

Section 4

Assessment and Management of Key Environmental Issues

PREAMBLE

This section describes the specific environmental features of the Project Site and its surrounds that would or may be affected during the life of the Nyngan Scandium. The proposed design and/or operational safeguards and management measures are presented, followed by an assessment of the predicted level of impact the proposed activities may have after implementation of these measures. Where appropriate, proposed monitoring programs are also described.

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4.1 ENVIRONMENTAL SETTING

4.1.1 Introduction

The descriptions of various environmental aspects of the Proposal throughout this section are reliant upon a range of background information common to many of the key environmental issues. In this subsection, the local setting is described and background information is provided on the topography, climate, geological setting and land ownership and land uses of the Project Site and surrounds. The information presented in this subsection provides a general overview of the environmental setting of the Project Site. More specific information in relation to particular environmental aspects of the Proposal are presented in the following subsections.

4.1.2 Topography and Drainage

4.1.2.1 Regional Topography and Drainage

The Project Site is located in an area of generally flat topography (**Figure 4.1**). Elevations range from approximately 224m AHD approximately 11km to the northwest of the Project Site, to approximately 160m AHD adjacent to the Bogan River, approximately 15km east of the Project Site. The regional topography generally falls towards the Bogan River.

The Project Site is located within the Macquarie-Bogan Catchment. The Macquarie-Bogan Catchment has a catchment of approximately 74 000km² within the Murray-Darling Basin from the Great Dividing Range south of Bathurst to Bourke in the west where the Bogan and Macquarie Rivers merge with the Darling River.

4.1.2.2 Project Site Topography and Drainage

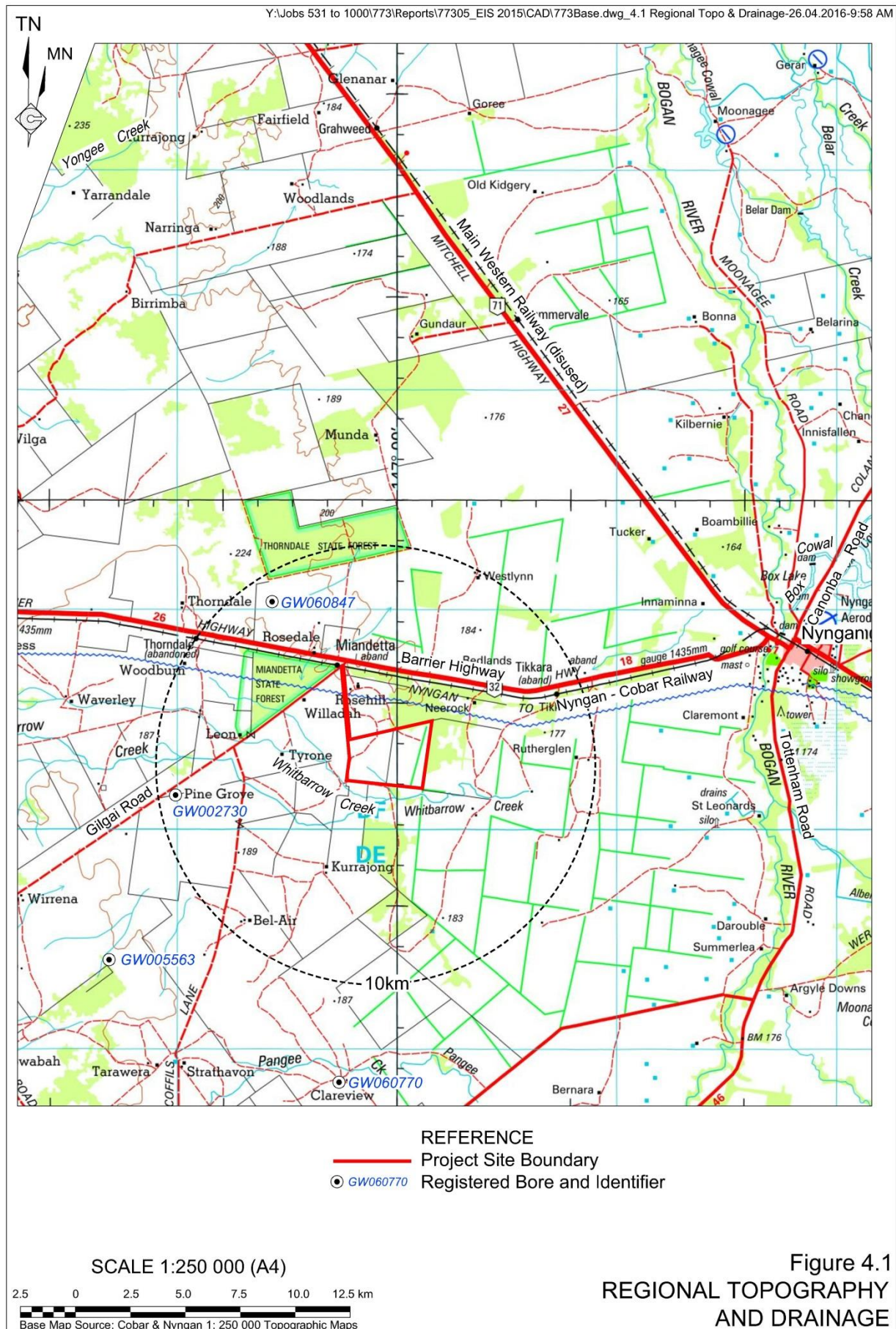
The Project Site is located in an area of relatively flat topography that slopes gently to the south (**Figure 4.2**). Elevation within the Project Site ranges from approximately 200m AHD at the site entrance to approximately 182m AHD on the southern boundary of the Project Site adjacent to Whitbarrow Creek. A small rise is located on the northeastern boundary of the Project Site, with elevations up to 190m AHD. Slopes within the Project Site are typically flat to up to 1:70 (V:H).

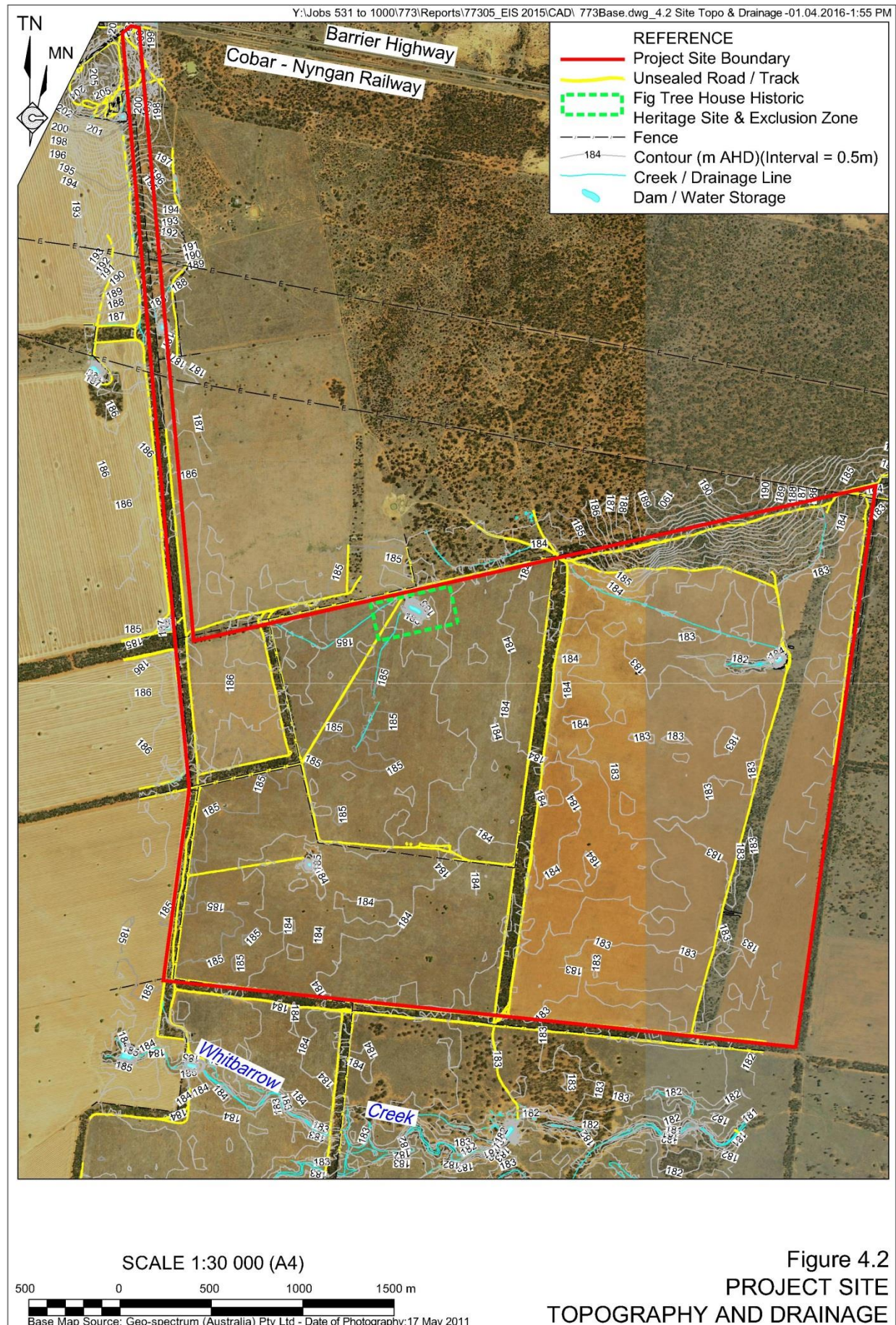
The Project Site drains to Whitbarrow Creek, which flows approximately 500m south of the Project Site boundary. Whitbarrow Creek flows to the east towards the Bogan River. An analysis of the catchment and anticipated flood regime of the Whitbarrow Creek is presented in Section 4.4.

4.1.3 Climate

4.1.3.1 Introduction and Data Sources

Meteorological conditions have the potential to influence a range of Proposal-related impacts on surrounding residences and the environment. This sub-section provides a brief overview of the meteorological conditions surrounding the Project Site; focusing particularly on those aspects of the climate that are likely to influence the potential Project-related environmental impacts.





4.1.3.2 Meteorological Data

Nyngan Airport Bureau of Meteorology-operated station (Station Number 051039) was selected in order to best represent to conditions within the Project Site. The following climate data from that station is presented in **Table 4.1**.

- Temperature – from 1959 to present.
- Rainfall – from 1879 to present.

Table 4.1
Climate Data

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Temperature (C°)													
Mean maximum temperature	34.3	33.3	30.5	25.6	20.7	17	16.4	18.5	22.6	26.6	30.1	33.0	
Mean minimum temperature	19.5	19.2	16.4	11.9	7.8	5.0	3.7	4.8	7.8	11.4	15.0	17.8	
Rainfall (mm)													
Mean rainfall	50.9	47.3	42.0	34.7	36.0	33.3	29.3	29.6	27.7	34.5	36.1	43.4	446.5
Highest rainfall	275.6	297.0	233.1	373.4	234.0	128.8	121.0	145.2	111.9	150.8	202.6	197.2	1127.0
Lowest rainfall	0	0	0	0	0	0	0	0	0	0	0	0	169.3
Highest daily rainfall	145.0	146.1	89.6	193.2	85.0	63.2	55.1	59.4	54.0	63.0	80.0	102.0	193.2
Source: Bureau of Meteorology – Nyngan Airport (Station Number: 051039)													

4.1.3.3 Temperature

January is typically the hottest month, with an average maximum temperature of 34.3°C. July is the coldest month with a mean maximum temperature of 16.4°C and a mean minimum temperature of 3.7°C.

4.1.3.4 Rainfall

Rainfall data has been recorded the Bureau of Meteorology Nyngan Airport Station since 1879. Mean annual rainfall is 446.5mm, with rainfall distributed throughout the year, with between 50.9mm and 27.7mm falling on average each month (**Table 4.1**). The driest year on record was 1965 when 169.3mm of rain was recorded. By contrast, the wettest year on record was 1950 when 1 127.0mm of rain was recorded.

The maximum daily rainfall recorded is 193.2mm which was recorded on 1 April 1989. Maximum daily rainfall exceeds monthly average rainfall for all months, indicating that intense storms with significant rainfall occur, particularly in summer and autumn.

4.1.3.5 Wind

A meteorological dataset for the Project Site was generated for 2014 by Ramboll Environ Australia Pty Ltd using the CSIRO prognostic meteorological model The Air Pollution Model (TAPM).

The predicted hourly varying wind speed and direction within the 2014 TAPM-generated meteorological dataset for the Project Site is presented as seasonal wind roses in **Figure 4.3**.

Some variation in the recorded wind field between seasons is experienced within the TAPM-generated Project Site dataset. The flow is generally aligned around the northeast-southwest axis, as with the annual wind roses, however a dominance of flow from the southwest occurs during the colder months while northeast flow becomes more frequent in the warmer months.

4.1.4 Regional and Project Site Geology

The surface geology surrounding the Project Site is dominated by Cainozoic alluvial plains with minor colluvium and outcrop (**Figure 4.4**).

The Project Site is located within the western-most structural zone of the Lachlan Fold Belt, namely, the Girilambone Structural Zone, which includes, Cambrian-Ordovician metasediments and minor basic volcanics of the Girilambone Group, intruded by numerous mafic and ultramafic bodies of similar Cambrian-Ordovician age, and by middle Silurian granite and volcanics.

The basement geology within and surrounding the Project Site is dominated the Gilgai and Honeybugle intrusive complexes. These intrusive complexes are Alaskan-type complexes made up of rocks ranging from hornblende monzonite, hornblendite, pyroxenite and olivine pyroxenite to dunite-peridotites. The rocks have been classified within the ‘Fifield Platinum Province’.

Scandium levels appear to be highest in the pyroxenite and olivine pyroxenite phases of the complexes. As a result, these rock types are the main bedrock sources for the scandium mineralization within the laterites. The highest scandium grades occur in the limonitic laterite units, overlaying or close to the pyroxenite source rocks.

The geological setting of the scandium deposit is presented in Section 2.3.2 and the published resource for the Proposal is presented in Section 1.4.2.

4.1.5 Land Ownership, Residences and Land Use

4.1.5.1 Land Ownership and Residences

Figure 4.5 presents the land ownership and residences within and surrounding the Project Site. This data was sourced from a search of the register of land titles administered by the Office of Land and Property Information.

Land within the Project Site is registered to two parties as follows.

- Owen Bernard Carter.
- EMC Metals Australia Pty Limited.

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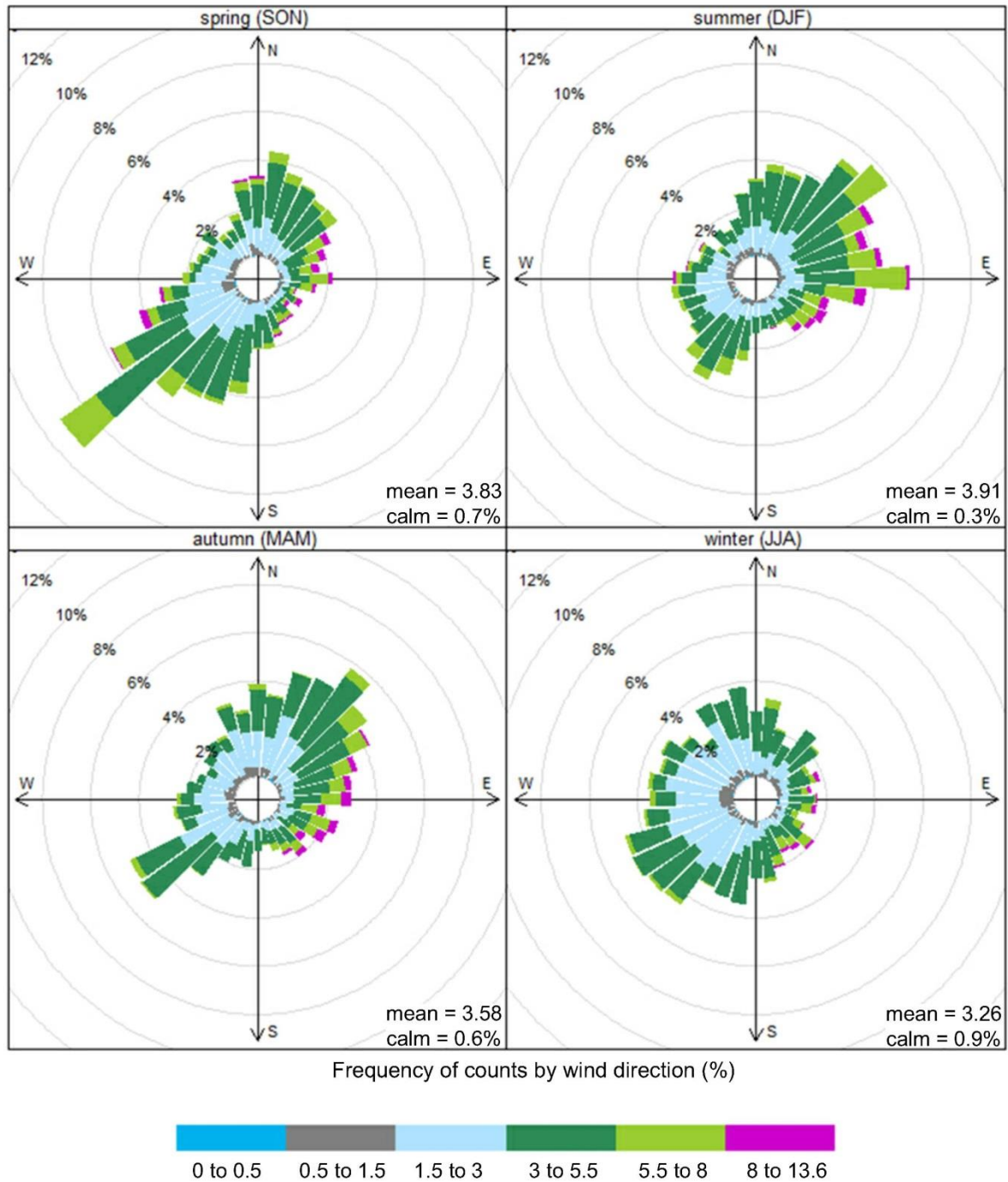
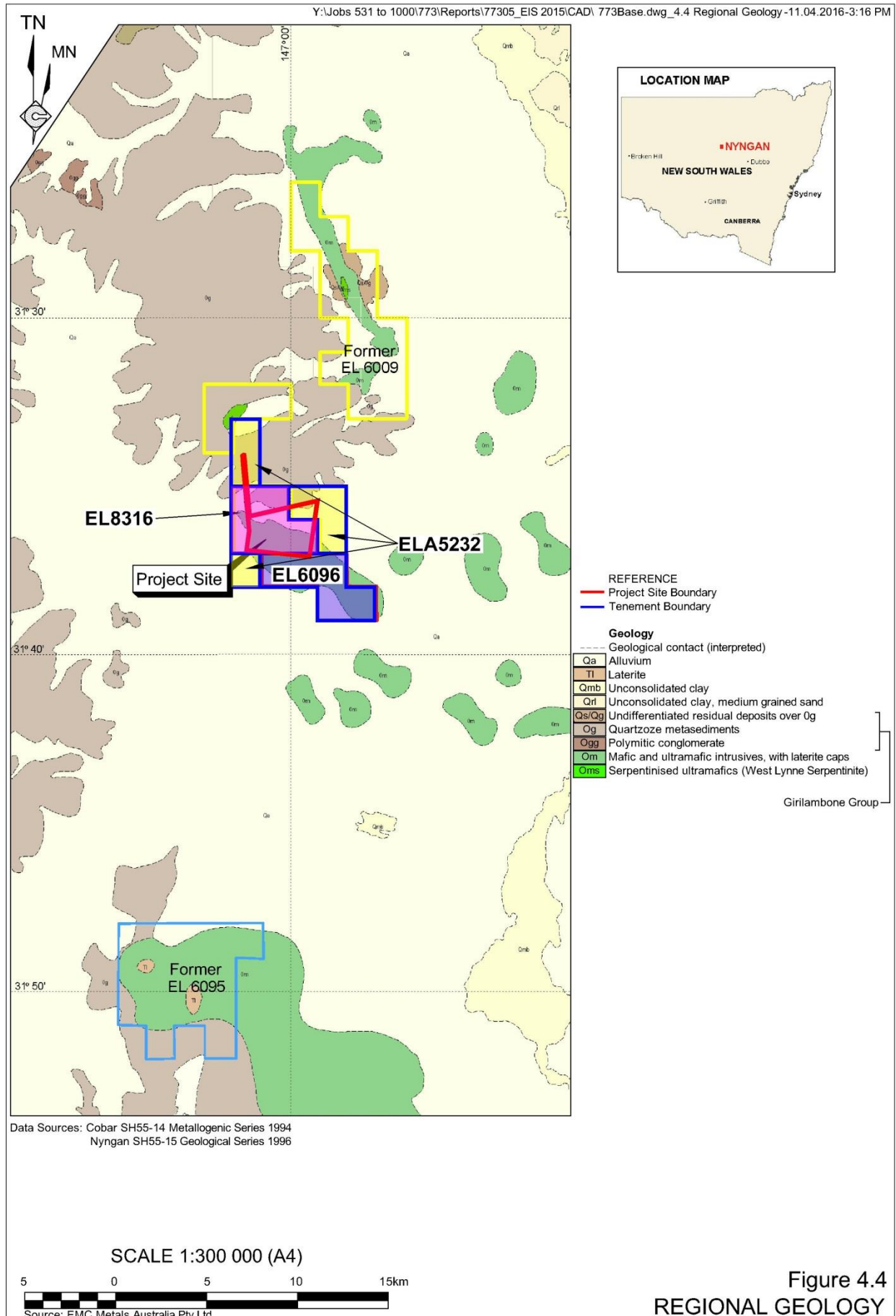
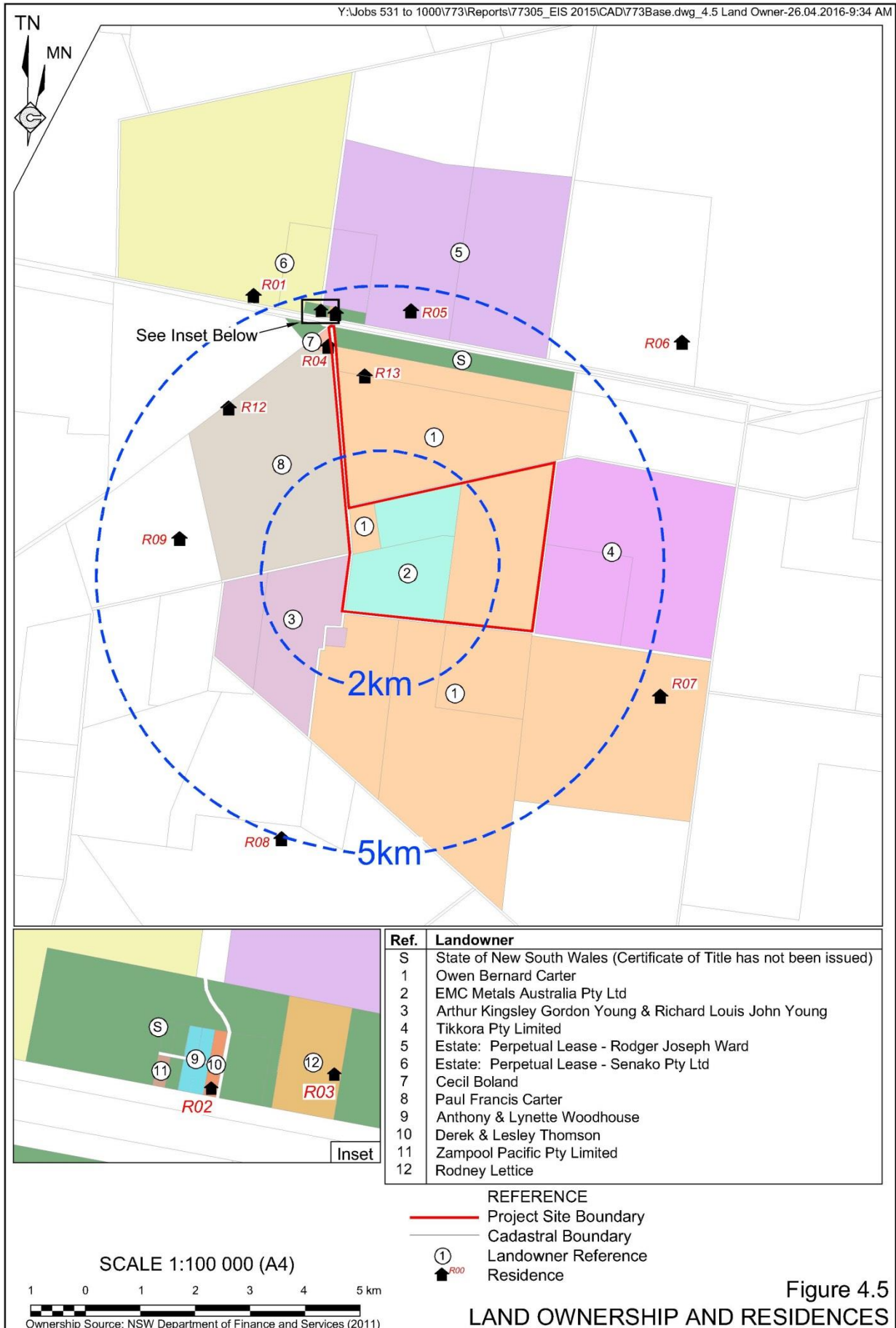


Figure 4.3
TAPM - GENERATED SEASONAL
PROJECT SITE WIND ROSES

Source: Ramboll Environ Australia Pty Ltd (2016)





Additional land to the north and south of the Project Site is also registered to Owen Bernard Carter. Land to the east of the Project Site is registered to Tikkora Pty Limited while land to the west of the Project Site is registered to Arthur Kingsley Gordon Young and Richard Louis John Young and Paul Francis Carter.

The Applicant is currently in the process of acquiring the land within the Project Site. It is anticipated that when operations commence the entirety of the land within the Project Site will be registered to EMC Metals Australia Pty Ltd.

Figure 4.5 also presents residences surrounding the Project Site. In summary, 11 residences are located within approximately 7km of the Processing Plant with the closest residence being 3.5km from the Processing Plant Area.

4.1.5.2 Land Use

Land uses surrounding the Project Site include the following (**Figure 4.6**).

- Agriculture – principally grazing and cropping, with areas of rural residential/homestead land use also present.
- Nature conservation with limited grazing.
- Transport – namely the Barrier Highway, Gilgai Road and the Nyngan-Cobar Railway.

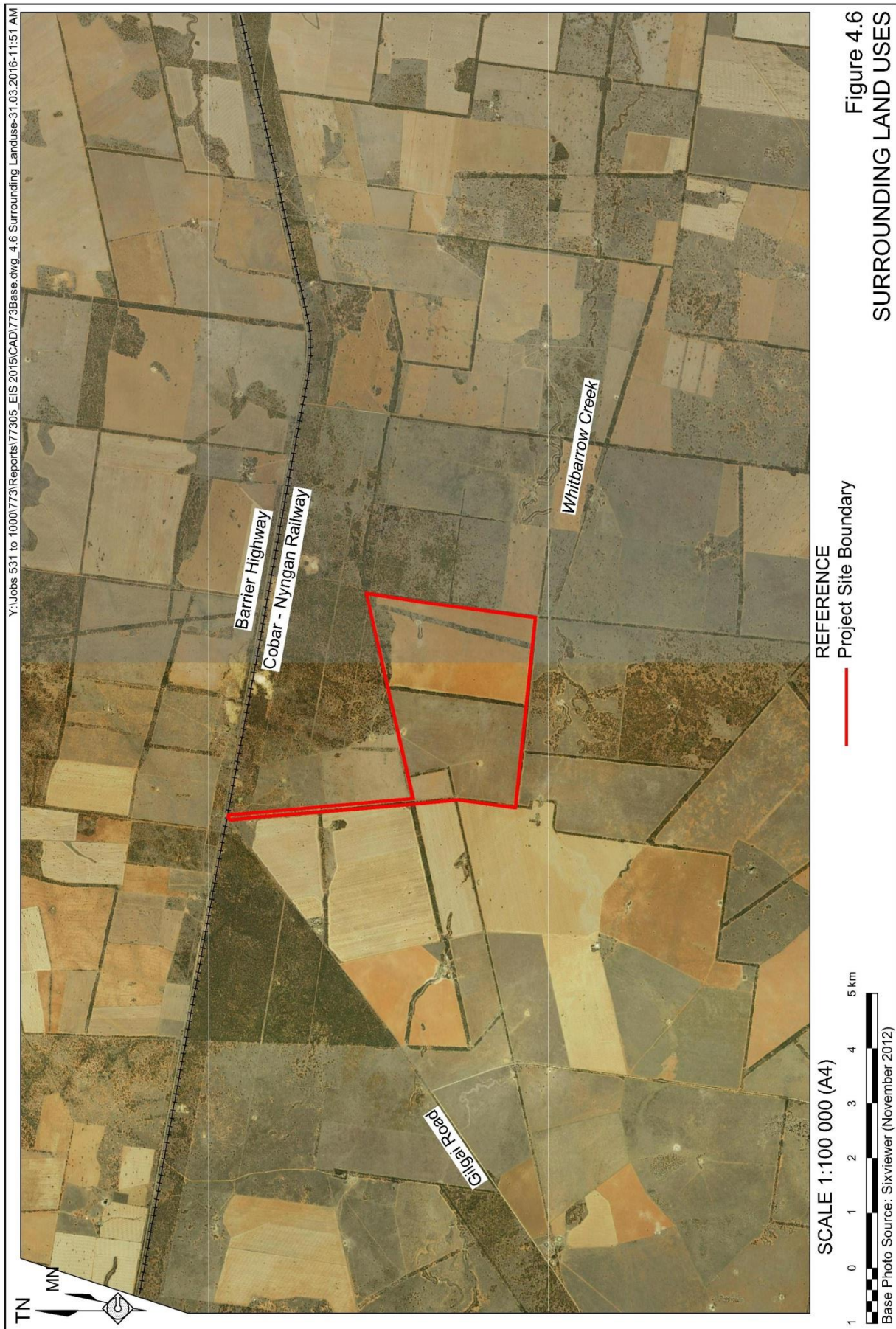
4.2 AIR QUALITY

4.2.1 Introduction

An air quality and greenhouse gas assessment for the Proposal was undertaken by Ramboll Environ Australia Pty Ltd (Ramboll Environ). The resulting report is presented as Part 2 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as Ramboll Environ (2016). This subsection of the EIS provides a summary of air quality and greenhouse gas assessment, and the management and mitigation measures that would be implemented to minimise associated impacts.

Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to air quality and their risk rankings after the adoption of standard mitigation measures are as follows.

- Emissions of PM₁₀/PM_{2.5}/TSP/Deposited dust from construction activities (moderate).
- Emissions of PM₁₀/PM_{2.5}/TSP/Dust from mining operations (moderate).
- Emissions of PM₁₀/PM_{2.5}/TSP/Deposited dust transportation operations (moderate).
- Deposited dust impacting agricultural productivity (low).
- Point source emission of gaseous substances (high).
- Fugitive emission of gaseous substances (high).
- Emission of odorous substance (moderate).



In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "air quality" as one of the key issues requiring assessment. The principal assessment requirement included the following.

"An assessment of the likely air quality impacts of the development in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW and the EPA's additional requirements, and having regard to the NSW Government's Voluntary Land Acquisition and Mitigation Policy: For State Significant Mining, Petroleum and Extractive Industry Developments; and an assessment of the likely greenhouse gas impacts of the development, having regard to the EPA's requirements."

4.2.2 Existing Air Quality Environment

4.2.2.1 Particulate Emissions

Air quality surrounding the Project Site is typical of an outback/rural environment. Ramboll Environ (2016) considers that given the lack of industrial and extractive operations in the region surrounding the Project Site, the dominant sources of particulate matter emissions in the vicinity of the Project include the following.

- Wind-generated dust from exposed areas within the surrounding region.
- Agricultural activities at neighbouring properties, particularly ploughing, sowing and harvesting.
- Vehicle movements along unsealed and sealed rural roads.
- Seasonal emissions from household wood burning.
- Episodic emissions from vegetation fires.

With the exception of periodic motor vehicle movements, it is considered that existing concentrations of fuel-combustion related pollutants would be negligible given the general absence of such sources in the Nyngan region.

No monitoring of particulate emission levels is conducted within the vicinity of the Project Site. In order to estimate background levels of particulate emissions at the Project Site, the following background levels have been assumed.

- The NSW EPA incremental criterion of $2\text{g/m}^2/\text{month}$, expressed as an annual average, has been used as a background level for deposited dust levels.
- Based on 95th percentile of PM_{10} and $\text{PM}_{2.5}$ concentrations data recorded from NSW OEH air quality monitoring stations at Tamworth, Albury, Wagga Wagga, Bathurst and Merriwa the following PM_{10} background concentrations have been assumed.
 - 24-hour average PM_{10} – $30.9\mu\text{g/m}^3$.
 - Annual average PM_{10} – $19.5\mu\text{g/m}^3$.
 - Annual average $\text{PM}_{2.5}$ – $7.8\mu\text{g/m}^3$.

4.2.2.2 Greenhouse and Other Gases

Locally, greenhouse gases are produced directly by farm equipment, livestock, and local traffic. Indirect emissions are resultant from the purchase of electricity to power local homesteads. The effects of greenhouse gas emissions on global temperatures, now referred to as “climate change”, are well documented and an assessment of greenhouse gas emissions has been included in Ramboll Environ (2016). In accordance with global reporting protocols, emissions of greenhouse gases are reported as CO₂ equivalent (CO₂-e).

In addition, an assessment of a range of other gaseous pollutants has been undertaken. Given the agricultural setting of the Project Site, background levels of these pollutants have been assumed to be negligible.

4.2.3 Potential Sources of Air Contaminants

4.2.3.1 Particulate Emissions

Particulate emissions (dust) would be the principal air contaminant generated on the Project Site. Ramboll Environ (2016) identified that the main sources of particulate emissions that would be generated by the Project would include:

- removal, haulage, handling and stockpiling of overburden material;
- excavation, loading and unloading of ore material;
- processing plant operations and delivery of processing reagents;
- general movement of heavy vehicles on unsealed roads within the Project Site;
- wind-generated erosion of exposed surfaces; and
- diesel and LPG combustion.

4.2.3.2 Greenhouse Gas Emissions

Ramboll Environ (2016) identified that the primary source of greenhouse gas emissions from the Project would be generated by two main sources.

- Direct emissions from combustion of diesel fuel and LPG by equipment and the processing plant.
- Indirect emissions associated with:
 - the consumption of purchased electricity;
 - the extraction, production and transportation of diesel fuel and LPG;
 - electricity lost in delivery in the transmission and distribution network;
 - off-site transportation of reagents and products; and
 - employee travel.

Although carbon dioxide (CO₂) would be the principal gas produced, greenhouse gases emitted as a result of the Project would also include limited amounts of carbon monoxide (CO), methane (CH₄), oxides of nitrogen (NO_x), sulphur dioxide (SO₂) and non-methane volatile organic compounds (NMVOCs). All greenhouse gas levels, however, are expressed as CO₂-e units.

Ramboll Environ (2016) defined the following three scopes (emission categories) of the greenhouse gas emitting sources of the Proposal in accordance with the *National Greenhouse Accounts Factors workbook* (DoE, 2015).

- Scope 1 Emissions.
These are the direct emissions from sources within the boundary of the Project Site such as the combustion of diesel and LPG by onsite plant and equipment.
- Scope 2 Emissions.
These are the indirect emissions from the consumption of purchased electricity by another organisation.
- Scope 3 Emissions.
These emissions are defined as all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned, or controlled, by the organisation. In the case of the Project, this includes the indirect emissions which arise as a result of the extraction, production and transport of diesel fuel and LPG, electricity lost in transmission, off-site transport of scandium ore and emissions generated from employee travel.

4.2.3.3 Other Gaseous Emissions

The Applicant would install a range of scrubbers and other controls to manage the emission gaseous substances during processing operations. Potential emission sources are shown schematically in **Figure 2.5**. In consultation with the Applicant, Ramboll Environ (2016) identified that the following emission sources have the potential to adversely impact on air quality surrounding the Project Site. Other emission sources were determined to have a negligible potential to adversely impact on the environment and have not been assessed.

- High Pressure Acid Leach Flash Vent Scrubber – SO₂, H₂S.
- Final Neutralisation Scrubber – H₂S.

4.2.4 Air Quality Criteria and Goals

4.2.4.1 Particulate Emissions

In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4g/m²/month. **Table 4.2** presents the allowable increase in dust deposition relative to the ambient levels as summarised by Ramboll Environ (2016).

Table 4.2
DECC Goals for Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2g/m ² /month	4g/m ² /month
Source: Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, (DEC 2005)		

The air quality criteria issued by federal and NSW government for particulate emissions, as summarised by Ramboll Environ (2016) are presented in **Table 4.3**.

Table 4.3
Impact Assessment Criteria for Airborne Particulates

Pollutant	Averaging Period	Concentration (µg/m ³)	Reference
TSP	Annual	90	NSW Department of Environment and Conservation (DEC) (2005) Approved Methods for Modelling and NSW EPA impact assessment criterion based on the subsequently rescinded National Health and Medical Research Council (NHMRC) recommended goal.
PM ₁₀	24-hour	50	NSW DEC (2005) Approved Methods for Modelling.
	24-hour	50 ¹	National Environment Protection Council (NEPC) (2003) National Environment Protection (Ambient Air Quality) Measure, as amended.
	Annual	30	NSW DEC (2005) Approved Methods for Modelling.
PM _{2.5}	24-hour	25	Advisory reporting goal issued by the NPEC (2003).
	Annual	8	Advisory reporting goal issued by the NPEC (2003).
Note 1: Provision made for up to five exceedances of the limit per year			
Source: Ramboll Environ (2016) - after Table 2			

4.2.4.2 Gaseous Pollutants

The processing operations described in Section 2.5 are anticipated to generate emissions of NO₂, CO, SO₂, H₂S and VOCs. Air quality criteria issued by federal and NSW government applicable to these potential gaseous emissions, as summarised by Ramboll Environ (2016) are presented in **Table 4.4**.

4.2.4.3 Greenhouse Gas Emissions

There are no specific guidelines are provided for maximum emissions of greenhouse gases. It is noted, however, that Australia is a signatory to the Kyoto Protocol which requires developed countries to meet national targets for greenhouse gas emissions over the five year period from 2008 to 2012.

Table 4.4
Air Quality Criteria for Gaseous Pollutants

Pollutant	Averaging Period	Concentration		Reference
		µg/m ³	ppm	
CO	1-hour	30 000	25	NSW EPA ¹
	8-hour	10 000	9	NSW EPA ¹
NO ₂	1-hour	246	0.12	NSW EPA ¹
		-	0.12	NEPM ²
	Annual	62	0.03	NSW EPA ¹
		-	0.03	NEPM ²
SO ₂	10-minute	712	0.25	NSW EPA ¹
	1-hour	570	0.20	NSW EPA ¹
		-	0.20	NEPM ²
	24-hour	228	0.08	NSW EPA ¹
		-	0.08	NEPM ²
	Annual	60	0.02	NSW EPA ¹
		-	0.02	NEPM ²
H ₂ S	99 th Percentile 1-second nose response	3.45	-	NSW EPA ¹
Benzene	99.9 th Percentile 1-hour	29	0.009	NSW EPA ¹
Formaldehyde	99.9 th Percentile 1-hour	20	0.018	NSW EPA ¹
Toluene	99.9 th Percentile 1-hour	360	0.09	NSW EPA ¹
Note 1: Approved Methods for Modelling DEC, 2005				
Note 2: Provision made for one exceedance of the limit per year				
Source: Ramboll Environ (2016) – After Table 4				

4.2.5 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the emission of particulates throughout the life of the Proposal.

- Limit, where practicable, excavation during periods of high winds.
- Limit disturbance to the minimum area necessary for mining and associated activities.
- Operate the largest practical truck size to reduce the number of movements necessary to transport the ore and waste rock.
- Adhere to all vehicle speed limits.
- Profile all surfaces to reduce velocity of overland winds.

- Apply vegetative cover to non-operational exposed surfaces as soon as practical after disturbance.
- Maintain operational exposed areas in a moist condition by using a water cart to water down areas likely to generate wind-blown and traffic-generated dust.
- Apply water to all roads and trafficked areas using a water truck to minimise the generation of dust.
- Cover stockpiles with weatherproof material to minimise generation of dust.
- Clearly define all haul roads edges with marker posts or equivalent to control their locations, especially when crossing large areas of non-descript disturbance.
- Close, rip and revegetate all obsolete roads.
- Reshape, topsoil and rehabilitate all completed areas as soon as practicable after the completion of mining operations.

In addition to the above, the Applicant would also implement the following management and mitigation measures to minimise the gaseous emissions throughout the life of the Proposal.

- Ensure that all potential sources of gaseous emissions are identified and appropriate control measures installed to ensure compliance with the *Protection of the Environment Operations Act 1997* Group 6 plants.
- Ensure that all emission control equipment is installed, maintained and tested in accordance with the manufacturer's recommendations.

4.2.6 Assessment of Impacts

Table 4.5 presents the particulate and gaseous emissions that are predicted to result from the Proposal by Ramboll Environ (2016). In summary, particulate or gaseous emissions are not anticipated to exceed the relevant criteria at any surrounding residence.

Table 4.6 presents the cumulative particulate emissions of the Proposal. As the residence with the greatest predicted Proposal-specific impact, Residence 4 has been used for the maximum receptor emissions. In summary, the cumulative impacts of the Proposal are not anticipated to exceed the relevant criteria at any surrounding residence.

Ramboll Environ (2016) estimated the annual greenhouse gas emissions from the Proposal as presented in **Table 4.7**. The annual Scope 1 and Scope 3 emissions at full production represent approximately 0.0083% of total greenhouse gas emissions for NSW and 0.0021% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2013. As a result, it is assessed that the Proposal would not result in significant greenhouse gas impacts.

As a result, and given the proposed management and mitigation measures, it is assessed that the Proposal would not result in significant air quality impacts.

Table 4.5
Predicted Proposal-only Emissions

Pollutant	TSP	PM ₁₀		PM _{2.5}		Dust Deposition	NO ₂		SO ₂			CO		H ₂ S	Benzene	Formaldehyde	Toluene
Unit	µg/m ³	µg/m ³		µg/m ³		g/m ² /month	µg/m ³		µg/m ³			µg/m ³		µg/m ³	µg/m ³	µg/m ³	µg/m ³
Averaging Period	Annual	24hr	Annual	24hr	Annual	Annual	1hr	Annual	1hr	24hr	Annual	1hr	8hr	1-second	1hr	1hr	1hr
R1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	13.2	<0.1	5.4	0.7	0.6	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
R2	0.2	0.5	<0.1	<0.1	<0.1	<0.1	16.9	0.1	6.6	0.9	0.9	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
R3	0.4	0.9	0.1	0.1	<0.1	<0.1	33.3	0.3	13.2	1.9	1.0	<0.1	<0.1	<0.1	<0.1	0.3	<0.1
R4	0.8	0.9	0.2	0.1	<0.1	0.2	27.8	0.6	10.9	1.8	1.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1
R5	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	18.7	0.1	7.8	1.1	1.3	<0.1	<0.1	0.1	<0.1	0.2	<0.1
R6	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	7.2	<0.1	2.8	0.4	1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R7	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	15.6	<0.1	6.0	0.8	1.2	0.1	<0.1	0.1	<0.1	0.1	<0.1
R8	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	9.2	0.1	3.3	0.6	1.4	0.2	<0.1	0.1	<0.1	<0.1	<0.1
R9	0.1	0.6	<0.1	0.1	<0.1	<0.1	24.4	<0.1	9.7	1.2	1.4	<0.1	<0.1	0.1	<0.1	0.2	<0.1
R10	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	4.0	<0.1	1.6	0.2	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R11	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	6.1	<0.1	2.4	0.3	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R12	<0.1	0.4	<0.1	<0.1	<0.1	<0.1	12.4	<0.1	4.5	0.7	0.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R13	0.2	0.4	<0.1	<0.1	<0.1	<0.1	12.2	0.2	4.5	0.9	1.5	0.2	<0.1	0.1	<0.1	<0.1	<0.1
Criteria	90	50	30	25	8	2	246	62	30 000	10 000	570	228	60	4	29	20	360



Table 4.6
Predicted Cumulative Particulate Emissions

Pollutant	Maximum Receptor Emissions	Ambient Background Level	Combined Background Level and Receptor Emissions	Assessment Criteria
Annual TSP	0.78	48.8	49.58	90
24-hour PM ₁₀	0.95	46.4	47.35	50
Annual PM ₁₀	0.24	19.5	19.74	30
24-hour PM _{2.5}	0.14	23.4	23.54	25
Annual PM _{2.5}	0.03	7.8	7.89	8

Table 4.7
Estimated annual greenhouse gas emissions

Annual Greenhouse Gas Emissions (tonnes CO ₂ -e / annum)						
Scope 1		Scope 2	Scope 3			Total
On-site Diesel	On-site LPG	Electricity	On-site Diesel	On-site LPG	Electricity	
585	11 182	5 870	30	578	887	19 132

Note: Greenhouse gas emissions are reported in tonnes of carbon dioxide equivalents (t CO₂-e)

4.2.7 Monitoring

The following air quality monitoring would be implemented throughout the life of the Proposal.

- Deposited dust – deposited dust gauges would be established on the northeastern and southwestern boundaries of the Project Site.
- Gaseous emissions monitoring, including:
 - periodic testing during use to ensure the effectiveness of the emissions controls, including scrubbers; and
 - monitoring and logging of in-stack particulate and gaseous pollutant concentrations of emission release points.

4.3 ECOLOGY

4.3.1 Introduction

An ecology assessment for the Proposal was undertaken by EnviroKey Pty Ltd (EnviroKey). The resulting report is presented as Part 3 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as EnviroKey (2016). This subsection of the EIS provides a summary of the ecology assessment and the management and mitigation measures that would be implemented to minimise ecological impacts.

It is noted that that EnviroKey (2016) undertook studies within an area larger than the Project Site. For the purposes of this document, that area is defined as the “Ecology Study Area”.

Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to ecology and their risk rankings after the adoption of standard mitigation measures are as follows.

- Loss of terrestrial ecology habitat, local vegetation and biodiversity (High).
- Injuries to native wildlife and fauna during clearing / earthworks (pre-strip) (Low).
- Adverse impacts on groundwater dependent ecosystems (Low).
- Adverse impacts on surface water dependent ecosystems (Low).
- Indirect impacts to fauna communities due to light / noise / pollution, etc. (Low).

In addition, the Secretary’s Environmental Assessment Requirements issued by DP&E identified “biodiversity” as one of the key issues requiring assessment. The principal assessment requirement included:

- “an assessment of the likely biodiversity impacts of the development, having regard to the principles and strategies in the NSW Biodiversity Offsets Policy for Major Projects and the requirements of OEH;
- measures taken to avoid, reduce or mitigate impacts on biodiversity;
- accurate estimates of proposed vegetation clearing; and
- a comprehensive offset strategy to ensure the development maintains and improves the biodiversity values of the region in the medium to long term.”

4.3.2 Regional and Local Setting

4.3.2.1 Regional Setting

The Project Site is located in the Cobar Peneplain Bioregion of the *Interim Bioregionalisation of Australia* (Thackway and Creswell 1995) and within the Canbelego Downs subregion (NPWS 2003). The undulating landscape is generally characterised by mainly open woodlands of Bimble Box, Red Box and White Cypress Pine, Mulga in the more arid areas and Mallee on rocky ridges and sandplains.

The Cobar Peneplain Bioregion has experienced significant vegetation losses since European Settlement, with 33% of the woody native vegetation cleared. The Bioregion does however, support dense shrubby woodlands with the widespread vegetation communities consisting of Poplar Box (*Eucalyptus populnea*), White Cypress Pine (*Callitrus glaucophylla*) and Gum Coolabah (*Eucalyptus intertexta*) communities, as well as extensive mulga areas where skeletal soils are present. Mallee woodland communities also form part of the regional vegetation and are considered to be of high conservation significance within the Bioregion. More than 90% of the original extent of mallee communities within the Cobar Peneplain Bioregion have been cleared or significantly altered.

The Bioregion's diverse landscape and vegetation also supports a wide variety of fauna species with 36 vulnerable and 7 endangered fauna species occurring in the Cobar Peneplain Bioregion, with an additional 64 birds, 12 mammals, 23 reptiles and 8 frogs considered as being of conservation concern.

4.3.2.2 Local Setting

With the exception of the Bogan River, located approximately 15km to the east of the Project Site, all water courses surrounding the Project Site are ephemeral and are likely to flow only after substantial rain.

The native vegetation of the surrounding area is dominated by Poplar Box Woodland, with varying intergrades of Gum Coolabah, Cypress Pine and occasional Mulga. The status of vegetation surrounding the Project Site is considered similar to the current status of regional vegetation in that varying degrees of clearing for broad-scale agricultural activities such as cropping and grazing has previously occurred. The local vegetation has also endured modification through feral animals such as goats, rabbits and pigs.

4.3.3 Predicted Species, Communities and Populations

EnviroKey (2016) conducted a search of on 4 April 2016 within a 50km radius of the Project Site for threatened flora and fauna species listed under the schedules of the *Threatened Species Conservation Act 1995* (TSC Act), within the Canbelego Downs subregion, on the Office of Environment and Heritage's (OEH) 'Threatened Species online database' and the OEH 'BioNET' database.

EnviroKey (2016) also undertook a search on the Commonwealth Department of the Environment Protected Matters Database on 4 April 2016, using a 50km radius surrounding the Project Site for species or communities listed within the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The results of the database searches are presented in **Table 4.8**.

Based on an analysis of habitat within the Project Site and online database searches (see **Table 4.8**), as well as the results of field assessments described in Section 4.3.5, EnviroKey (2016) determined that, the threatened species listed in **Table 4.9** have the potential to occur within the Project Site. It should be noted that no endangered ecological communities were identified as having the potential to be impacted as a result of the Proposal.

Table 4.8
Listed Species with Potential to Occur

TSC Act Fauna Species	
Birds	Birds (Cont'd)
Australian Bustard	Pied Honeyeater
Barking Owl	Pink Cockatoo
Brolga	Rainbow Bee-Eater
Brown Treecreeper (eastern subspecies)	Red-tailed Black Cockatoo (inland subspecies)
Cattle Egret	Spotted Harrier
Diamond Firetail	Superb Parrot
Fork-Tailed Swift	Turquoise Parrot
Gilbert's Whistler	Varied Sittella
Glossy Black Cockatoo	White-bellies Sea-Eagle
Glossy Ibis	White-fronted Chat
Grey Falcon	White-throated Needletail
Grey-crowned Babbler (eastern subspecies)	Mammals
Hooded Robin	Corben's Long-eared Bat
Little Eagle	Kultarr
Malleefowl	Little Pied Bat
Masked Owl	White-footed Tree-rat
Painted Honeyeater	Yellow-bellied Sheath-tail bat
TSC Act Flora Species	
Pine Donkey Orchid (<i>Diuris tricolor</i>)	Cobar Greenhood Orchid (<i>Pterostylis cobarensis</i>)
EPBC Act Fauna Species	
Australian Painted Snipe	Latham's Snipe
Cattle Egret	Malleefowl
Fork-tailed Swift	Painted Snipe
Great Egret	Rainbow Bee-eater
Superb Parrot	White-bellied Sea-Eagle
South-eastern Long-eared Bat	Silver Perch
Australian Bittern	Murray Cod
Koala	Regent Honeyeater
EPBC Act Flora Species	
A speargrass (<i>Austrostipa metatoris</i>)	Spike rush (<i>Elocharis obicis</i>)
EPBC Act Threatened Ecological Communities	
Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Grey Box (<i>Eucalyptus macrocarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia
South-Eastern Australia Weeping Myall Woodlands	
Source: Envirokey (2016) – Modified from Maps 2 to 4	

Table 4.9
Threatened Species with Potential to Occur within the Project Site

Species	TSC Act	EPBC Act	Species	TSC Act	EPBC Act
Australian Bustard ¹	X		Rainbow Bee-eater		X
Grey-crowned Babbler	X		Spotted Harrier	X	
Grey Falcon	X		Superb Parrot	X	X
Hooded Robin	X		Varied Sittella	X	
Little Eagle	X		White-throated Needletail	X	
Masked Owl	X		Kultarr	X	
Painted Honeyeater	X		South-eastern Long-eared Bat		X
Inland Forest Bat	X		Little Pied Bat	X	
Pied Honeyeater	X		Yellow-bellied Sheath-tail Bat	X	
Pink Cockatoo	X		Fork-tailed Swift ¹	X	X
Note 1: Whilst the species was not identified in Table 4.8 or within the Project Site, EnviroKey's experience within the region has determined that the species may potentially occur within the Project Site					
Source: EnviroKey (2016) – Modified after Table 10					

4.3.4 Field Survey Methodology

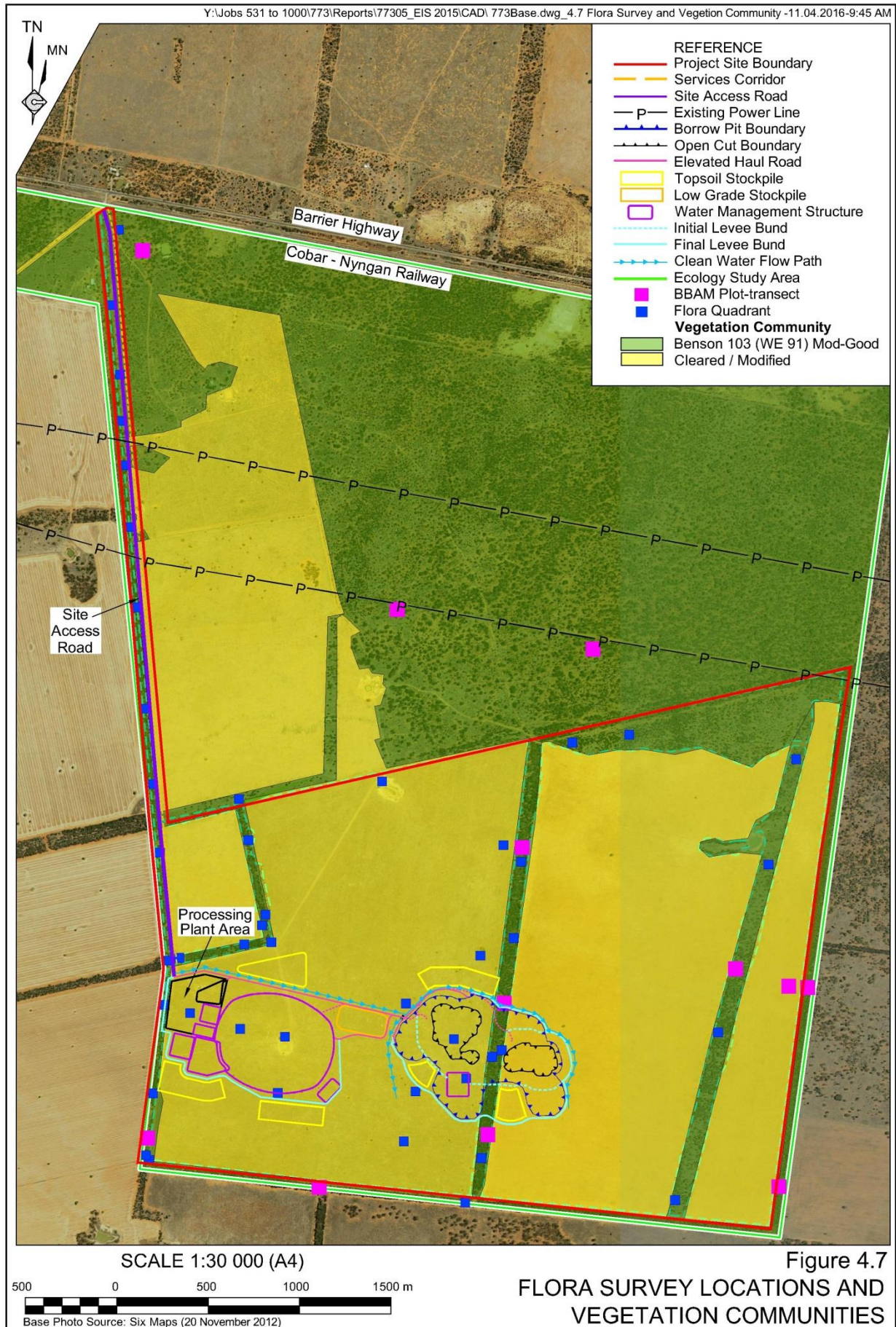
4.3.4.1 Flora Survey Methodology

Field surveys were completed by Envirokey between 30 and 31 July 2011 and between 6 and 9 December 2015. The methodology of the flora assessment is presented in detail in EnviroKey (2016). In summary, survey techniques included the following.

- Detection of any threatened biota as listed under the TSC Act and the EPBC Act.
- The use of air photo interpretation and quadrat sampling to survey for threatened species.
- Use of the 'random meander' method in order to collect species richness and diversity data and classify vegetation communities.
- Sampling methods, including the use of plots and transects, consistent with the Biobanking Assessment Methodology (BBAM), as presented in **Figure 4.7**.

4.3.4.2 Fauna Survey Methodology

Fauna field surveys were completed by EnviroKey between 4 December 2014 and between 6 and 9 December 2015. A further Grey-crowned Babbler-specific survey was conducted between 9 and 11 March 2015. A number of standard techniques were employed during the fauna surveys. These are described in detail in EnviroKey (2016) and are summarised briefly in **Table 4.10**. **Figure 4.8** presents the fauna survey locations.



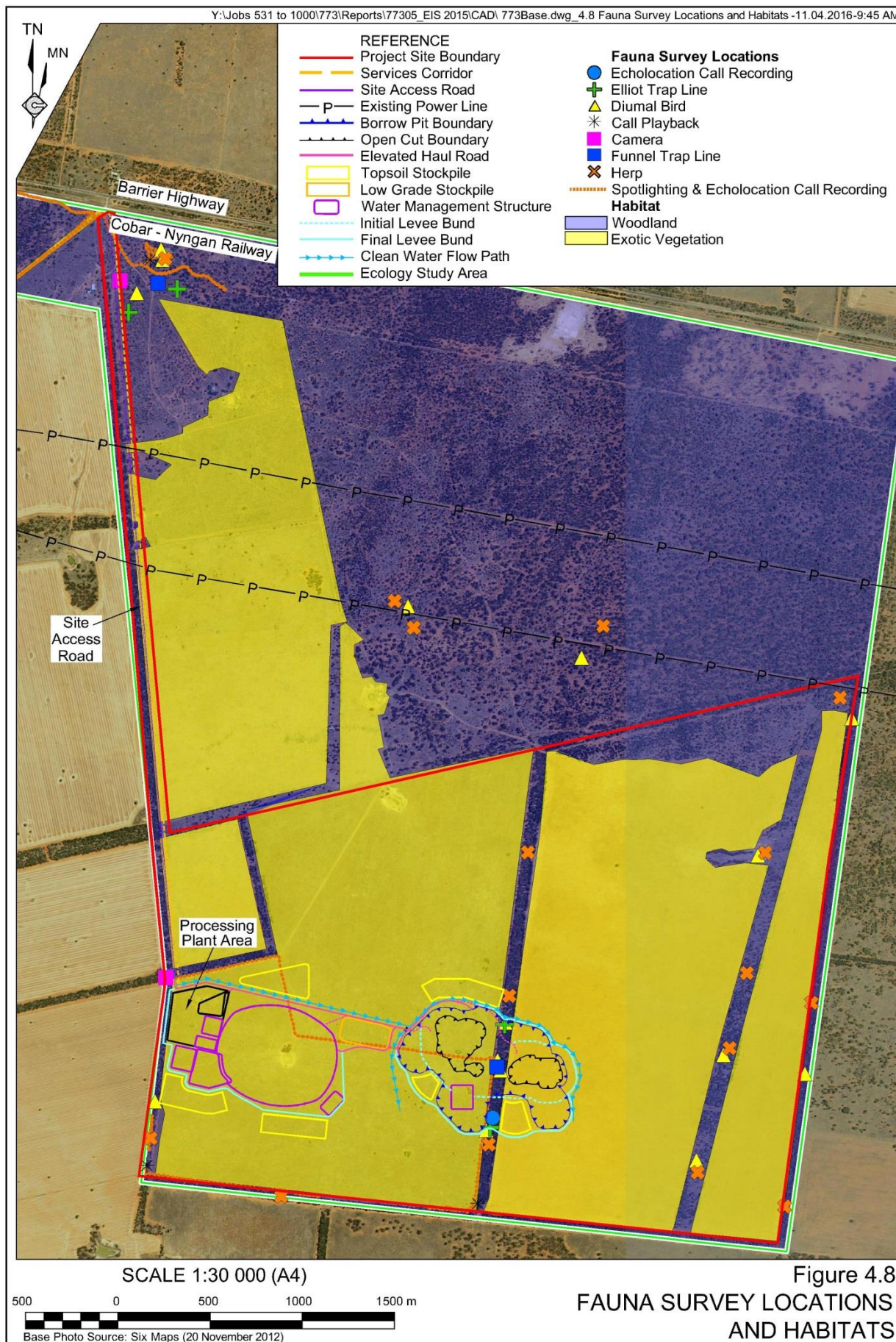


Figure 4.8

FAUNA SURVEY LOCATIONS
AND HABITATS

Table 4.10
Fauna Survey Methodology

Survey Type	Total Survey Effort
Diurnal Birds	15 locations for 20 minutes each. Total survey effort of 300 minutes.
Trap Lines	Two locations over 24 trap nights / 32 trap days.
Echolocation Call Recording	Two locations over four nights. Mobile monitoring over three transects with a total survey effort of 3 recording hours.
Elliot trapping	Four sites (25 traps each) over three nights giving a total of 300 trap nights.
Motion Activated Infrared Cameras	Three sites over 5 nights / 6 days resulting in 15 camera nights/18 camera days.
Call Playback	Three sites for one hour on each occasion. Total effort 3 person hours over three nights.
Spotlighting	Three sites were surveyed each night for 3 nights (9 surveys). Each survey was completed in one-person hour. Total survey effort was 9 person hours over three nights.
Herpetofauna Search	29 sites in total for 30 minutes each. Total survey effort 870 person minutes.
Track and Scat Search	Searches at the 15 bird survey sites for 10 minutes each. Total survey effort 150 minutes.
Habitat Assessment	Generally while traversing the Study Area.

Source: EnviroKey (2016) – After Section 6.1

4.3.5 Project Site Flora and Fauna

4.3.5.1 Introduction

EnviroKey (2016) presents a detailed list of all species, vegetation communities and habitats recorded within the Project Site. This subsection presents an overview of that information.

4.3.5.2 Vegetation Communities Identified

EnviroKey (2016), in accordance with the *BioMetric* classification system and consistent with Benson (2006), identified one native vegetation community within the Project Site, namely Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion (**Figure 4.7**). EnviroKey (2016) note that some variation in vegetation composition is evident and is associated with subtle differences in topography. However, this community generally aligned to Benson 103 more than any other vegetation community or sub-community. This Community is not classified as an Endangered Ecological Community under the TSC Act.

4.3.5.3 Flora Species Identified

Envirokey (2016) identified a total of 79 flora species within the Project Site, comprising 63 native species and 17 exotic species. A full list of identified flora species is provided in Appendix 4 of Envirokey (2016). No threatened flora species were recorded during field surveys.

Two noxious weed species, the Bathurst Burr (*Xanthium spinosum*) and the Galvanised Burr (*Sclerolaena birchii*), were present within the Project Site.

4.3.5.4 Fauna Species Identified

A total of 95 fauna were recorded by EnviroKey (2016) comprising:

- 18 reptile species (none threatened);
- 4 frog species (none threatened);
- 16 mammal species (including 8 species of microchiropteran bat, 3 being listed as vulnerable under the TSC Act); and
- 57 bird species (2 species listed as vulnerable under the TSC Act).

A consolidated list of identified fauna species is provided in Appendix 4 of EnviroKey (2016), however, **Table 4.11** and **Figure 4.9** present all fauna species listed under the TSC Act or EPBC Act recorded within the Project Site.

Table 4.11
Recorded Threatened Fauna Species

Scientific Name	Common Name	Status
<i>Melanodryas cucullata</i>	Hooded Robin	Vulnerable (TSC Act)
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler	Vulnerable (TSC Act)
<i>Vespadelus balstoni</i>	Inland Forest Bat	Vulnerable (TSC Act)
<i>Chalinolobus picatus</i>	Little Pied Bat	Vulnerable (TSC Act)
<i>Nyctophilus corbeni</i> ¹	Eastern Long-eared Bat	Vulnerable (TSC Act) Vulnerable (EPBC Act)
Note 1: Identification under the precautionary principle		
Source: Envirokey (2016)		

The following presents a brief discussion of the richness of the species observed within the Project Site.

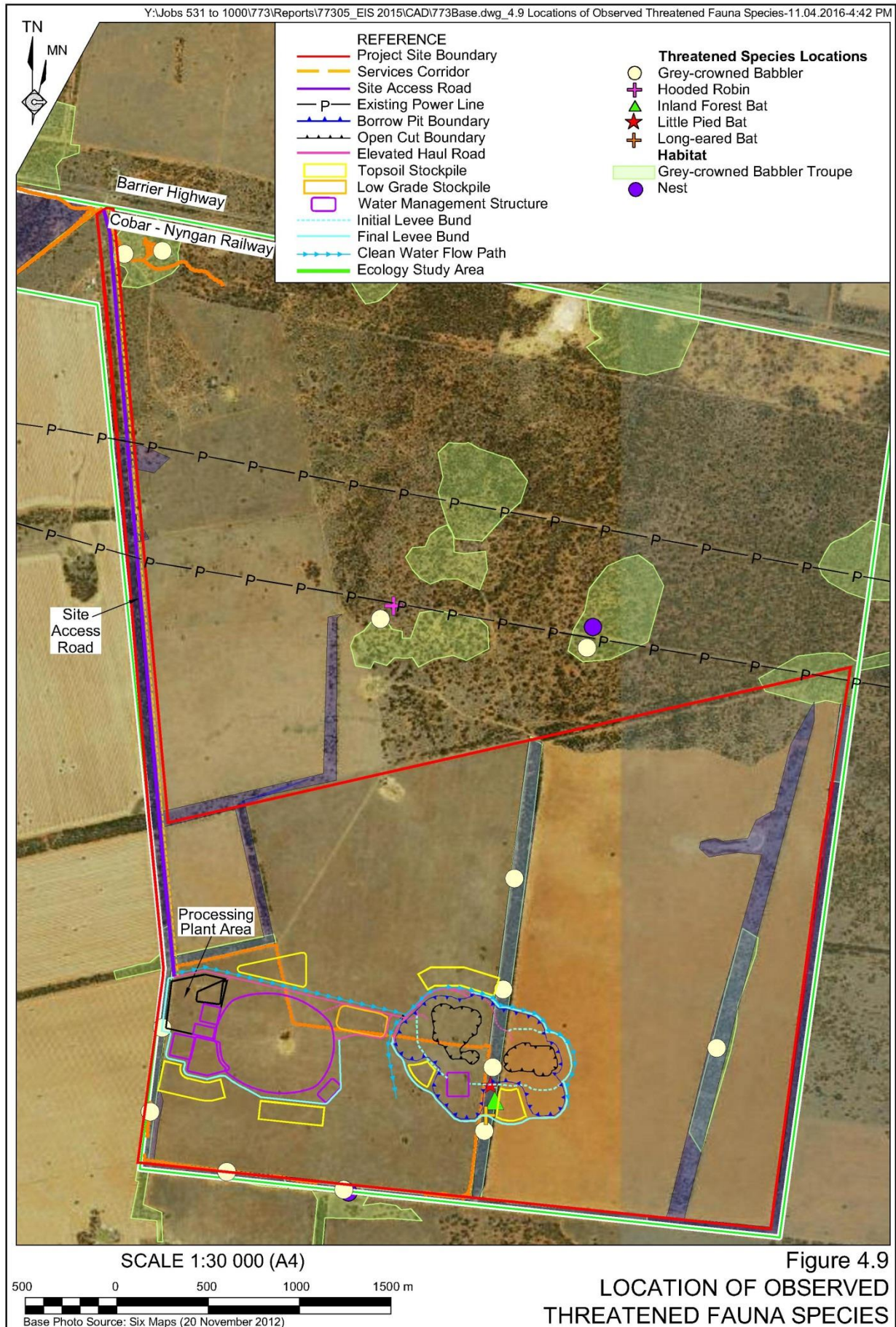
Avifauna

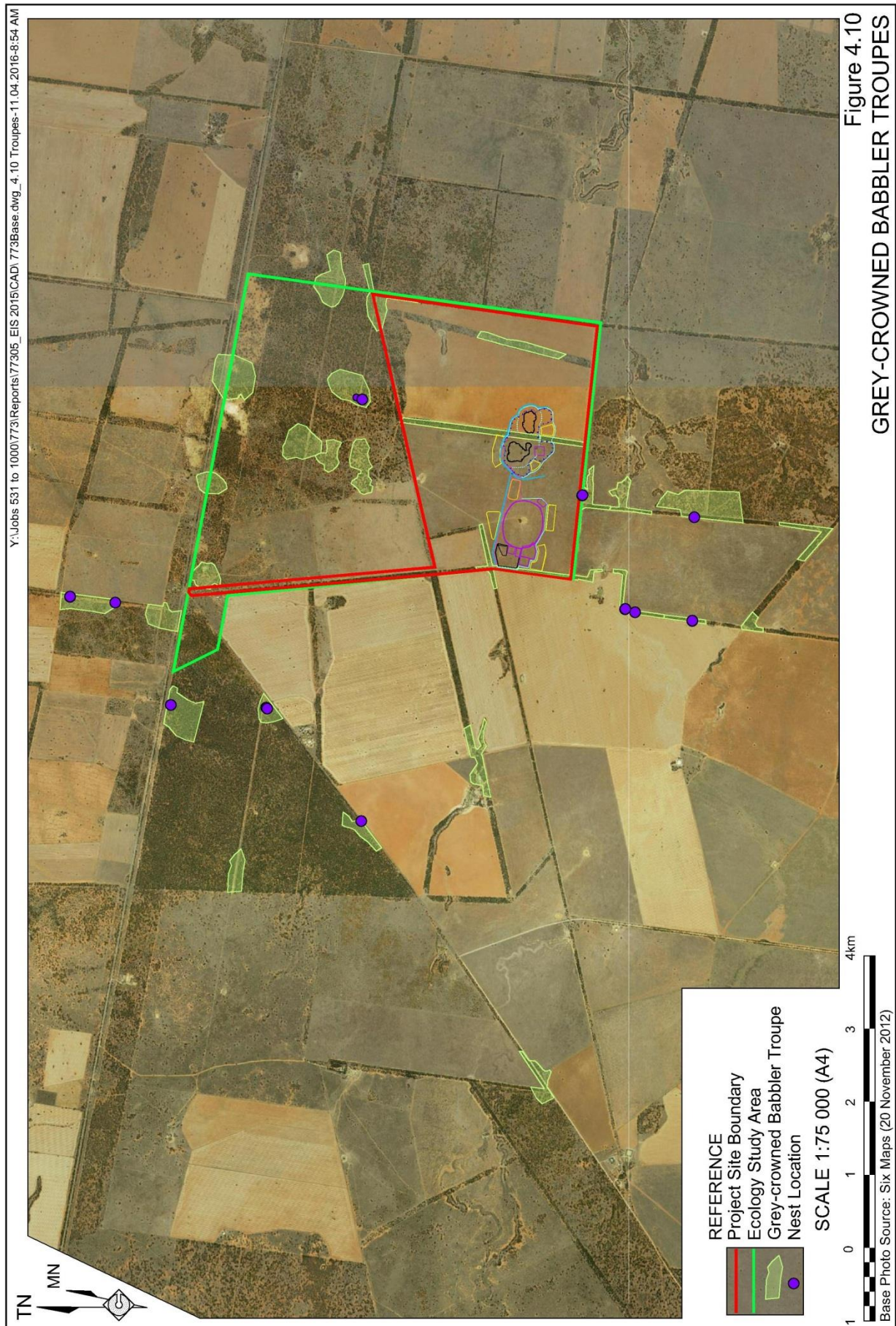
A total of 57 species of bird were recorded including two species listed under the TSC Act, namely the Hooded Robin and the Grey-crowned Babbler. The assemblage of birds recorded during this study is considered typical of semi-arid woodlands in western NSW.

The abundance of Grey-crowned Babbler sightings, however, was considered significant and EnviroKey (2016) undertook an additional field survey between 9 and 11 March 2015. That survey mapped the range of Grey-crowned Babbler troupes both within the Ecology Study Area and surrounding it. The results of that survey are presented on **Figures 4.9** and **4.10**. In summary, 29 troupes were identified within and surrounding the Ecology Study Area.

Mammals (excluding microchiropteran bats)

Eight species of mammal were recorded within the Study Area. Of these, five were introduced species. No threatened mammal species were recorded. Past land clearing for agriculture and the presence of introduced species (predators and competitors) provides an explanation as to the notable absence of many mammal species.





Microchiropteran Bats

Eight species of microchiropteran bat were recorded within the Project Site using Anabat recordings, two of which are listed under the TSC Act. A third threatened species was also potentially identified within the Project Site, as recordings could not be distinguished from the wider genus. This species was subsequently classified as occurring under the precautionary principle.

Reptiles

Reptile species richness is considered high, with 18 species recorded within the Project Site. No threatened reptile species were recorded and none are known or expected to occur in the local setting due to the absence of suitable habitat.

Frogs

Frog diversity is considered poor with four species detected during the field survey. A number of other frog species are also likely to occur within the Project Site, but the absence of heavy rain immediately prior or during the field survey was likely the reason for their non-detection. No threatened frog species were recorded as occurring within the Project Site.

4.3.6 Potential Direct and Indirect Biodiversity Impacts

4.3.6.1 Loss of Vegetation and Habitat

As no threatened ecological communities as listed by the TSC Act or EPBC Act occur within the Study Area, none would be impacted by the Proposal.

Field surveys to date have identified that the Ecology Study Area is utilised by threatened fauna. All species (with the exception of Grey-crowned Babbler) are highly mobile species that forage over large areas, and are unlikely to be confined to the boundaries of the Ecology Study Area, or in some instances, the wider locality.

The Proposal would result in likely direct impacts for five family ‘troupes’ of Grey-crowned Babblers. A significance assessment conducted under the EP&A Act determined that the Proposal is unlikely to have a significant effect on Grey-crowned Babbler provided management and mitigation measures are fully implemented (see Section 4.3.8.3).

It is calculated that approximately 11 hollow-bearing trees containing approximately 24 hollows would be removed as a result of the Proposal. It is also calculated that as many as 1 130 hollow-bearing trees containing and estimated 2 418 hollows may occur within the Ecology Study Area. The Proposal would result in the removal of less than 0.9% of the hollow-bearing trees potentially present.

4.3.6.2 Wildlife Connectivity and Habitat Fragmentation

Levels of connectivity would be partially impacted given the position of the Proposed Disturbance Footprint and the removal of vegetation in the thin lineal north-south tree line.

4.3.6.3 Injury and Mortality

Fauna injury or mortality can occur during the clearing phase through the removal of habitat and from collision with vehicles during the operation of the Proposal.

It is anticipated that some diurnal and mobile fauna species such as birds and larger reptiles may be able to move from the path of construction equipment during any clearing operations. Other fauna species such as those that are less mobile and nocturnal, are less likely to move away from clearing activity.

Operational impacts are likely to be most associated with vehicular traffic and direct mortality as a result of collisions with vehicles in high operation areas. Additional impacts may be associated with access to unsuitable water sources.

4.3.6.4 Potential Indirect Impacts on Flora and Fauna

Weeds and Feral Fauna Species

A total of 17 weed species were recorded from field surveys within the Project Site. Two declared noxious weed was identified within the Project Site, namely Bathurst Burr (*Xanthium spinosum*) and Galvanised Burr (*Sclerolaena birchii*). Both species are listed as a Class 4 Noxious Weed species on the NSW DPI Noxious Weeds list for the Bogan Local Government Area. Under this listing the growth of any plants must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed. There is some potential to disperse seeds and plant material into adjoining areas of native vegetation that are relatively weed-free. The most likely cause would be through the movement of soil by construction vehicles and machinery involved with the initial clearing and earthworks. There is also the potential for disturbance areas to be colonised by weed species which are present within the soil as a seed bank and require a disturbance event to trigger germination.

Noise, Vibration and Light

It is not anticipated that operation noise and vibration would have a significant effect based on previous studies at the nearby Tritton Mine and Girilambone Copper Mine where threatened species have been recorded foraging and breeding directly adjacent to current operations.

Light has the potential to disturb sleeping activity of diurnal fauna and foraging activity of nocturnal fauna. However, lighting would be restricted to a small proportion of the Project Site and it is not anticipated that these fauna would be significantly affected. Furthermore, it was also identified by EnviroKey in 2012 that lighting associated with similar mining operations provided opportunities for foraging for microchiropteran bats as the lights attract moths and other flying insects.

Cumulative Impacts

There is a potential cumulative impact on biodiversity given the proximity of the existing Nyngan Solar Farm. However, it is recognised that both operations are largely confined to cleared, agricultural land and EnviroKey (2016) determined that it is unlikely that the Proposal would contribute to a cumulative impact to the local biodiversity at any scale.

4.3.6.5 Management and Mitigation Measures

4.3.6.6 Introduction

The Applicant has designed the Proposal to minimise impacts on threatened species by firstly avoiding and then mitigating potential biodiversity impacts. The following subsections present the design features, operational controls and management measures proposed to avoid and mitigate impacts on local biodiversity.

4.3.6.7 Avoidance of Impacts

The layout of the surface infrastructure has been designed with the intent to minimise as far as practicable disturbance footprint and to concentrate activities in areas previously disturbed by agricultural activities. The clearing of remnant native vegetation would be minimised or delayed as long as possible and existing access tracks would be utilised where possible.

In particular, the Applicant would implement the following.

- Minimise disturbance of native vegetation during Stage 1 mining operations to that required to establish the proposed open cuts, elevated haul road and interim levee bund.
- Delay for as long as possible during Stage 2 mining operations disturbance of vegetation within the existing tree line. As Stage 2 operations would not commence until Year 9 and the Borrow Pit would be developed progressively, the Applicant anticipates that removal of vegetation within the existing tree line would be undertaken between Years 11 and 15.

4.3.6.8 Mitigation of Impacts

The Applicant would implement the following to mitigate disturbance of natural vegetation and threatened species habitat.

- Draft and implement a *Biodiversity Management Plan* to manage potential biodiversity impacts in general and the following issues in particular.
 - Pests and weed management.
 - Grey-Crowned Babbler management.
 - Fauna monitoring.
- Clearly mark-out the proposed disturbance footprint boundaries and identify vegetation to be cleared.
- Implement a hollow-bearing tree pre-clearance survey including inspection of all hollows and immediate surrounds a qualified professional for any species prior to clearing activities. If any fauna is identified, these would be relocated to areas outside of the proposed disturbance footprint prior to clearing.
- Ensure machinery required for the Proposal remains on existing vehicular access tracks or within the proposed disturbance footprint, where practicable. Where this is not possible, machinery would be manoeuvred to avoid sapling or remaining canopy trees wherever possible.

- Place felled canopy trees in adjacent vegetation areas outside of the proposed disturbance footprint to improve existing habitats.
- Eradicate any identified noxious weed and other weed material encountered, ensuring that the weed is destroyed and/or removed using appropriate methods to ensure weeds do not spread into the remainder of the Project Site.
- Install sediment and erosion control structures where appropriate.
- Stabilise exposed soils to prevent potential erosion.

4.3.7 Assessment of Impacts

4.3.7.1 Introduction

This subsection presents an assessment of the anticipated Proposal-related impacts on listed flora and fauna species and communities within the Project Site. The residual impacts are presented assuming the adoption of the various measures outlined in Section 4.3.7.

4.3.7.2 Vegetation Communities

The Proposal would result in disturbance of 9.3ha of ‘Benson 103 – Poplar Box – Gum-barked Coolibah – White Cypress Pine shrubby woodland mainly in the Cobar Peneplain Bioregion. EnviroKey (2016) identified a total of 1 193ha of this vegetation community within the Ecology Study Area. The Proposal would therefore disturb less than 0.7% of the Benson 103 vegetation community within the Project Site. EnviroKey (2016) concluded that the Proposal would not have a significant impact upon this vegetation community.

4.3.7.3 TSC Act Impact Assessment

Significance Assessments were undertaken by EnviroKey (2016) for the TSC Act-listed species identified as occurring or having the potential to occur within the Project Site, concluding that, following the implementation of the measures outlined in Section 4.3.7, the Proposal is unlikely to have a significant impact on identified threatened species.

4.3.7.4 EPBC Act Assessment

Significance assessments were undertaken by EnviroKey (2016) for the Superb Parrot (*Polytelis swainsonii*), which has the potential to occur within the Project Site, and the South-eastern Long-eared Bat (*Nyctophilus timoriensis*), which was identified within the Project Site (**Figure 4.9**). The significance assessments concluded that, following the implementation of the measures outlined in Section 4.3.7, the Proposal is ‘*unlikely*’ to have a ‘*significant effect*’ on the two threatened species.

Furthermore, although three migratory species were identified as potentially occurring within the Project Site, the overall Project Site was considered to not comprise habitat to support these species. As such, the impacts from the Proposal are ‘*unlikely*’ to impact the identified migratory species.

4.3.7.5 Matters of National Environmental Significance

No additional matters of National Environmental Significance were identified as being related to the Proposal.

4.3.7.6 Conclusion

EnviroKey (2016) has undertaken an assessment of significance of impact in accordance with OEH Guidelines and the 7-part test of Section 5A of the EP&A Act. It is concluded from the assessments of significance and the proposed management measures that the Proposal is unlikely to have a significant impact upon the identified species.

4.3.8 Assessment of Offsets

In order to compensate for unavoidable impacts as a result of the Proposal, the Applicant would secure a biodiversity offset through the use of a Biobanking Agreement (see Section 2.14).

In summary, EnviroKey (2016) determined using the OEH Biobanking Calculator (version 4.0) that 652 ecosystem credits would be required. As a result, based on the advice of EnviroKey (2016) the Applicant would establish a Biodiversity Offset Area of 64ha in the eastern section of the Project Site (**Figure 4.9** and **Table 4.12**). Section 2.14 presents a description of the management measures that would be implemented under the proposed Biodiversity Offset Strategy.

Table 4.12
Summary of Offsets

Biometric Vegetation Type	Proposed Disturbance	Biodiversity Offset Area
Benson ID 103 – Poplar Box – Gum Coolabah and White Cypress Pine Shrubby Woodland mainly in the Cobar Peneplain Bioregion.	9.3ha	64ha

In assessing the adequacy of the proposed Biodiversity Offset Strategy, reliance has been placed upon the *Biodiversity Offsets Policy for Major Projects* prepared by the NSW Office of Environment and Heritage. That policy is underpinned by six principles which have been addressed by EnviroKey (2016) as follows.

Principle 1: Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts

EnviroKey (2016) states that the majority of impacts would be confined to areas of non-native vegetation. The proponent has avoided and minimised impacts where possible through detailed design and the use of feasible mitigation measures.

Principle 2: Offset requirements should be based on a reliable and transparent assessment of losses and gains

EnviroKey (2016) has been prepared by appropriately qualified and experienced personnel to reliably and transparently assess the direct and indirect impact of the Proposal. The calculation of offset requirements was undertaken by an OEH Accredited Biobanking Assessor using the OEH Biobanking Calculator (version 4.0).

Principle 3: Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities

The Ecosystem Credit Summary identified that 185 ecosystem credits would be required to offset the Proposal. The Summary also identified the relationship between the biodiversity values lost, and those required to offset that loss in a ‘like-for-like’ manner. It is the intention of the Applicant, based EnviroKey (2016), that any Biodiversity Offset will be undertaken on adjoining land to the project site to strengthen connectivity across this highly fragmented landscape targeting the long-term viability of the threatened Grey-crowned Babbler. Using the BioBanking Credit Converter, 652 ecosystem credits converts to 64ha as the land required to offset these ecosystem credits.

Principle 4: Offsets must be additional to other legal requirements

The proposed biodiversity offset was not targeted by any person, agency or the crown to be undertaken on the land the subject of the Proposal.

Principle 5: Offsets must be ensuring, enforceable and auditable

Should the Proposal be approved, the Applicant would seek a BioBanking Agreement to secure the biodiversity offset.

Principle 6: Supplementary measures can be used in lieu of offsets

While the Applicant acknowledges this principle, it is considered that an appropriate offset site can be secured on the project site through a Biobanking Agreement.

4.4 SURFACE WATER

4.4.1 Introduction

A flooding assessment for the Proposal was undertaken by Knight Piésold. The resulting report is presented as Part 4 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as Knight Piésold (2016c). The assessment of other surface water-related impacts has been prepared by RWC. This subsection of the Environmental Impact Statement describes the management and mitigation measures that would be implemented to minimise surface water-related impacts and provides an assessment of the mitigated impacts.

Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to surface water and their risk rankings after the adoption of standard mitigation measures are as follows.

- Discharge of sediment-laden water impacting upon riverine ecology and downstream users (Low).
- Flood waters associated with Whitbarrow Creek inundate the Project Site, causing discharge of reagents (High).
- Pollution of surface water and shallow groundwater (High).
- Inability to discharge to surface water and groundwater systems without chemical or additional treatment (Low).
- Diversion and retention banks erosion / instability leading to increased sediment loads (Low).

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "water" as one of the key issues requiring assessment. The principal assessment requirement included:

- "an assessment of the likely impacts of the development on the quantity and quality of the region's surface ... resources;
- an assessment of the likely impacts of the development on ... watercourses, riparian land, water-related infrastructure, and other water users;
- an assessment of the likely flooding impacts of the development;
- a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;
- demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan;
- a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant Water Sharing Plan or water source embargo; and
- a detailed description of the proposed water management system, water monitoring program and other measures to mitigate surface and groundwater impacts."

4.4.2 Existing Surface Water Environment

The existing surface water environment is described in Section 4.1.2. In summary, however, the Project Site is largely flat, with surface water flows confined to sheet flows across the surface of the land. Whitbarrow Creek is located approximately 500m south of the Project Site boundary and flows in an easterly direction. The Whitbarrow Creek becomes indistinct to the southeast of the Project Site before waters from the Creek merge with the Bogan River approximately 17km east of the Project Site.

While a relatively small watercourse, Knight Piésold (2016c) determined that Whitbarrow Creek has a catchment upstream of the Project Site of approximately 2 432km². As a result, flooding during extreme was determined to be a significant risk for the Proposal.

4.4.3 Flood Study Methodology and Results

Knight Piésold (2016c) undertook an assessment of two design storm events, namely:

- a 1% (or 1 in 100 year) Annual Exceedance Probability (AEP) Storm; and
- a 0.1% (or 1 in 1 000 year) AEP Storm.

In undertaking the flood study, Knight Piésold (2016c) determined the following.

- Critical rainfall depth and duration for each modelled event.
- Anticipated runoff that would result from each modelled event.
- Nineteen subcatchments were identified, with a total area of 2 432km².

Flood modelling was undertaken using the Hydrological Modelling System software published by the Hydrologic Engineering Centre – US Army Corps of Engineers. **Table 4.13** presents the critical duration peak discharge for each storm event at the discharge point within the flood model. In summary, the critical durations for each modelled event is as follows.

- 1% AEP storm – 21 hours with a peak discharge rate of 2 350m³/s.
- 0.1% AEP storm – 24 hours with a peak discharge rate of 4 403m³/s.

Table 4.13
Critical Duration Peak Discharge Rates

Storm Duration (h)	Peak Discharge (m ³ /s)	
	1% AEP	0.1% AEP
6	1 433	4 106
12	1 816	4 205
18	2 314	4 304
24	2 222	4 403
30	2 289	3 750
36	2 194	3 432
48	2 079	3 845
72	2 058	2 110
Source: Knight Piésold (2016c) – After Tables 1.8 and 1.9		

Based on these results, Knight Piésold (2016c) determined flood levels for cross sections in the vicinity of the Processing Plant Area and the proposed open cuts. **Table 4.14** presents the results of that analysis.

Table 4.14
Modelled Flood Levels

Cross Section	Flood Level (m AHD)	
	1% AEP	0.1% AEP
Cross Section 3 – Processing Plant Area	184.8	185.2
Cross Section 1 – Open Cuts	183.5	184.0
Source: Knight Piésold (2016c) – After Table 2.1		

In light of the results of the analysis, Knight Piésold (2016c) recommended the following.

- Levee bunds would be constructed around the perimeter of the Processing Plant Area and the proposed open cuts, with crest elevations 1m above the 0.1% AEP storm flood level or 186.6m AHD and 185.6m AHD respectively.¹
- A floodway/causeway be constructed under the elevated haul road in the vicinity of the West Pit (**Figure 2.2**) capable of passing 2.6m³/s based on estimated flows from a 1% AEP storm.

¹ The proposed bund crest heights were determined based on three dimensional modelling of flood heights. As a result, the proposed crest heights are slightly more than 1m higher than the flood heights identified in **Table 4.14**.

Finally, Knight Piésold (2016c) identified that based on previous modelling of peak flows associated with the Bogan River at Nyngan, flooding of the Bogan River would not impact on the Project Site.

4.4.4 Management and Mitigation Measures

The Applicant would implement following management and mitigation measures to minimise the potential for surface water-related impacts throughout the operational life of the Proposal.

- Prepare a detailed *Surface Water, Sediment and Erosion Control Plan*, including a description of surface water management structures and procedures.
- Ensure that all surface water collected within the Processing Plant and Residue Storage Facility bunded area is either used within the Processing Plant or is permitted to evaporate.
- Ensure that all surface water within open cuts is collected and either used within the Processing Plant or is permitted to evaporate.
- Ensure, where practicable, that all surface water within the Borrow Pit is collected and either used within the Processing Plant or is permitted to evaporate. Where this is not practicable, for example, following an extreme rainfall event, ensure that collected water is tested to ensure compliance with the ANZECC (2000) irrigation guidelines prior to being discharged to land within the Project Site.
- Construct the Site Access Road, Elevated Haul Road and all other roads not within the bunded areas in accordance with *Managing Urban Stormwater – Volume 2C: Unsealed Roads*.
- Construct a floodway/culvert under the Elevated Haul Road capable of conveying a flow of up to 2.6^m³/s without eroding.
- Ensure that all fuel and chemical storage, delivery and handling areas are bunded to 110% of the size of the largest receptacle.
- Ensure that pumps and fluid lines for the delivery of chemicals or fuels would be bunded and/or protected. Transfer volumes would be monitored at all times to quickly identify any leaks and appropriate action to be undertaken.

In addition, the Applicant would also implement following management and mitigation measures to minimise the potential for surface water-related impacts throughout the rehabilitation and relinquishment phase of the Proposal.

- Develop a *Soil and Water Management Plan* for the rehabilitation and mine closure component of the Project describing all sediment and erosion control measures that would be implemented during the rehabilitation and relinquishment phase of the Proposal.
- Shape the decommissioned Residue Storage Facility into a raised plateau with a shallow dome profile so that water would be shed from its surface as sheet flow without concentration.

- Install an appropriate number of engineered drop structures on the rehabilitated face of the former Residue Storage Facility to safely transfer surface water down to original ground level and to prevent erosion of the embankment at the location of these structures.
- Ensure that rehabilitation, including the placement of soil and revegetation with endemic native species (for those areas to be used for nature conservation) or pasture species (for those areas to be used for agriculture) is undertaken promptly once sections of the Project Site are no longer required for mining-related purposes.
- Construct surface water control structures on the rehabilitated landform to limit the potential for erosion of newly placed soils.
- Ensure that sediment control structures constructed for the Project remain in place until rehabilitated areas are sufficiently stabilised.

4.4.5 Assessment of Impacts

Based on the flood modelling of Knight Piésold (2016c) and the Applicant's commitment to the management and mitigation measures described in Section 4.4.4, Proposal-related surface water impacts are anticipated to be as follows.

- Impacts to surface water quality – Negligible.

The Applicant would ensure that all water with the potential to contain chemicals or salt would be used within the Processing Plant or permitted to evaporate. Given the flexibility to adjust the importation of water from the Nyngan – Cobar Pipeline (see Section 2.7.4) and the ability to store water within the bunded area, the potential for unplanned discharge of chemical or salt-laden water is negligible.

The Applicant would also ensure that surface water within the Borrow Pit that maybe sediment-laden, but would not be chemical or salt-laden, would, to the extent practicable, be used for Proposal-related activities or would be permitted to evaporate. However, in the event that discharge of such water were required, the Applicant would ensure that it is tested and complies with the ANZECC (2000) irrigation guidelines before applying that water to land within the Project Site.

Finally, all unsealed roads outside the bunded area and the final landform would be constructed in accordance with the requirements of *Managing Urban Stormwater – Volumes 1, 2C and 2E*.

As a result, the Proposal would not result in adverse surface water quality impacts within or surrounding the Project Site.

- Impacts to surface water quantity – Negligible.

Knight Piésold (2016c) determined that the catchment of Whitbarrow Creek upstream of the Project Site is approximately 2 432km² or 243 200ha. The Proposal would result in bunding of an area of approximately 110.3ha, or 0.05% of the catchment of Whitbarrow Creek. As a result, the Proposal would not result in significant impacts to surface water flows within that Creek or the Bogan River.

- Flood-related impacts – Negligible.

Knight Piésold (2016c) undertook detailed modelling to determine the anticipated flood level in the event of a 0.1% AEP rainfall event. That modelling was used to determine the crest height for the proposed levee bunds, incorporating a 1m freeboard above the modelled flood height. Given the potential for a 0.1% AEP storm event during the life of the Proposal (0.1% x 20 years = 2.0%) and the proposed freeboard of 1m, the potential for inundation in the event of Whitbarrow Creek flooding is negligible.

In addition, given the small size of the proposed bunded area and the Applicant's commitment to install a culvert under the elevated haul road capable of conveying surface water flows resulting from a 1% AEP storm event, the potential for the Proposal to adversely impact on flood regimes surrounding the Project Site is negligible.

- Impacts to watercourses, riparian land, water-related infrastructure and other water users.

In light of the above, the Applicant contends that the Proposal would not impact on watercourses, riparian land, water-related infrastructure and other water users.

4.4.6 Monitoring

The Applicant would ensure that any water to be discharged from the Borrow Pit is tested to ensure compliance with the ANZECC (2000) irrigation guidelines before applying that water to land within the Project Site.

4.5 GROUNDWATER

4.5.1 Introduction

A groundwater assessment for the Proposal was undertaken by Ground Doctor Pty Ltd (Ground Doctor). The resulting report is presented as Part 5 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as Ground Doctor (2016). This subsection of the EIS provides a summary of the groundwater assessment, and the management and mitigation measures that would be implemented.

Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to groundwater and their risk rankings after the adoption of standard mitigation measures are as follows.

- Reduction in groundwater discharge to surrounding creeks/rivers, adverse impacts on groundwater dependent ecosystems or surrounding groundwater users (Low).
- Reduction in groundwater discharge to surrounding creeks/rivers, adverse impacts on groundwater dependent ecosystems or surrounding groundwater users (Moderate).
- Discharge of poor quality groundwater to surrounding aquifers (Moderate).

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "water" as one of the key issues requiring assessment. The principal assessment requirement included:

- "an assessment of the likely impacts of the development on the quantity and quality of the region's ... groundwater resources;
- an assessment of the likely impacts of the development on aquifers ... and other water users".

4.5.2 Existing Groundwater Environment

4.5.2.1 Surrounding Registered Bores

Ground Doctor (2016) conducted a search of the Department of Primary Industries – Water Registered Groundwater Bore database on 13 January 2016 for bores surrounding the Project Site. That search revealed two registered groundwater bores within 10km of the Project Site (**Figure 4.1**). **Table 4.15** presents an overview of the information recorded on the register in relation to those bores.

Table 4.15
Registered Bores with 10km of the Project Site

Bore ID	Depth (m)	Water Bearing Zones	Yield (L/s)	Lithology	Standing Water Level (mbgl)	Status
GW002730	128	33.5m (Sandy Clay)	0.0	Clay (0-41m) Rock / Clay (41-110m) Quartz (110-115m) Rock / Clay (115-128m)	Unknown	Unknown
GW060847	74	60-74m (Shale)	0.3	Topsoil (0-1m) Weathered Shale (1-50m) Shale (50-74m)	Unknown	Registered for stock watering

Source: Ground Doctor(2016) after Table 2

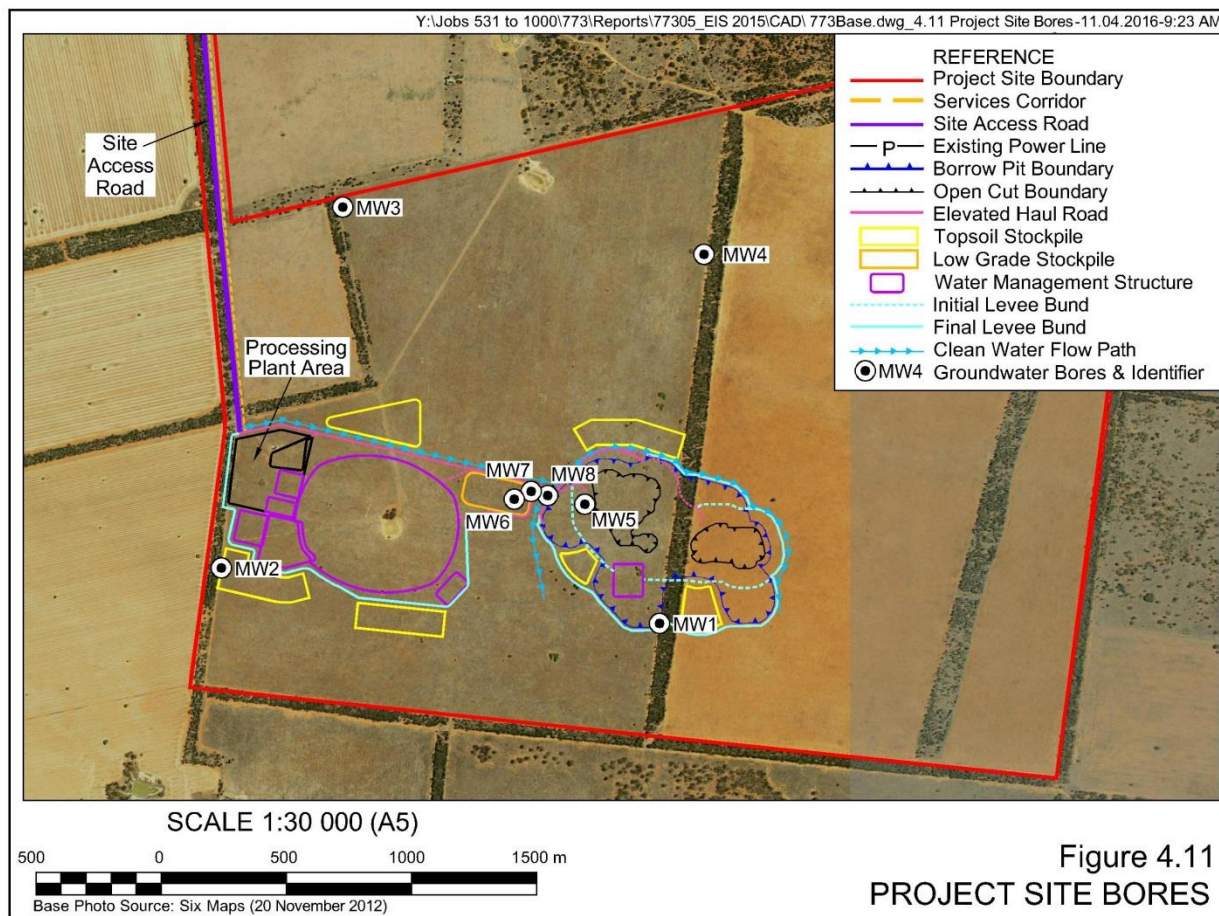
4.5.2.2 Project Site Groundwater Setting

The Impax Group Pty Ltd (Impax) undertook a field assessment of groundwater conditions within the Project Site in 2011. The resulting report is presented in full as Annexure C of Ground Doctor (2016) and is hereafter referred to as Impax (2011). Eight groundwater bores were installed within the Project Site (**Figure 4.11** and **Table 4.16**).

Table 4.16
Project Site Groundwater Bores

Bore ID:	Easting	Northing	Maximum Depth (m)	Collar Elevation (m AHD)	Approximate SWL (mbgl)	Approximate SWL Elevation (m AHD)
MW1	499556	6502495	45m	186.27	25.90	160.37
MW2	497805	6502695	45m	187.52	26.75	160.77
MW3	498298	6504114	45m	188.07	22.97	165.10
MW4	499745	6503947	45m	186.41	22.62	163.79
MW5	499256	6502963	45m	186.41	25.54	160.87
MW6	499022	6502981	45m	186.64	25.41	161.23
MW7	499044	6502978	45m	186.59	25.92	160.67
MW8	499097	6502979	45m	186.98	25.50	161.48

Source: Ground Doctor (2016) after Tables 3 and 5



Ground Doctor (2016) state that groundwater was intersected in the bores between 30mbgl to 42mbgl and was inferred to be present in fractures within the lateritic and saprolitic weathered rock profile. Standing water levels ranged between 22mbgl and 25mbgl, with the standing water levels indicating a groundwater flow gradient from north to south.

Impax (2011) collected groundwater samples from 5 bores. **Table 4.17** presents the results of the analysis of those samples. In summary, groundwater quality within the Project Site may be described as having a generally neutral pH with elevated salinity. Ground Doctor (2016) state that groundwater within the Project Site would be unsuitable for drinking, irrigation, watering of stock or discharge to surface water.

Table 4.17
Project Site Groundwater Quality

	MW1	MW2	MW3	MW4	MW7
pH	7.1	7.2	6.9	6.8	7.1
EC (μ S/cm)	31 060	34 700	26 000	38 530	32 900
Total Dissolved Solids (mg/L)	17 000	19 000	14 000	21 000	18 000

Source: Ground Doctor (2016) – after Table 7

4.5.2.3 Groundwater Dependent Ecosystems

Ground Doctor (2016) undertook a search of the Groundwater Dependent Ecosystems Atlas (Australian Government, Bureau of Meteorology, <http://www.bom.gov.au/jsp/weave/gde.html>), confirming that no groundwater dependant ecosystems exist within the Project Site.

The search also indicated that the Miandetta State Forest (located approximately 3.5km to the north west of the Project Site) has a high likelihood of having vegetation that is reliant on groundwater, and that woodlands located approximately 800m north of the Project Site boundary are recorded as having low potential for groundwater interaction. As Ground Doctor (2016) assessed that both environments were located outside the extent of possible drawdown impacts they are not discussed further in this document.

4.5.3 Assessment Methodology

4.5.3.1 Introduction

Ground Doctor (2016) undertook an assessment of groundwater-related impacts associated with the Proposal as follows.

- A conceptual model of groundwater processes within the Project Site was established based on available groundwater and geochemical data.
- A pump test was used to determine aquifer properties.
- An analytical model was used to quantify groundwater quantity impacts within the Project Site and Project-related groundwater take.

This subsection provides an overview of each of the above assessment methodologies.

4.5.3.2 Conceptual Model

In order to facilitate an assessment of the anticipated groundwater-related impacts associated with the Proposal, Ground Doctor (2016) developed a conceptual model of the Project Site groundwater setting and how that may be impacted by the Proposal. That model may be summarised as follows.

- Standing water levels within the Project Site are approximately 25mbgl.
- Groundwater gradient is generally north to south.
- Whitbarrow Creek (at an elevation of approximately 180m AHD) is unlikely to receive groundwater inputs, with standing water levels within the Project Site between 160m AHD and 165m AHD.

4.5.3.3 Aquifer Properties

Impax (2011) undertook a pump test using MW7 as the test bore and MW5, MW6 and MW8 as observation bores. The pump test was undertaken between 26 and 28 May 2011 as follows.

- MW7 was pumped at a rate of 0.5L/s for a period of 36 hours and 5 minutes.
- Standing water levels were monitored using downhole loggers in MW5, MW6, MW7 and MW8.
- Aquifer recovery was monitored for 30 hours following completion of the pump test.

The results of the pump test were analysed using the following methodologies. These methodologies are described in Section 6.5 of Ground Doctor (2011). The results of that analysis may be summarised as follows.

- Aquifer transmissivity 8.5m²/day to 12.3m²/day, with an average of 9.4m²/day.
- Aquifer permeability (K) assuming a 12m thick aquifer ranges from 0.7m/day to 1.0m/day, with an average of 0.8m/day.

4.5.3.4 Analytical Model

Ground Doctor (2016) used an analytical model developed by Marinelli and Niccoli (2000) to estimate potential water inflows and potential drawdown impacts of the Proposal. That analytical model is presented in detail in Sections 7.2 to 7.4 of Ground Doctor (2016). In summary, the Marinelli and Niccoli model assumes the following.

- The proposed open cuts are approximated as a cylinder.
- Groundwater flow is horizontal.
- The static (pre-mining) water table is approximately horizontal.
- Uniform distributed recharge occurs as a result of surface infiltration from rainfall; all recharge within the radius of influence (cone of depression), of the excavation is assumed to be captured by the excavation.
- Groundwater flow toward the excavation is axially symmetric.
- The aquifer is infinite in extent (i.e. the cone of depression does not encounter any zero recharge boundaries).

For the purposes of this assessment, Ground Doctor (2016) assumed the following.

- The range of average aquifer permeability was estimated to be 0.7m/day to 1.0m/day.
- The rate of water inflow into the Open Cut and the associated radius of the cone of depression for average horizontal aquifer permeability was assumed to be in the range of 1×10^{-6} m/sec to 1×10^{-5} m/sec.
- The average permeability of the base of the Open Cut and the vertical permeability of the aquifer was assumed to be 0.1 of the horizontal permeability.

4.5.4 Management and Mitigation Measures

The Applicant would implement following management and mitigation measures to minimise the potential for groundwater-related impacts.

- Store and use all chemicals in accordance with the manufacturer's instructions and the relevant Material Safety Data Sheets.
- Store all hydrocarbon and chemical products within a bunded area in accordance with *AS1940 – The storage and handling of flammable and combustible liquids*.
- Ensure that Material Safety Data Sheets and appropriate spill management equipment is available in the vicinity of all chemical storage areas.
- Develop and implement a management plan for the storage and handling of reagents and fuels throughout the life of the Project.
- Ensure all relevant personnel are provided with appropriate training in proper handling techniques for hydrocarbon and chemical products.
- Ensure that the volume of water pumped from the proposed open cuts is monitored and recorded to enable net groundwater inflows to be determined.
- Ensure that the Residue Storage Facility and other water storages are appropriately lined and monitored to minimise the potential for seepage of chemical-laden water into the underlying aquifer.
- Ensure that standing water levels in surrounding monitoring bores and groundwater inflow rates to the proposed mine are monitored monthly and should the actual groundwater inflows or reduction in standing water levels be greater than that assessed, ensure that the advice of a suitable qualified hydrogeologist is sought.

4.5.5 Assessment of Impacts

4.5.5.1 Introduction

A detailed assessment of groundwater impacts was undertaken by Ground Doctor (2016) and is presented in Section 8 of Ground Doctor (2016). The following subsections present a summary of those impacts.

4.5.5.2 Groundwater Inflows

East Pit

The quantitative analysis determined that groundwater inflow volumes into the East Pit would vary between 1L/s and 8.3L/s. However, Ground Doctor (2016) noted that inflow volumes are unlikely to approach 8.3L/s, and that volumes of closer to 1L/s are most likely.

West Pit

The quantitative analysis determined that groundwater inflow volumes into the West Pit would vary between 1.3L/s and 11.2L/s. However, Ground Doctor (2016) noted that inflow volumes are unlikely to approach 11.2L/s, and that volumes of closer to 1.3L/s are most likely.

4.5.5.3 Groundwater Drawdown

Groundwater would be removed from the Open Cut by evaporation and mechanical means, which would result in a maximum of 20m of groundwater drawdown within the footprint of the East Pit, and 25m of drawdown within the footprint of the West Pit. The maximum extent of groundwater drawdown would be 1 000m to 2 900m from the East Pit, and 1 300m to 3 600m from the West Pit. Ground Doctor (2016) notes that a drawdown distance close to the lower end of the range is most likely. These drawdown impacts would not intersect surrounding registered bores described in Section 4.4.2.2, and those bores are not anticipated to be impacted.

Following completion of mining operations, the standing water level of the groundwater beneath the Project Site would be approximately 0.5m to 3m below the pre-mining level. Steady state conditions would be established approximately 5 to 20 years after the completion of mining operations.

The elevations of Whitbarrow Creek and the Bogan River are both above the measured water table elevation within the Project Site, and are not anticipated to be impacted by groundwater drawdown.

4.5.5.4 Groundwater Quality

Ground Doctor (2016) identified the main potential sources of groundwater contamination within the proposed Project Site as the following.

- Spillage of fuel, chemicals and/or reagents.
- Leaching of acid and metals from waste rock.
- Leaching of acid and metals from residue.
- Leaching of acid and metals from the concentrate.
- Leaching of acid and metals from the exposed soil and rock within the proposed Open Cut.

Ground Doctor (2016) assessed that, provided that the management and mitigation measures presented in Section 4.4.4 are adhered to and all components are constructed as described in Section 2, the impacts of surface spillage and leaching on groundwater would be limited. The overburden and ore material within the proposed Open Cut are non-acid forming and are not anticipated to generate acid within the proposed Open Cut.

4.5.5.5 Aquifer Interference

The proposed Open Cut would intersect the water table, and as such would be regarded as an aquifer interference activity under the *NSW Aquifer Interference Policy* (NSW DPI, 2012). That policy is considered in Section 8.6 of Ground Doctor (2016). In summary, aquifer interference impacts are unlikely to be significant.

4.5.6 Monitoring

The Applicant would monitor the groundwater inflow rates to the proposed Open Cut and the standing water levels of the Project Site groundwater bores monthly. Should the actual groundwater inflows or reduction in standing water levels be greater than that assessed, the advice of a suitable qualified hydrogeologist would be sought.

4.6 NOISE

4.6.1 Introduction

A noise and blasting impact assessment for the Proposal was undertaken by Spectrum Acoustics Pty Limited (Spectrum). The resulting report is presented as Part 6 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as Spectrum (2016). This subsection of the EIS provides a summary of the noise and blasting impact assessment, and the management and mitigation measures that would be implemented to minimise impacts.

Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to surface water and their risk rankings after the adoption of standard mitigation measures are as follows.

- Amenity impacts on residential and other sensitive receptors (Moderate).
- Health impacts on residential and other sensitive receptors (Low).
- Amenity impacts on residential and other sensitive receptors (Low).

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "noise" as one of the key issues requiring assessment. The principal assessment requirement included:

- "an assessment of the likely operational noise impacts of the development (including construction noise) under the *NSW Industrial Noise Policy* ...; and
- an assessment of the likely road noise impacts of the development under the *NSW Road Noise Policy*".

4.6.2 Existing Noise Climate and Receivers

The noise climate in the area surrounding the Project Site is typical of a rural setting, with no significant surrounding industrial noise sources. Noises which are currently audible at surrounding residences include the following.

- Traffic on local roads, particularly Gilgai Road.
- Agricultural and rural noises such as farm machinery, stock, birds and insects.
- Domestic noises such as lawn mowers, pumps, dogs, etc.
- Wind generated noises such as wind in trees.

As a result, the Industrial Noise Policy (INP) default minimum background noise level of 30 dB(A), L_{90} has been adopted at all receivers.

Spectrum (2016) assessed noise levels at ten residential receivers surrounding the Project Site (Figure 4.5).

4.6.3 Assessment Criteria

The assessment criteria determined by Spectrum (2016) for the Proposal are presented in Table 4.18.

Table 4.18
Noise Assessment Criteria

	Operational noise criteria (All times)	Construction noise criteria (Daytime)	Sleep disturbance criteria	Road noise criteria	
				Day (7:00am to 10:00pm)	Night ¹ (10:00pm to 7:00am)
Recommended criteria	30 dB(A), L_{90}	40 dB(A), $L_{eq(15min)}$	45 dB(A), $L_{1(1min)}$	55 dB(A), $L_{eq(1hr)}$ (external)	50 dB(A), $L_{eq(1hr)}$ (external)
Source: Spectrum (2016) – After Section 4					

4.6.4 Assessment Methodology

The following provides a brief overview of the noise assessment methodology. Section 5 of Spectrum (2016) includes a full description of the modelling and assessment methodology.

Construction Noise Assessment Methodology

The assessment of construction noise was undertaken using Environmental Noise Model software (v3.05) from RTA Technology. The construction noise assessment assumed the operation of a single piece of road construction equipment with a sound power level of 104 L_w dB(A) $L_{eq(15min)}$ on the Site Access Road at the point closest to Residence R4 (Figure 4.5).

Operational Noise Assessment Methodology

The assessment of operational noise was also undertaken in accordance with the INP using the Environmental Noise Model software (v3.05) from RTA Technology. A range of noise sources representing an assumed worst-case noise emission scenario were modelled, including:

- an excavator operating at surface, not in-pit as would occur once mining operations have progressed; and
- a haul truck and bulldozer operating at the maximum elevation of the Residue Storage Facility, namely 30m above the natural surface.

Figure 4.12 presents the assumed location of the various noise sources modelled and Table 4.19 presents the modelled sound power levels.

Table 4.19
Modelled Sound Power Levels

Equipment	Number	Use	Sound Power Level (L _w dB(A), L _{eq} (15min))
Excavator (3)	2	Raw material excavation	106
Front End Loader	1	Truck loading, processing and moving stockpiles	113
Haul Truck (40t)	1	Hauling product	108
Bulldozer	1	Bund construction and rehabilitation	114
Grader ¹	1	Road construction	104
Processing plant	1	Processing	110
Water Cart (40t)	1	Hauling product	108
Road truck	1	Product haulage	92 ¹
Note 1: Assumes two vehicle movements per 15 minute interval			
Source: Spectrum (2016) – After Table 4			

Finally, Spectrum (2016) assumed the following meteorological conditions in accordance with procedures identified in the INP.

- Neutral conditions.
- Adverse wind from the South at 3m/s.
- Temperature inversion of 8°/100m.

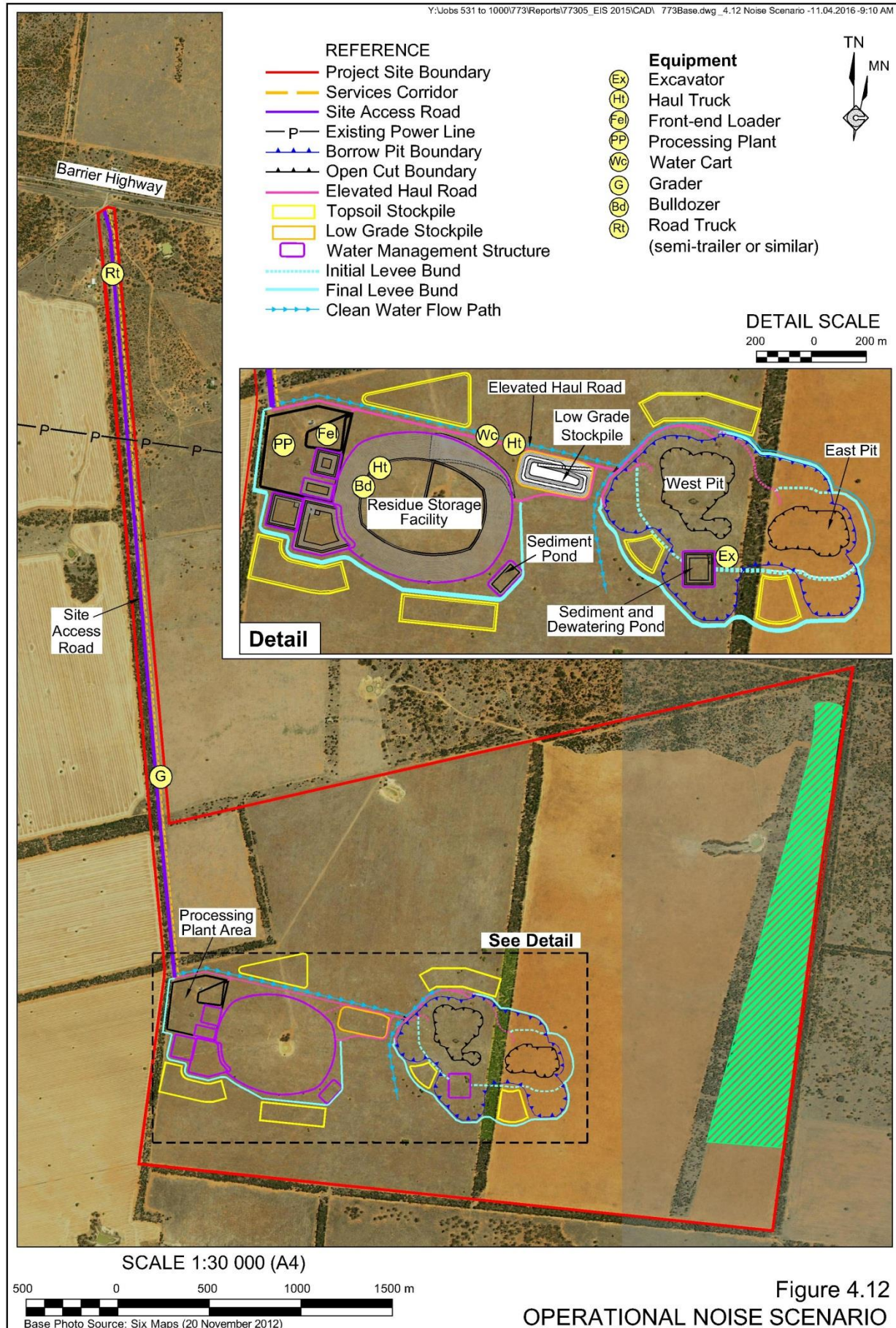
Road Traffic Noise

Road traffic noise was modelled using the US Environmental Protection Agency document No. 550/9-74-004 *Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974*. Spectrum (2016) state that this modelling method is the most mathematically robust model for intermittent traffic. Other models suggested by the *NSW Road Noise Policy* focus on areas of continuous or high-volume traffic noise, and were not considered appropriate for the purposes of the Proposal.

4.6.5 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential noise-related impacts associated with the Proposal.

- Strictly comply with the proposed hours of operation identified in Section 2.11.3.
- Regularly service all equipment on site to ensure sound power levels of each item remains at or below the default/or factory-set values.
- Install frequency modulated reversing alarms to all mobile equipment.
- Ensure that all truck drivers would be required to comply with a Code of Conduct outlining procedures for reducing noise impacts during transportation within the Project Site and off site.
- Maintain an open dialogue with the surrounding community and neighbours to ensure any concerns over noise or vibration are addressed.



In addition, it is noted that Residence R4 is located in close proximity to the Site Access Road. Noise-related impacts at that residence are likely to be associated with initial construction of the Site Access Road and subsequent road traffic on that road. As a result, the Applicant would implement the following management and mitigation measures specific to that residence.

- Prepare and implement a detailed *Road Construction Management Plan* in consultation with the owners of Residence R4 to ensure that road construction activities do not adversely impact on the residents living at that residence.
- Limit the speed of vehicles on the Site Access Road to a speed that would ensure that noise and dust impacts at Residence R4 are minimised to the extent practicable.
- Ensure regular and open consultation with the residents of Residence R4 during the construction operations and initial mining operations. Ensure that reasonable concerns are addressed promptly and effectively.

4.6.6 Assessment of Impacts

4.6.6.1 Construction Noise

Spectrum (2016) determined that construction noise levels of up to 49 dB(A) would be expected at Residence R4. This exceeds the recommended construction noise criteria by approximately 9 dB(A) $L_{eq(15\text{minute})}$, but it well below the highly affected level of 75 dB(A). Given the proposed management and mitigation measures identified in Section 4.6.5 and the fact that road construction operations would be for a very short period, Spectrum (2016) concluded that it is likely that road construction operation could be undertaken without adverse impact on the occupiers of Residence R4.

Construction noise levels of all other residences would not exceed the construction noise criteria.

4.6.6.2 Operational Noise

The predicted operational noise levels at surrounding residences are presented in **Table 4.20**. In summary, there are no predicted exceedances of operational noise criteria at any surrounding residences.

4.6.6.3 Road Traffic Noise

The closest residence to the Barrier Highway in the vicinity of the project site is Residence R2, located approximately 200m north of the Project Site entrance. Based on the daytime traffic noise criterion of 50 dB(A) $L_{eq(1\text{ hour})}$, it is predicted that over 13 truck movements per hour would result in the exceedance of the road noise criterion. As truck movements would be limited to a maximum of less than 8 movements per hour, exceedance of this criterion is not predicted.

Table 4.20
Predicted Operational Noise Levels at Surrounding Residences

Receiver	Predicted noise level (dB(A), L _{eq} (15 min))			Criterion (dB(A), L _{eq} (15 min))
	Meteorological condition			
	Neutral	South wind	Inversion	
R1	<20	<20	<20	35
R2	<20	<20	<20	35
R4	<20	20	24	35
R5	<20	<20	<20	35
R6	<20	<20	<20	35
R7	<20	<20	22	35
R8	<20	<20	<20	35
R9	<20	23	30	35
R12	<20	21	25	35
R13	<20	24	27	35
Source: Spectrum (2016) – Table 5				

4.6.7 Monitoring

Attended noise monitoring would be offered to surrounding residents, in particular, the residents at Residence R4, and would be undertaken on request.

4.7 TRAFFIC AND TRANSPORTATION

4.7.1 Introduction

A traffic and transport impact assessment for the Proposal was undertaken by Constructive Solutions Pty Ltd. The resulting report is presented as Part 7 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as Constructive Solutions (2016). This subsection of the EIS provides a summary of the traffic and transport impact assessment, and the management and mitigation measures that would be implemented to minimise impacts.

Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to traffic and transportation and their risk rankings after the adoption of standard mitigation measures are as follows.

- Elevated risk of accident / incident on local roads as a result of workforce/light vehicle movements (High).
- Increased traffic congestion as a result of workforce/light vehicle movements (Low).
- Road pavement deterioration as a result of workforce/light vehicle movements (Low).
- Elevated risk of accident / incident on local roads as a result of heavy vehicle movements (High).

- Increased traffic congestion as a result of heavy vehicle movements (Low).
- Road pavement deterioration as a result of heavy vehicle movements (Low).
- Conflicts with other users leading to damage to existing infrastructure resulting in community complaints and impact on the local road network. (Low).

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "traffic and transport" as one of the key issues requiring assessment. The principal assessment requirement included:

"an assessment of the likely transport impacts of the development on the capacity, condition, safety and efficiency of the local and State road network, having regard to the RMS' requirements".

4.7.2 Existing Road Traffic Environment

4.7.2.1 Roads and Intersections

Barrier Highway

The Barrier Highway is a State highway that provides an east-west road link between Nyngan and Broken Hill. The road adjacent to the intersection with Gilgai Road is sealed and consists of two 3.5m wide traffic lanes and sealed shoulders each approximately 0.25m wide. The remaining gravel shoulder/verge width is minimal, up to 0.5m wide in some places. Delineation on the barrier Highway is provided by centre and edge line marking, and guide posts. The regulatory speed limit is 100km/h. Generally, the Barrier Highway adjacent to the intersection with Gilgai Road is in good condition.

Intersection of the Barrier Highway and Gilgai Road

Gilgai Road forms a T intersection with the Barrier Highway approximately 95m north of the Site Access Road. Vehicles travelling along the Barrier Highway have right of way. The posted speed limit for the Barrier Highway is 110km/h and, whilst there is no posted speed limit for Gilgai Road, it is assumed to be 100km/h. A rural auxiliary left turn treatment – short turn lane is provided for west bound traffic turning left on to Gilgai Road, and a basic right turn treatment is provided for east bound traffic turning left on to Gilgai Road. The sight distance to the east is 560m, which is considered sufficient given that the Site Intersection Safe Distance is 285m. However, the sight distance to the west of this intersection is 200m, which is not sufficient.

Level Crossing on Gilgai Road

There is a level railway crossing on Gilgai Road, approximately 45m north of the Site Access Road. The level crossing is controlled by a single stop sign on the left of the road at each approach. Painted stop bars and double unbroken centre line markings are provided at the crossing and approaches. There are no signals in place to warn traffic of approaching trains. Railway crossing warning signs are provided on Gilgai Road and on the Barrier Highway on both approaches to the Gilgai Road intersection. There is sufficient distance (approximately 50m) for an articulated vehicle, including semi-trailers and B-Doubles, to queue between the railway crossing and the Barrier Highway intersection.

Gilgai Road

Gilgai Road is a minor local road which provides access to the Barrier Highway. It is approximately 45km long, and connects the Barrier Highway with the Nymagee Hermidale Road. The section of road approaching the intersection with the Barrier Highway is sealed and consists of two lanes with a total sealed width of 6.5m, and unsealed gravel shoulders varying in width between 0.5m to 1.0m. Whilst there is no posted speed limit for Gilgai Road, it is assumed to be 100km/h. Generally, Gilgai Road is in good condition.

Site Entrance

The Site Access Road forms a T intersection with Gilgai Road at the Site Entrance. Vehicles travelling along Gilgai Road have right of way. The proposed mine access road intersects with Gilgai Road approximately 95m south of the Barrier Highway. The Site Access Road currently has no controls or advanced warning signs. The width of the Site Access Road is approximately 4.0m. The level crossing is 45m to the north of the Site Access Road, and the sight distance along Gilgai Road is 202m to the south. This is considered sufficient, given that it is in excess of the Site Intersection Safe Distance (SISD) of 169m.

4.7.2.2 Traffic Volumes

Existing traffic volume data is presented in **Table 4.21**. **Table 4.21** also presents forecast growth extrapolated to 2025, using an average growth estimate of 2% per annum.

Table 4.21
Existing and Forecast Traffic Volumes

Road	Site	Existing Traffic (2015) (movements per day)			Forecast Traffic (2025) (movements per day)		
		Light Vehicle	Heavy Vehicle	Total	Light Vehicle	Heavy Vehicle	Total
Gilgai Rd ¹	570m from Coffills Lane	28	12	40	34	14	48
Barrier Highway ²	Nyngan 20km sign	566	275	841	690	335	1 025
Note 1: Data source – Bogan Shire Council (2008)							
Note 2: Data source – Roads and Maritime Services (2014)							
Source: Constructive Solutions (2016) – After Table 3							

4.7.3 Predicted Proposal-related Traffic Levels

Predicted changes to traffic volumes are presented in **Table 4.22**. In summary, the Proposal would result in an average of an additional 60 light vehicle movements and 10 heavy vehicle movements per day.

Table 4.22
Mine Operation Traffic Volumes

Road	Forecast (2025) Traffic		Additional Proposal- related Traffic		Combined Traffic		Combined Total
	LV	HV	LV	HV	LV	HV	(LV & HV)
Gilgai Road	34	14	60	10	94	24	118
Barrier Highway	690	335	60	10	750	345	1 095

4.7.4 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential traffic and transport-related impacts associated with the Proposal.

- Implement a suitable Code of Conduct for drivers of heavy vehicles, including subcontractors where applicable. Consult with all relevant road users during preparation of the Code of Conduct, including:
 - surrounding residents;
 - Bogan Shire Council; and
 - operators of school bus routes on Gilgai Road.
- Ensure all truck loads are being covered to prevent loose materials falling onto the roadway or the creation of excessive dust.
- The following signs would be erected prior to construction activities commencing.
 - A ‘Truck Entering’ sign on Gilgai Road on the southern approach to the proposed Site Access Road;
 - A ‘Reduce Speed’ sign on Gilgai Road approximately 350m to the southwest of the intersection of the Site Access Road;
 - Over-size truck warning signs on the Barrier Highway on the east and west approaches to Gilgai Road; and
 - A ‘Stop’ sign for drivers exiting the Project Site via the Site Access Road.
- Road markings and lane delineations on Gilgai Road would be maintained as necessary.
- Construct a suitable sealed BAR/BAL intersection between the Site Access Road and Gilgai Road in accordance with Austroads (2010).
- Undertake works in consultation with the Roads and Maritime Service to improve sight distances to the west along the Barrier Highway from the intersection with Gilgai Road.
- All truck drivers would be required to stop at the stop sign on the Site Access Road before entering Gilgai Road, and comply with all applicable intersection controls.

4.7.5 Assessment of Impacts

Constructive Solutions (2016) determined, taking into account the proposed management and mitigation measures, the Proposal would not result in significant traffic and transport impacts.

4.8 ABORIGINAL HERITAGE

4.8.1 Introduction

An Aboriginal heritage impact assessment for the Proposal prepared by Artefact Heritage Services (Artefact). The resulting report is presented as Part 8 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as Artefact (2016). This subsection of the EIS provides a summary of the Aboriginal heritage impact assessment, and the management and mitigation measures that would be implemented.

Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to Aboriginal heritage and their risk rankings after the adoption of standard mitigation measures are as follows.

- Unauthorised destruction of known sites.
- Unauthorised destruction of unknown sites within approval areas.

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "Heritage" as one of the key issues requiring assessment. The principal assessment requirement included "an assessment of the likely Aboriginal ... heritage (cultural and archaeological) impacts of the development, having regard to the OEH's requirements".

4.8.2 Consultation

Consultation with Aboriginal stakeholders for the Proposal was undertaken by Artefact in accordance with the Office of Environment and Heritage's *Aboriginal cultural heritage consultation requirements for proponents 2010*. In summary, an advertisement was placed in the *Nyngan Observer* on 25 June 2011 requesting expressions of interest from local Aboriginal community groups. Submissions closed on 8 August 2011. Letters requesting information on relevant Aboriginal stakeholder groups were sent on 8 August 2011 to:

- the Office of Environment and Heritage;
- the National Native Title Tribunal;
- the Office of the Registrar of the Aboriginal Land Rights Act;
- Bogan Shire Council;
- the Central West Catchment Management Authority; and
- the Nyngan Local Aboriginal Land Council.

Three Aboriginal groups/individuals expressed an interest in the project and were registered as Aboriginal stakeholders as follows.

- Nyngan Local Aboriginal Land Council.
- Bogan Aboriginal Corporation.
- John Shipp.

Representatives from each of these groups attended the site survey and were forwarded a draft copy of Artefact (2016) seeking comment on 20 November 2015. No comments were received.

4.8.3 History of the Project Site

Aboriginal people have lived in New South Wales for more than 60 000 years. Evidence of Aboriginal occupation has been found dated to between 40 000 years and 60 000 years BP (before present) at Lake Mungo in southwestern NSW.

The Project Site is located within the Murray Darling Basin, which includes the three largest rivers in Australia; the Murray River, the Darling River and the Murrumbidgee River. This region has been occupied by Aboriginal people for over 40 000 years, with early occupation concentrated around the freshwater lakes and rivers and their floodplains.

The Aboriginal people of the Bogan region, including the Wongaibon group that occupied the Project Site, resisted the European invasion of their land. However, by 1845 the European population was well-established and the local Aboriginal people could no longer maintain their traditional lifestyle and were forced to seek work on the local sheep and cattle stations. In 1919, an influenza epidemic devastated the remainder of the Aboriginal population of the Central West and those who survived were moved to a new reserve near Menindee in the 1930s.

4.8.4 Predictive Model

Artefact (2016) developed the following predictive model for the primary site types that may be present in within and surrounding the Project Site.

- Stone artefact size, density and site complexity are likely to be greater near reliable water and the confluence of a number of different resource zones.
- Rock shelters are unlikely to occur, given the absence of large stone outcrops.
- Shell middens are often found close to the ocean or to rivers or streams and are either along banks or within enclosed shelters. It is unlikely that midden material remains within the Project Site.
- It is unlikely that rock engravings, rock art or axe-grinding grooves remain within the Project Site due to the absence of suitable rock surfaces.
- Scarred trees may remain in Project Site. However, as intensive logging would have removed most trees old enough to bear cultural scars, the likelihood of recording a scarred tree is low.
- It is possible that a contact site (a site with evidence of early interaction between Aboriginal people and Europeans) is located within the Project Site.

4.8.5 Registered Sites of Aboriginal Significance

Artefact (2016) undertook a search of the Aboriginal Heritage Information Management System (AHIMS) was conducted on 17 November 2015 over a 30km by 27.5km search area centred on the Project Site.

No Aboriginal archaeological sites registered within the Project Site, with ten registered Aboriginal sites recorded within the search area, the majority of which are located in the vicinity of the Bogan River. Four of the sites were carved or scarred trees, and two were open sites including hearths, with the rest artefact scatters.

4.8.6 Survey Methodology

A survey of the Project Site and surrounding areas was undertaken by Artefact from 11 October 2011 to 13 October 2011. This survey was conducted in order to identify any visible Aboriginal sites or heritage items.

The Project Site and surrounds was divided into survey units with each survey unit surveyed using transects by an archaeologist and representatives from the Bogan Aboriginal Corporation, the Nyngan Local Aboriginal Land Council and an individual Aboriginal stakeholder.

The survey used vehicles to conduct transects of areas with low ground surface visibility and areas that had previously been disturbed by cropping or grazing. Remaining areas were surveyed by transects conducted on foot. Transects examined ground exposures for evidence of artefacts or other traces of Aboriginal occupation.

A handheld GPS was used to record the path of the surveyors. Photographs were taken to represent the landform units, vegetation communities and levels of disturbance along transects.

4.8.7 Survey Results

No Aboriginal sites were recorded during the survey and no areas of moderate or high archaeological potential were located. No particular cultural values were identified by the Aboriginal stakeholders that attended the survey.

4.8.8 Management and Mitigation Measures

In order to ensure that any sites or artefacts of historic heritage are not impacted by the Proposal, an unanticipated finds protocol would be developed to be implemented if unanticipated Aboriginal heritage sites or artefacts are discovered within the Project Site.

4.8.9 Assessment of Impacts

As no Aboriginal sites or areas of archaeological potential were recorded during the survey, and no cultural values were identified, it is assessed that the Proposal would not impact significantly on Aboriginal heritage.

4.9 NON-ABORIGINAL HERITAGE

4.9.1 Introduction

A non-Aboriginal heritage impact assessment for the Proposal was undertaken by Artefact. The resulting report is presented as Part 8 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as Artefact (2016). This subsection of the EIS provides a summary of the Non-Aboriginal heritage impact assessment, and the management and mitigation measures that would be implemented.

The Secretary's Environmental Assessment Requirements issued by DP&E identified "water" as one of the key issues requiring assessment. The principal assessment requirement included "an assessment of the likely ... historic heritage (cultural and archaeological) impacts of the development, having regard to the OEH's requirements".

4.9.2 History of the Project Site and Surrounds

Artefact (2016) state that an 1889 map of the Parish of Gilgai shows that Lot 7, the western section of the Project Site, was originally owned by Harriett E. Bayley, and that a house and tank were present to the north of Lot 7. Lot 1, the eastern section of the Project Site, was originally part of the West Bogan Holding No. 1, Block 497 A, and was held by Henry McKeon.

In 1921, Lot 7 was purchased by Arthur Seaton Machin, who used the property to graze sheep. In 1921, Lot 1 was granted to Clinton Machin, the son of Arthur Seaton Machin, who named the land 'Rosehill'. The Machin family also owned a further 5 438 acres of land in Gilgai and Birrigan.

In 1934, Lot 7 was run by the sons of Arthur Seaton Machin, Oswald, Clinton, Reginald, and Gordon, who sold wool and sheep under the name 'Machin Brothers'. Following the death of Clinton and Reginald in World War Two, Oswald and Gordon continued to run the business.

In 1946 Lot 1 was transferred to Oswald Machin and then subsequently sold to Bruce Johnstone. Lot 7 was sold to John, William, and Raymond Steele.

Since the 1950s, the Project Site and surrounds has continued to be used for agricultural purposes.

4.9.3 Registered Sites of Heritage Significance

Artefact (2016) state that there are no items within the Project Site listed on any of the following registries.

- Register of the National Estate.
- National Heritage List.
- State Heritage Register.
- Any Section 170 Registers.
- Bogan Local Environmental Plan 1991.
- Draft Bogan Local Environmental Plan 2011.

4.9.4 Survey Methodology

A survey of the Project Site and surrounding areas was undertaken by Artefact from 11 October 2011 to 13 October 2011.

The survey used vehicles to conduct transects of areas with low ground surface visibility and areas that had previously been disturbed by cropping or grazing. Remaining areas were surveyed by transects conducted on foot. Transects examined ground exposures for evidence of artefacts or other traces of historic occupation.

A GPS was used to record the path of the surveyors, and to record the coordinates of features, landforms and artefacts along transects. Photographs were taken to represent the landform units, vegetation communities, levels of disturbance and artefacts along transects. A scale was used for photographs where appropriate.

4.9.5 Survey Results

The survey identified one site of heritage significance, located in the northern section of the Project Site, in the vicinity of an existing agricultural dam (**Figure 4.2**). The site, hereafter referred to as the Fig Tree House Site after a substantial fig tree growing in the vicinity, includes a rectangular slab constructed from pieces of rock and brick, a timber structure that is unable to be identified and various surface artefacts. These are likely to be outbuildings associated with a house marked on an 1889 parish map (see Section 4.9.2).

The surface artefacts associated with the Fig Tree House Site include nails, ceramic fragments, glass fragments, a spoon, and a stoneware ink bottle. These artefacts are unable to be dated, but are consistent with artefacts typically found at nineteenth century domestic Australian sites.

It is possible that archaeological desposits associated with the Fig Tree House Site (including building foundations or artefacts) may be present within or immediately surrounding the site. Such evidence could yield information about domestic life and accommodation in rural Australia during the late nineteenth and twentieth centuries, as well as providing dating evidence for the site.

4.9.6 Management and Mitigation Measures

In order to ensure that any sites or artefacts of historic heritage significance are not impacted by the Proposal, the following management and mitigation measures would be implemented.

- The Fig Tree House Site and a 100m buffer around the site would be identified on site plans and no surface disturbing activities would be undertaken within that area.
- An unanticipated finds protocol would be developed to be implemented if unanticipated historical heritage sites or artefacts are discovered within the Project Site.

4.9.7 Assessment of Impacts

The area within 100m of the Fig Tree House Site has been assessed as having high archaeological potential. As the Fig Tree House Site is located approximately 700m north areas of proposed disturbance, the Proposal is not anticipated to impact the Site. No other sites or artefacts of historic heritage significance were identified within or surrounding the Project Site. As a result, Artefact (2016) concluded that the Proposal would not impact significantly on historic heritage.

4.10 VISUAL AMENITY

4.10.1 Introduction

The visual amenity assessment has been prepared by RWC. The following subsections address the existing visual environment, the likely changes to the visual amenity of the Project Site, the management and mitigation measures that would be implemented and assesses the visual impact of the Proposal.

It is noted at the outset that the value placed upon visual amenity and the impacts upon surrounding visual amenity varies from person to person and from location to location. As a result, a visual amenity assessment is, by its nature, is highly subjective. As a result, emphasis has been placed on providing a description of the existing visual amenity surrounding the Project Site and the measures that would be undertaken by the Applicant to minimise potential visual amenity-related impacts on surrounding residents and others. In addition, indicative descriptions and impressions of the anticipated visual landscape following completion of mining-related operations have been provided.

4.10.2 Existing Visual Environment

The existing visual amenity environment surrounding the Project Site is typical of rural areas in Western NSW, with the outlook from most rural residences and other vantage points predominantly that of scrubby vegetation within land used for agriculture (**Plate 4.1**).

The Project Site is effectively screened on all sides by native vegetation within tree lines and as the surrounding topography is largely flat, no views of the Project Site are available from surrounding residences or publicly available vantage points.

The Project Site is, however, located in a landscape with very few artificial light sources.



Plate 4.1
Typical Visual Setting within the Project Site

4.10.3 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential visual amenity-related impacts associated with the Proposal.

- Ensure that active dust suppression is undertaken to reduce the potential for the creation of a ‘dust cloud’.
- Construct the Processing Plant using non-reflective, neutral coloured materials.
- Ensure that night-time lighting is the minimum required for safe operations and that lighting is directed towards the ground (minimising the light spill from the Project Site).
- Ensure that lighting not required would be turned off, particularly in elevated sections of the Project Site, including on the Residue Storage Facility and Processing Plant.
- Undertake regular consultation with surrounding residents and address any visual amenity-related concerns to the extent reasonable and practicable.

4.10.4 Assessment of Impacts

As the Project Site is effectively screened by surrounding vegetation, potential visual amenity impacts are limited to those aspects of the Proposal that would be elevated well above the existing natural land surface such as the Residue Storage Facility and the higher components of the Processing Plant such as the lime silo.

Notwithstanding the above, the closest residence to the active sections of the Project Site would be approximately 3.5km. As a result, it is assessed that the proposed activities would not impact significantly on day-time visual amenity from surrounding residences or publicly available vantage points.

Furthermore, given the small scale of the Proposal and the limited night-time lighting that would be required, it is assessed that the proposed activities would not impact significantly on night-time visual amenity from surrounding residences or publicly available vantage points.

Finally, the proposed final landform would also provide for a landscape amenable for future agricultural and nature conservation uses and should therefore eventually blend with the surrounding undisturbed lands.

4.11 BUSHFIRE

4.11.1 Introduction

The bushfire assessment has been prepared by RWC. This subsection identifies the dominant vegetation type(s) within the Project Site and surrounding landholdings in order to determine the potential bushfire hazard associated with the Proposal. In identifying the bushfire hazard, the document “*Planning for Bushfire Protection*” produced by NSW Rural Fire Service in consultation with the then Planning NSW (now Department of Planning) in 2001 (RFS, 2001) has been referenced to guide the assessment.



Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to bushfire and their risk rankings after the adoption of standard mitigation measures are as follows.

- Fire initiated off site threatening mine operations and infrastructure (Low).
- Fire initiated on site threatening Site operations or spreading off site and impacting on stock and infrastructure (Low).

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "noise" as one of the key issues requiring assessment. The principal assessment requirement includes "an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks".

4.11.2 Existing Bush Fire Hazard Environment

Figure 4.6 presents the land uses within and surrounding the Project Site and **Figure 4.7** presents the vegetation communities identified by EnviroKey (2016). In summary, the vegetation within and surrounding the Project Site may be classified as follows.

- Woodland – areas of native vegetation, including tree lines and areas not used for agriculture.
- Cleared land – including areas used for agriculture.

4.11.3 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential bushfire-related impacts associated with the Proposal.

- Ensure that refuelling is undertaken within designated fuel bays or within cleared area of the Project Site.
- Ensure that a no smoking policy to be enforced in designated areas of the Project Site.
- Ensure that fire extinguishers and/or firefighting infrastructure such as pumps, hydrants, hoses and sprinklers are located and maintained within the Processing Plant Area, site vehicles and refuelling areas.
- Ensure that a water cart is available to assist in extinguishing any fire ignited.
- Ensure that suitable firebreaks are established and maintained.
- Ensure that the Rural Fire Service is consulted in relation to management of bushfire risks within the Project Site and the Applicant's capability to respond to off-site bushfire events.

4.11.4 Assessment of Impacts

Taking into account the fact that the proposed activities would largely be undertaken within a bunded and cleared area, the potential for the Proposal to impact on or be impacted by bushfire is negligible.

4.12 SOILS AND LAND CAPABILITY

4.12.1 Introduction

A soils and land capability impact assessment for the Proposal was undertaken by Strategic Environmental & Engineering Consulting (SEEC). The resulting report is presented as Part 9 of the *Specialist Consultant Studies Compendium* and is hereafter referred to as SEEC (2016). This subsection of the EIS provides a summary of the soil and land capability assessment, and the management and mitigation measures that would be implemented to minimise impacts.

Based on the risk analysis undertaken for the Proposal (Section 5.1 and **Table 5.4**), the potential impacts relating to surface water and their risk rankings after the adoption of standard mitigation measures are as follows.

- Inadequate soil available for rehabilitation purposes leading to less successful rehabilitation and increased rehabilitation costs and maintenance (Moderate).
- Degradation of soil in stockpiles leading to less successful rehabilitation and increased rehabilitation costs and maintenance to the Mine Area (Moderate).
- Erosion of soil stockpiles leading to increased sediment loads in creeks (Low).

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "land" as one of the key issues requiring assessment. The principal assessment requirement included:

- "an assessment of the likely impacts of the development on the soils and land capability of the site and surrounds;
- an assessment of the likely agricultural impacts of the development;
- an assessment of the likely impact of the development on landforms (topography), including the long term geotechnical stability of any new landforms (such as overburden dumps); and
- an assessment of the compatibility of the development with other land uses in the vicinity of the development in accordance with the requirements in Clause 12 of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007".

4.12.2 Existing Soils Environment

4.12.2.1 Regional Soils Setting

The Project Site is located within the broader context of the Pangee Land System, which occurs on level plains of Quaternary alluvium derived from the undulating land between Cobar and the Bogan River. The Pangee Land System overlies Silurian and Siluro-Devonian siltstones and sandstones.

4.12.2.2 Project Site Soils

SEEC (2016) identify that the Project Site is underlain by Unit 1 of the Pangee Land System which is described as "Unit 1 – Level Plains relief to 2m: Deep calcareous red earths with hardpan; isolated Gilgai areas".

SEEC (2016) excavated soil test pits in 2011, and samples were collected for laboratory analysis. The test pits and subsequent laboratory tests showed that the Project Site soils conform to the expectations of the land system mapping.

The following subsections present a summary of the various soil horizons present within the Project Site.

4.12.2.3 A1-Horizon (Topsoil)

The A1-Horizon (topsoil) is a sandy loam. It is characterised as follows:

- Type C for the purpose of sediment basin design.
- Non sodic.
- Non saline.
- Moderately alkaline.
- Moderate CEC.
- Saturated with cations.
- Very low in organic matter.
- Highly erodible by water and moderately erodible by wind.

4.12.2.4 A2-Horizon

The A2-Horizon is a sandy loam. It is characterised as follows:

- Type C for the purpose of sediment basin design.
- Marginally sodic.
- Non saline.
- Strongly alkaline.
- Moderate CEC.
- Saturated with cations.
- Extremely low in organic matter.
- Highly erodible by water and moderately erodible by wind.

4.12.2.5 B-Horizon

The B-Horizon is a gravelly sandy clay loam. It is characterised as follows:

- Type C for the purpose of sediment basin design.
- Highly sodic (the fine matrix).
- Non saline.
- Very strongly alkaline.

- Moderate CEC.
- Saturated with cations.
- Extremely low in organic matter.
- Moderately erodible by water and wind.

4.12.3 Land and Soil Capability

The Project Site's Land and Soil Capability (LSC) is assessed by considering its biophysical features and individual hazards in accordance with the document *The Land and Soil Capability Assessment Scheme* (OEH, 2012). The results of that assessment are presented in **Table 4.23**. In summary, the LSC ratings of the Project Site range from Class 1 to Class 3. As a result, the most limiting LSC rating, namely Class 3 has been applied to soils within the Project Site. Class 3 land is described by Office of Environment and Heritage (2012) as follows.

"Class 3 land has limitations that must be managed to prevent soil and land degradation. However, the limitations can be overcome by a range of widely available and readily implemented land management practices".

Table 4.23
Land and Soil Capability Hazard assessments

Hazard	Description	LSC Class Rating
Water erosion (Slope Class)	The site has slopes between 1 and 3%.	Class 3
Wind erosion	Surface soil is fine sandy loam to sandy clay loam with 20% clay (class low). Mean annual rainfall is <500mm. Wind erosive power is low. Exposure is high (open plain).	Class 3
Soil structure decline hazard	Surface soil is sandy loam to sandy clay loam with 20% clay.	Class 3
Soil acidification hazard	Surface soils are sandy loam to sandy clay loam. pH (CaCL2) is 7.4. Mean annual rainfall is <550mm.	Class 2
Salinity hazard	Recharge potential is low. Discharge potential is low. Soils are non to slightly saline.	Class 1
Water logging hazard	Soils are moderately drained	Class 2
Shallow soil and rockiness hazard	Soil depth is >100cm. There is no bedrock exposure.	Class 1
Mass movement hazard	Mean annual rainfall is >500mm. No mass movement present.	Class 1

Source: SEEC (2016) – Table 15

4.12.4 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential soil and Land capability-related impacts associated with the Proposal.

- Strip topsoil and subsoil together to a depth of approximately 300mm.
- Ensure that sufficient soil stripped and stockpiled to enable 300mm of soil to be placed over the rehabilitated landform, namely the Processing Plant Area, Residue Storage Facility, Borrow Pit and all other associated disturbance, with the exception of the open cuts which would remain as voids (see Section 2.13.3).
- Store stripped topsoil would be stored in stockpiles no more than 3m in height, and side slopes of 1:3 (V:H) or shallower.
- Ensure soil is not be stripped when either excessively dry or wet to preserve soil structure.
- Establish ground cover on soils exposed for more than two months in order to minimise wind and water erosion potential, and the threat of soil structural decline. Spray-on polymer covers or mulches may be used until vegetation can become established.
- Prevent the operation of machinery on soil stockpiles once formed and shaped to avoid compaction.
- Ensure that weeds are managed so that they do not become established on the soil stockpiles.

4.12.5 Assessment of Impacts

Based on the assessment provided by SEEC (2016) and the proposed management and mitigation measures, it is assessed that the Proposal would not result in significant soil or land capability impacts.

4.13 AGRICULTURAL LANDS AND ENTERPRISES

4.13.1 Introduction

The agricultural lands and enterprises assessment has been prepared by RWC. The following subsections address the agricultural setting of and likely changes to the surrounding agricultural activities undertaken within and surrounding the Project Site, and the management and mitigation measures that would be implemented, and assesses the anticipated impact of the Proposal on agricultural lands and enterprises.

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "land" as one of the key issues requiring assessment. The principal assessment requirement includes "an assessment of the likely agricultural impacts of the development".

4.13.2 Agricultural Setting

As presented in Section 4.1.5.2, the agricultural land uses surrounding the Project Site include grazing and cropping, with areas and structures of rural residential land use.

According to SEEC (2016), the land within the Project Site may be classified as Class 3 land, or land capable of sustaining cultivation on a rotational basis.

4.13.3 Potential Impacts

The Proposal would result in the following potential agricultural impacts.

- Disturbance of approximately 68.6ha of land that would be returned to agricultural uses following completion of the Proposal.
- Disturbance of approximately 76.4ha of land that would be returned to nature conservation or water storage and would be removed from agricultural operations.

4.13.4 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to minimise the potential agricultural-related impacts associated with the Proposal.

- Ensure that appropriate weed and pest management programs are implemented in consultation with surrounding landholders and the Bogan Shire Council weeds officer.
- Ensure that appropriate bush fire management measures as identified in Section 4.11.3 are implemented to prevent initiation of a bushfire within the Project Site or management of any fire that may impact on the Project Site.
- Ensure that preference for employment and service contracts is provided to residents and businesses within the Bogan Local Government Area and that opportunities for part-time or job sharing or that suitable rosters are provided to enable farmers to continue to operate their properties while earning an off-farm income through the Proposal.

4.13.5 Assessment of Impacts

Taking into account the fact that the Proposal would result in limited disturbance, either directly or indirectly or agricultural operations, the proposed activities are likely to have negligible adverse impacts on agricultural activities in the vicinity of the Project Site.

4.14 SOCIO-ECONOMIC ENVIRONMENT

4.14.1 Introduction

The visual amenity assessment has been prepared by RWC. This subsection provides an overview of the existing socio-economic setting, describes the economic contribution of the proposal, outlines the proposed management and mitigation measures and reviews the potential impacts upon the local and wider communities.

In addition, the Secretary's Environmental Assessment Requirements issued by DP&E identified "traffic and transport" as one of the key issues requiring assessment. The principal assessment requirement included:

- "an assessment of the likely social impacts of the development; and
- an assessment of the likely economic impacts of the development, paying particular attention to:
 - the significance of the resource;
 - economic benefits of the project for the State and region; and
 - the demand for the provision of local infrastructure and services".

4.14.2 Policy Context

4.14.2.1 Introduction

The following strategies and plans have been identified as applying to the region in which the Project Site is located and, as such, the objectives and aims of each has been summarised in the following subsections.

- *Orana Regional Action Plan (2012).*
- *Bogan Shire Community Strategic Plan – 2026 (2013).*
- *Bogan Shire Delivery Program 2013 – 2017 (2013).*

4.14.2.2 Orana Regional Action Plan

The *Orana Regional Action Plan* (Orana RAP) was compiled as part of the overarching planning document *NSW 2021 – A Plan to Make NSW Number One* (NSW 2021) prepared by the Department of Premier and Cabinet. The Principal objective of NSW 2021 is to 'rebuild the economy, return quality services, renovate infrastructure and protect our local environment and community'. To achieve that, the Orana RAP identifies, amongst other things, the following actions.

- Stimulate mineral and petroleum investment (Priority 1).
- Leverage opportunity for Orana from the growth within the mining sector (Priority 1).
- Build a strong and skilled local workforce (Priority 1).
- Develop the NSW Freight and Port Strategy (Priority 4).
- Provide funding to local councils to improve local infrastructure (Priority 4).

4.14.2.3 Bogan Shire Community Strategic Plan – 2026

The *Bogan Shire Community Strategic Plan – 2026* was compiled by Council and adopted in March 2013 to ‘identify the community’s main priorities and aspirations for the future and to plan strategies for achieving these goals’. These goals include the following.

- Goal 1 – Build the community by creating a connected and cohesive community with opportunities for all residents, workers and visitors.
- Goal 2 – Connect the community through a transport network which enables efficient movements of people and freight.
- Goal 3 – Manage the environment to support the current and long-term liveability of the Shire.
- Goal 4 – Enhance the health and safety of the community through provision of effective essential services and ensuring equitable access.
- Goal 5 – Develop the economy by stimulating and maintaining economic growth to build a strong economic and support the development of local businesses.
- Goal 6 – Maintain a responsible local government which is open and transparent in delivering responsive services to the community.

A range of strategies exist within the above listed goals that relate to the Proposal. In particular, strategies within Goal 5 (Economy) with the most applicable, socio-economic-related strategies outlined below.

- Strategy 5.1.1 – Work in conjunction with the mines to obtain mutual benefit from an abundance of natural mining resources which provide our shire with opportunities for local economic growth and employment.
- Strategy 5.1.5 – Support and strengthen local businesses networks to encourage the sharing of information and resources to build the capacity of local business and industry.
- Strategy 5.1.4 – Investigate opportunities to support the township of Nyngan and the villages of Girilambone, Coolabah and Hermidale.

4.14.2.4 Bogan Shire Delivery Program (2013 – 2017)

The Bogan Shire Delivery Program was developed and implemented by Council in June 2013 to translate the strategies within the *Bogan Shire Community Strategic Plan* into actions during the 2013 to 2017 period (Council office terms).

Strategies 5.1.1, 5.1.2 and 5.1.3 are identified in the Delivery Program to occur as ‘ongoing’ throughout the 2013 to 2017 period with either the General Manager or the Manager of Development and Environmental Services being the Council contact leader.

4.14.3 Community Profile

4.14.3.1 Surrounding Communities

The Project Site is located within Western NSW, approximately:

- 18km west southwest of the town of Nyngan.
- Approximately 25km east southeast of the village of Hermidale.

The Project Site is located within the Bogan Local Government Area (LGA), fully encompassed by the Orana Region of NSW. Communities surrounding the Project Site include the following.

- Immediate neighbours and local residents surrounding the Project Site (**Figure 4.5**).
- Residents of the town of Nyngan and the village of Hermidale.
- Residents of surrounding rural properties and other areas within the Bogan LGA.

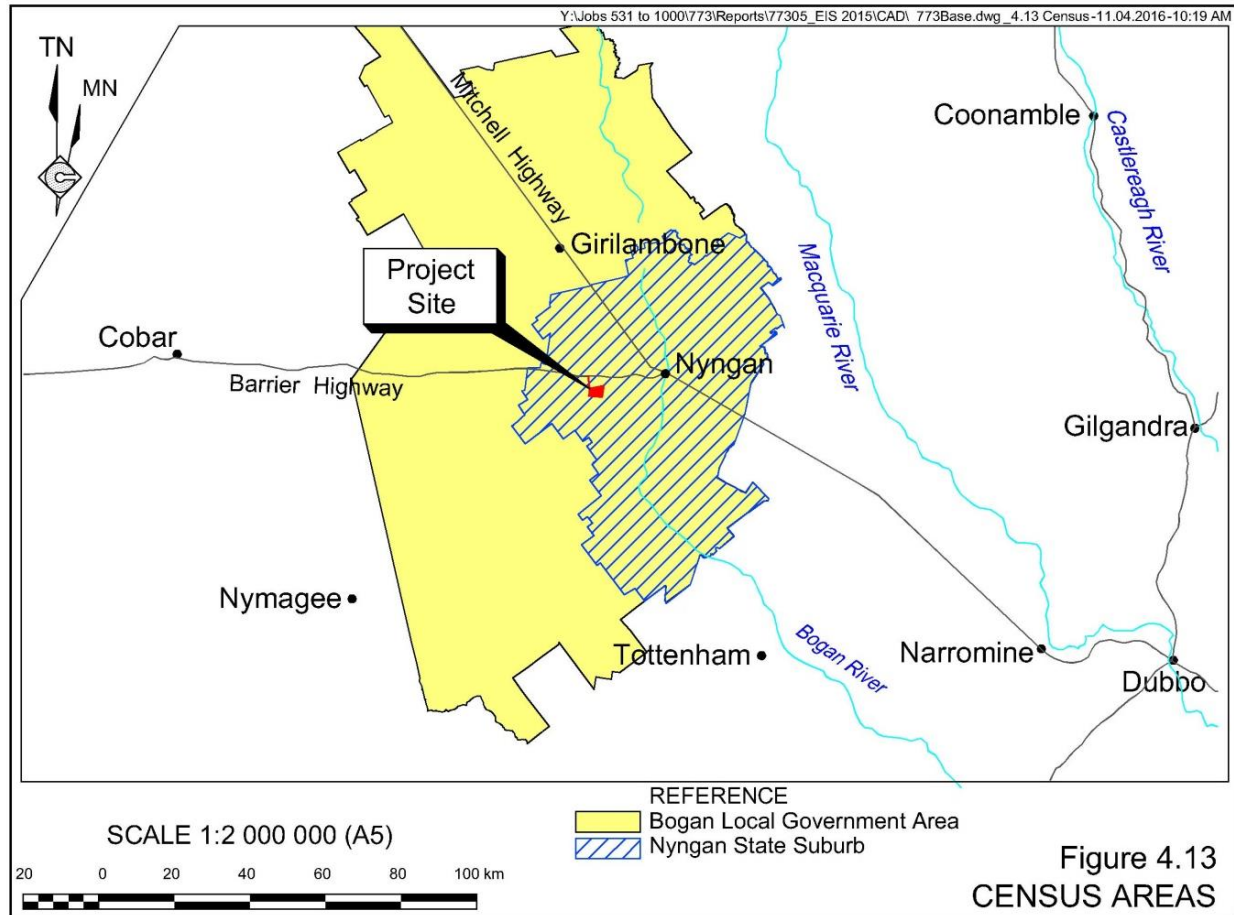
Each of these communities would be impacted to a greater or lesser degree depending on their proximity to the Project Site and the size, resilience and cohesiveness of the relevant community and its economy. For the purpose of this assessment, particular focus is placed on those communities most likely to be impacted by the Proposal, including the regional town of Nyngan and the Bogan LGA.

Nyngan is a regional township of approximately 2 000 people located approximately 660km northwest of Sydney in the geographical centre of New South Wales. The township was originally settled in 1835 by an exploration party but the local village of Canonba, located 28km north of Nyngan was the region's main village up until 1880. It was at this time that the Dubbo-Bourke branch of the Main Western Railway was built through Nyngan and that resulted in the township growing around the railway. Nyngan has continued to serve as an important regional centre but has declined in population over the 20th and 21st centuries due to outward migration.

The Bogan LGA is located within the Orana Region of New South Wales and is surrounded by the Warren LGA to the east, Lachlan LGA to the south, Cobar LGA to the west and the Bourke and Brewarrina LGA's to the north. Nyngan is the largest populated town within the Bogan LGA, with the population of the LGA recorded in 2011 as 2 900. The LGA is generally supported by agricultural production, grazing of sheep and cattle and cropping, primarily wheat, as well as mining activities.

4.14.3.2 Community Statistics

The following demographic data was sourced primarily from the Australian Bureau of Statistics (ABS) 2011 census data, with limited supporting data from the 2006 census (where available). All data has been gathered from the community profile tables and quick data sets from the ABS website (<http://www.abs.gov.au/>). Information is provided for the "Nyngan State Suburb" (Nyngan SS) and the Bogan LGA (**Figure 4.13**) as well as utilising NSW data for comparison purposes.



Population and Age Characteristics

Table 4.24 presents the population data from both the 2006 and 2011 census. In summary, the population of Nyngan SS and Bogan LGA in 2011 were 2 389 and 2 900 respectively. Population growth within the Nyngan SS and the Bogan LGA between 2006 and 2011 was significantly lower than the NSW average, with a population gain of only a 0.9% and 0.6% respectively, including a male population decline of 1.1% in Nyngan SS and 1.2% in Bogan LGA, compared with 5.3% gain for NSW as a whole.

Table 4.24
2006 and 2011 Census Population Statistics

	Nyngan SS			Bogan LGA			NSW		
	2006	2011	%	2006	2011	%	2006	2011	%
Total	2 368	2 389	0.9	2 882	2 900	0.6	6 549 177	6 917 658	5.3
Males	1 221	1 207	-1.1	1 496	1 478	-1.2	3 228 451	3 408 878	5.3
Females	1 147	1 182	3.1	1 386	1 422	2.5	3 320 726	3 508 780	5.4

Source: ABS 2011 and 2006 Census

Table 4.25 presents the 2011 Census population data broken down by age. In summary, the Nyngan SS age statistics are generally comparable to the Bogan LGA statistics across the majority of age brackets. In comparison to the whole of NSW, the Bogan LGA had a higher proportion of people aged between 5 and 14 and 65 and 74 years and a lower proportion of people between 25 and 34 years old. This potentially reflects limited economic and employment opportunities for those in the early stages of their working life.

Table 4.25
2011 Census Age Statistics

	Nyngan SS		Bogan LGA		NSW	
	No.	%	No.	%	No.	%
Children						
0-4	198	8.2	229	7.8	458 735	6.6
5-14	364	15.2	452	15.5	873 776	12.6
Studying or Working						
15-19	147	6.2	169	5.8	443 416	6.4
20-24	140	5.9	159	5.4	449 687	6.5
25-34	238	10.0	283	9.7	941 496	13.6
35-44	326	13.6	414	14.2	971 629	14.1
45-54	298	12.5	374	12.8	950 451	13.7
Approaching Retirement or Retired						
55-64	245	10.3	298	10.2	810 290	11.7
65-74	255	10.7	318	10.9	541 687	7.8
75-84	138	5.8	154	5.3	336 756	4.9
85+	41	1.7	49	1.6	139 735	2.0
Total	2 390		2 900		6 917 658	

Source: ABS 2011 Census

Employment

Table 4.26 presents employment statistics from the 2011 Census. These indicate that more persons are involved in full-time employment in the Nyngan SS and Bogan LGA when compared to NSW total labour force as a whole. The total labour force participation rates indicate that the Nyngan SS (58.9.2%) and the Bogan LGA (59.6%) have equivalent levels of full-time and part-time employment in comparison to NSW (59.7%).

Table 4.26
2011 Census Employment Statistics

	Nyngan SS	Bogan LGA	NSW
	2011	2011	2011
Employed			
Full-time ¹	686 (67.8%)	860 (68.9%)	2 007 925 (63.1%)
Part-time	258 (25.5%)	294 (23.5%)	939 464 (29.9%)
Employed, away from work	41 (4.1%)	55 (4.4%)	120 121 (3.8%)
Employed, hours not stated	27 (2.7%)	38 (3.0%)	70 821 (2.2%)
Total	1 012	1 247	3 138 331
Unemployed, Looking for			
Full-time work	45 (70.3%)	47 (2.1%)	116 697 (1.7%)
Part-time work	19 (29.7%)	29 (1.3%)	79 829 (1.2%)
Total	64	76	196 526
Labour Force Participation			
Total labour force	1 076	1 323	3 334 857
Not in labour force	622	722	1 933 275
Labour force status not stated	128	172	317 017
Total Persons	1 826	2 217	5 585 149
Labour force participation	58.9%	59.6%	59.7%

Source: ABS 2011 Census.

Industry of Employment

Table 4.27 presents employment by industry statistics from the 2011 Census. The most significant industry of employment in the Nyngan SS and Bogan LGA is agriculture, forestry and fishing, with 18.5% and 26.3% respectively, compared to the State average of 2.2%. Importantly, mining comprised 11.9% and 11.1% of employment within the Nyngan SS and Bogan LGA respectively, compared with the State average of 1.0%. This reflects the importance of mining within the local community and the reliance that the community places on the off-farm income that the industry provides.

Table 4.27
2011 Census Industry of Employment Statistics

	Nyngan SS		Bogan LGA		NSW	
	2011	% of Labour Force	2011	% of Labour Force	2011	% of Labour Force
Agriculture, forestry & fishing	188	18.5%	328	26.3%	69 576	2.2%
Mining	121	11.9%	138	11.1%	31 186	1.0%
Manufacturing	26	2.6%	31	2.5%	264 865	8.4%
Electricity, gas, water & waste services	16	1.6%	15	1.2%	34 203	1.1%
Construction	55	5.4%	55	4.4%	230 057	7.3%
Wholesale trade	7	0.7%	13	1.0%	138 890	4.4%
Retail trade	112	11.0%	116	9.3%	324 727	10.4%
Accommodation & food services	62	6.1%	72	5.8%	210 380	6.7%
Transport, postal & warehousing	44	4.3%	52	4.2%	155 027	4.9%
Information media & telecommunications	3	0.3%	4	0.3%	72 488	2.3%
Financial & insurance services	8	0.8%	9	0.7%	158 422	5.1%
Rental, hiring & real estate services	3	0.3%	4	0.3%	51 554	1.6%
Professional, scientific & technical services	22	2.2%	24	1.9%	247 295	7.9%
Administrative & support services	32	3.2%	37	3.0%	102 354	3.3%
Public administration & safety	75	7.4%	77	6.2%	192 634	6.1%
Education & training	80	7.9%	93	7.5%	248 951	7.9%
Health care & social assistance	97	9.6%	110	8.8%	364 321	11.6%
Arts & recreation services	11	1.1%	11	0.9%	46 330	1.5%
Other services	23	2.3%	23	1.8%	117 615	3.8%
Inadequately described/Not stated	29	2.9%	36	2.9%	77 455	2.5%
Total	1 014		1 248		3 138 330	

Source: ABS 2011 Census

Income

Table 4.28 presents income statistics from the 2011 Census. The data indicates that the median individual, family and household incomes in the Nyngan SS are greater than those of Bogan LGA, but are less than for NSW as a whole.

Table 4.28
2011 Census Income Statistics

	Nyngan SS	Bogan LGA	NSW
Median individual income (\$/weekly)	\$498	\$478	\$561
Median family income (\$/weekly)	\$1,215	\$1,182	\$1,477
Median household income (\$/weekly)	\$917	\$902	\$1,237
Source: ABS 2011 Census			

Housing Cost

Table 4.29 presents housing cost statistics from the 2011 Census. The data indicates that the Nyngan SS median housing loan monthly repayment was 6.0% higher than Bogan LGA, and 42.4% lower than NSW, with median weekly rents displaying similar trends with Nyngan SS approximately 7.1% higher than Bogan LGA, and 50% lower than NSW.

Table 4.29
2011 Census Cost of Housing and Household Size Statistics

	Nyngan SS	Bogan LGA	NSW
Median housing loan repayment (\$/monthly)	\$1,148	\$1,083	\$1,993
Median rent (\$/weekly)	\$150	\$140	\$300
Average number of persons per bedroom	1.1	1.1	1.1
Average household size	2.4	2.5	2.6
Source: ABS 2011 Census			

Education

Table 4.30 presents post-school education statistics from the 2011 Census. The data indicates that fewer people hold bachelor degrees, graduate diplomas and postgraduate degrees (university level education) in the Nyngan SS and Bogan LGA than for NSW as a whole. By contrast, people with certificate levels and advanced diplomas (TAFE level education) were more common in the Nyngan SS and Bogan LGA when compared to NSW. This may reflect the general lack of accessible universities for residents of in the Bogan LGA and limited professional opportunities for those with such qualification. By contrast, the higher proportion of TAFE-based qualification identifies that the Nyngan-based TAFE is critical infrastructure for the local population.

Table 4.30
2011 Census Post School Level of Education

	Girilambone SS	Bogan LGA	NSW
Postgraduate Degree Level	15 (1.8%)	15 (1.5%)	238 851 (7.5%)
Graduate Diploma and Graduate Certificate Level	13 (1.6%)	14 (1.4%)	82 617 (2.6%)
Bachelor Degree Level	126 (15.8%)	146 (15%)	787 336 (24.6%)
Advanced Diploma and Diploma Level	65 (8.1%)	95 (9.8%)	462 059 (14.4%)
Certificate Level	325 (40.6%)	387 (39.9%)	986 704 (30.9%)
Level of education inadequately described	14 (1.8%)	16 (1.7%)	100 290 (3.1%)
Level of education not stated	242 (30.3%)	298 (30.7%)	539 067 (16.9%)
Total	800	971	3 196 924
Source: ABS 2011 Census			

4.14.3.3 Community Facilities and Social Infrastructure

While Census data provides a range of information in relation to population statistics, a range of other factors are indicative of the level of social cohesiveness and resilience of communities. This subsection provides an overview of the facilities and social infrastructure that exist within the communities surrounding the Project Site.

Education

Early Childhood

A range of childcare services and support groups for younger children exist within the Bogan LGA and include, but are not limited to the following:

- A preschool centre in Nyngan offering a variety of early childhood services, including day care and pre-schooling, catering for children between the ages of 3 and 5.
- The Bogan Bush Mobile is a mobile playgroup that caters to children up to 6 years throughout the Bogan LGA.

Schools

Table 4.31 presents the number of public primary and secondary schools within the Bogan LGA, along with enrolment numbers.

Consultation with Regional Asset Planners for the Department of Education and Training for Western NSW identified that the Department takes a “whole of region” approach to managing capacity, with demountable classrooms available to all public schools where demand requires additional classroom space.

Table 4.31
Schools within the Bogan LGA

School	Years Available	Enrolment numbers (Pupils)*
Nyngan High School	Years 7 – 12	180
Nyngan Public School	Kindergarten – Year 6	142
Marra Creek Public School	Kindergarten – Year 6	10
St Joseph’s (private)	Kindergarten – Year 6	148
Hermidale Public School	Kindergarten – Year 6	14
Girilambone Public School	Kindergarten – Year 6	16
Pre-school	3 – 5 years old	Unknown
Pre-school (mobile)	0 – 6 years old	Unknown
* 2012 information		
Source: Department of Education and Training		

Higher Education

Nyngan College, a TAFE Western branch of TAFE NSW, is the only tertiary or adult education facility within the Bogan LGA and focuses on programs for the local community in agricultural, business and computing. Courses at Nyngan College include the following.

- Aboriginal programs.
- Agriculture, Horticulture and Animal Care.
- Arts, media and entertainment.
- Building, construction and architecture.
- Business, finance and property services.
- Environment and Conservation.
- Hairdressing and Beauty.
- Health and community services.
- Vocational Access.
- Information and communications technology.
- Language.
- Manufacturing and Engineering.
- Mining.
- Sport and recreation.
- Textiles, clothing, footwear and furnishings.
- Tourism, Travel and Hospitality.
- Transport: Automotive.

Health

A local public hospital, namely the Nyngan Multi-Purpose Service, caters for accidents and emergency services, admissions, aged care and outpatient services. The service also contains an ambulance service for transportation to surrounding hospitals for additional treatment, such as childbirth, mental health conditions and surgery.

Two general practice surgeries also exist in Nyngan, along with a dental surgery and pharmacy.

Recreational and Cultural Facilities

There is a large variety of recreational and cultural facilities available in the Bogan LGA, with most centred on the town of Nyngan. Cultural and tourism facilities include:

- the Nyngan Museum, Mid State Shearing Shed, Nyngan Agricultural Show grounds and annual show;
- Cobb and Co. Heritage Trail Tour and historical buildings throughout the township;
- Macquarie Marshes; and
- Bogan River (for water sports, fishing and other water activities).

Sporting and recreational infrastructure in Nyngan include:

- various sporting fields that accommodate a variety of sporting clubs (rugby league, soccer, netball, cricket and Little Athletics);
- a golf club;
- a lawn bowling club;

- a jockey club;
- a pony club;
- a tennis club;
- a boxing club;
- water ski club; and
- the Nyngan and District War memorial Swimming Pool and associated swimming club.

Other Community Facilities and Groups

A number of community facilities and social organisations exist in Nyngan, including:

- the Bogan Shire Library;
- craft groups;
- water sports clubs;
- scouts and girl guides clubs;
- a Men's Shed;
- Nyngan Garden Club;
- the Country Women's Association (CWA);
- Lions Club International; and
- Rotary International.

4.14.3.4 Economic Profile

The township of Nyngan, and by virtue the wider Bogan LGA, includes numerous industries and related businesses, including the following.

- | | |
|---|---|
| • Automotive Sales. | • Hardware. |
| • Accountants. | • Clothing. |
| • Gift Shops. | • News Agency and Post Office. |
| • Real Estates. | • Banking. |
| • Trades (Electricians, plumbers, engineers). | • Computing services. |
| • Restaurants, Cafes and Take-aways. | • Fuel stores. |
| • Hair and Beauty services. | • Insurance services. |
| • Rural supply services. | • Tourism services, including
the Mid State Shearing Shed. |
| • Caravan Park. | • Motels. |
| • Bed and Breakfasts. | • Pubs. |

4.14.4 Socio-Economic Adverse and Beneficial Impacts Provided by the Proposal

Adverse Impacts

Considering the relative isolation of the Project Site, the previously considered impacts on local noise, air quality and traffic would each have a minor impact on the properties within and adjacent to the Project Site.

Beneficial / Positive Impacts

The Project would provide direct full-employment for up to 75 people on a full time equivalent throughout the life of the Proposal. As it is the intention of the Applicant to source the majority of the Proposal workforce from the Nyngan and surrounding areas, this would have a positive impact on economic activities within Western NSW. Furthermore, in a similar manner to the Tritton Copper Mine, which is also located within the Bogan Local Government Area, the Proposal would provide important seasonal or part-time work for property owners and others within the agricultural industry, providing important off-farm income for those individuals. Anecdotal evidence from workers at the Tritton Copper Mine indicates that the income provided by that operation has prevented a number of farming operations from becoming unviable, with the significant social and economic impacts that these unviable operations would involve.

The Proposal would also contribute approximately \$12.4 million per year to the local and regional economies through the purchase of consumables and payment of wages. This expenditure is likely to generate additional economic activity and flow on effects within the Bogan LGA, providing further employment opportunities. The Proposal would also generate ongoing support for training and education of employees.

The Project would also contribute to the national and State economies through the payment of taxes and royalties and the purchase of goods and services from outside the local area.

4.14.5 Management and Mitigation Measures

In addition to the mitigation measures and management procedures relating to amenity aspects such as noise, air quality, visibility, transportation etc., described previously in Section 4, the Applicant would implement the following management and mitigation measures to ensure that Project-related benefits for the community surrounding the Project Site are maximised and adverse impacts are minimised, particularly given the small size of the surrounding communities.

- Engage in regular dialogue with surrounding residents in relation to the Applicant's activities and implement and maintain an "open door" policy for interested parties to discuss aspects of those activities that may be perceived as problematic.
- Negotiate a Voluntary Planning Agreement with Bogan Shire Council to ensure an equitable contribution to the local community, without adversely impacting on the financial robustness of the Proposal.

- Support community organisations, groups and events, as appropriate, and review any request by a community organisation for support or assistance.
- Form and maintain a Community Consultative Committee (CCC).
- Regularly brief the CCC and wider community on the Applicant's activities and seek feedback in relation to any actual or perceived adverse impacts. Seek advice on how to provide assistance to resolve issues raised by any member of the community in an effective, fair and equitable manner.
- Maintain a community complaints telephone line and ensure that the existence of the number is advertised widely.
- Give preference when engaging new employees, where practicable, to candidates from the surrounding communities over candidates with equivalent experience and qualifications from elsewhere and ensure that the mining and other contractors do so as well.
- Facilitate seasonal, part time and casual work that takes into account the requirements of surrounding agricultural operations.
- Encourage the involvement of the local Aboriginal community in the workforce.
- Encourage and support participation of locally-based employees and contractors in training or education programs to impart the appropriate skillsets and qualifications in them for continued development and economic growth within the surrounding communities following completion of the Proposal.
- Give preference, where practicable and cost-competitive, to suppliers of equipment, services or consumables located within the surrounding communities.
- Encourage and support, in consultation with the local community, the provision of services to the community. These may include health, education, transportation and other services.
- Ensure that the land capability of those sections of the final landform to be used for grazing is similar to the current land capability.

4.14.6 Impact Assessment

The Proposal would result in a range of socio-economic benefits to the community surrounding the Project Site. These benefits would include the following.

- Ongoing employment for up to 75 persons on a full time equivalent basis.
- Contribution to the local, Regional, State and National economies, including contributions of approximately \$12 million per year within the Bogan LGA through wages and salaries and purchase of goods and services, with additional indirect contributions.
- Continued support for local Community Organisations and Services.

Assessment of the potential socio-economic impacts demonstrates the beneficial impacts of the Proposal far outweigh any minor adverse impacts associated with the operations.

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