Section 4

Assessment and Management of Key Environmental Issues

PREAMBLE

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

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4.1 ENVIRONMENTAL SETTING

4.1.1 Introduction

The descriptions of various environmental aspects of the Proposal throughout this section are reliant upon a range of background information common to many of the key environmental issues. In this subsection, the local setting is described and background information is provided on the topography and drainage, land ownership and residences and climate of the surrounding area. The local setting relevant to specific environmental features is described throughout the remainder of Section 4.

4.1.2 Topography and Drainage

The Mine Site is situated in the far west of NSW, where regional landforms predominantly comprise rolling hills and lowlands (**Figure 4.1**). Other landforms present include tablelands and footslopes, alluvial plains, ranges, sandplains and dunefields. The regional landscape is dominated by the Barrier Range which lies to the north, west and south-west of Broken Hill.

The local topography is dominated by a series of northeast trending ridges (**Figure 4.2**). The Mount Darling Range, located approximately 6km to the southeast and east of the Mine Site is a range of low hills with steeply to very steeply incised drainage lines. The maximum elevation of the Mount Darling Range in the vicinity of the Mine Site is approximately 370m AHD. A second, less prominent northeast trending ridgeline is located approximately 4km to the northeast of the Mine Site, with a maximum elevation of 350m AHD at Round Hill. To the north of the Mine Site, elevations rise to 395m AHD within the Living Desert State Park.

The area immediately surrounding the Mine Site is dominated by flat to gently undulating areas associated with north and northeasterly flowing drainage lines with an elevation of between 270m AHD and 310m AHD.

Willa Willyong Creek drains an area to the south and east of the Mine Site and flows in a northeasterly direction before flowing into the Stephens Creek Reservoir located approximately 10km to the northeast of the Mine Site. Willa Willyong Creek is ephemeral and typically only flows after substantial rainfall. The Imperial Lake Reserve is located immediately to the northeast of the Mine Site.

The topography and drainage of the Mine Site is presented in Section 2.8.3.

4.1.3 Climate

4.1.3.1 Introduction and Data Sources

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

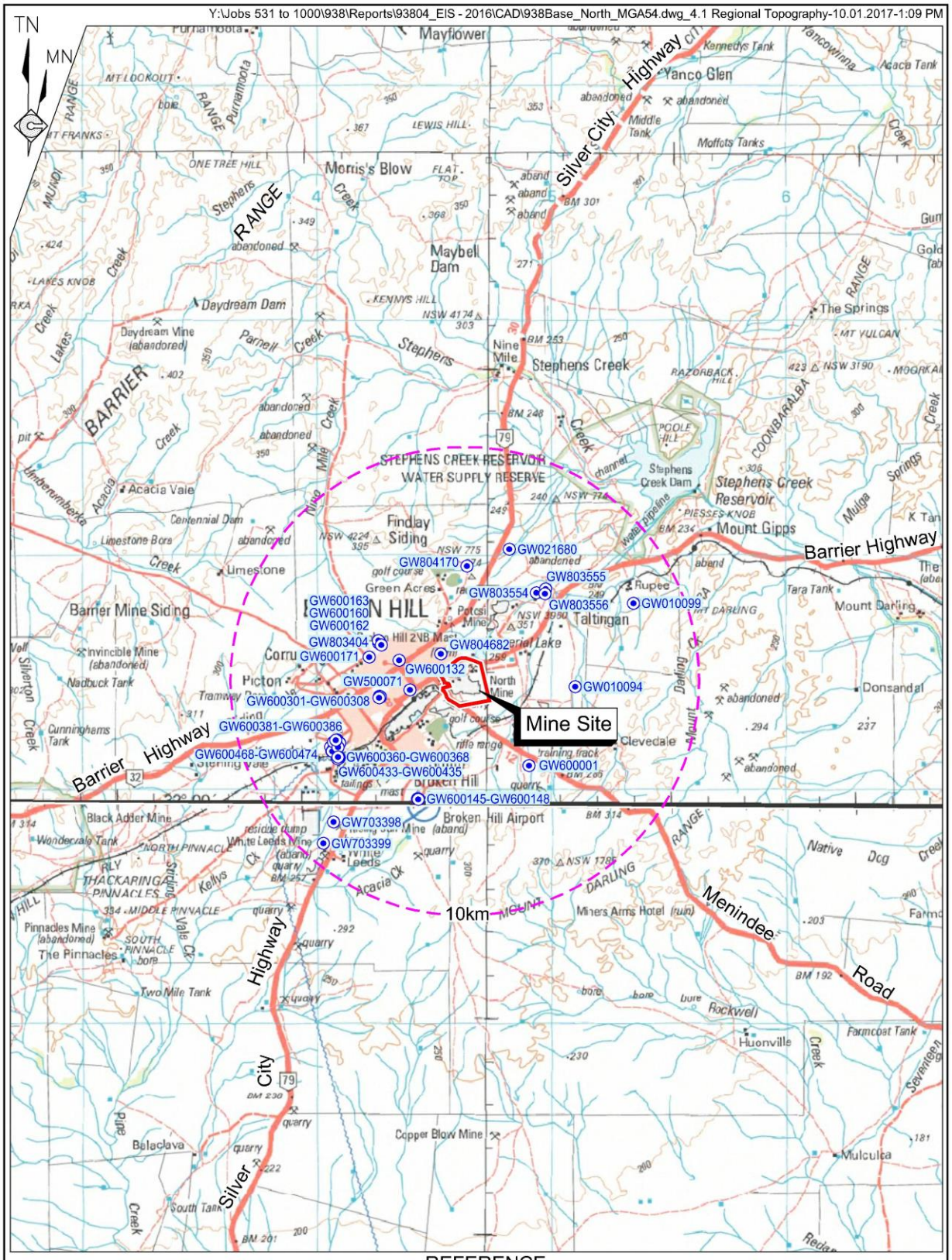


Figure 4.1
REGIONAL TOPOGRAPHY AND DRAINAGE

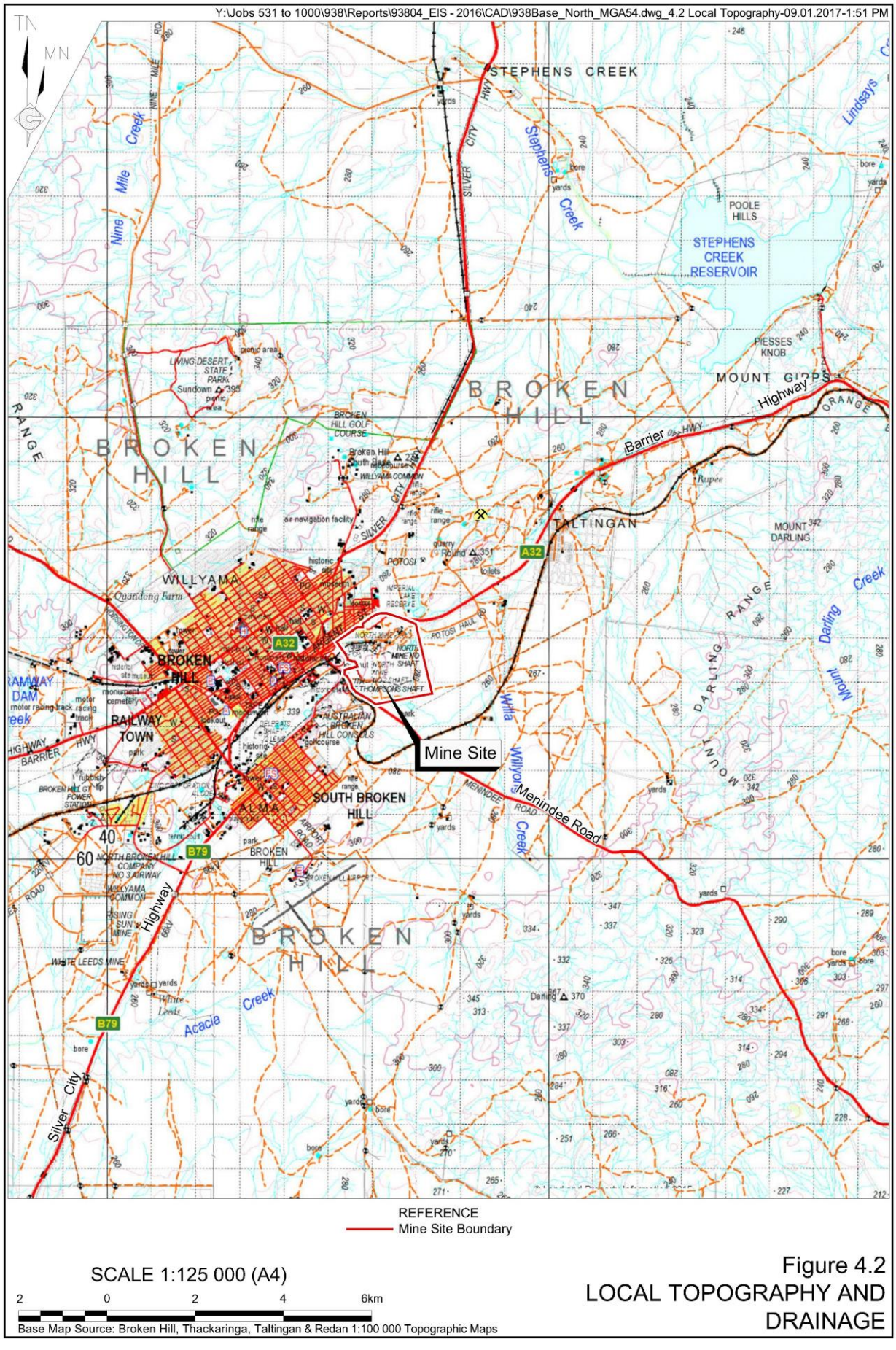


Figure 4.2
LOCAL TOPOGRAPHY AND DRAINAGE

Table 4.1 presents meteorological data obtained from the following Bureau of Meteorology sites.

- Broken Hill Airport automatic weather station (No. 047048) – located approximately 4km southwest of the Mine Site.
- Broken Hill (Patton Street) weather station (No. 047007) – located approximately 2.5km southwest of the Mine Site.
- Broken Hill (Stephens Creek Reservoir) weather station (No. 047031) – located approximately 12km to the northeast of the Mine Site.

Table 4.1
Climate Data

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Temperature (C°) (Broken Hill AWAS – 1957 to 2016)													
Mean maximum temperature	33.4	32.3	28.9	24.3	19.1	15.9	15.5	17.8	21.8	25.5	28.8	31.4	
Mean minimum temperature	19.1	18.5	15.2	11.2	7.9	5.6	4.8	5.6	8.5	11.6	14.8	17.1	
Rainfall (mm) (Broken Hill (Patton Street) – 1889 – 2015)													
Mean rainfall	25.6	25.8	21.6	17.8	22.4	22.3	18.9	18.7	20.2	23.9	21.3	21.8	259.8
Highest Monthly Rainfall	215.8	140.6	258.8	219.0	93.3	143.6	88.7	91.0	154.8	129.1	122.4	180.4	
Highest Daily Rainfall	73.6	94.8	139.4	93.5	62.2	58.0	32.8	46.5	91.4	55.1	103.1	87.2	
Mean number of rain days >1mm	2.3	1.8	1.8	1.7	2.4	2.3	3.0	2.8	2.5	2.8	2.5	2.0	27.9
Evaporation (mm) (Broken Hill (Stephens Creek Reservoir) – 1995 – 2016)													
Mean Monthly Evaporation	391	311	270	171	102	72	78	115	177	248	291	357	2581
Differential between Rainfall and Evaporation	365	285	248	153	80	50	59	96	157	224	270	335	2321
Source: Bureau of Meteorology Broken Hill Airport Station (station number 047048)													

4.1.3.2 Temperature

The general locality experiences hot summers, with the maximum average temperature of 33.4^{o}C in January, and warm winters, with the maximum and minimum average temperature of 15.5^{o}C and 4.8^{o}C respectively in July.

4.1.3.3 Rainfall and Evaporation

Average rainfall is relatively low with an average 259.8mm per year. Rainfall, however, can be highly variable with highest maximum recorded monthly rainfall between 5 and 12 times the means monthly rainfall. Indeed, highest daily rainfall is between two and six times mean monthly rainfall, indicating that intense rainfall events do occur.

Given the hot, arid climate, evaporation is high, with annual mean evaporation of 2 581mm. Mean monthly evaporation exceeds mean rainfall in all months by between 50mm and 365mm.

4.1.3.4 Wind

Pacific Environment Limited (PEL) prepared an Air Quality Assessment for the Proposal. The resulting report, referred to hereafter as PEL (2017a), is presented in as Part 1 of the *Specialist Consultant Studies Compendium* and is summarised in Section 4.2.

PEL (2017a) assessed the wind environment surrounding the Mine Site based on data collected at the Broken Hill Airport automatic weather station (No. 047048) between 1 January 2011 and 31 December 2015. Annual and seasonal wind roses for 2014 are presented in **Figure 4.3**. In summary, there is a high frequency annually of winds from the south. In autumn and summer, the prevailing winds are from the south and southeast, with some winds from the southwest. In winter and spring, the prevailing winds are from the south, southwest, west and northwest, with some winds from the north.

4.1.4 Land Ownership and Land Use

4.1.4.1 Land ownership

Figure 4.4 presents the land ownership and tenure within and surrounding the Mine Site. Due to the large number of surrounding residences, land ownership details have not been provided for individual lots within the urban area of Broken Hill. In summary, the majority of the Mine Site is located on land owned by the State of NSW, with a section of the Mine Site within the Willyama Common. Small sections of the Mine Site are not registered and are therefore presumed to be Crown Land.

4.1.4.2 Land Use

Land uses in the vicinity of the Mine Site include the following (**Figures 1.2** and **4.5**).

- Mining activities associated with the North Mine, including underground and open cut mining infrastructure.
- Mining activities associated with the Rasp Mine, located immediately to the west of the Mine Site, the Potosi Mine located approximately 2km to the northeast of the Mine Site and the Southern Operations, located approximately 3km to the southwest of the Mine Site.
- Extraction activities associated with the Mawsons Broken Hill Quarry located immediately to the southwest of the Mine Site.
- Residential/urban development immediately to the north and northwest of the Mine Site.
- Transportation infrastructure, including the Barrier Highway, Broken Hill – Parkes Railway, Menindee Road and urban streets within Broken Hill.
- Activities associated with the Willyama Common, including nature conservation and recreation.
- Outback Astronomy, a tourist business showing visitors to Broken Hill the night sky. The business is located approximately 6km to the northeast of the Mine Site.

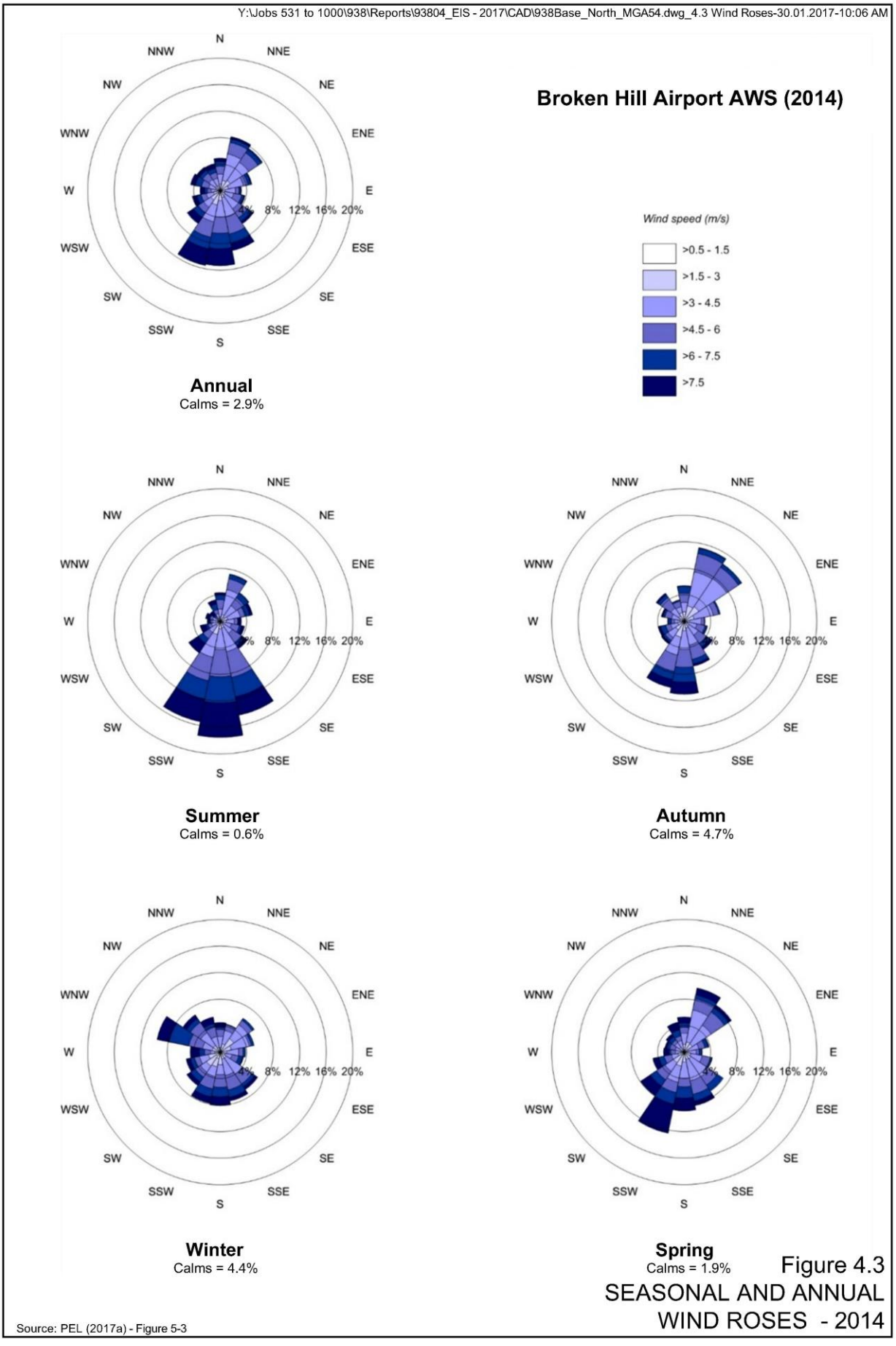


Figure 4.3
SEASONAL AND ANNUAL WIND ROSES - 2014

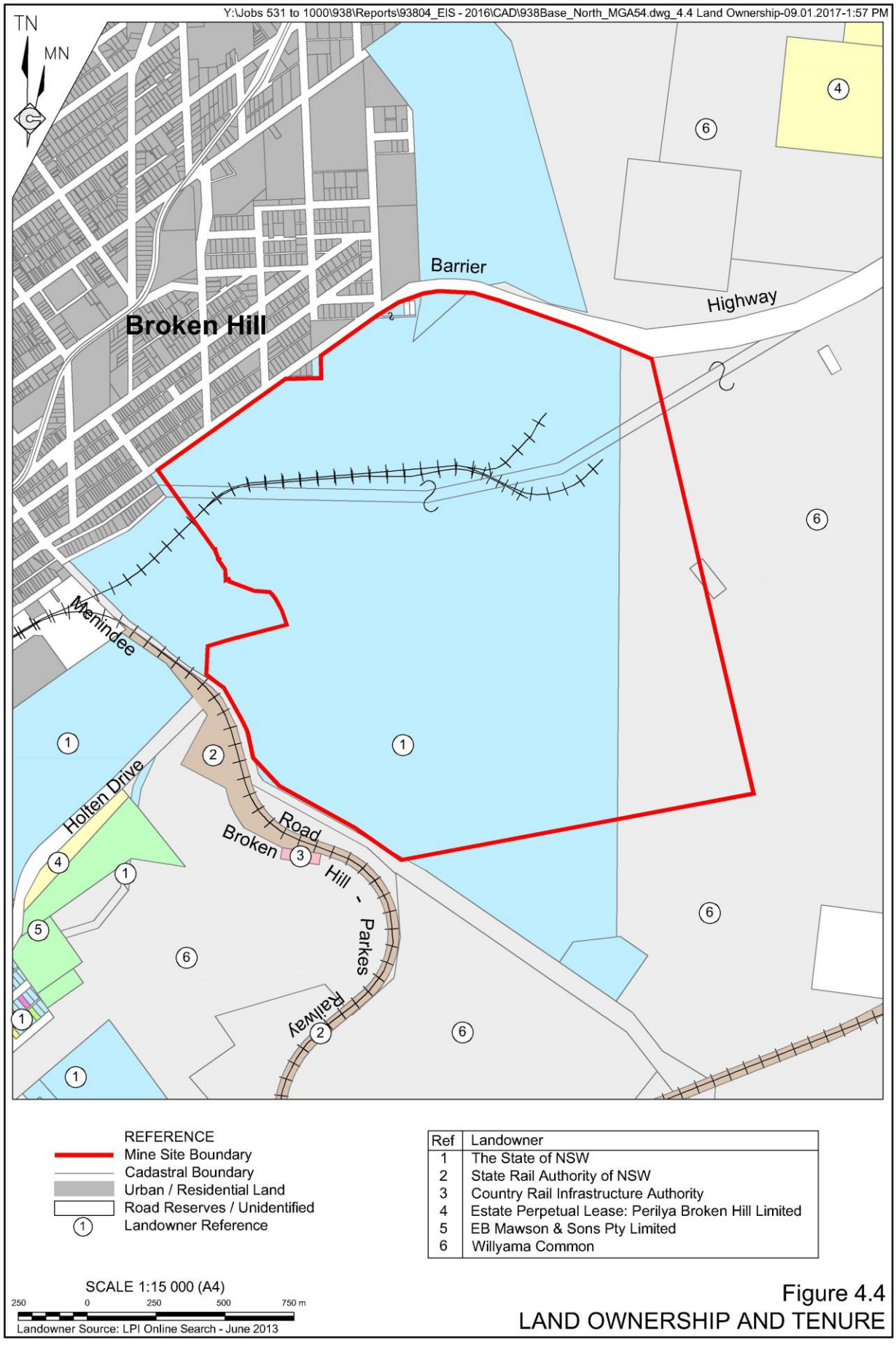


Figure 4.4
LAND OWNERSHIP AND TENURE

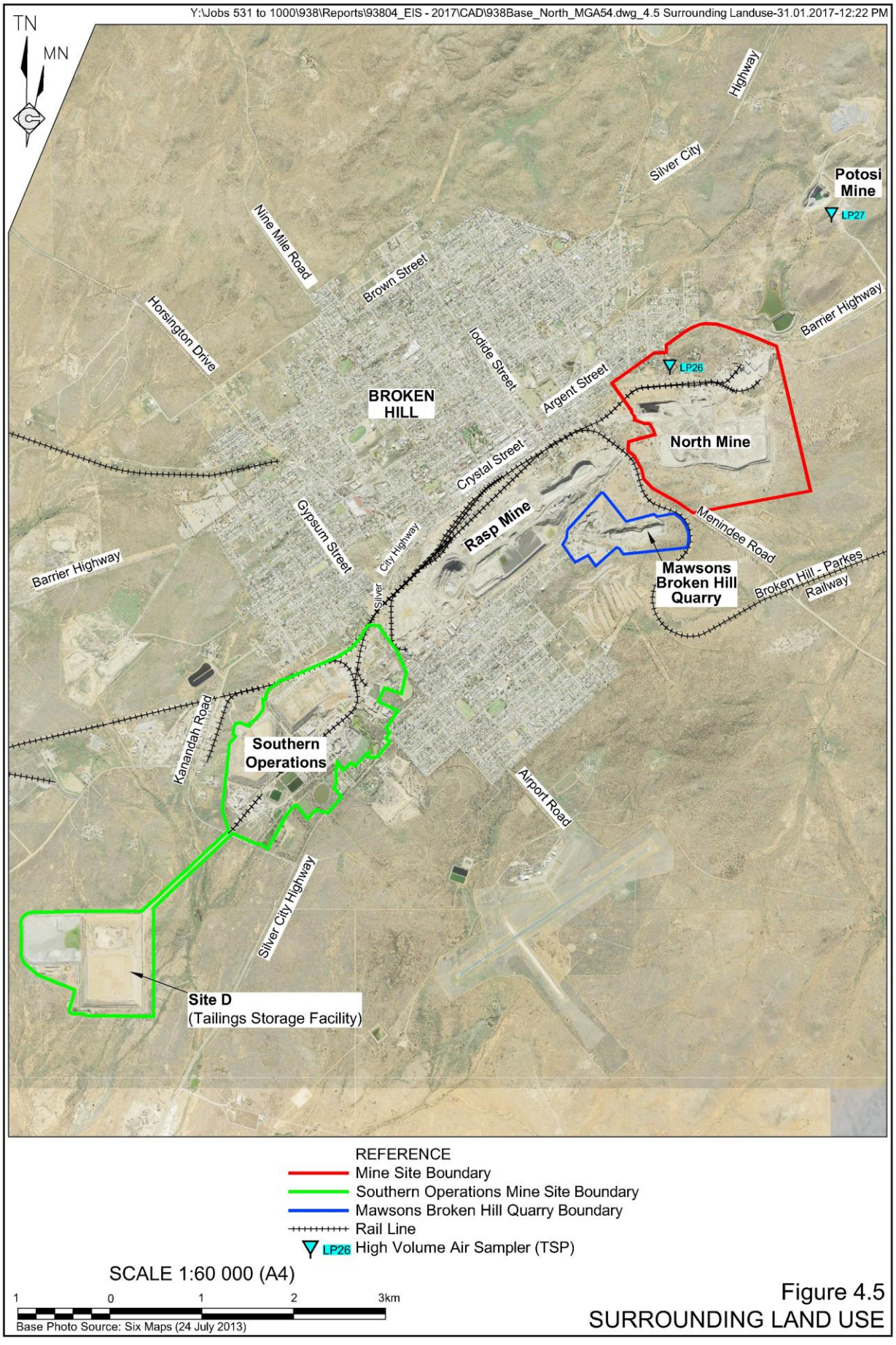


Figure 4.5
SURROUNDING LAND USE

4.2 AIR QUALITY

4.2.1 Introduction

Based on the risk assessment undertaken for the Proposal (see Section 5.2), the potential air quality-related impacts and their risk rankings after the adoption of standard mitigation measures are as follows.

- Health and / or amenity impacts on residential and other sensitive receptors due to:
  - Emissions of PM_{10}/$PM_{2.5}$/TSP/Dust from mining operations (moderate risk);
  - Emissions of PM_{10}/$PM_{2.5}$/TSP/Deposited dust transportation operations (moderate risk); and/or
  - Emissions of particulate lead through construction and mining operations (high risk).

Pacific Environment Limited (PEL) prepared an Air Quality and Human Health Assessment for the Proposal. The resulting report, referred to hereafter as PEL (2017a), is presented as Part 1 of the *Specialist Consultant Studies Compendium*. The following sub-sections draws on information presented in that report and describes the existing air quality environment, predicated changes to that environment as a result of the Proposal, the proposed management and mitigation measures and an assessment of air quality-related impacts.

PEL also prepared a human Health Risk Assessment for the Proposal drawing on the information presented in PEL (2017a). That assessment, referred to hereafter as PEL (2017b), is presented as Part 2 of the *Specialist Consultant Studies Compendium* and is summarised in Section 4.3.

4.2.2 Existing Air Quality Environment

4.2.2.1 Particulate Emissions

PEL (2017a) considers that the dominant sources of particulate matter emissions in the vicinity of the Mine Site include the following.

- The surrounding industrial and mining activities (see Section 4.1.4.2).
- Vehicle movements along unsealed and sealed roads.
- Vehicle exhaust and rail-related emissions.
- Seasonal emissions from household wood burning.
- Episodic emissions from vegetation fires.
- Naturally generated dust storms.

PEL (2017a) analysed the results of previous air quality monitoring undertaken from 2008 until the present. That analysis determined the following.

- The average dust deposition level of 2.0g/m^2/month is less than the cumulative impact assessment criterion of 4g/m^2/month and is typical of arid rural areas.

- The average annual total suspended particulate (TSP) concentration of 42.8µg/m³ for all recorded years is less than the guideline value of 90µg/m³.
- The average annual PM_{10} (particulate matter with an equivalent aerodynamic diameter of 10µm or less) concentration of 15.9µg/m^3 is within the annual guideline of 30µg/m³.

No site-specific $PM_{2.5}$ (particulate matter with an equivalent aerodynamic diameter of 2.5µm or less) data are available for the Broken Hill region.

4.2.2.2 Heavy Metals

PEL (2017a) determined that the annual average suspended lead concentration of 0.13µg/m^3 is below the NSW EPA criterion of 0.5µg/m^3. On average, lead concentrations represent approximately 0.3% of TSP concentrations.

4.2.2.3 Greenhouse Gases

Locally, greenhouse gases are produced directly by specialist equipment and local traffic. Indirect emissions are resultant from the purchase of electricity to power local households and businesses. The effects of greenhouse gas emissions on global temperatures, now referred to as "climate change", are well documented and an assessment of greenhouse gas emissions has been included in PEL (2017a). In accordance with global reporting protocols, emissions of greenhouse gases are reported as CO_2 equivalent (CO_2-e).

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

4.2.3 Potential Sources of Air Contaminants

4.2.3.1 Particulate Emissions

Particulate emissions would be the principal air contaminant generated within the Mine Site. PEL (2017a) identified that the main sources of particulate emissions that would be generated by the Proposal include:

- Hauling and unloading ore from the portal within the Cosmopolitan Open Cut to the ROM Pad and crusher.
- Loading of crushed ore to stockpiles and road trucks.
- Hauling crushed ore offsite on sealed and unsealed roads.
- Loading, hauling and stockpiling of tailings.
- Wind erosion from the ROM Pad and stockpiles.

Table 4.2 presents the estimated the annual emissions from the Mine Site determined by PEL (2017a).

Table 4.2
Estimated Emissions from the Proposal

Activity	TSP emissions	PM_{10} emissions		$PM_{2.5}$ emissions	
	Annual	Annual	Maximum Daily	Annual	Maximum Daily
ORE – Hauling ore from Portal to ROM Pad (unsealed)	9 817	2 459	4 039	246	404
ORE – Unloading ore at ROM Pad	675	319	524	48	79
ORE – FEL Loading ore to crusher	675	319	524	48	79
ORE – Crusher (uncontrolled)	2 925	1 125	1 848	1 125	1 848
ORE – Unloading crushed ore to stockpile	675	319	524	48	79
ORE – FEL Loading crushed ore to road trucks	675	319	699	48	106
ORE – Hauling crushed ore out of site (unsealed)	2 518	631	1 381	63	138
ORE – Hauling crushed ore out of site (sealed)	1 320	253	555	61	134
TAILINGS – FEL Loading tailings to haul trucks	337	160	272	24	41
TAILINGS – Hauling tailings from Tailings Storage Facility to Paste Fill Storage Facility (unsealed)	3 272	820	1 396	82	140
TAILINGS – Emplacing tailings at Paste Fill Plant Stockpile	337	160	272	24	41
TAILINGS – FEL Loading tailings to hopper at Paste Fill Plant Stockpile	337	160	272	24	41
WE – ROM Pad uncrushed ore stockpile	438	219	219	33	33
WE – ROM Pad crushed ore stockpile	219	110	110	16	16
WE – Paste Fill Plant tailings stockpile	219	110	110	16	16
Total	**24 438**	**7 480**	**12 742**	**1 909**	**3 197**
Note 1: all units in kg/year Note 2: WE = wind erosion					
Source: PEL (2017a) – after Table 8.2					

4.2.3.2 Metals

PEL (2017a) identify the following three sources of particulate matter with differing metal concentrations.

- Source 1 – Emissions from the haul road from the portal within the Cosmopolitan Open Cut to the ROM Pad. Metal concentrations from this source were determined based on sampling of the haul road undertaken by the Applicant.
- Source 2 – Emissions from the ROM Pad, Paste Fill Plant, Tailings Harvesting Area and associated haul road. Metal concentrations from this source were determined based on the average metal concentration of the North Mine orebody.

It is noted that this assumption is likely to be highly conservative because, with the exception of the ROM Pad, surface materials within each of these areas is unlikely to have metal concentrations as high as those assumed.

- Source 3 – Emissions from the ventilation shaft.

Table 4.3 presents the metal concentrations assumed by PEL (2017a) for Sources 1 and 2.

Table 4.3
Metal Concentrations in Particulate Material

Metal	Unit	Source 1	Source 2
Lead	%	0.51	4.12
Silver	ppm	9.13	76.00
Zinc	%	0.98	2.88
Copper	ppm	127.13	759.00
Iron	%	2.09	2.70
Mercury	ppm	0.48	2.20
Nickel	ppm	13.00	10.00
Arsenic	ppm	168.75	480.00
Manganese	%	0.29	0.62
Cadmium	ppm	5.57	17.00
Chromium	ppm	25.38	26.00
Source: PEL (2017a) – After Table 8.3			

Emissions from Source 3, namely the ventilation rise, were based on the results of emissions monitoring from the adjacent Rasp Mine in April 2016 and are presented in **Table 4.4**. It is noted that after the completion of modelling by PEL (2017a), the Applicant obtained monitoring results for three ventilation rises at its Southern Operations. In all cases, the resulting lead concentrations were substantially less than those modelled.

Table 4.4
Modelled Vent Shaft In-stack Concentrations

Metal	Modelled In-stack Concentration (µg/Nm^3)
Arsenic	5.03
Cadmium	2.22
Chromium	2.10
Copper	3.80
Lead	15.00
Manganese	2.70
Nickel	0.56
Silver	3.77
Zinc	18.00
Mercury	0.70
Note 1: Nm^3 = Normal cubic metres	
Source: PEL (2017a) – Table 8.5	

4.2.3.3 Greenhouse Gas Emissions

PEL (2017a) identified that the primary source of greenhouse gas emissions from the Proposal would be generated by the following.

- Fuel consumption during mining operations and construction.
- Indirect emissions associated with on-site electricity use.
- Indirect emissions associated with the production and transportation of fuels.
- Emissions from transportation.

PEL (2017a) defined the following three scopes (emission categories) of the greenhouse gas emitting sources of the Proposal in accordance with the *National Greenhouse Accounts Factors workbook* (DoE, 2015).

- Scope 1 Emissions.

  These are the direct emissions from sources within the boundary of the Mine Site such as the combustion of fuel on-site.

- Scope 2 Emissions.

  These are the indirect emissions from the consumption of purchased electricity by another organisation.

- Scope 3 Emissions.

  These emissions are defined as all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned, or controlled, by the organisation. In the case of the Proposal, this includes the indirect emissions which arise as a result of the extraction, production and transport of fuel, electricity lost in transmission, off-site transport and emissions generated from employee travel.

Table 4.5 presents a summary of the predicted greenhouse gas emissions that would result over the life of the Proposal.

4.2.4 Air Quality Criteria and Goals

4.2.4.1 Particulate Emissions

In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4g/m^2/month. **Table 4.6** presents the allowable increase in dust deposition relative to the ambient levels as presented by PEL (2017a).

The air quality mitigation and acquisition criteria issued by the NSW Department of Planning and Environment (DPE, 2014) for, as summarised by PEL (2017a) are presented in **Table 4.7**.

Table 4.5
Summary of Predicted Emissions – All Scopes

Year	Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions		Total
	Diesel	Electricity	Diesel	Electricity	
2	1 971	13 905	101	1 986	17 964
3	2 169	13 905	111	1 986	18 172
4	2 060	13 905	106	1 986	18 058
5	2 147	13 905	110	1 986	18 149
6	2 469	13 905	127	1 986	18 487
7	2 500	13 905	128	1 986	18 520
8	3 749	33 373	192	4 768	42 082
9	2 959	33 373	152	4 768	41 252
10	2 959	33 373	152	4 768	41 252
11	2 959	33 373	152	4 768	41 252
12	2 957	33 373	152	4 768	41 250
13	2 950	33 373	151	4 768	41 242
14	2 943	27 811	151	3 973	34 878
15	1 928	13 905	99	1 986	17 919
16	1 756	13 905	90	1 986	17 738
Total	**38 476**	**339 293**	**1 973**	**48 470**	**428 213**

Note: Units = t CO_2-e

Source: PEL (2017a) – After Table 10.1

Table 4.6
Dust Deposition Assessment Criteria

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2g/m^2/month	4g/m^2/month

Note: g/m^2/month – grams per square meter per month

Source: PEL (2017a) after Table 4.2

Table 4.7
Suspended Particulate Matter Assessment Criteria

Pollutant	Criterion	Averaging Period	Application
Mitigation Criteria			
TSP	90μg/m^3	Annual mean	Total impact
PM_{10}	50μg/m^3	24-hour average	Incremental impact[1]
	30μg/m^3	Annual mean	Total impact
Acquisition Criteria[2]			
TSP	90μg/m^3	Annual mean	Total impact
PM_{10}	50μg/m^3	24-hour average	Incremental impact[3]
	30μg/m^3	Annual mean	Total impact

Note 1: Zero allowable exceedances of the criterion over the life of the development

Note 2: Voluntary acquisition rights apply where the Proposal contributes to exceedances of the acquisition criteria at any residence or workplace on privately-owned land, or, on more than 25% of any privately-owned land, and a dwelling could be built on that land under exiting planning controls

Note 3: Up to five allowable exceedances of the criterion over the life of the development

Source: PEL (2017a) – after Tables 4.3 and 4.4

4.2.4.2 Metals

The specific impact assessment criteria for metals as presented by PEL (2017a) is summarised in **Table 4.8**.

Table 4.8
Metal Concentrations for Suspended Particulates

Substance	Averaging Period	Percentile	Impact Assessment Criteria (µg/m^3)
Arsenic	1-hour	99.9th	0.09
Cadmium	1-hour	99.9th	0.018
Chromium (as CR III)	1-hour	99.9th	9
Chromium(as CR VI)	1-hour	99.9th	0.09
Copper	1-hour	99.9th	18
Iron	1-hour	99.9th	50
Lead	1-hour	99.9th	0.5
Manganese and compounds	1-hour	99.9th	18
Mercury	1-hour	99.9th	0.18
Nickel	1-hour	99.9th	0.18
Silver	1-hour	99.9th	0.18
Zinc	1-hour	99.9th	90
Source: PEL (2017a) – Table 4.5			

4.2.4.3 Greenhouse Gas Emissions

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

4.2.5 Assessment Methodology

PEL (2017a) state that the overall approach to the air quality assessment generally followed the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005) using the Level 2 assessment methodology.

AERMOD was used to model particulate emissions associated with the Proposal. Section 6 of PEL (2017a) presents a discussion of the model set up and assumptions. In summary, however, PEL (2017a) used hourly meteorological data from the Broken Hill Airport AWS for 2014, as well as synthetic data generated by The Air Pollution Model (TAPM), as well as the emission inventory summarised in **Table 4.2**.

Two modelling scenarios were assumed as follows.

- Annual operations – this scenario assumed a steady state rate of production of 300 000tpa or approximately 820tpd evenly distributed throughout the year.

- Maximum daily operations – this scenario assumed the proposed maximum daily production rate of 1 800tpd for each day of the modelled year. This scenario was used to estimate the worst-case 24-hour particulate emissions.

4.2.6 Management and Mitigation Measures

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

- Prepare and implement an *Air Quality Management Plan* consistent with the Plan for the Southern Operations. That Plan would:
  - identify dust emission zones and associated risk classifications within the Mine Site;
  - describe the management measures to be implemented;
  - describe the air quality-related monitoring that would be implemented; and
  - provide a trigger – action – response plan to facilitate adaptive management of particulate emissions from the Mine Site.
- Install and operate dust suppression equipment on mobile crushers and other plant.
- Install fixed, automated water sprays on the ROM Pad to facilitate management of moisture levels within ore stockpiles.
- Install and operate a wheel wash and require all vehicles leaving the operational section of the Mine Site to pass through the wheel wash.
- Minimise the drop height during crusher, Paste Fill hopper and truck loading.
- Ensure that all vehicles transporting ore to the Southern Operations have their loads covered.
- Maintain operational exposed areas in a moist condition by using a water cart to water down areas likely to generate wind-blown and traffic-generated dust.
- Apply water or chemical suppressants to all roads and trafficked areas using a water truck to minimise the generation of dust.
- Limit, where practicable, operations during periods of high winds.
- Limit disturbance to the minimum area necessary for mining and associated activities.
- Operate the largest practical truck size to reduce the number of vehicle movements necessary.
- Adhere to all vehicle speed limits.
- Where practicable, profile all disturbed surfaces to reduce velocity of overland winds.
- Clearly define all haul roads edges with marker posts or equivalent to control their locations.

- Close, rip and rehabilitate all obsolete roads.
- Reshape, rip and rehabilitate all completed areas as soon as practicable after the completion of mining operations.

4.2.7 Assessment of Impacts

4.2.7.1 Particulate Emissions

Annual Average Emissions

Table 4.9 presents the results of the modelling of the annual average particulate emissions at surrounding residences. In addition, **Figures 4.6** and **4.7** present the average annual cumulative deposited dust and PM_{10} contours. In summary, particulate matter emissions are not anticipated to exceed the relevant criteria at any surrounding residence either as a result of the Proposal alone or cumulatively.

Table 4.9
Annual Average Particulate Matter Emissions

Pollutant	TSP ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		$PM_{2.5}$	Dust Deposition (g/m^2/month)	
Selected Residence	Proposal Only	Cumulative	Proposal Only	Cumulative	Proposal Only	Proposal Only	Cumulative
	Assessment criteria						
	$90\mu g/m^3$		$30\mu g/m^3$		-	$2g/m^2$/ month	$4g/m^2$/ month
R1	0.3	43.3	0.3	16.3	0.5	0.1	2.1
R2	0.4	43.4	0.5	16.5	0.6	0.2	2.2
R3	0.5	43.5	0.4	16.4	0.5	0.2	2.2
R4	0.4	43.4	0.4	16.4	0.4	0.2	2.2
R5	0.3	43.3	0.3	16.3	0.3	0.1	2.1
R6	0.3	43.3	0.2	16.2	0.3	0.1	2.1
R7	0.2	43.2	0.2	16.2	0.2	0.1	2.1
R8	0.2	43.2	0.2	16.2	0.2	0.1	2.1
R9	0.2	43.2	0.2	16.2	0.2	0.1	2.1
R10	0.2	43.2	0.2	16.2	0.2	0.1	2.1
R11	0.2	43.2	0.1	16.1	0.1	0.0	2.0
R12	0.1	43.1	0.1	16.1	0.1	0.0	2.0
R13	0.1	43.1	0.1	16.1	0.1	0.0	2.0
R14	0.1	43.1	0.1	16.1	0.2	0.0	2.0
R15	0.1	43.1	0.1	16.1	0.1	0.0	2.0
R16	0.1	43.1	0.1	16.1	0.1	0.0	2.0
R17	0.1	43.1	0.1	16.1	0.1	0.0	2.0
R18	0.0	43.0	0.1	16.1	0.1	0.0	2.0
R19	0.0	43.0	0.1	16.1	0.1	0.0	2.0
R20	0.0	43.0	0.1	16.1	0.1	0.0	2.0
R21	0.1	43.1	0.1	16.1	0.1	0.0	2.0
R22	0.2	43.2	0.1	16.1	0.1	0.0	2.0
R23	0.1	43.1	0.1	16.1	0.1	0.0	2.0

Source: PEL (2017a) – after Tables 9.1 to 9.4

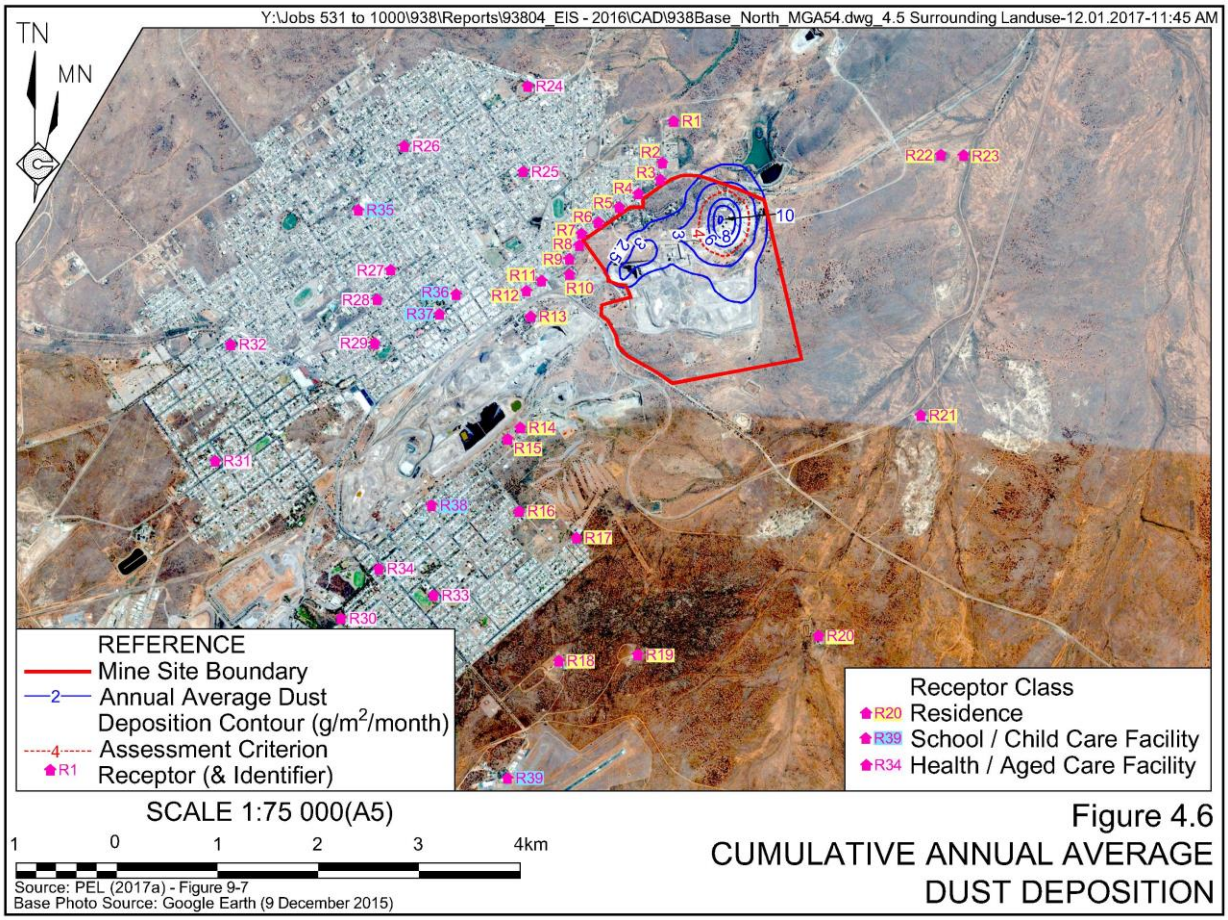


Figure 4.6
CUMULATIVE ANNUAL AVERAGE DUST DEPOSITION

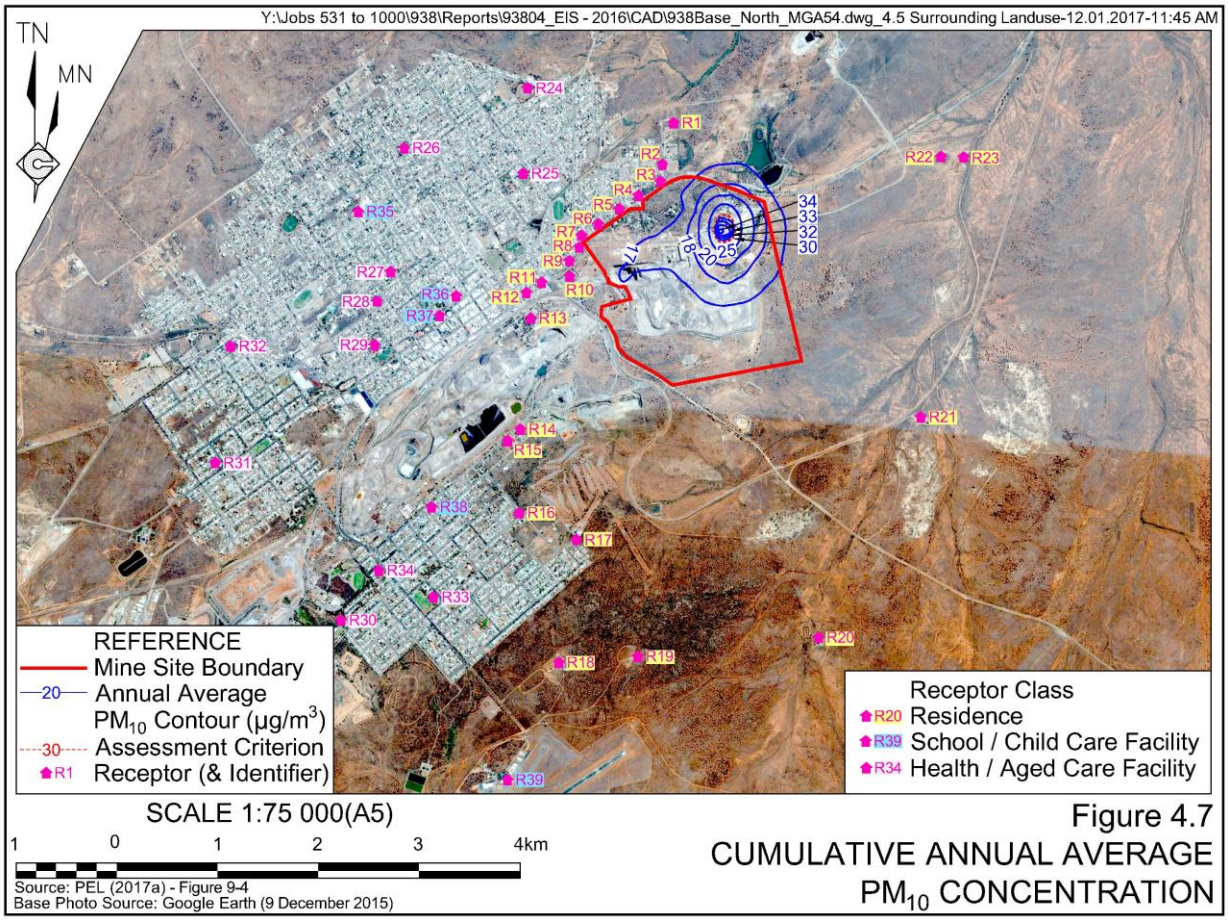


Figure 4.7
CUMULATIVE ANNUAL AVERAGE PM_{10} CONCENTRATION

24-hour Emissions

Table 4.10 presents the results of the modelling of the maximum 24-hour average concentrations of PM_{10} and $PM_{2.5}$ emissions at surrounding residences. In addition, **Figure 4.8** presents the maximum 24-hour average PM_{10} concentration contours. In summary, particulate matter emissions are not anticipated to exceed the relevant criteria at any surrounding residence as a result of the Proposal.

Table 4.10
Maximum 24-hour average Particulate Matter Emissions

Selected Residence	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)	
	Annual operations[1]	Maximum daily operations[1]	Annual operations[1]	Maximum daily operations[1]
	Assessment Criterion			
	50	50	-	-
R1	6.4	6.4	7.7	7.7
R2	14.6	14.6	16.0	16.0
R3	11.1	11.1	12.1	12.1
R4	3.3	3.3	4.1	4.1
R5	4.9	4.9	5.8	5.8
R6	5.5	5.5	6.5	6.5
R7	5.0	5.0	5.5	5.4
R8	3.0	3.5	3.4	3.4
R9	2.1	3.0	2.5	2.5
R10	2.5	2.5	3.4	3.4
R11	1.6	1.6	2.3	2.3
R12	1.5	1.5	2.1	2.1
R13	2.9	2.9	3.4	3.4
R14	5.1	5.1	6.9	6.9
R15	4.5	4.5	6.1	6.1
R16	0.9	0.9	1.2	1.2
R17	1.0	1.0	1.0	1.0
R18	1.0	1.0	1.1	1.1
R19	1.3	1.3	1.6	1.6
R20	1.3	1.4	0.8	0.8
R21	3.8	3.8	4.5	4.5
R22	4.3	4.3	5.9	5.9
R23	4.6	4.6	6.4	6.4

Note 1: See Section 4.2.4.1

Source: PEL (2017a) – after Tables 9.5 and 9.6

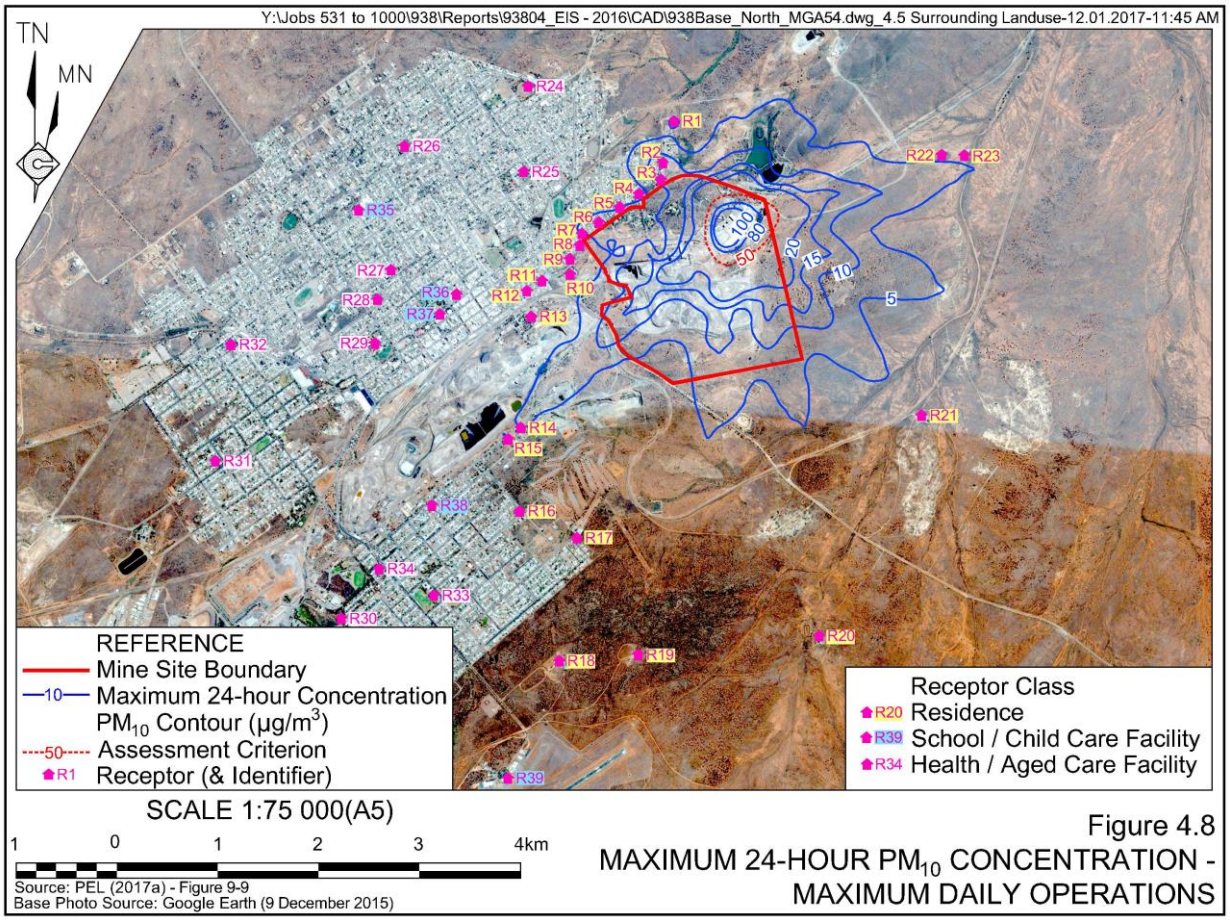


Figure 4.8
MAXIMUM 24-HOUR PM_{10} CONCENTRATION - MAXIMUM DAILY OPERATIONS

4.2.7.2 Metals

Table 4.11 presents the incremental metal concentrations in suspended particulates predicted to result from the Proposal. In summary, no heavy metal concentrations are predicted to exceed the relevant criteria at the Residence most likely to be impacted.

4.2.7.3 Greenhouse Gas Emissions

Table 4.12 presents a comparison of the predicted greenhouse gas emissions that would result from the Proposal and with the annual greenhouse global, Australian and NSW emissions inventories. Given the small contribution of the Proposal to these emission inventories it is assessed that the Proposal would not result in significant greenhouse gas impacts.

4.2.8 Monitoring

The Applicant would continue to undertake deposited dust and TSP monitoring, including contained metals, at the locations identified in EPL 2683. Currently this includes:

- monitoring of deposited dust at nine locations; and
- monitoring of TSP at two locations.

Monitoring would be undertaken in accordance with the *Air Quality Management Plan* to be prepared for the Proposal.

Table 4.11
Predicted Incremental Heavy Metal Concentrations

Substance	Maximum Predicted 99.9th Percentile Concentrations (µg/m³) across Receptors	Most Impacted Receptor	Assessment Period	NSW EPA Impact Assessment Criteria (µg/m³)	Incremental Concentration of % NSW EPA Criterion
Silver	0.020	R4	1-hr	0.18	13.5%
Zinc	0.300	R3	1-hr	90	0.3%
Copper	0.020	R4	1-hr	18	0.1%
Iron	0.300	R4	1-hr	50	0.6%
Mercury	0.005	R4	1-hr	0.18	2.5%
Nickle	0.004	R4	1-hr	0.18	2.0%
Manganese	0.070	R3	1-hr	18	0.4%
Chromium (as Cr III)	0.010	R4	1-hr	9	0.2%
Chromium (as Cr VI)	0.010	R4	1-hr	0.09	15.0%
Arsenic	0.030	R4	1-hr	0.09	36.0%
Cadmium	0.014	R4	1-hr	0.018	79.4%
Lead	0.006	R4	Annual	0.5	1.2%

Source: PEL (2017a) – after Table 9.7

Table 4.12
Comparison of Greenhouse Gas Emissions

Geographic coverage	Source Coverage	Timescale	Annual Emissions Mt CO_2-e	Reference
Proposal	Scope 1 only	Average annual	0.04	This report.
Global	Consumption of fossil fuels	Total since industrialisation 1750 – 1994	865 000	IPCC (2007). Figure 7.3 converted from Carbon unit basis to CO2 basis. Error is stated greater than ±20%
Global	CO_2-e emissions	2014	35 700	PBL Netherlands Environmental Assessment Agency 2015
Australia	1990 Base	1990	547.7	United Nations Framework on Climate Change – Kyoto Protocol base year data http://unfccc.int/ghg_data/kp_data_unfccc/base_year_data/items/4354.php
Australia	Kyoto target	Average annual 2008 – 2012	591.5	Based on 1990 net emissions multiplied by 108% Australia's Kyoto emissions target.
Australia	Total	2013	538.0	Taken from the National Greenhouse Gas Inventory 2013 http://www.environment.gov.au/system/files/resources/7d7f7ef6-e028-462e-b15c-ede14e222e65/files/national-inventory-report-2013-vol1.pdf
NSW	Total	2013	151.5	Taken from the State and Territory National Greenhouse Gas Inventory (2013) http://www.environment.gov.au/system/files/resources/9e33b185-1fb6-44b7-9d72-6979f3427b94/files/state-territory-inventories-2013.pdf

Source: PEL (2017a) – Table 10.3

4.3 HUMAN HEALTH

4.3.1 Introduction

Based on the risk assessment undertaken for the Proposal (see Section 5.2) the potential human health-related impacts and their risk rankings after the adoption of standard mitigation measures are as follows.

- Adverse impacts on human health or the environment due to:
  - Point source emission of particulate matter containing lead; and/or
  - Fugitive emission of particulate matter containing lead.

PEL prepared a human Health Risk Assessment for the Proposal drawing on the information presented in PEL (2017a) and in accordance with the protocols and guidelines recommended by the Australian enHealth Council (enHealth, 2012). The assessment, referred to hereafter as PEL (2017b), is presented as Part 2 of the *Specialist Consultant Studies Compendium*. It is noted that PEL (2017b) assessed risks associated with lead in particulate matter only. No assessment of other potential contaminants has been undertaken.

The following sub-sections draws on information presented in PEL (2017b) and provides a range of background information in relation to lead in the environment and potential health impacts of lead, the existing air quality environment predicated changes to that environment as a result of the Proposal the proposed management and mitigation measures and an assessment of the risk to human health posed by emissions of lead in particulate material from the Mine Site.

4.3.2 Background Information

4.3.2.1 Lead in the Environment

PEL (2017b) identify that there are three chemical forms, namely;

- metallic lead;
- inorganic lead compounds; and
- organic lead compounds containing carbon.

Naturally occurring forms or sources of lead include the following minerals.

- Galena (lead sulphide) – Other common varieties include cerussite ($PbCO_3$), Lead oxide, also called minimum (Pb_3O_4), plattnerite (PbO_2) and angelsite ($PbSO_4$). Lead exists in three oxidation states: Pb (0) – the elemental form, Pb (II) and Pb (IV). Metallic lead, Pb (0), exists in nature, but its occurrence is rare (UNEP 2006, IARC 2006, ATSDR 2007).

Anthropogenic sources are the most common sources of lead in the environment. Some of examples include the following.

- Exhaust from motor vehicles using leaded petrol.
- Emissions during smelting and refining of lead and manufacturing of products containing lead.

- Emissions during the production of iron and steel.
- The removal and remediation of lead paint.
- Incineration of municipal and medical wastes.

In Australia, most of the lead released into the environment from emissions or as industrial waste is deposited in soil. Lead in air are bound to fine particles of less than 1µm diameter, although some may be solubilized in acid aerosol droplets.

4.3.2.2 Effects of Lead on Humans

Absorption

Lead may be absorbed by humans through the following.

- Breathing air that contains very fine particles of lead.

  PEL (2017b) state that depending on the chemical speciation, particle size, and solubility in body fluids, up to 50% of inhaled lead compounds may be absorbed, with smaller particles of less than 1µm having greater deposition and absorption rates in the lungs than larger particles. Once deposited in the lower respiratory tract, particulate lead is almost completely absorbed, and different chemical forms of inorganic lead appear to be absorbed equally.

- Swallowing dust, soil, water or food that is contaminated with lead.

  PEL (2017b) identify that for infants and young children, dust and soil often constitute a major exposure pathway due to behaviour patterns such as hand to mouth activities. The intake of lead is influenced by the age, and biological and behavioural characteristics of the child, and the bioavailability of lead in the source material. In adults, approximately 10% of dietary lead is absorbed (higher during fasting) However, in infants and young children, as much as 50% of dietary lead is absorbed.

- Absorption via the skin.

  PEL (2017b) state that dermal absorption of inorganic lead is insignificant, however organic lead may be readily absorbed through the skin.

Distribution in the Body

PEL (2017b) state that during the first few weeks after exposure, lead is stored in both the soft tissue and the bones. Once the lead in blood and soft tissue is at equilibrium, the kinetics of lead entering and leaving the bones determines the blood lead level.. Bone accumulates lead during much of the lifespan and may then serve as an endogenous source, releasing lead back into the blood independently of exposure. This is particularly important during pregnancy, lactation and osteoporosis when bone density is reduced.

Metabolism

Lead may substitute for calcium and zinc in the body, affecting various biological processes. Lead may inhibit DNA repair and may adversely impact on several organ systems and functions.

Excretion

Lead is primarily excreted very slowly in urine, however, PEL (2017b) state that there are reports of excretion in faeces. Lead in the faeces includes both lead that has not been absorbed in the gastrointestinal tract and lead excreted in the bile.

4.3.2.3 Toxicity of Lead in Humans

Lead is toxic to multiple organ systems, and effects may range from enzyme inhibition and anaemia to disorders of the nervous, immune and reproductive systems, impaired kidney and cardiovascular functions, and even death at after very high exposure to lead (above 70µg/dL).

Some of the early signs of lead poisoning can be non-specific and are usually gastrointestinal. Symptoms include abdominal pain, constipation, nausea, vomiting, anorexia and weight loss.

The effects of lead at high levels of exposure include the following.

- Impaired neurodevelopment in children, potentially resulting from exposure in utero and during early childhood. Lead exposure in children is linked to a lower intelligence quotient (IQ), behavioural effects and learning disabilities. Epidemiological studies have shown that many important disturbances occur at blood lead concentrations of 10µg/dL to 15µg/dL. Extremely high blood lead levels in children (above 70µg/dL) can cause severe neurological effects, leading to lethargy, convulsions, coma and death.
- Impaired neurological performance in adults, including weakness in fingers, wrists, or ankles, attention dysfunction, aggression and delinquency, problems with thinking, anxiety, mood changes, dizziness, fatigue, sleep disturbance, headache, irritability, lethargy, a general feeling of discomfort, slurred speech, convulsions, muscle weakness, sensation of burning, tingling or prickling in the skin, inability to control movement of the arms and legs, tremors and paralysis.
- Impact on the blood-making organs and associated anaemia.
- Kidney damage and associated renal impact/failure.
- Cardiovascular effects, including increased blood pressure.

The effects of lead at low exposure (blood lead levels between 5µg/dL and 10µg/dL) include the following.

- A higher occurrence of behavioural problems (poor attention, impulsivity and hyperactivity) in children.
- Delay in physical sexual maturity or onset of puberty.

The effects of lead at very low exposure (blood lead levels less than 5µg/dL) may potentially include reduced average academic achievement and IQ in children. PEL (2017b) state it that is difficult to determine whether the observed effects were due to lead exposure or other factors and that it is difficult to ascertain whether blood lead levels less than 5µg/dL result in meaningful health effects. However PEL (2017b) state that there is no ‘safe’ level of lead that has been proven not to cause any health problems.

Blood Lead Levels in Broken Hill

PEL (2017b) state that the average blood lead level among Australians is not known but is likely to less than 5µg/dL.

As a result of past mining and processing activities, Broken Hill is considered a lead endemic area with widespread lead contamination and lead poisoning amongst the residents of the area. As a result, a range of programs have been established, including the following.

- Voluntary annual blood lead level screening for all 1 to 4 year-old children since 1991. This was extended to levels in pregnant women and neonates (via cord blood) in 1996.
- The Broken Hill lead management program was established in1994.
- The Broken Hill Community Reference Group, led by the Broken Hill City Council, and the Broken Hill Lead Steering Committee, were founded in 2008.
- In 2015, the NSW government released a ministerial announcement detailing its intention to invest into the Broken Hill Environment Lead Program with the aim of further reducing lead levels in Broken Hill over 5 years. The lead abatement project team would be overseen by the Environment Protection Authority, Far West LHD and Broken Hill Lead Reference Group.

The Applicant has participated in each of these programs since assuming control of is Broken Hill operations in 2003.

PEL (2017b) states the following in relation to blood lead levels in Broken Hill.

- There has been a steady decline in blood lead levels in children between 1 and 4 years of age, from 1991 through to 2014, with >80% of the study population showing a blood lead level of <10µg/dL in 2014.
- Since 2000, the number of children with blood lead levels < 5µg/dL has increased from 13% to 52% in 2014.
- Since 2000, the population mean blood lead level has fallen from 8.4µg/dL to almost 5µg/dL. This reduction in blood lead levels is largely due to the management measures, described above, that have been and continue to be implemented in Broken Hill.

PEL (2017b) state that as more than 80% of the children in Broken Hill have a blood lead level of < 10µg/dL, it is reasonable to consider 10µg/dL as a representative background blood lead level for the children of Broken Hill.

4.3.3 Existing Lead in the Environment

PEL (2017b) identified two components of lead in the environment surrounding the Mine Site, namely lead in soil and dust and lead in suspended particulates.

In relation to lead in soil, two data sources were relied upon as follows.

- *Lead dust in Broken Hill homes – a potential hazard for young children* (Boreland et al, 2002 – presented as Appendix C of PEL (2017b)).

  Boreland et al (2002) reported on a study of lead concentrations in soil by Broken Hill City Council in 1992. That study divided the City of Broken Hill into 10 districts (**Figure 4.9**). **Table 4.13** presents the results of that sampling program. In summary, Districts 1, 3, 4, 6 and 7 were determined to have "high soil lead levels".

- Exploration soil sample data.

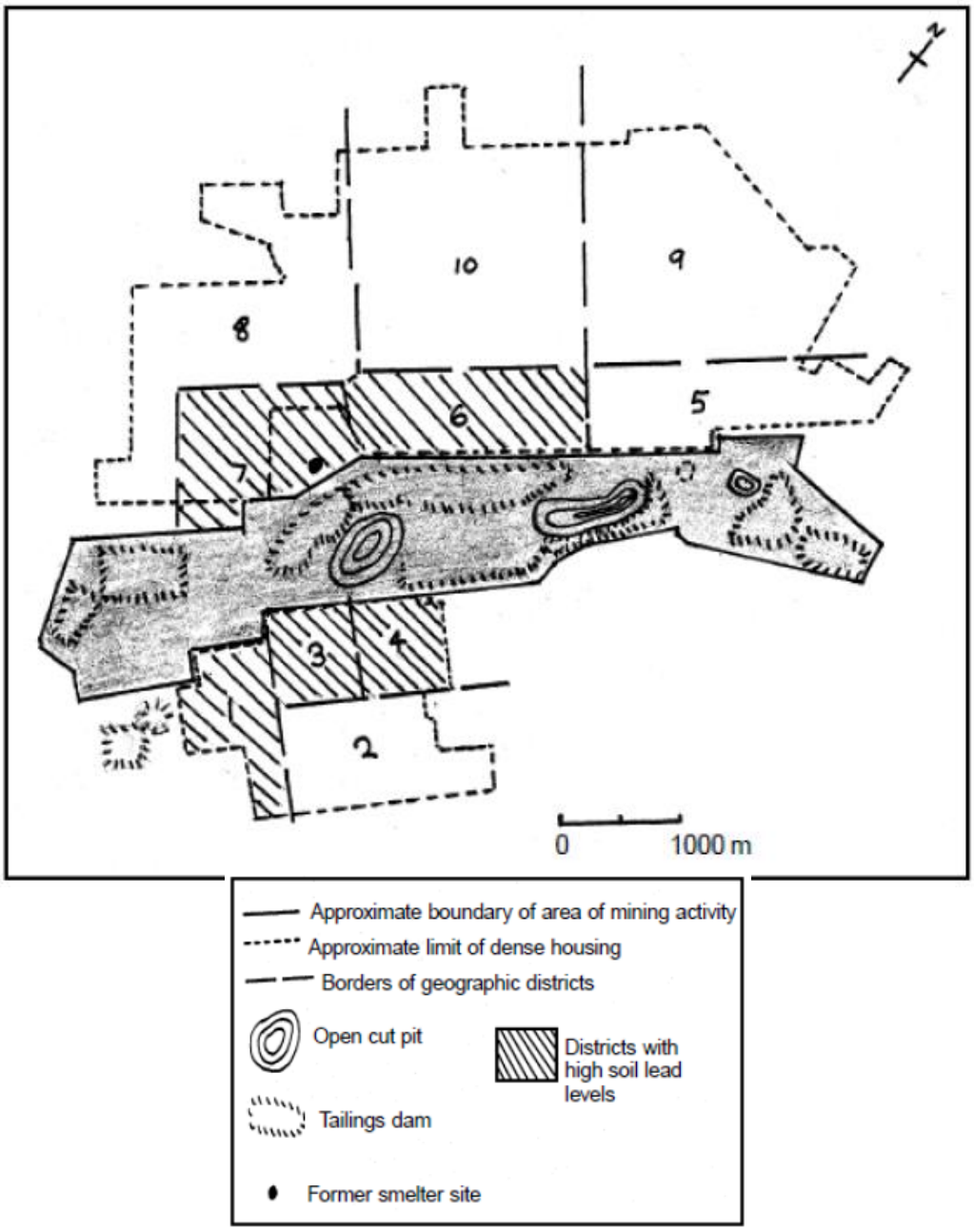
  The Applicant provided a database including 1 935 soil sample analyses collected for mineral exploration purposes over an area approximately 17.5km long and 3km wide, centred on the Line of Lode and the City of Broken Hill. The samples were collected and analysed using a variety of methods, with sampling density highest in areas of elevated soil lean levels. As a result, PEL (2017b) determined that this dataset was not adequate for the purposes of modelling lead-related impacts associated with the Proposal. Notwithstanding this, the mean soil lead level in the data set was 50.3µg/g, with only 79 samples or 4% of the dataset recording soil lead levels greater than 200µg/g.

In addition, PEL (2017b) relied on TSP data collected by the Applicant from 2008. The geometric mean lead concentration of the collected suspended particulates was 0.17µg/m^3.[1]

Table 4.13
Soil Lead Levels

District[1]	Number of Samples	Mean Lead Concentration (µg/g)
1	17	866
2	31	509
3	11	1 454
4	21	2 305
5	24	521
6	20	767
7	13	708
8	31	261
9	27	245
10	51	271
Note 1: See **Figure 4.9**		
Source: Boreland et al (2002) – After Table 1		

[1] It is noted that PEL (2017a) reference the average concentration of lead in suspended particulates as 0.13µg/m^3 whereas PEL (2017b) have relied upon the geometric mean of the same dataset for a value of 0.17µg/m^3.



Source: PEL (2017b) – After Figure 5-2

Original source: Boreland et al (2002) – Figure 1

Figure 4.9
BROKEN HILL SOIL LEAD LEVEL DISTRICTS

4.3.4 Assessment Methodology

PEL (2017b) state that the methodology adopted for the health Risk Assessment is consistent with the protocols and guidelines identified in the document *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards* (enHealth, 2012). This has resulted in the process being categorised into the following distinct components.

1. Hazard Assessment – reviews the hazards and health risks associated with exposure to lead. This component has been summarised in Section 4.3.2.
2. Exposure Assessment – identifies the groups of people who may be exposed to hazardous pollutants and provides an estimate as to the potential exposure concentrations based in part on the information provided in Section 4.3.3.
3. Risk Characterisation – provides a qualitative/quantitative evaluation of potential risks to human health.

The IEUBK Model for lead in children, developed by the U.S. Environmental Protection Agency (US EPA), Technical Review Workgroup (TRW) for Metals and Asbestos (US EPA, 2007) was used for the assessment. Adjustments were made to the default model inputs to account for Australian conditions and the data presented in Section 4.3.3. PEL (2017b) note that the model does not take into account management measures that may be implemented by the community to minimise exposure to lead soil and dust. The modelling of blood lead is therefore conservative.

Principal inputs to the model are presented in Section 5.2.2.3 of PEL (2017b). In summary, the inputs took into account:

- known or assumed lead levels/concentrations;
- anticipated increases in those levels/concentrations as a result of the Proposal;
- assumed ingestion/absorption rates; and
- bioavailability of the ingested/absorbed lead.

Four scenarios were modelled as follows, each including a background (existing) and cumulative (including the Proposal) result (**Table 4.14**).

Table 4.14
Human Health Risk Assessment Scenarios

Scenario	Location	Soil Lead Level (µg/g)	Suspended Particulate Lead Concentration (µg/m^3)
1	District 6 (see **Figure 4.9**)	767 (geometric mean soil lead level for District 6)	0.17 (geometric mean for all TSP samples)
2	LP26 (see **Figure 4.5**)	767 (geometric mean for District 6)	0.048 (average lead concentration for samples at this location)
3	LP27 (see **Figure 4.5**)	767 (geometric mean for District 6)	0.285 (average lead concentration for samples at this location)
4	District 6 worst case	1 011 (maximum soil lead level for District 6)	0.17 (geometric mean for all TSP samples)
Source: PEL (2017b) – After Section 5.2.2.2			

The model generated geometric mean blood lead levels for children up to 7 years of age.

4.3.5 Management and Mitigation Measures

The Applicant would implement the management and mitigation measures identified in Section 4.2.6 to minimise the emission of particulate matter generally. However, the Applicant would also implement the following lead-specific management and mitigation measures.

- Operate a wheel wash at both the North Mine Site and the Southern Operations Mine Site and ensure that no vehicles are permitted to leave operational sections of the Mine Sites without passing through the wheel wash.
- Ensure that all loads are covered prior to the vehicles leaving the Mine Site.
- Continue to participate and contribute to community and government agency lead monitoring and management programs, including the Broken Hill Lead Reference Group and the State government Environmental Lead Program.

4.3.6 Assessment of Impacts

Table 4.15 presents the results of the blood lead level modelling. The results may be summarised as follows.

- The geometric mean blood lead level for all age groups for all scenarios, including Scenario 4, the worst case scenario, is expected to be less than the 5µg/dL target level.
- Nil or a very minor 0.1µg/dL increase in geometric mean blood lead level are expected for all age groups for all scenarios, with the exception of children aged under 1 year under the worst case Scenario 4, where the increase would be 0.4µg/dL.

Table 4.15
Modelled Geometric Mean Blood Lead Level Results

Scenario	Input		GMBLL by age group						
	soil (µg /g)	air (µg/m3)	0.5-1	1-2	2-3	3-4	4-5	5-6	6-7
Scenario 1 – District 6									
Background	767	0.17	2.5	2.8	2.7	2.2	2.0	1.9	1.9
Cumulative	812.64	0.1734	2.5	2.8	2.7	2.3	2.1	2.0	1.9
Scenario 2 – LP26									
Background	767	0.1217	2.5	2.7	2.7	2.2	2.0	1.9	1.9
Cumulative	812.64	0.1251	2.5	2.8	2.7	2.2	2.0	2.0	1.9
Scenario 3 – LP27									
Background	767	0.2251	2.5	2.8	2.7	2.2	2.0	2.0	1.9
Cumulative	812.64	0.2308	2.5	2.9	2.8	2.3	2.1	2.0	2.0
Scenario 4 – District 6 worst case									
Background	1011	0.17	2.3	3.1	3.0	2.5	2.3	2.2	2.2
Cumulative	1056.64	0.1734	2.7	3.2	3.1	2.6	2.4	2.3	2.2
Source: PEL (2017b) – After Table 5.5									

PEL (2017b) also determined percentage of children living near the Mine Site with a 5% probability of a blood lead level exceeding the 10µg/dL and the 5µg/dL. **Table 4.16** presents the results of that assessment. In summary:

- Less than 0.1% of children would be expected to exceed the 10µg/dL blood lead level target, with 5.1% expected to exceed the 5µg/dL level under Scenario 1.
- Under the worst case Scenario 4, less than 0.22% of children are expected to exceed the 10µg/dL level, and less than 8.5% of exceeding 5µg/dL level.
- In all scenarios the Proposal would result in an increase the proportion of children exceeding the 10µg/dL and 5µg/dL level of less than 0.3% and 0.7% respectively.

Table 4.16
Modelled Probability of Exceeding Blood Lead Levels

Scenario	Input		Geometric Mean	% children above blood led level target	
	soil (µg /g)	air (µg/m3)		10µg/dL	5µg/dL
Scenario 1 – District 6					
Background	767	0.17	2.265	0.079	4.599
Cumulative	812.64	0.1734	2.322	0.094	5.131
Scenario 2 – LP26					
Background	767	0.1217	2.24	0.073	4.381
Cumulative	812.64	0.1251	2.297	0.088	4.899
Scenario 3 – LP27					
Background	767	0.2251	2.294	0.087	4.866
Cumulative	812.64	0.2308	2.351	0.103	5.416
Scenario 4 – District 6 worst case					
Background	1011	0.17	2.558	0.186	7.696
Cumulative	1056.64	0.1734	2.614	0.216	8.386
Source: PEL (2017b) – After Table 5.6					

Based on the results of the modelling, PEL (2017b) state that the Proposal is not expected to result in a significant change of the current background blood lead levels for residents in the vicinity of the Mine Site.

4.3.7 Monitoring

PEL (2017b) recommended lead monitoring and bioavailability studies at residences most exposed to the Proposal. The Applicant would implement the recommended program in conjunction with relevant government agencies and community groups during the life of the Proposal.

4.4 NOISE AND BLASTING

4.4.1 Introduction

Based on the risk assessment undertaken for the Proposal (see Section 5.2) the potential noise-related impacts and their risk rankings after the adoption of standard mitigation measures are as follows.

- Increased amenity impacts on residential and other sensitive receivers from:
  - noise emissions from mining operations (moderate to high risk); and
  - off-site traffic noise (low risk).
- Increased health impacts on residential and other sensitive receivers (low risk).

Muller Acoustic Consulting Pty Ltd (MAC) prepared a noise and blasting impact assessment for the Proposal. The resulting report referred to hereafter as MAC (2017) is presented as Part 3 of the *Specialist Consultant Studies Compendium*. The following sub-section draws on information presented in that report and describes the existing noise environment, predicated changes to the noise environment as a result of the Proposal, the proposed management and mitigation measures and an assessment of noise-related impacts.

4.4.2 Existing Noise Climate

MAC (2017) conducted unattended noise monitoring at three locations surrounding the Mine Site (**Figure 4.10**) to determine the existing noise climate. The measured background noise levels and their equivalent continuous levels are presented in **Table 4.17**.

Table 4.17
Background Noise Monitoring Summary

Location	Measured Rating Background Level (dBA)			Measured Equivalent Continuous Level (dBA)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
L1	30 (29)[2]	31	30 (22)[2]	43	43	38
L2	33	35	30 (26)[2]	50	50	46
L3	31	31	30 (25)[2]	48	47	45
Note 1: Day period is from 7:00am to 6:00pm. Evening period is from 6:00pm to 10:00pm. Night period is from 10:00pm to 7:00am						
Note 2: Where the measured rating background level is lower than 30dBA a level of 30dBA is applied and the measured level is shown in brackets						
Source: MAC (2017) after Table 5						

4.4.3 Surrounding Noise Catchments

As the Mine Site is located within the vicinity of multiple residences MAC (2017) has classified surrounding residential localities into representative Noise Catchments for the purposes of assessment. **Figure 4.10** also presents the noise catchments assessed by MAC (2017).

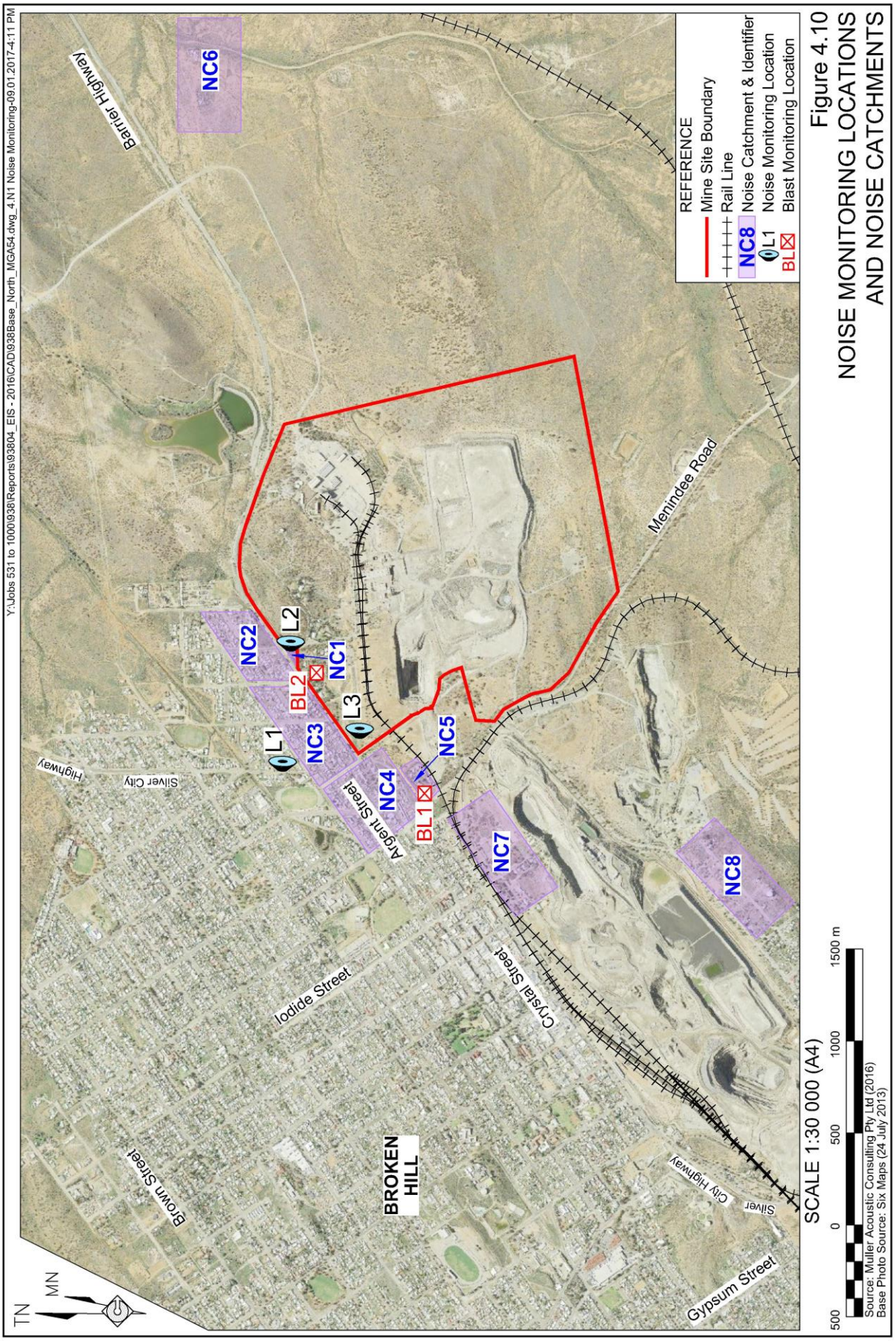


Figure 4.10
NOISE MONITORING LOCATIONS AND NOISE CATCHMENTS

4.4.4 Assessment Criteria

4.4.4.1 Operational Noise Criteria

The operational noise criteria for the Proposal consisting of intrusive and amenity criteria for each noise catchment has been determined by MAC (2017) in accordance with the *Industrial Noise Policy*. These criteria are presented in **Table 4.18**. **Table 4.18** also presents the Project Specific Noise Level (PSNL) which is the lower of the intrusive or amenity criteria.

Table 4.18
Project-Specific Noise Criteria

Receiver	Measured RBL LA_{90} dB(A)	Intrusiveness Criteria $LA_{eq(15minute)}$ dB(A)	Amenity Criteria $LA_{eq(period)}$ dB(A)	PSNL dB(A)
Day (7:00am to 6:00pm)				
NC1	33	38	55	38
NC2	33	38	55	38
NC3	31	36	55	36
NC4	31	36	55	36
NC5	31	36	55	36
NC6	30	35	55	35
NC7	30	35	55	35
NC8	30	35	55	35
NC9	30	35	55	35
Evening (6:00pm to 10:00pm)				
NC1	33	38	45	38
NC2	33	38	45	38
NC3	31	36	45	36
NC4	31	36	45	36
NC5	31	36	45	36
NC6	30	35	45	35
NC7	30	35	45	35
NC8	30	35	45	35
NC9	30	35	45	35
Evening (10:00pm to 7:00am)				
NC1	30	35	40	35
NC2	30	35	40	35
NC3	30	35	40	35
NC4	30	35	40	35
NC5	30	35	40	35
NC6	30	35	40	35
NC7	30	35	40	35
NC8	30	35	40	35
NC9	30	35	40	35

Source: MAC (2017) – after Table 6

4.4.4.2 Sleep Disturbance

An important aspect of intermittent noise is the potential to disturb the sleep of nearby residents. The EPA nominates that a screening criterion of background noise level (LA_{90}) plus 15dB shall apply to maximum noise level events calculated 1m from the bedroom facade at the nearest residential receivers. Based on the night-time rating background level an LAmax sleep disturbance criterion of 45dBA is applicable.

4.4.4.3 Construction Noise

MAC (2017) have nominated a worst case construction noise management level of 40dBA $LA_{eq(15minute)}$ at all surrounding residences.

4.4.4.4 Road Traffic Noise

Road traffic nose criteria are determined in accordance with the *NSW Road Noise Policy*. MAC (2017) identify that the all roads on the proposed transportation route may be classified as "freeway/arterial/sub-arterial roads' under the Policy. As a result the following road traffic noise criteria has been adopted.

- Daytime (7:00am to 10:00pm) – 60dBA $L_{Aeq(15hour).}$
- Night-time (10:00pm to 7:00am) – 55dBA $L_{Aeq(9hour)}$

4.4.5 Assessment Methodology

Assessment of operational noise was conducted by MAC (2017) using the Brüel and Kjær Predictor Type 7810 (Version 11.00) noise modelling software. A detailed description of this methodology is presented in Section 5 of MAC (2017). In summary, the model was developed by placing the various noise sources (of known sound power levels) in typical/worst case locations (**Figure 4.11**). **Table 4.19** provides the associated sound power levels and times of operation for each piece of equipment.

Table 4.19
Noise Sources and Sound Power Levels

Equipment	Indicative Number	Sound Power Level $L_{eq(15min)}$ (dB(A)	Period of Operation[1]		
			Day	Evening	Night
Construction Noise Sources					
Backhoe	1	103	✓		
Road Truck	1	102	✓		
Grader	1	108	✓		
Hand Tools	3	97	✓		
Operational Noise Sources					
Mobile Crusher	1	114	✓	✓	
Haul Truck	2	108	✓	✓	✓
Loader	2	106	✓	✓	✓
Paste Fill Plant	1	108	✓	✓	✓
Road Truck	1	102	✓	✓	
Note 1: Day period is 7:00am to 6:00pm evening is 6:00pm to 10:00pm night period is 10:00pm to 7:00am					
Source: MAC (2017) after Table 11					

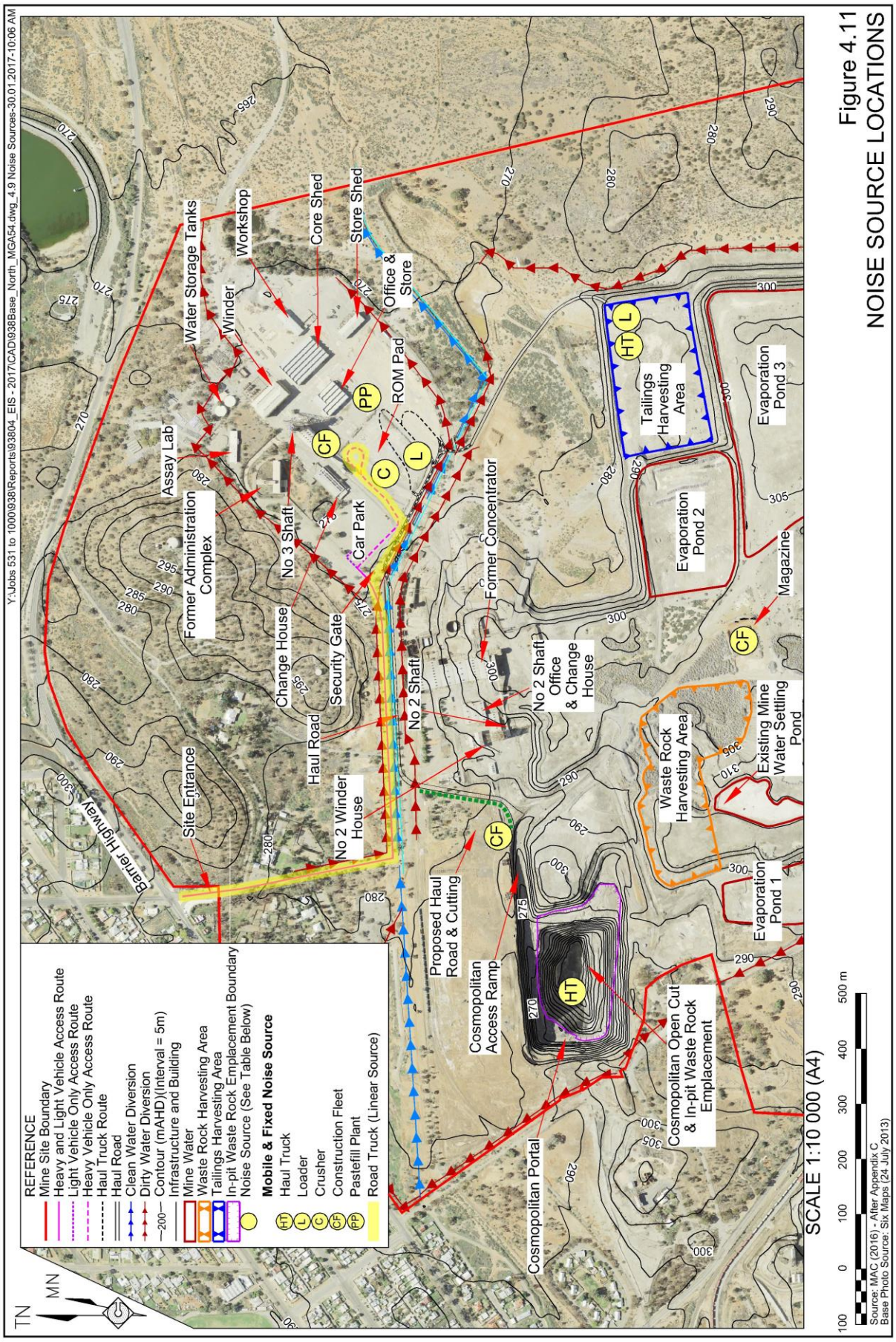


Figure 4.11
NOISE SOURCE LOCATIONS

The *Industrial Nosie Policy* requires an assessment of noise emissions under neutral and, where relevant, adverse meteorological conditions. Adverse meteorological conditions that are required to be assessed under the Policy include:

- source to receiver winds of less than 3m/s for 30% or more of the time in any seasonal period; and
- temperature inversions which typically apply at night during winter.

MAC (2017) undertook an assessment of the wind data from the Broken Hill Airport automatic weather station (No. 047048) and determined that winds of less than 3m/s did not occur for 30% or more of the time in any seasonal period. However, MAC (2017) did determine that temperature inversions are likely to apply to the Proposal and an assessment under atmospheric Stability Class F was undertaken.

4.4.6 Management and Mitigation Measures

The Applicant would implement the following noise and blasting management and mitigation measures throughout the life of the Proposal.

- Strictly comply with the proposed hours of operation identified in Section 2.11.2.
- Regularly service all on-site equipment 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 Applicant's Driver's Code of Conduct outlining procedures for reducing noise impacts during transportation within the Mine Site and off site.
- Maintain an open dialogue with the surrounding community and neighbours to ensure any concerns over noise or vibration are addressed.

4.4.7 Assessment of Impacts

4.4.7.1 Construction Levels

Construction noise levels for all noise catchments surrounding the Mine Site are presented in **Table 4.20** In summary, the predicted noise levels from construction of the Proposal are not anticipated to exceed the relevant criteria at any noise catchment.

4.4.7.2 Operational Noise

The operational noise levels at receivers surrounding the Mine Site as predicted by MAC (2017) are presented in **Table 4.21**. In summary, the operational noise levels associated with the Proposal are not anticipated to exceed the relevant criteria within any noise catchment. However, it is noted that the anticipated noise levels during the evening and night under temperature inversion conditions would be equal to the relevant Project-specific Noise Criterion for the single residence within NC1. However, it is noted that the assessment of noise impacts is likely to be highly conservative for the following reasons.

- The assessment included operation of the mobile crusher during the evenings. Section 2.11.1 identifies that crushing operations would be undertaken between 7:00am and 7:00pm only. As a result, the anticipated noise received within NC1 after 7:00pm would be substantially less than the modelled 38dBA.

Table 4.20
Predicted Construction Noise Levels

Noise catchment	Predicted Construction Noise Levels	Construction Noise Management Level
NC1	38	40
NC2	37	40
NC3	37	40
NC4	34	40
NC5	33	40
NC6	<30	40
NC7	<30	40
NC8	<30	40
NC9	<30	40
Units = dB(A) L_{max}		
Source: MAC (2017) after Table 14		

Table 4.21
Predicted Operational Noise Levels

Noise Catchment	Period of Operation[1]	Meteorological conditions		Project-specific Noise Criterion
		Neutral	Temperature Inversion[2]	
NC1	Day	37	NA	38
	Evening	38	NA	38
	Night	<30	35	35
NC2	Day	36	NA	38
	Evening	36	NA	38
	Night	<30	35	35
NC3	Day	31	NA	36
	Evening	31	NA	36
	Night	<30	32	35
NC4	Day	33	NA	36
	Evening	33	NA	36
	Night	<30	33	35
NC5	Day	<30	NA	36
	Evening	<30	NA	36
	Night	<30	31	35
NC6	Day	<30	NA	35
	Evening	<30	NA	35
	Night	<30	<30	35
NC7	Day	<30	NA	35
	Evening	<30	NA	35
	Night	<30	<30	35
NC8	Day	<30	NA	35
	Evening	<30	NA	35
	Night	<30	<30	35
NC9	Day	<30	NA	35
	Evening	<30	NA	35
	Night	<30	<30	35
Note 1: Day period is 7:00am to 6:00pm, evening is 6:00pm to 10:00pm and night period is 10:00pm to 7:00am Note 2: Temperature inversion conditions are only applicable for the night period				
Units = dB(A) $L_{eq\ (15\ min)}$				
Source: MAC (2017) after Table 12				

- The assessment assumed operation of a loader within the Tailings Harvesting Area during the night-time. While a loader would operate on an intermittent basis during the night time within the Paste Fill Plant Area, primarily during Stage 3 mining operations (North Mine Deeps), tailings harvesting operations would be undertaken between 7:00am and 7:00pm only. As a result, the anticipated noise received within NC1 between 10:00pm and 7:00am under temperature inversion conditions would be less than the modelled 35dBA.

Notwithstanding the above, the Applicant would liaise with the owner and tenant of the only occupiable house within NC1 to ensure that noise-related impacts are not having an unreasonable impact on their amenity and appropriate measures would be implemented to manage the issue if required.

4.4.7.3 Sleep Disturbance

The sleep disturbance noise levels for all noise catchments surrounding the Mine Site are presented in **Table 4.22**. In summary, the sleep noise disturbance levels of the Proposal are not anticipated to exceed criteria at any noise catchment. However, sleep disturbance noise levels are expected to be equal to the criterion at NC1 and NC2. MAC (2017) notes that the modelling assumed an L_{max} noise level of 120dBA. This is likely to be higher than the $L_{A(1\ min)}$ noise level required by the *Industrial Noise Policy*. As a result, the actual night-time noise emissions with the potential to cause sleep disturbance would be less than those modelled.

Notwithstanding the above, the Applicant acknowledges that impacts associated with noise emissions and sleep disturbance are subjective matters. As a result, the Applicant would ensure that it liaises with all surrounding residences and will address noise-related matters as they arise.

Table 4.22
Predicted Sleep Disturbance Levels

Noise catchment	Predicted Sleep Disturbance Noise Levels	Sleep Disturbance Criterion
NC1	45	45
NC2	45	45
NC3	42	45
NC4	41	45
NC5	39	45
NC6	32	45
NC7	36	45
NC8	31	45
NC9	<30	45
Units = dB(A) L_{max}		
Source: MAC (2017) after Table 13		

4.4.7.4 Road Traffic Noise

The road traffic noise levels for the closest receiver to the proposed transport route as predicted by MAC (2017) are presented in **Table 4.23**. In summary, the predicted road traffic noise levels are not anticipated to exceed criteria at any receiver within 15m of the roadway. In addition, the Applicant notes that it has operated truck haulage from the Potosi Mine since March 2013, with approximately 38 500 loads of ore transported to the Southern Operations. During that period, that has not been a single road traffic noise-related complaint.

Table 4.23
Predicted Road Noise Traffic Levels

Distance to Closest Receiver (m)	Measured Existing Road Traffic Noise	Predicted Proposal Noise Contribution[1]	Existing and Predicted Total Noise Contribution	Assessment Criteria
	dB(A) L_{max}[2]			
15	49.5	45.2	50.9	60
Note 1: Assuming 48 truck movements per day Note 2: Daytime Operations				
Source: MAC (2017) after Table 15				

4.4.7.5 Blasting

MAC (2017) calculated the ground vibration levels at the closest noise catchment surrounding the Mine Site namely at a distance of 890m using a maximum instantaneous charge weight of 120kg. The calculated ground vibration level would be 4.5mm/s, less than the 5.0mm/s criterion typically applied by the Environment Protection Authority.

As surface blasting does not form a component of the Proposal, air blast overpressure is not relevant to this application.

4.4.8 Monitoring

The Applicant would continue to monitor ground vibration at the Environment Protection Licence-nominated monitoring locations at BL1 and BL2 (**Figure 4.10**).

No noise-related monitoring is proposed. The Applicant would, however, liaise with surrounding residents particularly those within noise catchments 1 and 2 and would implement additional noise management measures or a noise monitoring program should noise emissions be an issue of concern for individual residents.

4.5 TRAFFIC AND TRANSPORTATION

4.5.1 Introduction

Based on the risk assessment undertaken for the Proposal (see Section 5.2), the potential traffic and transportation-related impacts and their risk rankings after the adoption of standard mitigation measures are as follows.

- Increased traffic levels due to movement of workforce and contractors resulting in:
  - elevated risk of accident/incident on local roads (moderate risk);
  - increased traffic congestion (low risk); and/or
  - road pavement deterioration (low risk).
- Increased heavy vehicle movements resulting in:
  - elevated risk of accident/incident on local roads (moderate risk);
  - increased traffic congestion (low risk); and/or
  - road pavement deterioration (low risk).
- Poor traffic management resulting from inadequate road infrastructure for the Proposal (moderate risk).

Tonkin Consulting prepared a transport assessment for the Proposal. The resulting report, referred to hereafter as Tonkin (2016) is presented as Part 4 of the *Specialist Consultant Studies Compendium*. The following sub-section draws on information presented in that report and describes the existing traffic and transportation environment, predicated changes to the traffic and transportation environment as a result of the Proposal, the proposed management and mitigation measures and an assessment of traffic and transportation-related impacts.

4.5.2 Existing Road Traffic Environment

4.5.2.1 Roads and Intersections

The proposed transportation routes are presented on **Figure 4.12** and are described in Section 2.7.4.3. In summary, laden trucks would exit the Mine Site, turn left onto Argent Street, turn left onto Menindee Road, right onto Crystal Street, right onto Gypsum Street and left on to the South Mine Site Access Road.

Tonkin (2016) undertook an assessment of the condition of the proposed transport route. That assessment may be summarised as follows.

- Intersection of the North Mine Site Access Road and Argent Street – is give way-controlled, with traffic on Argent Street having priority. The intersection is controlled by a traffic island that creates a left-turn lane for traffic exiting the Mine Site. Tonkin (2016) state that sight lines are adequate in all directions.
- Argent Street – is a sealed, two-lane section of the Barrier Highway, a State Road, with widened shoulders used as parking lanes on both sides of the road. The sign posted speed limit is 50km/h.

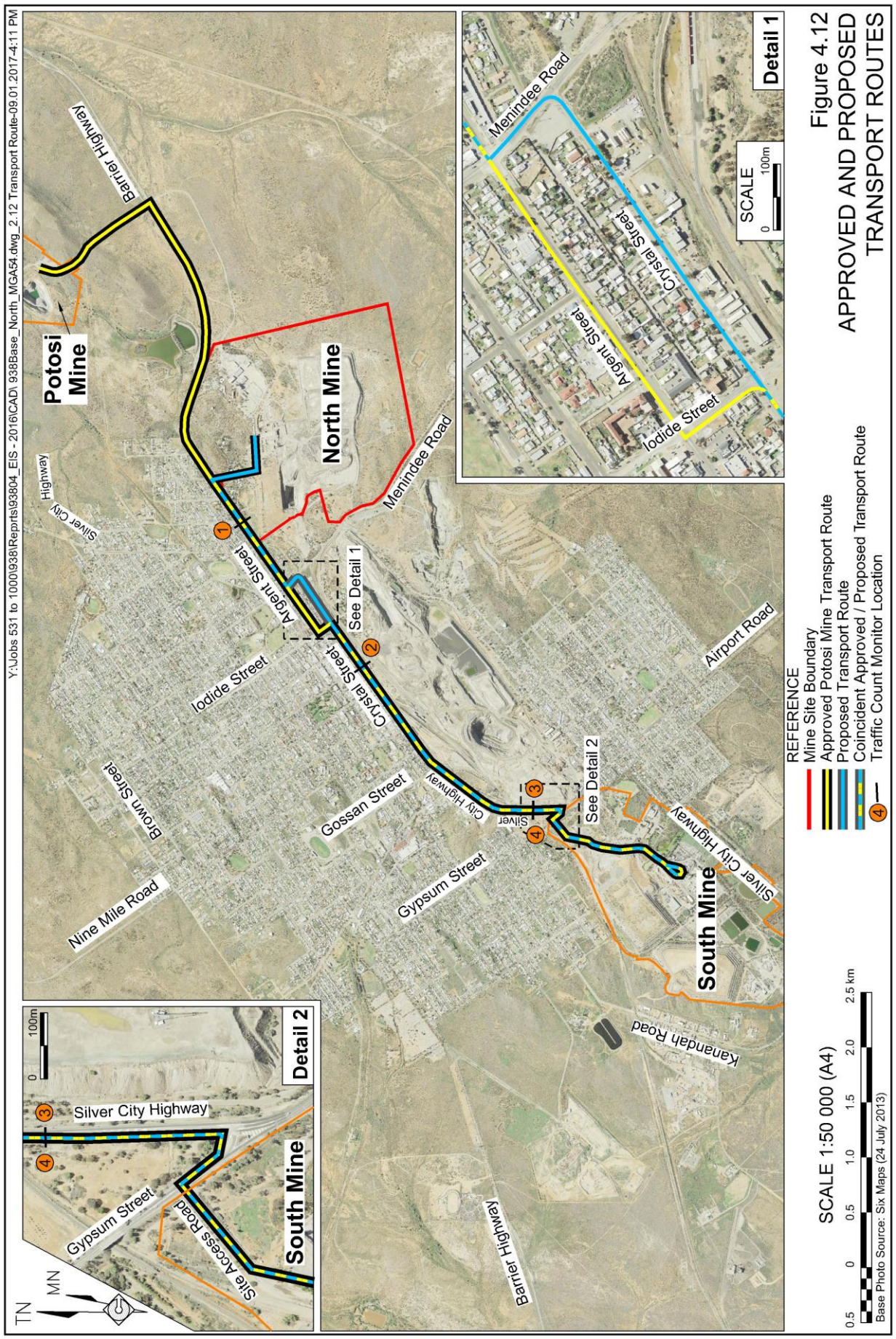


Figure 4.12
APPROVED AND PROPOSED TRANSPORT ROUTES

- Intersection of Argent Street and Menindee Road – is give-way controlled, with traffic on Argent Street having priority. Tonkin (2016) considers the sight distances of the intersection appropriate.
- Menindee Road – is a wide, sealed, two lane Regional road. Approximately 150m of this road would be used for transportation operations. The sign posted speed limit is 50km/h.
- Intersection of Menindee Road and Crystal Street – is give-way controlled, with traffic on Menindee Road having priority. Tonkin (2016) considers the sight distances of the intersection appropriate.
- Crystal Street/Silver City Highway/South Road (referred to hereafter as Crystal Street) – is a sealed, two-lane road, with the approximately 550m-long section of the road east of Iodide Street being classified as a local road and the remainder being the Silver City Highway and classified as a State Road. The sign posted speed limit is 50km/h to the east of Gossan St and 60kph west of that point.
- Intersection of Crystal Street and Gypsum Street – is give way-controlled, with traffic on Crystal Street having priority. The intersection includes a channelized right-hand turn lane for traffic turning into Gypsum Street as channelized slip lane for traffic turning left out of Gypsum Street. Tonkin (2016) considers the sight distances of the intersection appropriate.
- Gypsum Street – is a sealed, two-lane Regional road with no parking lanes. The proposed transportation route would utilise 120m of Gypsum Street. The sign posted speed limit is 50km/h.
- Intersection of Gypsum Street and the South Mine Site Access Road – is give way-controlled, with traffic on Gypsum Street having priority. Traffic islands on both the South Mine Site Access Road and Gypsum Street control turning movements. Tonkin (2016) considers the sight distances of the intersection appropriate.

4.5.2.2 Pavement Condition

Tonkin (2016) state that the existing pavement condition varies along the length of the proposed transport route, with sections of the route which are in good structural condition with minimal distress. However, bleeding on the surface, cracking and minor rutting were observed.

Concrete pavements in adequate condition are provided at the key intersections. However, Tonkin (2016) noted some minor pavement distress at interface between the concrete and granular pavements.

4.5.2.3 Traffic Volumes

Existing traffic volumes were determined by Tonkin (2016) based on counts undertaken between 21 and 30 June 2016 at four locations (**Figure 4.12)**. That data, presented in vehicles per day (vpd) with a percentage of commercial vehicles, is presented in **Table 4.24**.

Table 4.24
Existing Traffic Volumes

			Existing Traffic	
Location[1]	**Road**	**Site**	**Vpd[2]**	**Commercial Vehicles[3]**
1	Argent Street	East of Jabez Street	1 480	22%
2	Crystal Street	Rail Station	5 390	8%
3	Silver City Highway	East of Gypsum Street	5 890	6%
4	Gypsum Road	North of Access Road	4 230	7%
Note 1: See Figure 4.12 Note 2: vpd – vehicles per day Note 3: Commercial Vehicle = Class 3 to 13 vehicles				
Source: Tonkin (2016) – after Section 2.3				

4.5.2.4 Traffic Operation

Tonkin (2016) state that the operation of the road network is considered satisfactory, with congestion not an issue on the road network during peak periods and normal off peak operating conditions.

4.5.2.5 Crash Data

Tonkin (2016) analysed the crash data available for the proposed transportation route from 2010 to 2014. In summary, the relevant crash data includes the following.

- Five crashes on the section of the Barrier Highway/Argent Street that forms part of the proposed transportation route, of which three resulted in casualties.
- Nine crashes at the intersection of Argent Street and Iodide Street, of which four resulted in casualties. This intersection has resulted in more crashes than any other intersection in the central section of Broken Hill. This data, in part, contributed to the Applicant's decision to not include this intersection on the proposed transportation route.
- Three crashes at the intersection of Menindee Road and Crystal Street, of which two resulted in casualties.
- Eleven crashes on the section of Crystal Street that forms part of the proposed transportation route, of which eight occurred at intersections or junctions.
- No crashes occurred on the relevant section of Gypsum Street.

It is noted that the Applicant has transported ore from the Potosi Mine since March 2013, with a total of approximately 38 500 loads transported. During this time, there has been one minor traffic incident, with no injuries, and one reported near miss involving Potosi Mine-related ore transport vehicles.

4.5.3 Predicted Changes to Traffic Environment

Table 4.25 presents the proposed maximum traffic movements per day during the life of the Proposal. In summary, a maximum of 34 loads of 68 heavy vehicle movements and 140 trips or 280 light vehicle movements are anticipated. Section 3.4 of Tonkin (2016) presents the distribution of this additional traffic within Broken Hill. In summary, Tonkin (2016) assumed:

- all heavy vehicle traffic would travel on the proposed transport route (**Figure 4.12**); and
- light vehicles would be distributed throughout Broken Hill depending on the residential locations of workers.

Table 4.25
Proposed Maximum Traffic Levels

Vehicle Type	Maximum Movements per day
Light vehicles	140 trips or 280 movements
Heavy Vehicles (non-ore transportation)	2 loads or 4 movements
Heavy Vehicles (ore transportation)	32 loads or 64 movement (maximum) 16 loads or 32 movement (average)
Source: Perilya Broken Hill Limited	

4.5.4 Management and Mitigation Measures

In order to ensure that the traffic and transport impacts of the Proposal are minimised, the following management and mitigation measures would be implemented. These are consistent with the management and mitigation measures that are currently implemented for the Potosi Mine transportation operations.

- Operate a wheel wash at both the North Mine Site and the Southern Operations Mine Site and ensure that no vehicles are permitted to leave operational sections of the Mine Sites without passing through the wheel wash.
- Ensure that vehicles are not overloaded.
- Ensure that all loads are covered prior to the vehicles leaving the Mine Site.
- Ensure that all vehicles entering and leaving the North Mine and Southern Operations Mine Sites pass through automatic security gates and the drivers are required to swipe in and out electronically and that vehicles arriving and leaving the Mine Sites are videoed.
- Ensure that all vehicles have electronic data recording systems to measure location, speed and critical operational statistics, as well as dash cameras that constantly record video.
- Ensure that a Driver's Code of Conduct requiring the following is implemented and enforced.
  - Compliance with all RMS regulations regarding speed, load limits and driving hours.
  - Compliance with the requirement to cover loads.

  - Limit the use of the engine brake and other noisy driving practices in built-up areas.
  - Show courtesy to all road users at all times.
  - No parking whilst enroute between the Mine Site and the Southern Operations.

In addition, the Applicant would implement the proposed road upgrades identified in Section 2.7.4.4, including the following.

- Intersection of the North Mine Site Access Road and the Barrier Highway.
  - The proposed modifications are presented on **Figure 2.11** and are described in Section 2.7.3.2.
- Intersection of Gypsum Street – Crystal Street.
  - Widen the formation and seal of the left-turn lane from Gypsum Street to Crystal Street / Silver City Highway.
  - Broken Hill City Council have previously identified the surface of this intersection as a issue of concern for Council. The Applicant would enter into negotiations with Council as part a Voluntary Planning Agreement in relation to Council's proposed upgrade of this intersection.
- Intersection of Menindee Road and Crystal Street.
  - Relocate the painted Give Way line for traffic turning left out of Crystal Street.

Finally, the Applicant would negotiate a Voluntary Planning Agreement in relation to maintenance of that section of the proposed transport route that is classified as a "Local Road", namely the section of Crystal Street between the intersection with Menindee Road and Iodide Street. Maintenance of other sections of the proposed transport route that are classified as "Regional" or "State" roads is the responsibility of the Roads and Maritime Service and Broken Hill City Council.

4.5.5 Assessment of Impacts

Based on the assessment provided by Tonkin (2016) and the proposed management and mitigation measures, Tonkin (2016) identified the following.

- Mid-block traffic impacts.

  The anticipated increase in vehicle movement is not considered significant given the capacity of a single two-lane road is between 15 000 and 20 000 vehicles per day.
- Intersection of the Mine Site Access Road and Argent Street.

  There is not expected to be significant queueing of vehicles either entering or leaving the Access Road, including during peak times such as shift change.

- Other intersections.

  Queueing of vehicles may increase at other intersections on the proposed transportation route as a result to the increase in the number of heavy vehicles as they wait to turn. However, this is expected to be intermittent only as one vehicle is arriving every 30 minutes and, as traffic volumes are low, delays are expected to be short.

  Tonkin (2016) have recommended a range of modifications to the following intersections based on simultaneous turn analysis for A-double Road Trains.

  – Menindee Road and Crystal Street.
  – Gypsum Street and Crystal Street.
  – South Mine Access Road and Gypsum Street.

  The Applicant does not propose to implement the recommendations in full for the following reasons.

  – A heavy vehicle permit for A-double Road Trains operating at higher mass limits on the proposed transport route has been granted. The application process for that permit included an inspection of vehicles of that class travelling on the proposed route. The fact that the Permit was granted indicates that the granting authority determined that the intersections were suitable for the class of vehicles proposed.
  – The Applicant has obtained video imagery of an A-double truck travelling on the proposed transport route showing that such vehicles can, with the exception of left-hand turn movements out of Gypsum Street, negotiate the relevant intersections.
  – The proposed transportation route is largely on State and Regional Roads and the number of heavy vehicles movements proposed is only a small proportion of the total number of vehicles using those roads. As a result, the Applicant contends that should upgrades be required, they are the responsibility of Roads and Maritime Service or Broken Hill City Council.

- Road safety risk.

  The Proposal is not expected to increase the safety risk for the following reasons.

  – The existing road network has no existing safety issues.
  – Sight distance is adequate at all the intersections.
  – The proposed increase in traffic is expected to be limited.
  – Drivers are familiar with the vehicle types and movements being undertaken on the road network within the city.

- Pavement Impacts.

  Tonkin (2016) determined that the Proposal would be expected to bring forward pavement-related rehabilitation requirements for roads on the proposed transport route. As the majority of the majority of the proposed transport route comprises State or Regional roads, this is a matter for Roads and Maritime Service and

Broken Hill City Council. However, the Applicant would negotiate a Voluntary Planning Agreement in relation to maintenance of that section of the proposed transport route that is classified as a "Local Road", namely the section of Crystal Street between the intersection with Menindee Road and Iodide Street.

4.6 HISTORIC HERITAGE

4.6.1 Introduction

Based on the risk assessment undertaken for the Proposal (see Section 5.2), the potential historic heritage-related impacts and their risk rankings after the adoption of standard mitigation measures are as follows.

- Unauthorised impact to known historic heritage sites within the Mine Site due to site establishment and construction operations (low risk).

OzArk Environmental and Heritage Management Pty Ltd (OzArk) prepared a *Historic and Aboriginal Heritage Assessment and Statement of Heritage Impact* for the Proposal. The resulting report, referred to hereafter as OzArk (2017a), is presented as Part 5 of the *Specialist Consultant Studies Compendium*. The following sub-section draws on information presented in OzArk (2017a) and describes the existing historic heritage environment, predicated changes to that environment as a result of the Proposal, the proposed management and mitigation measures and an assessment of historic heritage-related impacts.

4.6.2 History of the Mine Site and Surrounds

The history of the Mine Site and surrounds is presented in detail in Section 1.5.2 of this *Environmental Impact Statement* and Section 4.2 of OzArk (2017a). In summary, the Mine Site has been the subject of surface disturbance since the late 1800s. Silver was first discovered along the Broken Hill Line of Lode in 1883, and mining operations have been undertaken within the Mine Site since that date.

4.6.3 Registered Sites of Heritage Significance

OzArk (2017a) undertook a search of the following registers for items of heritage significance.

National Heritage List

The City of Broken Hill is listed on the National Heritage List, with the following aspects noted in the listing.

- Outstanding significance to the nation for its role in creating enormous wealth.
- Its long, enduring and continuing mining operations.
- The community's deep and shared connection with Broken Hill as an isolated city in the desert.
- Its outback landscape, the planned design and landscaping of the town.

- The physical reminders of its mining origins such as the Line of Lode, the barren mullock heaps, tailings, skimps and slagheap escarpment and relict structures.
- The adoption of vanguard industrial relations and management policies, together with its role as a pioneer in setting occupational health and safety standards.
- It has significance as a place where outstanding technical achievement has occurred in refining ore for its minerals and it is also important as a place of research potential to reveal further information on mineral deposits with its range of complex minerals.
- The Broken Hill zinc-lead-silver ore deposit is one of the world's largest ore bodies and contains an extraordinary array of minerals. It is geologically complex and has national scientific significance.
- It is associated with persons of great importance to Australia's history.

NSW State Heritage Register

No items within the Mine Site are listed on the NSW State Heritage Register.

Broken Hill Local Environment Plan 2013

The *Broken Hill Local Environment Plan 2013* (Broken Hill LEP) identifies 32 items of local heritage significance within the Mine Site. **Table 4.26** identifies these items and presents the significance of and potential for impact on each item.

Table 4.26
Registered Sites of Heritage Significance and Proposed Impact

Page 1 of 2

Item	Significance	Potential impact
12 houses at Junction Circle	Local high	None
Ambulance Station (Number 2)	Local Moderate	None
Amalgamated Zinc – Archaeological site	Local Little	New road construction – potential minor impacts to area of low archaeological potential and little heritage significance.
Compressed Air and Power Line	Local Moderate	None
Drainage Channel	Local Low	Potential indirect impacts.
Houses 17 18 19 19B and 20	Local High	None
No. 1 Mill Foundations	Local High	New road construction – potential physical and indirect impacts to high significance item.
No. 1 Mill Tunnel	Local High	None
No. 2 Changehouse and Extension	Local High	None
No. 2 Filter House and Loading Station	Local High	None
No. 2 Lead Bin	Local High	New road construction – potential indirect impacts to high significance item.
No. 2 Mill	Local Exceptional	None
No. 2 Reagent Shed	Local High	None

Table 4.26 (Cont'd)
Registered Sites of Heritage Significance and Proposed Impact

Item	Significance	Potential impact
No. 2 Residue Pumphouse Number 12 Conveyor and Hopper	Local High	None
No. 2 Shaft Headframe and Crusher Station	Local High	None
No. 2 Shaft Winderhouse	Local High	None
No. 2 Thickener Vats	Local High	None
No. 3 Changehouse and Subsurface Plat	Local High	None – reuse of building with no changes to external fabric.
No. 3 Crusher House	Local High	None
No. 3 Shaft Headframe	Local High	None
No. 3 Transformers and Cooling Tower	Local Moderate	None
No. 3 Vent Fan	Local Little	None
No. 3 Winderhouse	Local High	None
North Broken Hill Entrance Gates	Local Moderate	None
North Mine Assay Office	Local Moderate	None
North Mine General Offices	Local High	None
North Mine Residences	Local High	None
Shed (former Saw Mill)	Local Moderate	None
Standard Gauge Railway Siding	Local Moderate	New road construction –impacts to sections of moderate heritage significance.
Tanks and Shed	Local Moderate	None
Water Tank on Lords Hill (outside Precinct)	Local Moderate	None
Weighbridge Station	Local Moderate	None
Source: OzArk (2017a) – after Table 4-2		

4.6.4 Assessment Methodology

The historic heritage assessment was undertaken in accordance with the NSW Heritage Branch guidelines, including:

- *Assessing Heritage Significance* (2001).
- *Statement of Heritage Impact* (2002).
- *Assessing Significance for Historical Archaeological Sites and Relics* (2009).

The assessment methodology is described in Section 4.1 of OzArk (2017a) and includes an assessment of historic heritage in accordance with the Broken Hill LEP 2013, the Broken Hill Development Control Plan and the Australia ICOMOS Burra Charter 1999.

4.6.5 Potential Heritage Impacts

Table 4.12 identifies the historic heritage items listed under the Broken Hill LEP that could potentially or would be impacted by the Proposal. In summary, these include the following (**Figure 4.13**).

- Amalgamated Zinc Archaeological Site (**Plate 4.1**).

  This site includes an area used by Amalgamated Zinc between 1905 and 1924, with a number of buildings demolished or reused for the No. 2 Mine infrastructure. OzArk (2017a) state that potential archaeological remains of the may be located in the vicinity of the proposed haul road and amenity bund.

- Drainage Channel (**Plate 4.2)**.

  The Drainage Channel is an existing water management structure in good condition. It would not be directly impacted by the Proposal and would continue to be used for water management within the Mine Site.

- No. 1 Mill Foundations (**Plate 4.3**).

  The No. 1 Mill Foundations are located on either side of the Cosmopolitan Open Cut Access Ramp. These foundations comprise arched sections concrete, brick and stone and are the most substantial remaining evidence of one of the earlier phases of mining activity within the Mine Site and the remnants of Broken Hill's first all-flotation mill. No direct impacts are proposed.

- No. 2 Lead Bin (**Plate 4.4**).

  The No. 2 Lead Bin is a reinforced concrete structure in poor condition located adjacent to the proposed haul road. The structure was previously used for storage of lead concentrate prior to loading into trains for transportation from the Mine Site. Indirect vibration-related impacts associated with haul truck movements may occur.

- No. 3 Change house and Subsurface Plat (**Plate 4.5** and **4.6**).

  This structure is constructed of reinforced concrete and has two levels. The lower level was fitted out with lockers, showers and toilets – all of which have been removed. The change house is connected to the No. 3 shaft by a concrete tunnel housing offices, the ambulance station and the access platform to the shaft. The roof is made from steel trusses and is constructed in a butterfly style. The front of the building has a wave shaped formed concrete veranda and a chrome and glass entrance area. Completed in 1954, the change house is one of the most stylistically distinctive buildings within the Broken Hill mining field and, unlike many of the other change houses, remains in good condition. The change house is currently used by the Applicant for its original purpose and would continue to be so used.

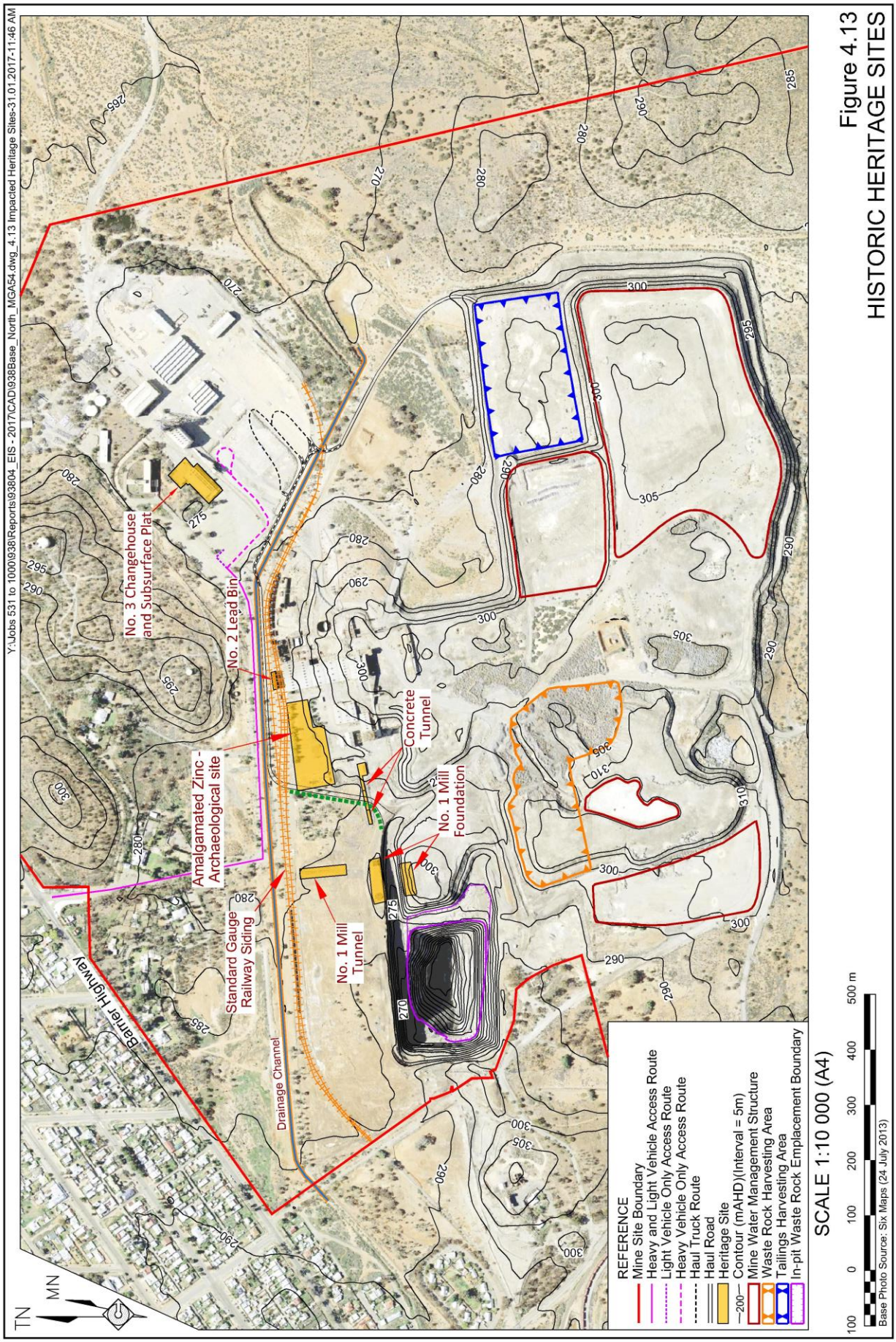


Figure 4.13
HISTORIC HERITAGE SITES

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Plate 4.1: Northwestern section of the Amalgamated Zinc Archeological Site
(Source: OzArk (2017a) - Figure 4.5)

Plate 4.2: Section stone built drainage channel
(Source: OzArk (2017a) - Figure 4.11)

Plate 4.3: No. 1 Mill Foundations facing southwest
(Source: OzArk (2017a) - Figure 4.2)

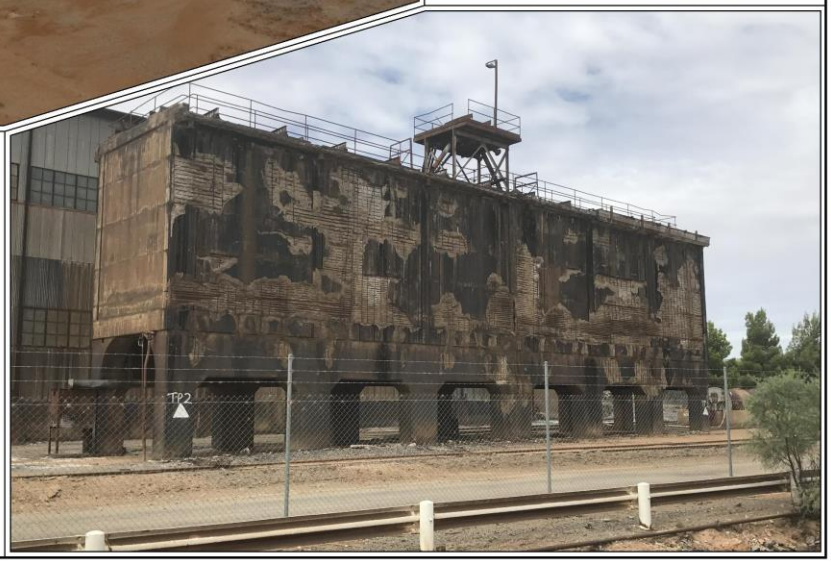

Plate 4.4: Lead bin showing decaying concrete
(Source: Perilya Broken Hill Limited)

- Standard Gauge Railway Siding (**Plate 4.7**).

  This rail siding, constructed in 1970 replaced the original narrow gauge line constructed in the 1890s. The Applicant considers that the line is no longer suitable for rail operations. The proposed haulage route would cross the existing siding in a single location to the north of the Cosmopolitan Open Cut.

- Concrete Tunnel (**Plate 4.8**).

  OzArk (2017a) describe the tunnel as being in poor condition, with much of it collapsed or removed. It is interpreted as once operating as underground shaft access for stretchers. The concrete tunnel would not be directly impacted, with the proposed haul road and amenity bund passing through a collapsed section of the tunnel.

4.6.6 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to ensure that Proposal-related impacts to historic cultural heritage are minimised.

- Restrict ground-disturbing activities to those prior areas of disturbance and to those areas identified presented in Section 2 of the *Environmental Impact Statement*.
- Implement an exclusion zone of at least 20m the No. 1 Mill Foundations.
- Undertake monitoring of the stability of the No. 1 Mill Foundations and Lead Bin and implement appropriate remediation or management measures as required.
- Minimise disturbance to the Concrete Tunnel where practicable and safe to do so.
- Undertake monitoring of the Drainage Channel to ensure that the stone lining remains intact.
- Install a covering with a protective layer of fill over the Standard Gauge Railway Siding to prevent damage from the heavy vehicle crossing. If that is not practicable, undertake long-term archival recording and salvage of the section of the Standard Gauge Railway Siding to be removed in accordance with the advice of a qualified archaeologist.

4.6.7 Assessment of Significance and Impacts

The heritage significance of the historic heritage items that would be impacted by the Proposal is presented in **Table 4.12** and is summarised and assessed below.

Amalgamated Zinc Archaeological Site

OzArk (2017a) state that this site has low archaeological potential as the area is likely to have been altered and disturbed by more recent construction work and any remains would have little archaeological significance. As a result, the Proposal would not result in significant impacts to this site.

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Plate 4.5: No. 3 Changehouse - external view
(Source: OzArk (2017a) - Figure 4.9)

Plate 4.6: No. 3 Changehouse - Internal view
(Source: A130116_IMG_3304)

Plate 4.7: Standard Gauge Rail Siding
(Source: OzArk (2017a) - Figure 4.12)

Plate 4.8: Concrete Tunnel looking northeast
(Source: C280416_IMG3690)

4.6.8 Drainage Channel

OzArk (2017a) state that this site has moderate archaeological significance. Given that there would be no direct impacts and that the site would continue to be used for its intended purpose, the Proposal would not result in significant impacts to this site.

No. 1 Mill Foundations

OzArk (2017a) state that the No. 1 Mill Foundations are of high heritage significance. However, given the implementation of the management and mitigation measures in Section 4.6.8 and that no direct disturbance is proposed, OzArk (2017a) determined that the Proposal would not result in significant impacts to this site.

No. 2 Lead Bin

OzArk (2017a) state that the No. 2 Lead Bin is of high heritage significance. However, given the implementation of the management and mitigation measures in Section 4.6.8 and that no direct disturbance is proposed, OzArk (2017a) determined that the Proposal would not result in significant impacts to this site.

No. 3 Change house and Subsurface Plat

OzArk (2017a) state the No. 3 Change house and Subsurface Plat have a high heritage significance, principally for its association with the No. 3 Mine and its external architectural design, particularly its exterior fabric and unusual roof line. The building would be reused for its intended purpose, with internal modifications to make the building more functional. OzArk (2017a) determined that the Proposal would not result in significant impacts to this site. Indeed, reuse of the building is an excellent heritage outcome.

Standard Gauge Railway Siding

OzArk (2017a) state that the Standard Gauge Railway Siding has moderate heritage significance for its association with all three mining precincts within the Mine Site. Given that there would be very limited direct impacts to this site, the Proposal would not result in significant impacts.

Concrete Tunnel

OzArk (2017a) state that the Concrete Tunnel is not an item of heritage significance and, as a result, the Proposal would not result in significant impacts.

4.6.9 Monitoring

The Applicant would undertake monitoring of the stability of the No. 1 Mill Foundations and Lead Bin and would implement appropriate remediation or management measures as required.

4.7 SURFACE WATER

4.7.1 Introduction

Based on the risk analysis undertaken for the Proposal (Section 5.2), the potential impacts relating to surface water and their risk rankings after the adoption of standard mitigation measures are as follows.

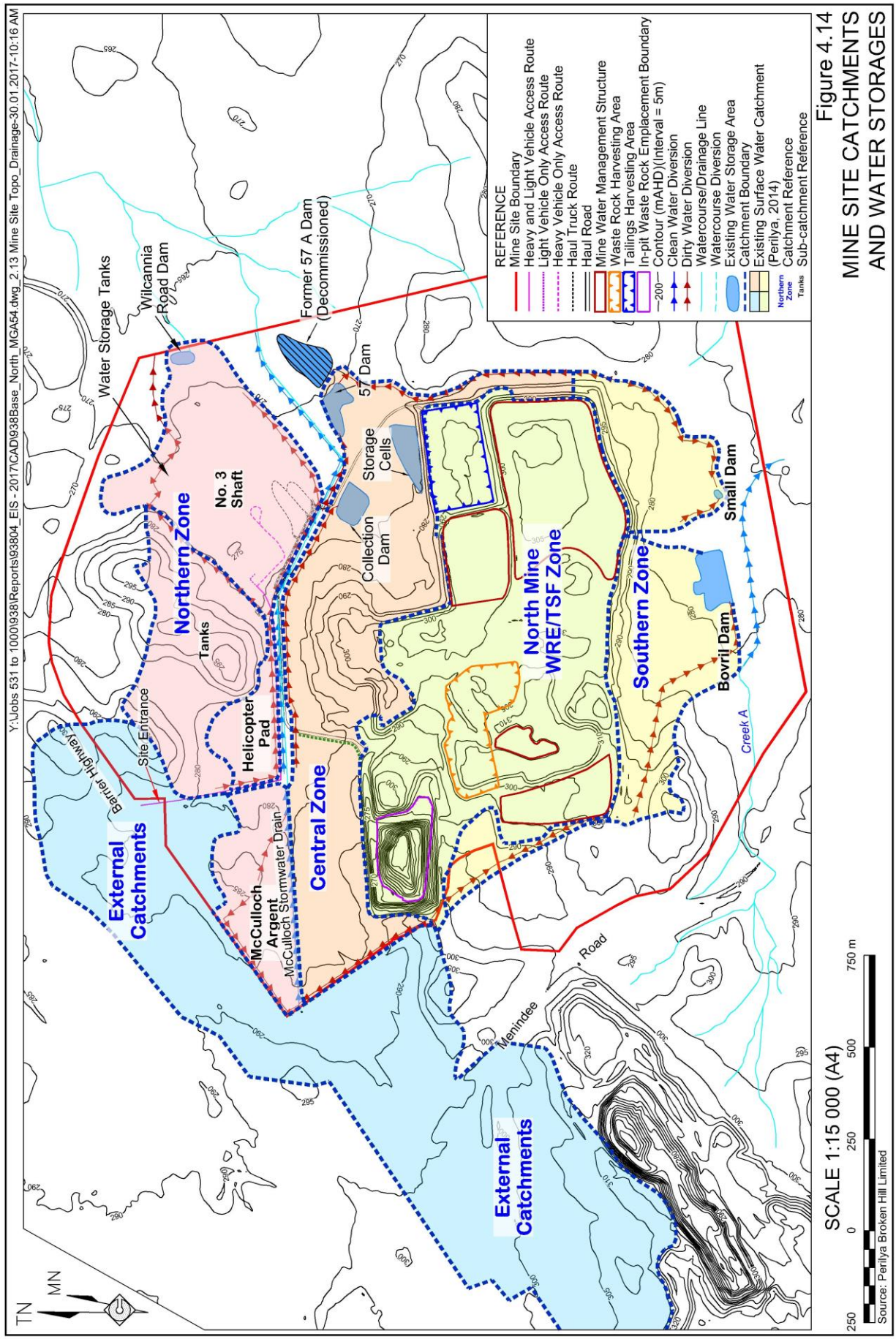
- Discharge of sediment-laden water impacting upon riverine ecology and downstream users (low risk).
- Inability to discharge to surface water and groundwater systems without chemical or additional treatment (low risk).
- Diversion and retention banks erosion and/or instability leading to increased sediment loads (low risk).

The following sub-section has been prepared by RWC based largely on a document entitled *EPL2683 Pollution Reduction Program – 100-year ARI Assessment – North Mine (Broken Hill)* dated June 2014 and referred to hereafter as Perilya (2014). That document is presented as **Appendix 5**. This subsection describes existing surface water environment within the Mine Site, as well as the potential surface water impacts of the Proposal, proposed management and mitigation measures and impact assessment.

4.7.2 Existing Surface Water Environment

The existing drainage and catchments within and surrounding the Mine Site are described in detail in Section 2.8.3 and are shown on **Figures 4.14**. The following provides a brief summary of that description.

- Willa Willyong Creek drains an area to the south and east of the Mine Site and flows in a northeasterly direction before flowing into the Stephens Creek Reservoir. The Creek is ephemeral and typically only flows after substantial rainfall.
- Within the Mine Site, two clean water drainages exist as follows.
  - McCulloch Stormwater Drain – collects water from the urban area to the west and north of the Mine Site and conveys it to the east through the Mine Site via a buried stormwater pipe and a lined channel. Water is discharged from the channel to natural drainage to the east of the Mine Site.
  - Creek A – an unnamed watercourse within the southern section of the Mine Site that drains an area to the west of Menindee Road and conveys that water to the east and southeast, exiting the Mine Site. A short section of the watercourse has been diverted to prevent mixing of clean and dirty water.
- Within the Mine Site, four dirty water catchments occur as follows.
  - Northern Zone – comprising an area to the north of the McCulloch Stormwater Drain. The Northern Zone comprises four sub-catchments which either drain internally or flow to the Wilcannia Road Dam.


Y:\Jobs 531 to 1000\938\Reports\93804_EIS - 2017\CAD\938Base_North_MGA54.dwg_2.13 Mine Site Topo_Drainage-30.01.2017-10:16 AM
REFERENCE
Mine Site Boundary
Heavy and Light Vehicle Access Route
Light Vehicle Only Access Route
Heavy Vehicle Only Access Route
Haul Truck Route
Haul Road
Mine Water Management Structure
Waste Rock Harvesting Area
Tailings Harvesting Area
In-pit Waste Rock Emplacement Boundary
Contour (mAHD)(Interval = 5m)
Clean Water Diversion
Dirty Water Diversion
Watercourse/Drainage Line
Watercourse Diversion
Existing Water Storage Area
Catchment Boundary
Existing Surface Water Catchment (Perilya, 2014)
Catchment Reference
Sub-catchment Reference
Northern Zone Tanks
Water Storage Tanks
Wilcannia Road Dam
Former 57 A Dam (Decommissioned)
57 Dam
Storage Cells
Collection Dam
No. 3 Shaft
Northern Zone
Tanks
Helicopter Pad
Site Entrance
Barrier Highway
External Catchments
McCulloch Argent
McCulloch Stormwater Drain
Central Zone
North Mine WRE/TSF Zone
Southern Zone
Small Dam
Bovril Dam
Creek A
Road
Menindee
External Catchments
TN
MN
Figure 4.14
MINE SITE CATCHMENTS AND WATER STORAGES
SCALE 1:15 000 (A4)
250 0 250 500 750 m
Source: Perilya Broken Hill Limited

- Central Zone – comprising the area to the south of the McCulloch Stormwater Drain and north of the North Mine WRE/TSF Zone. Potentially sediment-laden water within this sub-catchment is directed to the Collection Dam and/or the 57 Dam. If required, water from these storages may be pumped to a series of Storage Cells.
- North Mine WRE/TSF Zone – comprising the existing waste rock emplacements, tailings storage facilities and the Cosmopolitan Open Cut. This catchment in internally draining. In the event that surface water is discharged from this catchment, it would report to the Central or Southern Zones.
- Southern Zone – comprising an area to west and south of the North Mine WRE/TSF Zone. Potentially sediment-laden water within this sub-catchment is directed to the Bovril Dam or the Small Dam.

Perilya (2014) presents an assessment of the adequacy of the storage capacity of each of the above dirty water storages under a 1 in 100 year ARI storm event. That assessment may be summarised as follows. Based on that assessment, Perilya (2014) determined the following.

- The Collection, Small and Wilcannia Road Dams required enlargement. **Table 4.27** presents the calculated volumes required to retain the modelled stormwater event.
- A range of additional minor works were required to ensure the ongoing proper functioning of the surface water managements system.

The Applicant subsequently undertook the required works. As a result, the Mine Site currently does not discharge potentially sediment laden water during rainfall events that are less than the modelled 1 in 100 year ARI storm event.

Table 4.27
Estimated Dirty Water Storage Volumes

Storage	Estimated Volume (ML)
Wilcannia Road Dam	4.4
Collection Dam	8.8
57 Dam	6.5
Storage Cells	10.4
Bovril Dam	18.4
Total	**48.5**

Source: Perilya Broken Hill Limited

4.7.3 Potential Surface Water Impacts

Potential surface water impacts include the following.

- Discharge of salt-laden water from the evaporation ponds or mine water settling pond and associated downstream impacts.
- Discharge of sediment-laden water from disturbed sections of the Mine Site.

4.7.4 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to ensure that Proposal-related impacts to the surface water environment are minimised.

- Prepare a detailed *Surface Water, Sediment and Erosion Control Plan*, including a description of surface water management structures and procedures identified in Perilya (2014).
- Inspect and repair all surface water management structures monthly or immediately following all rainfall events of more than 20mm / 24-hours.
- Ensure that all surface water collected within the surface water storages is either used for dust suppression or mining-related purposes or is pumped to the evaporation ponds within 5 days.
- Store all hydrocarbon and chemical products within a bunded area in accordance with *AS1940 – The storage and handling of flammable and combustible liquids.*
- Ensure that the evaporation ponds are engineered and lined with a welded HDPE liner or similar.

4.7.5 Assessment of Impacts

Given that the Mine Site does not currently discharge potentially sediment laden water during rainfall events less than a 1 in 100 year ARI event and the evaporation ponds would be lined with an HDPE Liner, the Applicant anticipates that the Proposal would not result in adverse surface water-related impacts.

4.8 GROUNDWATER

4.8.1 Introduction

Based on the risk analysis undertaken for the Proposal (Section 5.2), the potential impacts relating to groundwater and their risk rankings after the adoption of standard mitigation measures are as follows.

- Reduction in groundwater discharge to surrounding creeks / rivers, adverse impacts on groundwater dependent ecosystems or surrounding groundwater users (not applicable).
- Reduction in groundwater discharge to surrounding creeks / rivers, adverse impacts on groundwater dependent ecosystems or surrounding groundwater users (not applicable).
- Discharge of poor quality groundwater to surrounding aquifers (low risk).

The following sub-section has been prepared by RWC and describes existing surface water environment within the Mine Site, as well as the potential surface water impacts of the Proposal, proposed management and mitigation measures and impact assessment.

4.8.2 Existing Groundwater Environment

Groundwater Level

The existing groundwater environment is described in Section 2.8.4.3. The information presented in that section may be summarised as follows.

- The Mine Site occurs within a fractured rock aquifer associated with the Willyama Supergroup. Groundwater within the aquifer is limited to fractures and faults within the surrounding rock formation. Such fracture-hosted aquifers are typically "tight" and low yielding. Groundwater recharge occurs via recharge by direct rainfall in subcrop areas or via leakage from the regolith or colluvial deposits associated with ephemeral water courses.
- The aquifer has been the subject of extensive dewatering since the commencement of mining operations in 1883. Following the cessation of mining operations in February 1998 and the standing water level within the North Mine workings has steadily increased from 1 714m below ground level (mbgl) to 579.2mbgl on 6 January 2017.

Groundwater Quality

The Applicant engaged C.M. Jewell & Associates Pty Ltd to prepare an assessment of the quality of water within the No. 3 Shaft. That report, referred to hereafter as Jewell (2011), is presented as **Appendix 6**. In summary, that assessment determined the following.

- pH – between 6.5 and 7.0.
- Electrical conductivity – between 12 000µS/cm and 13 000µS/cm.
- Metals – elevated concentrations of arsenic, cadmium, copper, iron, lead, manganese, nickel and zinc.

As a result, groundwater within the Mine Site does not meet the criteria for discharge to natural drainage.

Groundwater Users and Groundwater Dependent Ecosystems

Table 4.28 and **Figure 4.1** present the registered bores surrounding the Mine Site. In summary, there are 58 registered bores in the vicinity of the Mine Site. These bores are typically between 6m and 20m deep, with only 17 bores deeper then 20m and four deeper than 40m. Many of these bores are clustered around existing operations (**Figure 3.1**), including the Applicant's Southern Operations and Potosi Mine and Broken Hill Airport. As a result given the shallow depth of many of the bores, the Applicant presumes that most of the registered bores are monitoring bores.

The closest bore to the Mine Site is GW804682 which has a recorded depth of 38m and a yield of between 0.1L/s and 0.75L/s.

Table 4.28
Surrounding Registered Bores

Bore	Date drilled	Maximum depth (m)	Yield (L/s)	Aquifer
GW010094	1961	19.8	1.26	Not stated
GW010099	1961	18.3	0.63	Not stated
GW010094	1961	17.4	1.26	Not stated
GW010099	1961	15.2	0.63	Not stated
GW021680	1964	30.5	0.38	“Rock”
GW500071	1995	7.5	Not stated	Silt
GW600001	2000	44.3	Not stated	Not stated
GW600132	2006	15.0	0.01	Conglomerate
GW600144	2007	19.8	1.25	Not stated
GW600145	2008	7.2	1.26	Silty Clay
GW600146	2008	19.0	1.26	Clay
GW600147	2008	20.0	1.26	Clay
GW600148	2008	16.1	1.26	Clay
GW600160	2009	30.0	Not stated	Basalt
GW600162	2009	14.0	Not stated	Basalt
GW600163	2009	30.0	0.10	Basalt
GW600171	2009	30.0	1.25	Quartzite
GW600301	2011	20.4	Not stated	Amphibolite
GW600302	2011	20.54	Not stated	Amphibolite
GW600303	2011	12.0	Not stated	Not stated
GW600304	2011	16.0	Not stated	Not stated
GW600305	2011	16.0	Not stated	Not stated
GW600306	2011	23.2	Not stated	Not stated
GW600307	2011	18.9	Not stated	Not stated
GW600308	2011	12.8	Not stated	Not stated
GW600360	2008	19.0	Not stated	Not stated
GW600361	2008	26.0	Not stated	Not stated
GW600362	2008	17.0	Not stated	Not stated
GW600363	2008	19.0	Not stated	Not stated
GW600364	2008	22.0	Not stated	Not stated
GW600365	2010	25.0	Not stated	Not stated
GW600366	2010	16.0	Not stated	Not stated
GW600367	2010	20.0	Not stated	Not stated
GW600368	2010	20.0	Not stated	Not stated
GW600381	2012	6.0	Not stated	Not stated
GW600382	2012	6.0	Not stated	Not stated
GW600383	2012	6.0	Not stated	Not stated
GW600384	2012	6.0	Not stated	Not stated
GW600385	2012	6.0	Not stated	Not stated

Table 4.28 (Cont'd)
Surrounding Registered Bores

Bore	Date drilled	Maximum depth (m)	Yield (L/s)	Aquifer
GW600386	2012	6.0	Not stated	Not stated
GW600433	2012	17.0	Not stated	Not stated
GW600434	2012	17.7	Not stated	Not stated
GW600435	2012	20.0	Not stated	Not stated
GW600468	2013	2.0	Not stated	Not stated
GW600469	2013	6.0	0.10	Feldspar porphyry
GW600470	2013	40.0	1.0	Quartz porphyry
GW600471	2013	5.2	1.2	Feldspar porphyry
GW600472	2013	15.0	0.25	Feldspar porphyry
GW600473	2013	40.0	1.5	Feldspar porphyry
GW600474	2013	4.4	0.10	Feldspar porphyry
GW703398	2009	Not stated	Not stated	Not stated
GW703399	2009	Not stated	Not stated	Not stated
GW803404	2007	31.0	0.15	Basalt
GW803554	2008	100.0	0.50	Quartzite/Schist
GW803555	2008	100.0	0.2	Quartzite
GW803556	2008	100.0	0.5	Quartzite/Schist
GW804170	1999	141.5	Not stated	Not stated
GW804682	2010	38.0	0.10 to 0.75	Basalt
Source: NSW Water Info 2017				

There are no known groundwater dependant ecosystems in the vicinity of the Mine Site.

4.8.3 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to ensure that Proposal-related impacts to the groundwater water environment are minimised.

- Ensure that all produced groundwater is transferred either to the evaporation ponds or to the Southern Operations for use in processing operations.
- Store all hydrocarbon and chemical products within a bunded area in accordance with *AS1940 – The storage and handling of flammable and combustible liquids.*
- Ensure that the volume of water pumped out of and into the Mine is monitored and recorded to enable net groundwater extraction rate to be determined.
- Continue to monitor the standing water level within the No. 3 Shaft.

4.8.4 Assessment of Impacts

Under the NSW Aquifer Interference Policy, the aquifer within and surrounding the Mine Site may be classified as a "less productive fractured rock aquifer." Under that Policy, thresholds for determining minimal impact have been determined and are presented in **Table 4.29**. That table also includes an assessment of the Proposal against each of the identified criterion. In summary, the Proposal is not expected to exceed the minimal impact criteria.

Table 4.29
Groundwater Impact Assessment

Aquifer Interference Policy Consideration	Discussion and Assessment
Water Table	
Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan.	The Mine Site is not located within 40m of a high priority groundwater dependent ecosystem or high priority culturally significant site.
A maximum of a 2m decline cumulatively at any water supply work.	There are 58 registered bores surrounding the Mine Site, only four deeper than 40m and the deepest being 141.5m. In addition, the applicant understands that most of the surrounding bores are monitoring bores. The water level within the No. 3 Shaft on 6 January 2017 was 579.2mbgl, or more than 400m below the base of the deepest surrounding bore. As a result, the Proposal would not result in additional impacts to any water supply work.
Water Pressure	
A cumulative pressure head decline of not more than a 2m decline, at any water supply work.	See previous comment.
Water Quality	
Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity.	The Proposal would not result in a change to the quality of groundwater. As a result, there would be no change in the beneficial use category of the groundwater.

4.8.5 Monitoring

The Applicant would implement the following monitoring.

- Ensure that the volume of water pumped out of and into the Mine is monitored and recorded to enable net groundwater extraction rate to be determined.
- Continue to monitor the standing water level within the No. 3 Shaft.

4.9 ECOLOGY

4.9.1 Introduction

Based on the risk analysis undertaken for the Proposal (Section 5.2), the potential impacts relating to ecology factors and their risk rankings after the adoption of standard mitigation measures are as follows.

- Loss of terrestrial ecology habitat, local vegetation and biodiversity (low risk).
- Injuries to native wildlife and fauna during clearing / earthworks (pre-strip) (low risk).
- Adverse impacts on surface water dependent ecosystems (low risk).
- Indirect impacts to fauna communities due to light / noise / blasting etc. (low risk).
- Direct impacts to fauna communities, including microbats (moderate risk).

OzArk Environmental and Heritage Management Pty Ltd (OzArk) prepared an ecological assessment for the Proposal. The resulting report, referred to hereafter as OzArk (2017b) is presented as Part 6 of the *Specialist Consultant Studies Compendium*. The following sub-section draws on information presented in that report and describes the predicted and observed regional and local flora, fauna and vegetation communities, including threatened flora and fauna species within the Mine Site, as well as the potential ecological impacts of the Proposal proposed management and mitigation measures, and impact assessment.

4.9.2 Regional and Local Setting

The Mine Site is located adjacent to the Willyama Common, a reserve with grazing and clearing restrictions and higher biodiversity than the Mine Site. The Mine Site is located within the Barrier Ranges and the Barrier Downs Mitchell Landscape Units, characterised by lithosols and shallow calcareous soils.

OzArk (2017b) states that the Mine Site is located in areas mapped as in *Acacia aneura – Acacia tetragonophylla* tall shrubland. This is an open shrubland consisting of small acacias with extensive open areas and areas with dead shrubs. OzArk (2017b) state that as the Mine Site been extensively cleared, this vegetation type is no longer present.

4.9.3 Desktop Assessment

4.9.3.1 Methodology

OzArk (2017b) conducted a search of the following information sources and databases on 12 July 2016 over an area centred on the Mine Site with a 10km radius.

- Aerial photograph interpretation.
- Office of Environment and Heritage (OEH) Threatened Species online database.

- Department of Environment and Energy (DoEE) Protected Matters (EPBC Act) Database.
- Department of Primary Industries (DPI) Records Viewer.
- Royal Botanical Gardens Plant Information Network System.

4.9.3.2 Results

Table 4.30 presents the threatened species identified by OzArk (2017b) as occurring within 10km of the Mine Site. No threatened populations and communities were identified.

4.9.4 Field Survey Methodology

A field survey was carried out by OzArk (2017b) on 16 to 20 June 2016 in conjunction with the heritage assessment. The field survey included the following.

- Photo recording of flora species within the Mine Site.
- A microbat ultrasonic assessment, incorporating placement of an echolocation detector at the entrance to the Cosmopolitan Portal Mine Shaft for five nights and analysis of recorded calls using computer software. Mining operations were not in progress at the time that the survey was undertaken.

4.9.5 Mine Site Flora and Fauna

4.9.5.1 Vegetation Communities Identified

OzArk (2017b) state that the Mine Site is located in areas mapped as in *Acacia aneura – Acacia tetragonophylla tall shrubland*. However, due to extensive clearing for mining operations, this vegetation type is no longer present within the Mine Site and that the vegetation community within the Mine Site, where it exists, is a remnant of vegetation planted in the 1950s. As a result, the vegetation within the Mine Site is not consistent with any mapped vegetation communities and cannot be classified as any vegetation community. The vegetation present within the Mine Site is not classified as an Endangered Ecological Community.

4.9.5.2 Flora Species Identified

OzArk (2017b) identified a total of 15 flora species within the Mine Site, comprising 12 native species and 3 exotic species. A full list of identified flora species is presented in Appendix A of OzArk (2017b). No threatened flora species were recorded during field surveys.

One noxious weed species, namely Green Cestrum (*Cestrum parqui*) was observed within the Mine Site.

4.9.5.3 Fauna Species Identified

No opportunistic fauna survey or fauna trapping was conducted. No fauna species were observed during the field survey.

Table 4.30
Threatened Species within 10km of the Mine Site

Common Name	Scientific Name	TSC Act Status	EPBC Act Status
Flora			
Purple-wood Wattle	*Acacia carneorum*	Vulnerable	Vulnerable
Mallee Golden Wattle	*Acacia notabilis*	Endangered	
Creek Wattle	*Acacia rivalis*	Endangered	
Showy Indigo	*Indigofera longibractea*	Endangered	
Birds			
Redthroat	*Pyrrholaemus brunneus*	Vulnerable	
Little Eagle	*Hieraaetus morphnoides*	Vulnerable	
Rufous Fieldwren	*Calamanthus campestris*	Vulnerable	
Rainbow Bee-eater	*Merops ornatus*	Protected	Protected Under International Agreement
Blue-billed Duck	*Oxyura australis*	Vulnerable	
Spotted Harrier	*Circus assimilis*	Vulnerable	
Major Mitchell's Cockatoo	*Lophochroa leadbeateri*	Vulnerable (Category 2)	
Common Sandpiper	*Actitis hypoleucos*	Protected	Protected Under International Agreement
Ruddy Turnstone	*Arenaria interpres*	Protected	Protected Under International Agreement
Bush Stone-curlew	*Burhinus grallarius*	Endangered	
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	Vulnerable	
White-fronted Chat	*Epthianura albifrons*	Vulnerable	
Black Falcon	*Falco subniger*	Vulnerable	
Black-breasted Buzzard	*Hamirostra melanosternon*	Vulnerable (Category 3)	
Night Parrot	*Pezoporus occidentalis*	Extinct	Endangered
Australian Painted Snipe	*Rostratula australis*	Endangered	Endangered
Common Greenshank	*Tringa nebularia*	Protected	Protected Under International Agreement
Mammals			
Little Pied Bat	*Chalinolobus picatus*	Vulnerable	
Bolam's Mouse	*Pseudomys bolami*	Endangered	
Greater Stick-nest Rat	*Leporillus conditor*	Extinct	Vulnerable
Dusky Hopping-mouse	*Notomys fuscus*	Endangered	Vulnerable
Stripe-faced Dunnart	*Sminthopsis macroura*	Vulnerable	
Reptiles			
Western Blue-tongued Lizard	*Tiliqua occipitalis*	Vulnerable	
Ringed Brown Snake	*Pseudonaja modesta*	Endangered	

Source: OzArk (2016b) after Table 3-2

4.9.6 Potential Direct and Indirect Impacts

4.9.6.1 Loss of Vegetation and Habitat

Clearing of native vegetation is a key threatening process listed under the TSC Act and the EPBC Act. The Proposal would result in the clearing of approximately 1ha of vegetation. No areas identified as NSW or Commonwealth critical habitat would be impacted by the Proposal. No aquatic habitat would be impacted. No hollow-bearing trees would be impacted by the Proposal.

4.9.6.2 Wildlife Connectivity and Habitat Fragmentation

OzArk (2017b) determined that, due to the previous level of clearing within the Mine Site, the Proposal would not significantly impact any wildlife corridors or reduce habitat connectivity.

4.9.6.3 Potential Indirect Impacts on Flora and Fauna

The Proposal may result in indirect impacts to flora and fauna, including noise impacts and the dispersal and propagation of weed species.

OzArk (2017b) determined that noise impacts from the Proposal would not have significant impacts on fauna. Potential exists for the dispersal and propagation of weed species (including the Green Cestrum), however, OzArk (2017b) determined that these impacts would be minimal.

4.9.7 Management and Mitigation Measures

The Applicant has designed the Proposal to minimise impacts on threatened species by firstly avoiding and then mitigating potential biodiversity impacts.

The layout of the Proposal has been designed with the intent to minimise disturbance minimise the clearing of vegetation and utilise existing access roads and cleared areas where possible to ensure that no 'significant effect' would occur upon any threatened biota or their habitats.

The Applicant would implement the following management and mitigation measures to ensure that Proposal-related ecological impacts are minimised.

- Ensure that any declared noxious weeds identified during construction operations are managed in accordance with the requirements of the *Noxious Weeds Act 1993*.
- Ensure that all ground-engaging machinery is cleaned prior to arriving at or departing the Mine Site.
- Ensure that all food scraps and rubbish are disposed of in sealed, animal-proof containers to prevent increased levels of pest species within the Mine Site.

4.9.8 Assessment of Impacts

4.9.8.1 Vegetation Communities

The Proposal would result in the clearing of approximately 1ha of vegetation. No areas identified as NSW or Commonwealth critical habitat would be impacted by the Proposal. Given that the vegetation present within the Mine Site is not consistent with any mapped vegetation communities OzArk (2017b) determined that the Proposal would not have a significant impact on vegetation communities.

4.9.8.2 TSC Act Impact Assessment

Significance assessments in accordance with Section 5A of the EP&A Act were undertaken by OzArk (2017b) for two fauna species listed under the TSC Act with the potential to occur within the Mine Site. The significance assessments concluded that the Proposal would be unlikely to have a significant effect on either species.

4.9.8.3 EPBC Act Assessment

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

4.9.9 Assessment of Offsets

As no native communities would be disturbed by the Proposal, no offsetting is required in accordance with the OEH principles for the use of biodiversity offsets in NSW.

4.10 ABORIGINAL HERITAGE

4.10.1 Introduction

Based on the risk assessment undertaken for the Proposal (see Section 5.2), the potential Aboriginal heritage-related impacts and their risk rankings after the adoption of standard mitigation measures are as follows.

- Loss of heritage values due to unauthorised destruction of known sites (moderate risk).
- Loss of heritage values due to unauthorised destruction of unknown sites within approved areas (low risk).

OzArk Environmental and Heritage Management Pty Ltd (OzArk) prepared a *Historic and Aboriginal Heritage Assessment and Statement of Heritage Impact* for the Proposal. The resulting report, referred to hereafter as OzArk (2017a), is presented as Part 5 of the *Specialist Consultant Studies Compendium*. The following sub-section draws on information presented in that report and describes the existing Aboriginal heritage environment, predicated changes to that environment as a result of the Proposal, the proposed management and mitigation measures and an assessment of Aboriginal heritage-related impacts.

4.10.2 Assessment Methodology

Due to the previous disturbance within the Mine Site, a Due Diligence assessment was considered adequate for the purposes of assessment. The Due Diligence assessment incorporated desktop database searches and a site inspection.

Desktop Database Search

OzArk (2017a) undertook a search of the Aboriginal Heritage Information Management System (AHIMS) database on 2 March 2016 over the search area of Lot 7313 DP1185108 with a 1km buffer.

Site Inspection

A Site Inspection of the Mine Site was undertaken on 15 and 16 June 2016 in conjunction with the historic heritage assessment. The site inspection confirmed that the Mine Site has experienced high levels of ground surface disturbance, including the revegetated areas.

4.10.3 Results

Seven previously recorded Aboriginal sites were identified within the desktop database search area, however no previously recorded Aboriginal sites were identified within the Mine Site. No Aboriginal sites or objects were recorded during the site inspection.

4.10.4 Management and Mitigation Measures

The Applicant would implement the following management and mitigation measures to ensure that Proposal-related impacts to Aboriginal cultural heritage are minimised.

- Restrict ground-disturbing activities to those presented in Section 2 and **Figure 2.1**.
- Ensure that all employees are aware of their responsibilities concerning the management of any unanticipated discovered Aboriginal objects under the NPW Act.
- Ensure that, in the event that an unanticipated Aboriginal object is discovered, the following procedure is implemented.
  - Cease all ground surface disturbance in the area of the find immediately
  - Notify the following authorities or personnel of the discovery:
    - OEH (Environment Line: 131 555);
    - Relevant Aboriginal Community Representatives; and
    - NSW Police (if the find is suspected to be human remains).

4.10.5 Assessment of impacts

The Proposal would not result in the disturbance of any identified Aboriginal objects. In the event that unanticipated Aboriginal objects are discovered as a result of construction or operations, all ground-disturbing activities would be postponed pending advice from OEH.

On the basis of the above and the high levels of ground surface disturbance within the Mine Site, it is assessed that the Proposal would not result in significant Aboriginal heritage impacts.

4.11 VISUAL AMENITY

4.11.1 Introduction

Based on the risk analysis undertaken for the Proposal (Section 5.2), the potential impacts relating to visual amenity factors and their risk rankings after the adoption of standard mitigation measures are as follows.

- Amenity impact through change in content and composition of views from residences and public vantage points. (low risk).

- Visual intrusion or reduction in scenic quality at residential and other sensitive receptors (low risk).
- Local amenity impact of visibility of industrial traffic on residential and other sensitive receptors. (low risk).

The following sub-section has been prepared by RWC and describes existing visual environment within the Mine Site as well as the proposed management and mitigation measures and impact assessment.

4.11.2 Existing Visual Environment

The existing visual amenity environment surrounding the Mine Site is dominated by the existing Mine and other mines along the Broken Hill Line of Lode. The Mine Site is currently highly visible and would continue to be visible from residences and other vantage points surrounding the Mine Site. Indeed, the disturbed nature of the Mine Site is one of the factors that are identified in the listing of the City of Broken Hill in the National Heritage List.

4.11.3 Potential Visual Amenity Impacts

Potential visual amenity impacts include the following.

- Changes to the existing visual character of the Mine Site, including changes to the skyline.
- Movement of heavy vehicles within the Mine Site, including at night-time.
- Adverse impacts associated with night-time lighting, particularly in relation to the operation of the Outback Astronomy business, located approximately 6km to the northeast of the Mine Site (see Section 4.1.4.2).

4.11.4 Management and Mitigation Measures

In order to reduce the impact of the Proposal on local visual amenity, the Applicant would implement the following management and mitigation measures. It is noted that many of these controls serve a dual function in the management of other environmental parameters, e.g. air quality and waste management.

- Implement active dust suppression to reduce the potential for the creation of a ‘dust cloud’ over the Mine Site.
- Include appropriate waste management to prevent wind-blown rubbish.
- Ensure that night-time lighting is the minimum required for safe operation and is pointed towards the ground. Lighting not required would be turned off.
- Ensure that the operators of Outback Astronomy are consulted following the commencement of night-time operations to ensure that impacts associated with the Proposal are limited and implement adaptive management measures as required to resolve any identified issues.

4.11.5 Assessment of Impacts

Given that the majority of the proposed activity would take place underground, the fact that the operational sections of the Mine Site are located to the south of an area of elevated topography, the implementation of the management and mitigation measures presented in Section 4.11.4, and that the Mine Site is an area of longstanding mining-related disturbance, the proposed activity is not anticipated to result in significant aesthetic impacts.

In addition, night-time lighting at the surface would be limited to that required to safe operation of mobile plant, night-time visual amenity impacts, including on the operation of Outback Astronomy, are likely to be negligible.

4.12 BUSH FIRE

4.12.1 Introduction

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

Based on the risk analysis undertaken for the Proposal (Section 5.2), the potential impacts relating to bushfire and their risk rankings after the adoption of standard mitigation measures are as follows.

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

4.12.2 Existing Bush Fire Hazard Environment

Section 4.1.4.2 presents the land uses within and surrounding the Mine Site and Section 4.9 presents the vegetation communities identified by OzArk (2017b). In summary, the vegetation within and surrounding the Mine Site has been largely cleared and consists of remnant vegetation planted in the 1950s.

4.12.3 Management and Mitigation Measures

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

- Ensure that refuelling is undertaken within designated fuel bays or within cleared area of the Mine Site.
- Ensure that a no smoking policy is enforced within the Mine Site.

- Ensure that fire extinguishers and/or firefighting infrastructure such as pumps, hydrants, hoses and sprinklers are located and maintained within the Mine Site.
- Ensure that a water cart is available to assist in extinguishing any fire ignited.
- Ensure that relevant emergency services are consulted in relation to management of bushfire risks within the Mine Site and the Applicant's capability to respond to off-site bushfire events.

4.12.4 Assessment of Impact

The Proposal would be restricted to areas that have been previously cleared of vegetation. As a result, the impacts of the Proposal on bushfire are considered to be negligible.

4.13 SOILS AND CAPABILITY

4.13.1 Introduction

Based on the risk analysis undertaken for the Proposal (Section 5.2), the potential impacts relating to soil and land capability and their risk rankings after the adoption of standard mitigation measures are as follows.

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

The following sub-section has been prepared by RWC, and describes existing soil and land capability environment within the Mine Site as well as the potential soil and land capability impacts of the Proposal, proposed management and mitigation measures and impact assessment.

4.13.2 Regional Soil and Land Capability Setting

Based on the Department of Conservation and Land Management Soil Conservation Service land capability assessment methodologies, the Broken Hill area is classified as having a rural land capability of Class VI and therefore is considered capable of grazing use only, subject to standard soil conservation practices.

Soils in the Broken Hill region generally comprise lithosols, shallow skeletal soils with minimal profile development, on the upper slopes of the ranges and solonised brown soils (calcareous brown and red earths) and desert loams on the lower slopes and valleys.

4.13.3 Mine Site Soil and Land Capability Setting

Within the vicinity of the Mine Site, soils are highly disturbed by previous mining activities. Soils in areas that have not been disturbed by mining are classified as either Class VI (suitable for grazing) or Class VII (land best protected by green timber). Areas disturbed by mining operations would be classified as Class M or land disturbed by mining.

4.13.4 Management and Mitigation Measures

As no surface extraction operations would occur, no soil stripping or stockpiling would occur.

4.13.5 Assessment of Impacts

Given the limited soil resources and proposed mitigation measures, the Proposal is not anticipated to result in significant soil and land capability impacts.

4.14 AGRICULTURAL LANDS AND ENTERPRISES

4.14.1 Introduction

Based on the risk assessment undertaken for the Proposal (see Section 5.2), the potential agriculture-related impacts and their risk rankings after the adoption of standard mitigation measures are as follows.

- Negative impacts on agriculture within the Broken Hill LGA due to mining operations (Positive impact).
- Loss of High Quality Agricultural Land due to mining operations (not applicable).

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

4.14.2 Agricultural Setting

As presented in Section 4.1.4.2, the land uses surrounding the Mine Site includes very limited agriculture.

4.14.3 Potential Impacts

The Mine Site has been previously cleared and used for mining purposes. The Proposal would maintain the current land use of the Mine Site.

Potential exists for weeds to spread from the Mine Site to surrounding land, potentially impacting on agricultural operations surrounding the Mine Site.

4.14.4 Management and Mitigation Measures

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

- Ensure that appropriate weed and pest management programs are implemented in consultation with surrounding landholders and the Broken Hill Council weeds officer.

4.14.5 Assessment of Impacts

Disturbance caused by the Proposal would be limited to areas that have been previously used for mining operations and are not considered to be suitable for agricultural purposes. As a result, the impacts of the Proposal on agricultural lands and enterprises are considered to be negligible.

4.15 SOCIO-ECONOMIC

4.15.1 Introduction

Based on the risk analysis undertaken for the Proposal (Section 5.2), the potential impacts relating to socio-economic factors and their risk rankings after the adoption of standard mitigation measures are as follows.

- Impacts on land values and housing market within the Local Government Area (positive impact).
- Perception of negative health impacts on the community at surrounding residences (moderate risk).
- Equity imbalance in wages / access to resources between miners and other sectors within the surrounding community (positive impact).
- Community division between support and opposition for the Proposal within the community (moderate risk).
- Inability of local business to compete with mining wages leading to antagonism towards the Proposal from local businesses (positive impact).
- Mining operations lead to negative impacts on agriculture within the LGA (positive impact).
- Stress on the local services leading to community disharmony and poor relationships with the Applicant (positive impact).
- Increased pressure on local infrastructure (low risk).

The following sub-section has been prepared by RWC and describes the existing socio-economic environment within the Mine Site as well as the potential socio-economic impacts of the Proposal, proposed management and mitigation measures and impact assessment.

4.15.2 Policy Context

4.15.2.1 Introduction

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

- *Far West Regional Action Plan* prepared by the Department of Premier and Cabinet.
- *Community Strategic Plan – Year 1* compiled by Broken Hill City Council.

4.15.2.2 Far West Regional Action Plan

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

- Leverage opportunity for the Far West from the growth within the mining sector (Priority 1).
- New Frontiers Program to stimulate mineral and petroleum investment (Priority 1).
- Support primary industries (Priority 1).
- Access to apprenticeship and training opportunities (Priority 5).

4.15.2.3 Community Strategic Plan – Year 1

The Community Strategic Plan – Year 1 (2013) was compiled by Broken Hill City Council as part of Broken Hill 2033, a 20 year plan. The objectives of the Community Strategic Plan include the following.

- Objective 2.1 – A diverse range of businesses, industries and services to provide a range of employment opportunities for the people of Broken Hill.
- Objective 3.2 – A clean, reliable and sustainable water supply for the area.
- Objective 3.3 – A safe, sustainable and non-polluting environment after mining.
- Objective 3.4 – Natural flora and fauna environments are enhanced and protected.

A range of strategies exist within the above listed outcomes that relate to the Proposal, including the following.

- Strategy 2.1.1 – Gain an understanding of existing businesses, services and facilities of Broken Hill and future needs to build a sustainable economy.

- Strategy 3.2.1 – Undertake audit of water quality and then monitor and report status.
- Strategy 3.3.1 – Investigate and identify areas that could be remediated through re-vegetation.
- Strategy 3.3.2 – Develop transition plans to remediate disused mining precincts with consideration to heritage.
- Strategy 3.4.2 – Manage the impact of pests and weeds on Broken Hill's natural environment.

4.15.3 Community Profile

4.15.3.1 Surrounding Communities

The Mine Site is located within the Broken Hill Local Government Area, encompassed the Far West region of NSW. Communities surrounding the Mine Site include the following.

- Immediate neighbours and local residents surrounding the Mine Site.
- Residents of the city of Broken Hill.
- Residents of surrounding rural properties.

Each of these communities would be impacted to a greater or lesser degree depending on their proximity to the Mine Site and the size, resilience and cohesiveness of the relevant community and its economy. For the purpose of this assessment, particular focus is placed on that community most likely to be impacted by the Proposal, namely the City of Broken Hill.

Broken Hill is a rural city of approximately 19 000 people located approximately 500km by road northeast of Adelaide and 1 150km west of Sydney in the far west New South Wales. The City was originally settled in 1883 by Charles Rasp, who discovered silver and lead along the Broken Hill Line of Load. The Broken Hill Proprietary Company (now BHP Billiton) was founded in Broken Hill 1885, and mining operations expanded and continued throughout the 19th, 20th and 21st centuries.

The Broken Hill LGA is located within the Far West of New South Wales and is surrounded on all sides by the unincorporated lands of NSW. Broken Hill is the largest and only populated town within the Broken Hill LGA. The LGA is generally supported primarily by mining activities.

4.15.3.2 Community Statistics

The following demographic data was sourced primarily from the Australian Bureau of Statistics (ABS) 2011 census data, with limited supporting data from the 2006 census (where available). All data has been gathered from the community profile tables and quick data sets from the ABS website (http://www.abs.gov.au/). Information is provided for the "Broken Hill State Suburb" (Broken Hill SS) and the Broken Hill Local Government Area (Broken Hill LGA) (**Figure 4.15**), as well as utilising NSW data for comparison purposes.

Population and Age Characteristics

Table 4.31 presents the population data from both the 2006 and 2011 census. In summary, the population of Broken Hill SS and Broken Hill LGA in 2011 were 18 776 and 18 519 respectively. Population growth within the Broken Hill SS and the Broken Hill LGA between 2006 and 2011 was negative, with a population loss of 4.0% and 4.3% respectively, in comparison with a 5.3% population gain for NSW as a whole. This is likely to be related to the challenges that the Mining industry faced in Broken Hill and more broadly during this period.

Table 4.31
2006 and 2011 Census Population Statistics

	Broken Hill SS			Broken Hill LGA			NSW		
	2006	**2011**	**%**	**2006**	**2011**	**%**	**2006**	**2011**	**%**
Total	19 551	18 776	-4.0	19 359	18 519	-4.3	6 549 177	6 917 658	5.3
Males	9 516	9 165	-3.7	9 405	9 018	-4.1	3 228 451	3 408 878	5.3
Females	10 035	9 611	-4.2	9 954	9 501	-4.6	3 320 726	3 508 780	5.4
Source: ABS 2011 and 2006 Census									

Table 4.32 presents the 2011 Census population data broken down by age. In summary, the Broken Hill SS age statistics are generally comparable to the Broken Hill LGA statistics across the majority of age brackets. In comparison to the whole of NSW, the Broken Hill LGA had a higher proportion of people aged between 45 and 84 years old and a lower proportion of people under 44 years old. This potentially reflects limited economic and employment opportunities for those in the early stages of their working life.

Table 4.32
2011 Census Age Statistics

	Broken Hill SS		Broken Hill LGA		NSW	
	No.	**%**	**No.**	**%**	**No.**	**%**
Children						
0-4	1 088	5.8	1 070	5.8	458 735	6.6
5-14	2 285	12.2	2 271	12.2	873 776	12.6
Studying or Working						
15-19	1 151	6.1	1 144	6.2	443 416	6.4
20-24	1 045	5.6	1 034	5.6	449 687	6.5
25-34	1 920	10.2	1 884	10.2	941 496	13.6
35-44	2 150	11.5	2 122	11.5	971 629	14.1
45-54	2 781	14.8	2 733	14.8	950 451	13.7
Approaching Retirement or Retired						
55-64	2 655	14.1	2 598	14.0	810 290	11.7
65-74	1 815	9.7	1 790	9.7	541 687	7.8
75-84	1 392	7.4	1 381	7.5	336 756	4.9
85+	494	2.6	491	2.7	139 735	2.0
Total	**18 776**		**18 519**		**6 917 658**	
Source: ABS 2011 Census						

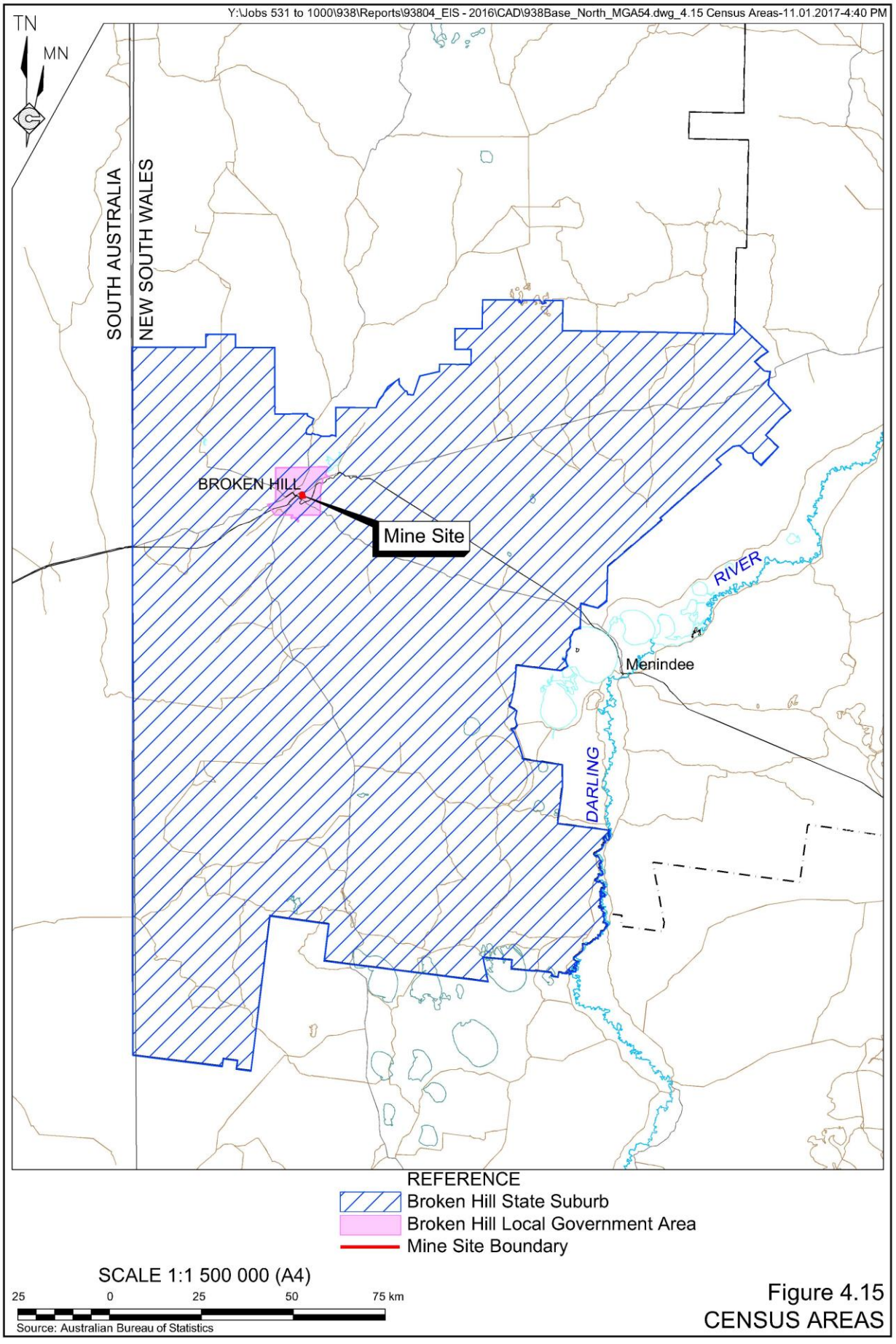


Figure 4.15
CENSUS AREAS

Employment

Table 4.33 presents employment statistics from the 2011 Census. These indicate that fewer persons are involved in full-time employment in the Broken Hill SS and Broken Hill LGA when compared to NSW total labour force as a whole. The total labour force participation rates indicate that the Broken Hill SS (50.6.2%) and the Broken Hill LGA (50.3%) have lower levels of participation in comparison to NSW (59.7%).

Table 4.33
2011 Census Employment Statistics

	Broken Hill SS	Broken Hill LGA	NSW
	2011	**2011**	**2011**
Employed			
Full-time[1]	4 502 (57.7%)	4 370 (57.2%)	2 007 925 (63.1%)
Part-time	2 100 (26.91%)	2 078 (27.2%)	939 464 (29.9%)
Employed away from work	358 (4.85%)	354 (4.6%)	120 121 (3.8%)
Employed hours not stated	205 (2.6%)	204 (2.7%)	70 821 (2.2%)
Total	**7 165**	**7 006**	**3 138 331**
Unemployed Looking for			
Full-time work	448 (5.7%)	445 (5.7%)	116 697 (1.7%)
Part-time work	190 (2.4%)	189 (2.4%)	79 829 (1.2%)
Total	**638**	**634**	**196 526**
Labour Force Participation			
Total labour force	7 803	7 640	3 334 857
Not in labour force	6 451	6 401	1 933 275
Labour force status not stated	1 146	1 136	317 017
Total Persons	**15 400**	**15 177**	**5 585 149**
Labour force participation	**50.6%**	**50.3%**	**59.7%**

Source: ABS 2011 Census

Industry of Employment

Table 4.34 presents employment by industry statistics from the 2011 Census. The most significant industry of employment in the Broken Hill SS and Broken Hill LGA is health care and social assistance, with 16.0% and 16.2% respectively, compared to the State average of 11.6%. Retail is also a significant industry of employment within the Broken Hill SS and Broken Hill Local Government Area, with 13.0% and 13.2% respectively compared to the State average of 10.4%. Importantly, mining comprised 10.2% and 10.4% of employment within the Broken Hill SS and Broken Hill LGA respectively, compared with the State average of 1.0%. This reflects the importance of mining within the local community and the reliance that the community places on the income that the industry provides.

Income

Table 4.35 presents income statistics from the 2011 Census. The data indicates that the median individual, family and household incomes in the Broken Hill SS and Broken Hill LGA are similar, but that these are lower than for NSW as a whole.

Table 4.34
2011 Census Industry of Employment Statistics

	Broken Hill SS		Broken Hill LGA		NSW	
	2011	**% of Labour Force**	**2011**	**% of Labour Force**	**2011**	**% of Labour Force**
Agriculture forestry & fishing	176	2.5	82	1.2	69 576	2.2%
Mining	731	10.2	726	10.4	31 186	1.0%
Manufacturing	223	3.1	224	3.2	264 865	8.4%
Electricity gas water & waste services	181	2.5	181	2.6	34 203	1.1%
Construction	404	5.6	395	5.6	230 057	7.3%
Wholesale trade	149	2.1	144	2.1	138 890	4.4%
Retail trade	928	13.0	925	13.2	324 727	10.4%
Accommodation & food services	692	9.7	679	9.7	210 380	6.7%
Transport postal & warehousing	269	3.8	268	3.8	155 027	4.9%
Information media & telecommunications	70	1.0	70	1.0	72 488	2.3%
Financial & insurance services	104	1.5	103	1.5	158 422	5.1%
Rental hiring & real estate services	53	0.7	52	0.7	51 554	1.6%
Professional scientific & technical services	165	2.3	165	2.4	247 295	7.9%
Administrative & support services	221	3.1	218	3.1	102 354	3.3%
Public administration & safety	543	7.6	536	7.7	192 634	6.1%
Education & training	583	8.1	584	8.3	248 951	7.9%
Health care & social assistance	1141	16.0	1137	16.2	364 321	11.6%
Arts & recreation services	73	1.0	64	0.9	46 330	1.5%
Other services	266	3.7	263	3.8	117 615	3.8%
Inadequately described/Not stated	195	2.7	190	2.7	77 455	2.5%
Total	**7167**		**7006**		**3 138 330**	

Source: ABS 2011 Census

Table 4.35
2011 Census Income Statistics

	Broken Hill SS	Broken Hill LGA	NSW
Median individual income ($/weekly)	$417	$414	$561
Median family income ($/weekly)	$994	$994	$1 477
Median household income ($/weekly)	$789	$786	$1 237

Source: ABS 2011 Census

Housing Cost

Table 4.36 presents housing cost statistics from the 2011 Census. The data indicates that the Broken Hill SS and Broken Hill LGA median housing loan monthly repayment was 47.8% less than NSW as a whole, with median weekly rents displaying similar trends with Broken Hill SS and Broken Hill Local Government Area having half the weekly median NSW rental cost.

Table 4.36
2011 Census Cost of Housing and Household Size Statistics

	Broken Hill SS	Broken Hill LGA	NSW
Median housing loan repayment ($/monthly)	$953	$953	$1 993
Median rent ($/weekly)	$150	$150	$300
Average number of persons per bedroom	1.1	1.1	1.1
Average household size	2.2	2.2	2.6
Source: ABS 2011 Census			

Education

Table 4.37 presents post-school education statistics from the 2011 Census. The data indicates that fewer people hold bachelor degrees, graduate diplomas and postgraduate degrees (university level education), as well as Advanced Diplomas in the Broken Hill SS and Broken Hill LGA than for NSW as a whole. By contrast, people with certificate (TAFE-based) qualifications were more common in the Broken Hill SS and Broken Hill LGA when compared to NSW as a whole. This may reflect the general lack of accessible universities for residents of the Broken Hill LGA and limited professional opportunities for those with such qualification. By contrast, the higher proportion of TAFE-based qualification identifies that the Broken Hill-based TAFE is critical infrastructure for the local population.

Table 4.37
2011 Census Post School Level of Education

	Broken Hill SS	Broken Hill LGA	NSW
Postgraduate Degree Level	123 (1.7%)	124 (1.7%)	238 851 (7.5%)
Graduate Diploma and Graduate Certificate Level	146 (2.0%)	146 (2.0%)	82 617 (2.6%)
Bachelor Degree Level	792 (10.9%)	782 (10.9%)	787 336 (24.6%)
Advanced Diploma and Diploma Level	650 (9.0%)	642 (9.0%)	462 059 (14.4%)
Certificate Level	3 062 (42.3%)	3 007 (42.0%)	986 704 (30.9%)
Level of education inadequately described	150 (2.1%)	150 (2.1%)	100 290 (3.1%)
Level of education not stated	2 323 (32.1%)	2 305 (32.2%)	539 067 (16.9%)
Total	**7246**	**7156**	**3 196 924**
Source: ABS 2011 Census			

4.15.3.3 Community Facilities and Social Infrastructure

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

Education

Early Childhood

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

- Preschool centres offering a variety of early childhood services, including day care and pre-schooling.
- Family Day Care comprising a network of family day care providers.

Schools

Table 4.38 presents the number of public primary and secondary schools within Broken Hill, along with 2016 enrolment numbers.

Table 4.38
Schools within Broken Hill

School	Years Available	2016 Enrolment numbers (Pupils)
Alma Public School	Kindergarten – Year 6	261
Broken Hill High School	Years 7 – 12	661
Broken Hill North Public School	Kindergarten – Year 6	277
Broken Hill Public School	Kindergarten – Year 6	203.5
Burke Ward Public School	Kindergarten – Year 6	325
Morgan Street Public School	Kindergarten – Year 6	330
Railway Town Public School	Kindergarten – Year 6	124
School of the Air[1]	Kindergarten – Year 6	154
Willyama High School	Years 7 – 12	487
Note 1: The School of the Air is located in Broken Hill, but provides distance education to students living outside the Broken Hill LGA.		
Source: Department of Education and Training		

Higher Education

Broken Hill College, a TAFE Western branch of TAFE NSW, is the only tertiary or adult education facility within Broken Hill, and constitutes two campuses. Courses at Broken Hill College include the following.

- Automotive training.
- Carpentry and joinery.
- Business.
- Ceramics and Fine Arts.
- Community and Children's Services.
- Electrical Trades.
- Fitting, Machining and Welding.
- General Education.
- Hairdressing and Beauty.
- Horticulture.
- Human Resources Management.
- Information Technology.
- Nursing.
- Tourism and Hospitality.
- Vocational Access.
- Welfare and Aged Care.
- Hospitality.

Health

The Broken Hill Base Hospital caters for accidents and emergency services, admissions, aged care and outpatient services. Additional health services, including a NSW Ambulance Service Base, a Diabetes Centre, a Child and Family Health Centre, an Aboriginal Health Service and a number of general practice surgeries, are also present. Broken Hill is also the headquarters of the South Eastern Section of the Royal Flying Doctor Service.

Recreational and Cultural Facilities

There are a large variety of recreational and cultural facilities available in Broken Hill, including:

- the Albert Kersten Mining and Minerals Museum and White's Mineral Art and Living Mining Museum;
- the Broken Hill Heritage Trail and historical buildings throughout the City;
- the Living Desert Reserve and Mutawinji National Park;
- various art galleries and studios; and
- Stephen's Creek Reservoir.

Sporting and recreational infrastructure in Broken Hill include:

- various sporting fields that accommodate a variety of sporting clubs (rugby league, rugby union, soccer netball, AFL and cricket);
- two golf courses;
- lawn bowling clubs;
- squash and tennis courts;
- motocross and dirt bike riding events;
- clay target, pistol and gun clubs;
- water ski and fishing venues; and
- the Broken Hill Regional Aquatic Centre.

Other Community Facilities and Groups

A number of community facilities and organisations exist in Broken Hill, including:

- the Broken Hill City Library;
- riding clubs;
- heritage and history community groups;
- bird and wildlife clubs;
- Scouts and Guides;
- gardening clubs;
- a men's shed;

- the Country Women's Association (CWA);
- various music groups and bands;
- Lions Club International; and
- Rotary International.

4.15.3.4 Economic Profile

Broken Hill includes numerous industries and related businesses, including the following.

- Automotive Sales.
- Accountants.
- Gift Shops.
- Real Estates.
- Trades (electricians, plumbers and carpenters).
- Restaurants, Cafes and Take-aways.
- Rural supply services.
- Caravan Park.
- Bed and Breakfasts.
- Hardware.
- Clothing.
- News Agency and Post Office.
- Banking.
- Computing services.
- Fuel stores
- Insurance services.
- Tourism services.
- Motels.
- Pubs.
- Hotels and clubs.

4.15.4 Potential Adverse and Beneficial Socio-Economic Impacts

The Proposal would potentially result in a range of non-significant localised air quality, noise and traffic-related impacts. These and other potential adverse impacts are assessed throughout Section 4.

By contrast, the Proposal would provide direct full-employment for up to approximately 140 people on a full time equivalent basis, a substantial proportion of the local workforce. As it is the intention of the Applicant to source the majority of the Proposal workforce from the Broken Hill area, this would have a very substantial positive impact on economic activities within Broken Hill and Western NSW.

The Proposal would also contribute between approximately $33 million and $88 million per year to the local and regional economies through the purchase of consumables and payment of wages and salaries. This expenditure is likely to generate additional economic activity and flow on effects within Broken Hill, providing further employment opportunities. The Proposal would also generate ongoing support for training and education of employees.

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

Finally, as the Applicant has repeatedly stated in briefings to agencies, its workforce and the community, while ever its operations remain active, potential exists to locate additional resources and extend the life of each of the operations beyond the currently identified life of mine of 2030. Indeed, the Applicant is seeking approval for a life of 25 years or 8 years longer than the existing life of mine plan for that reason. This would ensure that the Applicant and its employees would continue to contribute to the ongoing economic vitality of Broken Hill as it transitions away from a mining-dominated economy.

However, should the current and proposed mining operations cease, particularly if that shutdown were to occur in an unplanned manner, adverse economic and associated social impacts would be substantial.

4.15.5 Management and Mitigation Measures

In addition to the mitigation measures and management procedures relating to amenity aspects such as air quality, noise, traffic, heritage, surface water and groundwater, visibility, etc described previously in Section 4, the Applicant would implement the following management and mitigation measures to ensure that Project-related benefits for the community surrounding the Mine Site are maximised and adverse impacts are minimised.

- Engage in regular dialogue with surrounding residents in relation to the Applicant's activities and continue to implement and maintain an "open door" policy for interested parties to discuss aspects of those activities that may be perceived as problematic.
- Negotiate a Voluntary Planning Agreement with Broken Hill Council to ensure an equitable contribution to the local community, without adversely impacting on the financial robustness of the Proposal.
- Continue to support community organisations, groups and events as appropriate and review any request by a community organisation for support or assistance.
- Continue to liaise with the community through the existing, successful liaison mechanisms, including:
  - direct consultation with the Applicant's workforce and contractors;
  - publication of the Perilya Post:
  - maintenance of a complaints/information line and open and accurate provision of information to all community members who request it; and
  - regular liaison with all relevant government agencies.

  In light of the successful implementation of the current consultation procedures, the Applicant does not propose to establish a separate Community Consultative Committee.
- Continue to offer all positions as residential positions only.
- Encourage the involvement of the local Aboriginal community in the workforce.

- Give preference, where practicable and cost-competitive, to suppliers of equipment, services or consumables located within Broken Hill.
- 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.

4.15.6 Impact Assessment

The Proposal would result in a range of socio-economic benefits to the Broken Hill community. These benefits would include the following.

- Ongoing employment for up to 140 persons on a full time equivalent basis.
- Contribution to the local, Regional State and National economies including contributions of between approximately $33 million and $88 million per year within the Broken Hill LGA through wages and salaries and purchase of goods and services with additional indirect contributions.
- Continued support for local Community Organisations and Services.

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