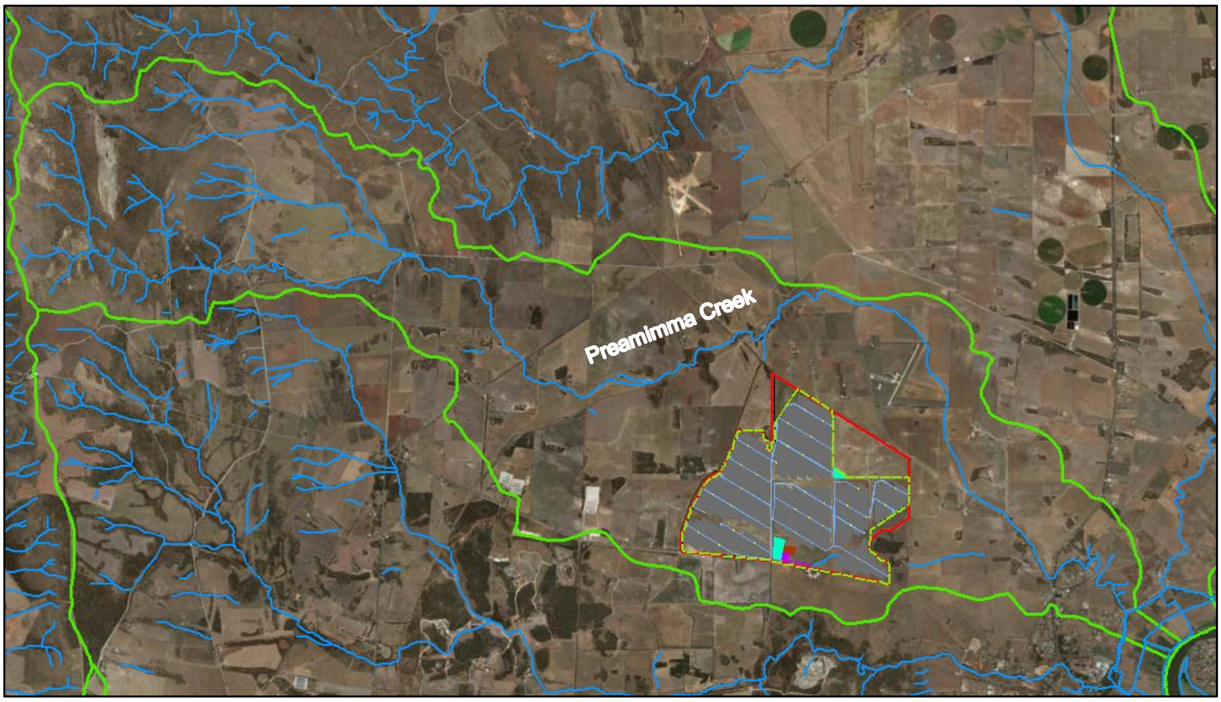
At the time of the site visit, vegetation typically comprised of pastures and crops with clusters of mature trees south east of the site boundary.

There are no defined access tracks across the site as the area is primarily being used for crop and cereal growth. Access to the paddocks is currently via gates off the existing roadways. Trafficability is expected to be acceptable for 4WD vehicles in dry conditions.

5.2 Surface Water

The Project site is located within the Preamimma Creek Catchment (Figure 3). Preamimma Creek has a catchment of approximately 75.19 km^2. Most of the catchment is used for agriculture. Runoff from the site generally flows from west to east towards the River Murray as indicated from the surface contours.

Figure 3 Preamimma Creek Catchment



Note: catchment boundaries (green), watercourses (blue).

Preamimma Creek runs west – east approximately 2 km north of the site (refer to Figure 7). Preamimma Creek is a very small stream in the southern Mount Lofty Ranges. It flows very occasionally, through agricultural land used mainly for sheep grazing, and cereal cropping, into the Mobilong Swamp on the Murray River floodplain.

The following information was taken from an Aquatic Ecosystem Condition Report conducted the Environmental Protection Agency (EPA) of South Australia in 2008 (Environmental Protection Agency of South Australia, 2015).

The condition report highlighted the following key points:

- Preamimma Creek is significantly affected by nutrient enrichment and fine sediment.
- The creek banks were extensively eroded by livestock and flood events.
- The riparian zone was severely disrupted with no trees and was dominated by weeds.

At the time of the site visit, Preamimma Creek was dry and showed evidence of significant erosion as shown in Figure 4.

Figure 4 Preamimma Creek

Given the relatively poor condition of Preamimma Creek, construction and operational activities will need to minimise any discharge of sediment or other pollutants / contaminants so as not to further reduce the creek's condition.

There is an existing water course in the south east of the site (Figure 7) that appears to be used as a discharge swale for an SA Water Pumping / Transfer Station (Figure 6). This water course flows in a north east direction away from the pumping station. The surface contours indicate that a small portion of the south east region of the site grades towards this drainage swale.

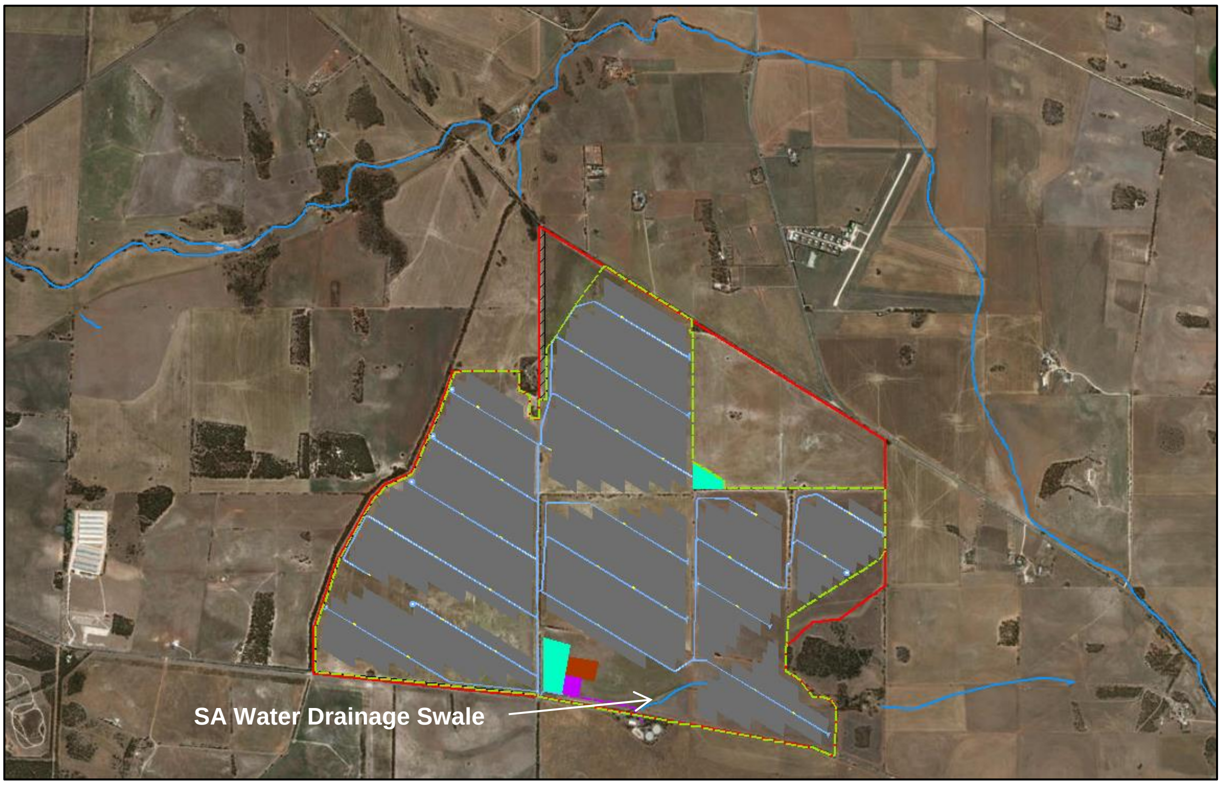
At the time of the site visit, no flow was seen in this drainage swale besides some ponding at the culvert entrance (Figure 5). SA Water should be consulted prior to the commencement of works to determine the requirement of this drainage swale and whether the site layout needs to be amended to retain it.

Figure 5 Drainage swale culvert

Figure 6 Drainage swale watercourse (N-E facing)

Note that while existing watercourse GIS datasets indicate that there is a watercourse that flows east from the eastern site boundary (Figure 7), there is no evidence from aerial imagery of a defined watercourse or incised creek.

Figure 7 Existing watercourses



Note: watercourses (blue).

5.3 Groundwater

The site is located within the Eastern Mount Lofty Ranges Prescribed Water Resource Area, which covers groundwater, water courses and surface water.

The proposed solar farm is located on top of both a fractured rock aquifer in Cambrian and Precambrian rocks (western portion of the site) and a sedimentary rock aquifer in limestone, sandstone, sand shale and clay (eastern portion of site). It is important to note that aquifers in limestone are often cavernous.

Four wells are located within the site boundary; 6727-607, 6727-608, 6727-450 and 6727-611. None of these well provided any indication on water quality. Well number 6727-611 indicated a reduced standing water level of 44.84 m AHD. Due to the minimal information provided by existing wells on-site, there is a great deal of uncertainty regarding existing groundwater conditions on-site.

Operational wells with low yields (0.2 - 0.6 L/s) used for observation are located close to the Murray Bridge township.

A review of the SARIG geology database identified a drillhole that has been historically drilled in the south western portion of the site (MS23). This was to a depth of 6.9m and no groundwater was struck. Given that there are no excavations to this depth as part of this project, it is expected that there will be no impact on the existing groundwater given the implementation of standard controls to prevent the leakage and spills of contaminants.

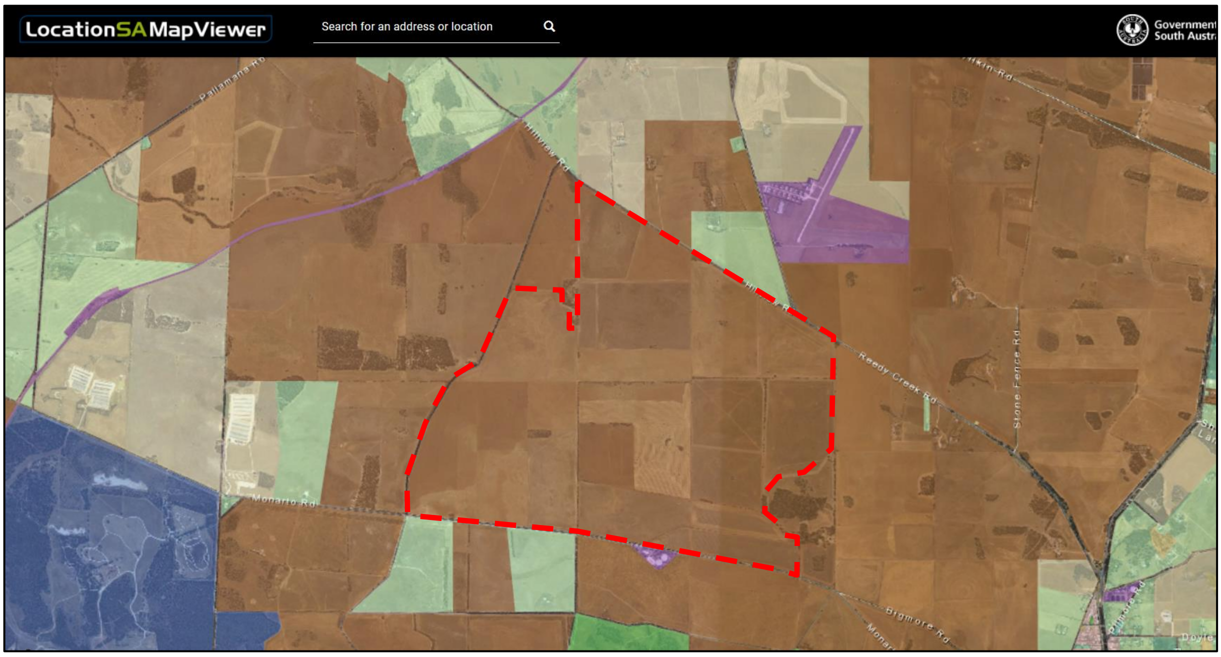
Figure 8 Well locations

5.4 Land Use

Reference to Location SA indicated that the site is located on agricultural land and is bounded by both agricultural and rural residential land. Industrial land is located to the north and south of side which is used for the Pallamana Aerodrome and SA Water Pumping / Transfer Station respectively. The land use map shows uniform agricultural land use across the site which indicates a low fraction impervious. There are no land uses on the site that are expected to yield significant volumes of surface runoff.

Figure 9 below provides an overview of the land uses surrounding the site.

Figure 9 Land uses (orange – agriculture, light green – rural residential, pink – industrial)



5.5 Historic Rainfall

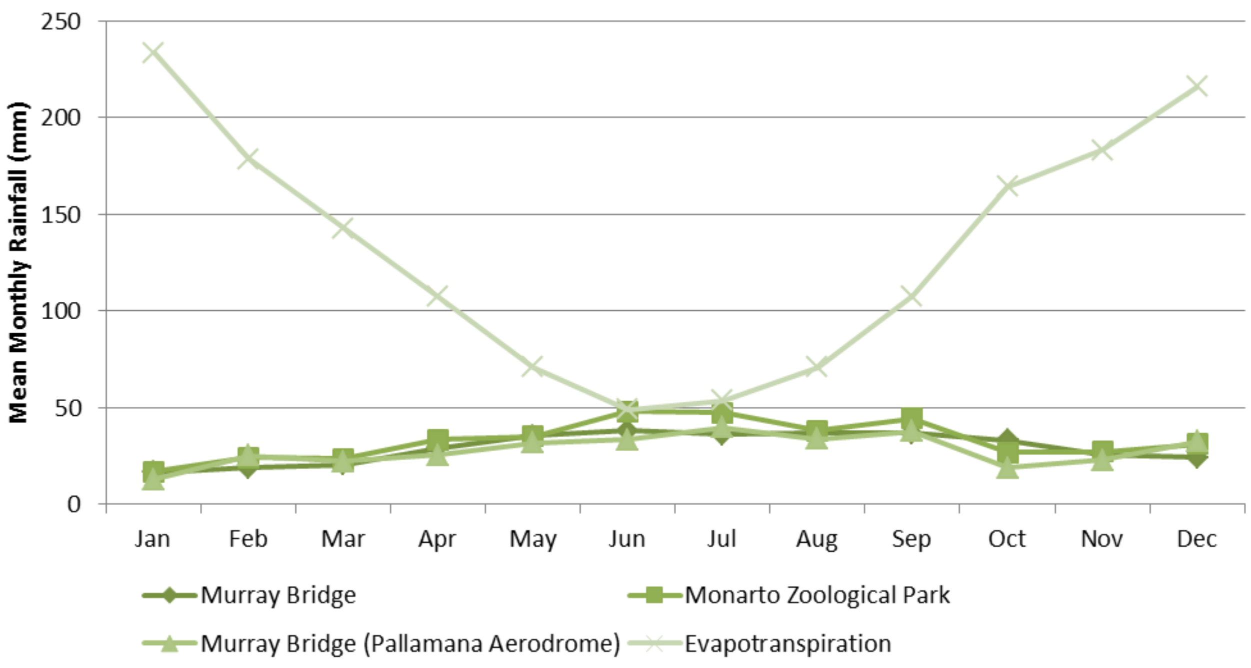
The Project is situated in a semi-arid region of South Australia. There are three BOM rain gauges located near the site as identified in Table 2. The rain gauge at Murray Bridge indicates a mean annual rainfall of 350 mm. It is important to note the rainfall records range between 12 and 133 years which introduces a level of uncertainty in the historic rainfall data surrounding the site.

The average monthly rainfall (calculated over the duration of each gauge record) ranges from approximately 10 mm to 60 mm. Figure 10 shows there is a distinct seasonal variation in rainfall with greater monthly average rainfall during the winter months.

Table 2 Rain gauges near the Project

Station No.	Station Name	Record Duration (years)	Annual Average Rainfall
24521	Murray Bridge	133	350
24582	Monarto Zoological Park	21	403
24584	Murray Bridge (Pallamana Aerodrome)	12	335

Figure 10 Monthly average rainfall and evapotranspiration



The mean monthly evapotranspiration data for the Murray Bridge (Pallamana Aerodrome) gauge is shown in Figure 10. The data shows a seasonal pattern in evaporation with higher losses during summer and lower losses during the winter. The data also demonstrates that over the course of the year, evaporation typically far exceeds the average rainfall.

6.0 Potential Impacts

Potential impacts to surface water resources due to construction and operation of the Project are identified below. Mitigation measures are then proposed in Section 7.0 to reduce these impacts.

6.1 Construction

Construction of the solar farm will likely require earthmoving for access roads, contouring, and installation of site infrastructure. This will reduce the vegetation coverage on-site and may increase erosion in the surrounding area.

Any alteration to existing flow paths throughout the Preamimma Creek catchment may lead to changes in surface runoff and impact the water quality due to increased sediment discharge.

The use and storage of fuels and chemicals for vehicles and plant on-site has the potential to contaminate the surrounding environment. On-site staff during construction phases will generate wastewater. If not properly treated and stored, the wastewater generated on-site has the potential to contaminate surface or groundwater through spills and leaks.

6.2 Operation

The Project will alter the existing catchment conditions by increasing impervious surfaces through the solar panels, roofed areas and hardstand. While the amount of impervious area of the solar farm is expected to be relatively low, localised impervious areas (hardstand and building) may lead to an increased concentration of runoff. There is the potential for increased erosion at these locations.

If the type of land cover is changed under the solar panels (i.e. reduced vegetation coverage), surface runoff and peak discharge may increase significantly. There is also potential for erosion of the soil at the base of the solar panels. Due to rainfall collecting on the panels, the kinetic energy of the water draining from the solar panels can be significantly greater than that of rainfall. It is possible that soil below the base of the solar panel could erode due to the concentrated flow of water off the panel (Cook & McCuen, 2013).

7.0 Mitigation Measures

The following management measures are proposed to mitigate the impacts listed in Section 6.0 and should be incorporated into the CEMP.

The CEMP should consider sediment, erosion control and management, as well as bunding and containment of any fuels stored on site given the stormwater from the site flows into Preamimma Creek. These measures will manage the water quality from the construction site and ongoing operation of the solar farm.

Reference should be made to the SA EPA construction guidelines regarding sedimentation and erosion control measures. The CEMP should also reference the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and relevant Stormwater Pollution Prevention codes of practice.

7.1 Erosion and Sediment Control

Erosion and sediment control measures should be developed for the Project prior to construction and should consider the following:

7.1.1 Design Phase

- Provision of appropriate stormwater management measures (swales, drains etc.).
- Maximising soil cover.
- Minimising the site footprint and impact on the surrounding hydrological conditions.
- Provision of erosion protection at locations with a high exposure to erosion forces.

7.1.2 Construction Phase

- Minimising the construction footprint to reduce the impact on the surrounding environment.
- Minimising earthworks during intense rainfall events.
- Installation of sediment / silt fences downhill of disturbed areas that are likely to generate runoff.
- Dust suppression methods to avoid wind dispersion of sediments into creeks.
- Scour protection in temporary drainage infrastructure.
- Regular inspection of site during construction for signs of erosion (particularly after large storm events).

7.1.3 Operations Phase

- Erosion protection at the base of solar panels to reduce the risk of erosion (e.g. planting and maintenance of vegetation at the base of solar panels).
- Scour protection in open drains and around culvert headwalls (if required).
- Gravel covering of highly trafficked areas.
- Development of a comprehensive drainage plan prior to Development Approval.

7.2 Contaminant and Pollutant Control

The following procedures should be implemented as part of the CEMP to minimise the risk of pollution and contamination of the surrounding environment.

- Implementation of appropriate spill control procedures.
- All refuelling facilities and chemical storage facilities will comply with relevant Australian Standards.
- Regular inspection of refuelling and chemical storage infrastructure.

- Sewage treatment and disposal to be conducted in accordance with relevant Australian Standards and council regulations.

8.0 Conclusion

Based on the existing environment and recommended mitigation measures, the Project is not expected to have an unacceptable impact on the hydrology and hydrogeology. The Project will not have any major excavations and hence will not impact on the existing groundwater with the implementation of standard controls to prevent spills of contaminants. The Project will not introduce a substantial amount of impervious area and will not significantly increase the runoff from the site.

9.0 References

Cook, L. M. & McCuen, R. H., 2013. Hydrologic Response of Solar Farm. *American Society of Civil Engineers,* 18(5).

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[Accessed 24 April 2018].

MasterPlan SA Pty Ltd

PROPOSED SOLAR AND BATTERY STORAGE FACILITY PROJECT, PALLAMANA

TRAFFIC SAFETY ASSESSMENT

July 2018

17-0089

Traffic • Parking • Transport

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DOCUMENT ISSUE

Revision issue	Date	Description	Approved by
Draft 1	28 February 2018	Draft Report	MLM
Draft 2	25 May 2018	Updated with figures for review	MLM
final	12 July 2018	Final Report	MLM
Rev A	31 July 2018	Minor amendments to final	MLM

CONTENTS

1.0 INTRODUCTION

It is proposed to construct a solar and battery storage facility on agricultural land north of Monarto The proposed facility, which will be developed on land currently used for cropping, will be constructed in accordance with RES Group's Drawing Number 03791D2101-02 dated 25 June 18.

MFY has been commissioned to provide advice in respect to road safety requirements associated with the development. Specifically, this assessment addresses driver distraction and access requirements for the land.

Austroads guidelines have been consulted in identifying the relevant safety concerns that may be applicable to such a facility. The assessment completed in accordance with these documents has informed the design criteria adopted for the project, as they relate to road safety. Advice has been provided in the preparation of the design in order for it to be developed so that the proposed facility will not impact the safe functionality of the road network.

A review of the proposed traffic route for delivery vehicles during construction has also been completed and presented in this report.

2.0 EXISTING SITUATION

The subject site is located within the the Rural City of Murray Bridge municipality. It is bounded by Hillview Road and Reedy Creek Road to the north, Monarto Road to the south and farmland to the east and west.

Reedy Creek Road is an arterial road under the care and control of the Commissioner of Highways. The road has an annual average daily traffic (AADT) volume of 1,400 vehicles per day (vpd) and a posted speed limit of 100 km/h.

Hillview Road and Monarto Road are local roads under the care and control of the Council. It is anticipated that both roads would have an annual average daily traffic (AADT) volume of less than 1000 vpd. The default rural speed limit of 100 km/h applies to these roads.

Figure 1 identifies the subject site.

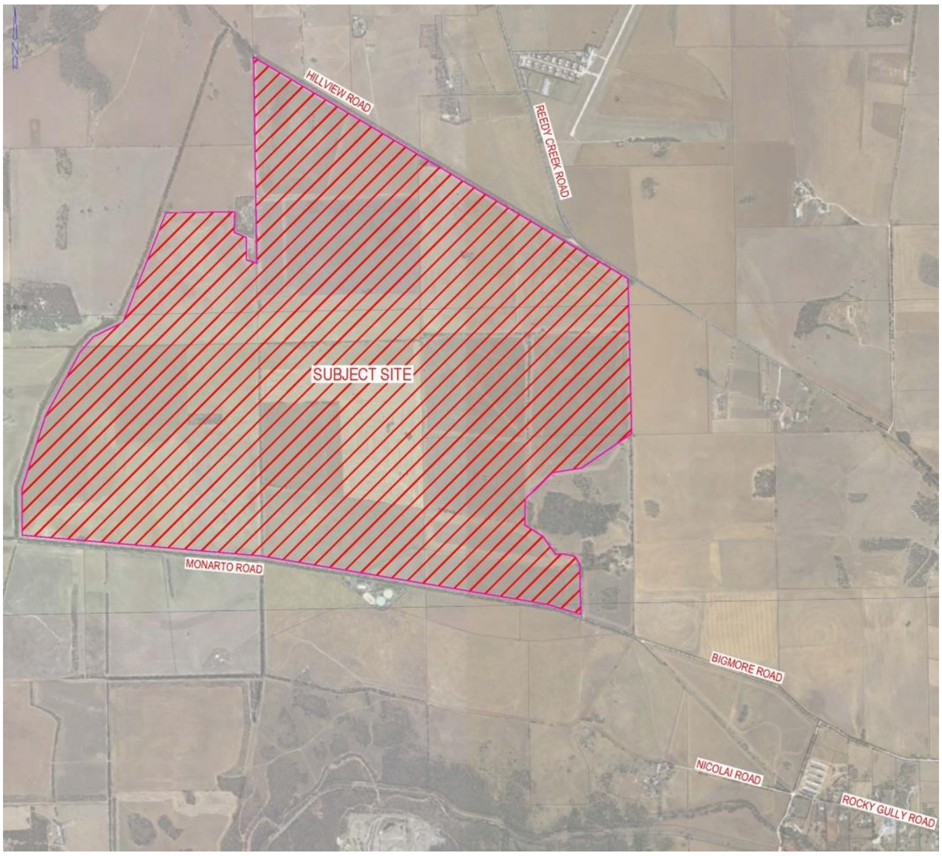

Figure 1: Locality Plan

3.0 PROPOSAL

It is proposed to develop a solar farm and battery storage facility at the subject site. The proposed development will comprise of the installation of solar (PV) panels, a battery storage zone and a transformer and utility facility.

Figure 2 identifies the proposed development.

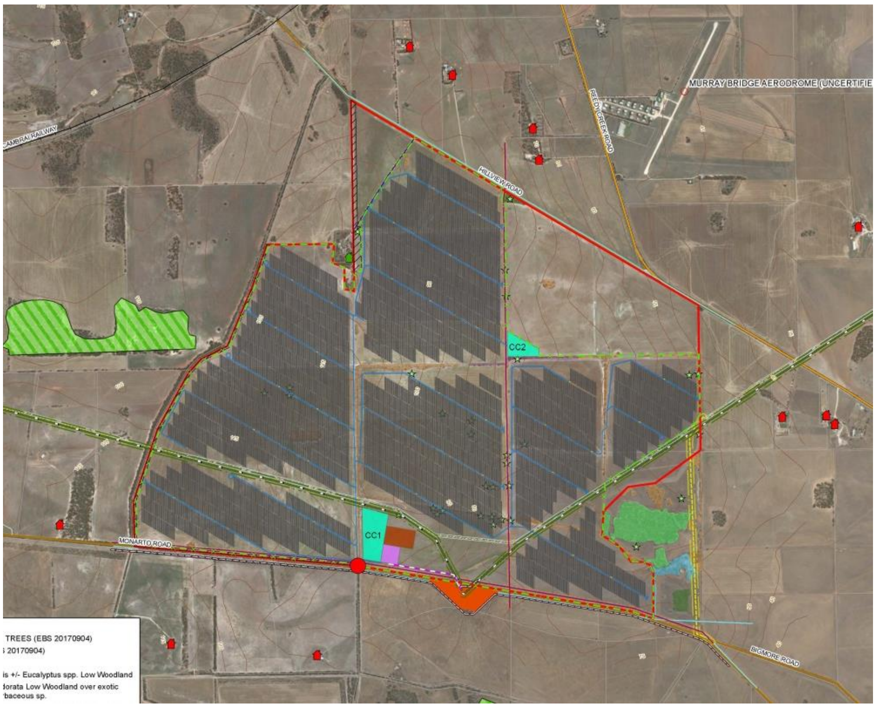

Figure 2: Proposed development

It is proposed that access to the development will be via Monarto Road. A sightline assessment of the access point identified that sightlines available for drivers exiting the site and for drivers on the approach on Monarto Road will meet the Safe Intersection Sight Distance (SISD) criteria identified in Austroads Guide to Road Design Part 4A, Unsignalised and Signalised Intersections.

Figure 3 illustrates the proposed access location.

Figure 3: proposed access location

The proposed access will primarily be used during the construction period, albeit maintenance vehicles will be able to access at this location. The volume of vehicles generated by the site will be negligible once construction is finalised. Accordingly, the proposal will not generate the demand for channelised lanes, as identified in Austroads 4A.

Emergency access for the site will also be available via the existing gate on HIllview Road.

4.0 SAFETY ASSESSMENT

The key issues that relate to safety for the subject development are driver distraction and provision of an adequate clear zone. Advice in relation to these road safety considerations is provided in Austroads "*Guide to Road Design – Part 6: Roadside Design, Safety and Barriers*" and "*Guide to Road Design - Part 6B: Roadside Environment".*

Specifically, the following safety issues are relevant to the assessment:

- whether the proposed solar panels and infrastructure are located within a clear zone; and
- whether the panels are located within the cone of vision for drivers from adjacent roads.

4.1 CLEAR ZONE ASSESSMENT

Austroads Guide to Road Design Part 6 provides the following definition of a clear zone:

> *"A clear zone is the area adjacent to the traffic lane that should be kept free from features that would be potentially hazardous to errant vehicles. The clear zone is a compromise between the recovery area for every errant vehicle, the cost of providing that area and the probability of an errant vehicle encountering a hazard. The clear zone should be kept free of non-frangible hazards where economically and environmentally possible. Alternatively, hazards within the clear zone should be treated to make them safe or be shielded by a safety barrier (Austroads 2008a)."*

The Guide also recommends that the clear zones should be applied to both rural and urban road designs in relation to greenfield sites (undeveloped land).

The clear zone width requirement identified in the Guide is based on the design speed, traffic volume and the batter grades. In reviewing the assessment factors, the following is identified:

- the design speed adopted for the assessment was 110 km/h (10 km/h greater than the applicable speed limit);
- the daily traffic volumes experienced on the arterial roads are less than 1,500 vehicles and on the local roads are less than 1000 vehicles; and
- a greater clear zone is required where the adjacent batter is a fill batter (rather than a cut batter). Review of the subject sections of the road identify that the grade of the land immediately adjacent the edge of the road (where it is a fill batter) is 4:1 or less.

On this basis, the clear zone requirement for the arterial roads will be up to 11.0 m and the local roads will be up to 8.0 m. Figure 4 identifies that the proposed development will not be located within the clear zone.

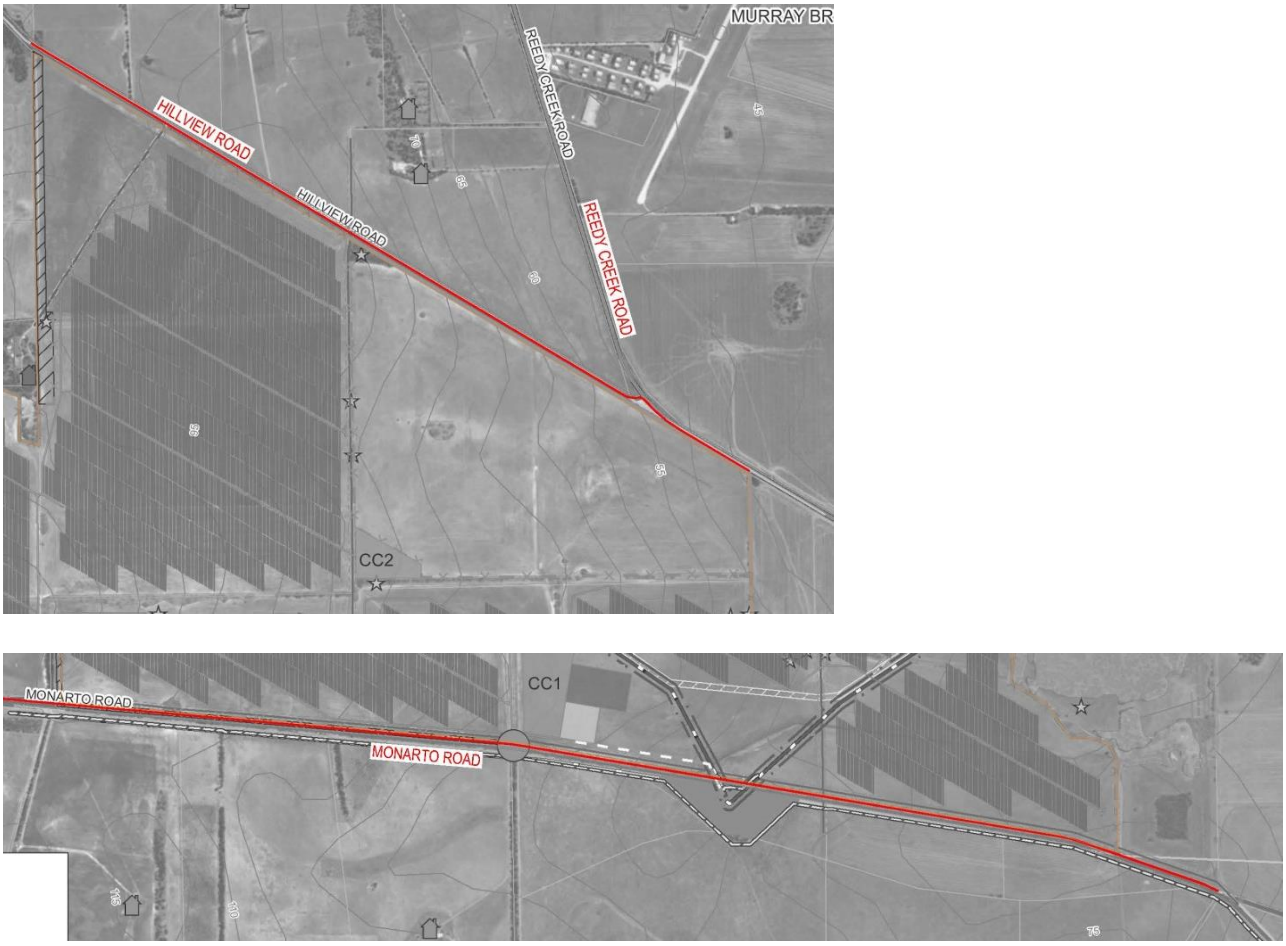

Figure 4: Clear zone assessment for the proposed development

The above figure identifies that the solar panels and other infrastructure will be installed outside the clear zone.

Accordingly, the proposed development will meet the clear zone requirement.

Importantly, even if the traffic volumes were to increase to be greater than 1500 vpd, the solar panels will remain outside the clear zone requirement of up to 13 m, as illustrated in Figure 5.

Figure 5: Clear zone assessment if traffic volume increased to over 1,500 vpd.

4.2 CONE OF VISION ASSESSMENT

The key aspect of road design relevant to the subject proposal is the roadside environment. In respect to this, Austroads GRD Part 6B provides the following advice:

> *"Road safety is a most important part of road design considerations. A safe system approach should be adopted; where roads (and vehicles) are designed to reduce the incidence and severity of crashes when they do occur (Section 1.4.3)."*

In adopting the safe system approach to road design, consideration needs to be given to visual amenity for drivers in addition to clearance requirements. In relation to visual amenity, Austroads GRD Part 6B states the following:

> *"Where practicable, the road should be designed to take advantage of any significant views to enhance the driving experience and contribute to tourism values. In areas lacking natural visual interest, landscape design should create regular areas of interest to alleviate boredom and help maintain driver concentration. Where there are few existing landmarks or landscape features, creating features as milestones helps drivers determine their progress on a journey and relieves visual monotony."*

> *"At highway speeds, distant views are more important than near views as features close to the road pass by very quickly and are difficult to focus on. Therefore, roadsides should provide a simple, non-distracting foreground to distant views."*

While the proposal is not a road design per se, the principles as they relate to driver distraction and appropriate views for a driver are relevant to consider. In relation to "driver distraction", Austroads GRD Part 6B provides the following advice:

> *"Screening should be used to conceal distracting and confusing views such as adjacent and parallel roads (excluding road alignments areas where they converge), or to delineate curves. Use the area of effective cone of vision (Figure 3.1) to decide where the framing and screening of views will be most effective."*

The cone of vision assessment provides guidance as to the area adjacent a road that could be within a driver's general field of vision. While the Guide does not stipulate that an object within the cone of vision will cause a distraction for drivers, removal of an object from (or screening of an object within) the cone of vision will mitigate the risk of driver distraction.

The cone of vision is assessed by identifying the area that relates to the angle of the driver's vision at any one location along the road and is dependent on the speed of the vehicle.

A cone of vision assessment has been undertaken for drivers travelling on Hillview Road, Reedy Creek Road and Monarto Road for a design speed of 110 km/h. Figures 6 and 7 illustrate the extent of the cone of vision for drivers travelling on Hillview Road, Reedy Creek Road and Monarto Road.

Figure 6: Cone of vision for drivers on Hillview Road and Reedy Creek Road

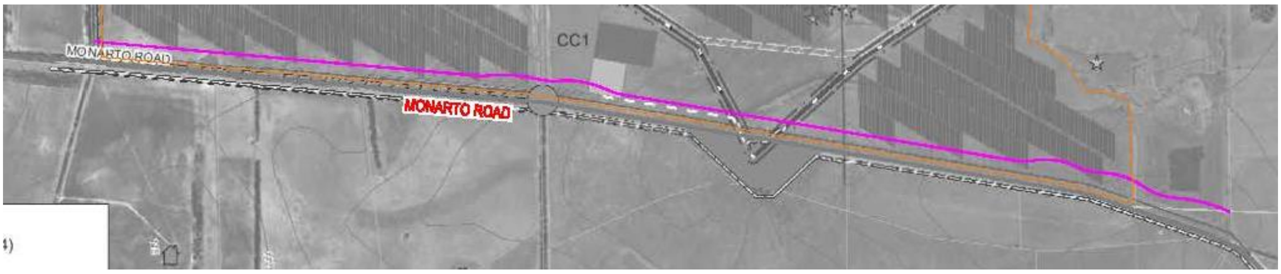

Figure 7: Cone of vision for drivers on Monarto Road

The above figures confirm that the proposed solar panels would be outside the cone of vision along Hillview Road and for most of the length of Monarto Road. However, there would be isolated locations where the panels will extend into the cone of vision along Monarto Road.

In accordance with Austroads GRD Part 6B, therefore, screening should desirably be located on the subject site, adjacent the sections of Monarto Road where the panels will include into the cone of vision as illustrated in Figure 8.

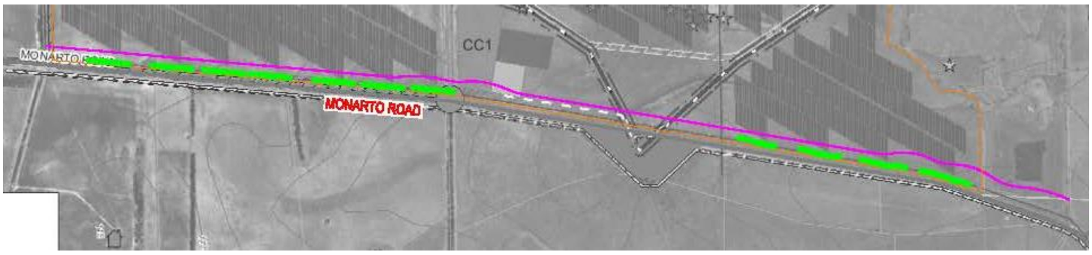

Figure 8: Recommended areas of screening along Monarto Road

The above screening could be achieved with landscaping.

5.0 TRAFFIC SUMMARY

The proposed solar farm will generate minimal traffic movements. Once operational, vehicles accessing the site will be limited to maintenance vehicles and trade will, therefore, have negligible impact on the road network as a result of the subject proposal.

5.1 CONSTRUCTION ACCESS

Unlike some types of power generating projects (such as wind farms), the delivery of infrastructure to the site does not require specialist or oversized vehicles. All deliveries during construction will occur using general access vehicles (up to a 19.0m semi-trailer in length). Accordingly, drivers would be permitted to use alternative routes to access the site. There are a number of arterial road alternatives that could be used which are designed to accommodate heavy vehicles.

Notwithstanding the above, Council has identified that its preferred construction route to be via Monarto Road, rather than using the heavy vehicles routes through the Murray Bridge township. Figure 9 illustrates the preferred construction access route to/from the site.

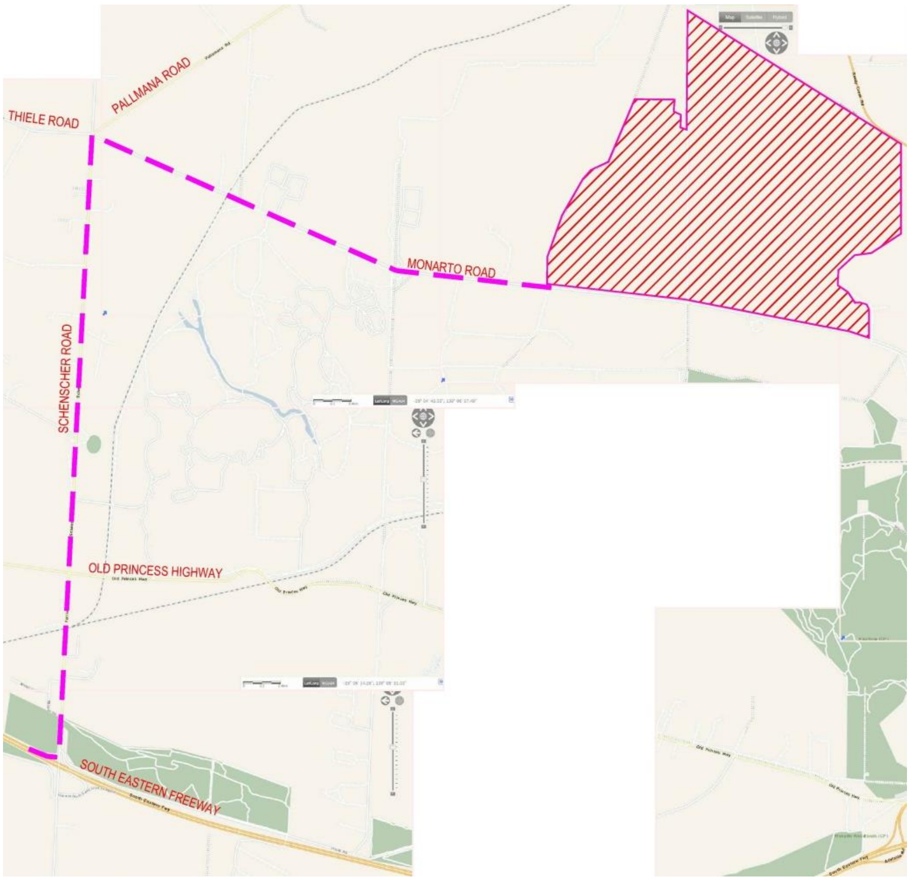

Figure 9: preferred construction access route to/from the site

The installation of the solar panels will occur over a six month construction period. During peak construction periods there could be up to fifty commercial vehicles a day accessing the site. The above road network will readily accommodate such a volume.

The potential impact associated with the construction access route, therefore, does not relate to capacity of the road network but rather accessibility along the route.

Given that only general access vehicles will be utilised to service the site, such vehicles are already accommodated on this route. Nonetheless, a review of key intersections has identified that the turning movements of delivery vehicles will be accommodated along the route, as illustrated in Figure 10.

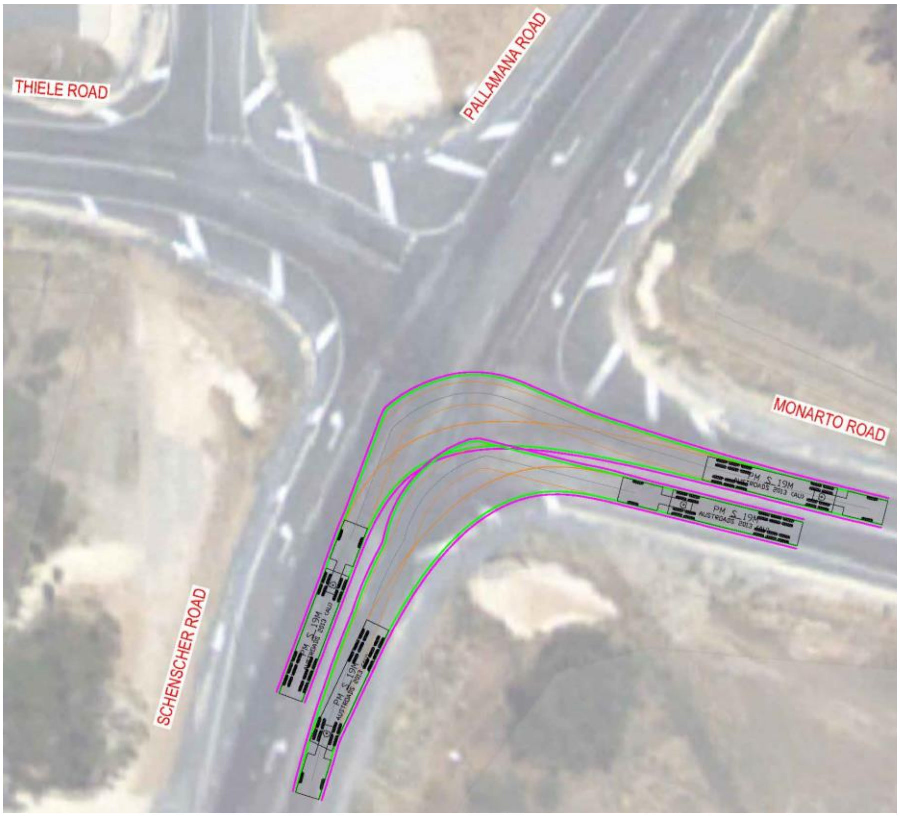

Figure 10: Turning movements for delivery vehicles along the route

In regard to traffic capacity and access, therefore, the proposal will have minimal impact on the road network.

Importantly, while the route has been nominated as the construction access route and is the route preferred by Council, alternative access would also be available via Maurice Road and Cypress Terrace or via Swanport Road and Mannum Road through Murray Bridge. Both routes are designed to accommodate heavy vehicles (the Maurice Road route is signed as a heavy vehicle detour route) and could readily accommodate the construction and delivery vehicles with minimal impact if required.

6.0 SUMMARY

In summary, the proposed solar farm and battery storage facility will result in very low traffic volumes which will have a negligible impact on the adjacent road network.

Safe and convenient access to the facility will be provided via Monarto Road and appropriate sight lines will be provided in accordance with Austroads requirements.

The proposed infrastructure will be located outside of clear zone requirements for drivers and hence the proposal will satisfy this safety criteria in Austroads relating to the roadside environment.

In regard to the matter of driver distraction, Austroads provides guidance in respect to an assessment of the cone of vision for drivers and areas where screening would be desirable to avoid infrastructure being located within a driver's general field of vision and, therefore, potentially creating a distraction. This report identifies recommended areas where such screening should be provided adjacent the proposed development.

Construction vehicles will be limited to general access vehicles, thus excluding the need for permits or specific traffic management plans. Construction vehicles could access the site via a number of alternative routes, albeit Council's preferred route via Monarto Road will be utilised where possible.

The above assessment, therefore, confirms that the proposal will satisfy the safety criteria of Austroads road design guidelines and will have minimal impact on the operation of the road network, subject to screening of the infrastructure in specific locations.

PALLAMANA SOLAR & BATTERY STORAGE FACILITY

DEVELOPMENT PLAN ASSESSMENT

AUGUST 2018

MASTERPLAN
TOWN + COUNTRY PLANNERS

DEVELOPMENT PLAN ASSESSMENT

PROPOSED PALLAMANA
SOLAR FARM AND BATTERY STORAGE FACILITY

For: RES Australia Pty Ltd

At: 166 and 229 Hillview Road, Pallamana

MASTERPLAN
TOWN + COUNTRY PLANNERS

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Contents

EXECUTIVE SUMMARY

RES Australia Pty Ltd (RES) propose to develop a 176MW solar farm and battery storage facility at 166 and 229 Hillview Road (Monarto Road), Pallamana (referred to as the Pallamana Solar Farm).

The site of the development is located within the Primary Production Zone – Policy Area 5 – North Central Area, Murray Bridge Plains, Murray Bridge Council Development Plan consolidated version dated 23 January 2018. A "solar farm and battery storage facility with ancillary infrastructure such as substations, maintenance sheds, access roads and connecting power lines (including to the National Electricity Grid)" is neither a complying or a non-complying form of development within the Murray Bridge Council Development Plan.

The Development Plan encourages and supports the development of renewable energy facilities in appropriate locations. The proposed Pallamana Solar Farm and Battery Storage facility adequately and appropriately addresses potential impacts, particularly those associated with visual amenity, protection of flora and fauna, European and aboriginal heritage, aviation, glare and traffic movements in a manner sought by the Development Plan.

An assessment of the merits of the solar farm and battery storage facility has been undertaken against the relevant provisions of the Murray Bridge Council Development Plan. Following this assessment, it is considered that the proposed development is not seriously at variance with the Development Plan.

On balance, the proposed Pallamana Solar Farm and Battery Storage facility is a suitable form of development within the Primary Production Zone, that appropriately addresses potential impacts and thereby warrants the granting of Development Plan Consent.

1.0 INTRODUCTION

MasterPlan SA Pty Ltd has been engaged by RES Australia Pty Ltd (RES) to undertake an assessment of the proposed Pallamana Solar Farm and Battery Storage facility (referred to as the Pallamana Solar Farm) against the provisions of the Murray Bridge Council Development Plan. In preparing this report, the following development application documents, including the plans and reports listed below, have been reviewed:

- Volume 1 – Project Summary;
- Volume 2 – Technical Reports, including:
  - Economic Impact Assessment – Pallamana Solar Farm Project by Essential Economics (Ref: 17205b – July 2018);
  - Pallamana Solar Array and Battery Storage Project, Ecological Assessment by EBS Ecology (Ref E70503 dated July 2018);
  - Landscape Character and Probable Visual Effect Assessment – Pallamana Solar and Energy Storage Facility by Wax and BGLA (final dated 6 August 2018);
  - Pallamana Solar Farm Aeronautical Impact Assessment by Aviation Projects (Ref: 101807-01 – final dated July 2018);
  - Aeronautical Impact Assessment – Monarto Solar Farm by Landrum & Brown (Ref: LB00097 dated October 2017);
  - Geology, Topography and Soils – Pallamana Solar Farm by AECOM (Ref: 60577009 dated 11 July 2018);
  - Surface Water and Hydrology – Pallamana Solar Farm by AECOM (Ref: 60577009 dated 11 July 2018);
  - Traffic Safety Assessment – Proposed Solar and Battery Storage Facility Project, Pallamana by MFY (Ref: 17-0089 dated July 2018); and
  - Land Capability Assessment – Proposed Pallamana Solar and Battery Storage Facility by MasterPlan (Ref: 50359 dated 6 August 2018).
- Volume 3 – Plans and Details by RES, including:
  - Site Location Plan Drawing No. 03791D2204-04;
  - Site and Locality Plan Drawing No. 03791D2102-01;
  - Site Layout Drawing No. 03791D1001-04;
  - Site Layout Enlargement Drawing No. 03791D1002-01;
  - Technical Figure 1 – Single Axis Tracker Drawing No. 03707D2206-01;
  - Technical Figure 2 – Typical Access Track Detail Drawing No. 03707D3501-03;
  - Technical Figure 3 – Typical Temporary Construction Compound Drawing No. 03707D3502-03;
  - Technical Figure 4 – Typical Conversion Unit – PCU Drawing No. 03707D4001-03;

- Technical Figure 5 – Typical Fence Detail Drawing No. 03707D2204-03;
- Technical Figure 6 – Typical Security Lighting & CCTV Support Detail Drawing No. 03707D2201-03;
- Technical Figure 7 – Indicative Utility Facility Layout Single Transformer Drawing No. 03707D4004-01;
- Technical Figure 8 – Typical Control Room Drawing No. 03707D4003-01;
- Technical Figure 9 – Typical Storage Shed Drawing No. 03707D3503-01;
- Technical Figure 10A – Storage Building Site Plan Drawing No. 03791D3403-01;
- Technical Figure 10B – Battery Storage Building Elevations Drawing No. 03791D3404-01;
- Technical Figure 11 – Typical 33KV Overhead Line Poles Drawing No. 037074101-02; and
- Technical Figure 12 – Typical Infill Plant Layout Drawing No. 03791D2204-01.

- relevant legislations, including the *Development Act 1993, Development Regulations 2008* and the *Planning, Development and Infrastructure Act 2016*;
- undertaken a site and locality inspection;
- reviewed the provisions of the Murray Bridge Council Development Plan (consolidated 23 January 2018);
- reviewed the Environment and Food Production Areas (GRO G17/2015); and
- Aboriginal Affairs & Reconciliation Register Searches dated 30 January 2018 and 6 August 2018.

2.0 BACKGROUND

RES is the world's largest independent renewable energy company, with the expertise to develop, engineer, construct, finance, and operate projects around the globe. It has deployed over 13GW of utility renewable energy projects across 250 projects in 12 countries over 35 years, involving wind, solar and energy storage technologies.

RES has been developing renewable energy projects in Australia since 2004. RES' recent Australian projects include the Emerald Solar Farm (72MW) which is currently under construction, the operational Ararat Wind Farm (75 turbines, 235 MW) and the approved Murra Warra Wind Farm (116 turbines, 418 MW) in Victoria and the operational Taralga Wind Farm (51 turbines, 107 MW) in New South Wales. Currently, RES has a development application submitted with the State Commission Assessment Panel to develop the Twin Creek Wind Farm and Energy Storage project within the Mid North region of South Australia.

3.0 STATE STRATEGIC SETTING

The South Australian Government has an active programme to deliver reductions in greenhouse gas emissions.

South Australia's Strategic Plan (SASP) establishes targets and priorities as a blueprint for the future of South Australia. First prepared in 2004, the SASP has been updated twice since that time and currently comprises seven strategic priorities, 10 economic priorities and 100 measurable targets.

The proposed development is directly aligned with the South Australian Strategic Plan target for renewable energy is: "support the development of renewable energy so that it comprises 33 percent of the state's electricity production by 2020". In addition to establishing a target for renewable energy, the SASP has a goal to reduce greenhouse gas emissions. The SASP Target in relation to greenhouse gas emissions reduction is to "achieve the Kyoto target by limiting the state's greenhouse gas emissions to 108 percent of 1990 levels during 2008-2012, as a first step towards reducing emissions by 60 percent (to 40 percent of 1990 levels) by 2050". South Australia has achieved its Kyoto target of restricting emissions levels to less than 36.4 Mt $CO2$-e through to 2012 and is now working towards the 2050 target. Continuing to provide alternative sustainable energy sources is viewed as a technique to a reduction in greenhouse gas emissions.

In addition to strategic targets relating to renewable energy and greenhouse gas emissions, the SASP contains a number of goals relating to economic growth. A number of these are outlined below in terms of the anticipated benefits of the proposed development.

> *VISION: A strong, sustainable economy that builds on our strengths.*
>
> *GOAL: We develop and maintain a sustainable mix of industries across the state.*
>
> *Target 66 Emissions Intensity: Limit the carbon intensity of total South Australian electricity generation to 0.5 tonnes of CO2/MWh by 2020.*

The generation of renewable energy from the proposed facility will provide stable and affordable electricity over the long term allowing predictable growth and expansion whilst also contributing to the State's goal to minimise carbon intensity associated with electricity generation.

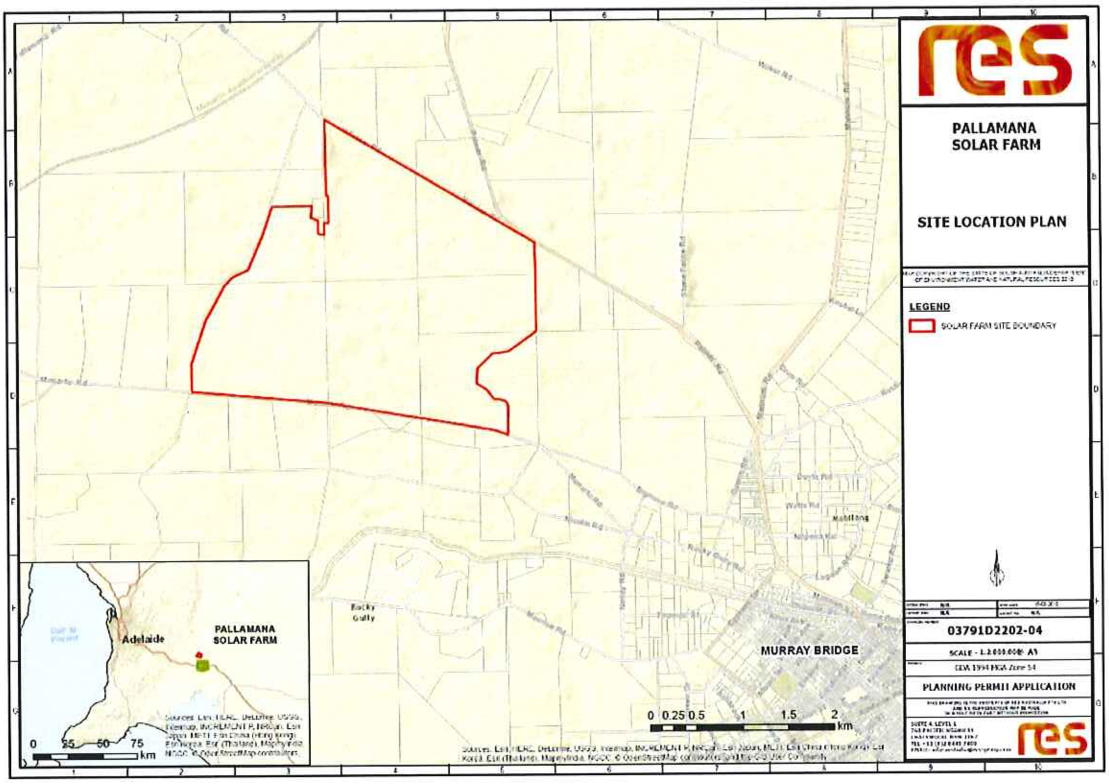
> *VISION: We have a skilled and sustainable workforce.*
>
> *GOAL: All South Australians have job opportunities.*
>
> *Target 47: increase employment by 2.0 percent each year from 2010 to 2016*

In March 2017, the South Australia Government released an "Energy Plan" with a vision "to source, generate and control more of South Australia's power supply in South Australia so we can increase self-reliance and provide reliable, competitive and clean power for all into the future." The Energy Plan contains the following goals:

- *provide South Australia with large-scale storage for renewable energy so power is available when it is needed, beginning the transformation to next-generation renewable technology;*
- *create new investment in cleaner energy to increase competition, put downward pressure on prices and provide more energy system stability;*
- *create more electricity generation to increase competition and put downward pressure on prices.*

4.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

The Pallamana Solar Farm project is located within the Rural City of Murray Bridge Council area and the South Australian Murray Darling Basin (SAMDB) Natural Resources Management (NRM) region. The proposed development is located approximately 4.0 kilometres north-west of the outskirts of the urban area of Murray Bridge, as identified in RES – Site Location Plan (Drawing No. 03791D2202-04) and shown below.



4.1 Development Components Overview

The proposed development will consist of the following components:

- solar panels with a generating capacity of approximately 176MW;
- approximately 690,000 solar photovoltaic (PV) panel (such as a multi-crystalline silicon, mono-crystalline silicon or thin film or similar panel). The expected power rating is likely to be in the range of 320W to 400W per panel;
- the panels (and stand) are approximately 4.0 metres in height, with each PV panel having a variable tilt angle of approximately 60 degrees;
- the panels may be constructed either portrait or landscape, depending on the final panel and mounting infrastructure selected;
- the panels are constructed in rows that comprise approximately 84 modules. The rows are typically 4.0 to 8.0 metres apart (between structural poles), which at its closest point would result in panels approximately 2.0 to 6.0 metres between PV panels. All PV panels will have anti-reflective coating;
- the panels are connected to inverters and subsequently a transformer prior to connection to the substation (which may include an additional step up transformer);
- underground cabling between solar arrays and inverters;
- overhead transmission line connection to the substation (SA Water site on southern side of Monarto Road) including 132kV tee-off pole;
- two temporary construction and laydown compounds;
- fencing of the site (2,000 millimetre cyclone fencing);
- retention of existing screen landscaping;
- infill vegetative screening along Monarto Road and Hillview Road boundaries;
- vehicular access from Monarto Road and emergency access from Hillview Road; and
- electrical inverter and transformer enclosures and associated electrical equipment.

The following photograph is of a solar farm illustrates a typical solar farm with solar arrays.

Photograph of a typical single axis tracker photovoltaic panels in a solar farm

4.2 Plans and Details

Plans of the proposed development are included in Volume 3 of the application documents.

Details of the anticipated or typical infrastructure to be installed in the proposed development include the following and details are contained in Volume 1 of the application documents.

4.3 Construction and Operation

The development has two phases, namely the construction phase and then secondly the operational phase.

4.3.1 Construction Phase

The construction phase would incorporate the following elements:

- construction traffic for transportation of all component parts to the site;
- vehicle utilised in movement of component parts is anticipated to be semi-trailer and other smaller commercial vehicles;
- delivery of components is anticipated via the South Eastern Freeway and exit freeway to Ferries McDonald Road, Schenscher Road and Monarto Road;

- infrastructure materials such as concrete, reinforcement, pavement and surfacing material will be sourced locally from quarries and suppliers;
- the construction period is anticipated to be approximately 12-18 months;
- site preparation for the solar farm would involve earthworks to prepare the site of the temporary construction compound and internal roads and surfaces;
- all excavated material would be stored and used on-site. Removal of material off site is not anticipated;
- preparation of concrete pads for foundations for plant, equipment and site buildings would then occur, followed by installation of these structures. Subsequently excavation and footings for the solar arrays would occur;
- the solar PV panels would be installed and all electrical infrastructure connected;
- construction occurring between the hours of 7.00 am and 7.00 pm Monday to Saturday, with no work on Sundays or Public Holidays; and
- it is anticipated that up to 200 people being directly employed during construction phase of the solar farm.

4.3.2 Operation Phase

The ongoing operation of the solar farm and battery storage facility involves monitoring and maintenance, with trained personnel on site on a regular basis and in the intervening periods the operation of the solar panels are monitored remotely.

4.4 Buildings and Structures

The site of the development will accommodate the buildings and structures in addition to the solar arrays.

- **Control Building** – this building is transportable and approximately 120 square metres (10 metres x 12.0 metres). The control building would comprise amenities and storage components and also accommodate telecommunications, operations and security systems.
- **Inverters and transformers** – inverters are similar to large shipping containers and convert the direct current (DC) electricity that is generated from the solar panels into alternating current (AC). Within these containers or adjacent will be transformers stepping up the voltage to an internal reticulation voltage within the solar farm typically either 11, 22 or 33dV. Depending on the final inverter selected, in the vicinity of 35 inverters are proposed to be installed on the site and located to the south of the solar arrays. The inverters are typically installed on a concrete pad footing or raised steel frames.

- **Transformer** – a main grid connection transformer is proposed to be located within the construction and operations compound adjacent the Monarto Road boundary so that a direct connection can occur via an overhead transmission line to the existing 132kV Electranet network that transverses the site and the SA Water substation. The transformer will be installed on a concrete pad. This transformer will step up the voltage from the internal reticulation voltage to 132kV.

- **Underground Cabling** – underground cabling will be utilised for cables connecting the inverters to the transformer. Cable trenches will typically be installed along access roads and tracks.

- **Transmission Line** – The connection to the SA Water substation to the south of the site.

- **Security Fencing** – permanent security fencing in the form of 2.0 metre high chain mesh will be constructed around the perimeter of the solar arrays and ancillary infrastructure.

- **Temporary Construction Compound** – during the construction phase of the development it is proposed to develop a compound for the delivery and storage of materials. A site office in the form of a transportable building would be located within the compound. The temporary construction compound would be fenced for security purposes for the construction period and along with the site office then removed upon completion of construction.

- **Battery Storage** - The development also includes a battery energy storage facility. The key uses of batteries include helping to lower consumer costs by shifting cheaper renewable generation to periods of higher demands. Batteries can also provide security and stability services to the grid by injecting bursts of power into the network to help balance load and supply over very short time scales. Externally the battery storage facility looks like one large purpose built buildings, with inverters located on the outside of the building. These buildings will contain racks of Lithium Ion (li-ion) batteries which will be connected to the inverters and then on to the grid transformers at the terminal station through a small switch yard.

- **Site Access** – access to the site will be from a new access from Monarto Road.

- **Internal vehicle tracks** – post construction internal vehicle access driveways will be retained throughout the solar arrays for access to key equipment. These internal access tracks will be unsealed and generally up to 5.0 metres in width. Solar PV module rows will be spaced approximately 4.0 metres to 6.0 metres apart to allow access for service and cleaning. The spaces between module rows will generally not be gravelled and will allow for regeneration of groundcover.

- **Earthworks** – the site requires minimal site work, other than construction of a hardstand area for the construction compound and operations/control building and level bases for the inverters/transformers. Earthworks associated with the construction of the solar panels involves a post driver for the construction of the posts which support the steel frames of the solar panels.

5.0 PROCEDURAL MATTERS

5.1 Section 49

In accordance with the definition of "public infrastructure" in Section 49 of the *Development Act, 1993*, RES are providing electricity infrastructure, as identified in part (a). Electricity proposed to be generated by the solar farm will be distributed to the national grid.

> ***public infrastructure*** *means—*
> *(a) the infrastructure, equipment, structures, works and other facilities used in or in connection with the supply of water or electricity, gas or other forms of energy, or the drainage or treatment of waste water or sewage;*
> *(b) roads and their supporting structures and works;*
> *(c) ports, wharfs, jetties, railways, tramways and busways;*
> *(d) schools, hospitals and prisons;*
> *(e) all other facilities that have traditionally been provided by the State (but not necessarily only by the State) as community or public facilities;*

Crown sponsorship has been granted, a copy of which is included in Volume 1 of the application documents. Pursuant to Section 49 (4a) the application will be referred to the Rural City of Murray Bridge for consideration and report. Notification in the form of a public advertisement is required as the development has a value exceeding $4 million.

5.2 Development Plan

The development is within the Rural City of Murray Bridge and is located within the Primary Production Zone – Policy Area 5 – North Central Area, Murray Bridge Plains, Murray Bridge Council Development Plan consolidated version dated 23 January 2018. A solar farm and battery storage facility is neither a complying or a non-complying land use within the Primary Production Zone of the Murray Bridge Council Development Plan.

5.3 Referrals and Additional Requirements

5.3.1 State Heritage

There are no places of State Heritage significance within the site of the development. Similarly, there are no places of State Heritage significance within the proximity of the development which would materially affect the context within which the State heritage place is situated. Consequently, it is considered that the application does not require referral to the Minister administering the *Heritage Places Act 1993*.

5.3.2 Commissioner of Highways

The site of the development adjoins Reedy Creek Road, a designated arterial road. Access to the development is not proposed from Reedy Creek Road, and subsequently the application would not require the formal referral to the Commissioner of Highways.

5.3.3 *River Murray*

The development is not located within the River Murray Water Protection Area, shown as the River Murray Protection Area - Tributaries Area (in accordance with Concept Plan Map MuBr/16) Development Constraints Water Management Areas of the Murray Bridge Council Development Plan). It is considered that the application does not require formal referral to the Minister for the time being administering the River Murray Act 2003.

5.3.4 *Country Fire Service (CFS)*

The Murray Bridge Council Development Plan contain Bushfire Protection Area (BPA) maps of bushfire risk. The subject land is within the General Bushfire Risk area.

Referral to the CFS is required for certain forms of development, particularly dwellings, tourist accommodation and other forms of habitable buildings in a High Bushfire Risk Area of a Bushfire Protection Area. Given the proposal does not involve any of these forms of development, formal referral to the CFS is not required.

5.4 Electricity Connection

RES have obtained a certificate of compliance pursuant to Schedule 5 of the *Development Regulations 2008* from the Office of Technical Regulator (OTR) in relation to the security and stability of the State's power system, which is included in Volume 1 of the application documents.

RES recognise the licensing and registration requirements of a generator on the National Electricity Market and as a generator within the State of South Australia. These require satisfaction of requirements from entities such as ElectraNet, Australian Electricity Market Operator (AEMO) and Essential Services Commission of South Australia (ESCOSA).

RES also recognises ESCOSA's directive around integration of new generation sources into networks in seeking to provide network support. These requirements, as well as potential future requirements, are accommodated in the project design through the earmarked solar technology and supporting electrical infrastructure.

RES will work with the statutory bodies in relation to an agreed set of performance standards applicable for the facility, to the satisfaction of all appropriate parties through the standard connection process.

5.5 Project Timing

RES are seeking a period of five years in which to substantially commence the development from the operative date and substantial completion to be extended to eight years from the operative date of the consent.

6.0 SUBJECT LAND AND LOCALITY

The subject land is located to the approximately 4.0 kilometres north-west of outskirts of the urban area of Murray Bridge and 60km south east of Adelaide. The site of the development is bounded by Monarto Road to the south and Reedy Creek Road and Hillview Road to the north.

6.1 Legal Description

The subject land is included in rural address 166 and 229 Hillview Road, Pallamana and on land legally described as:

- Section 192, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5858 Folio 256;
- Section 196N, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5858 Folio 257;
- Sections 193 and 196S, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5858 Folio 258;
- Section 197, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5858 Folio 259;
- Section 166, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5487 Folio 88; and
- Allotment 285, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5802 Folio 294.

Copies of the Certificates of Title are contained in Volume 1 of the development application documents.

6.2 Description of the Subject Land

A detailed description of the subject land is contained in Volume 1 of the development application documents and the technical reports from EBS Ecology (Ecological Assessment report dated July 2018) and Landscape Character and Probable Visual and Effect Assessment (dated July 2018) by WAX Design. Both of these reports are contained in Volume 2 of the development application documents.

Overall the site on the development (referred to as the Project Site in Volume 1) has an area of approximately 780 hectares. The "site of the development" is only portion of Section 197 and Allotment 285 (referred to as the Subject Land in Volume 1). The site of the development is shown on the plans in RES – Site Location Plan - Drawing No. 03791D2202-04.

Currently the subject land is utilised for cropping and grazing. The site of the development does not contain any dwellings or significant outbuildings. The subject land comprises a variety of infrastructure, including overhead 132kV electricity lines, 33kv and 19kV electricity lines and a SEAGas underground pipeline.

The land is undulating and contains scattered vegetation adjacent fences line and patches throughout the site. EBS Ecology (in the Ecological Assessment Report) notes that *"most of the project site has very low ecological value"*.

WAX Design, in the Landscape Character and Probable Visual Effect Assessment describe the landscape character of the site as:

> *The subject land and the immediate locality to the north are formed by an undulating tableland with numerous local ridges and creeks. The underlying land cover is predominantly cropped agriculture. This rural landscape is punctuated by shelter belts of trees and woodland areas that form defined vegetated elements in the landscape. Four transmission lines run through the site, which reflect existing infrastructure elements within the locality.*
>
> *The topographic variation in combination with the existing areas of vegetation create a visually enclosed landscape character with a degree of visual complexity that results in pockets of landscape with contained views extending for a few kilometres before being the surrounding ridgelines, and vegetation belts contain the visual character forming defined viewsheds.*
>
> *The site extends across an elevated plateau that forms the highest point of the Monarto tablelands between Murray Bridge and the Bremer River corridor. The site is defined by several local undulations that form localised basins and depressions that limit the degree of visibility within the wider locality.*

6.3 Description of the Locality

A detailed description of the locality is contained in the Volume 1 – Summary report of the application documents, along with the EBS Ecology and WAX Design technical reports. As noted in Volume 1: *"the locality of the site of the development is characterised by primary production activities, particularly cropping and grazing, along with associated scattered dwellings and farm buildings. Within the wider locality there are also intensive animal keeping activities, the Monarto Zoological Park, Pallamana Airfield, Kinchina Conservation Park, a quarry on Maurice Road, and to the south-east on the edge of Murray Bridge is the Mobilong Prison"*.

The Murray Bridge Council Development Plan describes the policy area within which the site is located as *"... characterised by a range of farming activities on relatively large properties, including grazing and cropping, some intensive animal keeping involving meat and wool production, and rural industries. The area contains the Pallamana Airfield. It is desirable that these activities continue, and development other than that associated with general farming and primary production activities takes into account the existing character of the area"*.

As stated above, the locality contains the Pallamana Airfield (also referred to as Murray Bridge aerodrome). The airfield is located to the north of Reedy Creek Road and north of the subject land. Pallamana Airfield is utilised for general aviation and particularly flight training. The aerodrome has two runways.

Monarto Zoological Park is a large non-agricultural land use to the south east of the subject land. The northern boundary of the free range zoo is Monarto Road. Public access to the zoo is not in the vicinity of the subject land, but rather from Old Princes Highway. The Monarto Zoological Park Zone, as defined by the Murray Bridge Council Development Plan is diagonally opposite the south-western corner of the subject land.

On the southern side of Monarto Road opposite the subject land is SA Water pumping station and substation. Further south of the pumping station is Kinchina Conservation Park and a quarry on Maurice Road, and to the south-east on the edge of Murray Bridge is the Mobilong Prison".

7.0 DEVELOPMENT PLAN ASSESSMENT

The site of the proposed Palmer Solar Farm is located within the Rural City of Murray Bridge and is located within the Primary Production Zone – Policy Area 5 – North Central Area, Murray Bridge Plains, of the Murray Bridge Council Development Plan consolidated version dated 23 January 2018.

An assessment of the proposed development against the Development Plan requires the consideration of the following issues:

- land use;
- efficient energy generation;
- visual amenity;
- noise;
- reflection;
- impact on flora and fauna;
- soil erosion, water supply and stormwater management;
- traffic and access;
- aviation;
- indigenous and European heritage; and
- bushfire.

These matters are discussed and assessed below.

7.1 Land Use

Renewable energy facilities, such as solar farms are a form of development that the Development Plan envisages being located to harvest natural resources for the efficient generation of electricity, as stated in the Objectives and Principles of Development Control (PDC) of General Section – Renewable Energy Facilities. Unfortunately, the appropriate locations for these facilities are not necessarily specified in the Zone provisions of the Development Plan. The Primary Production Zone is silent of the appropriateness of a renewable energy facility.

Renewable Energy Facilities

Objective 1	**Development of renewable energy facilities that benefit the environment, the community and the state.**
Objective 2	**The development of renewable energy facilities, such as wind farms and ancillary development, in areas that provide opportunity to harvest natural resources for the efficient generation of electricity.**

Objective 3 **Location, siting, design and operation of renewable energy facilities to avoid or minimise adverse impacts on the natural environment and other land uses.**

PDC 1 **Renewable energy facilities, including wind farms and ancillary development, should be:**

(a) **located in areas that maximize efficient generation and supply of electricity; and**
(b) **designed and sited so as not to impact on the safety of water or air transport and the operation of ports, airfields and designated landing strips.**

Viewing the appropriateness of the land use in a holistic manner, the site of the development satisfies the renewable energy criteria in the following manner:

- the development is of significant benefit to the state via the generation of sustainable and stable electricity being directed to the national electricity grid;
- Pallamana is an appropriate location for a solar farm given its climate and solar access;
- the site of the development is located physically adjacent an existing SA Power Networks substation;
- generation of electricity can be done efficiently given the location and connectivity to the electricity grid;
- construction and layout of the solar farm and energy storage infrastructure will have minimal adverse environmental impacts given the design and siting of the facility to retain areas of vegetation; and
- the site of the development does not impact on the safety of air transport and the operation of airfields and designated landing strips, albeit that the subject land is in the locality of the Pallamana airfield.

General provisions of the Development Plan under the heading of "Energy Efficiency" supports on-site power generation including photovoltaic cells. The proposed development is commercial rather than domestic in nature, which is inferred by the reading of all the Energy Efficient policies as a whole, the policy recognises that photovoltaic cells are a form of power generation that requires appropriate solar access for efficient generation. The proposed development has been designed and sited to maximise solar access and electricity generation.

Energy Efficiency

Objective 1 **Development designed and sited to conserve energy, and minimise waste.**

Objective 2 **Development that provides for on-site power generation including photovoltaic cells and wind power.**

PDC 1 **Development should provide for efficient solar access to buildings and open space all year around.**

PDC 2 **Buildings should be sited and designed:**

- **(a)** **to ensure adequate natural light and winter sunlight is available to the main activity areas of adjacent buildings**
- **(b)** **so that open spaces associated with the main activity areas face north for exposure to winter sun.**

On-site Energy Generation

PDC 3 **Development should facilitate the efficient use of photovoltaic cells and solar hot water systems by:**

- **(a)** **taking into account overshadowing from neighbouring buildings**
- **(b)** **designing roof orientation and pitches to maximise exposure to direct sunlight.**

In addition to the provisions of the Development Plan relating to Renewable Energy and Energy Efficiency, the general provisions of the Plan contain policy that supports the provision of infrastructure in appropriate locations, as quoted below. Development of the solar farm is being undertaken by RES in an orderly and economical manner. RES as the developer has identified the land as being suitable for the solar and energy storage development given its proximity and linkages to existing electricity infrastructure for ease of connection. Siting of the solar farm is not only efficient from the connection perspective, but also has the benefit of adequate separation to non-associated adjoining owners and occupiers.

PDC 3 quoted below supports the expansion of the economic base of the region. Development of a solar farm and energy storage facility within the region is a relatively new and unique form of development within the Rural City of Murray Bridge. As detailed in the economic analysis undertaken by Essential Economics (contained within Volume 2 of the application documents), notes that *"the Pallamana Solar Farm project will involve approximately $200 million in investment during the construction phase and will support 200 direct and 320 indirect positions over the 12-month construction period. Once operational, 4 direct and 12 indirect jobs will be supported by the facility on an ongoing basis"*. For these reasons, the proposed development will expand the economic base of the region.

Orderly and Sustainable Development

Objective 1: **Orderly and economical development that creates a safe, convenient and pleasant environment in which to live.**

Objective 3 **Development that does not jeopardise the continuance of adjoining authorised land uses.**

Objective 4 **Development that does not prejudice the achievement of the provisions of the Development Plan.**

PDC 1 **Development should not prejudice the development of a zone for its intended purpose.**

PDC 2 **Land outside of townships and settlements should primarily be used for primary production and conservation purposes.**

PDC 3 **The economic base of the region should be expanded in a sustainable manner.**

PDC 6 **Development should be located and staged to achieve the economical provision of public services and infrastructure, and to maximise the use of existing services and infrastructure.**

Objective 3 and PDC 2 of General Section – Orderly and Economic Development seeks to protect envisaged land uses, which in the case of the subject land is primary production activities. Specifically Objective 3 quoted above seeks to ensure that a development does not prejudice the continuation of adjoining lawful land uses. Development of the subject land for a solar and energy storage facility does not prejudice the ongoing lawful use of land in the locality, including land which is used for agriculture, the zoological park or the Pallamana airfield. The development does not create external impacts that would adversely affect the ongoing use of the properties in the locality for their lawful land uses.

The intent of the Primary Production Zone and North Central Policy Area 5 (as quoted below) is the continuation of a range or primary production activities. As previously stated, the provisions of the Primary Production Zone do not specifically anticipate solar and energy storage land uses. However, the underlying intent to support renewable energy facilities is noted in the Objectives and Desired Character Statement, albeit that these provisions specifically relate to wind farms. It is considered that the intent of the Development Plan was not to specifically exclude other forms of renewable energy production, but rather the policies were written at a point in time to address the newly emerging wind farm developments and other forms of renewable energy facilities on a commercial scale were not anticipated.

In terms of form of development, the solar arrays and ancillary infrastructure would reduce the productive capacity of the subject land for agricultural purposes for the life of the project. Grazing of stock at low ratios would still be possible during the life of the development. In the long term, at the end of the productive life of the solar farm, the land could be reverted to more traditional farming purposes.

Objective 2 encourages economically productive, efficient and environmentally sustainable primary production. Whilst not a traditional form of primary production, the solar farm is an economically productive, efficient and environmentally sustainable development for energy production. It is anticipated that the economic value of the production of electricity from the subject land over its project life would significantly exceed the productive value from cropping or grazing. Or stated differently, the productive value of the subject land should not be limited to "farming" or an analysis of the land capability assessment that is based on soil assessment.

It is noted from the Desired Character Statement that the subject land is within the "*Environment and Food Production Areas (EFPAs) area which has been established under the Planning, Development and Infrastructure Act 2016. EFPAs have been introduced to help protect vital food and agricultural lands and contain the threat of urban sprawl by reducing the ability to subdivide land for housing development*". The proposed development does not contribute or promote urban development and it therefore not at odds with the intent of the Desired Character Statement in terms of EFPA's. Whilst the development reduces the productive potential of the land for food production, it is providing sustainable energy to the State.

Desired Character Statement

This policy area is characterised by a range of farming activities on relatively large properties, including grazing and cropping, some intensive animal keeping involving meat and wool production, and rural industries. The area contains the Pallamana Airfield. It is desirable that these activities continue, and development other than that associated with general farming and primary production activities takes into account the existing character of the area....

The area comprises stands of native vegetation protected by way of Heritage Agreements which will be protected.

The area has also been identified as an area where Branched Broomrape has been located. Branched Broomrape is a noxious weed that extracts all its nutrient requirements from its host plants and therefore is a serious threat to the markets of agricultural products as well as reducing yields of a range of host crops. Development will ensure that the spread of Branched Broomrape is minimised and wherever possible eradicated.

PDC 1 **The following forms of development are envisaged in the policy area:**

- **farming**
- **intensive animal keeping.**

PDC 2 **Development should not be undertaken unless it is consistent with the desired character for the policy area.**

7.2 Land Capability

The subject land has historically been utilised for dryland farming. Cropping and grazing continues on the land.

As discussed in the Land Capability Assessment contained in Volume 2, the subject land has a higher land use potential for growing of barley (moderately high to moderate potential) relative to the moderate to moderately low potential for wheat production.

As a result of the proposed development of the solar farm, approximately 780 hectares of the primary production land used for agriculture will be unavailable for cropping. This equates to approximately 0.02% of the cropped land in southern South Australia.

There is still potential for stock to be grazed on the subject land during the life of the project and the land to be reverted to cropping activities following decommissioning of the solar farm.

Principle of Development Control 5 under the heading of Natural Resources (General Section of the Development Plan) states that the development should be appropriate to the land capability. The capability of the subject land has been found to be appropriate for a "solar farm" in addition to the traditional methods and definition of "farming" (use of land for any purpose of agriculture, cropping, grazing, or animal husbandry). Hence, the capability of the land could be readily expanded to take account of the solar access/resources of any site.

The second component of PDC 5 quoted below, is the protection and conservation of water resources and biodiversity. There are no surface water resources on the subject land and the development has been designed in a manner to minimise impacts on ground water, as outlined in the AECOM Surface Water and Hydrology report contained in Volume 2 of the development application documents. In designing the site layout areas of vegetation have been either excluded from the development site, or retained with suitable buffers from the proposed development infrastructure, albeit that a small area (3.68ha) of remnant vegetation is proposed to be removed. The proposal seeks to supplement vegetation via infill landscaping along Monarto Road and Hillview Road, which further assist the vegetation corridors and biodiversity of the area.

Natural Resources

PDC 5 **Development should be appropriate to land capability and the protection and conservation of water resources and biodiversity.**

7.3 Design, Siting and Appearance

A commercial scale solar farm, is a relatively new form of development in South Australia and particularly within the Rural City of Murray Bridge. A solar farm which has a significantly different design and appearance to other forms of development in the locality.

Structures and buildings associated with the solar farm vary from other buildings and structures found on traditional farms and the impacts of the design and appearance of the solar arrays and ancillary structures are discussed below. There is however some consistency between the battery storage building with a floor area of 1,386 square metres and many of the intensive animal keeping buildings which are an envisaged land use within the locality.

Development of the solar farm involves the construction of up to 690,000 photovoltaic panels over a 780 hectare site with ancillary infrastructure. By design, the solar farm has a different visual impact than other forms of development, particularly those that may be anticipated in the Primary Production Zone. As described by WAX Design (in the Landscape Character and Probable Visual Effect Assessment, dated July 2018 and contained in Volume 2 of the application documents) the solar arrays are a low lying form of development that have insignificant vertical visual effect, but due to the number of panels or scale of the development can potentially have a horizontal visual effect due to the visual mass of the development across the landscape/field of view.

It is noted that the renewable energy provisions of the Development Plan recognise that infrastructure associated with wind turbines have a distinct and different visual impact. Whilst this acknowledgment is not extended to infrastructure associated with solar farms, this is considered a lag of policy (that is, the policy has not kept time with the changing nature of renewable energy being developed), rather than a deliberate exclusion from the policy. Objective 4 and PDC 8 of the Infrastructure policy in the General Section of the Development Plan infers that "infrastructure" and specifically "electricity infrastructure" may have a visual impact and should be designed and sited to minimise the impact. It is considered that the design and siting of the proposed solar farm suitably minimises the visual impact, for the reasons discussed below and in the Landscape Character and Probable Visual Effect Assessment.

Infrastructure

Objective 1	**Infrastructure provided in an economical and environmentally sensitive manner.**
Objective 2	**Infrastructure, including social infrastructure, provided in advance of need.**
Objective 3	**Suitable land for infrastructure identified and set aside in advance of need.**
Objective 4	**The visual impact of infrastructure facilities minimised.**
Objective 5	**The efficient and cost-effective use of existing infrastructure.**

PDC 2 **Development should only occur only where it provides, or has access to, relevant easements for the supply of infrastructure.**

PDC 8 **Electricity infrastructure should be designed and located to minimise its visual and environmental impacts.**

PDC 11 **Utility buildings and structures should be grouped with non-residential development where possible.**

The Objectives and Principles of Development Control under the heading of "Design and Appearance" (some of which are quoted below) are often not directly applicable to a solar farm. The functional and utilitarian design of the solar farm should be recognised as being different to other forms of buildings or structures. PDC 1 does recognise that a building (which includes a structure by definition) maybe of a contemporary nature. The nature of the development requires extensive arrays of solar PV panels and its style is appropriate in terms of the scale of the development on the site and in the locality.

The solar farm should be assessed in terms of its design and siting and visibility from adjoining land with regard to the context of its setting and its shape, size, materials and colour. The design and siting of the solar farm has a number of significant attributes which minimise the visual impact on the locality, including:

- the orientation of the PV panels is generally in a north south direction (which panels tracking east to west during the day) to maximise the efficient capture of sunlight. This orientation means that the panels are not facing Monarto Road. The orientation in combination with the existing (and proposed) vegetation along Monarto Road, limits the views of the development from the Monarto Zoological Park, as sought specifically by PDC 10 of the Primary Production Zone;

  Primary Production Zone

  PDC 10 **Any development likely to visually impact or create excessive odour, noise, dust or other nuisances, should be located 500 metres or more from the Monarto Zoological Park Zone.**

- the panels are located with a significant setback to the boundaries, including a setback of approximately 50 metres from Monarto Road and Hillview Road;
- a non-reflective coating is applied to the panels to minimise glare;

- the site of the development is currently screened by vegetation along the boundaries and road reserve of Monarto Road, Hillview Road and Reedy Creek Road (to varying extents);
- additional infill landscaping is proposed adjacent Monarto Road and Hillview Road;
- the elevated plateau associated with the underlying topography of the site removes that potential for views across the proposed development. The solar panels are typically viewed as horizontal linear bands of infrastructure in the landscape;
- the ancillary structures such as inverters, transformer and control building can be constructed of colour coated finishes that make them less visually intrusive;
- the buildings and ancillary infrastructure are sited within a minimum setback of 50 metres from Monarto Road;
- buildings and infrastructure (other than the solar arrays) are grouped together to the south of the site adjacent the vehicular entrance from Monarto Road. The utility zone containing these buildings are appropriately setback from the road and will be seen as part of the overall site infrastructure, rather than individual elements.

Design and Appearance

Objective 1 **Development of a high architectural standard that responds to and reinforces positive aspects of the local environment and built form.**

PDC 1 **The design of a building may be of a contemporary nature and exhibit an innovative style provided the overall form is sympathetic to the scale of development in the locality and with the context of its setting with regard to shape, size, materials and colour.**

PDC 2 **Buildings should be designed and sited to avoid creating extensive areas of uninterrupted walling facing areas exposed to public view.**

PDC 3 **Buildings should be designed to reduce their visual bulk and provide visual interest through design elements such as:**

(a) articulation
(b) colour and detailing
(c) small vertical and horizontal components
(d) design and placing of windows
(e) variations to facades.

PDC 4 **Where a building is sited on or close to a side boundary, the side boundary wall should be sited and limited in length and height to minimise:**

(a) the visual impact of the building as viewed from adjoining properties
(b) overshadowing of adjoining properties and allow adequate sun light to neighbouring buildings.

PDC 6 **Transportable buildings and buildings which are elevated on stumps, posts, piers, columns or the like, should have their suspended footings enclosed around the perimeter of the building with brickwork or timber, and the use of verandas, pergolas and other suitable architectural detailing to give the appearance of a permanent structure.**

PDC 7 The external walls and roofs of buildings should not incorporate highly reflective materials which will result in glare.

PDC 20 Buildings in rural areas should be sited a minimum distance of:

(a) 100 metres from the South Eastern Freeway
(b) 50 metres from primary arterial road other than the South Eastern Freeway
(c) 50 metres from a secondary arterial road.

Siting and Visibility

Objective 1 Protection of scenically attractive areas, particularly natural and rural landscapes.

PDC 1 Development should be sited and designed to minimise its visual impact on:

(a) the natural, rural or heritage character of the area
(b) areas of high visual or scenic value, particularly rural areas
(c) views from the River Murray, public reserves, tourist routes and walking trails.

PDC 2 Buildings should be sited in unobtrusive locations and, in particular, should:

(a) be grouped together
(b) where possible be located in such a way as to be screened by existing vegetation when viewed from public roads.

PDC 4 Buildings outside of urban areas and in undulating landscapes should be sited in unobtrusive locations and in particular, should be:

(a) sited below the ridgeline
(b) sited within valleys or behind spurs
(c) sited in such a way as to not be visible against the skyline when viewed from public roads
(d) set well back from public roads, particularly when the allotment is on the high side of the road.

PDC 8 Development should be screened through the establishment of landscaping using locally indigenous plant species:

(a) around buildings and earthworks to provide a visual screen as well as shade in summer, and protection from prevailing winds
(b) along allotment boundaries to provide permanent screening of buildings and structures when viewed from adjoining properties and public roads
(c) along the verges of new roads and access tracks to provide screening and minimise erosion.

Primary Production Zone

PDC 14 Buildings should primarily be limited to farm buildings (including storage and implement sheds, pump sheds and the like), a detached dwelling associated with primary production on the allotment and residential outbuildings that are:

(a) grouped together on the allotment and set back from allotment boundaries to minimise the visual impact of buildings on the landscape as viewed from public roads
(b) screened from public roads and adjacent land by existing vegetation or landscaped buffers.

PDC 17 Any building or modification to the land form should not be located closer than 50 metres to a watercourse identified on a current series 1:50 000 SA Government topographic map.

PDC 18 Buildings should be set back a minimum of 50 metres from every public road, other than adjacent to the South Eastern Freeway and the Old Princes Highway where the setback should be a minimum of 100 metres.

In addition to the Design and Appearance provisions of the Development Plan, the Objectives of the Natural Resources (General Section) and provisions of the Primary Production Zone, seek to protect the natural features of the rural landscape and its scenic qualities.

Natural Resources

Objective 13 Protection of the scenic qualities of natural and rural landscapes.

Objective 17 Protection of the natural features against mismanagement and intensive development, to prevent the degradation of the quality of the surrounding landscape.

Primary Production Zone

Objective 4 Protection of primary production from encroachment by incompatible land uses and protection of scenic qualities of rural landscapes.

Desired Character Statement

This zone covers the majority of the rural area throughout the Rural City of Murray Bridge. The zone will incorporate environmentally sustainable rural activities and maintain a rural character. Development will be undertaken in a manner that minimises adverse impacts on water resources, biodiversity or the visual and scenic quality of the environment, and does not result in air and land pollution, weed infestation, vermin proliferation or the uneconomic provision of infrastructure.

A detailed visual assessment of the locality has been undertaken by WAX Design and the conclusion of their Landscape Character and Probable Visual Effect Assessment (at page 53) it states that "based on the visual assessment, this report concludes that the degree of visual change that will result from the development of the Pallamana Solar and Energy Storage Facility will be slight with isolated areas of moderate impact".

The visual effect described as "slight" to "moderate" utilises the GrimKe assessment matrix (which is shown in Table 3 of the Landscape Character and Probable Visual Effect Assessment). A slight change is described as indistinct or barely distinguishable from the surroundings. Moderate change to the landscape is a having a "visible" appearance, where the change will be distinguishable from the surrounding landscape whilst the underlying landscape visual character is retained.

As discussed in Section 7.0 of the Landscape Character and Probable Visual Effect Assessment, the visual effect of the proposed solar farm can be assessed having regard to the existing landscape quality and the degree of visual change in the existing environment. This assessment is not a measure of a viewer's response or sensitivity to landscape change. It is likely that there will be a variety of views with regard to the visual change in the environment, some of which will be positive, whilst others maybe negative.

In conclusion, the visual assessment by WAX Design (Section 8.0) states:

> *The existing landscape that surrounds the proposed Pallamana Solar and Energy Storage Facility has a modified rural character that is defined by the tablelands and undulating landscapes of the Southern Mount Lofty Ranges. The proposed solar farm is located in an area of elevated land to the northwest of Murray Bridge. The combination of localised topographic variations, and significant belts of vegetation results in a visual effect that is contained to 2-3 kilometres.*
>
> *The topography of the site and the continuous sloped elevation towards the Murray River ensures that there are limited opportunities within the locality for the proposed development to be seen from elevated locations.*
>
> *The detailed visual impact assessment describes the visual effect as slight with isolated areas of moderate, with a degree of visual change that ranges from 20% to 29%. The variation in the degree of visual change results from variations in the landscape character and the amount of visual absorption provided by existing landscape elements, particularly in relation to local landforms and vegetation associated with the Monarto Tablelands. The visual effect produced by the proposed development in the existing landscape character produces three distinct visual effects to the northwest, east and south.*
>
> *To the northwest, the existing landscape character is defined by the undulating topography of the Southern Mount Lofty Ranges. Numerous ridgelines and valleys, in combination with extensive areas of vegetation, create visual screens across the landscape restricting views to the proposed site. From the northwest, the Pallamana Solar and Energy Storage Facility is not visible in the landscape, and no visual effect is produced.*
>
> *The Monarto Zoological Park forms a densely vegetated landscape character to the south. The existing vegetation and recent re-vegetation of the park increase the landscape screening and amenity to the edges of the zoological park. The potential for any visual impact between the two sites is minimised due to the extent of vegetation and surrounding ridgelines to the north.*
>
> *South of the proposed solar and energy storage facility, the underlying landform of the Kinchina and Narrinyeri Hills result in a series of pronounced topographic variations that define the visual character of the landscape, creating a contained visual character. The combination of topography and vegetation cover in the form of the Kinchina Conservation Park produces significant screening, and no visual effect is produced.*

Further south, Gifford Hill provides an elevated location from which potential visual effects may be experienced. However, at distances of five to seven kilometres, the narrow profile and colouration of the solar panels will produce a similar visual effect to the existing belts of evergreen trees that are present in the locality. The similarity in form and colour reduces the visual contrast of the proposed development within the existing landscape character, and the degree of visual change is likely to be considered as negligible when viewed from regional and sub-regional locations.

Along Reedy Creek Road to the southeast, the arrangement of the solar panels, orientation of the underlying topography and a reduction in screening vegetation results in Pallamana Solar and Energy Storage Facility being visible in the existing rural landscape. From viewpoint 1, a distinct section of the proposed development is visible and produces a visual effect that is described as moderate. The proximity of the viewpoint to the solar and energy storage facility and the significance of the adjacent road corridor on which the viewpoint is located, increase the visual effect.

From locations further to the south and north, the inter-relationship of vegetation and the rising topography on which the development is sited reduces the visibility of the solar and energy storage facility. The solar panels are visible as a narrow horizontal band of development, set behind the boundary vegetation of the site. The elevation of the solar panels on the site restricts potential views over or across the proposed development limiting the visual effect. This is demonstrated in viewpoint 2 and reflected in the degree of visual change which is measured at 28%.

The existing topography and vegetation cover associated with Pallamana Solar and Energy Storage Facility results in an enclosed visual character with few locations where a significant proportion of the proposed development is visible. From the south, northwest and areas on the edge of Murray Bridge, the proposed development is screened, and no visual effect occurs. To the northeast and east, along Reedy Creek Road and the adjoining agricultural landscape, the solar panels and associated infrastructure will be visible. The location of the solar panels on the east facing slope of the site increases the visibility of the proposed development with the visual effect extending out across the landscape to a maximum of three kilometres. Beyond this distance, the visibility of the proposed development will be limited.

The visual management techniques described in paragraph 5.8, aim to reduce the visual effect and the inclusion of earth mounding along the cadastral boundaries, planted with native shrubs and small mallee trees will provide additional screening. This integrated planning and landscape design approach will further limit the visual effect of the proposed solar farm, particularly to the northeast and east, particularly along Reedy Creek Road.

Based on the visual assessment, this report concludes that the degree of visual change that will result from the development of the Pallamana Solar and Energy Storage Facility will be slight with isolated areas of moderate impact. In addition, the existing landscape has the capacity to accommodate the proposed development. It is our interpretation and evaluation that the degree of visual change associated with the proposed development will be acceptable retaining the existing regional rural character, defined by the development plan principles.

Development of the Pallamana Solar Farm will result in a visual change in the locality, however, it is considered that existing vegetation and proposed supplementary landscaping, in combination with the design and siting of the development contribute to an extent of change would not adversely impact on the underlying character of the area and generally accords with the intent of the Development Plan.

7.4 Interface Between Land Uses

Various provisions of the Development Plans establish that development should not detrimentally affect the amenity of a locality or cause unreasonable interference through a variety of potential impacts, as stated in the Interface Between Land Uses provisions of the Development Plan.

Interface between Land Uses

Objective 1 **Development located and designed to minimise adverse impact and conflict between land uses.**

Objective 2 **Protect community health and amenity from adverse impacts of development.**

Objective 3 **Protect desired land uses from the encroachment of incompatible development.**

PDC 1 **Development should not detrimentally affect the amenity of the locality or cause unreasonable interference through any of the following:**

- **(a)** **the emission of effluent, odour, smoke, fumes, dust or other airborne pollutants**
- **(b)** **noise**
- **(c)** **vibration**
- **(d)** **electrical interference**
- **(e)** **light spill**
- **(f)** **glare**
- **(g)** **hours of operation**
- **(h)** **traffic impacts.**

PDC 7 **Development that emits noise (other than music noise) should include noise attenuation measures that achieve the relevant Environment Protection (Noise) Policy criteria when assessed at the nearest existing noise sensitive premises.**

PDC 8 **Development with the potential to emit significant noise (e.g. industry) should incorporate noise attenuation measures that prevent noise from causing unreasonable interference with the amenity of noise sensitive premises.**

It is considered that once operational the solar farm would not create adverse impacts, for the following reasons:

- the development does not result in emission of effluent, odour, smoke, fumes, dust or other airborne pollutants;
- noise generated from components of the solar farm will be compliant with relevant Australian Standards and EPA policy;
- the nearest non stakeholder dwelling to the solar farm is approximately 300 metres (north of Hillview Road). The nearest non-stakeholder dwelling to the infrastructure components or utility area (substation, construction compound etc) is approximately 700 metres to the south (south of Monarto Road). This dwelling has a setback of approximately 1.0 kilometre to the existing substation and SA Water infrastructure on Monarto Road;
- the solar panels are orientated to the north and treated with anti-glare coating. The siting and design features minimises the potential for glare from adjoining dwellings;
- the traffic and transportation assessment has assessed the potential for driver distraction in terms of visibility of the solar farm from vehicles travelling along Monarto Road, Hillview Road and Reedy Creek Road and concluded that this is not a concern with the inclusion of additional vegetation screening adjacent Monarto Road;
- any lighting of operational structures within the solar farm can be orientated in a manner that they do not create nuisance to adjoining neighbours. Interference by way of light spill or glare is unlikely given the setback and separation distances to the nearest sensitive land uses;
- electrical interference from infrastructure within the solar farm is considered to be minimal and all plant and equipment installed will be required to meet all relevant Australian Standards; and
- once operational the solar farm would only require maintenance visits and otherwise would be managed remotely and hence traffic movements in the operational phase would be minimal.

It is recognised that during the construction phase of the solar farm there would be additional traffic movements, construction noise, dust and the like. The construction period is relatively short (12-18 months) and the draft Construction Environmental Management Plan accompanying the development application would adequately manage and minimise the impacts on adjoining owners and occupiers and the people utilising nearby road.

7.4.1 Aviation and Glare

The site of the development is located to the south of the Pallamana Airfield (also known as the Murray Bridge aerodrome). RES engaged Landrum and Brown and subsequently Aviation Projects to prepare an aeronautical impact assessment of the proposed development on the airfield.

Renewable Energy Facilities provisions of the Development Plan requires that renewable energy facilities avoid or minimise adverse impacts on other land uses and not impact on the safety of air transport and operation of airfields. In addition, PDC 1 of the Interface between Land Uses provisions seek to ensure development does not create unreasonable interference through a range of potential impacts, including glare and glint.

The Aeronautical Impact Assessment reports (contained in Volume 2 of the application documents) note that the solar facility will have no impact on controlled airspace, air routes, published instrument approach procedures or restricted airspace, aviation communications, navigation or surveillance installations.

Consultation with the owners of the Murray Bridge aerodrome was undertaken by Aviation Projects during the consultation phase of the project. At that time, concerns were expressed in relation to an aircraft suffering a loss of power on departure from runway 19 and having no ability to avoid landing on or into the solar panel array, would suffer much more serious consequences than in the current circumstances. As a result, although not a mandatory obligation, RES modified the proposed solar farm layout to incorporate a forced landing area that mitigates this risk.

In relation to potential glare from the solar panels, the Aeronautical Impact Assessment reports undertook a solar glare assessment, as the solar panels are within direct line and close to runways where glare may distract an aircraft pilot. The Landrum and Brown report defines glare as "*a continuous source of excessive brightness with possible after image or temporary loss of vision. Glint is defined as a momentary flash of light (page 11)*". The results of the ForgeSolar analysis undertaken by Aviation Projects based on the final layout of the projects glare is acceptable and the proposed use of anti-reflective coating will serve to further reduce any potential glare issues.

The conclusion of the aviation impact assessments is that the proposed Pallamana solar farm will not have an adverse impact on aviation safety at Pallamana (Murray Bridge aerodrome). This assessment combined with the fact that the panels will be installed using anti-reflective coating further reduces the potential impact. For these reasons it is considered that the proposed development satisfies the provisions of the Development Plan in relation to potential impact between land uses. On this basis, it is considered that the proposal does not impact on the operation of the Pallamana airfield.

Interface between Land Uses

PDC 1 **Development should not detrimentally affect the amenity of the locality or cause unreasonable interference through any of the following:**

(a) **...**
(f) **glare ...**

Renewable Energy Facilities

Objective 3 **Location, siting, design and operation of renewable energy facilities to avoid or minimise adverse impacts on the natural environment and other land uses.**

PDC 1 **Renewable energy facilities, including wind farms and ancillary development, should be:**

- **(a)** **located in areas that maximize efficient generation and supply of electricity; and**
- **(b)** **designed and sited so as not to impact on the safety of water or air transport and the operation of ports, airfields and designated landing strips.**

7.4.2 Air Quality

The potential impacts on air quality are generally those associated with the construction phase of the project, particularly movement of vehicles and earthworks required in constructing access tracks, trenching and the solar arrays, which may create a risk of causing a dust nuisance. Minimising air pollution is sought by the Interface between Land Uses provisions, including PDC's 1 and 11.

Interface between Land Uses

PDC 11 **Development with the potential to emit harmful or nuisance-generating air pollution should incorporate air pollution control measures to prevent harm to human health or unreasonable interference with the amenity of sensitive uses within the locality.**

Minimisation of dust during the construction phase is addressed in the draft Construction Environmental Management Plan (CEMP) and the need to undertake the development pursuant to the developers' duty of care under the *Environment Protection Act 1993,* and relevant EPA policies and guidelines.

In addition, a Construction Traffic Management Plan will be prepared prior to construction to identify the route for vehicles and any specific mitigation required, i.e. management of potential fugitive material during transportation, operation of equipment to control exhaust emissions and a procedure for complaints. Mitigation methods identified to date include identification of routes to avoid (wherever possible) residential land uses, all vehicles and equipment will be operated and maintained to comply with regulatory standards for exhaust emissions, construction site roads watered down, spray down with water pavement materials and aggregates before transporting, and covering any loads of dust generating or odorous materials entering or leaving site. These practices are satisfactory in meeting the intent of the Development Plans in relation to minimising nuisance in relation to air quality.

7.5 Flora and Fauna

EBS Ecology has undertaken desktop and field assessment of the subject land and prepared the Pallamana Solar Array and Battery Storage Project Ecological Assessment, which is included in Volume 2 of the development application documents. The Ecological Assessment has identified the site as having a very low ecological value but areas of remnant vegetation are important from a landscape context. There are no nationally threatened ecological communities within the site of the development.

As quoted below, the Development Plan contains extensive provisions seeking to protect and enhance the natural environment. The development will result in changes to the existing environment, but has sought to minimise the adverse impact on the natural environment by:

- the site of the development excluding portion of Section 193 (CT 5858/258) in the south east corner so that vegetation in that area is retained;
- retention of vegetation as connective pathways to areas of large intact patches or areas formally protected (outside of the site of the development);
- retention of vegetation along boundary/fencelines;
- vegetation management to aid regeneration;
- minimising earthworks for the construction of the solar farm by utilising the existing site levels wherever possible;
- development the main construction compound in close proximity to Monarto Road to minimise extent of construction traffic through the site;
- enhancing vegetation along the road corridors, including Monarto Road and Hillview Road;
- ensuring suitable management during construction and post construction to address erosion and pest plants.

Natural Resources

Objective 1	**Retention, protection and restoration of the natural resources and environment.**
Objective 2	**Protection of the quality and quantity of South Australia's surface waters, including inland, marine and estuarine and underground waters.**
Objective 3	**The ecologically sustainable use of natural resources including soil and water resources, including underground water, surface water and watercourses (as defined in the current *Environment Protection (Water Quality) Policy*).**
Objective 6	**Development sited and designed to:** **(a) protect natural ecological systems** **(b) achieve the sustainable use of water** **(c) protect water quality, including receiving waters** **(d) reduce runoff and peak flows and prevent the risk of downstream flooding** **(e) minimise demand on reticulated water supplies** **(f) maximise the harvest and use of stormwater** **(g) protect stormwater from pollution sources.**
Objective 8	**Native flora, fauna and ecosystems protected, retained, conserved and restored.**
Objective 9	**Restoration, expansion and linking of existing native vegetation to facilitate habitat corridors for ease of movement of fauna.**

Objective 10 **Minimal disturbance and modification of the natural landform.**

PDC 1 **Development should be undertaken with minimum impact on the natural environment, including air and water quality, land, soil, biodiversity, and scenically attractive areas.**

PDC 2 **Development should ensure that South Australia's natural assets, such as biodiversity, water and soil, are protected and enhanced.**

PDC 3 **Development should not significantly obstruct or adversely affect sensitive ecological areas such as creeks, wetlands, estuaries and significant seagrass and mangrove communities.**

Biodiversity and Native Vegetation

PDC 31 **Development should retain existing areas of native vegetation and where possible contribute to revegetation using locally indigenous plant species.**

PDC 32 **Development should be designed and sited to minimise the loss and disturbance of native flora and fauna, including riparian, riverine animals and plants, and their breeding grounds and habitats.**

PDC 33 **Native vegetation should be conserved and its conservation value and function not compromised by development if the native vegetation does any of the following:**

- **(a)** **provides an important habitat for wildlife or shade and shelter for livestock**
- **(b)** **has a high plant species diversity or includes rare, vulnerable or endangered plant species or plant associations and communities**
- **(c)** **provides an important seed bank for locally indigenous vegetation**
- **(d)** **has high amenity value and/or significantly contributes to the landscape quality of an area, including the screening of buildings and unsightly views**
- **(e)** **has high value as a remnant of vegetation associations characteristic of a district or region prior to extensive clearance for agriculture**
- **(f)** **is growing in, or is characteristically associated with a wetland environment.**

Provisions of the Development Plan state that development should not increase the potential for, or result in, the spread of pest plants. Management of weed species during construction and in the operational phase is incorporated in the Draft Construction Environmental Management Plan, which forms part of the application documents.

Primary Production Zone

PDC 12 **Development should not occur within 500 metres of a National Park, Conservation Park, Wilderness Protection Area or significant stands of native vegetation if it will increase the potential for, or result in, the spread of pest plants.**

Natural Resources

PDC 37 Development should be located and occur in a manner which:

- **(a)** **does not increase the potential for, or result in, the spread of pest plants, or the spread of any non-indigenous plants into areas of native vegetation or a conservation zone**
- **(b)** **avoids the degradation of remnant native vegetation by any other means including as a result of spray drift, compaction of soil, modification of surface water flows, pollution to groundwater or surface water or change to groundwater levels**
- **(c)** **incorporates a separation distance and/or buffer area to protect wildlife habitats and other features of nature conservation significance.**

An assessment of the proposed development against the intent of the Natural Resources provisions of the Development Plan indicates that the proposal will have minimal adverse impacts on the subject land in relation to clearance of native vegetation. On the contrary, the development has been designed to retain areas of native vegetation and supplement the existing vegetation corridors by new and supplementary planting.

7.6 Landform, Water Resources and Water Quality

An assessment of the landform and hydrology has been undertaken in the Surface Water and Hydrology report and Geology, Topography and Soils Assessment reports, which forms part of the application documents (Volume 2). These reports identify the potential impacts of the proposed development, including increased risk of erosion and sedimentation.

The provisions in the general section of the Development Plans which relate to water quality, soil erosion, sloping land, water sensitive design and stormwater management, include:

PDC 6 Development should be designed to maximise conservation, minimise consumption and encourage re-use of water resources.

PDC 8 Development should be sited and designed to:

- **(a) capture and re-use stormwater, where practical**
- **(b) minimise surface water runoff**
- **(c) prevent soil erosion and water pollution**
- **(d) protect and enhance natural water flows**
- **(e) protect water quality by providing adequate separation distances from watercourses and other water bodies**
- **(f) not contribute to an increase in salinity levels**
- **(g) avoid the water logging of soil or the release of toxic elements**
- **(h) maintain natural hydrological systems and not adversely affect:**
  - **(i) the quantity and quality of groundwater**
  - **(ii) the depth and directional flow of groundwater**
  - **(iii) the quality and function of natural springs.**

PDC 11 Development should have adequate provision to control any stormwater over-flow runoff from the site and should be sited and designed to improve the quality of stormwater and minimise pollutant transfer to receiving waters.

PDC 18 Stormwater management systems should:

- **(a) maximise the potential for stormwater harvesting and re-use, either on-site or as close as practicable to the source**
- **(b) utilise, but not be limited to, one or more of the following harvesting methods:**
  - **(i) the collection of roof water in tanks**
  - **(ii) the discharge to open space, landscaping or garden areas, including strips adjacent to car parks**
  - **(iii) the incorporation of detention and retention facilities**
  - **(iv) aquifer recharge.**

In addition, there are a number of provisions of the Development Plan relating to soil conservation and erosion.

Natural Resources - Soil Conservation

PDC 41 **Development should not have an adverse impact on the natural, physical, chemical or biological quality and characteristics of soil resources.**

PDC 42 **Development should be designed and sited to prevent erosion.**

PDC 43 **Development should take place in a manner that will minimise alteration to the existing landform.**

PDC 44 **Development should minimise the loss of soil from a site through soil erosion or siltation during the construction phase of any development and following the commencement of an activity.**

Sloping Land

Objective 1 **Development on sloping land designed to minimise environmental and visual impacts and protect soil stability and water quality.**

PDC 1 **Development and associated driveways and access tracks should be sited and designed to integrate with the natural topography of the land and minimise the need for earthworks.**

PDC 2 **Development and associated driveways and access tracks, including related earthworks, should be sited, designed and undertaken in a manner that:**

- **(a)** **minimises their visual impact**
- **(b)** **reduces the bulk of the buildings and structures**
- **(c)** **minimises the extent of cut and/or fill**
- **(d)** **minimises the need for, and the height of, retaining walls**
- **(e)** **does not cause or contribute to instability of any embankment or cutting**
- **(f)** **avoids the silting of watercourses**
- **(g)** **protects development and its surrounds from erosion caused by water runoff.**

PDC 3 **Driveways and access tracks across sloping land should be accessible and have a safe, all-weather trafficable surface.**

AECOM have advised to mitigate the potential impacts of the development, a range of measures should be included a Construction Environmental Management Plan (CEMP). A draft CEMP has been prepared as part of the development application and this is included in Volume 4 of the application documents. This draft CEMP includes methods to address the potential impacts, including the following, a number of which will be further detailed in the final design:

- develop a comprehensive drainage plan prior to Development Approval;
- develop a plan for reuse of roof water prior to Development Approval;
- undertake development in stages to minimise area of disturbance;
- maximise soil cover;
- re-establish ground cover vegetation at the earliest opportunity post construction;
- provide erosion protection at locations with a high exposure to erosion forces;

- minimising earthworks during intense rainfall events;
- installation of sediment/silt fences downhill of disturbed areas that are likely to generate runoff;
- incorporate dust suppression methods to avoid wind dispersion of sediments into creeks;
- incorporate scour protection in temporary drainage infrastructure;
- incorporate erosion protection at the base of solar panels to reduce the risk of erosion (e.g. planting and maintenance of vegetation at the base of solar panels, as required);
- gravel covering of highly trafficked areas;
- incorporate areas of bunding for fuel and chemical storage; and
- incorporate approved waste water treatment facilities.

Development of the solar farm following the topography of the land with minimal cut and fill, combined with a final CEMP will appropriately manage the potential impacts of the development in relation to erosion, sedimentation and stormwater management in a manner that suitably addresses the intent of the Development Plan.

7.7 Transportation and Access

As outlined in the relevant provisions of the Development Plans, there are various policies in relation to traffic and access, including the provision of safe and efficient movement from public roads, minimising visual impacts of internal access tracks, ensuring that the solar farm does not interfere with airfields, that the landform is not altered significantly, and any potential impacts on flora and fauna. Matters of landform, visual amenity, and impacts on flora and fauna have been discussed in previous sections of this report.

The key issue with regard to traffic and transport relate to the additional vehicles accessing the proposed solar farm during its construction, and the potential for driver distraction. A detailed Traffic Safety Assessment has been undertaken by MFY and is included in Volume 2 of the development application documents.

There are numerous provisions of the Development Plans which seek to ensure safe and convenient movement of people and goods, including those quoted below.

Transportation and Access

Objective 2 **Development that:**

(a) **provides safe and efficient movement for all motorised and non-motorised transport modes**
(b) **ensures access for vehicles including emergency services, public infrastructure maintenance and commercial vehicles**
(c) **provides off street parking**
(d) **is appropriately located so that it supports and makes best use of existing transport facilities and networks.**

PDC 1 Land uses arranged to support the efficient provision of sustainable transport networks and encourage their use.

PDC 2 Development should be integrated with existing transport networks, particularly major rail and road corridors as shown on *Location Maps* and *Overlay Maps - Transport*, and designed to minimise its potential impact on the functional performance of the transport networks.

PDC 13 Development should make sufficient provision on site for the loading, unloading and turning of all traffic likely to be generated.

PDC 22 Development should have direct access from an all weather public road.

PDC 23 Development should be provided with safe and convenient access which:

(a) avoids unreasonable interference with the flow of traffic on adjoining roads
(b) accommodates the type and volume of traffic likely to be generated by the development or land use and minimises induced traffic through over-provision
(c) is sited and designed to minimise any adverse impacts on the occupants of and visitors to neighbouring properties.

PDC 25 The number of vehicle access points onto arterial roads shown on *Overlay Maps - Transport* should be minimised, and where possible access points should be:

(a) limited to local roads
(b) shared between developments.

PDC 28 Driveways, access tracks and parking areas should be designed and constructed to:

(a) follow the natural contours of the land
(b) minimise excavation and/or fill
(c) minimise the potential for erosion from runoff
(d) avoid the removal of existing vegetation
(e) be consistent with *Australian Standard AS 2890 Parking facilities.*

PDC 30 Development should provide off-street vehicle parking and specifically marked disabled car parking places to meet anticipated demand in accordance with *MuBr/2 - Off Street Vehicle Parking Requirements.*

PDC 31 Development should be consistent with *Australian Standard AS 2890 Parking facilities.*

PDC 32 Vehicle parking areas should be sited and designed in a manner that will:

(a) facilitate safe and convenient pedestrian linkages to the development and areas of significant activity or interest in the vicinity of the development
(b) include safe pedestrian and bicycle linkages that complement the overall pedestrian and cycling network
(c) not inhibit safe and convenient traffic circulation
(d) result in minimal conflict between customer and service vehicles
(e) avoid the necessity to use public roads when moving from one part of a parking area to another
(f) minimise the number of vehicle access points to public roads
(g) avoid the necessity for backing onto public roads
(h) where reasonably possible, provide the opportunity for shared use of car parking and integration of car parking areas with adjoining development to reduce the total extent of vehicle parking areas and the requirement for access points
(i) not dominate the character and appearance of a centre when viewed from public roads and spaces
(j) provide landscaping that will shade and enhance the appearance of the vehicle parking areas.

As summarised in Volume 1, MFY identify that the key issues that relate to safety for the development are driver distraction and provision of an adequate clear zone. More specifically MFY examined whether the proposed solar panels and infrastructure are located within a clear zone; and whether the panels are located within the cone of vision for drivers from adjacent roads.

In relation to the clear zone, MFY note that the required for the clear zone would be 11 metres for the arterial road (Reedy Creek Road) and 8.0 metres for local roads (Hillview Road and Monarto Road). The assessment undertaken notes that the solar panels and other infrastructure will be installed outside of the clear zone and the development will meet the clear zone requirement.

MFY have reviewed the principles of Austroads (GRD Part 6B) in relation to road safety and the visual amenity for drivers to assess the potential for driver distraction. This assessment, referred to as a "cone of vision" assessment provides guidance as to the area adjacent the road that could be in a driver's general field of vision. MFY undertook this assessment for drivers travelling on Hillview Road, Reedy Creek Road and Monarto Road. The assessment notes that "the proposed solar panels would be outside the cone of vision along Hillview Road and for most of the length of Monarto Road. However, there would be isolated locations where the panels will extend into the cone of vision along Monarto Road. In accordance with Austroads GRD Part 6B, therefore, screening should desirably be located on the subject site, adjacent the sections of Monarto Road where the panels will include into the cone of vision" (page 8). Screening in the form of infill landscaping is proposed along Monarto Road to ensure satisfaction the infrastructure of the development, in this case some of the solar (PV) arrays, is not viewed as a distracting or confusing element by a driver travelling along Monarto Road.

Transportation of components for the development of the Pallamana Solar Farm are anticipated via an existing heavy vehicle route, namely the South Eastern Freeway, Schenscher Road and Monarto Road. Delivery of components for the construction of the Pallamana Solar Farm will be via general access vehicles (up to 19.0 metre semi-trailer in length) and the proposed route is one of a number of arterial road alternatives that could be used which are designed to accommodate heavy vehicles. The assessment undertaken by MFY concludes that the access route can readily accommodate the volume of traffic that would be anticipated by the development. Furthermore, the site access has suitable sightlines and there is no need for the construction of channelised lanes.

The assessment by MFY confirms that the proposal will satisfy the safety criteria of Austroad road design guidelines and will have minimal impact on the operation of the road network, subject to the screening of the infrastructure adjacent Monarto Road (as proposed).

7.8 Heritage

The Development Plan contains numerous provisions relating to protection of places of heritage significance. There are no places of State or local heritage significance within the site of the development listed in the Development Plan.

Volume 1 of the development application documents notes that a search of the Register of Aboriginal Sites and Objects, administered by the Department of the Premier and Cabinet, Aboriginal Affairs and Reconciliation has no entries for Aboriginal sites within the project area.

On the basis that there are no items of heritage significance or known aboriginal sites, the proposal is unlikely to detract from the heritage and cultural significance of the locality, and thereby complies with the relevant provisions of the Development Plans.

Heritage Places

Objective 1 The conservation of State and local heritage places.

7.9 Bushfire

The site of the development is within a general bushfire risk area. The proposed development is not considered to pose an unacceptable bushfire risk, as it:

- has suitable access from Monarto Road and emergency access from Hillview Road;
- incorporates a range of internal access tracks;
- is not located adjacent areas of dense vegetation, or is suitably separated from the existing and proposed vegetation screens; and
- does not compromise buildings that are to be permanently occupied.

Bushfire

PDC 8 The following bushfire protection principles of development control apply to development of land identified as General, Medium and High bushfire risk areas as shown on the *Bushfire Protection Area BPA Maps - Bushfire Risk.*

PDC 9 Development in a Bushfire Protection Area should be in accordance with those provisions of the *Minister's Code: Undertaking development in Bushfire Protection Areas* that are designated as mandatory for Development Plan Consent purposes.

PDC 10 Buildings and structures should be located away from areas that pose an unacceptable bushfire risk as a result of one or more of the following:

(a) vegetation cover comprising trees and/or shrubs
(b) poor access
(c) rugged terrain
(d) inability to provide an adequate building protection zone
(e) inability to provide an adequate supply of water for fire fighting purposes.

7.10 Development Plan Assessment Summary

The appropriateness of the solar farm and battery storage facility has been assessed against all of the relevant provisions of the Development Plan and concludes that the site of the development satisfies the provisions in the following manner:

- the development is of significant benefit via the generation of sustainable and stable electricity;
- the development will benefit the state by providing storage of renewable energy for distribution into the national electricity grid at peak periods;
- Pallamana is an appropriate location for a solar farm given its climate and solar access;
- the site of the development is located with physical access to existing overhead electricity infrastructure that can accommodate efficient connection to the electricity grid;
- the site of the development varies the productive capacity of the land from dryland farming to harvesting solar energy;
- the area of land removed from productive dryland farming, approximately 780 hectares, is not the highest yielding farming land within the Primary Production Zone;
- development of a solar farm and battery storage facility does not preclude the continuation of other dryland farming and primary production activities in the locality;
- construction and layout of the development has been designed to minimise environmental impacts by retaining and supplementing areas of vegetation;
- the development does not create conditions which create unreasonable nuisance or disturbance to adjoining land owners and occupiers;
- a slight to moderate visual change to the landscape is an outcome of the development, but the design and siting of the facility minimises the impact on adjoining land owners and occupiers and adjacent road users by:
  - retention of roadside vegetation;
  - retention of onsite patches of vegetation;
  - inclusion of additional areas of new vegetation planting;
  - avoidance of PV panels within the 'cone of vision' adjacent arterial roads; and
  - incorporation of anti-reflective coating on the PV panels.
- the development does not impact on the safety of air transport and the operation of the Pallamana airfield (Murray Bridge aerodrome);

- noise from infrastructure will be compliant with relevant noise criteria for sensitive receivers;
- the proposal contains suitable methodology that minimises impacts such as dust, noise and vibration through the construction phase; and
- the proposal contains suitable methodology for managing traffic movements, particularly during construction.

On balance, the proposed Pallamana Solar Farm and Energy Storage project is a suitable form of development within Primary Production Zone.

8.0 CONCLUSION

Following an assessment of the proposed development against the Development Plans, it is considered that the proposed development is not significantly at variance with the Development Plans.

On balance, the proposed Pallamana Solar Farm and Battery Storage project is a suitable form of development within the Primary Production Zone that suitably addresses potential effects, and thereby warrants the granting of Development Plan Consent.

Julie Jansen FPIA
BA, BA (Hons), GDURP

31 August 2018

LAND CAPABILITY ANALYSIS

AT: Lot 166 Hillview Road, Pallamana

FOR: RES Australia Pty Ltd

1.0 INTRODUCTION

This report has been prepared to assess the land capability of the subject land at Lot 166 Hillview Road, Pallamana, which is the subject of the proposed Pallamana Solar Farm and Battery Storage Facility for RES Australia Pty Ltd.

The subject land is within a Primary Production Zone and used for cereal cropping and grazing. A summary of the subject land is provided in Section 2.

As a result of the proposed development of the solar farm, approximately 780 hectares of the primary production land used for agriculture will be unavailable for cropping. Land within and around the solar panels will be grazed at low stock numbers.

The SA Government Aginsight website indicates there are around 4.0 million hectares of farm land cropped each year in southern South Australia. In terms of land area, the subject land is approximately 0.02% of the cropped land in southern South Australia. Therefore it is considered that the loss of this property for agriculture is negligible in the regional context.

There is also potential for the land to be reverted to current primary production activities at the end of the life cycle of the proposed solar farm.

An assessment has been undertaken of the land use potential for agricultural purposes on the subject land in relation to the main two cereal crops grown in the area; wheat and barley. A summary of the criteria used for the Land Capability Analysis and the analysis in relation to the subject land follows.

2.0 SITE DETAILS

Site Details	
Applicant	RES Australia Pty Ltd.
Proposed Development	Renewable energy facility incorporating 176MW solar farm and battery storage facility and ancillary infrastructure.
Property Location	Subject land is included in rural address Lot 166, Hillview Road, Pallamana. Section 192, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5858 Folio 256. Section 196N, Hundred of Mobilong, in the area names Pallamana, Certificate of Title 5858 Folio 257. Sections 193 and 196S, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5858 Folio 258. Section 197, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5858 Folio 259. Section 166, Hundred of Mobilong, in the area named Pallamana, Certificate of Title Volume 5487 Folio 88.
Zoning	Primary Production Zone – Policy Area 5 – North Central Area. Murray Bridge Council Development Plan dated 23 January 2018.
Environment and Food Production Area	Located within the E&FPA, an area of rural, landscape, environmental significance, protected from urban encroachment.

3.0 LAND CAPABILITY ANALYSIS CRITERIA

The Land Capability Analysis undertaken for the subject land is based on the land use potential analysis as set out in DEWNR Technical Note 2016/29 "Land Use potential for agricultural crops in Southern South Australia: Summary of assessment and mapping methodology" dated December 2016.

This document provided a summary of the methodology which linked Soil Landscape Mapping prepared in 2009 with modelled Land Use potential for various agricultural crops grown in southern South Australia.

In the following assessment the land use potential for both wheat and barley, the two cereal crops grown in this area, have been analysed using Land Use potential spatial data sets, available for download from Enviro Data SA and the Government Aginsight website.

The land use potential modelling approach only deals with the soil and land attributes which impact on the productivity and management requirements of different crops. This type of assessment describes the capability of land for a specific type of crop and is a preliminary overview of the situation. It does not describe the suitability of the land for such uses which requires a more detailed assessment to consider such influences as economics, climate, landscape, pest and disease incidence and water availability.

The land use potential assessment criteria is summarised in the following table: Land Use Potential Class Definitions. In this situation soil and land attribute ratings are assigned to Land Use potential classes ranging from land with high potential (Class 1) through to land with low potential (Class 5).

Table 1: Land Use Potential Class Definitions

Land use potential class	Potential	Definition
Class 1	High	Land with high productive potential and requiring no more than standard management practices to sustain productivity.
Class 2	Moderately high	Land with moderately high productive potential and/or requiring specific, but widely accepted and used, management practices to sustain productivity.
Class 3	Moderate	Land with moderate productive potential and/or requiring specialised management practices to sustain productivity.
Class 4	Moderately low	Land with marginal productive potential and/or requiring very highly specialised management skills to sustain productivity.
Class 5	Low	Land with low productive potential and/or permanent limitations which effectively preclude its use.
Class X	Not applicable *	Other eg. urban, evaporation pans, quarry, rock, saline soil, reservoir etc.

The DEWNR technical note 2016/29 provided Spatial data statistics for land use potential for wheat grain in all areas of Southern South Australia, which is summarised in Table 2.

Table 2: Land Use Potential For Wheat Spatial Data Statistics Calculated From Land Use Potential Analysis Data

Land use potential Analysis data class	Class 1	Class 2	Class 3	Class 4	Class 5	Class X	TOTAL
Potential	High potential	Moderately high potential	Moderate potential	Moderately low potential	Low potential	Not applicable	
Proportion of wheat growing areas	0%	15%	15%	70%	0%	0%	100%

This found that there were no Class 1 (high potential) or Class 5 (low potential) areas and 70 percent of the South Australian wheat growing areas were Class 4 with moderate to low potential productivity.

4.0 LAND CAPABILITY ANALYSIS FOR SUBJECT LAND

The land capability analysis for the subject land is based on the land use potential data for both wheat and barley which are two types of cereal crops grown in the region.

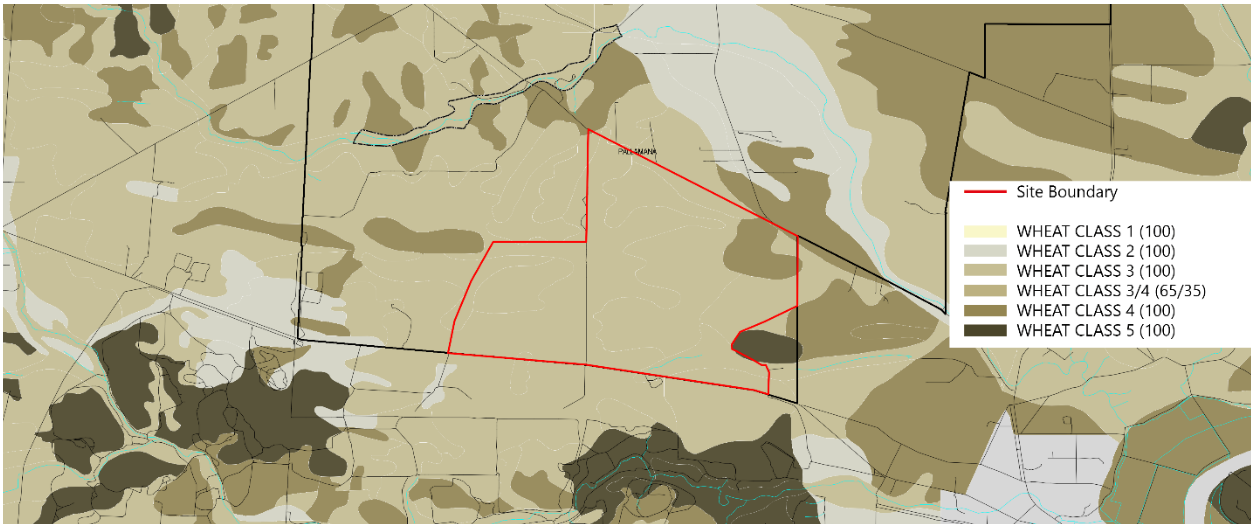


Figure 1: Land Use Potential for Wheat

Based on the land use potential classes outlined in Section 3, the subject land and surrounding area shown in Figure 1, contains a number of wheat classes including Class 3, Class 3/4, Class 4 and Class 5. There are no high to moderately high Class 1 or 2 areas for wheat growing in the area. The majority of the area is Class 3/4 which is a transition area that is 65 percent Class 3 and 35 percent Class 4.

The subject land is predominately within the Class 3/4 area, being 65 percent moderate land use potential to 35 percent moderately low potential for wheat growing. A small component in the north-east corner is entirely Class 4 (moderately low) potential.

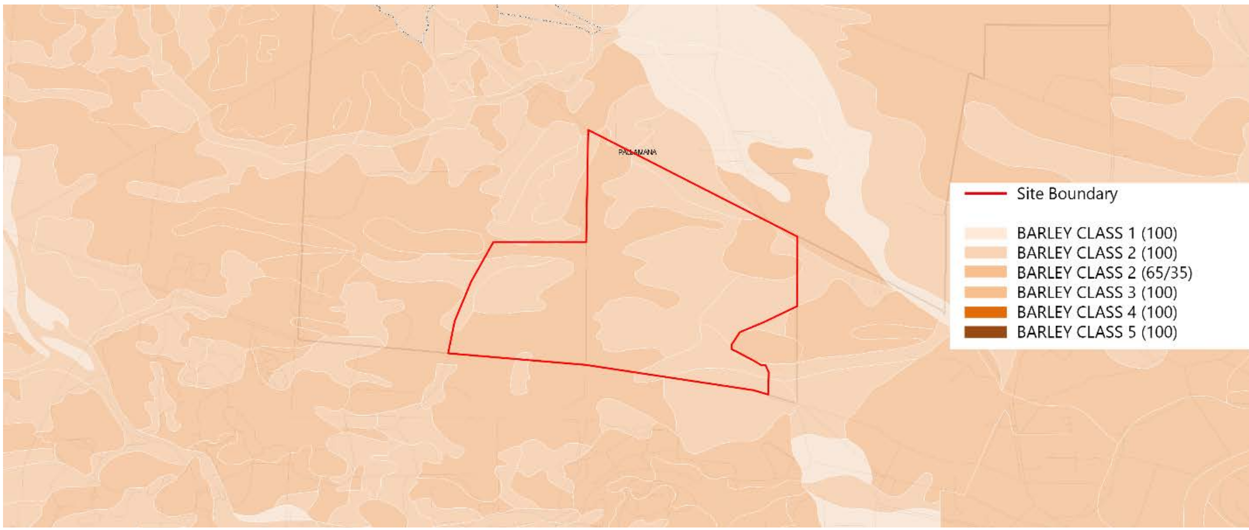


Figure 2: Land Use Potential for Barley

Figure 2 – Land Use Potential for Barley shows a combination of Class 2 (65/35), which is the transition of moderately high to moderate land use potential for barley and Class 3 (all moderate potential). The subject land has more potential as a barley production area than wheat which all the land being moderate to moderately high and no low potential areas, compared to wheat production.

5.0 SUMMARY

The subject land has a higher land use potential for growing of barley (moderately high to moderate potential) relative to the moderate to moderately low potential for wheat production.

As a result of the proposed development of the solar farm, approximately 780 hectares of the primary production land used for agriculture will be unavailable for cropping. This equates to approximately 0.02% of the cropped land in southern South Australia.

There is still potential for stock to be grazed on the subject land during the life of the project and the land to be reverted to cropping activities following decommissioning of the solar farm.

Wayne Gladigau MPIA
B/A in Planning

21 August 2018