Section 4

Assessment and Management of Key Environmental Issues

PREAMBLE

This section provides relevant background information relating to the environmental issues identified in Section 3 and listed below.

- *Ecology.*
- *Groundwater.*
- *Surface water.*
- *Noise and blasting.*
- *Aboriginal heritage.*
- *Historical heritage.*
- *Air quality and energy.*
- *Traffic and transportation.*
- *Soils and land capability.*
- *Visual amenity.*
- *Bushfire management.*
- *Socio-economic setting.*

For each identified issue, information relating to the existing environment, the proposed mitigation measures and management procedures that would be implemented throughout the life of the Project, are presented.
A detailed assessment of the likely residual impacts and, where relevant, programs to monitor the potential environmental impacts, are also outlined. The extent of detail provided reflects the potential likelihood and severity of impacts and the priority for each environmental issue determined in Section 3.4.4.

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4.1 BACKGROUND

4.1.1 Introduction

This sub-section presents background information pertinent to the Project Site and the environmental issues that may be impacted upon by the Project. The information presented comprises descriptions of topography, climate, geology, land ownership and residences, land uses and the community surrounding the Project Site.

4.1.2 Topography and Drainage

4.1.2.1 Regional Topography and Drainage

The Project Site is located in an area of typically flat to gently undulating topography with elevations typically between 325m AHD and 375m AHD (**Figure 4.1**). Elevations become generally lower to the north and northwest, with elevations in the vicinity of Cobar, located approximately 70km to the northwest of the Project Site, approximately 100m to 150m lower than in the vicinity of the Project Site. Isolated, steep sided hills occur surrounding the Project Site, including the following.

- Mount Shume (482m AHD) located approximately 23km to the west-southwest of the Project Site.
- Mount Priory (438m AHD) located approximately 17km to the northwest of the Project Site.
- Mount Nymagee (519m AHD) located approximately 10km to the north of the Project Site.
- Mount Babinda (437m AHD) located approximately 22km to the northwest of the Project Site.
- Mount Hathaway (484m AHD) located approximately 10km to the south-southeast of the Project Site.

Surface water drainages in the vicinity of the Project Site are uniformly ephemeral and typically indistinct (**Figure 4.1**). The Project Site is located in the headwaters of the Box Creek Catchment which flows generally to the west and northwest. Immediately to the east of the Project Site, surface waters within the Grahway Pangee Creek Catchment typically flow to the northeast while immediately to the south of the Project Site surface waters within the Crowal Creek Catchment typically flow to the west. All catchments are part of the Barwon Darling and Far Western Catchments. It is likely that most surface water in the vicinity of the Project Site evaporates or infiltrates locally and does not leave the Box Creek Catchment.

4.1.2.2 Local Topography and Drainage

The Area immediately surrounding the Project Site is typically flat to gently undulating, with elevations ranging from approximately 300m AHD to 380m AHD (**Figure 4.2**). A number of small hills with a maximum elevation of more than 400m AHD occur to the north, northwest, south and northeast at distances of between 4km and 10km from the Project Site. Slopes on the flanks of the small hills may be as steep as 1:10 (V:H).

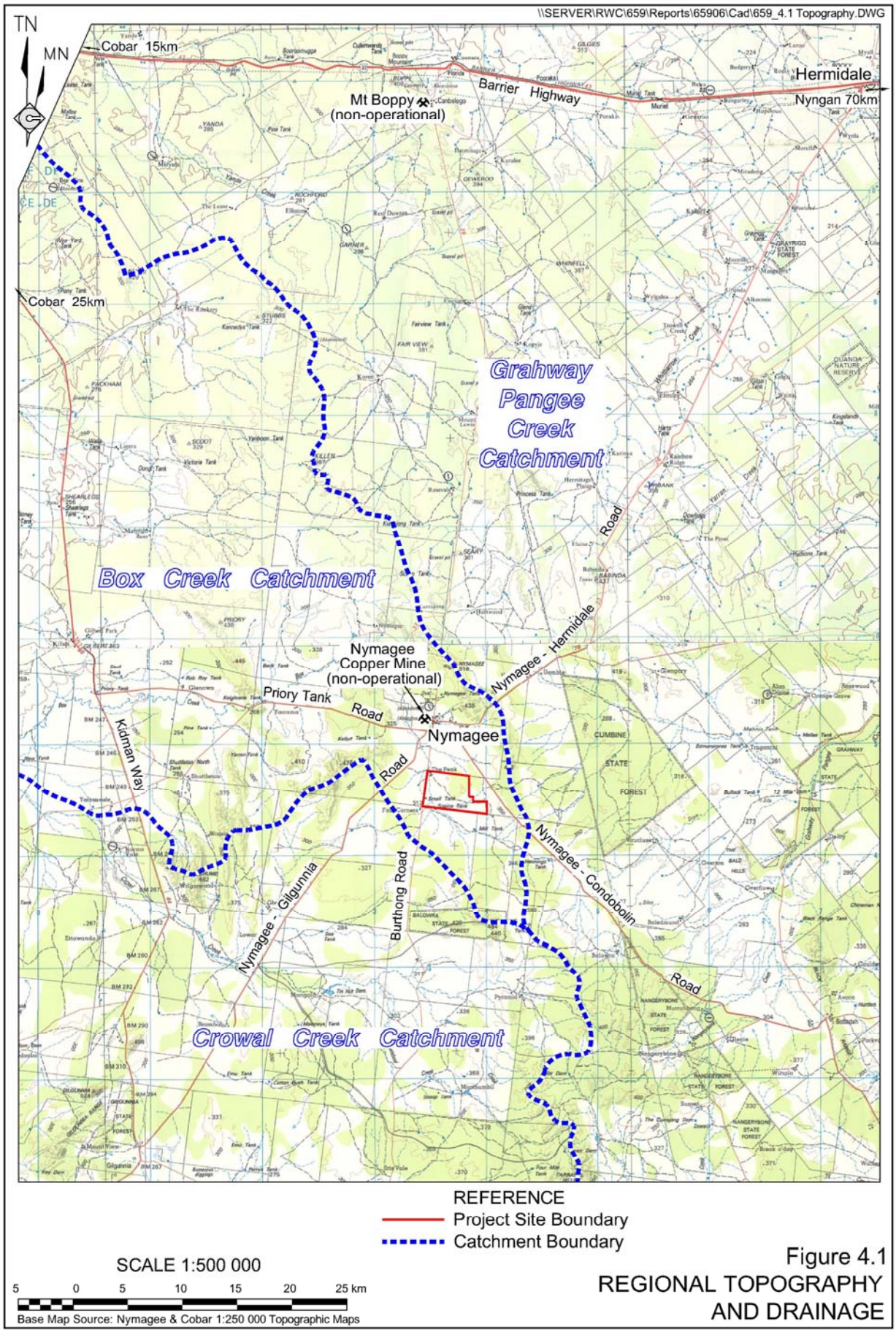


Figure 4.1
REGIONAL TOPOGRAPHY
AND DRAINAGE

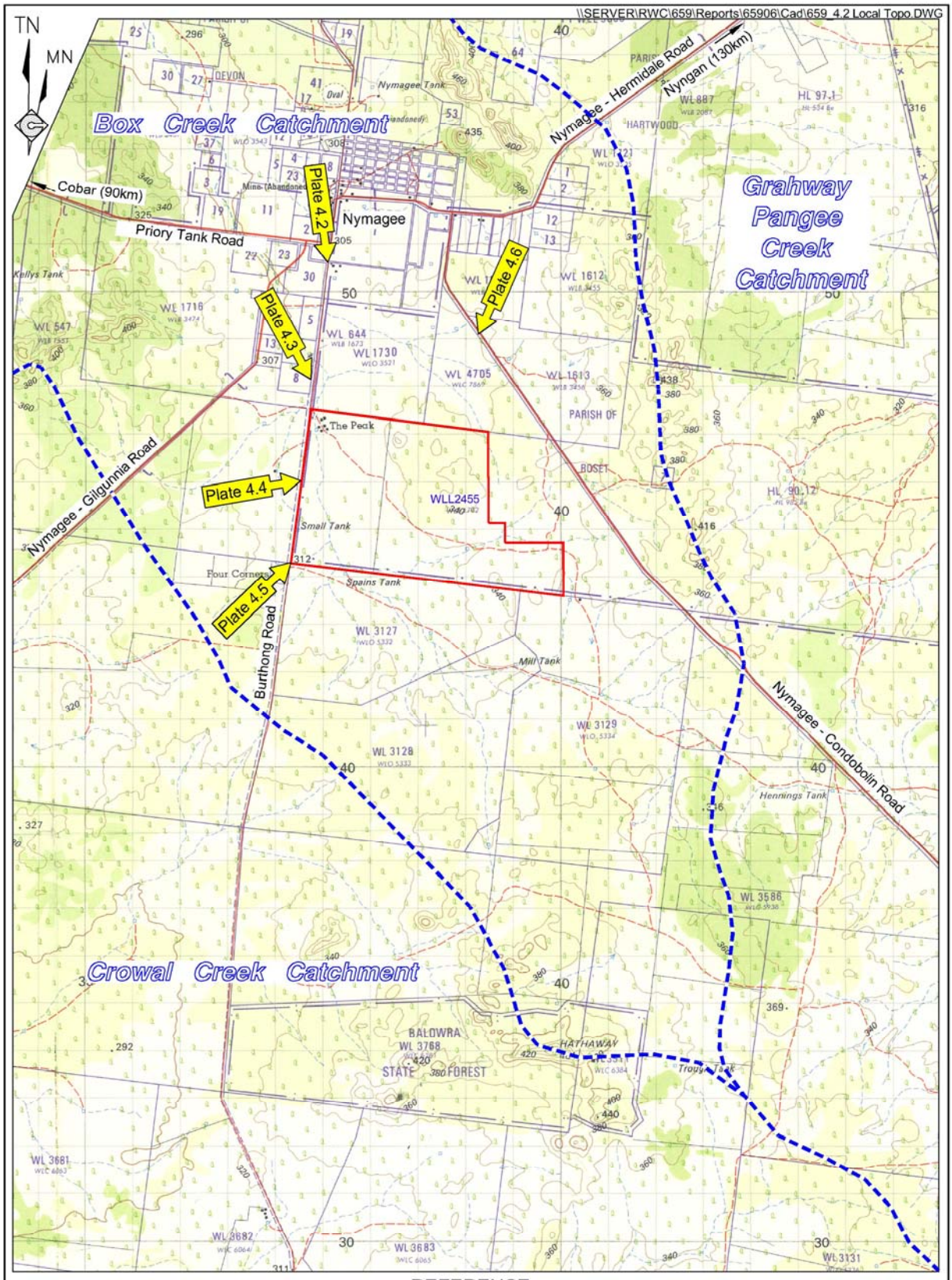


Figure 4.2
LOCAL TOPOGRAPHY AND DRAINAGE

A number of indistinct, ephemeral, unnamed creeks and drainages occur in the vicinity of the Project Site (**Figure 4.2**). Drainages to the south, west, north and immediately east of the Project Site within the Box Creek Catchment all typically flow to the northwest. Drainages further east within the Grahway Pangee Creek Catchment typically flow to the east while drainages in the Crowal Creek Catchment typically flow to the southwest.

4.1.2.3 Project Site Topography and Drainage

The western, southwestern and southeastern sections of the Project Site are typically flat to gently west-sloping, with slopes of 1:80 (V:H) or less **(Figure 4.3)**. The central section of the Project Site is dominated by a series of five hills with maximum elevations from south to north of approximately 468m AHD, 363m AHD, 358m AHD, 375m AHD and 355m AHD. Maximum slopes on these hills are as high as 1:2 (V:H). The northwestern most of these hills is referred to as the Peak, after which the 'The Peak' property was named.

The northeastern section of the Project Site is typically northeast to northwest sloping, with average slopes ranging from 1:20 to 1:80 (V:H). Two small hills with maximum elevation of approximately 348m AHD are located in the northeastern section of the Project Site.

The Project Site is traversed by three unnamed creeks, referred to for the purposes of this document as Watercourses A, B and C (**Figure 4.3**). Watercourse A enters the southwestern section of the Project Site and joins Watercourse B. Watercourse B drains most of the Project Site and flows east to west through the existing Back Tank West. Watercourse C enters the southwestern section of the Project Site and flows into Pete's Tank.

Two catchments exist within the Project Site, referred to as Catchments A and B. Catchment A embraces the majority of the Project Site while Catchment B covers the northeast section of the Project Site boundary. Catchment C occupies the northeastern-most section of 'The Peak' property. All three catchments form sub-catchments within the Box Creek Catchment.

4.1.3 Climate

4.1.3.1 Meteorological Data Sources and Climate Data

Meteorological data were sourced from the following Bureau of Meteorology stations.

- Cobar MO (Station number 048027) – Open station (1962 – present)
- Cobar Post Office (Station number 048030) – Closed (1881 – 1965)

These meteorological stations are located approximately 90km to the northwest of the Project Site. Data from both stations were combined to obtain average temperature and rainfall data for the period 1881 to 2009. All climate data are presented in **Table 4.1**.

4.1.3.2 Temperature

The Cobar region is characterised by a mild to hot climate. January is the hottest month, with a maximum mean temperature of 35°C. July is the coldest month with a mean maximum temperature of 16°C and a minimum temperature of 4°C.

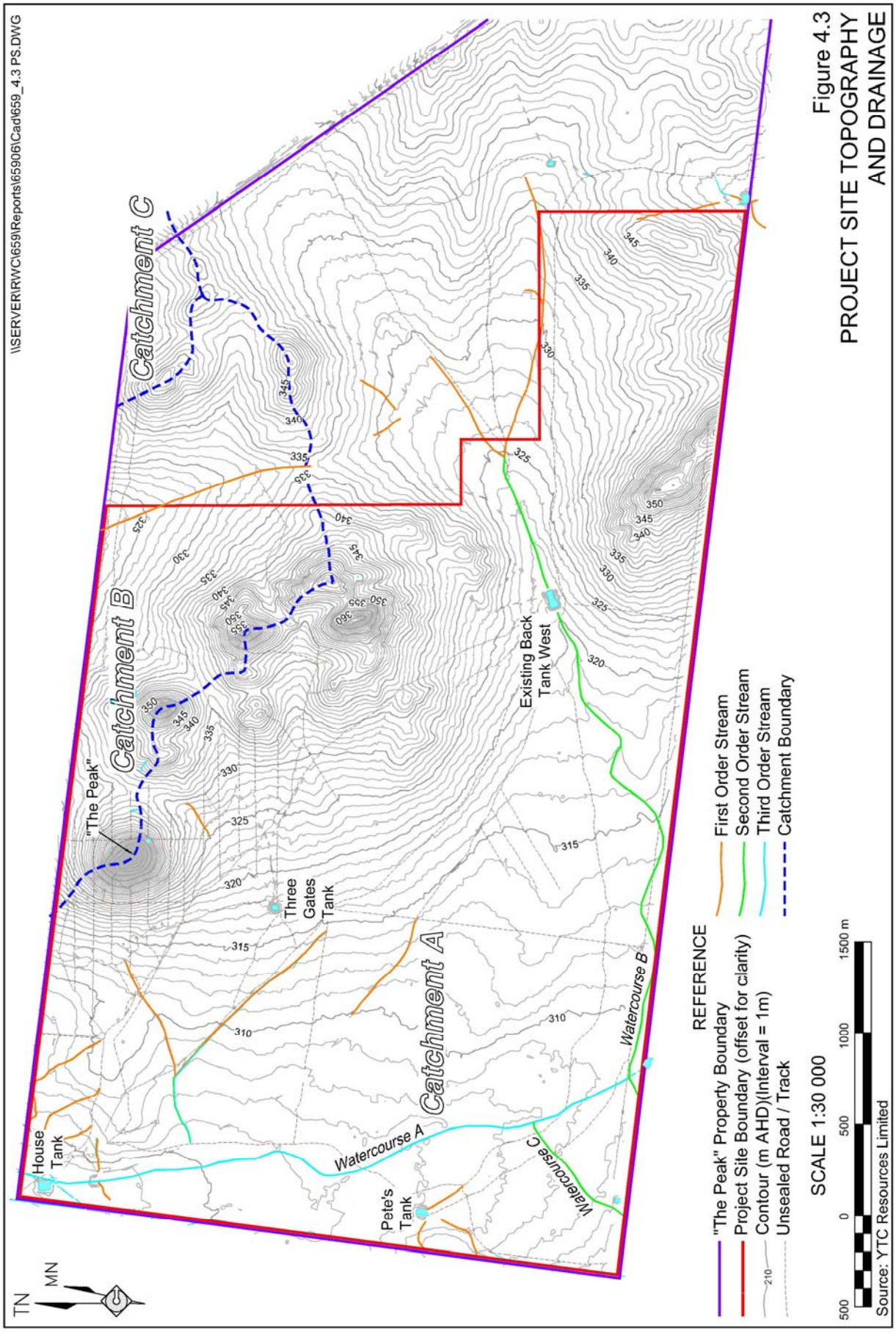

\\SERVER\RWC\659\Reports\659006\Cad\659_4.3 PS.DWG
Figure 4.3
PROJECT SITE TOPOGRAPHY AND DRAINAGE
Catchment C
Catchment B
Catchment A
"The Peak"
Existing Back Tank West
Three Gates Tank
House Tank
Pete's Tank
Watercourse A
Watercourse B
Watercourse C
TN
MN
REFERENCE
"The Peak" Property Boundary
Project Site Boundary (offset for clarity)
Contour (m AHD)(Interval = 1m)
Unsealed Road / Track
First Order Stream
Second Order Stream
Third Order Stream
Catchment Boundary
SCALE 1:30 000
500 0 500 1000 1500 m
Source: YTC Resources Limited

Table 4.1
Climate Data

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Temperature (°C)[1]													
Mean maximum temperature	35	34	31	26	20	17	16	18	22	27	30	33	
Mean minimum temperature	20	19	17	12	8	6	4	6	9	12	16	18	
Rainfall (mm)[1]													
Mean rainfall	38.6	39.1	32.0	26.2	30.1	29.6	25.7	28.5	23.6	32.2	31.5	35.8	373
Highest rainfall	239.6	281.2	238.1	201.4	144	103.6	102.4	114.4	104.6	130.5	157.1	157.8	799.7
Lowest rainfall	1.4	0	0	0	0	0.3	0.2	0	0	0	0.4	1.4	116.3
Highest daily rainfall	113.3	89.7	114.3	71.4	59.4	43.4	44.6	56.9	44.4	52.6	56.6	78.7	114.3
Evaporation (mm)[2]													
Mean daily Evaporation	11.5	10	8.2	5.3	3.1	2.1	2.3	3.4	5.4	7.4	9.5	11.2	6.6
Mean monthly Evaporation[3]	356.5	280	254.2	159	96.1	63	71.3	105.4	162	222	294.5	336	204.6

Note 1: Data Source - Cobar MO (May 1962 – December 2009) and Cobar Post Office (February 1881 – December 1965).
Note 2: Data Source - Cobar MO (1975 to 2010)
Note 3: Calculated from daily average evaporation.
Source: Bureau of Meteorology Stations – Cobar MO NSW (Station No:0428027) & Cobar Post Office (Station No: 0428237))

4.1.3.3 Rainfall and Evaporation

Mean annual rainfall is 373mm, with rainfall distributed reasonably evenly throughout the year, the mean monthly rainfall in the range23.6mm to 39.1mm. Rainfall is, however, characterised by with infrequent, high intensity rainfall events and maximum daily rainfall values are between 2 and 3.5 times average monthly rainfall values. On average 69 rain days occur per year, with 4 to 7 rain days experienced each month on average.

The driest year on record was 1982 when 116.3mm of rain was recorded. By contrast, the wettest year on record was 1891 when 799.7mm of rain was recorded.

Mean daily evaporation varies through the year, from 11.5mm/day in January to 2.1mm/day in June. Annual average evaporation is 2 409mm/year and exceeds average rainfall by between two and nine times in every month of the year.

4.1.3.4 Wind and Atmospheric Stability

An analysis of the wind environment surrounding the Project Site is presented in Environ (2011). In summary, the meteorological model component of the CSIRO prognostic meteorological model, The Air Pollution Model (TAPM), was used to generate annual, seasonal and diurnal wind speed and direction using the 2009 wind data measured at the Cobar MO weather station. The seasonal wind roses generated for the Project Site using TAPM are depicted in **Figure 4.4**. These wind roses show distinct seasonal shifts in the wind field. During summer and autumn, east to south-southwest airflow prevails, with a significantly lower incidence of westerly winds, particularly in summer. With the onset of winter, southwest to northeast winds become increasingly prevalent. Spring shows an increase in southerly and easterly airflow is dominated by westerly and west-northwesterly winds. The strongest winds typically occur from the northerly quadrant.

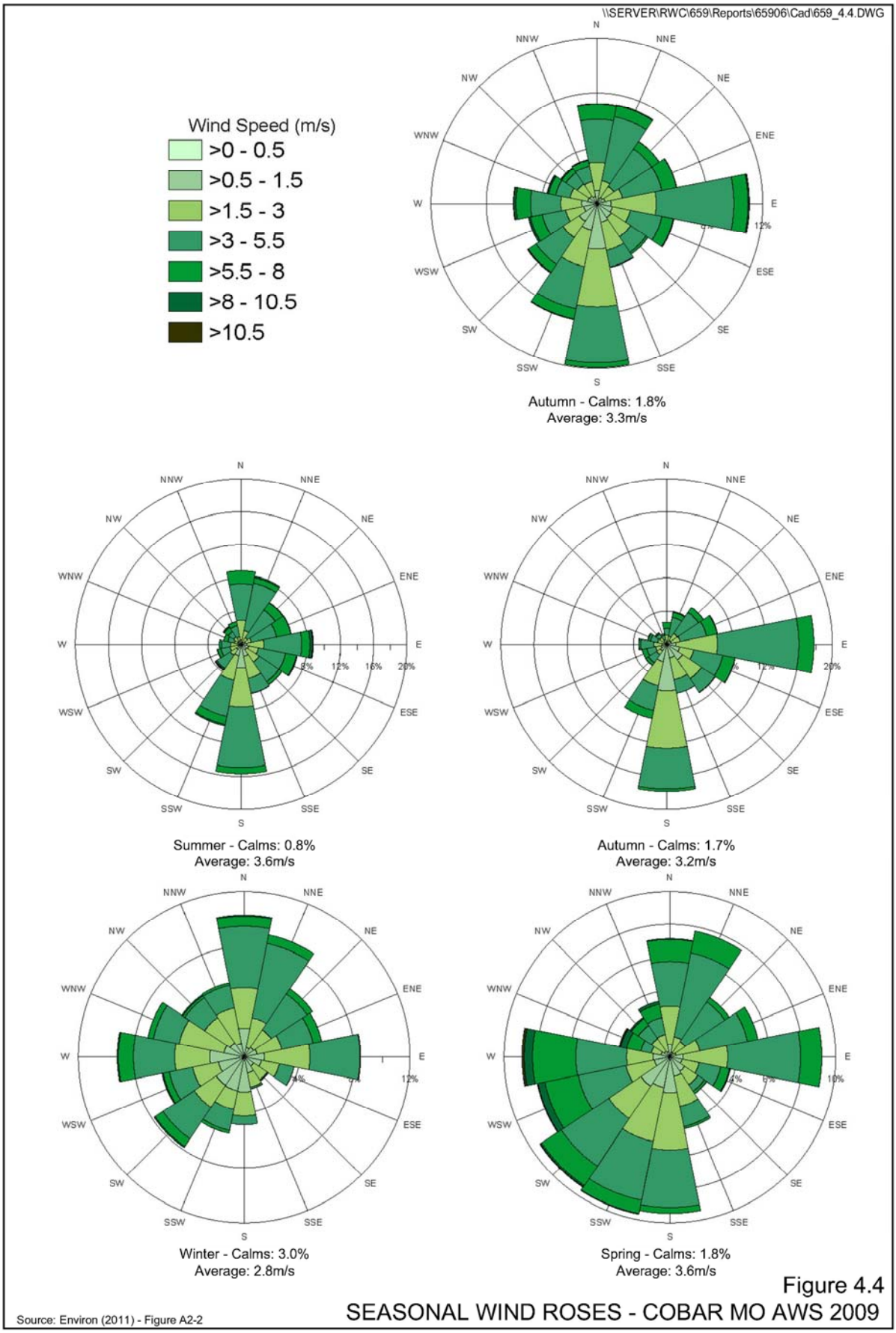


Figure 4.4
SEASONAL WIND ROSES - COBAR MO AWS 2009

Source: Environ (2011) - Figure A2-2

Comparison of day-time and night-time wind roses from the 2009 TAPM Project Site dataset showed no significant diurnal shift in airflow, with day-time and night-time airflow patterns being relatively similar. Daytime wind speeds were on average slightly higher (3.9m/s) than nocturnal wind speeds (3.2m/s), with a similar incidence of calm periods throughout the two periods (1.0% day versus 0.9% night).These results indicate that thermo-topographic flows are not prevalent within the Project Site.

4.1.4 Local and Regional Geology

4.1.4.1 Regional Geology

The Project Site is located entirely within the Nymagee 1:100,000 Geological Sheet. A detailed account of the geology within this area is presented within MacRae (1987). The setting, structure and mineralisation of the Cobar Basin region has been summarised by NSW Geological Survey publications, including Glen (1991 and 1994), Glen et al. (1996), Suppel and Gilligan (1993) and Gilligan and Byrne (1994).

This sub-section presents an overview of that information. The regional geology surrounding the Project Site is shown in **Figure 4.5**. The Project Site is associated with the Girilambone Group, Silurian Granitoids, the Mouramba Group, the Lower Amphitheatre Group and Shume Formation.

The Girilambone Group comprises a predominantly sedimentary sequence of rhythmically bedded fine to coarse-grained quartz sandstone with lesser quartzo-feldspathic sandstone, siltstone and chert. Minor amounts of intercalated basic volcanics, conglomerate and marl are also present (Suppel and Gilligan, 1993).

Two major granitoid bodies intrude the Girilambone Group within the Nymagee area. The Nymagee Igneous Complex occurs to the north and northeast of Nymagee and the Erimeran Granite is located to the southeast and south of Nymagee. Both of these granitoid bodies have been categorized “S-type” (MacRae, 1987) and are described as porphyritic, medium to coarse-grained biotite granites or adamellites (Suppel and Gilligan, 1993).

The Mouramba Group is the eastern-most component of the Cobar Basin and comprises shallow-water sediments with minor volcanics. Two units are described as follows:

- The Burthong Formation consists of a sequence of very fine to medium sandstone to inter-bedded sandstone and siltstone (MacRae, 1987). Several volcanic horizons occur in the more eastern parts and the Hathaway Conglomerate Member, a polymict arkosic conglomerate, occurs in the southern area of Burthong Formation outcrop.
- The Roset Sandstone overlies the Burthong Formation and comprises thick-bedded, cross-bedded and ripple cross-laminated sandstone. The Roset Sandstone is interpreted to have a lensoidal character with inter-fingering between the Roset Sandstone and the underlying Burthong Formation.

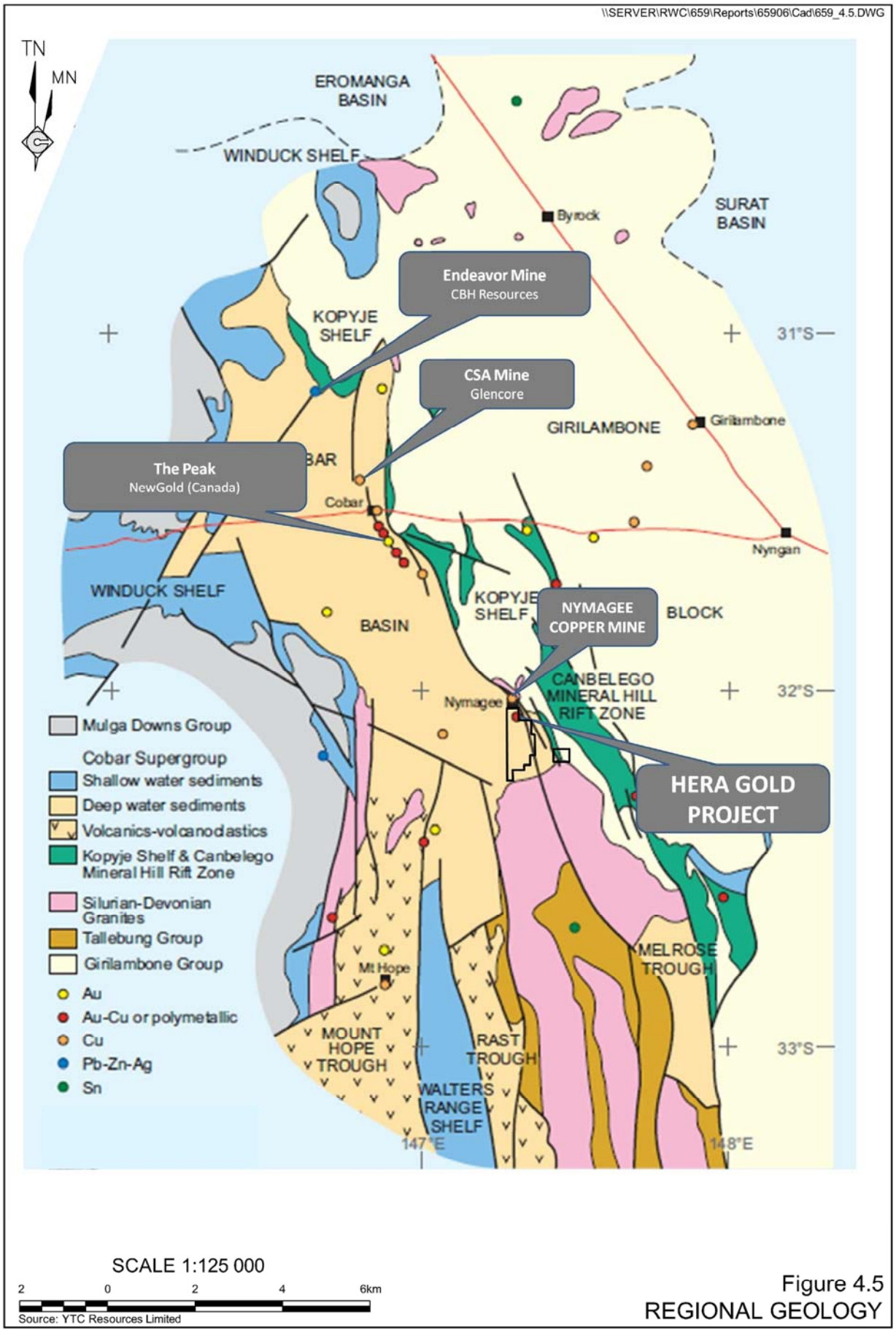


Figure 4.5
REGIONAL GEOLOGY

The Lower Amphitheatre Group is the western-most or younger portion of the Cobar Basin and comprises inter-bedded fine to medium grained sandstone and siltstone. The unit is typically medium-bedded (5cm to 30cm) with a turbiditic character. Sedimentary features include massive, parallel laminations, ripple cross laminations and graded bedding (MacRae, 1987).

The Shume Formation is the interface between the Upper Amphitheatre and the Winduck Shelf and comprises inter-bedded silicified sandstone and minor siltstone. The unit is typically massive, sandstone dominant and forms prominent ridges. The Shume Formation has been correlated to the Biddabirra Formation (MacRae, 1987) and contains minor porphyritic volcanics to the west of the Nymagee licence areas.

4.1.4.2 Local and Project Site Geology

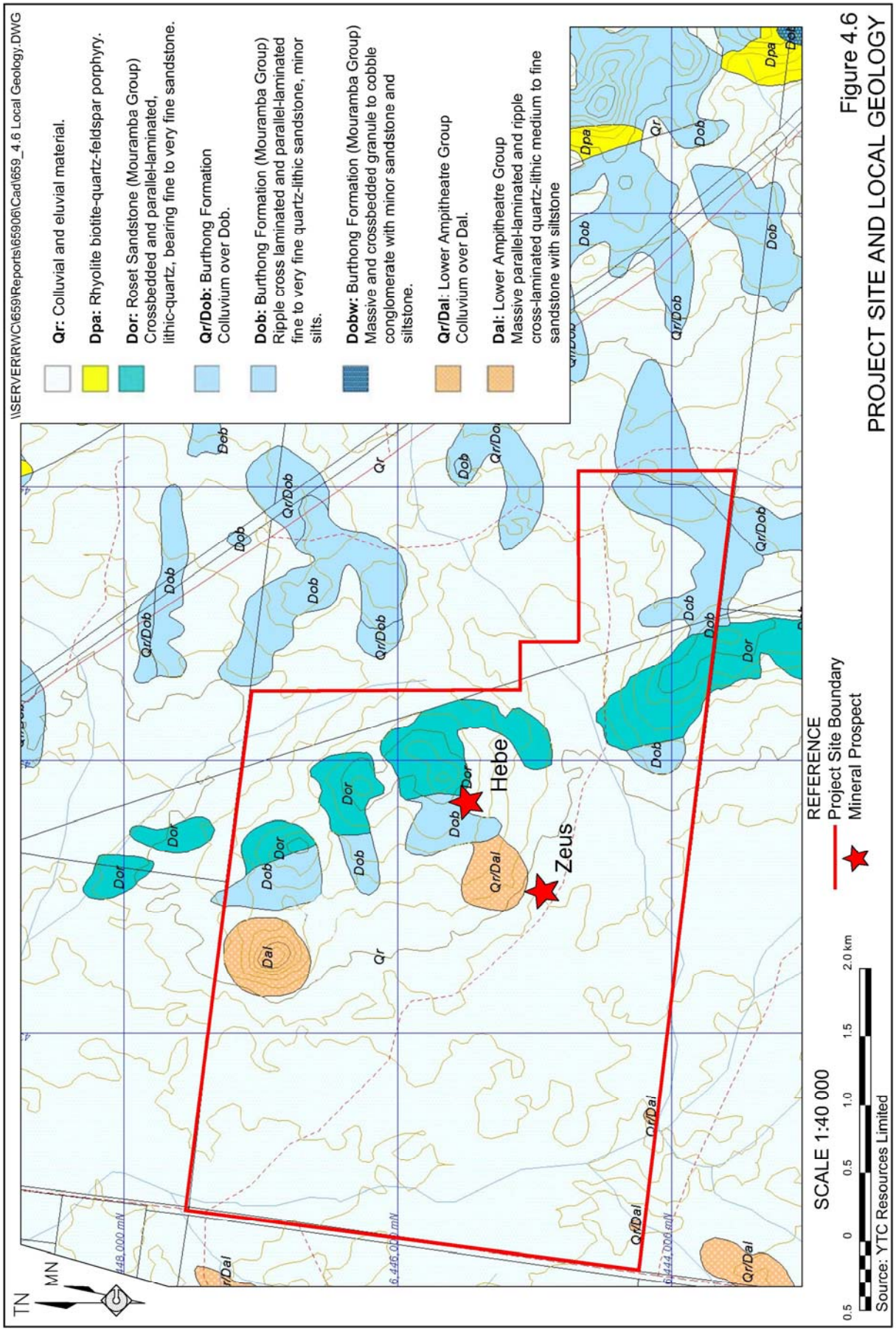
The Project Site is part of a broader exploration package, namely Exploration Licence (EL) 6162. The geology of EL6162 has been described by Cooper (2011). This sub-section presents a summary of the relevant components of that report. **Figure 4.6** presents a plan showing basement geology within and surrounding the Project Site.

Basement geology within and surrounding the Project Site lies in places beneath a thin veneer of recent alluvial and colluvial sediments and tallus slope material locally derived from the exposed stratigraphy. The colluvial layer is generally less than 1.0m thick and overlays variably weathered bedrock. The colluvial slope extends some 300m from a low silicified hill known as The Peak and gives way to a broad erosional plane underlying a thin veneer of residual and colluvial sediments. A series of low hills comprised of slightly to moderately weathered Paleozoic bedrock occur to the east and south of The Peak. These hills are prominent and in most cases appear to represent more silicified zones of the primary Paleozoic stratigraphy.

The Project Site is located close to the eastern margin of the Paleozoic Cobar Basin, near the contact between the shelf facies of the Mouramba Group and turbiditic sediments of the Amphitheatre Group. The most dominant structural feature of the eastern margin of the Cobar Basin, the 300km long Rookery Fault, is interpreted to pass some 1km to the east of the Hera Project. The sedimentary sequence faces to the west of that fault with the main stratigraphic units as follows

- Mouramba Group
  - Rosset Sandstone (Dor)
    Cross-bedded and parallel-laminated, lithic-quartz medium to fine sandstone interbedded with ripple cross laminated fine to very fine sandstone
- Burthong Formation (Dob)

  Ripple cross laminated and parallel-laminated fine to very fine quartz lithic sandstone, with lesser laminated, bioturbated siltstone and interlaminated siltstone and fine sandstone
- Lower Amphitheatre Group (Dal)
  - Massive, parallel – laminated and ripple cross laminated quartz lithic medium to fine sandstone with interbedded siltstone and interlaminated siltstone and sandstone at the base


\\SERVER\RWC\659\Reports\65906\Cad\659_4.6 Local Geology.DWG
Qr: Colluvial and eluvial material.
Dpa: Rhyolite biotite-quartz-feldspar porphyry.
Dor: Roset Sandstone (Mouramba Group) Crossbedded and parallel-laminated, lithic-quartz, bearing fine to very fine sandstone.
Qr/Dob: Burthong Formation Colluvium over Dob.
Dob: Burthong Formation (Mouramba Group) Ripple cross laminated and parallel-laminated fine to very fine quartz-lithic sandstone, minor silts.
Dobw: Burthong Formation (Mouramba Group) Massive and crossbedded granule to cobble conglomerate with minor sandstone and siltstone.
Qr/Dal: Lower Ampitheatre Group Colluvium over Dal.
Dal: Lower Ampitheatre Group Massive parallel-laminated and ripple cross-laminated quartz-lithic medium to fine sandstone with siltstone
Hebe
Zeus
REFERENCE
Project Site Boundary
Mineral Prospect
SCALE 1:40 000
0.5 0 0.5 1.0 1.5 2.0 km
Source: YTC Resources Limited
TN MN
Figure 4.6
PROJECT SITE AND LOCAL GEOLOGY

Interpretation from the recent drilling (2004 – 2011), places the Hera Deposit within the Mouramba Group of sediments, consistent with the Burthong Formation and Rosset Sandstone as described by MacRae (1987). The sediment package dips steeply to the west to west-northwest. The beds are generally disrupted and boudinaged by a strong cleavage. The Hera mineralisation is contained within the strongly cleaved sequence as part of a high strain zone in the hanging wall of the Rookery Fault.

The Hera mineralisation is characterised by several lenses of intense cleavage parallel vein-type and breccia style mineralisation grading to massive sulphide in places, comprising pyrrhotite, sphalerite, galena, pyrite and chalcopyrite with locally zones of appreciable gold. The host sandstones and siltstones are pervasively silicified with the zones of silicification extending more than 20m into the hanging wall and footwall. The silicified alteration envelopes also contain varying degrees of dark green chlorite alteration and commonly contain disseminated, pyrrhotite typically aligned parallel to the cleavage. Quartz veining is commonly associated with the main zones of sulphide mineralisation. Similar, weakly mineralised alteration zones occur at the Zeus and Hebe Prospects, 1km to the south and southeast of the Hera Deposit.

The sulphide lenses strike around 346° true and dip steeply to the west (>80º) consistent with the cleavage developed within the host sediments. Based on drilling, the top of the sulphide package occurs approximately 100m below surface and appears to plunge moderately to the south at approximately 45°, extending along strike for at least 550m.

Drilling to date has outlined more than ten lenses of sulphide and occasionally gold mineralisation. Of these, the Main Lens (North and South), Hays South, Hays North and Far West Lens have been identified to host economic mineralisation.

An East-West striking fault (the Offset Fault) has been interpreted to displace the Main Lens mineralisation in a right-lateral or sinistral sense by approximately 25m. The Offset Fault is not always evident in drill core, possibly due to its orientation which is sub-parallel to the trend of drilling and also due to re-healing of the faults structure with quartz fill. A fault of this orientation has, however, been mapped at surface and has its locus at the Kershaw North shaft on the top of 'The Peak'.

In summary, mineralisation associated with the Hera deposit may be classified as follows.

- General narrow lenses with quite variable economic widths within the lens along strike. Main Lens contains the majority of resources with additional mineralisation hosted by Hays South, Hays North and Far West Lenses..
- Sub-vertical dip for both Main Lens and Far West Lens.
- Strike - approximately 340º true.
- Strike length - 600m with potential for extensions along strike to both north and south.
- Depth - 100m to 470m below surface, with potential for deeper extensions.
- Host rock - Generally homogeneous siltstone/ sandstone with minor dacitic volcaniclastics. Bedding dips to west at 60º to 70º and strikes 340º to 350º true.

- Minor jointing and significant cleavage development.
- Significant gold grades are not always associated with base metal mineralisation but can be associated with quartz veining outside the main base metal mineralised zone.

4.1.5 Surrounding Land Ownership, Residences and Land Use

4.1.5.1 Land Ownership and Residences

The land ownership and closest residences surrounding the Project Site are presented in **Figure 4.7**.

4.1.5.2 Land Use

Land uses surrounding the Project Site are shown in **Figure 4.8** and include the following.

- Agriculture – principally grazing of sheep. Agricultural activities are principally undertaken in cleared areas on undulating hills.
- Nature conservation and forestry – these land uses are principally restricted to areas of steeper slopes and areas unsuitable for other land uses. The Balowra State Forest is located approximately 9km south of the Project Site.
- Residential and rural residential – The township of Nymagee, located approximately 4km north of Project Site, and surrounding areas include areas of rural residential and residential land use.
- Mineral exploration and mining – Sections of the Project Site have been the subject of historic mining operations and more recent mineral exploration activities. Copper mining at the Nymagee Copper Mine (1881 – 1917) was undertaken 4.5km north of the Project Site.

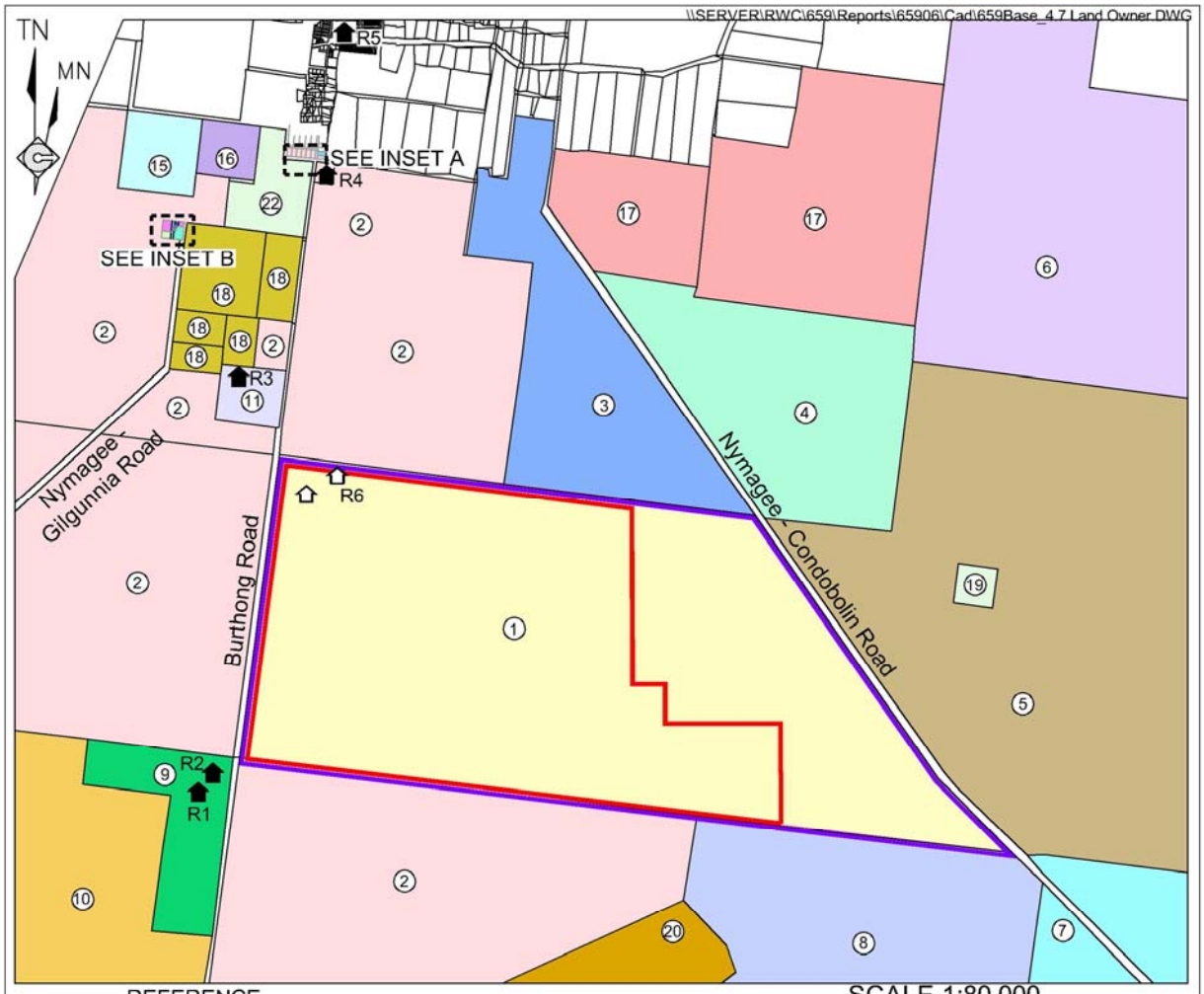
4.1.6 Surrounding Community

4.1.6.1 Introduction

The data presented in this sub-section relate to the census statistical area of Nymagee State Suburb (Nymagee), Cobar Local Government Area (LGA) and the NSW as a whole (NSW) (**Figure 4.9**) and have been obtained from the 2006 Census produced by the Australian Bureau of Statistics.

4.1.6.2 Population and Population Growth

A summary of the 2006 population statistics for Nymagee, Cobar LGA and NSW is shown in **Table 4.2**.

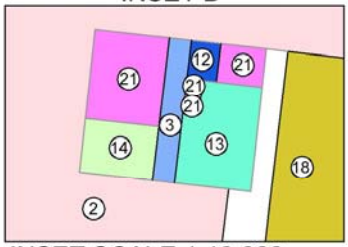


REFERENCE
"The Peak" Property Boundary
Project Site Boundary
Cadastral Boundary
① Land Owner Reference
Residence (Project-related)
Residence (Non Project-related)

SCALE 1:80 000
1 0 1 2 3 4km

INSET A

INSET B



INSET SCALE 1:10 000
100 0 100 200m

Ref.	Land Owner
1	Perpetual Lease (YTC Resources Limited)
2	Perpetual Lease (JB Dunne)
3	State of NSW
4	Perpetual Lease (CW Dillon)
5	Perpetual Lease (CA & EA Halloran)
6	Perpetual Lease (JB Cutting)
7	Perpetual Lease (PG & MN Harley)
8	Perpetual Lease (Harley Balowra Pty Limited)
9	Perpetual Lease (EJ Harland)
10	Perpetual Lease (KJ Burcher)
11	BWT & GH Hay
12	G Hurst, G Woolnough, W Clarke, W Kelynack & G Lane
13	F Jolly, HWG Innes, TJ Glynn, JC Daw, H Harris
14	Trustees of Roman Catholic Church for Diocese of Wilcania-Forbes
15	Timbarra Estates Pty Limited
16	Preliminary Syndicate Limited
17	Perpetual Lease (WB Kilkeary)
18	JB Dunne
19	JB Cutting
20	Reference Not Held
21	Crown Land
22	Reference Not Held
23	Reference Not Held
24	Reference Not Held

Note: Residence R5 has been selected, for the purposes of the Air Quality Assessment, to be representative of the village of Nymagee

Land Owner Source: Department of Lands Title Search July 2010

Figure 4.7
SURROUNDING LAND OWNERSHIP AND RESIDENCES

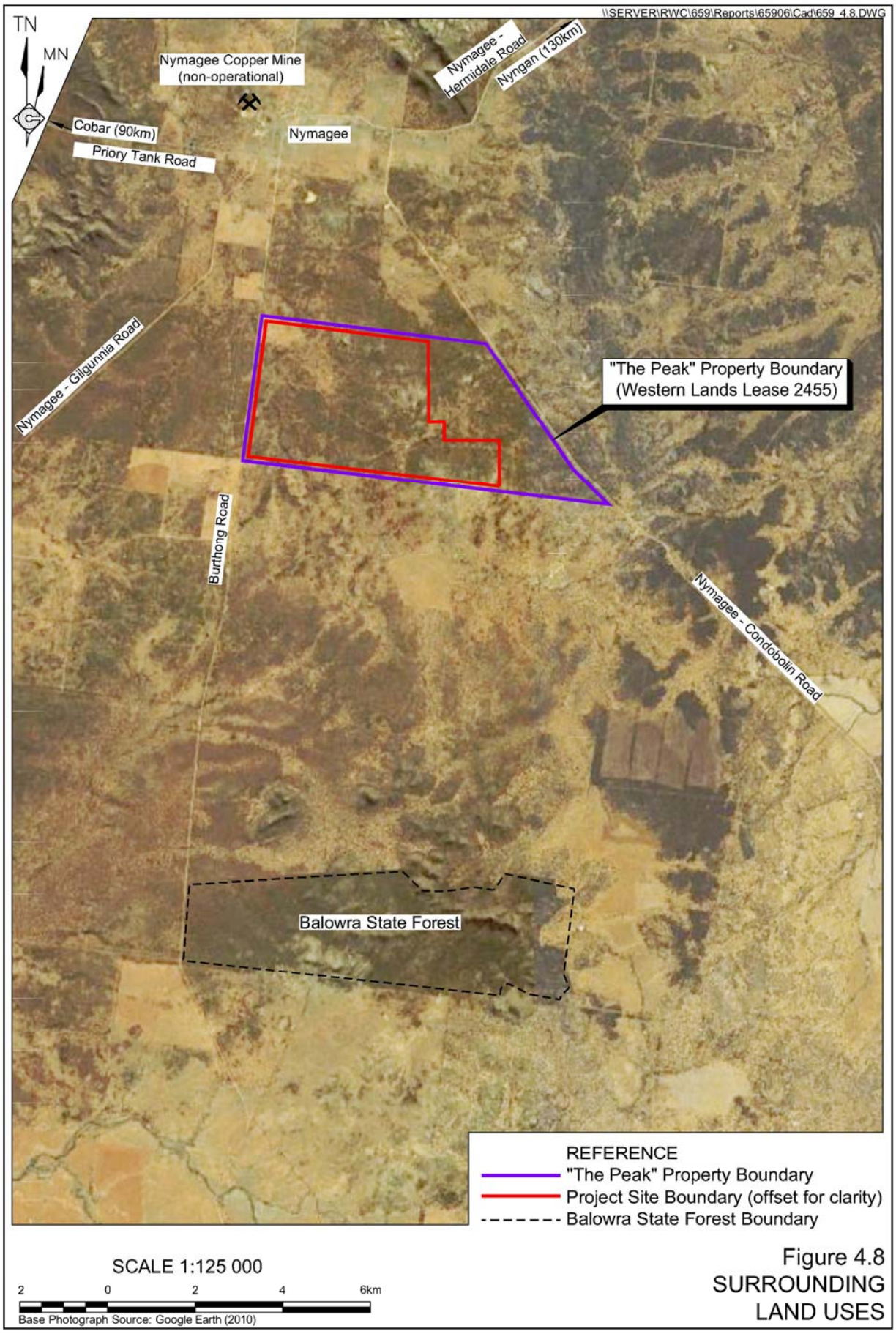


Figure 4.8
SURROUNDING LAND USES

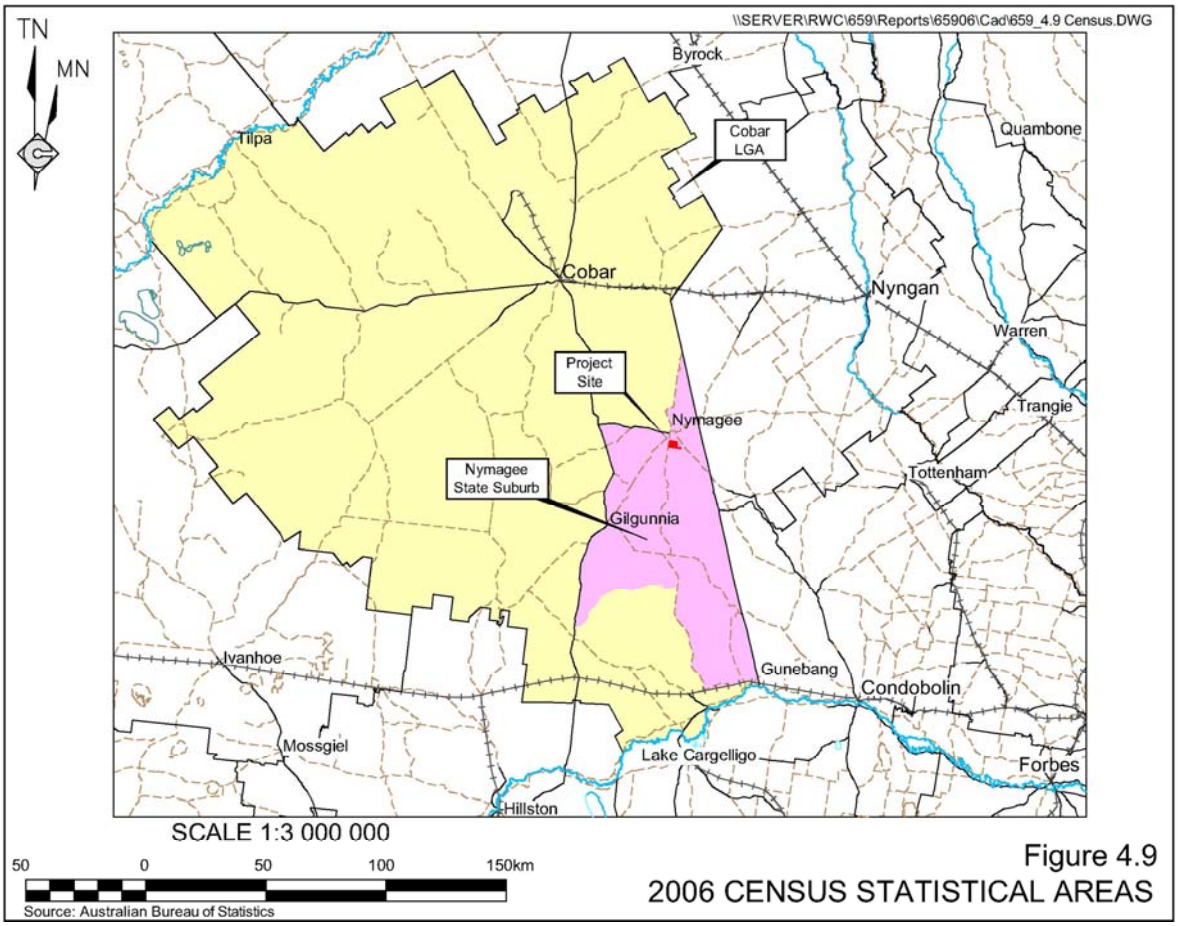


Table 4.2
2006 Census Population Statistics

		Nymagee		Cobar LGA		NSW State	
	Age Groups	**Persons**	**Percentage**	**Persons**	**Percentage**	**Persons**	**Percentage**
Children	0-4 years	12	11.1%	383	7.8%	420 431	6.4%
	5-14 years	13	12.0%	744	15.1%	878 483	13.4%
Studying or Working	15-24 years	0	0%	680	13.8%	871 717	13.3%
	25-54 years	50	46.3%	2101	42.7%	2 753 219	42.0%
Approaching Retirement or Retired	55-64 years	17	15.7%	478	9.7%	719 551	11.0%
	65 years and over	16	14.8%	533	10.8%	905 778	13.8%
	Total Persons	108	100%	4919	100%	6 549 178	100%
Source: Australian Bureau of Statistics - 2006 Census							

The data indicate that in Nymagee the proportion of persons aged 14 years and younger (23.1%) was similar to the proportion of persons of the same age group in Cobar Shire (22.9%) and NSW as a whole (19.8%).

In contrast, no persons aged 15 to 24 years were reported as residing in Nymagee. The proportion of that age group in Cobar LGA (13.8%) is similar to NSW (13.3%).

The proportion of people residing in Nymagee and Cobar LGA between the ages of 25 and 54 years (46.3% and 42.7%, respectively) was similar to the proportion for NSW (42.0%). However, the proportion of people aged 55 years and over in Nymagee (30.5%) is significantly higher than within Cobar LGA (20.5%) and NSW (24.8%).

The data indicate that a greater proportion of people aged over 55 live within and in the vicinity of township of Nymagee than in Cobar Shire or in NSW as a whole. This may be the result of a greater proportion of agricultural operations owned and operated by people with a higher average age than elsewhere, together with the lower cost of living.

The data recording no persons between the age of 15 and 24 is highly unusual and may reflect the limited education and training opportunities for young people surrounding the Project Site.

During the 2001 Census, 115 persons were recorded within Nymagee (Collection district 1021108), compared to 108 recorded in the 2006 Census. The decrease in population between the 2001 Census and 2006 Census was approximately 6.4%. However, given the small population size, this change would not be statistically relevant. For the Cobar LGA, the population decrease between 2001 and 2006 was approximately 4% while for the NSW there has been an increase of approximately 4% in the same period. This may reflect changes in the local economic and employment situation within the Cobar LGA between 2001 and 2006.

4.1.6.3 Employment, Occupation and Industries

Employment statistics from the 2006 Census for Nymagee, Cobar LGA and NSW are presented in **Table 4.3**. The data indicate that the unemployment rate in Nymagee in 2006 was 24.2%, significantly higher than for the Cobar LGA and NSW (4.9% and 6.0%, respectively). The workforce participation rate in Nymagee was higher (60.2%) than the Cobar LGA (36.0%) and NSW (47.2%). This data may reflect the lack of employment opportunities surrounding the Project Site.

Table 4.3
2006 Census Employment Statistics

	Nymagee		Cobar LGA		NSW State	
	Persons	**Percentage**	**Persons**	**Percentage**	**Persons**	**Percentage**
Employed						
Full-time(a)	43	65.2%	1 579	69.4%	1 879 628	61%
Part-time	7	10.6%	517	22.7%	842 713	27%
Employed, away from work(b)	0	0%	68	3.0%	187 103	6%
Total	50	75.8%	2 164	95.1%	2 909 444	94%
Unemployed, looking for						
Full-time work	12	18.2%	88	3.9%	115 165	4%
Part-time work	4	6.1%	33	1.5%	67 994	2%
Total	16	24.2%	111	4.9%	183 159	6%
Labour Force Participation						
Total labour force	53		1 365		3 092 603	
Total Persons	88		3 790		6 549 177	
Labour force participation	60.2%		36.0%		47.20%	
Source: Australian Bureau of Statistics - 2006 Census						

A summary of the 2006 Census statistics relating to industry of employment is presented in **Table 4.4**. The data indicate that 'Agriculture, forestry and fishing' employed almost two thirds of the Nymagee-based workforce (65.4%) and 'Mining' employed 15.4% of the workforce. In Cobar LGA 'Mining' employed the largest proportion (30.8%) of the workforce and 'Agriculture, forestry and fishing' employed 9.7% of the workforce. State-wide, 'Manufacturing', 'Retail Trade', 'Construction' and 'Healthcare & Social assistance' at approximately 10% each were the principal industries, while 'Agriculture, forestry and fishing' and 'Mining' employed just 3.4% total of the NSW workforce.

These trends reflect the generally rural nature of the area surrounding Nymagee and Cobar and the importance of mining and agriculture for communities within the area.

Table 4.4
2006 Census Industry of Employment Statistics

	Nymagee		Cobar LGA		NSW State	
	Persons	**Percentage**	**Persons**	**Percentage**	**Persons**	**Percentage**
Agriculture, forestry & fishing	34	65.4%	218	9.7%	78 661	2.7%
Mining	8	15.4%	692	30.8%	20 318	0.7%
Manufacturing	4	7.7%	86	3.8%	277 986	9.6%
Electricity, gas, water & waste services	0	0%	12	0.5%	29 184	1.0%
Construction	0	0%	97	4.3%	212 729	7.3%
Wholesale trade	0	0%	74	3.3%	136 761	4.7%
Retail trade	0	0%	184	8.2%	323 929	11.1%
Accommodation & food services	0	0%	150	6.7%	190 454	6.5%
Transport, postal & warehousing	3	5.8%	45	2.0%	145 518	5.0%
Information media & telecommunications	0	0%	12	0.5%	68 976	2.4%
Financial & insurance services	0	0%	18	0.8%	144 867	5.0%
Rental, hiring & real estate services	0	0%	17	0.8%	50 588	1.7%
Professional, scientific & technical services	0	0%	41	1.8%	213 247	7.3%
Administrative & support services	0	0%	45	2.0%	90 431	3.1%
Public administration & safety	0	0%	125	5.6%	174 915	6.0%
Education & training	0	0%	134	6.0%	219 679	7.6%
Health care & social assistance	3	5.8%	130	5.8%	304 335	10.5%
Arts & recreation services	0	0%	14	0.6%	39 574	1.4%
Other services	0	0%	81	3.6%	110 094	3.8%
Inadequately described/Not stated	0	0%	71	3.2%	77 194	2.7%
Total	**52**	100%	**2 246**	100%	**2 909 440**	100%

Source: Australian Bureau of Statistics - 2006 Census

4.1.6.4 Income

The income statistics for Nymagee and, for comparison purposes that for Cobar LGA and NSW State compiled in the 2006 Census are presented in **Table 4.5**. The data indicate that median individual, family and household incomes in Nymagee were between 32.5% and 44.1% lower than NSW as a whole, while incomes in the Cobar Shire were comparable or higher than the corresponding incomes in NSW as a whole.

This difference is likely to be attributable to the fact that there are proportionally fewer people working in Nymagee than in Cobar Shire or NSW and that, typically, wages and salaries available for workers in agricultural industries are lower than other areas within the State.

Table 4.5
2006 Census Income Statistics

	Nymagee	Cobar LGA	NSW State
Median individual income ($/weekly)	311	455	461
Median family income ($/weekly)	604	1 257	1 181
Median household income ($/weekly)	579	1 054	1 036
Source: Australian Bureau of Statistics - 2006 Census			

4.1.6.5 Housing

A summary of the housing cost statistics for Nymagee, Cobar LGA and NSW are provided in **Table 4.6**. The data indicate that none of the houses in Nymagee were occupied by tenants, and that the median monthly loan repayment in Nymagee was comparable to that for Cobar LGA, at approximately $600 to $800, but less than the NSW median. In addition, the average household size was marginally smaller in Nymagee than in Cobar LGA and NSW as a whole.

Table 4.6
Cost of Housing and Household Size Statistics - 2006

	Nymagee	Cobar LGA	NSW State
Median housing loan repayment ($/monthly)	771	900	1 517
Median rent ($/weekly)	0	120	210
Average number of persons per bedroom	1.1	1.1	1.1
Average household size	2.1	2.5	2.6
Source: Australian Bureau of Statistics - 2006 Census			

4.1.6.6 Nymagee Community Profile

Nymagee is a small village in central NSW, located approximately 100km by road from Cobar, 120km by road from Nyngan and 600km by road from Sydney.

Nymagee was originally a copper mining town and in its peak supported a population of over 2 200 people, half of these being Chinese migrants. However, when the Nymagee Copper Mine closed in 1917, most of the residents moved out of Nymagee. In 1999, local residents started an outback music festival to increase tourism and encourage new residents to move to the town. The first festival was visited by 600 tourists and the festival has since been held intermittently and has increased Nymagee's tourism by 60% and significantly increased the number of permanent residents.

Nymagee is also the setting of the poem 'Clancy of the Overflow', a poem written by Banjo Patterson. The sheep station, 'The Overflow' featured in the poem is situated about 32km southeast of Nymagee.

In the 2006 Census, Nymagee had a population of 108 people and a total of 23 families. There are 55 occupied private dwellings in a total of 73 private dwellings.

Community facilities in Nymagee include:

- a multi-function community hall;
- police station;
- Rural Fire Service shed
- tennis courts and pavilion;
- cricket oval and pavilion;
- CWA Hall;
- air strip; and
- community facility associated with the former Nymagee school.

The only non-farming commercial operation in Nymagee is the Metropolitan Hotel.

In summary, Nymagee is a small, close knit community where the majority of residents, if not all, know each other. Given the community size, the community is heavily reliant on surrounding centres, principally Cobar and Nyngan, for services and access to social, commercial, education and employment facilities.

4.1.6.7 Cobar Community Profile

Cobar LGA is located in the Orana Region of central northern New South Wales, approximately 700km northwest of Sydney. Cobar LGA is bounded by Bourke LGA to the north, Bogan LGA to the north-east, Lachlan LGA to the south-east, Carrathool LGA to the south, and Central Darling LGA to the west.

Cobar LGA is a predominantly rural area. The main population centre is Cobar, with small villages at Euabalong, Mount Hope and Nymagee. The LGA encompasses a total land area of approximately 44 000km^2. Rural land is used mainly for agriculture, particularly sheep grazing, and for copper, lead, silver, zinc and gold mining.

The original inhabitants of the Cobar area were the Ngemba and Wongaibon Aboriginal people. European settlement dates primarily from the 1860s, with land used mainly for grazing. Population was minimal until 1870 when copper was discovered and the township of Cobar was established. Growth took place from the late 1800s into the early 1900s, spurred by copper mining. The population declined significantly following World War I, due to the closure of the Great Cobar Mine. The population gradually increased from the 1930s, aided by the establishment of gold mining. Copper mining in Cobar recommenced in the 1960s. The population increased during the 1980s, boosted by the opening of a number of silver, lead and zinc mines. The population fluctuated slightly during the 1990s, and then was relatively stable between 2001 and 2006 at about 5 100 persons. The majority of the population of the LGA live in the township of Cobar.

Community facilities within Cobar include the following.

- TAFE NSW - Western Institute (Cobar College).
- The 31 bed Cobar District Hospital.
- One high school.
- Two primary schools.
- Cobar aerodrome.
- Cobar Golf Course.
- Dalton Park Racecourse.
- Alisa Fitzsimmons Memorial Oval.
- Numerous parks, including the Bathurst Street Reserve.

Community organisations in Cobar include the following.

- Cobar Bowling & Golf Club.
- Cobar Memorial Services Bowling Club.
- Cobar Rugby League Football Club.
- Cobar Tennis Association.

In addition, Cobar has an active retail centre and a number of businesses operate within the town, including but not limited to:

- two supermarkets;
- seven motels;
- three hotels;
- three service stations; and
- numerous small businesses, including retail outlets, hairdressers and service industries.

Finally, Cobar is connected to Nyngan (and Dubbo) to the east and Broken Hill (and Adelaide) to the west via the Barrier Highway, to Condobolin (and Sydney, Canberra and Melbourne) to the south east via the Kidman Way. In addition, Cobar is serviced by rail and regular commercial air services introduced in late 2010.

4.2 ECOLOGY

4.2.1 Introduction

The ecology assessment for the Project was undertaken by OzArk Environmental and Heritage Pty Ltd. The full assessment is presented as Part 1 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as OzArk (2011a). This sub-section presents an overview of that assessment and should be read in conjunction with the full assessment.

A risk analysis presented in Section 3.4 identified the following potential Project impacts relating to ecology (fauna and flora) requiring assessments. The unmitigated risk rating associated with each impact is indicated in parenthesis.

- Removal of native vegetation due to clearing activities including:
  - loss of, or alteration to, existing habitats (high risk);
  - direct adverse impact on threatened species, populations or endangered ecological communities (high risk).
- Disturbance to threatened species, populations and endangered ecological communities:
  - local or regional reduction in distribution of threatened species, populations or endangered ecological communities (high risk); and
  - possible local extinction of threatened species, populations or endangered ecological communities (high risk).
- Disturbance to fauna and fauna habitat as a result of ongoing operations, e.g. dust etc.
  - local or regional reduction in distribution of threatened species, populations and endangered ecological communities (moderate risk); and
  - possible local extinction of threatened species, populations and endangered ecological communities (high risk).
- Pooling of cyanide–contaminated water within the Tailing Storage Facility resulting poisoning of native fauna (extreme risk).

The Director-General's requirements have highlighted 'Biodiversity' as one of the environmental issues that need to be addressed in the *Environmental Assessment*, with the following issues specifically required to be addressed:

- accurate estimates of any vegetation disturbance associated with the Project;
- impacts on threatened species or populations or their habitats, endangered ecological communities, groundwater dependent ecosystems and native vegetation generally;
- impacts on threatened species or populations or their habitats, endangered ecological communities, groundwater dependent ecosystems and native vegetation generally; and
- a detailed description of the measures that would be implemented to maintain or improve the regional biodiversity values in the medium to long term.

This sub-section provides information on the predicted and observed regional and local flora, fauna and vegetation communities, including threatened flora and fauna species, as well as an assessment of the anticipated significance of Project-related impacts, if any.

4.2.2 Predicted Regional and Local Flora and Fauna

4.2.2.1 Database Searches

The following database searches were undertaken to identify listed fauna and flora species and ecological communities that may occur within the vicinity of the Project Site.

- Department of Sustainability Environment, Water, Population and Communities (DSEWPaC) Protected Matters *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Database:
  - Date of search – 1 June 2011;
  - Point data search on Project Site with 10km buffer.
- Office of Environment and Heritage (OEH) Threatened Species online database:
  - Date of search – 31 May2011;
  - Combined geographic and habitat search in Western (Nymagee-Rankin Springs (NRS)) Catchment Management Authority (CMA) and Central West (Nymagee-Rankin Springs) CMA.
- NSW Government Wildlife Atlas GIS request (License Number CON99042):
  - Date of search – 9 April 2010;
  - Search within Western Catchment Management Authority and Western (Nymagee-Rankin Springs) Catchment Management Authority.
- NSW Government Wildlife Atlas online database:
  - Date of search – 31 May 2011;
  - Selected area search with the co-ordinates (145.72000, –32.51000; 147.25000, –31.54000).
- NSW Legislation SEPP 44 website: Koala Habitat Protection:
  - Date of search – 31 May 2011;
  - Schedule 1: LGAs listed and Schedule 2: Feed Trees listed.
- NSW Department of Primary Industries – Records Viewer:
  - Date of search – 31 May 2011;
  - Search for protected aquatic biodiversity in the Cobar LGA.
- NSW Department of Primary Industries - Noxious Weeds:
  - Date of search – 31 May 2011;
  - Search within Cobar LGA.
- Cobar Local Environmental Plan 2001:
  - Date of search – 9 April 2010;
  - Searched entire document including Schedules 1 – 5.

4.2.2.2 Database Search Results

Table 4.7 presents the results of the database searches for listed species, communities, populations and critical habitat identified in the previous sub-section.

Table 4.7
Listed Regional Threatened Flora and Flora Species and Threat Level

Scientific Name	Common Name	Status or Threat[1]
Flora Species		
Acacia curranii	Curly-bark Wattle	V (EPBC Act)
Austrostipa metatoris	A Speargrass	E (EPBC Act) E (TSC Act)
Austrostipa wakoolica	A Speargrass	E (EPBC Act) E (TSC Act)
Atriplex infrequens	A Saltbush	V (TSC Act)
Bothriochloa biloba	Lobed Bluegrass	V (EPBC Act)
Diuris tricolor	Pine Donkey Orchid	V (TSC Act)
Monotaxis macrophylla	Large-leafed Monotaxis	E (TSC Act
Pterostylis cobarensis	Cobar Green Hood Orchid	V (EPBC Act) V (TSC Act)
Rulingia procumbens	No common name	V (EPBC Act) V (TSC Act)
Swainsona sericea	Silky Swainsona Pea	V (TSC Act)
Fauna Species		
Antechinomys laniger	Kultarr	E1 (TSC Act)
Ardeotis australis	Australian Bustard	E1 (TSC Act)
Ardea alba	Great Egret	Marine species (EPBC Act); Migratory species (CAMBA,JAMBA[2])
Ardea ibis	Cattle Egret	Marine species (EPBC Act); Migratory species (CAMBA,JAMBA[2])
Botaurus poiciloptilus	Australasian Bittern	E (TSC Act)
Burhinus grallarius	Bush Stone-curlew	E (TSC Act)
Cacatua leadbeateri	Major Mitchell's Cockatoo	V (TSC Act)
Calyptorhynchus lathami	Glossy Black-cockatoo	E2 (TSC Act)
Calyptorynchus banksii	Red-tailed Black Cockatoo	V (TSC Act)
Certhionyx variegatus	Pied Honeyeater	V (TSC Act)
Cinclosoma castanotus	Chestnut Quail-thrush	V (TSC Act)
Chalinolobus picatus	Little Pied Bat	V (TSC Act)
Circus assimilis	Spotted Harrier	V (TSC Act)
Climacteris picumnus	Brown Treecreeper	V (TSC Act)
Crinia sloanei	Sloane's Froglet	V (TSC Act)
Daphoenositta chrysoptera	Varied Sittella	V (TSC Act)
Dasyurus maculatus	Spotted-tailed Quoll	V (TSC Act) V (EPBC Act)
Delma australis	Marble-faced Delma	E1 (TSC Act)
Epthianura albifrons	White-fronted Chat	V (TSC Act)
Falco hypoleucos	Grey Falcon	V (TSC Act)
Gallinago hardwickii	Latham's Snipe	Migratory and Marine species (EPBC Act)
Grantiella picta	Painted Honeyeater	V (TSC Act)

Table 4.7 (Cont'd)
Listed Regional Threatened Flora and Flora Species and Threat Level

Scientific Name	Common Name	Status or Threat[1]
Fauna Species (Cont'd)		
Grus rubicunda	Brolga	V (TSC Act)
Haliaeetus leucogaster	White-bellied Sea Eagle	Migratory species (EPBC Act)
Hirundapus caudacatus	White-throated Needletail	Migratory species (EPBC Act)
Hamirostra melanosternon	Black-breasted Buzzard	V (TSC Act)
Hieraaetus morphnoides	Little Eagle	V (TSC Act)
Leipoa ocellata	Malleefowl	E1 (TSC Act) V (EPBC Act)
Limosa limosa	Black-tailed Godwit	V (TSC Act)
Lophoictinia isura	Square-tailed Kite	V (TSC Act)
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V (TSC Act)
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V (TSC Act)
Merops ornatus	Rainbow Bee-eater	Migratory species (EPBC Act)
Neophema pulchella	Turquoise Parrot	V (TSC Act)
Ninox connivens	Barking Owl	V(TSC Act)
Ningaui yvonneae	Southern Ningaui	V (TSC Act)
Nyctophilus timoriensis (South-eastern form)	Greater Long-eared Bat	V (TSC Act) V (EPBC Act)
Oxyura australis	Blue-billed Duck	V (TSC Act)
Onychogalea fraenata	Bridled Nailtail Wallaby	E4 (TSC Act) E (EPBC Act)
Petrogale penicillata	Brush-tailed Rock-wallaby	E1 (TSC Act) V (EPBC Act)
Pachycephala inornata	Gilbert's Whistler	V (TSC Act)
Petaurus norfolcensis	Squirrel Glider	V (TSC Act)
Petroica phoenicea	Flame Robin	V (TSC Act)
Phascogale tapoatafa	Brush-tailed Phascogale	V (TSC Act)
Phascolarctos cinereus	Koala	V (TSC Act)
Polytelis swainsonii	Superb Parrot	V (TSC Act) V (EPBC Act)
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V (TSC Act)
Pyrrholaemus brunneus	Redthroat	V (TSC Act)
Pyrrholaemus saggitatus	Speckled Warbler	V (TSC Act)
Rostratula benghalensis australis	Painted Snipe (Australian subspecies)	E (TSC Act) E (EPBC Act)
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V (TSC Act)
Sminthopsis macroura	Stripe-faced Dunnart	V (TSC Act)

Table 4.7 (Cont'd)
Listed Regional Threatened Flora and Flora Species and Threat Level

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Scientific Name	Common Name	Status or Threat[1]
Fauna Species (Cont'd)		
Stagonopleura guttata	Diamond Firetail	V (TSC Act)
Stictonetta naevosa	Freckled Duck	V (TSC Act)
Tiliqua occipitalis	Western Blue-tongued Lizard	V (TSC Act)
Tyto novaehollandiae	Masked Owl	V (TSC Act)
Endangered Ecological Communities		
Inland Grey Box Woodland		TSC Act
Artesian Springs Ecological Community		TSC Act
Weeping Myall Woodlands		TSC Act and EPBC Act
Endangered Populations		
Nil		
Critical Habitat		
Nil		

Note 1: V – Vulnerable (TSC Act or EPBC Act); E – Endangered (EPBC Act); E1 – Endangered (TSC Act); E2 – Endangered Population (TSC Act); E4 – Presumed Extinct(TSC Act); E4A – Critically Endangered (TSC Act)
Note 2: CAMBA refers to China-Australia Migratory Bird Agreement; JAMBA refers to Japan-Australia Migratory Bird Agreement.
Source: OzArk, (2011a) - modified after Tables 3, 4 and 5

A search of the Noxious Weeds List from the Department of Primary Industries website, carried out on 31 May 2011, to elucidate weeds declared noxious in the Cobar Local Government Area revealed 85 noxious weeds have the potential to be recorded within the Project Site.

4.2.2.3 Predicted Species, Communities and Populations

Based on an analysis of habitat within the Project Site, as well as the results of a previous ecological survey within the Project Site (CSUJC-EC (2006)), other surveys undertaken in the vicinity of the Project Site (Cumbine State Forest) and the results of the online database searches (see **Table 4.7**), OzArk (2011a) identify the threatened species, communities and populations listed in **Table 4.8** as having the potential to occur within the Project Site.

4.2.3 Survey Methodology

4.2.3.1 Survey Guidelines

The surveys for the ecology assessment were undertaken in accordance with the following guidelines.

- Biodiversity Survey Guidelines Working Draft(DEC, 2004),
- Threatened Species Assessment Guidelines: The Assessment of Significance (DECC, 2007); and
- Field Survey Methods (DECCW, 2009).

Table 4.8
Listed Species, Communities, Populations with the Potential to Occur within the Project Site

Scientific Name	Common Name	Status or Threat[1]
Flora Species		
Diuris tricolor	Pine Donkey Orchid[2]	V (TSC Act)
Monotaxis macrophylla	Large-leafed Monotaxis[2]	E (TSC Act)
Bothriocloa biloba	Lobed Blue-grass[2]	V (EPBC Act)
Pterostylis cobarensis	Cobar Greenhood Orchid[2]	V (EPBC Act) V (TSC Act)
Rulingia procumbens	No common name[2]	V (EPBC Act) V (TSC Act)
Fauna Species		
Melithreptus gularis gularis	Black-chinned Honeyeater[3,4]	V (TSC Act)
Petrogale penicillata	Brush-tailed Rock-wallaby[2]	E1 (TSC Act) V (EPBC Act)
Cinclosoma castanotus	Chestnut Quail-thrush[3,4]	V (TSC Act)
Stagonopleura guttata	Diamond Firetail[3]	V (TSC Act)
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)[3,4]	V (TSC Act)
Melanodryas cucullate	Hooded Robin[3,4]	V (TSC Act)
Antechinomys laniger	Kultarr[2]	E1 (TSC Act)
Chalinolobus picatus	Little Pied Bat[3]	V (TSC Act)
Cacatua leadbeateri	Major Mitchell's Cockatoo[3,4]	V (TSC Act)
Leipoa ocellata	Malleefowl[2]	E1 (TSC Act) V (EPBC Act)
Certhionyx variegates	Pied Honeyeater[3]	V (TSC Act)
Pachycephala inornata	Gilbert's Whistler	V (TSC Act)
Crinia sloanei	Sloane's Froglet	V (TSC Act)
Chthonicola sagittate	Speckled Warbler[3,4]	V (TSC Act)
Dasyurus maculates	Spotted-tailed Quoll	V (TSC Act) V (EPBC Act)
Polytelis swainsonii	Superb Parrot[3,4]	V (TSC Act) V (EPBC Act)
Pyrrholaemus brunneus	Redthroat	V (TSC Act)
Endangered Ecological Communities		
None predicted to occur within the Survey Area		
Populations		
None predicted to occur within the Survey Area		

1:V – Vulnerable (TSC Act or EPBC Act); E – Endangered (EPBC Act); E1 – Endangered (TSC Act); E2 – Endangered Population (TSC Act); E4 – Presumed Extinct(TSC Act); E4A – Critically Endangered (TSC Act)

2:Habitat present within Project Site

3:Previously recorded within Project Site (CSUJC-EC (2006)

4:Previously recorded in the vicinity of the Project Site (Cumbine State Forest)

Source: OzArk (2011a) –modified after Table 7

As indicated in Section 5.1 of OzArk (2011a), the ecology assessment within the proposed areas of disturbance was undertaken in a manner that would permit the collected data to be used in an assessment in accordance with the BioBanking Assessment Methodology.

4.2.3.2 Previous Project Site Ecology Assessments

One previous ecology assessment of the Project Site had been undertaken in 2006 by Charles Sturt University Johnstone Centre – Environmental Consulting (CSUJC-EC (2006)) The results of that survey has been discussed in detail in OzArk (2011a) and RWC (2006), and are included in this ecology summary at the relevant sub-sections.

4.2.3.3 Survey Area

The survey area for the ecology assessment comprised areas within the Project Site boundary predominantly and part of the Peak property on the east of the Project Site boundary.

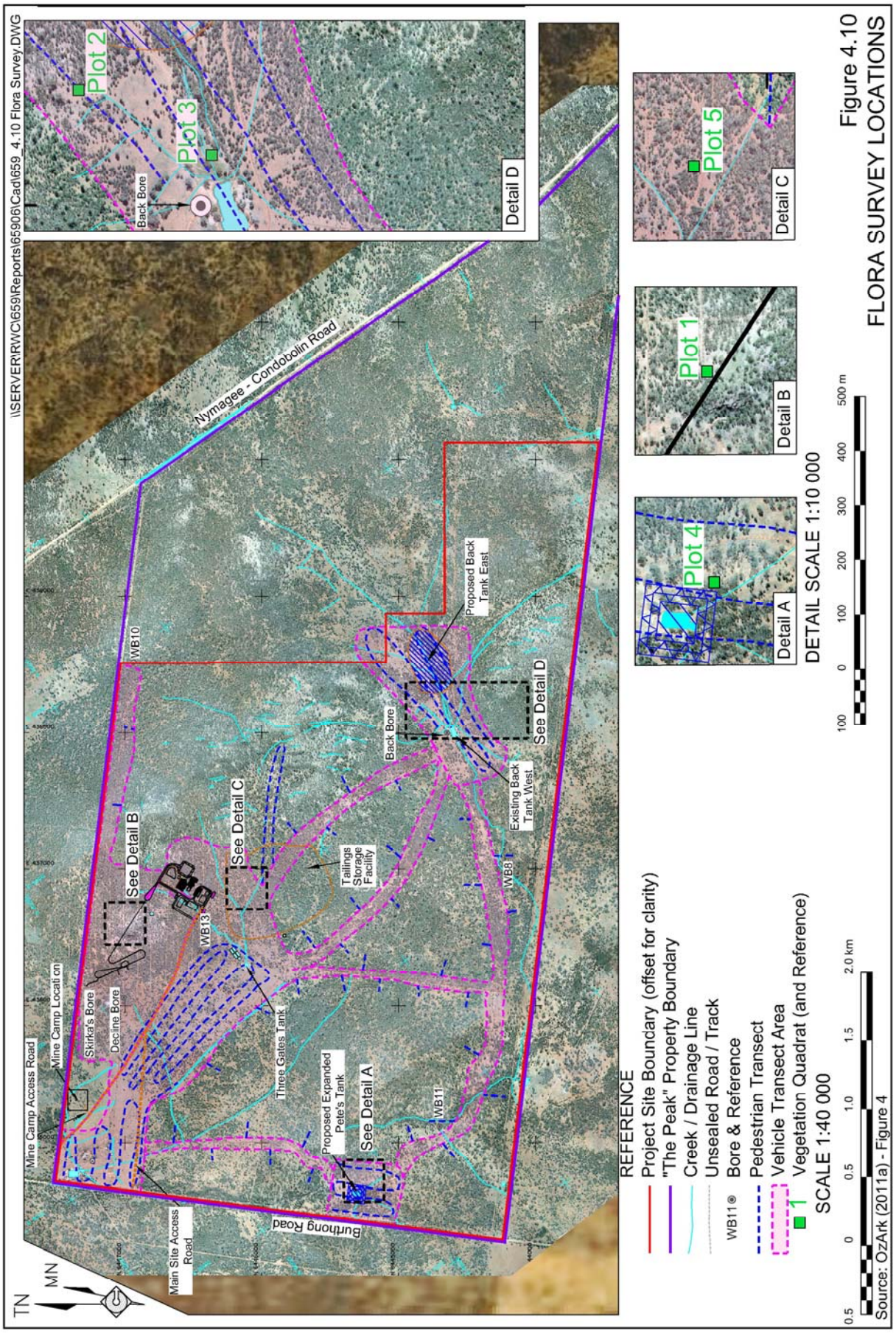
4.2.3.4 Flora Survey Methodology

Flora field surveys were carried out over five and half days between 25 and 29 April 2010 and on 15 October 2011 and were undertaken in conjunction with the site fauna surveys (Section 4.2.3.3). Approximately 80% of the areas surveyed within the Project Site were surveyed on foot while the remaining areas were surveyed using a vehicle. The pedestrian and vehicle transect boundaries surveyed are depicted in **Figure 4.10**.

The surveys were conducted according to the Random Meander Method described by Cropper (1993), known to be a suitable method for detecting the presence of rare species during flora surveys. Targeted searches for threatened flora species predicted to occur within the Project Site in areas of potential habitat were undertaken within five vegetation plots also shown in **Figure 4.10**. The hollow-bearing trees with habitat value within and areas adjacent to the areas to be disturbed by the Project were physically inspected, however, no formal mapping was undertaken.

Classification of the observed vegetation communities and species mix within those communities is referenced to the *BioMetric Vegetation Community* classification (OEH) while the plant identification was in accordance with the nomenclature of Harden (1990, 2002) and Cunningham *et al.* (1992). Eucalyptus species were additionally identified using the EUCLID software (Centre for Plant and Biodiversity Research, 1997). The national conservation significance of flora was determined by referencing to *Rare or Threatened Australian Plants* (ROTAP–Briggs and Leigh) and the Schedules associated with the TSC Act and/or the EPBC Act.

A targeted search for the habitats for two orchids, namely *Diuris tricolor* and *Pterostylis cobarensis*, that have the potential to occur within Project Site was undertaken. It is noted that both these species only flower in during September to November when they are easier to detect. It is also noted that the CSUJC-EC (2006) survey was undertaken during the identified spring flowering period and that survey did not identify the species within the Project Site.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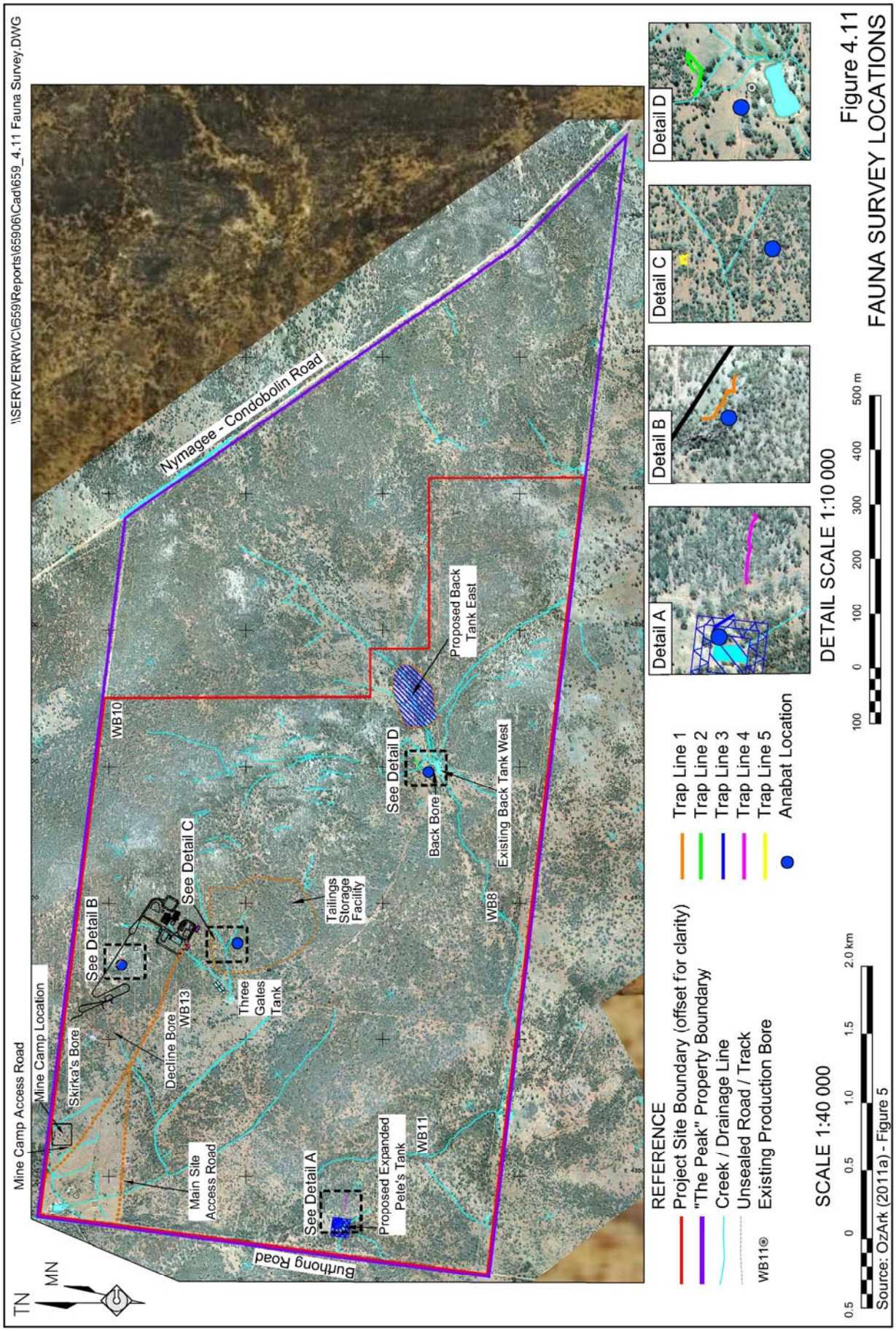
Plot 2
Plot 3
Back Bore
Detail D
Plot 5
Detail C
Plot 1
Detail B
Plot 4
Detail A
Nymagee - Condobolin Road
WB10
Proposed Back Tank East
See Detail D
Back Bore
See Detail B
See Detail C
Tailings Storage Facility
Existing Back Tank West
WB8
WB13
Mine Camp Access Road
Mine Camp Location
Skirka's Bore
Decline Bore
Three Gates Tank
Proposed Expanded Pete's Tank
See Detail A
WB11
Buttonong Road
Main Site Access Road
TN
MN
REFERENCE
Project Site Boundary (offset for clarity)
"The Peak" Property Boundary
Creek / Drainage Line
Unsealed Road / Track
WB11® Bore & Reference
Pedestrian Transect
Vehicle Transect Area
1 Vegetation Quadrat (and Reference)
SCALE 1:40 000
0.5 0 0.5 1.0 1.5 2.0 km
DETAIL SCALE 1:10 000
100 0 100 200 300 400 500 m
Source: OzArk (2011a) - Figure 4
Figure 4.10
FLORA SURVEY LOCATIONS

4.2.3.5 Fauna Survey Methodology

Fauna field surveys were undertaken over four and half days between 25 and 29 April 2010 and were undertaken in conjunction with the site flora surveys (Section 4.2.3.2). A number of standard techniques were employed during the fauna surveys. These are described in detail in OzArk (2011a) and are summarised briefly as follows.

- Ultrasonic Bat Call Detection –an Anabat SD2 bat recorder (Titley Electronics) was set as a stationary sound-activated unit to record between the hours of 4.30pm and 7.30am consecutively each night at one of four locations shown in **Figure 4.11**.
- Call Playback – nocturnal birds were surveyed through call playback and followed by spotlight searches within the general areas of Three Gates Tank, Back Tank and Pete's Tank and surrounding access roads. This technique was employed specifically for the detection of the Masked Owl (*Tyto novaehollandiae*) and Barking Owl (*Ninox connivens*).
- Bird Surveys – both nocturnal and diurnal bird surveys were conducted within all areas to be disturbed and opportunistically during all other activities being undertaken during the survey period. All vegetation types were surveyed for bird species and targeted bird watching was undertaken near habitat trees to identify possible nesting or roosting areas. Birds were identified via visual observation and characteristic call. Bird species of conservation significance were determined by referencing to Smith *et al.* (1994) and Reid (1999).
- Scat and tracks – all scats and raptor pellets (owls, eagles and hawks) encountered during survey were collected and examined to determine species presence. Scats and tracks were identified in accordance with Trigg (2004).
- Herpetofauna surveys – both nocturnal and diurnal herpetological surveys were conducted within all areas to be disturbed as well as opportunistically during all other activities during the survey period, including during the spotlighting surveys. The diurnal component consisted of hand searches for frogs and reptiles under rocks, logs, bark, ground debris and other debris around drainage lines and Back and Pete's Tanks. The Project Site habitat was assessed in terms of its suitability for threatened herpetofauna species.
- Live Trapping – for small to medium-sized terrestrial and arboreal mammals was undertaken over four consecutive nights and conducted along the five transect lines marked in **Figure 4.11** using 'A' type aluminium folding traps (Elliott Scientific). The traps were set on the ground around logs, dense grass and animal runways approximately 10m to 15m apart and were baited with a standard mixture of peanut butter, rolled oats, fish paste, fish sauce and honey. All traps, lined with grasses and leaves to protect any captured animal from the elements, were placed in sheltered and shaded locations. Traps were checked between 6.30am and 9.30am daily and reset after removal of any trapped mammals.


\\SERVER\RWC\659\Reports\65906\Cad\659_4.11 Fauna Survey.DWG
Nymagee - Condobolin Road
Mine Camp Access Road
Mine Camp Location
Skirka's Bore
Decline Bore
WB13
Three Gates Tank
See Detail B
See Detail C
Tailings Storage Facility
WB10
See Detail D
Proposed Back Tank East
Back Bore
Existing Back Tank West
WB8
Main Site Access Road
See Detail A
Proposed Expanded Pete's Tank
WB11
Burthong Road
Detail A
Detail B
Detail C
Detail D
REFERENCE
Project Site Boundary (offset for clarity)
"The Peak" Property Boundary
Creek / Drainage Line
Unsealed Road / Track
WB11® Existing Production Bore
Trap Line 1
Trap Line 2
Trap Line 3
Trap Line 4
Trap Line 5
Anabat Location
SCALE 1:40 000
0.5 0 0.5 1.0 1.5 2.0 km
DETAIL SCALE 1:10 000
100 0 100 200 300 400 500 m
Source: OzArk (2011a) - Figure 5
TN MN
Figure 4.11
FAUNA SURVEY LOCATIONS

- Pitfall Trapping – four pit-traps made from clean and emptied 20-litre oil drums were placed flush to the ground surface within the Tailings Storage Facility area over two consecutive nights. The pits, with 10cmto 20m of drift fence at their openings, were placed up to 15m apart and connected to adjacent understorey by drift fencing. The traps were lined with leaf litter and bark to shelter captured fauna from predators and excessive sun. Pit traps were checked between 8:30am and 9:30am daily.
- Aquatic habitats - existing storage dams, creeks and drainage lines were assessed by visual inspection. Dams were walked (circumnavigated) and revisited during nocturnal targeted assessments. Habitat value was assigned following the convention developed by Fairfull and Witheridge (2003).

4.2.4 Project Site Flora and Fauna

4.2.4.1 Introduction

OzArk (2011a) presents a detailed list of all species, vegetation communities and habitats recorded within the Project Site, including those identified during the CSUJC-EC (2006) survey. This sub-section includes an overview of that information.

4.2.4.2 Vegetation Communities Identified

OzArk (2011a), in accordance with the *BioMetric* classification system and consistent with Benson (2006), identify four main vegetation communities within the Project Site. Each of these communities is described as follows.

- Benson 103 –Poplar Box – Gum-barked Coolibah – White Cypress Pine shrubby woodland mainly in the Cobar Peneplain Bioregion. This vegetation community dominates the Project Site and can be classified further into sub-communities reflecting the change in dominant canopy, as follows.
  - Benson 103 - Poplar Box – Gum-barked Coolibah – White Cypress Pine.
  - Benson 103 – Bimble Box dominated.
  - Benson 103 – White cypress pine dominated. This community is characterised by variable density of vegetation from very dense to open.
  - Benson 103 – *Eremophila* and hopbush regrowth.
  - Benson 103 – Yarren (*Acacia hemaphylia*).
- Benson 174 – Mallee – Smooth-barked Coolibah woodland on red earth flats of the eastern Cobar Peneplain Bioregion. This vegetation type occurs in clusters within Benson 103.
- Benson 180 –Grey Mallee – White Cypress Pine woodland on rocky hills of the eastern Cobar Peneplain Bioregion. This vegetation community occurs on The Peak and integrates with Benson 174.

Cleared/disturbed areas associated with prior landuse. This community includes a small area of Lobed Blue-grass (*Bothriochloa biloba*) regrowth and cleared areas associated with tracks. OzArk (2011a) notes that the general diversity and natural ratios of species within the Project Site are unbalanced as follows.

- Red Box (*E. Intertexta*) has been lopped, ringbarked or removed throughout much of the Project Site.
- White Cypress Pine has invaded much of the disturbed areas within the northern half of the Project Site.
- The area surrounding the proposed Back Tank West and Pete's Tank and associated broad drainage lines in the southern half of the Project Site is dominated by low branching 'mallee' formed by Bimble Box, Gum–barked Coolibah (*Eucalyptus intertexta*) and Bimble Box (*Eucalyptus populnea subsp. Bimbil*). White Cypress Pine *(Callitris glaucophylla*) occurred throughout the areas surveyed in varying densities. Sticky Wallaby Bush (*Beyeria viscosa*) Wallaby Bush (*Bertya cunninghamii*), Western Golden Wattle (*Acacia decora*), Punty Bush (*Cassia eremophila*), Erempohilas (*Eremophila sp.),* Wedge leaf hopbush (*Dodonaea viscosa subsp. Cuneata*), Bush Mallee Pea (*Eutaxia microphylla)* and Silver Cassia *(Senna form taxon 'artemisioides',* dominate the mid canopy layer and provide a dense understorey in moderately disturbed/cleared areas. A generally herbaceous grassy understorey is intermittently present throughout the site including *Austrostipa* sp., *Aristida sp.,Austrodanthonia sp., Chenopodium sp. Maireana sp. and* saltbushes.

4.2.4.3 Flora Species Identified

OzArk (2011a) state that 135 species of flora have been identified within the Project Site, of which 133 are native species and 2 are listed as noxious.

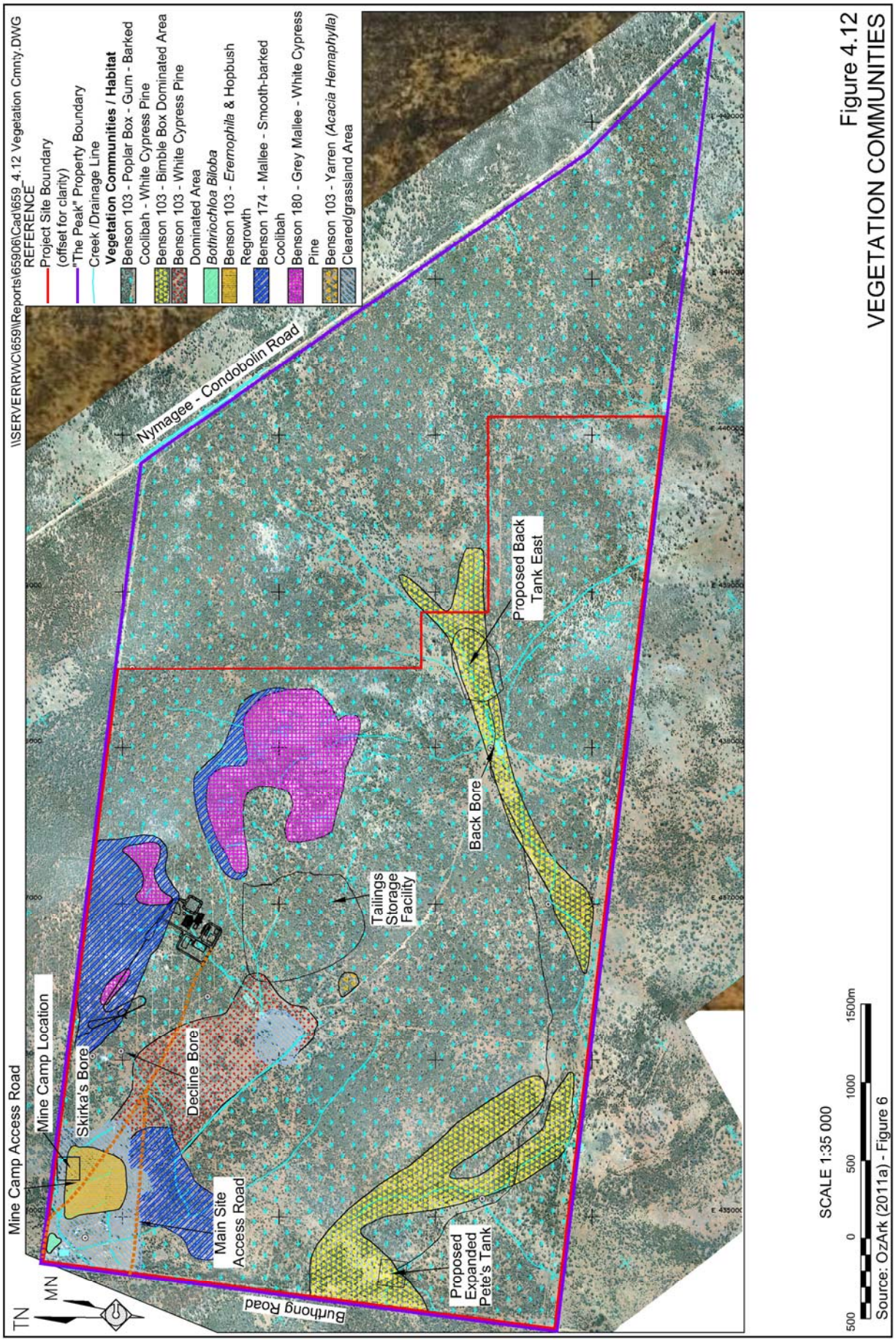
One population of the EPBC Act listed species, namely Lobed Blue-grass (*Bothriocloa biloba*), was recorded in the north-eastern section of the site access road between the homestead and Burthong Road (approximately 140m x 40m) in a previously cleared and disturbed area (**Figure 4.12)**. OzArk (2011a) state that this species is not likely to extend beyond this cleared habitat.

Two species of noxious weeds were identified, namely Bathurst Burr and Galvanised Burr. Both are Class 4 noxious weeds in the Cobar LGA in accordance with the *Noxious Weeds Act*.

4.2.4.4 Fauna Species Identified

A total of 103 vertebrate fauna species (97 native and six introduced) were recorded during the OzArk survey and incidental observations, comprising the following.

- Five reptile species (no threatened species, one with local conservation concern);
- Three frog species (no threatened species, two with local conservation concern);
- 78 bird species signalling moderate to high bird diversity with the Project Site, including six TSC Act threatened species, one EPBC Act migratory species and fourteen species of local conservation concern;


\\SERVER\RWC\659\Reports\65906\Cad\659_4.12 Vegetation Cmnty.DWG
REFERENCE
Project Site Boundary
(offset for clarity)
"The Peak" Property Boundary
Creek /Drainage Line
Vegetation Communities / Habitat
Benson 103 - Poplar Box - Gum - Barked Coolibah - White Cypress Pine
Benson 103 - Bimble Box Dominated Area
Benson 103 - White Cypress Pine Dominated Area
Bothriochloa Biloba
Benson 103 - Eremophila & Hopbush Regrowth
Benson 174 - Mallee - Smooth-barked Coolibah
Benson 180 - Grey Mallee - White Cypress Pine
Benson 103 - Yarren (Acacia Hemaphylla) Cleared/grassland Area
Nymagee - Condobolin Road
Mine Camp Access Road
Mine Camp Location
Skirka's Bore
Decline Bore
Main Site Access Road
Tailings Storage Facility
Back Bore
Proposed Back Tank East
Proposed Expanded Pete's Tank
Burthong Road
TN
MN
SCALE 1:35 000
500 0 500 1000 1500m
Source: OzArk (2011a) - Figure 6
Figure 4.12
VEGETATION COMMUNITIES

The full list of all vertebrate fauna species recorded during the OzArk survey undertaken in April 2010 are given in Appendix 2 of OzArk (2011a).

The CSUJC-EC (2006) survey recorded a total of 145 vertebrate fauna (139 native and six introduced) species during surveying times and incidental observations comprising:

- 23 reptile species (no threatened or species of conservation concern);
- 7 frog species (no threatened or species of conservation concern);
- 95 bird species including nine threatened and 13 species of conservation concern; and
- 20 mammals including one threatened and one species of conservation concern.

A summary of all threatened fauna species recorded within the Project Site during the OzArk (2011a) and the CSUJC-EC(2006) survey are given in **Table 4.9**. Detailed threatened species profiles are provided in Table 23of OzArk (2011a).

All species recorded during this assessment have been previously recorded within the locality or region. It should be noted that NSW or nationally listed critical habitats and/or critically endangered populations were not recorded within the Project Site.

Of the 78 bird species (77 native and one introduced) recorded during the survey all except one (a tawny frogmouth) were observed during diurnal bird surveys (in the vicinity of the homestead and the House Tank within the various small seeded grasses). This reflects the general absence of nocturnal birds from the Project Site. This has been postulated to be due a lack of scrubby understorey and heavy grazing, which would impact on habitat for small marsupial and mice prey birds such as owls, nightjars, boobooks and frogmouths within the Project Site. The large number of bird species recorded has been attributed to the abundance of habitats within the Project Site.

Eleven bird species and two bat species listed as threatened under the TSC Act were recorded (see **Table 4.9**) during the OzArk (2011a) and CSUJC-EC (2006). No threatened or migratory species listed under the EPBC Act were recorded within the Project Site during the OzArk (2011a) survey but the Superb Parrot (also listed as threatened under TSC Act) was recorded in CSUJC-EC (2006). CSUJC-EC (2006) also recorded four other TSC Act threatened species (Speckled Warbler, Pied Honeyeater, Chestnut Quail-thrush, Chestnut Quail-thrush, Black-chinned Honeyeater) that were not recorded during the OzArk (2011a) survey.

Furthermore, it is likely that other threatened bird species not recorded to date (listed in **Table 4.7** from database searches) may occur within the Project Site since habitats similar to those surveyed exist throughout the Project Site.

Fourteen bird species of conservation concern, as identified by Reid (1999) and Smith *et al.* (1994), were recorded and include the Southern Whiteface, Restless Flycatcher, Eastern Yellow Robin, Jacky Winter, Red-capped Robin, White-browed Babbler, Noisy Friarbird, Western Gery gone, Noisy Friarbird, Jacky Winter, Crested Bellbird, Rufous Whistler, Wedge-tailed Eagle and Spotted Bowerbird. These species, while not listed under the TSC Act, are listed as of some conservation concern and/or near threatened and likely to become threatened if appropriate management of existing habitat is not undertaken.

Table 4.9
Recorded Threatened Species

Scientific Name	Common Name	Level of Threat	Benson 103	Benson 174	Benson 180	Cleared /Disturbed	Survey
Circus assimilis	Spotted Harrier	TSC Act				O	OzArk 2011a
Cacatua leadbeateri	Major Mitchell's Cockatoo	TSC Act	X			XO	OzArk 2011a CSUJC-EC 2006
Stagonopleura guttata	Diamond Firetail	TSC Act	X			XO	OzArk 2011a CSUJC-EC 2006
Melanodryas cucullata	Hooded Robin	TSC Act	XO			XO	OzArk 2011a CSUJC-EC 2006
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	TSC Act	XO	O	O	XO	OzArk 2011a CSUJC-EC 2006
Neophema pulchella	Turquoise Parrot	TSC Act				O	OzArk 2011a
Certhionyx variegates	Speckled Warbler	TSC Act	X				CSUJC-EC 2006
Certhionyx variegates	Pied Honeyeater	TSC Act	X				CSUJC-EC 2006
(Cinclosoma castanotus)	Chestnut Quail-thrush	TSC Act	X				CSUJC-EC 2006
Melithreptus gularis gularis	Black-chinned Honeyeater	TSC Act	X				CSUJC-EC 2006
Polytelis swainsonii	Superb Parrot	TSC Act EPBC Act	X			X	CSUJC-EC 2006
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	TSC Act	O				OzArk 2011a
Chalinolobus picatus	Little Pied Bat	TSC Act	X		O		OzArk 2011a CSUJC-EC 2006
O= OzArk (2011a) records; **X**= CSUJC-EC 2006 records							
Source: OzArk (2011a) –modified from Table 13							

Ten species of Microchiropteran bat were recorded over the four consecutive nights of Anabat recording, two of which (Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) and Little Pied Bat (*Chalinolobus picatus*)) are listed under the TSC Act.

No mammals were trapped during the survey period which could either be due to seasonality factors and absence of the species; it was concluded the latter was the more probable explanation. Seven ground-dwelling mammals were recorded during the survey in locations where the understorey vegetation remains, particularly on 'The Peak' topographic feature and in the vicinity of the existing Back Tank West.

Tracks and scats of the fox, and to a lesser extent the cat, were frequently recorded within the Project Site in all habitat types. Rabbit and goat tracks and scats were most commonly recorded throughout the Project Site, however, were absent from the grassland near the homestead.

No mammals were trapped during the survey period. Seven ground-dwelling mammals were recorded where understorey vegetation remained, particularly on 'The Peak' topographic feature and in the vicinity of the Back Tank West site. The general absence of leaf litter and ground debris in each vegetation community noted above has restricted the ability for many small ground-dwelling mammals, such as the Malleefowl and Bush-stone Curlew to occur.

Tracks and scats of the fox, and to a lesser extent the cat, were frequently recorded within the Project Site in all habitat types. Rabbit and goat tracks and scats were most commonly recorded throughout the Project Site, however, were absent from the grassland near the homestead.

A total of five species of reptile and three species of amphibian were recorded during the survey. These numbers are considered less than expected for the site and reflects the high levels of disturbance to habitats suitable for these species. Changes in hydrology as well as habitat degradation particularly loss of ground cover due to grazing by feral goats is also believed to have contributed to the low diversities of frogs and reptiles recorded.

4.2.4.5 Habitats Recorded

The vegetation communities within the Project Site, comprising a total of four main structural vegetation types noted in Section 4.2.4.1 (and their distribution shown in **Figure 4.12)**, provide structural habitats within the Project Site, all with slightly different key habitat elements. Appendix 4 of OzArk (2011a) provides the threatened species predicted or known to occur within these vegetation types.

Over 50 high habitat value tree stags were recorded in the area to the west of the Tailing Storage Facility on either side of the proposed Main Access Road. These hollow bearing trees dominate the Benson 103 White Cypress Pine vegetation community (see **Figure 4.12)**, and potentially provide habitat for small marsupials, hollow-dependent birds, bats and reptiles. However, a lack of ground debris in this area reduces the potential for safe passage of small ground-dwelling marsupials and mice for the occupation of the hollows.

As a general observation, it was found only limited number of live trees were of an age to possess hollows. High habitat value hollow-bearing dead tree stags (*E. intertexta* or *glaucophylla*) were found to be scattered throughout the Project Site outside of the areas that would be disturbed.

4.2.5 Management and Mitigation Measures

4.2.5.1 Introduction

The Proponent would implement the following management and mitigation measures during the life of the Project.

Prior to Project Commencement

- Develop a *Biodiversity Management Plan* (BMP) comprising:
  - pest animal controls for the control of feral goat, cat, dog and fox;
  - weed control program for the removal of noxious weeds and reducing further weed invasion;

  - development of Biodiversity Strategy including a Biodiversity Offset Area (see Section 2.16);
  - development of a Grazing Management Plan using grazing as a management tool in a controlled manner.
- Engage appropriately qualified and experienced ecologists to undertake pre-clearance surveys within areas to be cleared of vegetation.
- Implement a Driver Code of Conduct for all personnel accessing the Project Site.
- Implement management controls to ensure minimisation of impacts to nests and habitats of the recorded threatened species, including inductions, toolbox meetings and making available fact sheets on the recorded threatened bird species (including descriptions and photographs of the species, their habitats including 'typical' nest shapes) to personnel responsible for vegetation clearing and excavation activities,.
- Schedule clearing of substantive trees, where practicable, to between April and September to reduce the risk of impact to tree-dependent microbats. Where this is not practicable, ensure that all hollows suitable for such microbats are inspected prior to clearing operations and roosting bats relocated by a suitably qualified and experienced wildlife handler.
- Use suitably qualified personnel to handle the removal of bats of any species.
- Clearly mark areas to be cleared of vegetation.
- Park machinery required for the Project within designated areas and/or disturbed areas only.
- Clear hollow-bearing trees or trees with dead stags only after a series of alternating 'gradual nudge' (e.g. with a dozer) and 'wait' to allow the occupants of hollows (if any) to escape.
- Disturb only those sections of land, proposed for the construction of the Back Tank East, required for the dam wall construction and allow the remaining area to flood intermittently with the vegetation still standing.
- Salvage tree trunks, major and minor branches from areas requiring clearing for subsequent relocation within areas to be rehabilitated or throughout the Project Site to create habitat with structural complexity and critical habitat currently absent from the Project Site.
- Erect signs within the Project Site notifying the ecological values of the felled trees and to warn against their collection for firewood.
- Remove and properly dispose of any noxious or other weeds encountered site clearing to prevent their spread to other locations within the Project Site, especially to drainage lines and storage dam areas.

- Minimise impacts to the local waterways and downstream creeks during expansion of Pete's Tank and construction of the proposed Back Tank East through:
  - planning of the site establishment activities so that the in-stream work is kept to a minimum and would occur as a single event, where possible;
  - limit machinery access to one designated location on the bank and create the shortest access track between this location and the point of activity; and
  - clear vegetation from unstable or erodible banks by hand rather than using heavy machinery.
- Install appropriate surface water and erosion and control measures in accordance with the requirements of Landcom (2006).

Operational Phase

- Manage potential risk to the health of the biota (birds, other wildlife and livestock) from the Tailings Storage Facility through engineering controls including the creation of suitable and alternative habitats in the vicinity of the storage dams (expanded Pete's Tank and the proposed Back Tank East) through revegetation of the disturbed areas.
- Undertake monitoring of bat on an annual basis would occur to establish any trend in population changes since commencement of the Project.
- Undertake monitoring of the ongoing rehabilitation activities within the Project Site to ensure native vegetation regeneration is successful and to control weed invasion.
- Conduct annual monitoring of the Grey-crowned Babbler, Hooded Robin, Diamond Firetail and microbat populations including their breeding locations to gauge breeding success and to ensure recovery of local populations are successful following the land disturbing activities.
- Undertake annual surveys of the Kultarr to establish a population census and compile information for use in the management of this species within the Project site and to allow year to year comparisons of any changes in habitat usage and population trends.
- Implement the proposed Biodiversity Offset Strategy to ensure a Tier 1 'improve or maintain' or a Tier 2 'no net loss' outcome in accordance with the requirements of the BioBanking Assessment Methodology.

Following Completion of Mining Operations

- Monitor the rehabilitation activities within the Project Site to ensure native vegetation regeneration is successful and to ensure that weed invasion controls are effective.
- Implement the industry best practice land management measures, e.g. implementation of a weed and feral animal control program.

- Continue with the annual monitoring of the Grey-crowned Babbler, Hooded Robin, Diamond Firetail and microbat populations including their breeding locations to gauge breeding success and to ensure recovery of local populations are successful.
- Continue with the annual formal surveys of the Kultarr to establish a population census and compile information for use in the management of this species following rehabilitation activities and to allow year to year comparisons of any changes in habitat usage and population trends.
- Implement fully the Biodiversity Offset Strategy described in Section 2.16, including ensuring that the strategy would be implemented in perpetuity.
- Prepare a *Biodiversity Management Plan* in consultation with the relevant government agencies prior to the commencement of ground disturbing activities that are not already approved. That plan would include the following.
  - Fencing of the entire Biodiversity Offset Area with a fence suitable to exclude pest animals, in particular goats.
  - Implementation of a weed and pest animal control program within the fenced Biodiversity Offset Area and the remainder of WLL2455.
  - Amelioration where required to re-establish pre-existing vegetation communities. In other areas where amelioration is not required, natural regeneration would be permitted.
  - Regular monitoring of the Biodiversity Offset Area and other sections of WLL2455, including fixed quadrats and/or transects, to track changes in biodiversity with time.
  - Measures that would be implemented within the area identified on **Figure 2.12** as having a final land use of 'nature conservation.'

4.2.6 Impact Assessment

4.2.6.1 Introduction

This sub-section presents an assessment of the anticipated Project-related impacts on the vegetation communities, threatened fauna and flora species recorded or considered as potentially likely to occur within the Project Site. The assessment considers separately the impacts on TSC Act and EPBC Act listed threatened species and koalas under SEPP 44 habitat guidelines.

4.2.6.2 Impacts on Vegetation Communities

The Project would disturb approximately 77ha of land within the Project Site. **Table 4.10** lists the vegetation communities, and the corresponding areas, that would be impacted upon by the Project. Out of the 77ha, approximately 2ha has already been disturbed. As a result, approximately 75ha of native vegetation would be disturbed. Percentages of these vegetation communities to be removed relative to the Project Site area (1 532ha) and 'The Peak' property area ((2 128ha) area are also given in **Table 4.10**. For these calculations 'cleared/grassland' has been classified as a vegetation community (OzArk 2011). In summary, the Project would remove less than approximately 5% of existing vegetation within the Project Site, which equates to approximately 3.6% within 'The Peak' property.

Table 4.10
Direct Impacts on Vegetation Communities

Vegetation Community	Area to be disturbed (ha)	Percentage Project Site to be disturbed	Percentage 'The Peak' property to be disturbed
Benson 103 – Poplar Box – Gum-barked Codibah – White Cypress Pine	58.4	3.8%	2.74%
Benson 103 – Bimble Box dominated	10.2	0.7%	0.48%
Benson 103 – White Cypress Pine dominated	1.7	0.1%	0.08%
Benson 103 – Eremophila and hopbush regrowth	1.6	0.1%	0.08%
Benson 103 – Yarren (*Acacia hemaphylia*)	0	0%	0%
Benson 174 – Mallee – Smooth-barked Coolibah	3.2	0.21%	0.15%
Benson 180 – Grey Mallee – White Cypress Pine	0.1	0.01%	0.01%
Bothriochloa biloba	0	0%	0%
Cleared/disturbed area	2.1	0.13%	0.10%
TOTAL	**77.3**	5.0%	3.6%
Source: OzArk (2011a) -modified from Table 14			

4.2.6.3 TSC Act Impact Assessment

Seven-part tests and/or Assessments of Significance were prepared for the following TSC Act threatened species recorded or considered as highly likely to occur within the Project Site.

- Kultarr (*Antechinomys laniger*).
- Major Mitchell's Cockatoo (*Calyptorhynchus leadbeateri*).
- Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*).
- Little Pied Bat (*Chalinolobus picatus*).
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis* (eastern subspecies).
- Brown Treecreeper (*Climacteris picumnus victoriae*).
- Hooded Robin (*Melanodryas cucullate*).
- Chestnut Quail-thrush (*Cinclosoma castanotus*).

- Speckled Warbler (*Pyrrholaemus sagittate*).
- Pied Honeyeater (*Certhionyx variegates*).
- Diamond Firetail (*Stagonopleura guttata*).
- Superb Parrot (*Polytelis swainsonii*) (also EPBC Act).
- Black-chinned Honeyeater (*Melithreptus gularis gularis* (eastern subspecies).
- Turquoise Parrot (*Neophema pulchella*).
- Spotted Harrier (*Circus assimilis*).
- Pine Donkey Orchid (*Diuris tricolor*).
- Cobar Greenhood Orchid (*Pterostylis cobarensis*).
- Lobed Bluegrass.

The results of the 7-part tests and/or Assessments of Significance for each threatened species noted above are presented in Appendix 3 of OzArk (2011a). The tests determined that Project-related impacts on threatened species are unlikely to be significant.

4.2.6.4 EPBC Act Assessment

Assessments of Significance were prepared for the following EPBC Act threatened species recorded or considered as highly likely to occur within the Project Site.

- Superb Parrot (*Polytelis swainsonii*) (also TSC Act).
- Cobar Greenhood Orchid (*Pterostylis cobarensis*) (also TSC Act).
- Lobed Blue-grass (*Bothriochloa biloba*).

The results Assessments of Significance for each threatened species noted above are presented in Appendix 3 of OzArk (2011a). The tests determined that Project-related impacts would not be significant and that referral to the Commonwealth Minister for the Environment is not required for the Project.

4.2.6.5 SEPP 44 – Koala Assessment

Cobar LGA is not listed under Schedule 1 (Local Government Areas) of SEPP 44: Koala Habitat Protection or Schedule 2 (Feed Trees Listed). Although koalas have the potential to occur within the Project Site due to the existence of Bimble Box vegetation community, no koalas were recorded during the two surveys undertaken within the Project Site (OzArk (2011a) and CSUJC-EC (2006)). An assessment of the species profiles detailing information on ecological requirements (see Table 23 of OzArk (2011a)) prepared for threatened species with the potential to occur within the Project Site concluded that it is unlikely the Koala would occur.

4.2.6.6 Assessment of the Key Threatening Processes

The 34 Key Threatening Processes (KTP) listed under the TSC Act were assessed for the Project (see Table 17 of OzArk (2011a)).The assessment revealed that the Project would involve five KTPs, including:

- clearing of native vegetation;
- loss of hollow-bearing trees;

- invasion of native plant communities by exotic perennial grasses;
- removal of dead wood and dead trees; and
- bushrock removal.

4.2.6.7 Assessment of the Biodiversity Offset Strategy

The Biodiversity Offset Strategy proposed by the Proponent is discussed in Section 2.16 and Section 9.5 of OzArk (2011a). The latter describes in detail how the Project's Biodiversity Offset Strategy is consistent with the relevant polices of DSEWPaC and OEH, namely:

- Interim Policy for Biodiversity Offsets for Part 3A Projects (DECCW, 2010) (OEH Interim Part 3A Offset Policy);
- Principles for the use of Biodiversity Offsets in NSW (OEH Offset Principles); and
- Draft Policy Statement: Use of Environmental Offset under the EPBC Act 1999 (DSEWPaC Draft Policy Statement).

The discussions given below refer to the proposed Biodiversity Offset Strategy for the project (see Section 2.16).

OEH Interim Part 3A Offset Policy

Under this policy, the Proponent is required to:

- describe, quantify and categorize the biodiversity values and impacts of a proposal;
- identify, for benchmarking purposes, the offsetting that would be required to meet the improve or maintain standard; and
- provide the information for calculating offsets under this policy.

In relation to each of the above points, the Proponent notes the following.

- Section 4.2.4 and OzArk (2011a) describes, quantifies and categorizes the biodiversity within the Project Site, focusing particularly on the proposed areas of disturbance.
- Section 2.16 and Section 9.5.2 of OzArk (2011a), describes the Biodiversity Offset Strategy and the Preferred and Alternative Biodiversity Offset Areas including a range of measures that would be implemented to secure and manage the strategy. That section indicates that the Proponent would achieve a Tier 1 'maintain or improve' or a Tier 2 'no net loss' outcome under the BioBanking Assessment Methodology (BBAM).
- Finally, as indicated in Section 4.2.3 and Section 5.1 of OzArk (2011a), the ecology assessment within the proposed areas of disturbance was undertaken in a manner that would permit the collected data to be used in an assessment in accordance with the BBAM. In addition, as further indicated in Section 2.16.3, in assessing the Biodiversity Offset Strategy, the Proponent would commit to undertake the assessment of the proposed Biodiversity Offset Area in accordance with the requirements of BBAM.

As a result, the Proponent contends that the requirements of the OEH Interim Part 3A Offset Policy have been achieved.

OEH Offset Principles

The following summarises how the Project would comply with the 13 OEH Offset Principles in relation to the proposed offset areas and the Biodiversity Offset Strategy overall.

1. **Impacts must be avoided first by using prevention and mitigation measures.**
   The Project has been designed to ensure that the smallest practicable area of native vegetation is disturbed. Measures that have been implemented in the design of the Project or would be implemented during the site establishment and operational phases and following Project completion are as follows.

   – The proposed mining operations have been designed for an underground mine rather than an open-cut mine to minimise the areas that would be disturbed.
   – The Project has been designed to avoid remnant native vegetation, where possible.
   – The proposed Back Tank East has been located in a saddle-point location to exploit its natural topography for the creation of the 90ML dam which would minimise the impact footprint and the land-disturbing activities required to be undertaken.
   – Minimal removal of trees from the proposed Back Tank East footprint will occur; trees will be left in the dam following construction and subsequent flooding.
   – The Proponent would commit to implementation of mitigation measures at all phases of the Project (see Section 4.2.5).

   Section 9.5.2.3 of OzArk (2011a) identifies that the proposed Biodiversity Offset Strategy is likely to exceed the minimum requirements calculated by a BioBanking Credit Report and that at a minimum, the proposed Biodiversity Offset Strategy would result in a Tier 2 or 'no net loss' benchmark of the OEH Part 3A Interim Offsets Policy. The Project is, however, likely to meet Tier 1 if no red flag species are recorded in the September to November 2011 assessment.
2. **All regulatory requirements must be met.**
   The Proponent would comply with all regulatory requirements for the Project.
3. **Offsets must never reward ongoing poor performance.**
   The Proponent contends that environmental performance record within the EL 6162 boundary, within which the current exploration activities are being undertaken, is of a high standard. Examples of good environmental management demonstrated by the Proponent, to date, include the following.

   – Management of exploration operations in a manner that ensures minimal disturbance of vegetated areas.
   – Management of noise, traffic and dust arising from the exploration activities such that the surrounding neighbours and the residents of Nymagee are not affected.
   – All personnel accessing the site follow a stringent Driver Code of Conduct prepared by the Proponent.

- No removal of hollow-bearing trees or dead trees.
- Management of weeds throughout the EL 6162 boundary area.

4. Offsets will complement other government programs.

The Biodiversity Strategy would complement existing NSW Government conservation objectives as the proposed Biodiversity Offset Area would preserve an area by means of positive long-term biodiversity outcomes including legal protection and medium to long-term management of a significant area of native vegetation for conservation.

The Proponent would address the KTPs identified for the Project (see Section 4.2.6.6). The proposed Biodiversity Offset Area and the management of land via the *Biodiversity Management Plan* would address many of the KTPs through destocking, weed control and feral animal control.

5. Offsets must be underpinned by sound ecological principles.

The proposed Biodiversity Offset Strategy:

- would permit the ongoing beneficial use of the Biodiversity Offset Area, ensuring that resources remain available in perpetuity to manage the land in an appropriate manner;
- would protect the proposed Biodiversity Offset Area by using the appropriate management procedures (e.g. implementation of vermin and feral animal controls) to ensure that the understory and shrub layers are not destroyed and the ecological values of these areas are enhanced in the long term; and
- would be assessed using the BBAM.

6. Offsets should aim to result in a net improvement in biodiversity over time.

As noted above the proposed Biodiversity Offset Strategy would, through appropriate land management and via a *Biodiversity Management Plan*, prevent the future destruction of the proposed offset areas by noxious weeds, vermin and feral animals. This would result in a net improvement in biodiversity within the Project's Biodiversity Offset Area over time.

7. Offsets must be enduring and they must offset the impact of the development for the period that the impact occurs.

The Proposed Biodiversity Offset Strategy would be secured through an amendment to the conditions of WLL2455 to identify the proposed Biodiversity Offset Area as an area that is to be used for nature conservation in perpetuity.

8. Offsets should be agreed prior to the impact occurring.

As indicated in Section 3.2.3, the Proponent has commenced negotiations with OEH, Department of Primary Industries – Crowns Lands Division and Darling Livestock Health and Pest Authority in relation to establishing the proposed Biodiversity Offset Strategy. In addition, as indicated in Section 9.5.2.3 of OzArk (2011a), the Proponent will be undertaking further assessment of the proposed Biodiversity Offset Area during the flowering period of the Cobar Greenhood Orchid. As a result, the Proponent has committed in Section 4.2.5 to prepare the *Biodiversity Management Plan* prior to the commencement of ground disturbing activities that are not already approved.

The Proponent contends that the requirements of this principle have been achieved.

9. **Offsets must be quantifiable and the impacts and benefits must be reliably estimated.**
   As indicated in Section 2.16, the Proponent would assess both the proposed areas of disturbance and the proposed Biodiversity Offset Area using the BBAM. As a result, the Proponent contends that the proposed Biodiversity Offset Strategy would be quantifiable and the impacts capable of being reliably estimated.

10. **Offsets must be targeted.**
    The Proponent notes that the proposed Biodiversity Offset Area comprises the same vegetation types as those that would be disturbed and that the strategy would be assessed using the BBAM.

11. **Offsets must be located appropriately.**
    The proposed Biodiversity Offset Area is located immediately to the east of the Project Site boundary within 'The Peak' property.

12. **Offsets must be supplementary.**
    The proposed Biodiversity Offset Area is not protected by existing covenants or other measures and not funded by other schemes.

13. **Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.**
    The Proponent anticipates that the Biodiversity Offset Strategy would be secured through a modification to the conditions of consent associated with WLL2455.

DSEWPaC Draft Policy Statement

The EPBC Act-listed matters of national environmental significance identified within or considered to have the potential to occur within the Project Site include the following.

- Superb Parrot (*Polytelis swainsonii*) (EPBC Act) – sighted overflying the area.
- Cobar Greenhood Orchid (*Pterostylis cobarensis*) (EPBC Act), precautionary principle applied.
- Lobed Blue-grass (*Bothriochloa biloba*) (EPBC Act), recorded within the Project Site.

These species were assessed in accordance with the DSEWPaC *Draft Policy Statement: Use of environmental offset under the EPBC Act 1999.* That document includes three considerations as follows.

- Consideration 1 –Consistency with DSEWPaC definition
  OzArk (2011a) note at Table 20 that the proposed Biodiversity Offset Strategy is consistent with all DSEWPaC definitions.

- Consideration 2 – Types of environmental offsets

  Actions that can be considered as environmental offsets are generally categorised into direct and indirect offsets. Direct offsets are aimed at on-ground maintenance and improvement of habitat or landscape values. Indirect offsets are the range of other actions that improve knowledge, understanding and management leading to improved conservation outcomes. All three direct offset aims for the Project's offset areas are consistent with DSEWPaC defined environmental offset aims.

- Consideration 3 – Principle for the use of environmental offsets

  OzArk (2011a) state that the proposed Biodiversity Offset Strategy is consistent with the eight principles used to assess any proposed environmental offsets to ensure consistency, transparency and equity under the EPBC Act (see Table 22 of OzArk 2011a)).

Effectiveness of the Proposed Offsets

The conclusion reached from an assessment of the proposed Biodiversity Offset Strategy in accordance with the DSEWPaC Draft Policy Statement and the OEH Offset Principles is that the attainment of a 'Tier 2 No Net Loss' (at minimum) in accordance with the *OEH Interim policy on assessing and offsetting biodiversity impacts of Part 3A developments* (DECCW, 2010) is considered achievable since:

1. OEH offset requirements for threatened species will be achieved through habitat offsetting through the BioBanking Assessment Methodology;
2. OEH offset requirements for native vegetation (habitat) as the type, location and volume of offsets will be consistent with the 13 Offset Principles (see above); and
3. the Biodiversity Offset Strategy will be consistent with the eight DSEWPaC principles for biodiversity offsets (see above and Table 22 of OzArk (2011a)).

4.2.6.8 Overall Assessment of Impacts

The Proponent would minimise impacts from Project activities through implementation of mitigation measures (see Section 4.2.5) and the Biodiversity Offset Strategy, the latter to compensate for habitat loss arising from vegetation clearing. The mitigation measures proposed within the Project Site would fall in the following general activities:

- the preservation of tree hollows;
- promoting native grass regeneration;
- creating structural complexity within the existing vegetation;
- planting winter flowering eucalypts and understorey;
- feral animal and weed control;
- adoption of the Kultarr as a flagship species for the purposes of the Biodiversity Offset Strategy; and
- incorporation of engineering and design controls in the Project components (e.g. Tailings Storage Facility and storage dams) for the management of potential risks to the health of the existing biota within the Project Site.

It is concluded that by adopting these mitigation measures no significant environmental impacts to threatened species, communities or populations of flora or fauna, due to the Project would occur. This conclusion is consistent with the principles of *Environmentally Sustainable Development*.

4.2.7 Monitoring

The Proponent would ensure that the following ecology-related monitoring is undertaken during the life of the Project.

- Ensure that all areas undergoing rehabilitation are be monitored on a 6 monthly basis to determine the success or otherwise of the management, mitigation and ameliorative measures and the rehabilitation programs. Review of the rehabilitation program would be undertaken if monitoring reveals inadequacy in the rehabilitation objectives.
- Establish a set of photographic reference points and use photographs, taken at six monthly intervals, to document activities within the Project Site, including weed control and revegetation activities.
- Undertake monitoring of the ongoing rehabilitation activities within the Project Site to ensure native vegetation regeneration is successful and to control weed invasion.
- Undertake annual surveys of the following species to establish any population changes and identification of breeding locations following project commencement and after project completion:
  - Microbats;
  - Grey-crowned Babbler;
  - Hooded Robin;
  - Diamond Firetail; and
  - Kultarr.

The results of the monitoring program would be reported in each Annual Environmental Management Report prepared for the Project and submitted to the appropriate government agencies and all stakeholders.

4.3 GROUNDWATER

4.3.1 Introduction

The groundwater assessment for the Project was undertaken by The Impax Group. The full assessment is presented as Part 2 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as Impax (2011). This summary should be read in conjunction with that report.

A risk analysis presented in Section 3.4identified the following potential Project-related impacts relating to groundwater. The unmitigated risk rating associated with each impact is indicated in parenthesis.

- Pollution of groundwater due to leaching of contaminants from the Tailings Storage Facility (low to high).
- Pollution of groundwater due to hydrocarbon spills (medium).
- Reduction of groundwater levels due to mining and associated drawdown (medium to high).
- Dewatering of local hard rock aquifers as a result of blasting induced fracturing (high).
- Reduced volume and/or quality of water recharging surface water flows (medium).

The Director-General's Requirements for the Project identified 'Water – including a detailed groundwater model' as one of the key issues that requires assessment.

Impax (2011) considered the following documents during preparation of the groundwater assessment.

- *Guidelines for Groundwater Protection in Australia* (ARMCANZ and ANZECC 1995). This guideline provides a framework for preventing groundwater contamination in Australia.
- *NSW State Groundwater Policy and Framework Document* (NSW Department of Land and Water Conservation 1997). The Framework document sets out the overall direction of groundwater management in NSW and provides broad objectives and principles to guide groundwater management. The document refers to the specific policy documents listed below which outline the objectives and principles of minimising impacts to groundwater quality and quantity, and impacts to groundwater dependant ecosystems.
- *NSW State Groundwater Quantity Protection Policy* (NSW Department of Land and Water Conservation 1998).
- *NSW State Groundwater Quality Protection Policy* (NSW Department of Land and Water Conservation 1998).
- *NSW State Groundwater Dependant Ecosystems Policy* (NSW Department of Land and Water Conservation 2002).
- *Guidelines for Fresh and Marine Water Quality* (ANZECC 2000).
- *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (NSW EPA 2003).

The following sub-sections describe and assess the groundwater environment, identify the proposed management and mitigation measures, assess the anticipated groundwater impacts relating to the Project and identify the proposed groundwater monitoring program.

4.3.2 Surrounding Groundwater Users

Impax (2011) undertook a search of the NOW-administered Natural Resources Atlas on 8 June 2011 within a search radius of 10km from the Project Site. A total of 9 registered groundwater bores were identified within the search area (**Figure 4.13**). Details associated with each of the registered bores are presented in **Table 4.11.**

Each of the non-Project-related bores, with the exception of WB2 and WB3, are registered for "stock" watering. WB2 and WB3 are registered as monitoring bores.

Impax (2011) notes the following in relation to the groundwater environment surrounding the Project Site.

- Groundwater yields were recorded as ranging from 0.25L/s to 2.5L/s.
- Groundwater quality descriptions ranged from "good" to as high as 7 000ppm of total dissolved solids (TDS).

4.3.3 Project Site Groundwater Setting

4.3.3.1 Introduction

The Proponent notes that there have been three previous hydrogeological studies and a groundwater management plan prepared for the Project Site as follows.

- Hydrogeological Assessment of Skirka's Bore at 'The Peak' Station, Nymagee, NSW, Geoterra Pty Ltd, 25 October 2005.
- Hera Project Groundwater Status Report, Nymagee, NSW, Geoterra Pty Ltd, 31 May 2006.
- Hera Project Groundwater Management Plan, Nymagee, NSW, Geoterra Pty Ltd, 11 May 2007.
- Aquifer Pumping Test Report, 'The Peak' Nymagee, NSW, The Impax Group, 11 May 2011.

Those studies were aimed at identifying sufficient water supplies for mining-related purposes. The management plan addressed management of groundwater that would be encountered during construction of the exploration decline under the Part 5 Approval.

As a result of the 2005 and 2006 Geoterra reports, the Proponent's predecessor, Triako Resources Limited, made an application for groundwater licences for Back Bore, the decline and Skirka's bore (**Figure 4.13**) in 2007, or prior to the commencement of the Murray Darling Basin Groundwater Embargo.

Table 4.11
Registered Bores

Bore ID	Depth (m)	SWL (m)	Water Bearing Zone	Yield (L/s)	Lithology	TDS (ppm)	Project Related
GW017385	61	46.6	19.2-19.2m (Schist) 50.3-50.3m (Slate)	0.51	Loam Sandy (0-1m) Schist (1-46m) Slate (46-61m)	500-1000	No
GW017386	100.9	58.2	85.3-85.3m (Slate)	0.25	Clay (0-2m) Slate Soft (2-30m) Slate Hard (30-101m)	1000-3000	No
GW018014	82.9	15.2	70.1-70.1m (Quartzite)	0.51	Clay (0-2m) Quartzite Soft (2-24m) Quartzite Solid (24-83m)	3000-7000	No
GW020656[2] (Original Back Bore)	74.1	55.8	68.6-68.6m (Slate)	0.63	Clay (0-2m) Slate (2-34m) Quartzite (34-46m) Slate (46 - 74m)	"Good"	Yes
GW020657 (House Bore)	74.1	54.3	59.7-59.7m (Slate)	0.63	Clay (0-2m) Slate (2-46m) Quartzite (46-48m) Slate (48-74m)	"Good"	Yes
GW802946 (Skirka's Bore)	85	65	72-76m (Siltstone)	1.1	Alluvium (0-10m) Silcrete (10-12m) Kaolinitic Clay (12-25m) Siltstone (25-85m)	-	Yes
GW804183 (WB2)	108	100	88-102m (Siltstone) 102-108m (Siltstone)	2.5	Gravel (0-5m) Siltstone (5-108m)	-	No
GW804184 (WB3)	108	-	74-90m (Siltstone)	0.6	Gravel (0-2m) Clay (2-8m) Siltstone (8-108m)	-	No
GW804185 (WB4)	120	52.8	88-120m (Siltstone)	1	Clay (0-4m) Sandstone / Siltstone (4-30m) Siltstone (30-120m)	-	Yes

Note 1: SWL = Standing Water Level, TDS = Total dissolved solids
Note 2: The original Back Bore within the Project Site was rendered unusable and has been replaced by a second bore drilled adjacent to the original bore.
Note 3: Bores WB2 and WB3 were drilled by the Proponent's predecessor as monitoring bores. WB2 is currently an open hole and WB3 have been converted to a 50mm production bore. The Proponent understands that both are too small to be production bores.

Sources – Impacts (2011) – modified from Table 2

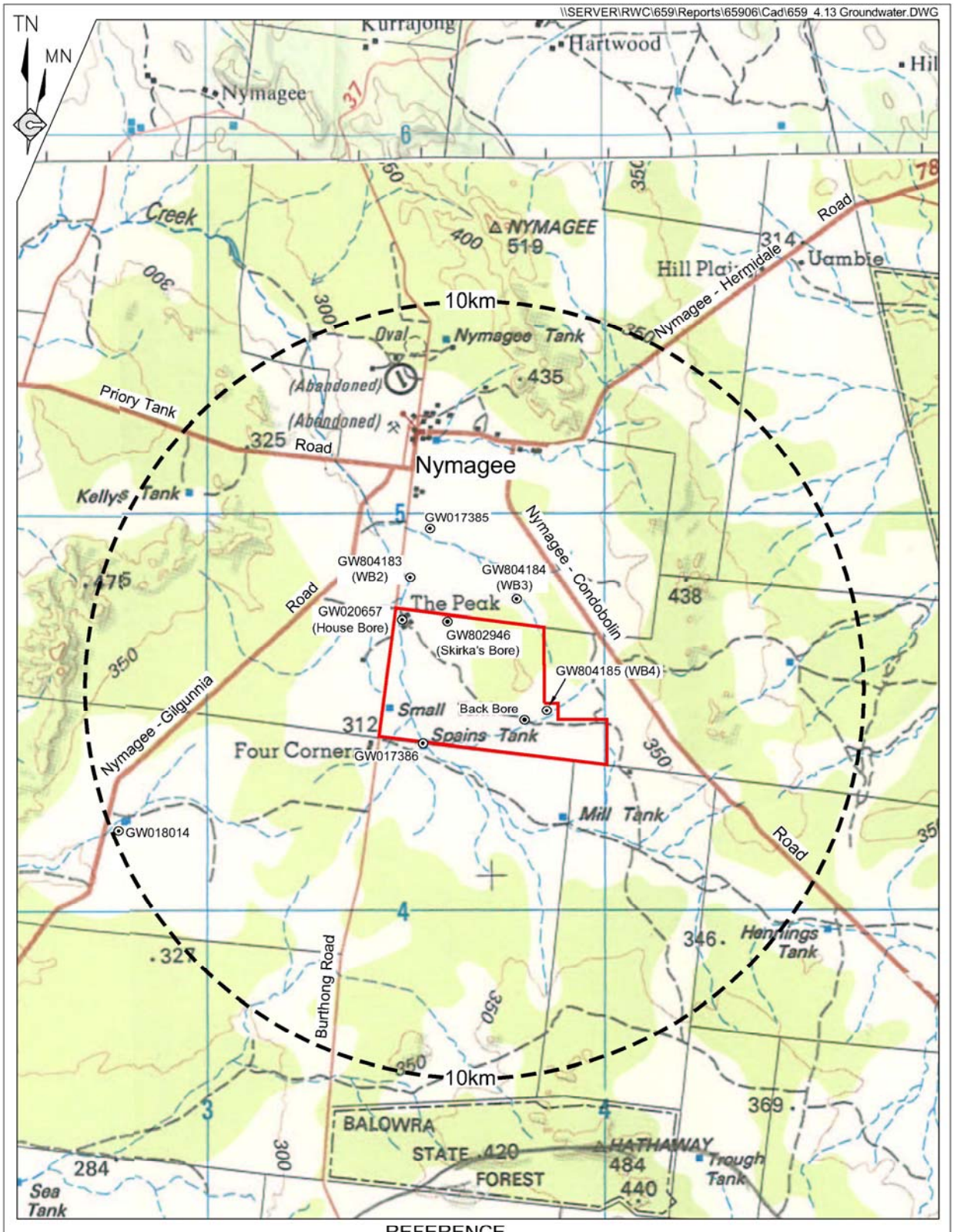


Figure 4.13
REGISTERED GROUNDWATER WORKS LOCATIONS

In August 2010, NOW informed the Proponent that they intended to issue groundwater licences for the Project for a total of 147ML/yr. The Proponent subsequently requested that the issue of the groundwater licences be deferred pending the results of further aquifer testing. The results of that testing is presented in the document *Aquifer Pumping Test Report, 'The Peak' Nymagee*, NSW prepared by The Impax Group and dated 11 May 2011. The results of that assessment are presented in the following sub-sections.

4.3.3.2 Groundwater Exploration Bores

During the most recent groundwater exploration program undertaken by the Impax Group in late 2010 and early 2011 a range of bores were used as pumping and monitoring bores. The location of each of these bores is presented on **Figure 4.13** and **Table 4.12** presents drilling and construction details in relation to each.

Table 4.12
Groundwater Bore Construction Details and Water Quality

Bore ID	Purpose	Hole Depth	Casing Depth	EC[1] (µS/cm)	pH[1]	SWL[1] (m bgl)
WB2	Obs	108m	Open Hole	-	-	54m
WB3	Obs	108m	108m	5 650[2]	8.1[2]	45m
WB4	Obs	120m	120m	5 800[2]	8.0[2]	53m
WB5	Obs	150m	150m	3 910[2]	8.4[2]	71m
WB7	-	103m	-	-	-	-
WB8	Pump	140m	140m	5600-5800[1]	7.8-8.0[1]	70m
WB9	-	115m	-	-	-	-
WB10	Pump	120m	90m	4700-5800[1]	7.7-7.9[1]	55m
WB11	Pump	144m	122m	5600-5800[1]	7.7-7.9[1]	63m
WB12	Pump	136m	96m	5600-5800[1]	7.7-7.9[1]	60m
WB13	Pump	136m	108m	5600-5800[1]	7.7-7.9[1]	71m
Decline Bore	Pump	150m	148m	-	-	63m
Back Bore	Pump	120m	120m	3 170[2]	7.0[2]	63m
Skirka's Bore	Pump	85m	85m	-	-	63m
House Bore	-	74m	74m	2 740[2]	7.5[2]	-
Observation Bore 1	Obs	150m	150m	-	-	63m
Observation Bore 2	Obs	150m	150m	5 490[2]	8.1[2]	69m
Observation Bore 3	Obs	150m	150m	4 640[2]	8.1[2]	71m
GW017386	Obs	101m	101m	-	-	52m

Note 1: Field-measured water quality during drilling operations. Obs = Observation
Note 2: Laboratory-measured water quality following purging of the bore.

Source: Impax (2011) – modified from Tables 5, 6, 7, 8, 9 and 11.

4.3.3.3 Groundwater Quality and Beneficial Uses

Water quality within the Project Site is presented in **Table 4.12**. Impax (2011) notes the following in relation to the observed water levels, water quality and potential beneficial uses for groundwater within the Project Site.

- Standing water level.

  There are some relatively large variations in groundwater elevation over relatively short horizontal distances within the Project Site. Impax (2011) suggest that this may indicate the presence of several discrete or semi-discrete aquifer systems characterised by northwest to southeast trending structures and that groundwater flow may occur primarily along a northwest/southeast plane, with little connectivity in the southwest to northeast plane.

- Water Quality.

  Measured electrical conductivity of groundwater ranges between 2 740µS/cm and 5 800µS/cm. Measured pH ranged from 6.7 to 8.6 but was generally in the range between 7.7 and 8.2, indicating mildly alkaline conditions within the aquifer.

- Beneficial Uses.

  Impax (2011) notes the following in relation to potential beneficial uses for groundwater within the Project Site.

  – Groundwater within the Project Site is not suitable for use as drinking water without treatment.
  – Groundwater associated with House Bore and Back Bore may be suitable to irrigate the most salt tolerant crops, however, groundwater from the remaining bores would not be suitable for irrigation.
  – Groundwater within the Project Site is suitable for stock water.
  – Groundwater within the Project Site exceeds the relevant Australian and New Zealand Guidelines for Fresh and Marine Water Quality trigger values and is therefore are not suitable for discharge to surface waters.

Finally, Impax (2011) notes that given the depth to standing water level of between 50m and 70m, it is unlikely that groundwater would discharge to surface within 10km of the Project Site. As a result, there is unlikely to be any groundwater dependent ecosystems surrounding the Project Site.

4.3.3.4 Aquifer Testing

This sub-section provides a brief overview of the aquifer testing that was undertaken by Impax (2011) in late 2010 and early 2011. A detailed description of that test program is provided in Section 6 of Impax (2011).

In summary, pump tests were undertaken on six bores, namely:

- Back Bore;
- Decline Bore;
- WB8;

- WB10;
- WB11; and
- WB13 (Figure 4.10).

Each bore was pumped for up to 7 days, and the water level in the bore during and following pumping operations was measured. **Table 4.13** presents an overview of the results of the pump tests.

Table 4.13
Pump Test Results - Summary

Bore ID:	Back Bore	Decline Bore	WB8	WB10	WB11	WB13
Bore Depth:	120m	148m	140m	90m	122m	108m
Screened Interval:	108-114m	136-148m	98-134m	72-84m	98-116m	90-102m
SWL:	63m	63m	70m	58m	63m	72m
Available Drawdown:	40m	40m	35m	14m	35m	18m
Pumping Duration:	7.1 Days	7 Days	6 Days	1.1 Days	6 Days	3.2 Days
Start Date:	2 Nov 2010	13 Dec 2010	1 Mar 2011	8 Mar 2011	11 Mar 2011	19 Mar 2011
End Date:	9 Nov 2010	21 Dec 2010	7 Mar 2011	9 Mar 2011	17 Mar 2011	22 Mar 2011
Average Pumping Rate:	3.8L/s	0.75L/s	2.2L/s	0.5L/s	2.0L/s	1.7L/s
Drawdown at 100min:	3.3m	9.0m	2.2m	10.0m	12.5m	1.8m
Maximum Drawdown:	9.05m	-	3.8m	16.47m	16.3m	6.2m
Maximum Drawdown in Observation Bores:	Observation Bore 1 - 4.26m	Skirka's Bore - 1.31m	Observation Bore 2 - 1.34m Neighbours Bore - 0.47m	Nil	Neighbours Bore - 0.56m	WB5 - 5.8m
Calculated Transmissivity:	$6.7m^2$/day	$3.0m^2$/day	$19.3m^2$/day	$1.3m^2$/day	$10.2m^2$/day	$4.8m^2$/day
Calculated Storativity	6.7×10^{-4}	9.0×10^{-4}	1.7×10^{-3}	-	2.8×10^{-4}	-

Source: Impax (2011) – modified from Tables 15 to 20.

Impax (2011) notes that the aquifer testing program indicated that the Project Site is likely to be characterised by a number of discrete aquifers with low- or zero-recharge boundaries rather than a single regional aquifer, and that the discrete aquifers are likely to have dual porosity. In addition, based on the results of the test work, Impax (2011) established an estimated safe yield for each bore tested. Each of these issues is discussed separately below.

Zero-Recharge Aquifer Boundaries and Dual Porosity

Impax (2011) notes that drawdown in most of the bores tested increased after approximately 16 hours and that this may be an indication of the fact that the extent of drawdown of groundwater reached a zero-recharge or low-recharge boundary condition. Alternatively, the aquifer may have dual porosity, namely, water is present within large permeable fractures. However, recharge into those fractures is limited to flow through the solid rock or through minor fractures with much lower permeability.

In estimating permeability to be used during modelling, Impax (2011) has taken this dual porosity or low recharge boundaries into account. However, as discussed in more detail below, Impax (2011) notes that as the assessment methodology assumes an infinite aquifer, should zero-recharge boundaries be intersected, then the estimate safe yields may significantly overestimate the actual yields from the tested bores.

Safe Yields

Impax (2011) used the results of the pumping tests to estimate the long term yield for each bore using the method outlines in Section 6.3 of that report. In summary, the safe yield for each tested bore was estimated using the observed rate of drawdown from the pumping test to estimate the pumping rate which could be sustained for long term pumping using the formula presented in Fetter (1994). That methodology allows an estimate of long term yields from bores over periods of 1 million minutes (1.9 years) and 10 million minutes (19 years). **Table 4.14** presents the results of that analysis.

Table 4.14
Estimated Safe Yields

Bore ID	Estimated Safe Yield (1 million minutes continuous pumping)	Estimated Safe Yield (10 million minutes continuous pumping)
Back Bore	3.9L/s or 122ML/year	3.1L/s or 97ML/year
Decline Bore	1.2L/s or 37ML/year	1.1L/s or 34ML/year
WB8	8.2L/s or 258ML/year	6.9L/s or 217ML/year
WB10	0.2L/s or 6ML/year	0.2L/s or 6ML/year
WB11	2.8L/s or 88ML/year	2.5L/s or 78ML/year
WB13	1.3L/s or 41ML/year	1.0L/s or 31ML/year
TOTAL	**17.6L/s or 555ML/year**	**14.8L/s or 466ML/year**
Source: Impact (2011) – modified from Table 21		

It is, however, noted that in calculating the safe yields no account has been taken of interference associated with pumping from other bores. As a result, it is possible that the estimate safe yields may overestimate the actual yields for this reason and in the event that a zero-recharge boundary is intersected. Despite this, however, Impax (2011), state that a safe yield of between 250ML/year and 300ML/year should be achievable and that NOW could consider increasing the anticipated groundwater application for the production bore licences from 147ML/year.

4.3.4 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures to ensure that groundwater in the vicinity of the Project Site is not adversely impacted as a result of the Project.

- Store all hydrocarbon and chemical products within a bunded area complying with the relevant Australian Standard.
- Refuel all equipment within designated, sealed areas of the Project Site, where practicable.
- Undertake all maintenance works involving hydrocarbons, where practicable, within designated areas of the Project Site such as the maintenance workshop.

- Direct all water from wash-down areas and workshops to oil/water separators and containment systems.
- Ensure all hydrocarbon and chemical storage tanks are either self-bunded or bunded with an impermeable surface and a capacity to contain a minimum 110% of the largest storage tank capacity.
- Design and construct the Tailings Storage Facility as described in Section 2.6 and in accordance with the requirements of the relevant government agencies. Key design parameters would be as follows.
  - Construct the floor and walls of the Tailings Storage Facility in a manner that would achieve an appropriate permeability to prevent leachate leakage.
  - Ensure that the Tailings Storage Facility embankment is keyed into the underlying material in a manner that would prevent down-slope migration of potentially contaminated groundwater from the facility.
  - Construct seepage collection structures at the foot of the Tailings Storage Facility embankment and ensure that any captured seepage is automatically pumped back to the Tailings Storage Facility.
  - Install piezometers at appropriate intervals at the base of the Tailings Storage Facility embankment and monitor these regularly to assess the integrity of the facility (see Section 4.3.7).

4.3.5 Assessment Methodology

4.3.5.1 Introduction

Impax (2011) undertook an assessment of groundwater-related impacts associated with two mining scenarios, namely:

- construction of the decline prior to the commencement of ore-extraction operations (decline development scenario); and
- completion of mining operations (post-mining scenario).

These two scenarios were assessed using equations developed by Marinelli and Niccoli (2000). Sections 7.1 and 7.2 of Impax (2011) present a detailed description of the assessment methodology. However, for completeness, the following sub-sections present an overview of the assessment methodology.

4.3.5.2 Conceptual Site Model and Modelled Parameters

The following presents an overview of the conceptual site model and the parameters used during the assessment.

- Decline development would commence at surface and progress to approximately 550m below ground level (bgl).
- Extraction or ore material and the creation of stopes would commence approximately 150m bgl and would extend to approximately 550m bgl.

- The standing water level in the vicinity of the proposed underground mine is approximately 60m bgl, with groundwater likely to be encountered at depths greater than 70m bgl.
- All groundwater inflow would be collected and pumped to the surface for use in mining-related operations. No pre-mining dewatering activities would be undertaken.
- The standing water level within the vicinity of the underground workings would need to be lowered by up to approximately 550m bgl or 490m below the pre-mining standing water level.
- It is likely that permeability decreases with depth below the standing water table as the formation becomes tighter.
- As underground mining progresses, it is likely that zero- or low-recharge boundaries will be intersected and groundwater inflows would be decreased.
- Hydraulic conductivity values ranging from $5x10^{-8}$m/s to $5x10^{-6}$m/s were assumed. The hydraulic permeability values adopted are assumed to reflect the upper limit for the fractured rock mass. Thus they could be considered conservative and are considered to represent a worst case scenario.

4.3.5.3 Decline Development Scenario Assumptions

Impax (2011) made the following assumptions when modelling the decline development scenario.

- The decline is a tunnel approximately 5m wide and 5m high that would be excavated at a slope of approximately 1:7 (V:H) to a depth approximately 200 bgl.
- For the purposes of modelling the decline was represented as an open circular cylinder with radius of 5m and vertical walls from the surface to a depth of 200m bgl.
- It was assumed that the bulk of groundwater inflow to the decline would be via seepage from the walls between depths of 60m and 200m bgl.
- It was assumed that groundwater inflows from the base of the decline would be negligible.

4.3.5.4 Post-mining Scenario Assumptions

Impax (2011) made the following assumptions when modelling the post-mining scenario.

- For the purposes of modelling it was assumed to underground mine and decline could be represented by an open circular cylinder with radius of 250m and vertical walls from the surface to a depth of 550m bgl.

- It was assumed that the bulk of groundwater inflow to the underground would be via seepage from the walls of the underground and decline between depths of 60m and 250m bgl.
- It was assumed that groundwater inflows from the lower 300m of the walls and from the base of the underground would be negligible.

4.3.6 Assessment of Impacts

4.3.6.1 Groundwater Inflows

Decline Development Scenario

Table 4.15 presents the estimated inflow to the decline versus depth of decline assuming the average aquifer permeability (K) is 4.5×10^{-7}m/s. The table indicates that the no groundwater would be expected to flow into the decline from the surface to a depth of approximately 60m bgl. Below that depth, the modelling suggests that rates of groundwater inflow would gradually increase from nil to approximately 4.6L/s or 397kL/day as the decline progresses to a depth of 200m bgl. As the decline progresses, the radius of influence or area of modelled groundwater drawdown would gradually increase from nil to approximately 3 520m.

Table 4.15
Estimated Groundwater Inflow Versus Decline Depth (assuming K = 4.5 x 10^{-7}m/s)

Depth of Decline (m bgl)	Drawdown Required (m)	Estimated Inflow		Radius of Influence (m)
		(L/s)	kL/day	
60	0	0.0	0	0
80	20	0.1	9	520
100	40	0.4	35	1080
120	60	0.9	78	1590
140	80	1.6	138	2100
160	100	2.4	207	2570
180	120	3.4	294	3050
200	140	4.6	397	3520
Source: Impax (2011) -modified from Table 23				

The Proponent would pump water that flows into the decline to the surface for use for mining-related purposes. However, the Proponent notes that the actual volume of water that would be required to be pumped to the surface would be less than that modelled for the following reasons.

- As noted in Section 4.3.6.2, Impax (2011) anticipate that a low-recharge boundary is likely to be intersected at distances closer than 3 520m to the proposed mine. As a result, the actual rate of inflow to the decline would be expected to be less that that modelled.
- Water losses through evaporation and the fact that the exhaust ventilation would have a significantly higher humidity than the intake ventilation. Similar underground projects have identified that losses through evaporation may be as high as 0.2L/s.

- A proportion of the water that flows into the decline (and underground mine once stoping operations commence), would be lost through removal from the decline with the waste rock (and ore material). Similar mining operations with ore production rates of up to 350 000t/year have estimated these losses to be approximately 0.6L/s.

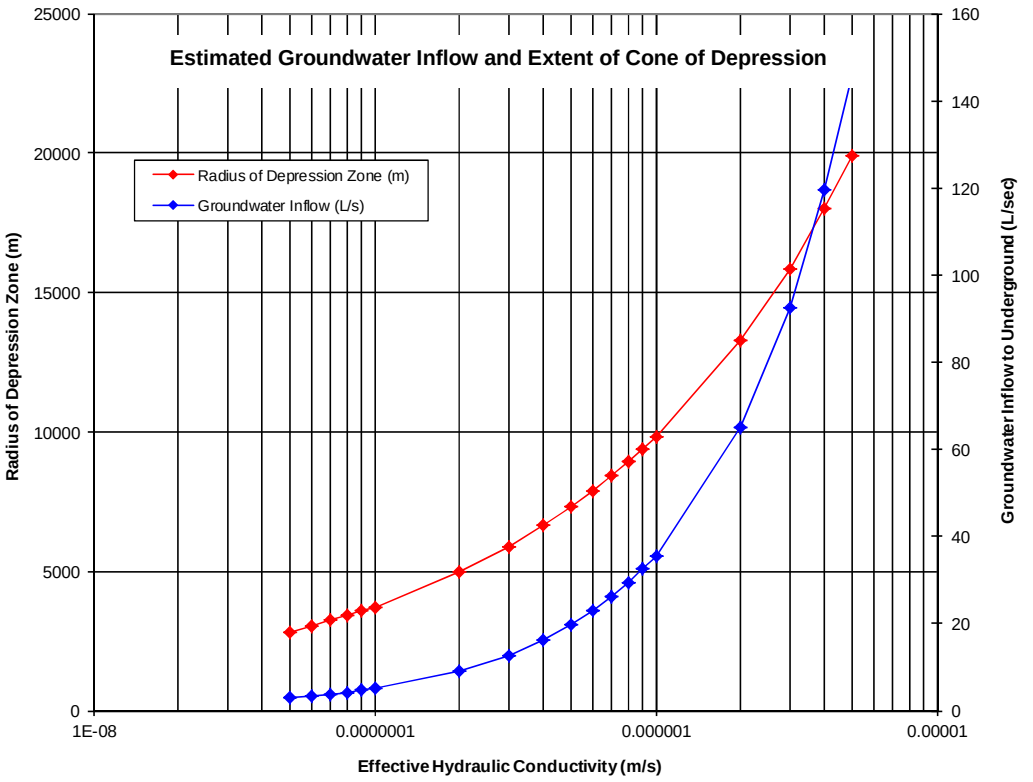
Once pumped to the surface, groundwater would be stored within the Raw Water Dam and Process Water Dam which would be lined to prevent seepage of salt-laden water, and chemical-laden water once processing operations commence. That water would be used for mining-related purposes, including surface and underground drilling operations and dust suppression and, following treatment, within the Mine Camp. It is noted that as processing operations would not commence until the decline is approaching 200m bgl, that use of significant volumes of water within the processing plant would not be likely to occur.

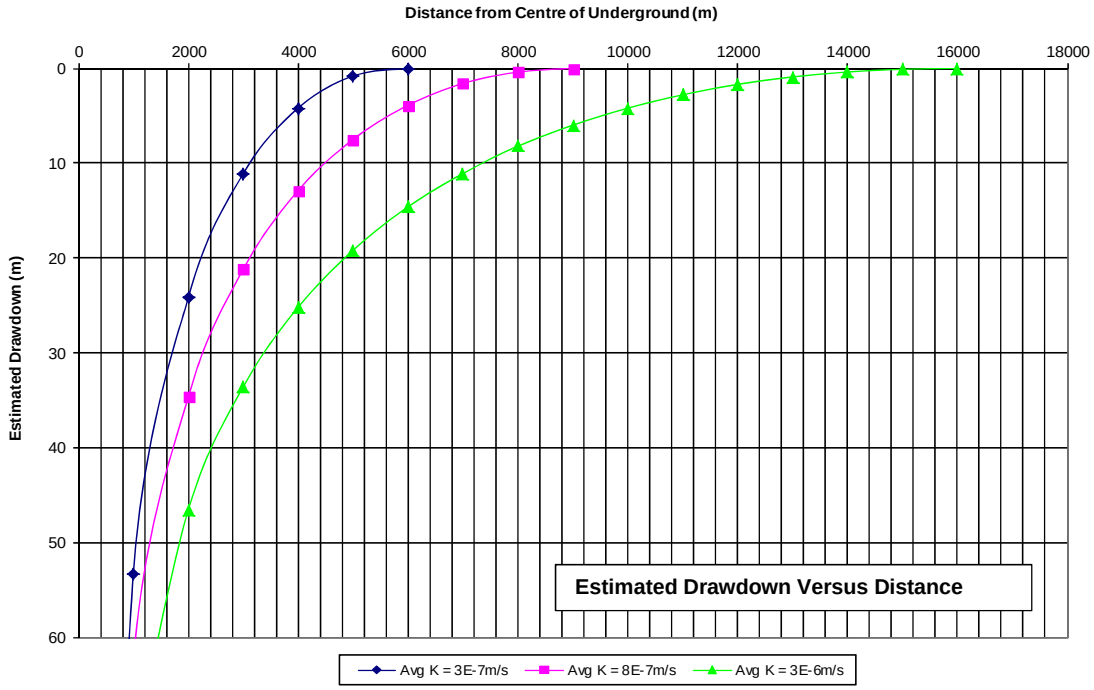
Additional water that is not used for mining-related purposes would be allowed to evaporate from the Raw Water Dam and the Process Water Dam. As noted in Section 4.1.3.3, the differential between rainfall and evaporation in the vicinity of the Project Site is approximately 2 036mm/year. In arid environments such as the Project Site, up to 38% of pumped water may be lost through spray evaporation. Should additional evaporation capacity be required, pumps would be established on the dams and water would be sprayed through the air over the surface of those dams. As a result, the Proponent would not be required to discharge salt-laden water from the decline to surface drainage.

Post-mining Scenario

Figure 4.14 presents the results of the post-mining scenario for a range of assumed permeability values. That data indicate that the theoretical groundwater inflows are expected to be between 12L/s and 93L/s and the theoretical extent of the radius of influence or the groundwater depression zone would be between 5 880m and 15 850m from the centre of the proposed underground mine.

Figure 4.14 also presents a plot of the estimated drawdown versus distance from the centre of the proposed underground mine for permeability values of 3×10^{-7}m/s, 8×10^{-7}m/s and 3×10^{-6}m/s. For each of these scenarios, the extent of the radius of influence would be 15 880m, 8 950m and 5 880m respectively. At a distance of approximately 3km, namely the distance to the closest non-Project-related bore that could be used to provide stock water, the estimated drawdown would be approximately 33m, 21m and 11m respectively for each of the assumed permeability values.





Source: Impax (2011) – Figures 12 and 13

Figure 4.14
Post-mining Scenario Groundwater Modelling Results

Impax (2011) note, however, that the methodology of Marinelli and Niccoli (2000) assumes that the aquifer is infinite in lateral extent and that groundwater drawdown will propagate laterally until equilibrium is reached between water discharging into the underground mine and water recharging the aquifer (assumed to be 1% of the rainfall falling within the cone of depression). However, as noted in Section 4.3.3.4, Impax (2011) notes that the aquifers within the Project Site are likely to have dual porosity or a low-recharge boundary and, based on the observations during the pumping tests, that boundary may be encountered within 1 000m of the proposed underground mine. As a result, the methodology of Marinelli and Niccoli (2000) is likely to overestimate both the groundwater inflow and extent of groundwater drawdown.

In light of the above, Impax (2011) states that groundwater inflow is likely to be initially relatively high as larger, high permeability fractures are emptied. Once this happens, however, and the radius of influence reaches a low- or nil-recharge boundary standing water level surrounding the proposed underground mine would be lowered relatively quickly and the rate of inflow would be limited to local groundwater recharge (i.e. assumed to be 1% of rainfall that falls within the aquifer boundary or cone of depression).

Table 4.16 presents the estimated groundwater recharge for cone of depression with various radii, assuming the average rate of aquifer recharge is 1% of average annual rainfall or 3.7mm/yr. If, as suggested by Impax (2011), a low- or zero-recharge boundary occurs within 1 000m of the proposed underground mine, the estimated groundwater inflow into the completed mine would be approximately 0.4L/s.

Table 4.16
Estimated Groundwater Inflow Versus Radius of Cone of Depression

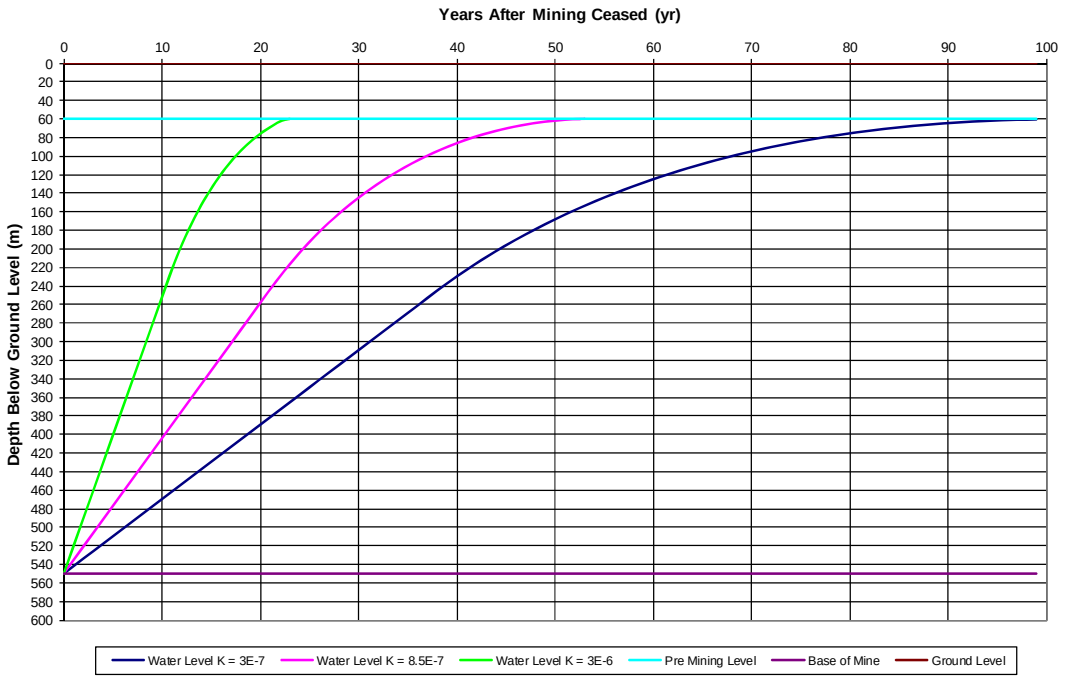
Radius of Cone of Depression (m)	Area of Cone of Depression (m^2)	Estimated Recharge (m^3/year)	Estimated Recharge (L/s)
1000	3141593	11624	0.4
2000	12566371	46496	1.5
3000	28274334	104615	3.3
4000	50265482	185982	5.9
5000	78539816	290597	9.2
6000	113097336	418460	13.3
7000	153938040	569571	18.1
8000	201061930	743929	23.6
9000	254469005	941535	29.9
10000	314159265	1162389	36.9
Source: Impax (2011) – modified from Table 24			

4.3.6.2 Groundwater Recovery

Once mining is completed, the underground workings and decline would be sealed and would be permitted to fill with groundwater. Impax (2011) estimated the amount of time that it would take to completely fill the proposed workings using the Darcy Equation. Section 7.8 of Impax (2011) presents the assumptions used in that analysis. In summary, these are as follows.

- The underground mine and decline were approximated by assuming they were a circular cylinder with 250m radius and vertical walls 550m high with a post-mining volume of 5.5 million cubic meters.
- Groundwater inflow would occur between depths of 60m bgl and 250m bgl.
- As the water level rises within the workings groundwater inflow would be steady until the water level is 250m bgl from which point, the rate of groundwater inflow would decrease gradually to nil when the water level is 60m bgl.
- Groundwater recovery was estimated using permeability values, namely 3×10^{-7}m/s, 8.5×10^{-7}m/s and 3×10^{-6}m/s.
- The radius of the cone of depression, and therefore the area available for recharge, was calculated using the methods outlined in Section 4.3.6.1 and that groundwater recharge represented 1% of average annual rainfall.

Figure 4.15 presents the results of the modelling. In Summary, full groundwater recovery is expected to take between 20 years and 100 years following the cessation of mining operations. It is noted, however, that just as the presence of a low- or zero-recharge boundary surrounding the proposed underground mine would reduce groundwater inflow to the mine, the rate of recovery would also be slower than that indicated.



Source: Impax (2011) – Figure 14

Figure 4.15
Groundwater Recovery

4.3.6.3 Surrounding Groundwater Users

As indicated in Section 4.3.2, the three closest non-Project-related bores (see **Figure 4.13**) capable of providing groundwater are:

- GW017386 which is located approximately 3 100m south of the proposed underground mine and approximately 650m southeast of WB11;
- GW017385, which is located approximately 2 400m north of the proposed underground mine; and
- GW018014, which is located approximately 10 300m southwest of the proposed underground mine and approximately 8300msouthwest of WB11.

Impax (2011) concludes that standing water levels within bore GW017386 are likely to be adversely impacted by groundwater extraction from production bore WB11. However, a licence for extraction from that bore has been prepared and submitted separately to NOW. In addition, modelling suggests that the radius of influence of the underground mine may extend up to 15.8km from the proposed mine. However, as noted in Section 4.3.6.1, Impax (2011) anticipate that a low- or zero-recharge boundary would be intersected within 1 000m of the proposed underground mine. As a result, the actual radius of influence of the proposed mining operation would be significantly less than that modelled. To ensure that water levels in bores GW017385 and GW018014 are not adversely impacted, they would be monitored as described in Section 4.3.7.

The Proponent acknowledges its obligations to ensure that the rights of owners of existing bores are not adversely impacted as a result of the Project. As a result, in the event that any Project-related adverse impacts on standing water levels in the above bore are observed, the Proponent would contact the owner on the bore and would:

- deepen and re-equip (if required) the bore;
- providing alternative water supply; or
- provide another form of mutually agreeable compensation.

The Project has the potential to impact on standing water levels within a single non-Project related registered bore (GW017386). The Proponent would contact the owner of the bore and would:

- deepen and re-equip (if required) the bore;
- provide alternative water supply; or
- provide another form of mutually agreeable compensation.

4.3.6.4 Groundwater Quality

Impax (2011) notes that the principal potential sources of groundwater contamination within the Project Site would be as follows.

- Spillage of fuel, chemicals and/or reagents.
- Leaching of acid from waste rock.
- Leaching of acid, heavy metals and cyanide from tailings.
- Leaching of acid and heavy metals from the concentrate.

The Proponent would implement a range of management and mitigation measures identified in various sub-sections in Sections 2 and 4. In summary, however, these would include the following.

- Storage of all chemicals and hydrocarbons in bunded and sealed areas
- Construction of an acid forming material encapsulation area and transportation of any potentially acid forming material back underground.
- Construction of a Tailings Storage Facility with an appropriate liner and implementation of appropriate seepage collection and monitoring procedures.
- Construction of a covered, concrete-sealed concentrate storage area and regular removal of concentrate from the Project Site.

As Impax (2011) note, dewatering of the proposed underground mine would create a groundwater flow gradient toward the mine. As a result, in the unlikely event of any significant groundwater contamination occurring, it would be contained on site and contaminated groundwater would be recovered by dewatering.

4.3.6.5 Groundwater Dependent Ecosystems

Impax (2011) did not identify any groundwater dependent ecosystems on or in the vicinity of the Project Site and indicate that taking into account the standing water levels in bores within and surrounding the Project Site, namely between 50m bgl and 70m bgl and the surrounding topography, that none are likely to occur within 10km of the Project Site.

4.3.7 Monitoring

Section 9 of Impax (2011) presents a detailed overview of the proposed groundwater monitoring program. **Table 4.17** presents an overview of that monitoring program.

Table 4.17
Groundwater Monitoring Program

Page 1 of 2

Bore ID	Groundwater Level	Groundwater Quality		Production
		Field[1]	Laboratory[2]	
WB3	Monthly	Monthly	Annual	
WB4	Monthly	Monthly		
WB5	Monthly	Monthly		
WB8	Monthly	Monthly	Annual	Continuous[4]
WB10	Monthly	Monthly	Annual	Continuous[4]
WB11	Monthly	Monthly	Annual	Continuous[4]
WB12	Monthly	Monthly		
WB13	Monthly	Monthly	Annual	Continuous[4]
Decline Bore	Monthly	Monthly		Continuous[4]
Back Bore	Monthly	Monthly	Annual	Continuous[4]
Skirka's Bore	Monthly	Monthly		Continuous[4]
House Bore	Monthly	Monthly	Annual	
Observation Bore 1	Monthly	Monthly		

Table 4.17 (Cont'd)
Groundwater Monitoring Program

Bore ID	Groundwater Level	Groundwater Quality		Production
		Field[1]	Laboratory[2]	
Observation Bore 2	Monthly	Monthly		
Observation Bore 3	Monthly	Monthly		
GW017385	Monthly	Monthly		
GW017386	Monthly	Monthly		
GW018014	Annual	Annual		
Underground workings			Annual	Continuous[4]
Tailings Piezometers			Monthly[3]	

Note 1: Field analysis = electrical conductivity and pH.
Note 2: Laboratory analysis = pH, electrical conductivity, dissolved oxygen, redox potential major cations, major anions, nutrients, total cyanide, free cyanide and WAD cyanide.
Note 3: If water present.
Note 4: During pumping operations.

Impax (2011) – modified from Section 9

4.4 SURFACE WATER

4.4.1 Introduction

The surface water assessment for the Project was undertaken by SEEC. The full assessment is presented as Part 3 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as SEEC (2011a). This sub-section presents a summary of that report and should be read in conjunction with the full assessment.

A risk analysis presented in Section 3.4 has identified the following potential Project impacts relating to surface water requiring assessments. The unmitigated risk rating associated with each impact is indicated in parenthesis.

- Reduction in environmental flows through onsite capture of water (medium to high risk).
- Discharge of dirty, saline or contaminated water (other than from the Tailings Storage Facility) (high risk).
- Discharge of contaminated water (from the Tailings Storage Facility) (medium to high risk).
- Discharge of saline groundwater (medium to high risk).
- Changes to hydrology of creeks and drainage lines (medium risk).
- Changes to local flood regimes (low to medium risk).
- Soil erosion (due to the erosive actions of water) (medium to high risk).
- Sedimentation of water within and discharged from the Project Site (high risk).

The Director-General's requirements have highlighted Water as one of the key issues that requires assessment at the Project Site. The specific requirements include:

- a detailed site water balance;
- potential water quality impacts on the environment and other water users; and
- a description of final landform water management.

The following sub-sections address these requirements and those of OEH and the NSW Office of Water (see **Appendix 2**). The sub-sections describe and assess the existing drainage and surface water environment, identify the surface water management issues, proposed surface water controls and the safeguards and mitigation measures that would be implemented within the Project Site. An assessment of the residual impacts following the implementation of the mitigation measures is also presented.

4.4.2 Existing Environment

4.4.2.1 Local and Project Site Drainage and Catchments

The local and the Project Site drainage systems are described in detail in Sections 4.1.2.2 and 4.1.2.3 and illustrated in **Figures 4.2** and **4.3**. In summary, however, the Project Site is cut by a number of unnamed ephemeral drainage lines, referred to here as Watercourses A, B and C. These drainage lines flow occur within Catchments A and B in **Figure 4.3**.

Generally the watercourses within the Project Site are ill-defined. Watercourse A, a second-order stream (Strahler stream ordering system), enters the southwestern section of the Project Site and joins Watercourse B to become a third order stream. It has a catchment of approximately 80km^2 and flows northwards, roughly parallel to the western Project Site boundary.

Watercourse B drains most of the Project Site and flows east to west through the existing Back Tank West. This is a second order stream and has a catchment upstream of Back Tank of approximately 10.1km^2.

Watercourse C, also a second-order stream, enters the southwestern section of the Project Site and flows into Pete's Tank. It has a catchment of approximately 4km^2.

4.4.2.2 Proponent's Harvestable Right and Existing Water Storages

Harvestable Rights Provisions of the *Water Management Act 2000*do not apply to the Project Site since it is located in the Western Division of New South Wales. However, water may only be drawn from second order streams or less, unless the Proponent seeks a water licence. Since a licence would *not* be sought for this Project surface water would only be harvested from storages located on Watercourses B and C and any small off-line impoundment built for the purpose of trapping sediment.

Four surface water dams exist within the Project Site and one dam would be constructed as part of the Project:

- House Tank – This dam is used to the meet the water requirements of the existing on-site accommodation facilities.
- Three Gates Tank –This dam would be used for direct capturing of stormwater runoff (dirty water) from the Surface Facilities Area and for storage of water following treatment in the upstream five setting ponds.

- Pete's Tank – It is proposed to increase the capacity of this dam to approximately 20ML and surface area of approximately1.7ha. Water stored in this dam would be used to meet Project-related operational water requirements and would be connected to the Raw Water Dam via the proposed internal pipeline network.
- Back Tank West – This dam currently collects water flowing in Watercourse B and would capture excess water flow from the proposed Back Tank East.
- Back Tank East –This dam would be constructed with capacity of approximately 90 ML with a footprint of 11.4 ha. Water stored in this dam would be harvested to meet the operational water requirements. It will be connected to the Raw Water Dam within the Processing Plant via the proposed internal pipeline network.

4.4.3 Assessment Criteria

The Project would refer to the ANZACC/ARMCANZ (2000) guidelines (see also Section 4.4.7) for the water quality trigger levels for the relevant analytes to gauge the quality of water leaving the Project Site.

4.4.4 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures to ensure that no polluted waters leave the Project Site and compromise the water quality of receiving waters.

General Management and Mitigation Measures

- Prepare a detailed *Surface Water, Sediment and Erosion Control Plan,* including a description of surface water management structures and procedures to ensure that the criteria identified in Section 4.4.3, any additional criteria included in the Environment Protection Licence or project approval are achieved.

Sediment and Erosion Control Measures

- Construct sediment and erosion control structures for the separation of clean, dirty and contaminated water on site (as shown in **Figure 2.4** and discussed briefly in Section 2.2.4) comprising the following.
  - Clean water diversions in the vicinity of the Surface Facilities Area and Tailings Storage Facility to divert clean water away from the disturbed areas:
  - Dirty water diversions to channel water to sediment basins to allow sediment to settle out from dirty water prior to discharge to natural drainage. All outlets would be designed for the 100-year ARI storm event.
  - Contaminated water collection structures, including downstream of the Tailings Storage Facility and within the processing plant to collect and channel potentially contaminated water to suitable structures for pumping to the Process Cater Dam or the Tailings Storage Facility.
- Construct the unpaved access roads (Main Site Access Road and Light Vehicle Road) with a crowned surface to shed water onto surrounding land.
- Install mitre drains, where necessary, to reduce concentrated flow.

- Ensure access roads would be gravel-sheeted using crushed waste rock.
- Construct a causeway, appropriately stabilised upstream and downstream, where the Main Site Access Road crosses Watercourse A approximately 250m from the Main Site Entrance.
- Ensure that all water management structures are constructed to the specifications identified in Landcom (2004) and DECC (2008).
- Inspect all surface water control structures at least quarterly and following any rainfall event of more than 25mm in 24-hours to ensure their adequacy and identify where remedial action is required.

Discharge of Pollutants

- Ensure processing/tailings water would be contained within a closed loop and re-used within the Processing Plant.
- Design and construct the Tailings Storage Facility to prevent leakage of leachate into the groundwater.
- Construct a clean water diversion upstream of the Tailings Storage Facility to completely divert any upslope run-on. This bund would be stabilised to effectively convey the 100-year ARI, time-of-concentration flow from the upstream catchment.
- Construct a leachate collection drain and pond downslope of the Tailings Storage Facility to collect potentially contaminated leachate from the Tailings Storage Facility, if any, and pump it back to the Tailings Storage Facility.
- 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.
- Ensure that stormwater trapped in settling ponds and sediment basins is pumped only to the Raw Water Dam for reuse in ore processing activities, or alternatively is treated with flocculants, if required, to achieve total suspended solids concentration of 50mg/L prior to release off site.

Final Landform and Water Management Structures

- 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 progressive and final rehabilitation of the Project Site.
- Shape the decommissioned Tailings 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;

- Ensure that rehabilitation, including the placement of soil and revegetation with endemic native species 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. This would comprise the following.
  - Retain of clean water diversion structures upstream of the Tailings Storage Facility. These structures would be designed to withstand a 1 in 100 year ARI rainfall event.
  - Install an appropriate number of engineered drop structures on the rehabilitated face of the former Tailings 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 sediment control structures constructed for the Project remain in place until rehabilitated areas are sufficiently stabilised.

Onsite Waste Water Management

- Treat wastewater using aerated wastewater treatment systems and dispose of the secondary-treated effluent in a dedicated, vegetated, irrigation areas.

4.4.5 Site Water Balance

4.4.5.1 Introduction

This sub-section describes the Project Site's water balance and provides an overview of the proposed water sources, the Project's water requirements, and the water balance modelling undertaken to establish the water supply confidence for the Project.

4.4.5.2 Water Requirements

As noted in Section 2.2.5, the Project would require approximately 167ML/year for processing activities and the Mine Camp. SEEC (2011a) identify that water requirements for dust suppression would be approximately 20ML/year giving a total new or makeup water requirement of 187ML/year for all operational requirements.

4.4.5.3 Water Sources

Makeup water would be obtained in priority order from the following sources:

1. Groundwater sourced from dewatering operations within the underground mine.
2. Stormwater run-off stored in Three Gates Tank or in other dirty-water storage structures within the Project Site.
3. Stormwater run-off stored in the proposed expanded Pete's Tank or the proposed Back Tank East.
4. Groundwater sourced primarily from four bores located within the Project Site namely, Back Bore and Bores WB8, WB11 and WB13 (see **Figure 2.1**).

4.4.5.4 Modelling Methodology

The Surface Water Balance modelling was undertaken using computer software MUSIC (Model for Urban Stormwater Improvement Conceptualisation, eWater). MUSIC was used because a very good set of pluviograph data from the nearby Cobar for a period of 48 years was available for modelling.

Although the Project would not rely wholly on surface water (see Section 4.4.5.2), the modelling was undertaken assuming that surface water would be the primary source of make-up water.

The modelling apportioned the combined make-up and dust suppression demands (187ML/year) to be distributed 18% and 82% to Pete's Tank and Back Tank East, respectively, based on the holding capacity of the two dams, i.e. 33.6ML/year and 153.3ML/year, respectively.

Details of the other relevant parameters used in the modelling can be found in Section 4.1 of SEEC (2011a).

4.4.5.5 Modelling Results and Conclusions

Supply Confidence Modelling Results

The results of the supply confidence modelling are shown in **Figure 4.16**.

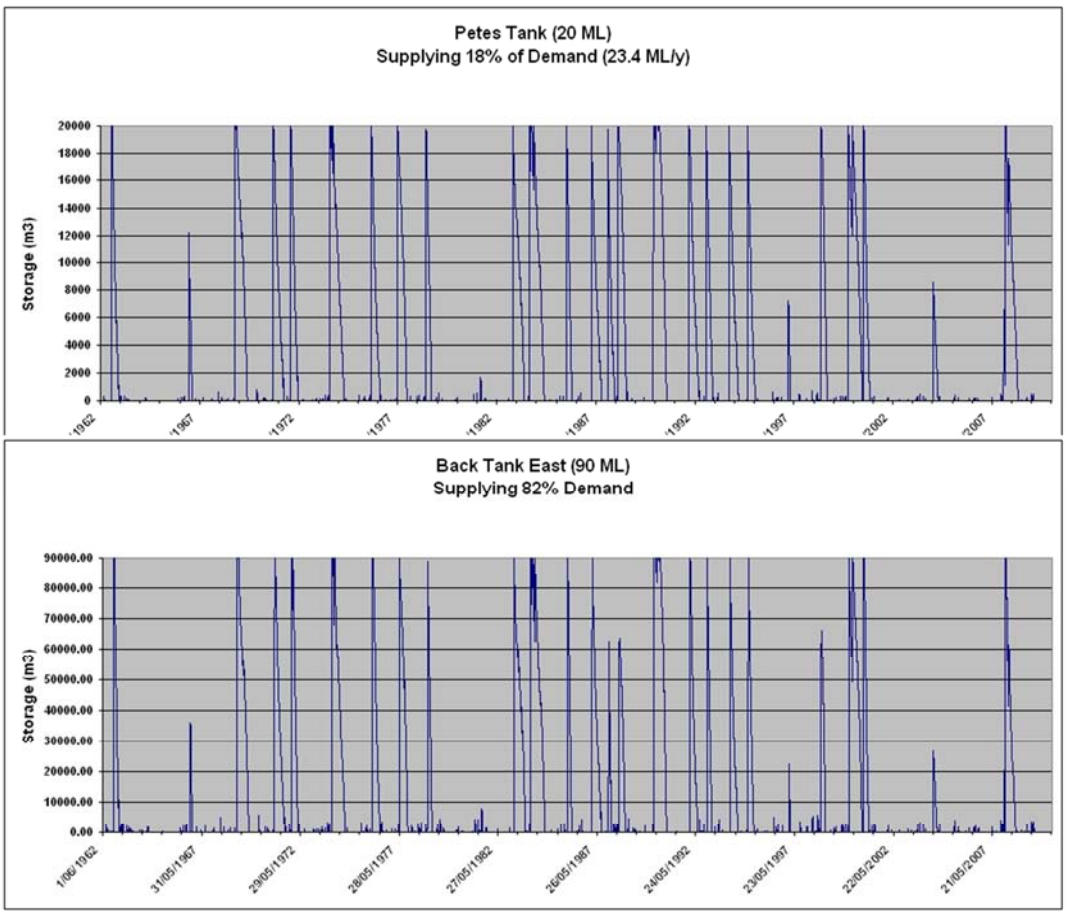


Figure 4.16
Surface Water Supply Confidence Modelling

Source: SEEC (2011a) – Figures 5 and 6

The modelling results tends to indicate that, based on past rainfall data (1962 to 2010), surface water within Back Tank East and Pete's Tank would not meet Project-related water requirements and that there would be extended periods (often more than one year) when surface water would not be available for harvesting. Typically, large rainfall events would produce up to 1 year's supply but they cannot be guaranteed to occur every year.

As a result, the Project would be required to rely on groundwater to make up the anticipated shortfall in surface water supply. SEEC (2011a) notes that the best way to use harvested surface water, when available, would be to use it at full demand until the dams are empty. They would then be ready to capture as much of the next rainfall event as possible.

Effect on Downstream Hydrology

Given that both Back Tank East and Pete's Tank would both drain into the third order watercourse (Watercourse A) that drains through the west of the Project Site further modelling was undertaken to gauge the effect of water usage from Pete's Tank and Back Tank East on downstream hydrology. For the purposes of this assessment, a Project Site discharge location near the Existing Site Entrance and the House Dam was selected. The discharge location has a catchment of approximately 92km^2, including 10.1km^2 to Back Tank East and 4km^2 to Pete's Tank. SEEC (2011a) then determined, based on 48 years of rainfall data, the expected frequency and volume of discharges from House Tank both without the proposed dams and following their construction/expansion. The modelling results are presented in **Figure 4.17**.

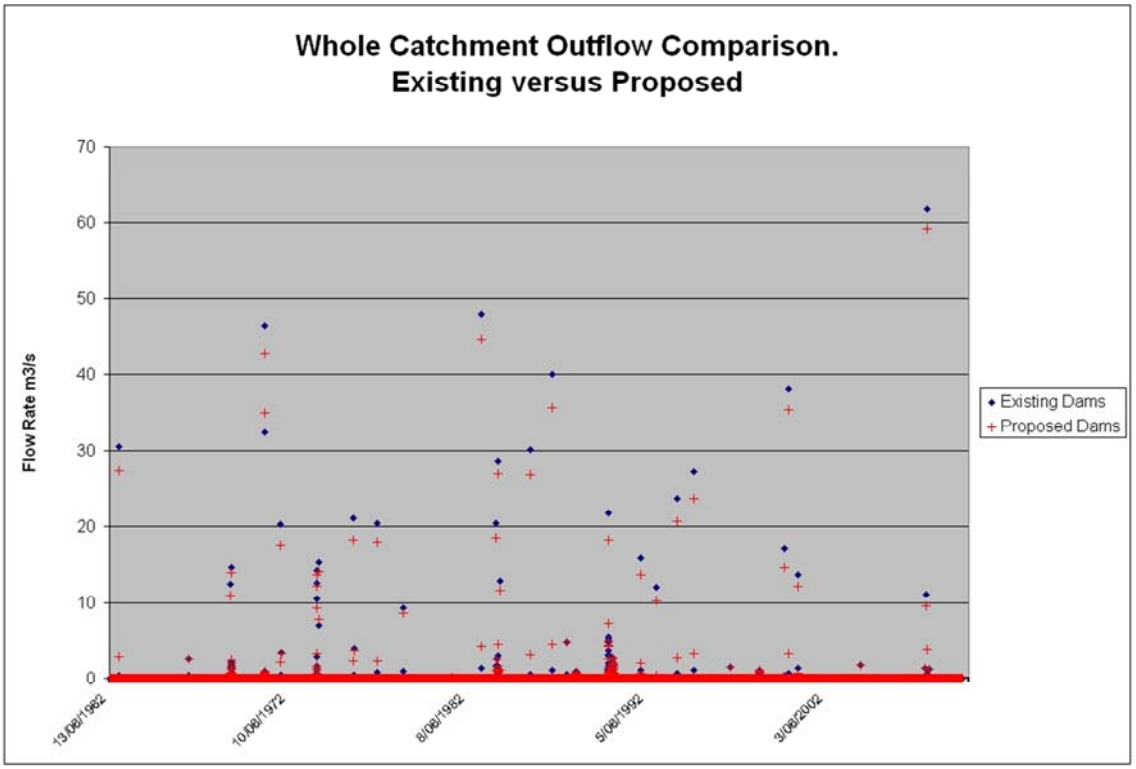


Figure 4.17
Downstream Hydrology Assessment Results

Source: SEEC (2011a) – Figure 7

The data presented in **Figure 4.17** indicate that predicted flow rates following construction of the proposed dams would be typically slightly lower than the existing flow rates, although there will be no change in the frequency of flows. SEEC (2011a) concludes the following.

- There would be no change in the *frequency* of flows. MUSIC modelling results by SEEC (2011a) show that there would be 830 discharge events in 48 years under both the existing scenario (existing Pete's Tank and Back Tank West only) and following the expansion and construction of the enlarged Pete's Tank and Back Tank East, respectively.
- The total mean annual *volume* of discharges would be 3% less, namely 1 500ML/year following construction of the enlarged Pete's Tank and Back Tank East compared with 1 550ML/year with the existing Pete's Tank and Back Tank West only. It was concluded that such a small change would be difficult to measure, particularly taking into account the infrequent rainfall events and arid climate surrounding the Project Site. In addition, as noted in Section 4.1.2.1, surface water in the vicinity of the Project Site typically evaporates or infiltrates locally and does not leave the Box Creek Catchment in all but the most significant rainfall events. As a result, a 3% reduction in surface water flows is not considered significant.

4.4.6 Assessment of Impacts

SEEC (2011a) concludes the following in relation to the anticipated Project-related surface water impacts.

- With the proposed sediment and erosion measures in place it is unlikely the Project would have the potential to adversely impact on the water quality of the receiving waters.
- Negligible impacts associated with the final landform are envisaged since all created landforms would be stabilised in accordance with Landcom (2004) requirements.
- No adverse impacts associated with wastewater, generated within the Surface Facilities Area and the Mine Camp, would result since the waste water would be treated appropriately and disposed of in designated irrigation areas.
- There would be no offsite discharges of contaminated water because the processing water and tailings water would be contained within appropriately constructed areas and surface water (and groundwater) monitoring would identify any leakage early, enabling the issue to be rectified.
- With the proposed mitigation measures in place it is concluded that the Project would not have a measurable detrimental impact on the surface water quality or quantity of the receiving waters downstream from the Project Site.

4.4.7 Monitoring

Given the Project Site ultimately drains into uncontrolled streams within the Barwon Darling and Far Western Catchments (from Box Creek to Crowl Creek and finally into Sandy Creek) the Project is not required to observe the water quality objectives of any specific controlled rivers in a Catchment Management Authority Area. However, the Project Site's monitoring program objectives would be consistent with the OEH guidelines applicable to the rangeland areas which can be summarised as follows.

- To protect (with appropriate water quality) aquatic ecosystems (allowing for their ephemeral or intermittent nature) and stock water.
- Reduce chemical and sediment loads.

Accordingly, the nominated Trigger Values for monitoring water quality within the Project Site and leaving the site would be consistent with the ANZECC/ARMCANZ (2000) guidelines values, noted below.

- Total phosphorous: 25 µg/L
- Chlorophyll–a: 5 µg/L
- Salinity: (125 – 2200) µS/cm
- pH: 6.5 – 8.5
- Total nitrogen: 500 µg/L
- Turbidity: (6 – 50) NTU
- Dissolved oxygen: 85 – 110%
- Chemical contaminants or toxicants[1]

The monitoring locations and the rationale for their selection are given below:

- Monitoring Location 1 – Back Tank East (and Back Tank West prior to construction of Back Tank East). The catchment for this location entirely within the Project Site boundary, but does not include the Surface Facilities Area in it catchment. It will not get fed by groundwater and would continue to have a low-intensity land use, and would thus provide an ideal location against which the House Tank data (see below) could be compared against once mining-operations commence.
- Monitoring Location 2 – House Tank. This monitoring location is downstream from the Surface Facilities Area within the Project Site and would be representative of the receiving water (Watercourse A) just before it leaves the Project Site. This location would be used for baseline monitoring prior to commencement of mining operations.

The sampling frequency would be four times a year including following heavy rainfall events. Analyses of the samples would be undertaken at an independent NATA registered laboratory for the analyte suite given above, and to include aluminium species if Alum is used as a flocculant. The trigger levels for response actions would be either the baseline data collected for the analyte suite from the House Tank and Back Tank West locations, or the ANZECC/ARMCANZ trigger levels if statistically reliable baseline values are not available.

[1]For Protection of Aquatic Ecosystems in NSW, the ANZECC 2000 Guidelines provide default trigger values for major physico-chemical stressors in Tables 3.3.2 and 3.3.3 (pages 3.3-10 & 11) and for Toxicants in Table 3.4.1 (page 3.4-5)

Following project approval a detailed *Surface Water, Sediment and Erosion Control Plan,* including surface water monitoring procedures, would be prepared for the site by a suitably qualified consultant. That plan would identify actions to be undertaken if any of the trigger values are exceeded.

4.5 NOISE AND BLASTING

4.5.1 Introduction

The noise and vibration assessment for the Project was undertaken by Spectrum Acoustics Pty Ltd. The full assessment is presented as Part 4 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as Spectrum (2011). This summary should be read in conjunction with that report.

A risk analysis presented in Section 3.4identifiedthe following potential Project-related impacts relating to noise and blasting(vibration).The unmitigated risk rating associated with each impact is indicated in parenthesis.

- Increased noise and levels associated with Project activities causing annoyance, distractions, i.e. amenity impacts (moderate).
- Sleep disturbance as a result of maximum noise levels (moderate).
- Increased noise levels associated with the Project leading to impacts on local fauna (moderate).
- Structural damage to buildings and structures (moderate).
- Nuisance/amenity impacts on surrounding landowners / residents (moderate).

The Director-General's Requirements for the Project identified "Noise and Blasting" (including construction, operation and road traffic noise) as one of the key issues that requires assessment. The following have been specifically requested by DECCW to be addressed in the *Environmental Assessment*.

- Potential impacts on the noise amenity of the surrounding area to be assessed in accordance with the NSW Government's Industrial Noise Policy (INP) accounting for all noise sources associated with the mine.
- The noise assessment should be based on adequate monitoring of pre-mine background noise which represents seasonal variations and the influence of weather factors such as temperature inversions and other unusual features which influence noise.
- Blasting and vibration impacts should also be assessed against the relevant guidelines.

The noise and blasting assessment was undertaken in accordance with the following guidelines and document.

- NSW Industrial Noise Policy (INP).
- Environmental Criteria for Road Traffic Noise (ECRTN)[2].
- Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990(ANZECC Guidelines).
- AS 2187.2-1993 "Explosives – Storage, Transport and Use Part 2: Use of Explosives"

The following sub-sections describe and assess the existing noise and blasting environment, identify the proposed management and mitigation measures, assess the anticipated noise and blasting impacts relating to the Project and identify noise and vibration management issues,.

4.5.2 Existing Environment

Background noise levels surrounding the Project Site are typical of a rural environment with minor contributions from transport noise and agricultural and domestic activities. The principal sources of noise that contribute to background noise levels include:

- traffic on local roads and the streets of Nymagee;
- farm equipment such as tractors and cultivators;
- domestic activities such as lawn mowers and chainsaws;
- insects such as cicadas, especially during spring and summer months;
- livestock and other farm and native animals; and
- wind through vegetation.

In light of the above, Spectrum (2011) has assumed the default INP background noise levels of 30dB(A).

In addition, Spectrum (2011) has adopted the default INP temperature inversion for arid and semi-arid areas of 8ºC/100m. Finally, Spectrum (2011) notes that there are no prevailing winds with strengths of 3m/s or less for more than 30% of the time in any season during the day, evening or night. As a result, winds are not a feature of the noise environment surrounding the Project Site.

4.5.3 Assessment Criteria

4.5.3.1 Operational Noise Criterion

Spectrum (2011) identifies, in accordance with the INP, that the relevant intrusiveness criterion for the Project is 35dB(A), $L_{eq(15\text{-minute})}$, namely the assumed default background noise level plus 5dB(A). This criterion would apply during the day, evening and night at all surrounding non-Project related residences.

[2] It is noted that the Environmental Criteria for Road Traffic Noise was replaced by the NSW Road Noise Policy on 1 July 2011. However, the Proponent has been advised by OEH that the former guidelines are to be used where those guidelines are identified in the Director-General's Requirements for the Project.

Given the absences of other industrial noise sources in the vicinity of the Project Site, the intrusiveness criterion is the controlling criterion. As a result, the amenity criterion has not been assessed.

4.5.3.2 Sleep Disturbance Criterion

In accordance with OEH recommendations, the sleep disturbance criterion applicable for the Project at each non-Project-related residence was taken to be equal to the intrusiveness criterion (35dB(A),$L_{eq(15\text{-minute})}$)plus 10dB(A), namely, 45dB(A),$L_{1(1\text{-minute}).}$

4.5.3.3 Road Traffic Noise Criteria

For the purposes of the road traffic noise assessment, the roads along the transportation route have been classified by Spectrum (2011) as "local roads" in accordance with the *NSW Environmental Criteria for Road Traffic Noise.* The relevant traffic noise criteria applicable for the Project-related additional traffic are therefore as follows.

- Day time (7:00am – 10:00pm) criterion, $L_{Aeq(1hr)}$ = 55dB(A);
- Night time (10:00pm – 7:00am) criterion, $L_{Aeq(1hr)}$ = 50dB(A).

4.5.3.4 Blasting Criteria

Spectrum (2011) identifies that, in accordance with the ANZECC Guidelines, the **annoyance criteria** due to blasting are as follows.

- Maximum overpressure level – 115dB, may be exceeded for up to 5% of the total number of blasts over a 12-month period, but not to exceed 120dB at any time.
- Maximum vibration velocity – 5mm/s Peak Vector Sum, may be exceeded for up to 5% of the total number of blasts over a 12-month period, but not to exceed 10mm/s at any time.

The residential **building damage criteria** due to blasting, as nominated in AS 2187.2-1993 *"Explosives – Storage, Transport and Use Part 2: Use of Explosives"*, and adopted for the Project areas follows.

- Vibration level – 10mm/s.
- Air blast level – 133dB.

The annoyance criterion, being more stringent than the building damage criteria, has been adopted as the relevant criteria.

4.5.4 Assessment Methodology

4.5.4.1 Operational and Sleep Disturbance Noise Assessment

The operational noise assessment was conducted using RTA Technology's *Environmental Noise Model* v3.06 (ENM). The assessment investigated the potential noise impacts associated with Project-related activities within the Project Site.

The operational noise assessment determined the predicted operational noise levels at the four closest non-Project related residences, namely R1 toR4 (**Figure 4.18**).

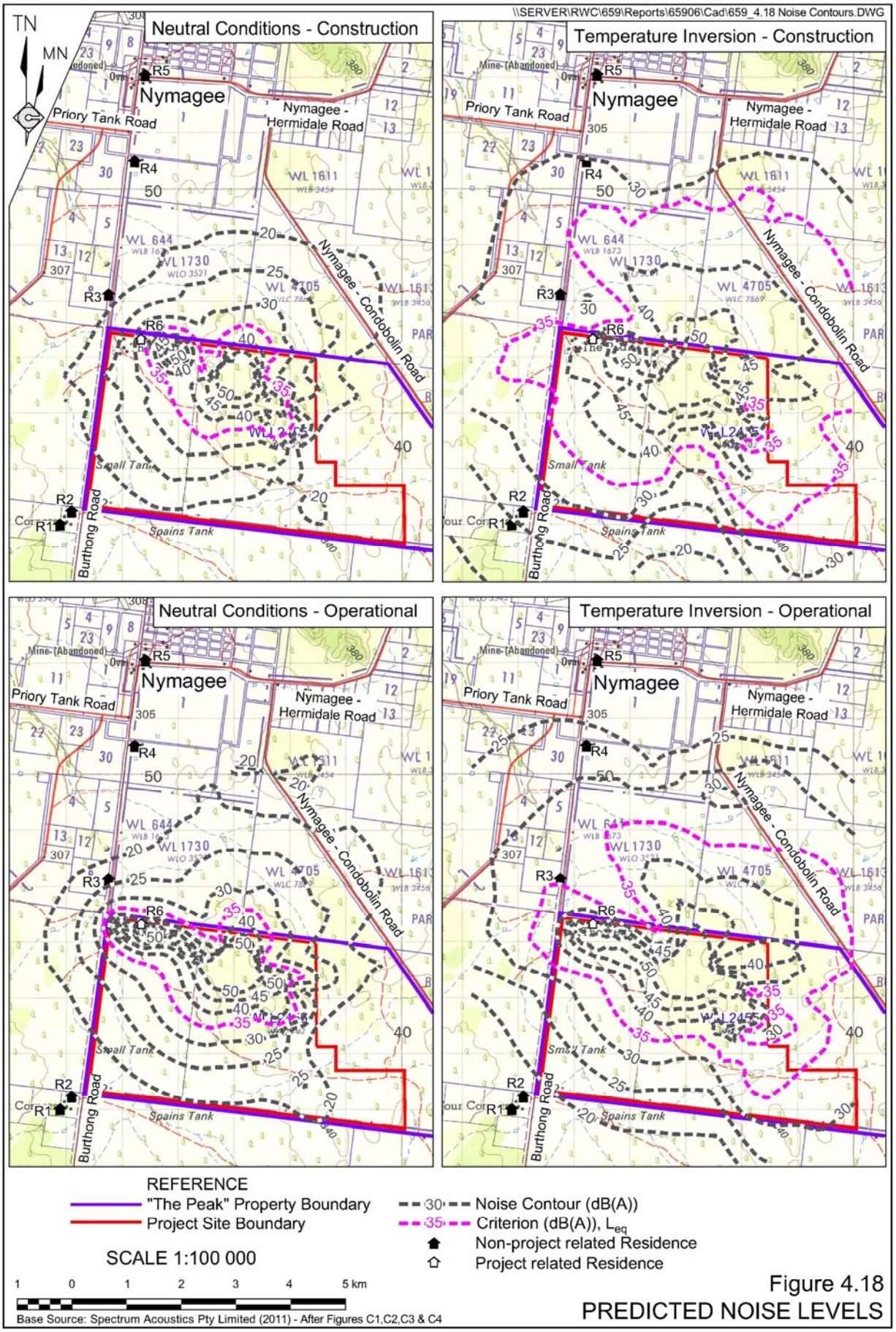


Figure 4.18
PREDICTED NOISE LEVELS

Noise emissions from within the Project Site were modelled for two scenarios as follows.

- Scenario 1 – Site Establishment

  This scenario includes noise from the following sources (see Figure B1 of Spectrum (2011):

  – the establishment of the Surface Facilities Area, including a box cut, portal and decline, processing plant and the associated run-of-mine pad;
  – construction of a Tailings Storage Facility;
  – construction of the Main Site and Light Vehicle Access Roads and an associated intersections with Burthong Road;
  – establishment of a Mine Camp;
  – construction of the proposed water storages; and
  – construction of ancillary infrastructure, including soil stockpiles, internal roads and tracks and surface water management structures.

- Scenario 2 – Operational Noise

  This scenario includes noise from the following sources (see Figure B2 of Spectrum (2011):

  – Continuous operation of a front-end loader to manage stockpiles, ore blending and delivery to the ROM pad.
  – Movement of haul trucks between the box cut and the ROM pad / temporary waste rock emplacement.
  – Processing operations including:
    - a crushing and screening circuit;
    - a primary ball mill for grinding; and
    - a gravity circuit (comprising a feed screen and centrifugal concentrator) and flotation circuit and transfer of tailings to the Tailings Storage Facility.
  – Operation of equipment at the Tailings Storage Facility including water pumps, haul trucks and miscellaneous mobile equipment required to progressively lift and maintain the Tailings Storage Facility.
  – Transport of the bulk concentrate product from the processing area to Burthong Road (via semi-trailer).
  – Miscellaneous operations on the Project Site, including:
    - equipment maintenance within laydown areas and workshops; and
    - light vehicles movements to/from, and around the Project Site.

Both the site establishment and operational scenarios were modelled under the following atmospheric conditions.

- *Daytime lapse:* 25^{o}C, 50% relative humidity, no wind, –1^{o}C/100m vertical temperature gradient (dry adiabatic lapse rate).
- *Inversion:*5^{o}C, 70% relative humidity, inversion strengths of +8^{o}C/100m.

4.5.4.2 Road Traffic Noise Assessment

Road traffic noise from Project-related vehicles was undertaken in accordance with the methodology identified in 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"*.Section 6.4 of Spectrum (2011) presents a detailed description of that methodology.

4.5.4.3 Blasting Assessment

The blasting assessment was undertaken using standard equations for predicting blast overpressure and ground vibration levels, developed by the United States Bureau of Mines. Section 6.5 of Spectrum (2011) provides further details in relation to the equations used. A MIC of 66kg for underground blasting was assumed for the purposes of the ground vibration assessment, while a MIC of 36kg was assumed for box cut blasting for the purposes of the air blast overpressure assessment.

4.5.5 Management and Mitigation Measures

The Proponent would implement the following noise management and mitigation measures throughout the life of the Project.

- Strictly comply with the proposed hours of operation identified in **Table 2.13**.
- 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 the YTC Resources Limited's Driver Code of Conduct outlining procedures for reducing noise impacts during transportation within the Project Site and off site.
- Ensure that all blasts are designed by a suitably qualified and experienced blasting engineer or shot-firer and that each is designed to achieve the relevant criteria at the closest residence.
- Prepare a Noise Management Plan prior to the commencement of mining activities which would incorporate the specific details of all noise controls and provide measures to address noise criteria exceedances and/or complaints should they occur.
- Maintain an open dialogue with the surrounding community and neighbours to ensure any concerns over noise or vibration are addressed.

4.5.6 Assessment of Impacts

4.5.6.1 Site Establishment Noise Levels

The predicted site establishment, operational and sleep disturbance noise levels at residences R1 to R4 under neutral and temperature inversion conditions are presented in **Table 4.18**. Noise contours depicting predicted operational noise levels for site establishment and operational scenarios under neutral and temperature inversions conditions are presented in **Figure 4.18**.

Table 4.18
Predicted Noise Levels[1]

Receiver	Site Establishment		Operational Phase		Sleep Disturbance
	Neutral	Inversion	Neutral	Inversion	Inversion
Criterion[1]	**35**	**35**	**35**	**35**	**45**
R1	<20	25	<20	<20	30
R2	<20	26	<20	<20	31
R3	20	33	25	35	39
R4	<20	31	<20	28	33

Note 1: Unit for site establishment and operational phase predicted noise is dB(A), $L_{eq(15min)}$; unit for sleep disturbance is dB(A), L_{max}.

Source: Spectrum Acoustics (2011) – modified from Table 8.1

Results presented in **Table 4.18** show that the site establishment, operational and sleep disturbance predicted noise levels at the four nearest receivers are below the relevant criterion.

4.5.6.2 Road Traffic Noise Levels

In the vicinity of the Project Site, Residence R3 would be the nearest residence to the proposed transportation route in the vicinity of the Project Site. Assuming a maximum hourly vehicle movements of 2 heavy vehicles and 30 light vehicles, Spectrum (2011) states that the anticipated road traffic noise level at Residence R3 would be 44.3dB(A). This is significantly below both the daytime and night time traffic noise criteria of 55dB(A) and 50dB(A) respectively.

The closest residences to the proposed heavy vehicle transportation route in the vicinity of Cobar are located approximately 20m from the road. At this distance, Spectrum (2011) notes up to 31 heavy vehicles per hour during the day and 9 heavy vehicles per hour during the night could use the proposed transportation route without exceeding the relevant criteria. Given that the Project-related activities would generate significantly less traffic than these predicted vehicle movements the Project would achieve the relevant criteria along the entire nominated heavy vehicle transportation route.

4.5.6.3 Blasting Noise and Vibration Levels

Spectrum (2011) identifies the following anticipated blasting-related impacts at Residence R3, located approximately 2 200m from the proposed blasting operations.

- For underground blasting using a MIC of 66kg, the peak vibration velocity has been calculated to be 0.1mm/s at 2 200m. This is well below the 95% exceedance criterion of 5mm/s for a sensitive (heritage) building damage.
- For box cut blasting using a MIC of 36kg, a peak blast overpressure (with +3dB correction) has been calculated to be 105dB at 2 200m. This is well below the 95% exceedance criterion of 115dB.

4.5.7 Monitoring

In order to confirm the noise levels associated with the Project, The Proponent would undertake attended noise monitoring during the site establishment phase of the Project and for a further six months during the operational phase.

4.6 ABORIGINAL HERITAGE

4.6.1 Introduction

The Aboriginal assessment for the Project was undertaken by OzArk Environmental and Heritage Management Pty Ltd. The full assessment is presented as Part 5 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as OzArk (2011b). It is noted that that report also presents the results of the historic or non-Aboriginal heritage assessment. Relevant information from OzArk (2011b) in relation to the Aboriginal heritage assessment is summarised in the following sub-sections. This summary should be read in conjunction with OzArk (2011b)

A risk analysis undertaken by R.W. Corkery & Co Pty Limited (Section 3.4 and **Table 3.8**) has identified the following potential Project impacts relating to Aboriginal Heritage requiring assessments. The unmitigated risk rating associated with each impact is indicated.

- Removal or destruction of known Aboriginal sites and/or artefacts (moderate risk).
- Removal or destruction of currently unidentified Aboriginal sites and/or artefacts (moderate risk).

The Director-General's requirements have identified Heritage, both Aboriginal and non-Aboriginal as a key issue that should be addressed in the *Environmental Assessment* (**Appendix 2**).

The Aboriginal Heritage assessment presented in OzArk (2011b) and summarised in this sub-section comprises results of surveys conducted in 2004 by Archaeological Surveys & Reports Pty Ltd, referred to hereafter as the 2004 Appleton assessment and a second survey conducted in April 2010 by OzArk Environmental and Heritage Management Pty Ltd, referred to hereafter as the 2010 OzArk assessment.

4.6.2 Consultation with the Aboriginal Community

4.6.2.1 Introduction

Initial consultation with the Aboriginal community was undertaken in accordance with the *Interim Community Consultation Requirements* (Department of Environment and Conservation 2005). Following the release of *Aboriginal Cultural Heritage Consultation Requirements for Proponents* by DECCW in April 2010, those guidelines have been used for subsequent consultation. It is noted that the 2004 Appleton assessment pre-dated the 2005 *Interim Community Consultation Requirements*.

The following four stages were undertaken for the Consultation Program during the 2010 OzArk assessment. A detailed log of the consultation program is presented in Appendix 2 of OzArk (2011b).

4.6.2.2 Stage 1 – Notification and Registration of Interest

Advertisements for stakeholder expressions of interest were placed in the Condobolin Argus and Condobolin Weekly on 10 March 2010 in accordance with Stage 1 of the *Interim Community Consultation Requirements* (ICCR). Letters were also sent to the Condobolin and Cobar Local Aboriginal Land Councils (LALC), OEH (then DECCW), Cobar Shire Council, NTSCORP and the Register of Aboriginal Owners.

A second round of letters were then sent to additional groups identified as a consequence of the first round of advertising and agency contact. The following organisations / individuals formally registered interest by the close of Stage 1 of the ICCR process.

- Condobolin LALC.
- Cobar LALC.
- Mount Grenfell Site Board of Management (MGSBOM).
- Murrin Bridge LALC.
- Elaine Ohlsen (individual).

4.6.2.3 Stage 2 – Presentation of Background Information and Survey Methodology

The Condobolin and Cobar LALCs were provided with copies of the 2004 Appleton assessment report for background information. The proposed heritage assessment methodology was sent to all stakeholders seeking specific cultural information (should any be available), as well as inviting comment or input on the methodology proposed, in accordance with Stage 2 ICCR.

No comments on the methodology were received by any of the registered stakeholders. Two positions were made available for Aboriginal community representatives to participate in the heritage assessment fieldwork.

4.6.2.4 Stage 3 – Literature Searches and Surveys

The relevant database searches were undertaken to gather information on previously recorded Aboriginal Sites and background information on the Project Site (discussed further in Section 4.6.3).

The 2004 Appleton survey involved:

- Mr Peter Knight representing the Condobolin LALC; and
- Mr Noel Powell representing the Wiradjuri Condobolin Culture and Heritage Company Pty Ltd.

The 2010 OzArk survey team comprised:

- Bradley Bell, Rebecca Shepherd (both as paid sites officers)and one other sites officer (provided by Condobolin LALC) representing the Condobolin LALC;
- Norm Ohlsen representing the Cobar LALC; and
- Ben Churcher and Kim Tuovinen from OzArk.

An overview of the survey methodology and results is presented in Sections 4.6.4 and 4.6.5.

4.6.2.5 Stage 4 – Review of Draft Heritage Assessment Report by Aboriginal Stakeholders

Copies of the draft Heritage Assessment report was sent to both the Condobolin and Cobar LALCs and the three other stakeholders (Mt Grenfell Historic Site Board of Management, Murrin Bridge LALC, Elaine Ohlsen) on 9 June 2011. All stakeholders were informed in writing that comments on the draft report were due by COB on Tuesday 5 July 2011. No verbal or written comments were received from the stakeholders by the deadline of 5 July 2011.

4.6.3 Previously Identified Sites and Predictive Model

4.6.3.1 Database Searches

The following databases were searched to identify previously recoded Aboriginal sites in the vicinity of the Project Site.

- The NSW Office of the Environment and Heritage's (OEH)Aboriginal Heritage Information Management System (AHIMS).
- The NSW Heritage Office State Heritage Register and Inventory.
- The Australian Heritage Database.
- The Register of the National Estate, *Environment Protection and Biodiversity Conservation Act 1999* online data-base (2010),
- The Cobar Local Government Area Local Environmental Plan 2001.
- Other relevant sources of information included the following.
- A review of available relevant literature including previous consulting reports, academic theses /articles and available works on the history and ethnography of the Condobolin/Cobar region.
- Consultation with the registered stakeholders (discussed in Section 4.6.2) which included the Cobar LALC and the Condobolin LALC and other relevant State government departments as required.

A search of the National Native Title Tribunal website (last updated 10 February 2011) revealed that there are currently no native title claims over the Project Site.

4.6.3.2 Previously Identified Sites

The results of database searches, the dates the searches were undertaken are summarised in **Table 4.19.**

The AHIMS results reveal that no Aboriginal sites are known to be located within a search area comprising a 10km by 10km grid centred on the Project Site.

4.6.3.3 Predictive Model

The AHIMS results may not be assumed to be a true reflection of past Aboriginal settlement patterns but could be indicative of the small amount of archaeological research that has taken place in the past in the vicinity of the Project Site. According to Appleton (2004), summarised in OzArk (2011b), 'The Peak' may have played a role in past Aboriginal religious or ceremonial practices but evidence is lacking as to what significance, if any, The Peak held with past Aboriginal inhabitants, especially as Appleton recorded no Aboriginal objects or sites in the area. Appleton concluded that there was little probability for there to be any artefacts within the area he surveyed.

Table 4.19
Heritage Database Search Results

Database	Date of search	Type of search	Comment
Australian Heritage Database http://www.environment.gov.au/heritage/ahdb/	10/5/10	Cobar LGA	There are 13 listed 'Indigenous Places' without location information. No places listed on the search are believed to be within the Project Site. Aboriginal Registered Stakeholders did not highlight any issues within the Project Site.
NSW Heritage Office State Heritage Register and State Heritage Inventory http://www.heritage.nsw.gov.au/	10/5/10	Cobar LGA	No places on the search are within the Project Site.
National Native Title Claims Search http://www.nntt.gov.au/Applications-And-Determinations/Search-Applications/Pages/Search.aspx	(accurate to February 2011)	NSW	No Native Title Claims cover the Project Site.
Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) Protected Matters (EPBC Act) Database http://www.environment.gov.au/erin/ert/epbc/index.html	10/5/10	Cobar LGA	None of the Aboriginal places on the RNE occur near the Project Site.
Office of Environment and Heritage's Aboriginal Heritage Information Management System (AHIMS)	15/4/10	(10 x 10)km grid centred on the Project Site boundary.	No sites have been recorded within the search area.
Local Environment Plan	10/5/10	Cobar LEP 2001	None of the Aboriginal places noted occur near the Project Site.
Source: OzArk (2011b) – modified from Table 1			

OzArk (2011b) present a predictive model for the presence of sites of Aboriginal heritage significance within the Project Site. In summary, it was determined that there was a low probability of locating Aboriginal objects or sites within the Project Site, based on the assessment results of Appleton (2004), the results of the AHIMS database search and a desktop study of the Project Site.

The following general predictions could be made regarding the nature of sites and their location in the Project Site using the concept of stream ordering, previous research within the general area (described in Section 4.2 of OzArk (2011b)) and the knowledge gained from a review of the local context discussed above.

- Away from permanent water, open sites are likely to be smaller, less complex and more likely to be the result of one-off occupation episodes
  - The Lachlan River runs approximately100km south of the Project Site while the Project Siteitself contains no discernable drainage features. It is therefore predicted that should open sites be recorded, they are likely to be of low density and complexity.
- Isolated finds may occur anywhere
  - Isolated finds are a relatively common occurrence in the wider area, particularly near resource extraction areas such as quarries. The probability of isolated finds that are the result of post-formation processes, i.e. disturbance, is high in deflated landscapes such as those of the Project Site. It is therefore predicted that there is a likelihood of recording isolated finds in environments such as the Project Site.
- Modified Trees
  - Although rare, these site types are relatively frequent within the wider area, often associated with water courses. However, given the history of early tree clearing and ring-barking (discussed below) and a lack of drainage features it would be unlikely that many mature trees of an age to possess a cultural scar would remain.
- Quarries may occur where appropriate raw materials outcrop in the landscape
  - Quartz quarries are possible as reefs of outcropping quartz are an occasional occurrence in the Project Site, particularly in the region of the proposed Surface Facilities Area.
- Natural mythological or cultural/ceremonial sites may be found anywhere
  - The survey team was accompanied by Aboriginal representatives of the Condobolin/Cobar area to assist in the identification of any known mythological/cultural sites occurring within near the Project Site. Those Aboriginal knowledge holders who did not attend the fieldwork were provided a copy of draft report for comment.

The predictive modelling indicated that there was a low probability of recording Aboriginal objects or sites within the Project Site due to the landform characteristics of the Project Site, specifically that there are no discernable drainage systems within the Project Site.

4.6.4 Survey Methodology and Constraints

The survey areas covered by 2004 Appleton and 2010 OzArk assessments are illustrated in Figure 2 of OzArk (2011b).

The 2004 Appleton survey, conducted on 18 March 2004, focussed on 'The Peak' and the scalded areas to the south of 'The Peak'. The survey areas, comprising the summit, the cliff lines and slopes, were inspected thoroughly, both for artefacts, paintings and engravings. The survey continued from a line west-east across the base of 'The Peak' slopes to the north of 'The Peak'. The investigators who undertook the survey generally walked three abreast and approximately 40m apart, from northeast to southwest and back, targeting any erosion features within the 120m to150m wide transect.

The 2010 OzArk survey area was walked by five surveyors keeping at least 5m apart. The surveys were conducted on 27 and 28 April 2010. The surveys comprised four separate areas, namely areas covering:

- the Tailings Storage Facility;
- Pete's Tank;
- the existing Back Tank West and the proposed Back Tank East; and
- the Surface Facilities area.

The 2004 Appleton and the 2010 OzArk survey areas are depicted in **Figure 4.19**.

It is noted that the design of the Tailings Storage Facility was adjusted following the 2010 OzArk assessment. Similarly the Mine Camp was also incorporated into the Project after that assessment. This is addressed in more detail in Section 4.6.6.

The perimeter of each survey block was first surveyed, before internal transects were designed and walked. Each of the larger areas for the proposed Tailings Storage Facility and the proposed expanded Back Tank location had four internal transects surveyed, as well as the perimeter transect.

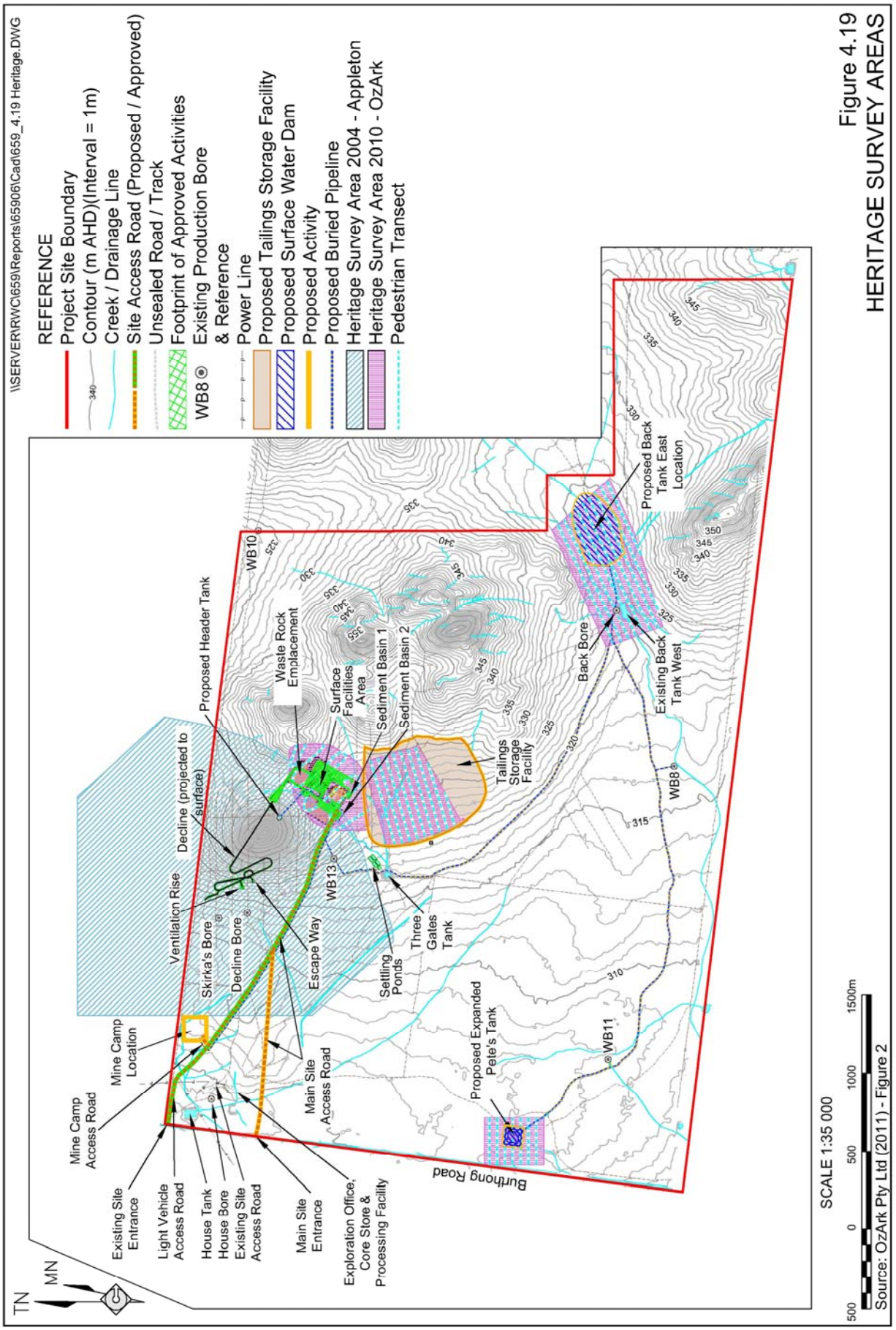
No heritage survey constraints were identified in either the 2004 Appleton or the 2010 OzArk surveys. The dry conditions, the clear sky and high ground visibility on the days the surveys were conducted offered the optimal conditions for detection of Aboriginal objects and artefacts.

4.6.5 Survey Results

4.6.5.1 Artefacts and Objects Recorded

No Aboriginal sites or objects were recorded during the 2004 Appleton or the 2010 OzArk assessments. These assessments have concluded that there was, and remains, a low potential for the existence of any undetected Aboriginal sites or objects within the Project Site. This conclusion is additionally based the Project Site topography and landform and an assessment of the likely impact to any previously existing sites by European disturbances, not the least being timber felling and topsoil erosion through clearing, stocking and flood events.

The Aboriginal representatives who took part in the 2004 Appleton and 2010 OzArk assessments (see Section 4.6.2.4), each of whom claim local knowledge of past Aboriginal occupation and land use, have confirmed that the areas that were surveyed hold little cultural significance.


\\SERVER\RWC\659\Reports\659060\Cad\659_4.19 Heritage.DWG
REFERENCE
Project Site Boundary
Contour (m AHD)(Interval = 1m)
Creek / Drainage Line
Site Access Road (Proposed / Approved)
Unsealed Road / Track
Footprint of Approved Activities
Existing Production Bore
& Reference
Power Line
Proposed Tailings Storage Facility
Proposed Surface Water Dam
Proposed Activity
Proposed Buried Pipeline
Heritage Survey Area 2004 - Appleton
Heritage Survey Area 2010 - OzArk
Pedestrian Transect
Figure 4.19
HERITAGE SURVEY AREAS
Proposed Back Tank East Location
Back Bore
Existing Back Tank West
Proposed Header Tank
Waste Rock Emplacement
Surface Facilities Area
Sediment Basin 1
Sediment Basin 2
Tailings Storage Facility
Decline (projected to surface)
Ventilation Rise
Skirka's Bore
Decline Bore
Escape Way
Settling Ponds
Three Gales Tank
Proposed Expanded Pele's Tank
Mine Camp Location
Mine Camp Access Road
Main Site Access Road
Existing Site Entrance
Light Vehicle Access Road
House Tank
House Bore
Existing Site Access Road
Main Site Entrance
Exploration Office, Core Store & Processing Facility
Burtlong Road
WB8
WB10
WB11
WB13
TN
MN
SCALE 1:35 000
500 0 500 1000 1500m
Source: OzArk Pty Ltd (2011) - Figure 2

4.6.6 Assessment of Heritage Significance

Since no Aboriginal sites or objects were recorded during the 2004 Appleton or 2010 OzArk assessments, no further assessments of heritage significance were undertaken.

4.6.6.1 Likely Impacts on Aboriginal Heritage

Since no Aboriginal sites or objects were recorded as part of the 2004 Appleton or 2010 OzArk assessments and no area within the Project Site has been assessed as holding archaeological potential it has been concluded that there will be no impact to cultural heritage arising from the Project.

4.6.7 Management and Mitigation Measures

No specific management recommendations concerning the management of Aboriginal heritage sites have arisen from the heritage assessment as no Aboriginal sites or objects were recorded in during either the 2004 Appleton or the 2010 OzArk assessments.

The Proponent would adhere to the following general management recommendations of the Aboriginal Heritage assessment (OzArk 2011b).

- Undertake further site inspections of those sections of the Mine Camp and Tailings Storage Facility that were not surveyed during the 2010 OzArk assessment prior to disturbing the ground to confirm the assessment that there are no objects or sites of Aboriginal heritage significance within the proposed areas of disturbance.
- Cease all work in the vicinity of an Aboriginal sites or objects found during ground-clearing construction works, and seek advice from OEH, the National Parks and Wildlife Service and Condobolin and Cobar Local Aboriginal Land Councils will be sought on how to best proceed. Work would not recommence in the area of the find, until the officials contacted have inspected the material and permission has been given to continue with the construction works.

4.7 HISTORICAL HERITAGE

4.7.1 Introduction

The Historical Heritage Assessment for the Project was undertaken by OzArk Environmental and Heritage Management Pty Ltd. The full assessment (along with the Aboriginal Heritage Assessment) is presented as Part 5 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as OzArk (2011b). Relevant information from that assessment is summarised in the following sub-sections.

It is noted that the term "Historical Heritage" relates to that component of the heritage record that is not associated with Aboriginal heritage. To ensure consistency with OzArk (2011b), the following sub-sections using the term "Historical Heritage."

A risk analysis undertaken by R.W. Corkery & Co Pty Limited (Section 3.4 and **Table 3.7**) has identified loss or destruction of items of historical heritage significance and having an unmitigated risk rating of moderate.

The Director-General's requirements have highlighted non-Aboriginal Heritage as an issue that requires to be addressed in the *Environmental Assessment*.

4.7.2 Recorded History of the Project Site

The Project Site has been influenced by development of the nearby Nymagee Copper Mine and the Project Site's subsequent use as a sheep farm. No known historical heritage studies have been carried out previously in the vicinity of the Project Site.

The earliest prospecting activity in the area is poorly documented, but was probably in the Cobar belt during in the 1860s. Settlement extended along the Barwon River in the 1840s and along the Darling River frontages in the 1850s although the entire hinterland between the Barwon and the Darling Rivers saw little permanent settlement prior to 1870s.

Commencing about 1869, a rapid spread of settlement began, spurred on by the discovery of first signs of mineralisation at Cobar and Girilambone. At Cobar, both copper (1869 – 1870) and gold (1871) were discovered in close succession, although the development of gold extraction did not commence till well after copper recovery was underway.

The nearby township of Nymagee was originally built as a support town for the Nymagee Copper Mine (operated from 1881 to 1907 and then from 1913 to 1917), and at its peak supported a population of over 2200 people, half of those being Chinese migrants. The Chinese migrant population most likely provided labour for the collection of wood (the 'timber-getters') from the surrounding country for the wood-fired smelter used in the Nymagee Copper Mine.

Nymagee is also home to "Clancy of the Overflow" a poem written by the famous bush poet Banjo Patterson. The sheep station, "The Overflow"" featured in the poem is situated about 32km southeast of Nymagee.

4.7.3 Registered Sites of Heritage Significance

Searches of the following databases and literature sources were made to identify registered sites of heritage significance.

- Cobar Local Environment Plan 2001 – Schedule 1.
- NSW Heritage Branch - State Heritage Inventory listing of places of heritage significance.
- National Trust listing of places of heritage interest.

No registered sites were identified within the Project Site.

4.7.4 Survey Methodology

Field survey for historical items was carried out at the same time as the Aboriginal heritage assessment and followed the same methodology as set out in Section 4.8.4.

4.7.5 Survey Results

4.7.5.1 Introduction

No items of historic heritage significance were recorded during the survey.

The following two groups of items of potential historical heritage significance were noted by the surveyors.

- A rubbish tip consisting of one car wreck and some bottles probably dating to the mid-twentieth century.
- Toe-holds in trees used by timber-getters (see **Plate 4.1**).

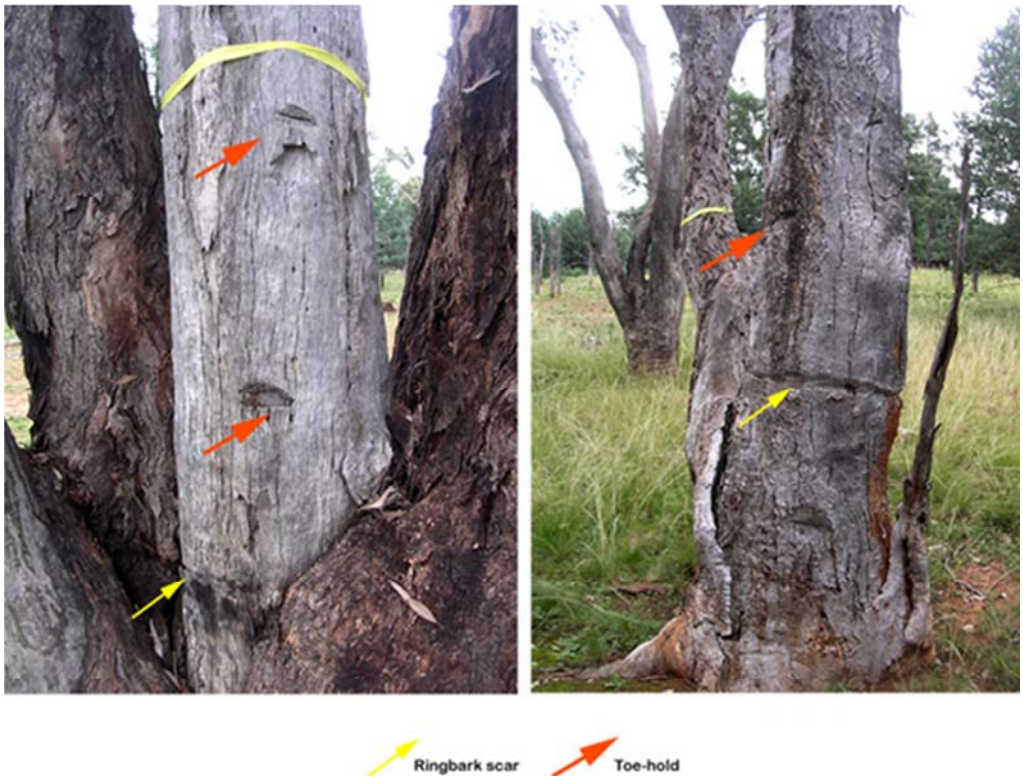


Plate 4.1 Timber-getters Toe-holds

The significance assessments of these two items were conducted in accordance with *Heritage Act 1977* requirements and guidelines provided in the Heritage Council of NSW manual *Assessing Heritage Significance* (Heritage Council of NSW 2001) outlined in detail in Section 5.6 of OzArk (2011b). Conclusions reached are summarised in the following sub-sections along with general descriptions of the items.

4.7.5.2 Rubbish Tip

The rubbish tip consists of a rusted car body and approximately a dozen unbroken glass bottles. It is located on denuded soils and there is little likelihood of further sub-surface items or deposits. From the evidence available, the rubbish dump appears to date from mid twentieth century and there are no other signs of structures etc. associated with the rubbish dump. It is therefore assumed to be a farm's rubbish tip that was probably created in one or two episodes and was never very extensive.

4.7.5.3 Tree-holds

A number of toe-holds were observed on dead trees in the vicinity of Back Tank East and further to the east. All of the trees in this section of the Project Site showed evidence of ring-barking and while some had regenerated from below the ring-bark cut, others were dead, standing timber. The number of toe-holds varied from one to three or more and all had been created by making a quick cut in the side of the tree and large enough for a toe-hold rather than a cut to support planking or other structures. Most of the toe-holds were shallow and roughly cut and it was not clear if a steel axe had been used. In most cases the trees with the toe-holds had their upper branches lopped and the lopped braches were always well off the ground and always at the point where the main trunk branched into two major limbs. In some cases the cut was 5m to 6m off the ground.

However, it should be noted there is no evidence of the age of the toe-holds or the ethnicity of the people who cut them. In discussions with the Aboriginal representatives accompanying the survey, it was determined that the toe-holds date from the late nineteenth/early twentieth century and were probably made by Chinese timber getters. The Aboriginal representatives were satisfied with the hypothesis put to them and agreed that the sites did not represent Aboriginal places.

4.7.6 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures as recommended by OzArk (2011b).

- Undertake further site inspections of those sections of the Mine Camp and Tailings Storage Facility that were not surveyed during the 2010 OzArk assessment prior to disturbing the ground to confirm the assessment that there are no further items of historic heritage significance within the proposed areas of disturbance.
- Ensure that trees identified to possess toe-holds and bark-rings located to the east of the proposed Bank Tank East (listed in Table 4of OzArk (2011b)) not be removed.

4.7.7 Impact Assessment

OzArk (2011b) states that the Project is unlikely to impact upon any items of historical heritage significance.

4.8 AIR QUALITY AND GREENHOUSE GAS

4.8.1 Introduction

The air quality and energy assessments were undertaken by ENVIRON Australia Pty Ltd. The full assessment is presented in Part 6 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as Environ (2011).This sub-section summarises the relevant sections of that report.

A risk analysis undertaken by R.W. Corkery & Co Pty Limited (Section 3.4 and **Table 3.8**) has identified the following potential Project impacts relating to air quality and greenhouse gas emissions requiring assessments. The unmitigated risk rating associated with each impact is presented in parenthesis.

- Nuisance / amenity impacts from deposited dust (moderate risk).
- Adverse health impacts (if PM_{10} levels are excessive) (high risk).
- Increased contribution to greenhouse effect (moderate risk).

The Director-General's Requirements identified air quality and energy as two of a number of key issues that requires assessment within the Project Site. The energy component requires:

- Calculations of the Scope 1, 2 and 3 emissions from the mining operations;
- Descriptions of measures that would be implemented to ensure that the mining operations are energy efficient.

The following sub-sections describe the existing air quality environment surrounding the Project Site, air quality criteria used to assess the Project impacts on the environment, proposed operational safeguards and mitigation measures, and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4.8.2 Existing Environment

4.8.2.1 Existing Sources of Air Pollutants

A review of the National Pollutant Inventory (NPI) and NSW Office of Environment and Heritage (OEH) environment protection licence databases for the identification of significant existing sources of air pollutants in the Nymagee region determined that there are no notable industrial or extractive operations surrounding the Project Site. The closest operations with the potential to generate air pollutant emissions are situated near Cobar, approximately 100km to the northwest. Given the lack of industrial and extractive operations in the Nymagee region, the dominant sources of particulate matter emissions in the vicinity of the Project include:

- wind-generated dust from exposed areas;
- dust entrainment due to vehicle and animal movements; and
- episodic emissions from vegetation fires.

Fugitive dust from long-range transport of fine particles would also to contribute to suspended particulate concentrations within the Project Site.

4.8.2.2 Background Dust Levels

No monitoring of ambient deposited dust, PM_{10} (suspended dust with a diameter of less than 10µm) and total suspended particulates (TSP) levels or concentrations have been conducted in the vicinity of the Project Site.

In order to enable a cumulative assessment of Project-related dust impacts, Environ (2011) adopted the following background dust levels.

- Deposited dust – 2.2g/m^2/month.

  This figure has been derived from data acquired between July 2009 and July 2010 by Endeavor Mine (CBH Resources) at one of their monitoring sites, located approximately 110km north to northwest of the Project Site.

- PM_{10} (annual average) – 18.4µg/m^3.

  This figure has been derived from data acquired by the OEH Tamworth station between 2005 and 2009.

- PM_{10} (24 hour variable concentration) – variable.

  Daily data from the DECCW PM_{10} monitoring station in Bathurst, excluding exceedances of OEH criterion of 50µg/m^3, for 2009 has been used.

- Total Suspended Particulate (annual average) – 46.0µg/m^3.

  This figure has been calculated from the annual average PM_{10} concentration of 18.4µg/m^3recorded by the OEH at Tamworth on the basis that the PM_{10} particle size fraction is typically of the order of 40% of the TSP mass within rural areas.

4.8.2.3 Greenhouse Gases

The concentrations of fuel-combustion related pollutants (greenhouse gases) surrounding the Project Site would be negligible given the general absence of energy-intensive industries in the vicinity of the Project Site. However, limited emissions associated with vehicle movements do occur.

4.8.3 Potential Sources of Air Contaminants

4.8.3.1 Sources of Particulate Emissions

Potential sources of dust emissions associated with the Project include the following.

- Surface-based materials handling activities across the Project Site by the front-end loader in the vicinity of the Processing Plant and associated stockpiles.
- Vehicle entrainment of particulate matter due to the haulage of ROM ore along the haul road from the box cut to the ROM pad and the movements along the unsealed site access road by product transportation road trains and miscellaneous vehicles.
- Trucks tipping ROM ore on the ROM Pad.
- Wind erosion associated with exposed surfaces within the surface facilities area, including on the ROM pad and surge ore stockpiles.
- Wind erosion associated with operation of the Tailings Storage Facility.
- Maintenance of unsealed roads by grader.

- Handling of ore within the Processing Plant, including primary and secondary crushing, screening, conveyor transfer points and wind erosion from open conveyor belts.
- Emissions from the ventilation rise associated with underground operations.
- Diesel combustion emissions from onsite electricity generation and mobile plant.

Stockpiles associated with the stripping of topsoil would be stabilised through vegetation by the commencement of the operational phase and would therefore not be a significant contributing source to site emissions.

4.8.3.2 Sources of Greenhouse Gas Emissions

The primary sources of greenhouse gas (GHG) emissions would be as follows. The relevant scope for each component is identified.

- Combustion of diesel for electricity generation (Scope 1 and Scope 3).
- Combustion of diesel by mobile equipment (Scope 1 and Scope 3).
- Emissions associated with explosive use (Scope 1).
- Transportation of bulk concentrate product off site (Scope 3).

4.8.4 Assessment Criteria

Table 4.20 presents the relevant cumulative air quality criteria for the Project.

Table 4.20
Air Quality Criteria

Pollutant	Averaging Period	Criteria	Reference
TSP	Annual	90µg/m³	NSW OEH[1,2]
PM_{10}	24-hour	50µg/m³	NSW OEH[1]
	24-hour	50[4]µg/m³	NEPM[3]
	Annual	30µg/m³	NSW OEH[4]
Deposited Dust	Annual Maximum Increase in Deposited Dust Level	2 g/m^2/month	DEC, 2005[5]
	Annual Maximum Total Deposited Dust Level	4 g/m^2/month	DEC, 2005[5]

Note 1: NSW DEC, 2005 Approved Methods.
Note 2: NSW DEC impact assessment goal based on the subsequently rescinded National Health and Medical Research Council (NHMRC) recommended goal.
Note 3: NEPM, 2003, National Environment Protection (Ambient Air Quality) Measure, as amended.
Note 4: Provision made for up to five exceedances of the limit per year.
Note 5: Approved Methods DEC, 2005

Source: Environ (2011) – modified from Tables 3 and 4

4.8.5 Assessment Methodology

4.8.5.1 Sensitive Receptors

The closest four non-project related residences, identified as R1 to R4 in **Figure 4.7** were selected as sensitive receptors for the purposes of the air quality assessment. An additional receptor, identified as R5 in **Figure 4.7**, was selected to be representative of the township of Nymagee. Finally, the air quality assessment also included an assessment of dust levels at the Mine Camp, identified as R6 in **Figure 4.7**. It is noted however, that this location is considered to be a Project-related residence and has been included here for completeness.

4.8.5.2 Particulate Matter Dispersion Modelling

The assessment of air quality was undertaken in accordance with *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005).Fugitive dust sources associated with the Project were principally quantified through the application of Australian National Pollutant Inventory (NPI) emission estimation techniques and United States Environmental Protection Agency (USEPA) AP-42 predictive emission factor equations. Particulate releases were quantified for various particle size fractions, with the TSP fraction being estimated and simulated to provide an indication of nuisance dust deposition rates. Fine particulates (PM_{10}) were estimated using ratios for the smaller particle size fractions available within the literature.

The atmospheric dispersion modelling carried out within the air quality assessment utilised the US-EPA regulatory AERMOD model (US-EPA, 2004) and results were analysed for TSP, PM_{10}, dust deposition, chemical pollutants (SO_2, NO_2, CO and benzene) and metallic species including heavy metals (antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver).

Fugitive emissions within the Processing Plant of carbon disulphide (CS_2) and hydrogen sulfide (H_2S) as a result of the use of potassium amyl xanthate and copper sulfate in flotation tanks, and hydrogen cyanide through use of sodium cyanide in leach tanks, were also modelled. A summary of the particulate matter emissions inventory used in the dispersion modelling is presented in **Table 4.21.** A more detailed emission summary, and the justification and assumptions made in developing the inventory is given in Section 6.2 and Table 9 of Environ (2011).

A single modelling scenario configured to reflect a worst-case operational 24-hour period continuously throughout a calendar year was established and the results presented in Section 4.8.7 reflect this scenario.

The prevailing wind regime used in the dispersion modelling was the TAPM-generated meteorological data for 2009 discussed in Section 4.1.3.4.

Table 4.21
Particulate Matter Emissions Inventory

Particulate Source	TSP Emissions		PM_{10} Emissions	
	tonnes/year	%	tonnes/year	%
Tailings Storage Facility wind erosion	306.6	38.2	153.3	45.9
Processing Plant	169.9	21.1	41.4	12.4
Unsealed Roads	131.4	16.4	38.9	11.6
Ventilation Rise	113.5	14.1	56.8	17.0
Materials Handling	51.8	6.4	25.9	7.8
Stockpile wind erosion	24.5	3.0	12.2	3.7
Diesel combustion	5.8	0.7	5.8	1.7
Total	**803.5**	**100%**	**334.2**	**100%**
Source: Environ (2011) - Table 9 and Figure 10				

Wind erosion from the Tailings Storage Facility is by far the largest source of both TSP and PM_{10} emissions. The second largest source of TSP emissions is expected to be the Processing Plant operations (principally crushing and dry screening) while the second largest source of PM_{10} emissions is expected to be the Ventilation Rise. The combined TSP and PM_{10} emissions from the Tailings Storage Facility. Emissions from unsealed roads, materials handling, stockpile wind erosion and diesel combustion contribute approximately 27% and 25% of the total annual TSP and PM_{10} emissions, respectively.

4.8.5.3 Greenhouse Gas Emissions

The greenhouse gas emissions were calculated largely using the methods prescribed by the Australian Government Department of Climate Change and Energy Efficiency (DCCEE (2010)) and methodologies contained within the National Greenhouse Accounts Factors (NGA Factors (2010).

Section 11 of Environ (2011) presents a detailed description of the greenhouse gas assessment methodology. As a result, that information is not presented in this document.

A summary of the Project's greenhouse gas emission sources for Scopes 1 to 3 are given below.

- Scope 1 (Direct Emissions) of the Project are as follows.
  - Diesel Combustion for electricity generation and operation of mobile equipment (see Section 11.3.1 of Environ (2011));
  - LPG Combustion for Gold Room furnace (see Section 11.3.2 of Environ (2011)); and
  - Explosives (see Section 11.3.3 of Environ (2011)).
- Scope 2 (Indirect Emissions): Given the majority of electricity required for the Project would be sourced from the onsite diesel generators Scope 2 emissions from the site is anticipated to be insignificant (see Section 11.4 of Environ (2011)).

- Scope 3 Emissions (Indirect Emissions) of the Project are as follows.
  - Extraction, production and transport of purchased fuels consumed (see Section 11.5.1 of Environ (2011));
  - Distribution of product from the Project Site by road haulage (see Section 11.5.2 of Environ (2011)), rail transportation (see Section 11.5.3 of Environ (2011)) and international shipping (see Section 11.5.3 of Environ (2011)).

As noted in Section 2.9.2.2 the bulk concentrate product (approximately 40 000t per year) would be transported via roads to Endeavour Mine and/or Hermidale Rail Siding, for rail transport to the Port of Newcastle and subsequent shipping to India and/or Japan. Given that the exact product distribution for each destination has not been finalised and likely to be variable throughout the life of the Project, Scope 3 emissions for the Project have been calculated based on transportation route of the greatest distance based by the following route:

- haulage by diesel road trucks to the rail siding at Endeavor Mine;
- rail transportation to the Port of Newcastle; and
- bulk carrier shipping to Bombay, India.

Environ (2011) note that the Project's Scope 3 emissions should be viewed as a conservative upper estimate for this reason.

4.8.6 Management and Mitigation Measures

4.8.6.1 Dust Management and Mitigation Measures

The Proponent would implement the following dust management and mitigation measures throughout the life of the Project.

- Limit disturbance to the minimum area necessary for mining and associated activities.
- Spray unsealed access roads and other trafficked areas with water carts at a rate of 2 L/m^2/hour, as required, when visible dust is generated.
- Incorporate water spray facilities to all transfer points in the crushing and screening circuit within the Processing Plant.
- Enclose crushing and dry screening plant components of the Processing Plant, with venting to a fabric filter or equivalent for removal of particulate matter from the airstream prior to release. Alternatively, install suitable alternate dust control measures such as water sprays to ensure that the required level of dust suppression is achieved.
- Maintain approximately 75% of the Tailings Storage Facility area as wet, with emissions restricted to 25% of the surface area of the Tailings Storage Facility.
- Cap or otherwise treat the Tailings Storage Facility during rehabilitation activities following completion of mining operations.

- Maintain and inspect the crusher and dry screen circuit hood and filter systems and all other dust control technologies, in accordance with supplier recommendations.
- Ensure site personnel understand fundamentals of particulate emissions, and have been trained to make timely reporting of any visible emissions to allow for prompt and appropriate action to be undertaken for the management of the identified emissions.
- Restrict speed limit of 40 km/hr on all internal access roads to minimise dust generation.
- Install temporary wind breaks in the vicinity of the Tailings Storage Facility and implement chemical suppressant (biodegradable) technology within the facility to minimise emissions, if required.
- Maintain ore handling areas / stockpiles in a moist condition by using water carts to water down areas affected by wind-blown and traffic-generated dust.
- Minimise drop-heights from the ROM bin to the primary crusher.
- Clearly define all edges of site access roads with marker posts or equivalent to control their locations, especially when crossing large areas of non-descript disturbance.
- Limit the development of minor roads and clearly define the locations of these.
- Establish vegetative cover over all long-term topsoil stockpiles not regularly used, within three months of stockpiling.
- Profile all surfaces to reduce velocity of overland winds.
- Contour the final landform shape to avoid strong wind flows and smooth gradients to reduce turbulence at surface.
- Apply vegetative cover to non-operational exposed surfaces, e.g. Tailings Storage Facility wall, ROM pad batters, as soon as practical after disturbance.
- Reshape, topsoil and rehabilitate completed Waste Rock Emplacement areas as soon as practicable and when no longer required for mining-related purposes.

4.8.6.2 Greenhouse Gas Management and Reduction Measures

The Proponent would implement the following measures to minimise the emissions of greenhouse gases throughout the life of the Project.

- Progressively optimise the underground mine design to minimise travel distances for mining equipment and re-handling of waste and ore material.
- Use mining equipment which is regularly maintained and serviced to maximise efficiency.

- Optimise the design of the Processing Plant to:
  - minimise the amount of conveyor operating hours with zero load;
  - maximise the use of gravity to move material through the Processing Plant reducing the need for pumping; and
  - maximise the use of energy efficient motors within the Processing Plant.
- Adopt the use of energy efficient lighting technologies and hot water and air conditioning systems wherever practical.
- Maximise the recovery of recyclable materials where practicable, including:
  - waste hydrocarbons;
  - polyethylene; and
  - scrap metals.
- Minimise waste sent to landfill through the development of appropriate purchasing and waste management plans.
- Progressively review and implement energy efficiency measures throughout the life of the Project.

4.8.7 Assessment of Impacts

4.8.7.1 Deposited Dust

The predicted incremental and cumulative annual average levels of deposited dust at ground level at the selected receptor locations as a result of the Project are given in **Table 4.22.** Predicted incremental dust contours are presented in **Figure 4.20.**

Table 4.22
Predicted Annual Average Dust Deposition Levels[1]

Residence	Incremental (Project Only)	Cumulative (Project + Background[2])
Criteria	**2**	**4**
R1	0.2	2.4
R2	0.2	2.4
R3	0.3	2.5
R4	0.1	2.3
R5	<0.1	2.2
R6	1.5	3.7

Note 1: Units = g/m^2/month
Note 2: Dust Deposition Background – 2.2 g/m^2/month (see Section 4.10.2.2)
Source: Environ (2011) –modified from Table 20

Results presented within **Table 4.22** indicate that the predicted incremental and cumulative dust deposition levels as a result of the Project satisfy the relevant criteria at all selected receptor locations.

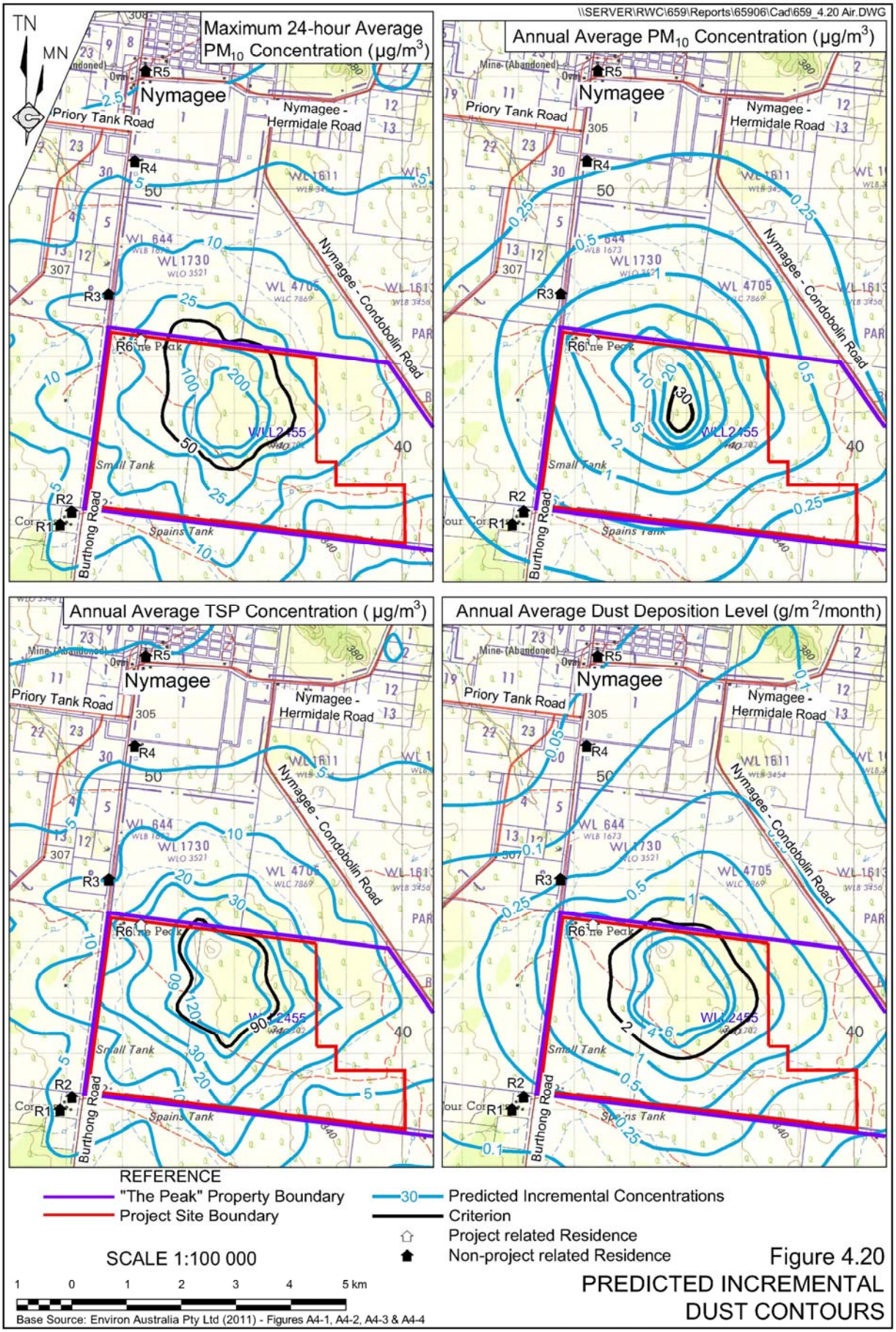


Figure 4.20
PREDICTED INCREMENTAL DUST CONTOURS

4.8.7.2 Total Suspended Particulates

The predicted incremental and cumulative annual average ground level concentrations of TSP at the selected receptor locations as a result of operations at the Project Site are presented in **Table 4.23**. Predicted incremental TSP concentration contours are presented in **Figure 4.20.**

Table 4.23
Predicted Annual Average TSP Concentrations[1]

Residence	Incremental (Project Only)	Cumulative (Project + Background[2])
Criteria	**-**	**90**
R1	0.5	46.5
R2	0.6	46.6
R3	1.3	47.3
R4	0.4	46.4
R5	0.2	46.2
R6	5.8	51.8
Note 1: Units = µg/m^3 Note 2: Annual Average TSP Background – 46 µg/m^3 Note 3: Assessment Criteria: Annual – 90 µg/m^3		
Source: Environ (2011) –modified from Table 16		

4.8.7.3 24-hour PM_{10}

The maximum 24-hour average predicted incremental and cumulative ground level concentrations of PM_{10} at the selected receptor locations as a result of the Project Site are presented in **Table 4.24**. For receptor location R6 (Mine Camp) the modelling was performed for the following PM_{10} concentrations in exhaust air.

- 10mg/m^3 – this concentration corresponds to the Safe Work Australia time-weighted (8-hour) average exposure standard for inspirable dust (equating roughly to PM_{10}) (NOHSC (1995)) which would be the maximum concentration permitted within the underground workings and is likely to represent a very significant overestimation of PM_{10} concentration in exhaust air from the ventilation rise.
- 1.6mg/m^3 – this concentration corresponds to an actual PM_{10} concentration measurement made within the ventilation exhaust of an underground coal mine with mining rate of 5.2 Mtpa, approximately 15 times greater than the Project's proposed maximum mining rate of 350 000tpa
- 0mg/m^3 – this concentration was used to demonstrate the anticipated particulate matter concentrations in the absence of emissions from the exhaust ventilation rise.

It is noted that the information presented in **Table 4.24** represents the maximum 24-hour average concentration during the 12 month period modelled. As a result, the data presented is a worst-case scenario and 24-hour average PM_{10} concentrations on the remaining 364 days of the year would be expected to be less than the concentrations presented in **Table 4.23.**

Predicted incremental maximum 24-hour PM_{10} concentration contours are presented in **Figure 4.20.**

Table 4.24
Predicted 24-hour Average PM_{10} Concentrations[1]

Residence	Cumulative (Project + Background)[1]	Incremental Component (Project Only)[1, 4]	Background Component[1,2]
Criteria[3]	**-**	**50**	**-**
R1	48.4	<0.1	48.4
R2	48.4	<0.1	48.4
R3	48.9	0.5	48.4
R4	48.7	0.3	48.4
R5	48.6	0.2	48.4
R6 – Vent Rise Concentration of 10 mg/m^3	52.9	20.9	32.0
R6 – Vent Rise Concentration of 1.6 mg/m^3	49.5	1.1	48.4
R6 – No Vent Rise Emissions	49.5	1.1	48.4

Note 1: Units = $\mu g/m^3$
Note 2: 24-hour PM_{10} background data varies on a daily basis (assumed 48.4 $\mu g/m^3$)
Note 3: Assessment Criteria: 24-hour – 50 $\mu g/m^3$
Note 3: The incremental concentration shown in this table is from the 24-hour period with the greatest cumulative 24-hour PM_{10} concentration. By contrast, **Figure 4.20** illustrated the maximum incremental 24-hour PM_{10} concentration.

Source: Environ (2011)– Tables 18

The results presented in **Table 4.24** illustrate that the maximum cumulative 24-hour PM_{10} concentrations associated with the Project, derived from this cumulative assessment approach, would be lower than the OEH assessment criterion of 50$\mu g/m^3$ at the selected non-project related receptor locations (R1 – R5). However, the maximum cumulative 24-hour PM_{10} concentrations would exceed the OEH criterion when the modelling is performed assuming a PM_{10} concentrations of 10 mg/m^3 within the exhaust ventilation rise, falling to less than the criterion when the PM_{10} concentrations is reduced to 10 mg/m^3 and 0 mg/m^3. Environ (2011) note that the emission estimation from the ventilation rise has been based on a set of highly conservative assumptions and as a result, the predicted results should be viewed as an upper bound estimation of possible concentrations that could be experienced at the receptor locations.

It should be noted from **Table 4.24** that the incremental PM_{10} concentration contributions to the maximum cumulative 24-hour PM_{10} concentrations at the receptors R1 to R5 are very small, and in the case of R6 is highly dependent on the assumed emissions from the Ventilation Rise.

Frequency analysis undertaken to determine the likelihood of the likelihood of PM_{10} emissions from the Project causing an exceedance of the cumulative 24-hour average assessment criterion of 50$\mu g/m^3$ showed the 24-hour average incremental increase in PM_{10} from the Project is predicted to be less than 5$\mu g/m^3$ approximately 98% of the time across selected non-project related receptors (R1 – R5) and less than 10 $\mu g/m^3$ at all times. When the frequency distribution of the OEH Bathurst and Tamworth average PM_{10} concentration datasets showing that the frequency of PM_{10}concentrations greater than 30$\mu g/m^3$ occurs at approximately 8% and 4%, respectively, of the time it is concluded that the potential for the proposed operations at the Project Site to cause a cumulative exceedance of the OEH 24-hour average PM_{10} criterion is extremely low.

The predicted 24-hour average PM_{10} concentrations at the Mine Camp (R6) are higher than those predicted for the non-project related receptors (R1 – R5), although the 24-hour average PM_{10} concentration attributable to the Project is predicted to be less than 20 µg/m³ approximately 98% of the time at R6. Environ (2011) note the most significant contributing source to the predicted PM_{10} concentrations at R6 is the exhaust ventilation rise. However, as the data presented in **Table 4.24** shows the predicted concentrations at R6 is highly dependent on the assumed PM_{10} concentration at the Ventilation Rise. Environ (2011) has concluded, based on this observation, that the predicted concentrations at R6 should be viewed as an upper bound estimation of possible concentrations that could be experienced.

4.8.7.4 Annual Average PM_{10} Concentrations

The predicted incremental and cumulative annual average ground level concentrations of PM_{10} at the selected receptor locations as a result of the Project Site are presented in **Table 4.25.** Predicted incremental annual average PM_{10} concentrations are presented in **Figure 4.20.**

Table 4.25
Predicted Annual Average PM_{10} Concentrations[1]

Residence	Incremental (Project Only)	Cumulative (Project + Background[2])
Criteria[3]	**-**	**50**
R1	0.3	18.7
R2	0.4	18.8
R3	0.8	19.2
R4	0.2	18.6
R5	0.1	18.5
R6	3.4	21.8
Note 1: Units = µg/m³ Note 2: Annual Average PM_{10} Background – 18.4 µg/m³ (see Section 4.10.2.2) Note 3: Assessment Criteria: Annual – 30 µg/m³ (OEH)		
Source: Environ (2011) –Table 19		

It can be seen from the results presented in **Table 4.25** that the predicted cumulative PM_{10} concentrations are less than the applicable NSW criterion at all selected receptor locations.

4.8.7.5 Metallic Species Concentrations

The predicted incremental ground level concentrations of metallic species relevant to the Project predicted for the selected receptor locations (R1 to R6) as a result of operations at the Project Site is presented in **Table 4.26**.

Table 4.26
Predicted Incremental Metallic Species Concentrations[1]

Pollutant	R1	R2	R3	R4	R5	R6	Assessment Criterion (µg/m^3)
Antimony	0.022	0.002	0.007	0.002	0.001	0.022	9
Arsenic	0.003	0.003	0.013	0.003	0.002	0.042	0.09
Barium	0.029	0.032	0.102	0.034	0.021	0.242	9
Cadmium	0.001	0.001	0.003	0.001	0.001	0.008	0.018
Chromium	0.002	0.003	0.003	0.001	0.001	0.006	0.09
Copper	0.031	0.035	0.11	0.037	0.022	0.262	18
Lead[2]	0.001	0.001	0.002	0.001	<0.001	0.01	0.5
Manganese	0.011	0.012	0.012	0.004	0.003	0.029	18
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.18
Nickel	0.001	0.001	0.001	<0.001	<0.001	0.002	0.18
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.18
Note 1: Unit = µg/m^3 Note 2: Averaging Period for Lead is Annual							
Source: Environ (2011) – Table 21							

It can be seen from the results presented in **Table 4.26** that the predicted incremental concentrations for metallic species relevant to the Project satisfy the applicable NSW OEH criteria at all selected receptor locations.

4.8.7.6 Combustion Emission Concentrations

The predicted incremental ground level concentrations of various diesel combustion-related emissions of CO, NO_2, SO_2 and benzene at the selected receptor locations as a result of operations at the Project Site are given in **Table 4.27**.

Table 4.27
Predicted Incremental Concentrations of Diesel Combustion Pollutants[1]

Pollutant	Averaging Period	R1	R2	R3	R4	R5	R6	Assessment Criterion (µg/m^3)
CO	1-hour	90.3	104.7	266.3	145.9	75.0	147.1	30,000
	8-hour	19.4	22.0	67.9	18.4	10.8	64.7	10,000
NO_2	1-hour	85.7	89.2	128.8	99.2	82.0	99.5	246
	Annual	0.7	0.7	2.8	0.7	0.4	9.8	62
SO_2	1-hour	0.1	0.1	0.4	0.2	0.1	0.3	570
	24-hour	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	228
	Annual	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	60
Benzene	1-hour (99.9th Percentile)	0.2	0.2	0.5	0.2	<0.1	1.8	29
Note 1 : Unit = µg/m^3								
Source: Environ (2011) – Table 22								

It can be seen from the results presented in **Table 4.27** that the predicted incremental concentrations for various diesel-combustion related pollutants emitted by the Project satisfy the applicable NSW OEH criteria at all selected receptor locations.

4.8.7.7 Fugitive Ore Processing Emission Concentrations

The predicted incremental ground level concentrations of fugitive trace emissions of H_2S, CS_2 and HCN from the gravity processing/flotation/concentrate leaching within the Processing Plant is presented in **Table 4.28**.

Table 4.28
Predicted Incremental Concentrations of Fugitive Emissions from Ore Processing[1]

Pollutant	Averaging Period	R1	R2	R3	R4	R5	R6	Assessment Criterion (µg/m^3)
H_2S	1-Second (99th Percentile)	0.02	0.03	0.04	0.02	0.01	0.09	1.38
CS_2	1-hour (99.9th Percentile)	0.12	0.13	0.21	0.11	0.06	0.42	70
HCN	1-hour (99.9th Percentile)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	200
Note 1: Unit – µg/m^3								
Source: Environ (2011) – Table 23								

It can be seen from the results presented in **Table 4.28** that the predicted incremental concentrations for H_2S, CS_2 and HCN emissions from the gold processing circuit at the Project satisfy the applicable NSW OEH criteria at all selected receptor locations.

4.8.7.8 Cyanide Emissions

Cyanide emission concentrations, as weak acid dissociable (WAD) cyanide species, from the Tailings Storage Facility would be insignificant as the Proponent would manage the Project Site in accordance with NICNAS Category 1 (NICNAS (2010)) and ensure the WAD cyanide concentration in the tailings is reduced to <10 mg/L prior to discharge to the Tailings Storage Facility (see Section 2.5.11). For this reason cyanide emissions from the Tailings Storage Facility was not included in the emissions inventory and the dispersion modelling.

4.8.7.9 Greenhouse Gas Emissions

The greenhouse gas sources and the estimated emissions are given in **Table 4.29**, and were calculated using the relevant emission factors from the guidelines DCCEE (2010).

Table 4.29
Predicted Annual Greenhouse Gas Emissions

Emission Source	Emissions (t CO_2-e)			Total (t CO_2-e)
	Scope 1	Scope 2	Scope 3	
Diesel[1]	19,074.7		1.5	19,076.2
LPG[2]	28.1		0.002	28.1
Explosives[3]	55.4			55.4
Rail transport[4]			1,360	1,360
Shipping transport[5]			28,032	28,032
TOTAL	**19,158.2**	**0**	**29,394**	**48,558**

Note 1: Scope 1 and Scope 3 emission factors for diesel oil (energy content of 38.6 GJ/kL) are, respectively, 2,682.7 and 204.6 kg CO2-e/kL fuel (NGA Factors (2010)).
Note 2: Scope 1 and Scope 3 emission factors for LPG gas (energy content of 25.7 GJ/kL) are, respectively, 1539.4 and 128.5 kg CO_2-e/kL fuel (NGA Factors (2010)).
Note 3: Scope 1 emission factor of explosives is 170 kg CO_2-e /t explosives (NGA Factors (2010)).
Note 4: Scope 3 emission factor for rail transport is 20.0 g CO_2/t-km
Note 5: Scope 3 emission factor for shipping transport is 29.2 g CO_2/t-km

Source: Environ (2011) – adapted from Tables 26 and 27.

The operation of the Project is expected to generate approximately 48 558t CO_2-e annually. In comparison, the annual GHG emissions for NSW and Australia in 2008 totalled 164.7 Mt and 575.8 Mt CO_2-e, respectively (DCCEE, 2008). When the Project annual GHG emissions are compared with the NSW and Australian totals for 2008, the Project represents an increase of approximately 0.0125% and 0.0036% on state and national level GHG emissions, respectively. It should be noted that in calculating these increases the Scope 3 emissions associated with shipping the products to overseas locations have been excluded as the majority of these emissions would occur offshore.

Given that the final product destination could be an international customer, annual global emissions were also considered in Environ (2011). The Intergovernmental Panel on Climate Change (IPCC) reports that global GHG emissions for 2004 (most recently published year) were approximately 49 Gt CO_2-e. When the annual GHG emissions calculated for the Project (including Scope 3 shipping emissions) are compared with the NSW and Australian totals for 2008 and global total for 2004, the Project represents an increase of approximately 0.030%, 0.0084% and 0.000099% on state, national and global level GHG emissions, respectively.

4.8.7.10 Source Significance on PM10 and TSP Concentrations

Environ (2011) undertook an assessment of the significance of the contributions of the individual emission sources within the Project Site on the TSP and PM_{10} modelling results. Their assessment concluded that the key contributing sources to annual ground level concentrations at all receptors are the exhaust ventilation rise, Processing Plant (dominated by the crushing and dry screening circuit) and the movement of vehicles along unsealed roads (primarily associated with light vehicle movements between the Mine Camp and the Processing Plant). The contribution of diesel combustion to the predicted ground level concentrations at each receptor varied, and shown to be dependent on the proximity of receptors to the onsite diesel-fired generators.

4.8.8 Monitoring

The Proponent would implement a comprehensive *Air Quality Monitoring Program* in consultation with OEH and the surrounding Community to monitor the impacts of the Project on the air quality.

The Air Quality Monitoring Program would be developed to confirm on an on-going basis, the consistent and effective implementation of dust management measures within the Project, and to demonstrate compliance with the relevant air quality criteria. The Program would comprise both the source-based measurements and ambient particulate monitoring as follows,

- Source-based Measurements – The in-stack particulate concentration in the Ventilation Rise exhaust stream would be monitored and logged for the initial 12 months of mining operations to assess the performance of the system and clarify the uncertainty in the emission estimation process. Continuation of this monitoring program would be reviewed in consultation with OEH following the initial 12 months monitoring period.
- Ambient Particulate Monitoring
  - Deposited dust would be monitored monthly at a minimum of two locations within the Project Site.
  - PM_{10} concentration would be measured using a suitable methodology at the Mine Camp for the initial 12 months of mining operations. Continuation of this monitoring program would be reviewed in consultation with OEH following the initial 12 months monitoring period.

The monitoring of ambient PM_{10} concentrations would be conducted in accordance with a method that complies with published Australian Standards and with the recommendations of the NSW OEH *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007). Deposited dust would be conducted in accordance with AS 3580.10.1-2003 *Methods for Sampling and Analysis of Ambient Air - Determination of Particulates - Deposited Matter - Gravimetric Method.*

In addition to air quality monitoring, real-time meteorological monitoring would be conducted within the Project Site. Meteorological monitoring would be conducted in accordance with the recommendations of the NSW OEH *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007). Real-time meteorological data, specifically wind measurements, would be used to inform dust management planning and impact potential minimisation at the Project Site.

4.9 TRAFFIC AND TRANSPORTATION

4.9.1 Introduction

The traffic assessment for the Project was undertaken by Traffic Solutions Pty Ltd. The full traffic assessment report is presented as Part 7 of the *Specialist Consultant Studies Compendium*. Relevant information from the assessment is summarised in the following sub-sections referred to hereafter as Traffic Solutions (2011). This sub-section summarises the relevant sections of that report.

A risk analysis undertaken by R.W. Corkery & Co Pty Limited (Section 3.4 and **Table 3.8**) has identified the following potential Project impacts relating to traffic and transportation requiring assessment. The unmitigated risk rating associated with each impact is indicated in parenthesis.

- Increased traffic levels due to movement of workforce and contractors or heavy vehicle movements for product transportation.
  - Elevated risk of accident / incident on local roads (high).
  - Road pavement deterioration (moderate).

The Director-General's requirements for the Project has identified "traffic" as a key issues that needs to be addressed in the *Environmental Assessment* and to include a detailed description of the measures that would be implemented during construction and operation to minimise impacts on Burthong Road, Cobar-Condobolin Road, Hermidale-Nymagee Road and Kidman Way.

The proposed traffic levels and heavy vehicle transportation route is described in Section 2.9 and the route is shown on **Figure 2.10.** In summary, the Project would result in up to 12 heavy vehicles movements per day during the construction phase of the Project and up to 6 heavy vehicle movements during the operational phase of the Project.

4.9.2 Existing Environment

4.9.2.1 Road Classification and Road Authorities

The Roads and Traffic Authority (RTA) and Cobar Shire Council (Council), as the relevant road authorities in the vicinity of the Project Site, classify the surrounding road network slightly differently. **Table 4.30** presents the classification of the relevant roads used by each authority.

Table 4.30
Road Classification in the Vicinity of the Project Site

Road Name	RTA Classification	Council Classification	Responsible Authority
Kidman Way	Main Road No. 61	Main Road No. 410	RTA
Nymagee-Hermidale Road	Regional Road No. 228	Main Road No. 228	Council[3]
Priory Tank Road[1]	Regional Road No. 61	Main Road No. 461	Council[3]
Nymagee-Gilgunia Road	Regional Road No. 419	Main Road No. 419	Council[3]
Burthong Road[2]	Local Road	Secondary Road No. 19	Council
Note 1: Priory Tank Road is also known as Priory Tank to Lachlan Shire Boundary. Note 2 Burthong Road is also known as Nymagee-Burthong Road. Note 3: With funding assistance from the RTA			
Source: Traffic Solutions (2011) – Section 3			

4.9.2.2 Daily Traffic Volumes

Table 4.31 presents traffic volumes on roads in the vicinity of the Project Site from the RTA's *Annual Average Daily Traffic Data (AADT) 2005 for the Western Region.*

Table 4.31
Measured Traffic Volumes

Road	Location	AADT (year)	Year data collected
Kidman Way	8km south of Cobar	500	2005
Kidman Way	North of Priority Tank Road	157	2005
Nymagee – Hermidale Road	2km south of Barrier Highway	56	2005
Priory Tank Road	South of Nymagee-Hermidale Road	27	1992
Nymagee – Gilgunnia Road	South of Priority Tank Road[1]	72	1992
Nymagee – Hermidale Road	East of Priority Tank Road[1]	28	1992
Source: Traffic Solutions (2011) – Table 3.1.			

The traffic volumes at two survey locations on Kidman Way have been recorded on five occasions between 1992 and 2005. That data is presented in **Table 4.32.**

That data indicates that traffic volumes on the roads surrounding the Project Site fluctuate and that no clear traffic growth estimate can be made.

Table 4.32
Existing Traffic Volume on Kidman Way from 1992 to 2005

Road	Location	AADT				
		1992	1996	1999	2000	2005
Kidman Way	8km south of Cobar	237	170	232	287	500
Kidman Way	North of Priority Tank Road	83	107	209	251	157
Source: Traffic Solutions (2011) – Table 3.2.						

4.9.2.3 Maximum Hourly Traffic Volumes

Hourly measured traffic data for the roads surrounding the Project Site is not available. However, Traffic Solutions (2011) suggest that the peak hour flows along Kidman Way (south of Cobar) would be less than 50 vehicles per hour. The assessment also suggested that the daily flows along Burthong Road would be less than the Nymagee – Gilgunnia Road route. As a result Traffic Solutions (2011) suggests that peak hour flows along Burthong Road would be less than 5 vehicles per hour.

4.9.2.4 Level of Service

Level of service is a qualitative assessment of the effect of factors such as speed, volume of traffic, geometric features, traffic interruptions, delays and freedom to manoeuvre on a road in accordance with the RTA's *Guide to Traffic Generating Developments.* Traffic Solutions (2011) determined that the Level of Servicefor Burthong Road would be 'A' or very good.

4.9.2.5 Existing Road Conditions

Burthong Road

Burthong Road is a two-way, sealed road with no centre line and a 100km/h speed limit in the vicinity of the Project Site and 50km/h through Nymagee.

The Existing Site Entrance easily exceeds the Australian Standard requirements *AS 2890.1 and 2 Parking Facilities* for the posted speed limit along Burthong Road.

As noted above the existing peak hour flows along Burthong Road would be less than 5 vehicles per hour.

Priory Tank Road

Priority Tank Road is a sealed road with 110km/h speed limit.

Kidman Way

Kidman Way is a sealed road with 110km/h speed limit. As noted above the peak hour flows along Kidman Way south of Cobar would be less than 50 vehicles per hour.

Existing Intersection Operation

All intersections along the proposed heavy vehicle transportation route operate at a very good level of service with no delays. These intersections are sealed with 1 lane in each direction and no sealed shoulders.

4.9.3 Project-related Roadworks and Traffic

4.9.3.1 Vehicle Access and Parking

The Proponent would upgrade the intersection at the Existing Site Entrance and construct a new Main Site Entrance 500m south of the existing intersection on Burthong Road. These would be constructed to the following standard.

- Main Site Entrance – constructed in accordance with RTA's *Austroads Guide to Road Design* (Austroads) guidelines for a basic left turn rural intersection treatment (BAL) (shown in **Figure 2.3**) sufficient for 36m road train vehicle access. The initial 100m of the Main Access Site Road would be sealed. While it is noted that the largest vehicle the Proponent proposes to use is a B-double, the proposed intersection would be designed and constructed to take road trains to allow for future expansion.
- Existing Site Entrance – Upgraded to meet the Austroads guidelines for a BAL treatment sufficient for light vehicles and light, rigid trucks. The initial 50m of the Light Vehicle Access Road would be sealed.

4.9.3.2 Internal Roads and Car Parks

The Proponent would construct the following internal roads and car parks (**Figure 2.1**).

- Main Site Access Road – As described in Section 2.2.3 and illustrated on **Figure 2.1**, the Proponent would construct the Main Site Access Road from Burthong Road for a distance of 1 100m where it would join the approved Light Vehicle Access Road and continue to the Surface Facilities Area. The Main Site Access Road would indicatively have a sealed 7.0m wide pavement with sealed shoulder, for the initial 100m from Burthong Road. The remainder of the road would be a 7m wide unsealed road, with 1m wide shoulders.

- Light Vehicle Access Road – The approved Light Vehicle Access Road will extend from the Existing Site Entrance to the Main Site Access Road and would be used for light vehicles and light rigid trucks only. The road would be a 6m wide unsealed road, with 1m wide shoulders.
- Mine Camp Access Road – The Mine Camp Access Road would provide access to the Mine Camp from the Light Vehicle Access Road and would be used by light vehicles or light rigid trucks only. The road would be a 6m wide unsealed road, with 1m wide shoulders.
- Other internal roads – The Proponent would construct or upgrade a range of other internal roads to provide access between the various components of the Project Site.
- Vehicle Parking – the Proponent would construct three unsealed light vehicle parking areas with the Project Site at the Mine Camp, contractor's offices and Proponent's offices. In addition, a range of hardstand areas would be constructed to cater for heavy vehicles and mining equipment.

4.9.3.3 Traffic Generation

Table 2.12 presents the proposed 85th percentile daily traffic levels that would be generated by the Project. In summary, the Project would generate approximately 40 light vehicle and 12 heavy vehicle movements per day during construction phase of the Project and approximately 30 light vehicle and 6 heavy vehicle movements per day during the operational phase of the Project.

Traffic Solutions (2011) estimates that during the construction phase of the Project these traffic levels would equate to an additional 5 peak hour vehicles on Burthong Road. That additional traffic is not likely to alter the existing operation level of service 'A' for the surrounding roads.

4.9.4 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures throughout the life of the Project.

- Construct the Main Site Entrance intersection on Burthong Road and upgrade of the existing site access intersection to a Basic left turn (BAL) rural intersection treatment in accordance with RTA's Austroads guidelines to cater for 36m road trains and light vehicle/light rigid trucks respectively.
- Regularly inspect and clear long grass and bushes that grow on the road shoulder to maintain the maximum possible sight distance.
- Treat internal roads with chemical suppressants, where appropriate, to minimise dust generation.
- Restrict vehicle speed to 40km/hr.
- Ensure that all vehicles transporting bulk concentrate are loaded using a front-end loader fitted with a bucket load indicator to avoid overloading.

- Ensure product is transported from the Project Site between the hours of 7:00am and 10:00pm.
- Prepare, implement and enforce a Driver's Code of Conduct for all heavy vehicle drivers accessing the Project Site regularly.
- Investigate any complaints in relation to transportation of concentrate promptly.
- Prepare and implement a *Traffic Management Plan* to document relevant procedures to be implemented during the intersection construction works and throughout the life of the Project.
- Negotiate an appropriate arrangement with Cobar Shire Council in relation to the ongoing maintenance and, where required, upgrading of local roads used by heavy vehicles to transport material to and from the Project Site It is anticipated that any arrangement would take into account the proportional contribution of Project-related heavy vehicle movements to the total heavy vehicle movements on those roads.

4.9.5 Assessment of Impacts

Traffic Solutions (2011) concluded the following in relation to Project-related traffic impacts on the surrounding road network.

- There would be adequate vehicle access and parking within the Project Site.
- The Project would not adversely impact on the existing level of service "A" of surrounding roads.
- The proposed Main Site Access Road and Existing Site Entrance intersections would be constructed to a BAL type intersection design.
- The proposed heavy vehicle transportation route is designated for road trains and the additional heavy vehicle traffic generated by the Project would not have an unacceptable impact upon the operation of the roads along that route.

4.10 SOIL AND LAND CAPABILITY

4.10.1 Introduction

The soil and land capability assessment was undertaken by SEEC. The full assessment is presented in Part 8 of the *Specialist Consultant Studies Compendium* and is referred to hereafter as SEEC (2011b). This sub-section summarises the assessment of the soils and the land capability classification of the Project Site.

A risk analysis undertaken by R.W. Corkery & Co Pty Limited (Section 3.4 and **Table 3.8**) has identified the following potential Project impacts relating to soils and land capability requiring assessments. The unmitigated risk rating associated with each impact is indicated.

- Reduction in soil quality and availability through poor management practices (high).
- Increased erosion or erosion potential of soils (moderate to high).

While Director-General's requirements do not identify soils as a key environmental issue for the Project, the soils assessment was undertaken to better understand the properties of the soils within the Project Site and to provide strategies for their appropriate handling during the establishment, operational and rehabilitation phases.

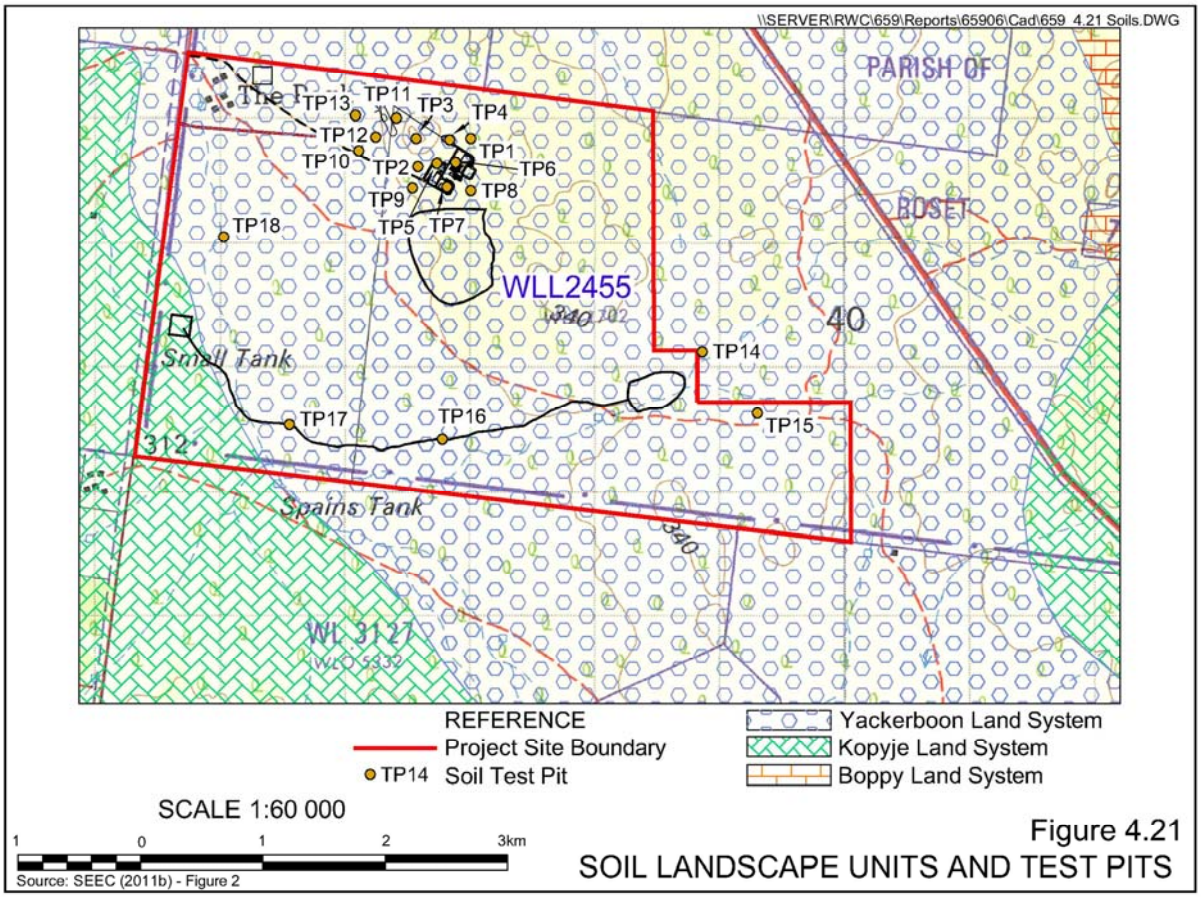
This sub-section describes the soils present within the Project Site and especially those sections of the Project Site that would be disturbed. It identifies the soil and land management issues associated with the Project and the proposed soil-related controls and operational safeguards that would be implemented.

4.10.2 Existing Environment

4.10.2.1 Soil Landscapes

The broad-scale land system mapping by Walker (1991) indicates that the Project Site lies on two land systems as follows (**Figure 4.21**).

- The Yackerboon Land System – dominant system and underlies majority of the Project Site, except the far southwest and southeast sections.
- The Kopyje Land System – underlies the far southwest and southeast sections of the Project Site including the Pete's Tank location.



The Yackerboon Land System comprises three soil units, consisting of Red Earths and some Lithosols, as follows:

- Unit 1 – Ridge Crests: Acid Red Earths with areas of loamy Lithosols. Abundant quartz and other gravel.
- Unit 2 – Ridge Slopes: Neutral pH Red Earths and areas of calcareous red earths.
- Unit 3 – Drainage Tracts: Calcareous Red Earths with pockets of deep sandy alluvial soil.

The Kopyje Land System comprises three soil units consisting of Red Earths and Lithosols as follows.

- Unit 1 – Mallee Crests: Loamy and sandy Lithosols. Abundant quartz and other gravel.
- Unit 2 – Open crests and slopes: Loamy Lithosols and neutral (pH) Red Earths. Variable quartz and gravel.
- Unit 3 – Drainage Lines: Deep neutral calcareous Red Earths with hardpans.

4.10.2.2 Project Site Soils

SEEC (2011b) excavated 18 test pits, focused particularly on the Surface Facilities Area (**Figure 4.21**). Each test pit was logged and samples were collected from three pits for laboratory analysis. The results of that test pitting program broadly confirmed the soil landscape mapping presented in **Figure 4.21**.

Soils within the Surface Facilities Area are typically very gravelly, quartz-rich, shallow soils (Lithosols) with bedrock typically shallower than 1m, with deeper uniform Red Earths without coarse fragments on the surrounding slopes and plains. The following provides a brief overview of the results of the physical and chemical analyses undertaken for the excavated soils.

- Soil Erodibility – Red Earths were determined to be moderate erodible while the Lithosols were highly erodible.
- Wind Erosion – Red Earths were determined to have a very high wind erodibility rating while the Lithosols have a high erodibility rating.
- Soil Loss and Erosion Hazard – Red Earths and Lithosols were determined have a very low soil loss of 18t/ha/year and 112t/ha/year respectively.
- Soil Structure and Engineering – Red Earths were determined to have a moderate structure while the Lithosols were determined to have little structure.
- Soil Dispersibility – Red Earths were determined to be non-dispersible while the Lithosols were determined to be variably dispersible.
- Soil Drainage – Red Earths were determined to moderately well to imperfectly drained over the entire soil profile while the Lithosols were determined to be moderately permeable.

- pH and Salinity – Red Earths were determined to be strongly acidic and non-saline while the Lithosols were determined to be neutral to slightly alkaline and can be non-saline to moderately saline.
- Cation Exchange Capacity, Base Saturation and Organic Matter Content - Red Earths were determined to have a low cation exchange capacity, high base saturation and very low organic matter content while the Lithosols were determined have a low to moderate cation exchange capacity, very high base saturation and very low to extremely low organic matter content.

4.10.3 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures throughout the life of the Project.

- Minimise handling of all soils, so that they retain their structural integrity, by clearly marking areas for stripping and stockpiling..
- Strip topsoil within the Surface Facilities Area to a depth of 20cm and store in stockpiles no more than 2m high.
- Strip topsoil within the Tailings Storage Facility and other areas of the Project Site to a depth of 30cm and store in stockpiles no more than 2m high.
- Strip subsoil in all areas to bedrock and store in stockpiles no more than 3m in high.
- Refrain from stripping or placing soils during wet conditions.
- Ensure that machinery used for stripping operations would dump their loads neatly and uniformly so that the stockpile does not require further forming prior to establishment of vegetation cover.
- Avoid driving of machinery on the topsoil and subsoil stockpiles to minimise compaction and further degradation of soil structure.
- Construct upslope water diversion banks to direct overland surface water flow away from the soil stockpiles.
- Implement downslope sedimentation controls as required, until the surface of the soil stockpiles are stabilised by vegetation.
- Ensure that the formed soil stockpile surfaces would have a generally uneven surface that is as 'rough' as possible, in a micro-scale, to assist in surface water runoff control and seed retention and germination.
- Sow the soil stockpiles with endemic native species as groundcover to stabilise them as soon as possible after placement, with regular watering if necessary to speed up establishment and attain a cover of at least 30%. The vegetation would not only assist stabilise the surface, it would minimise erosion and sedimentation.

- Ensure that slopes less than 2% are rehabilitated with Red Earths. As this soil unit is erodible, furrowing would not be used and the length of exposed slopes would be kept less than 80m by using windrows of mulch placed along the contour and ensuring that that these would not act as drains themselves.
- Ensure that slopes between 2% and 10% have a concave profile and are covered with Lithosols.
- Ensure that slopes of more than 10% are protected with rock-pitching.
- Ensure that during soil placement operations soil is placed directly onto a scarified surface without compaction and in correct order, namely topsoil overlying subsoil.
- Add, where appropriate, organic matter comprising composted cleared vegetation.
- Use organic material in preference to fertilizers during rehabilitation.
- Ensure that soil management procedures are developed in accordance with Landcom (2004).

4.10.4 Land Capability

SEEC (2011b) state that as the Project Site is in far western NSW there is no Agricultural Land Classification mapping available. However, the dry and irregular climate means the Agricultural Land Classes are:

- Class IV for Red Earths.
- Class V for Lithosols.

The Proponent would seek to re-establish these classifications on the final landform.

4.10.5 Assessment of Impacts

The impacts of the Project on the soils to be disturbed within the Project Site are considered to be insignificant given the proposed mitigation and management procedures outlined in Section 4.10.3 and the proposal for ongoing development of management procedures using best industry practice guidelines contained in Landcom (2004) as the stripping and stockpiling operations progress.

4.11 VISUAL AMENITY

4.11.1 Introduction

The visual amenity aspects and impacts of the Project were assessed by R. W. Corkery & Co. Pty Limited. The assessment was undertaken in a qualitative manner and can be considered subjective.

A risk analysis undertaken by R.W. Corkery & Co Pty Limited (Section 3.4 and **Table 3.8**) has identified the following potential Project impacts relating to visual aspects requiring assessments. The unmitigated risk rating associated with each impact is indicated in parenthesis.

- Changes in visual characteristics of the Project Site (low),
- Impacts of night lighting (moderate).

The Director-General's Requirements for the Project identified "Visual" as one of the key issues that requires assessment at the Project Site.

The sub-section outlines the existing visual aspects of the Project Site as experienced by surrounding residents and landowners, the proposed safeguards and mitigation measures and an assessment of the likely visual impact of the Project.

4.11.2 Existing Environment

The existing visual character of the Project Site and the surrounding areas is that of rural lands in western NSW with a combination of exposed and vegetated land supporting agricultural activities and residential buildings along Burthong Road and Nymagee. The Project Site is flat to gently undulating in the western section but generally hilly in the northern and south-eastern sections of the site. These small hills can be seen from Burthong Road. Small existing buildings within the Project Site are only partly visible from Burthong Road due to screening by native vegetation.

With the exception of the Proponent's exploration activities within the Project Site and, further north in the vicinity of the Nymagee Copper Mine, there is currently no industrial activity in the vicinity of the Project Site. Limited night time street lighting is in Nymagee. Lighting associated with the Proponent's mineral exploration activities is at times visible from residences in Nymagee.

Plates 4.2 to **4.6** present a range of views of the Project Site from publicly accessible vantage points. The location of each of the photographic points is identified in **Figure 4.2**. The photographs indicate that visibility of the Project Site is extremely limited as a result of dense vegetation.

4.11.3 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures to minimise the impact of its activities on the visual aspects surrounding the Project Site throughout the life of the Project.

- Construct the Processing Plant and other on-site infrastructure from non-reflective, neutral-coloured material.
- Progressively rehabilitate disturbed sections of the Project Site no longer required for the Project, and re-vegetate areas that are bare or only have remnant vegetation.
- Undertake active dust management measures to reduce the potential for the creation of a 'dust cloud', especially during site establishment activities
- Manage waste within the Project Site in an appropriate manner such that the site will not become littered with wind-blown rubbish.
- Maintain the Project Site in a clean and tidy condition at all times.
- Ensure that night-time lighting is directed towards the active areas of operation only and towards the ground to minimise the light spill from the Project Site.

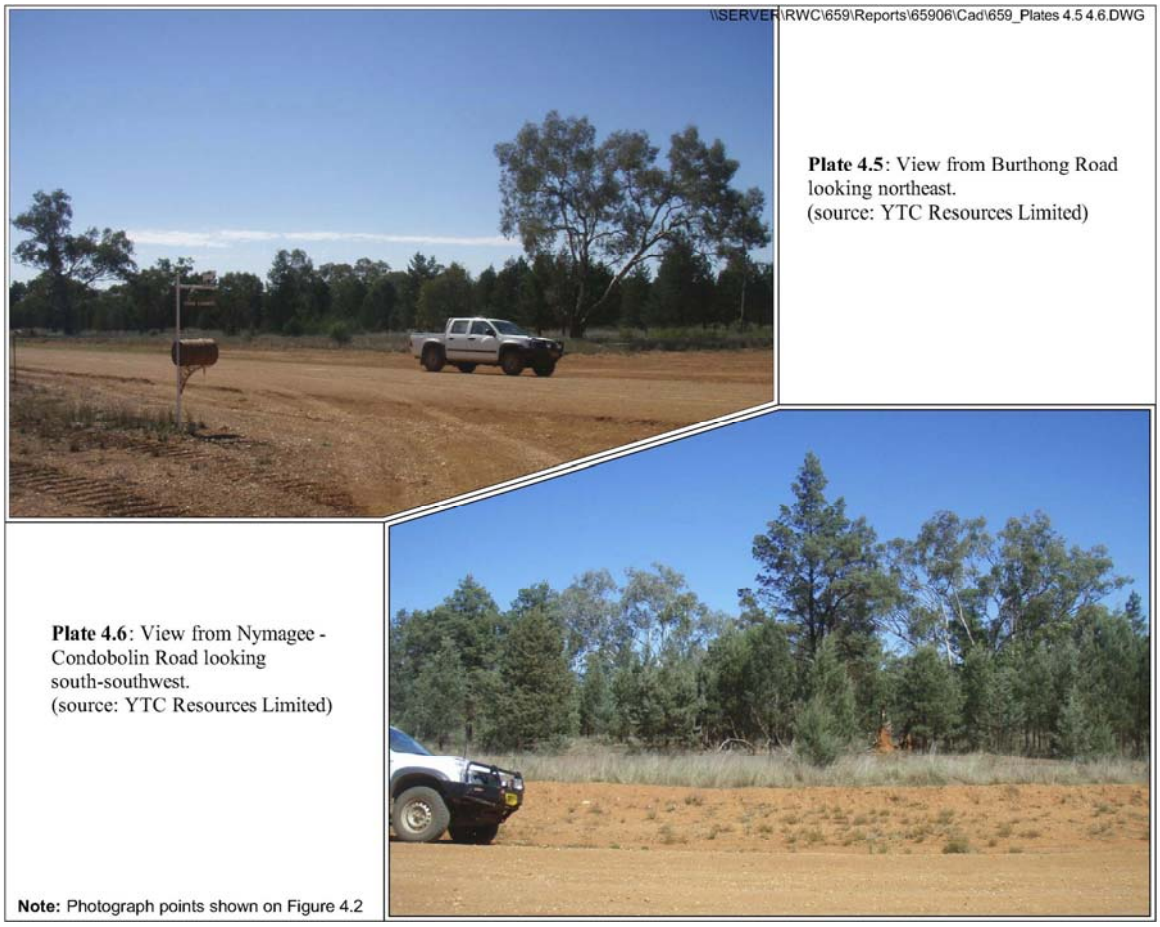
- Ensure that lighting is turned off when not required.
- Construction of bunds around the fuel storage and refuelling area and the ROM pad.

Plate 4.2: View from Burthong Road looking south.
(source: YTC Resources Limited)

Plate 4.3: View from Burthong Road looking southeast.
(source: YTC Resources Limited)

Plate 4.4: View from Burthong Road looking east-northeast.
(source: YTC Resources Limited)

Note: Photograph points shown on Figure 4.2



4.11.4 Assessment of Impacts

Based on the relative isolation of the Project Site both from surrounding residential locations and public vantage points such as major roads, combined with the fact that the principal Project-related structures would be constructed to the east or south of 'The Peak' and the proposed landscape and visual amenity related controls, it is assessed that the Project would not impact significantly on the visual amenity surrounding the Project Site.

The proposed final landform would also provide for a landscape amenable for grazing and should therefore eventually blend with the surrounding undisturbed lands.

4.12 BUSHFIRE HAZARD

4.12.1 Introduction

The bushfire assessment was undertaken by R.W. Corkery & Co Pty Limited using the guidelines entitled *Planning for Bush Fire Protection*, NSW Rural Fire Service (2006) and referred here as PBP (2006). A number of parameters (vegetation, effective upslope, appropriate fire (weather) area) that could influence bushfire hazard within the Project Site were used to describe the existing environment and assess the bushfire hazard rating. These are discussed in the following sub-sections.

A risk analysis undertaken by R.W. Corkery & Co Pty Limited (Section 3.4 and **Table 3.8**) has identified the following potential Project impacts relating to bushfire hazard requiring assessments. The unmitigated risk rating associated with each impact is indicated in parenthesis.

- Initiation of fire on the Project Site and spread to adjoining properties including:
  - Injury or health impacts on project personnel (moderate);
  - Destruction / damage of native vegetation and fauna habitat (moderate).

This sub-section reviews the existing bushfire hazard within and surrounding the Project Site and the impacts on the surrounding lands, it considers the safeguards, controls and management procedures to be followed to reduce the risk of fire initiation within the Project Site and respond to bushfire on lands external to the Project Site, and assesses the environmental risk posed by local bushfire hazard.

4.12.2 Assessment of Bushfire Hazard

In determining the relevant bushfire hazard within the Project Site, the Proponent notes the following.

- The Fire Danger Index has been determined to be 80.
- Vegetation within the Project Site can be classed as semi-arid woodlands. In accordance with PBP (2006), the total fuel load for the Project Site, assuming a fuel load of 20t/ha for woodlands and a Project Site area of 1 532ha, is 30 640t. Since 77.3ha of the Project Site would be cleared of vegetation, the actual fuel load would be (30 640t – (77.3 ha x 20t/ha) = 29 094t.
- Slopes within the Project Site range from flat to 1:2 (V:H) in the vicinity of 'The Peak'.

Based on the above, the bush fire attack category for the Project Site is Level 3 or Extreme.

4.12.3 Management and Mitigation Measures

Given that the Project Site has been assessed fall under bush fire attack category of Level 3, the Proponent would ensure the following safeguards and controls would be adopted to minimise the risk of initiation of fires within the within the Project Site.

- Ensure that refuelling is undertaken within designated fuel bays or within cleared areas of the Project Site.
- Implement a no smoking policy in all but designated sections of the Project Site.
- Ensure that fire extinguishers are maintained within all vehicles.
- Ensure vegetation clearing during high or extreme bushfire hazard conditions (as defined by the NSW Rural Fire Service) would be avoided.
- Ensure that there is a focus on house-keeping.
- Ensure that vegetation clearing extends at least 15m from all infrastructure.
- Ensure that a water cart available to assist in extinguishing any fire ignited.

- Liaise with the Rural Fire Service, Cobar Shire Council and Office of Environment and Heritage (NPWS) to determine when back-burning or fire control activities are planned.
- Ensure that access to onsite water storages for the NSW Rural Fire Services is available in the event of a fire within or surrounding the Project Site.

4.12.4 Assessment of Impact

Based on the assessment conducted for bushfire hazard due to the Project and the management and mitigation measures that would be put in place, the Project is unlikely to increase the fire hazard rating of the Project Site and the surrounding areas.

Assuming the management measures identified above are implemented, the risk to the safety of mine personnel due to bushfires would be minimised while the abilities of the NSW RFS to combat the bushfires assisted through access to the Project Site water storages would be enhanced.

4.13 WASTE MANAGEMENT

4.13.1 Introduction

'Waste' was identified in the Director-General's Requirements for the Project as one of the key issues that requires assessment at the Project Site, and is to include:

- accurate estimates of the quantity and nature of the potential waste streams of the Project, including tailings and waste rock and potential acid mine drainage; and
- a detailed description of the measures that would be implemented to minimise, re-use, recycle and dispose of any waste produced on site.

The Office of Environment and Heritage has specifically requested the following to be included in the *Environmental Assessment*.

- Identification of all wastes to be generated by all aspects of the project and procedures for the handling and management of all wastes produced. The handling of overburden material is an important aspect for consideration.
- Assessment of the potential for acid mine drainage from acid forming materials should be addressed and management/mitigation measures identified.
- Management actions for tailings material during processing should be identified, including actions to present potential impacts to groundwater, surface water or any other environmental aspect.

A risk analysis undertaken by R.W. Corkery & Co Pty Limited for the Project (Section 3.4 and **Table 3.8**) has identified the following potential Project impacts relating to waste management requiring assessments. The unmitigated risk rating associated with each impact is also indicated in parenthesis.

- Production of contaminating or polluting materials, e.g. waste oils, tailings, general non-putrescible and putrescible waste (low to moderate).
- Acid Mine Drainage from mineralised waste rock (moderate).

This sub-section has been prepared by R.W. Corkery & Co Pty Limited in consultation with the Proponent. It discusses the waste streams that would be generated by the Project and compiles information on waste management presented in various sub-sections in Section 2.

4.13.2 Waste Streams and Management Measures

4.13.2.1 Waste Rock and Acid Leachate Management

Table 2.10 indicates that approximately 280 000m^{3}of waste rock would be generated throughout the life of the Project. All waste rock would either be used for on-site activities comprising construction of site access roads, the ROM pad and Tailings Storage Facility embankment or returned underground for backfilling of stopes created from ore extraction activities.

Measures that would be implemented to manage the acid mine drainage within the Waste Rock Emplacement are discussed in detail in Section 2.7.3. The Waste Rock Emplacement would be designed to store the potentially acid-forming waste material within an encapsulation area that would drain to the Leachate Management Pond (see **Figure 2.2**). Both these structures would be designed in a manner that would ensure that potentially acidic leachate would not be permitted to flow off site or seep into groundwater (see Section 2.7.3). Potentially acid forming material would be transported underground as soon as practical.

4.13.2.2 Tailings

The tailings or waste generated from the ore-processing activities would be stored within the Tailings Storage Facility. The management of the tailings, including construction requirements of the Tailings Storage Facility is described in Section 2.6. Importantly, the Tailings Storage Facility would be impermeable (see Section 2.6.2.2), the tailings pipeline would be placed within a trench which would be regularly inspected, and lysimeters would be installed within the trench and monitored regularly to confirm no leakage of the leachate from the Tailings Storage Facility is occurring.

As discussed in Section 2.6, the Tailings Storage Facility would be appropriately sized to contain all of the tailings materials that would be produced throughout the life of the Project.

4.13.2.3 Hydrocarbons

The management of hydrocarbons within the Project Site is described in Section 2.11.3.4. Waste oils and greases would be stored within bunded sections of the refuelling area prior to disposal using a licensed waste contractor at an appropriately licensed facility, as outlined in **Table 2.11**. Waste hydrocarbons would be stored in accordance with the requirements of *AS 1940:2004 – Safe Storage & Handling of Flammable & Combustible Liquids*.

Surface water runoff from the refuelling area, the laydown area, the workshops and the wash bay would be directed to an oil separator. The waste oil/water mixture collected within the oil separator would be appropriately disposed of, again using a licensed contractor.

The management of any hydrocarbon spills within the Project Site is described in Section 2.11.3.4. Briefly, appropriate hydrocarbon spill kits would be located in the vicinity of all hydrocarbon storage areas and the Proponent would ensure that all contractors and employees are appropriately trained in their use.

4.13.2.4 Chemicals and Reagents

No waste chemicals and reagents used in the Processing Plant would arise as the Proponent would ensure the chemicals and reagents purchased would be sufficient to meet their requirements and any chemicals that remain at the end of the life of the Project would be returned to the supplier.

In addition, that proponent would ensure that WAD cyanide concentrations in tailings to be pumped to the Tailings Storage Facility would be <10ppm WAD. Hydrogen peroxide would be used for this process, with the resulting reaction products being stable cyanide complexes, water and oxygen. As such no specific waste requiring special waste management will be generated during this destruction process.

The chemical suppressants (e.g. Gluon) to be used on stockpiles and unsealed roads following application and curing, convert to an inert, wind-resistant and water-insoluble material (binding soil matrix particles together) and as such not likely to pose any significant environmental threat.

4.13.2.5 General Waste and Recyclable Materials

Quantities and management of general waste, both putrescible and non-putrescible waste, and recycling materials are discussed in Section 2.8 and would be undertaken in accordance with the *Protection of the Environment Operations (Waste) Regulation 2005*. The underlying principle for all waste management would be to minimise waste generation, and to recover, re-use and to recycle waste materials as much as possible.

Waste would be stored with the Project Site in their separate categories (e.g. residual waste, recycling material comprising used paper, glass and plastics, tyres and batteries, scrap steel and other metals, waste oils and greases, and waste water prior to their disposal as outlined in **Table 2.11**.

4.13.3 Assessment of Impacts

Given the measures that would be adopted by the Proponent to manage waste generated within the Project Site it is unlikely that:

- any potentially contaminating solid waste would enter the surrounding environment;
- any contamination of downstream local waterways, aquatic habitats and groundwater with hydrocarbons, litter and acid mine drainage would occur; or
- any degradation of visual amenity of the surrounding environment through litter dispersal from the Project Site and improper management of waste within the Project Site.

4.14 SOCIO-ECONOMIC CLIMATE

4.14.1 Introduction

This sub-section has been prepared by R. W. Corkery & Co Pty Limited in consultation with the Proponent,

'Socio-economic' is identified in the Director-General's Requirements for the Project as one of the key issues that requires assessment, including a detailed description of the management of the Mine Camp.

A risk analysis undertaken by R.W. Corkery & Co Pty Limited for the Project (Section 3.4 and **Table 3.8**) has identified the following potential Project impacts relating to the socio-economic climate. The unmitigated risk rating associated with each impact is also indicated in parenthesis.

- Reduction in availability of skilled labour for other industries (moderate).
- Increased pressure on local infrastructure (moderate to high);
- Perceived or real impacts on local amenity of neighbouring properties (moderate).

This sub-section addresses the socio-economic impacts of the Project, and provides an overview of the proposed management and mitigation measures to minimise any socio-economic impacts that may alter in a negative manner the existing socio-economic setting of the locality.

4.14.2 Potential Socio-economic Impacts

The following socio-economic impacts, actual or perceived, could result from the Project.

- Community would not be consulted on a regular basis or informed adequately of the proposed activities and their implications on the community and the environment.
- Local purchasing practices will not be implemented by the Proponent.
- Recruitment and training opportunities, particularly for young people and including from the local Indigenous community, will not arise from the Project.
- No beneficial economic flow-on from the Project to the community will occur.
- The Proponent will not provide donations and in-kind support for community groups.
- The Proponent will not contribute to infrastructure development in Nymagee or the Cobar LGA.
- The Proponent will not properly rehabilitate the disturbed areas within the Project Site on Project completion.

4.14.3 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures to ensure that the Project-related benefits to the surrounding communities are maximised and adverse impacts are minimised to the greatest extent practicable. These measures have been categorised, where possible, to reflect potential socio-economic impacts noted in Section 4.14.2.

Social and Community

- Continue to engage in regular dialogue with surrounding neighbours in relation to the Project activities and maintain an "open door" policy for interested parties to discuss aspects of proposed activities that may be perceived as problematic.
- Support community organisations, groups and events, as appropriate, and review any request by a community organisation for support or assistance to resolve any issues raised throughout the life of the Project.
- Form and maintain a Community Consultative Committee (CCC) and which would include representative members of the surrounding community and Cobar Shire Council.
- Regularly brief the CCC and wider community on activities within the Project Site and seek feedback in relation to any perceived or otherwise of Project-related 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.
- Instigate and maintain a community complaints telephone line, and ensure this mechanism of complaints receival by the Proponent is advertised widely using flyers and verbal announcements at community consultation meetings.
- Negotiate with Council and the surrounding community to support one or more community projects in accordance with the document entitled "Community Enhancement Program (File P5-78)". The support may, in consultation with Council and the surrounding community, be monetary or in-kind.

Employment and Training

- Give preference when engaging new employees, where practicable, to candidates from the surrounding community over candidates with equivalent experience and qualifications from elsewhere and ensure that the mining and other contractors do so as well.
- 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 the continued development of the economic growth within the surrounding communities following Project completion.

Economic Contribution and Development

- Give preference, where practicable and cost-competitive, to suppliers of equipment, services or consumables located within the surrounding community.
- Assist community members and others, as appropriate, to establish complementary businesses where those businesses would provide a benefit to the community through increased economic development.
- Assist Cobar Shire Council to promote and encourage economic development that would continue beyond the Project life.

Infrastructure and Services

- Ensure that infrastructure and services established as part of the Project would remain available for alternative uses throughout the life of the Project and upon cessation of mining activities.
- 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.

Rehabilitated Lands

- Ensure that the land capability of those sections of the final landform to be used for grazing is similar to the current land capability.

4.14.4 Impact Assessment

The overall socio-economic impact of the Project would be beneficial, although it is recognised that minor adverse impacts, perceived or actual, may result from the Project. The Proponent would take all reasonable and feasible measures to minimise these adverse impacts. The Proponent notes the following.

- The Project would provide employment opportunities and make economic contributions to the surrounding communities, NSW and Australia as follows:
  - Approximately 100 full-time equivalent positions during the construction phase of the Project, and up to approximately 100 full-time equivalent positions during the operational phase. Preference would be given, where all other factors are the same, to engaging local employees, contractors or suppliers over those not located within the Cobar LGA.
  - The capital cost of the Project is anticipated to be approximately $80 million, of which a portion would be spent within the Cobar LGA, particularly on services and locally supplied equipment.
  - The Project would contribute the following to the local, regional, State and national economies.
  - Approximately$15 million per year would be contributed to the local and regional economy through wages and purchases of local goods and services.
  - Approximately $25 million per year would be contributed to the State and national economy through purchases of goods and services within NSW and Australia.
  - Approximately $3 million per year would be contributed to the local, State and national governments through the payment of rates, taxes and royalties.
- The Project would:
  - improve environmental monitoring systems in the vicinity of the Project Site through the establishment of the Project Site's Environmental Monitoring System comprising the following.
    - Mining Operations Plan.
    - Biodiversity Management Plan.
    - Water, Sediment and Erosion Control and Management Plan comprising:

  - A Site Water Balance.
  - Surface Water Monitoring and Response Plan.
  - Groundwater Monitoring and Response Plan.
  - Erosion and Sediment Control Plan.
- Air Quality Monitoring Plan.
- Noise Monitoring Plan.
- Hydrocarbon, Chemical and Reagent Management Plan.

– contribute to a heightened community awareness of the Government's Occupational Health & Safety requirements and environmental issues.

Assessment of the potential socio-economic impacts (both adverse and beneficial) demonstrates the beneficial impacts of the Project far outweigh any minor adverse impacts associated with the operations.