

Section 4

Assessment and Management of Key Environmental Issues

PREAMBLE

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

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4.1 BACKGROUND

4.1.1 Introduction

The descriptions of various environmental aspects of the Proposal throughout this section are reliant upon a range of background information common to many of the key environmental issues. In this subsection, the local setting is described and background information is provided on the topography, climate, land ownership and residences, land uses and the community surrounding the DZP Site.

4.1.2 Topography and Drainage

4.1.2.1 Regional Topography and Drainage

Figure 4.1 presents the regional topography and drainage surrounding the DZP Site. The DZP Site is located at the western side of the Great Dividing Range, with steeply sloped and deeply incised valleys and ridges with elevations in excess of 800m AHD located approximately 50km to the east-southeast of the DZP Site.

Approximately 30km to the southeast and southwest of the DZP Site are two north-south orientated ranges, namely the Catombal Ranges and Harveys Range respectively. The Catombal Ranges has a maximum elevation at Mt Arthur of 522m AHD, while maximum elevations in the Harveys Range are between 700m AHD and 775m AHD.

To the south of the DZP Site, an area of undulating topography associated with Dog Trap Hill includes a range of low hills with elevations between 450m AHD and 607m AHD, with gentle slopes.

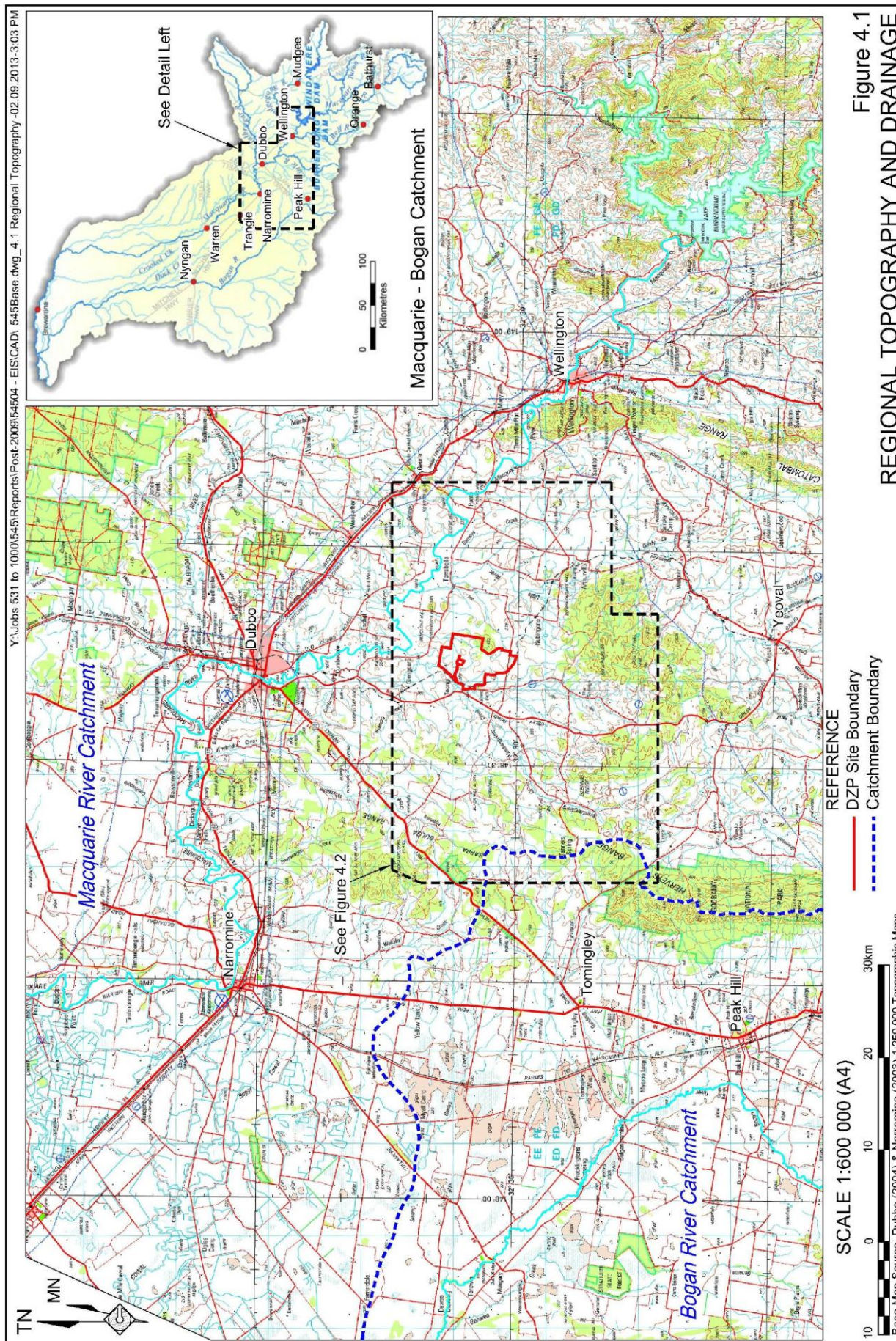
To the northeast and north of the DZP Site, the topography is undulating, with gentle slopes and elevations between 300m AHD and 450m AHD.

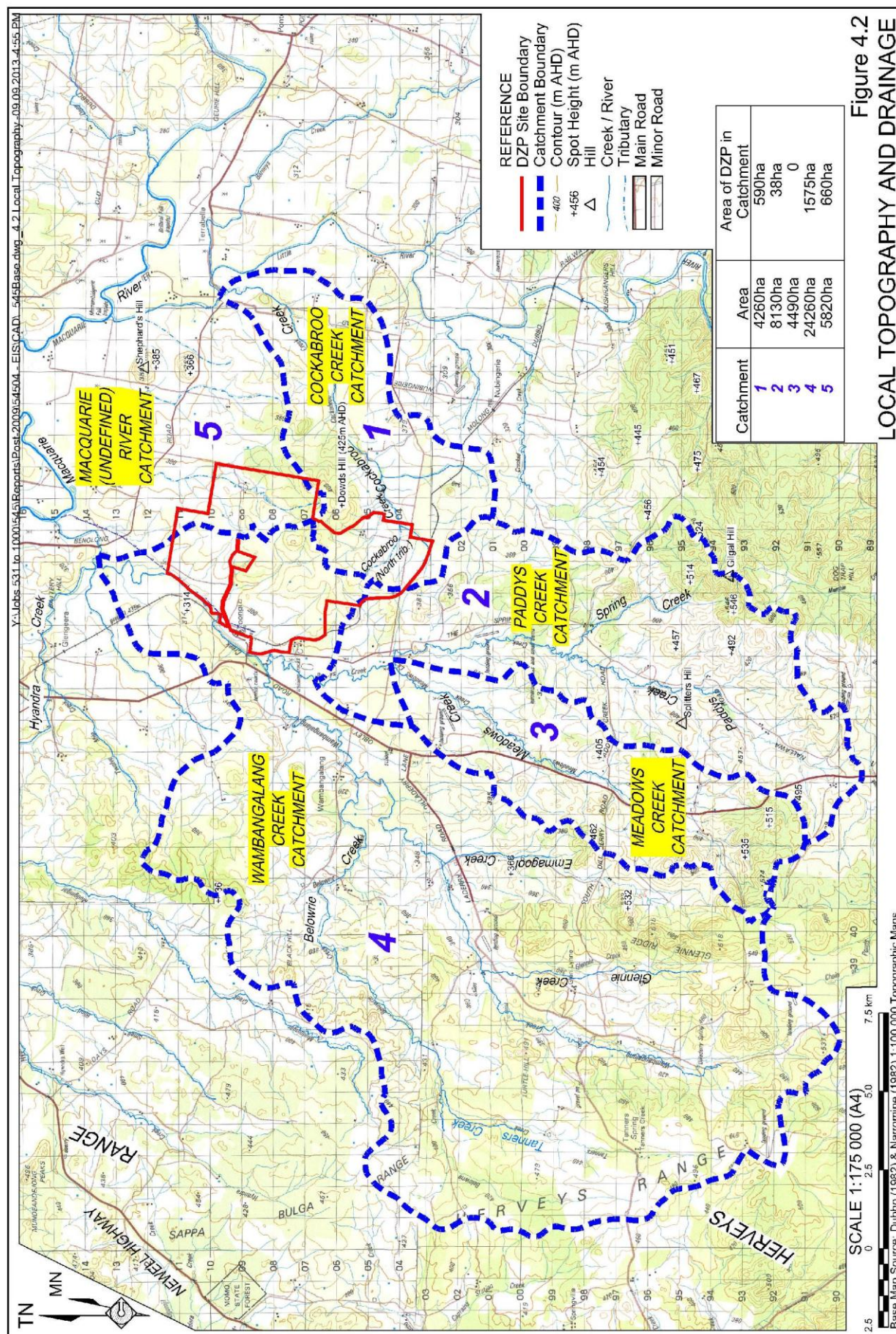
To the northwest and west of the DZP Site and west of the Harveys Range, the topography is flat to very gently sloping, with elevation between 250m AHD and 325m AHD.

The DZP Site is located in the upper section of the Macquarie River Catchment which in turn is located within the wider Macquarie-Bogan Catchment. The Macquarie – Bogan Catchment comprises an area of approximately 74 800km², and merges with the Darling River near Brewarrina in western NSW. The Macquarie-Bogan Catchment includes two major water storages, namely the Windamere Dam, located near Rylstone, with a capacity of 361GL, and Burrendong Dam, located approximately 50km to the east of the DZP Site, with a capacity of 1 154GL. Key water management issues within the catchment include water sharing and water use, reductions in flow and associated adverse impacts on the Ramsar-listed Macquarie Marches (located in the lower reaches of the catchment) and salinity.

4.1.2.2 Local Topography and Drainage

Figure 4.2 presents the local topography and drainage surrounding the DZP Site. Approximately 10km to the south of the DZP Site, is an area of hills with variably steep to moderate slopes and elevations between 450m AHD and 550m AHD.





The area immediately surrounding the DZP Site is characterised by undulating hills with moderate to gentle slopes, surrounded by creek flats and floodplains. Elevations vary between 546m AHD on Gilgal Hill approximately 12km south of the DZP Site and 275m AHD along the banks of the Macquarie River to the north and east of the DZP Site.

Surface water drainage surrounding the DZP Site typically flows to the north and northeast, towards the Macquarie River, located approximately 2.25km from the closest point of the DZP Site. Catchments surrounding the DZP Site may be described as follows.

Wambangalang, Paddys and Meadows Creeks Catchments

The greater Wambangalang Creek catchment (Catchment 4 on **Figure 4.2**), including the catchments of Meadows and Paddys Creeks, drains north-northeast before joining the Macquarie River approximately 7km north of the DZP Site. The catchment drains an area of approximately 345km² or approximately 0.5% of the Macquarie River catchment. The DZP Site is located in the lower section of the catchment.

Principal creeks draining into Wambangalang Creek include on the western side of the catchment Belowrie, Glennie, Emmagool and Tanners Creeks. Meadows Creek drains the central section of the catchment and Paddys and Springs Creeks drain the southeastern section of the catchment. All flows are ephemeral but may have some degree of subsurface flow through unconsolidated alluvium.

Topography in the head of the catchment is steep to undulating with granite tors, pavements and rocky outcrops occurring especially near the catchment divide. Igneous intrusions such as Turtle Hill form high hills and knolls in excess of 500m AHD which can have steep slopes and rocky outcrops. These rise significantly above the surrounding land.

In the lower catchment (where the DZP Site is located) slopes are undulating to gentle, although elevations of approximately 400m AHD occur over the western section of the DZP Site along the catchment boundary with Cockabroo Creek. Elevations within the catchment range from 620m AHD to 275m AHD, a fall of 345m.

Cockabroo Creek Catchment

The Cockabroo Creek Catchment (Catchment 1 on **Figure 4.2**) drains to the east before joining the Little River approximately 4km east of the DZP Site. This small catchment of 4 260ha drains surface flows off a local high point, namely Dowds Hill, with an elevation of 425m AHD. Slopes are typically undulating to gentle, with steeper slopes in the vicinity of Dowds Hill.

Macquarie River (Undefined) Catchment

The Macquarie River (Undefined) Catchment (Catchment 5 on **Figure 4.2**), an area of approximately 5 820ha, flows via several ephemeral channels directly into the Macquarie River, approximately 7km to the north of the DZP Site. While the catchment is bound by several isolated hills up to 385m AHD, the elevation is generally below 320m AHD and slopes are flat to undulating.

4.1.2.3 DZP Site Topography and Drainage

Figure 4.3 presents the topography and drainage within the DZP Site. In summary, the DZP Site is dominated by a series of hills with maximum elevations between 325m AHD and 400m AHD. Dowds Hill, located immediately to the southeast of the DZP Site has an elevation of 425m AHD. The lowest sections of the DZP Site are located on the western boundary of the Site, with elevations of approximately 275m AHD, adjacent to the Wambangalang Creek.

Slopes within the DZP Site vary from approximately 1:60 (V:H) in the vicinity of Wambangalang Creek to approximately 1:5 (V:H) on the flanks of the higher hills. The surface of the steeper sections of the DZP Site varies from a common semi-continuous rock pavement to steeper outcrops of boulders.

The DZP Site includes four catchments as follows.

- **Cockabroo Creek Catchment**

The Cockabroo Creek Catchment occupies the southeastern section of the DZP Site. Within the DZP Site, the catchment drains to an unnamed, ephemeral creek which, for the purposes of this assessment, is referred to as Cockabroo Creek (North Tributary). Approximately 1km of that creek within the DZP Site may be classified as a third order stream (based on the Strahler stream ordering classification).

- **Macquarie River (Undefined) Catchment**

The Macquarie River (undefined) Catchment occupies the eastern section of the DZP Site. Within the DZP Site, the catchment drains to one of two unnamed ephemeral creeks, which, for the purposes of this assessment, are referred to as Watercourse A and Watercourse D. Watercourse A may be classified as a second order stream within the DZP Site, while Watercourse D becomes a third order stream approximately 600m upstream of the DZP Site boundary.

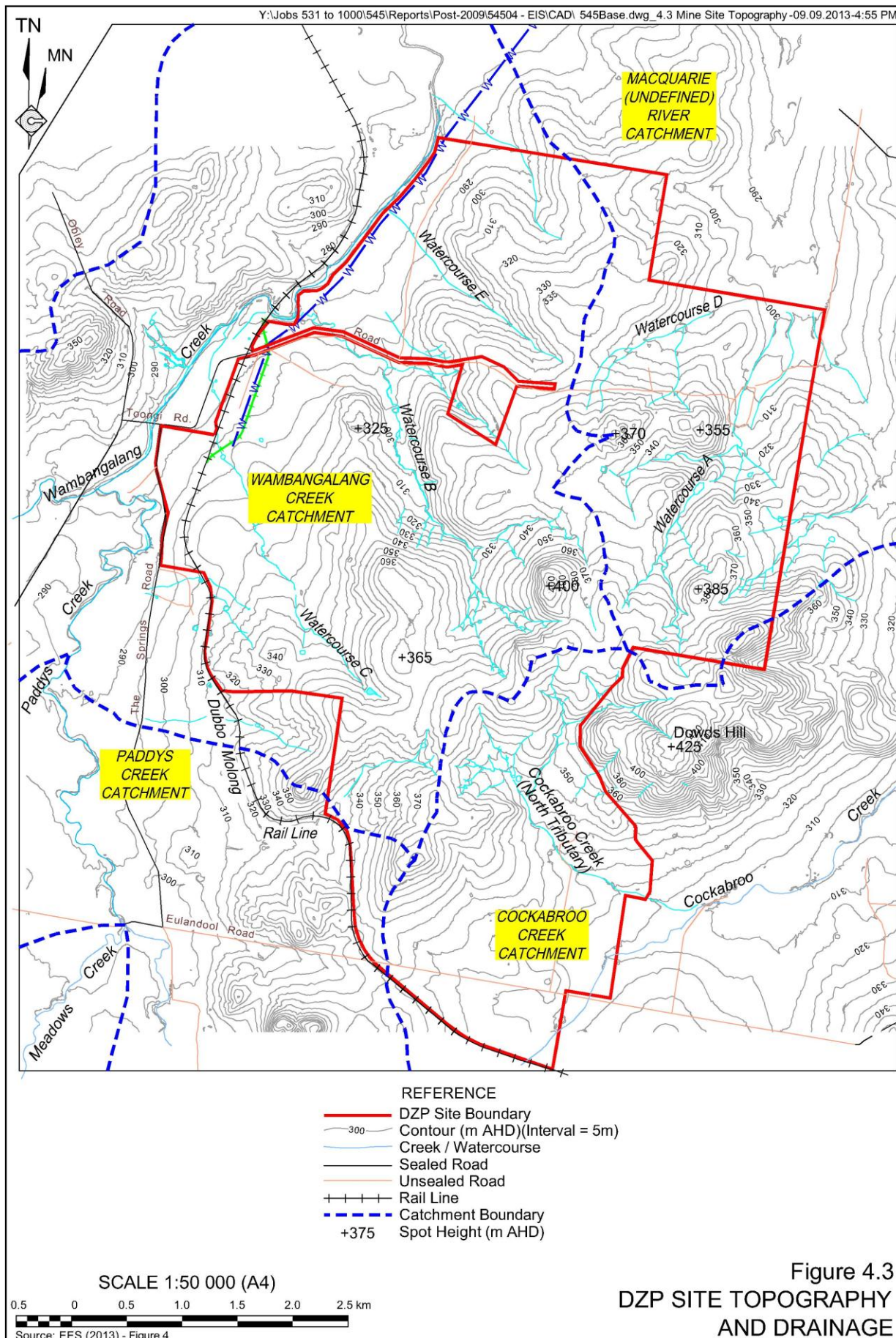
- **Wambangalang Creek Catchment**

The Wambangalang Creek Catchment occupies the western section of the DZP Site. Within the DZP Site, the catchment drains to one of three unnamed ephemeral creeks, which, for the purposes of this assessment, are referred to as Watercourse B, Watercourse C and Watercourse E. Watercourse B may be classified as a third order stream within the DZP Site, while Watercourse C and Watercourse E are second and first order streams respectively.

- **Paddys Creek Catchment**

The Paddys Creek Catchment, which forms part of the larger Wambangalang Creek Catchment, occupies a very small area in southwestern section of the DZP Site.

SEEC (2013) notes that there are approximately 64 existing farm dams (with a total estimated volume of approximately 82ML) within the DZP Site and surrounding properties which are, or would be owned by the Applicant upon receipt of development consent for the Proposal.



Environmental Earth Sciences (EES) (2013) confirms that ephemeral springs occur within the DZP Site, generally at the break point of steeper slopes where the surface is intermittently incised by a rising groundwater table following rainfall events. Such springs are known to occur on Cockabroo Creek (North Tributary), Watercourse B and Watercourse A, feeding several of the farm dams. Sub-surface groundwater flows are towards the local creeks, with Paddys Creek to the west listed as having a “high potential for groundwater interaction” by the *Groundwater Dependent Ecosystem Map* published by the Bureau of Meteorology (BOM, 2012). Groundwater interaction refers to a surface water system that is “reliant on surface expression of groundwater”. Wambangalang Creek to the north of Obley Road and Cockabroo Creek to the north of Eulandool Road, are both identified by as having a “moderate potential for groundwater interaction” (BOM, 2012).

4.1.3 Climate

4.1.3.1 Introduction and Data Sources

This subsection describes climatic conditions surrounding the DZP Site. The data presented in this section has been sourced from the following Bureau of Meteorology weather stations.

- Temperature and Humidity - Dubbo Airport AWS (Station Number 065070), located approximately 24km to the north-northwest of the DZP Site.
- Rainfall – Dubbo (Mentone) (Station Number 065030), located approximately 11km to the southwest of the DZP Site.
- Evaporation – Wellington Agricultural Research Centre (Station Number 065035), located approximately 36km to the east-southeast of the DZP Site.

Climate data from the above sources is presented in **Table 4.1**.

Table 4.1
Climate Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature (°C) (1993 to 2013)													
Mean maximum	33.4	31.8	28.7	24.6	19.9	16.3	15.4	17.4	21.1	24.6	28.3	31.0	
Mean minimum	18.2	17.7	14.3	10.1	6.4	4.3	3.1	3.3	6.1	9.2	13.6	15.7	
Relative Humidity (%) (1993 to 2010)													
Mean 9am	56	62	64	64	76	86	86	76	67	56	56	52	
Mean 3pm	32	36	36	37	47	57	55	47	43	36	35	30	
Monthly Rainfall (mm) (1894 to 2013)													
Mean	66.4	53.5	52.8	47.0	50.7	53.6	54.6	53.8	42.7	55.5	54.7	57.5	647.3
Lowest	1.8	0.0	0.0	0.0	0.0	1.6	1.3	0.0	0.0	0.0	0.0	0.0	274.6
5th %ile	6.7	2.0	0.9	0.9	2.2	8.9	7.3	9.2	7.6	4.7	5.2	4.8	359.1
Median	47.0	37.2	35.6	32.8	42.0	44.4	50.5	49.0	37.8	47.0	40.9	51.3	643.7
95th %ile	170.4	156.3	158.0	153.7	120.6	126.7	120.6	111.8	94.9	142.7	144.3	134.9	971.0
Highest	292.0	292.5	299.2	341.4	179.4	219.1	177.0	134.2	151.6	208.6	224.6	201.0	1 527.1
Evaporation (Pan) (mm) (1965 to 2005)													
Mean Daily	8.8	7.8	6.3	4.2	2.5	1.6	1.7	2.4	3.4	5.1	6.9	8.6	4.9
Mean Monthly	273.0	218.4	195.3	126.0	77.5	48.0	52.7	74.4	102.0	158.0	207.0	266.6	1 798.9
Source: Bureau of Meteorology – Climate Data Online													

4.1.3.2 Temperature and Humidity

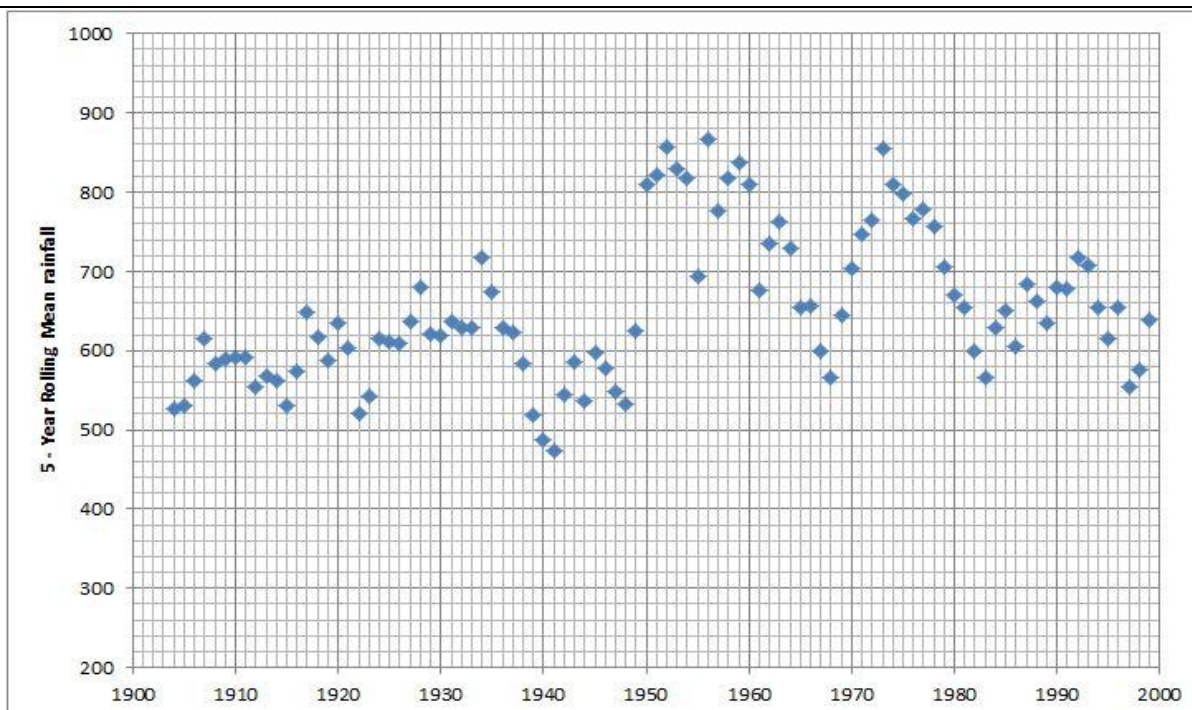
January is typically the warmest month of the year with a mean daily maximum temperature of 33.4°C and mean daily minimum temperature of 18.2°C. The coolest month of the year is typically July with the lowest mean daily maximum temperature of 15.4°C and coldest mean minimum temperature of 3.1°C.

In both the 9:00am and 3:00pm relative humidity data sets, the highest humidity is experienced in June at 86% and 57% respectively. Conversely, the least humid month is December with a 9:00am and 3:00pm relative humidity of 52% and 30% respectively.

4.1.3.3 Rainfall

On average, 647.3mm of rain is recorded each year, with that rainfall spread relatively evenly throughout the year. January is typically the wettest month (66.4mm) and September is the driest month (42.7mm). Rainfall can, however be highly variable from year to year with annual rainfall varying from 274.6mm to 1527.1mm and monthly rainfall varying from nil to 341mm.

SEEC (2013) notes that the rainfall patterns at the Dubbo (Mentone) station reveal a number of long-term trends. In summary, the period from 1894 to around 1950 was relatively consistent, however, from 1950 onwards, an approximately 20-year wet/dry cycle is evident, with the periods 1950 to 1960 and 1970 to 1980 being wetter than the intervening decades (see **Figure 4.4**).



Source: SEEC (2013) – Figure 10

Figure 4.4
ROLLING 5-YEAR RAINFALL TOTALS

4.1.3.4 Evaporation

Mean evaporation at the Wellington Agricultural Station throughout the year is 4.9mm per day or 1 798.9mm per year. Monthly evaporation varies between 48mm in June and 273mm in January. Mean monthly pan evaporation is greater than mean monthly rainfall in all months except June and July.

4.1.3.5 Wind Speed and Direction

Pacific Environment Limited (PEL) (2013) reviewed wind data collected for three different periods, namely 2003, 2005-2008 and 2010-2012, at the Toongi Meteorological Station and Dubbo Airport AWS. That data was used to inform a model of the local wind environment prepared using the CALMET software, an industry standard software package.

Figures 7 to 14 of PEL (2013) present the wind roses for each of the eight years during which data has been collected. The year 2008 was ultimately selected as representative of the prevailing annual conditions of the local setting by PEL (2013) and **Figure 4.5** presents the wind roses for this year.

In summary, wind distribution patterns at the DZP Site are dominated by winds from the south-southwest in autumn, winter and spring, with northeasterly winds dominating in summer.

4.1.3.6 Temperature Inversions

An inversion is an increase temperature with height, or to the layer within which such an increase occurs. Inversions are common during the winter when subsiding air from a high pressure system (also referred to as an anti-cyclone) warms as it descends and produces a layer of warmer air around 1 000m to 2 000m above the surface. This inversion is strengthened at night due to radiational cooling of the lowest levels of the atmosphere.

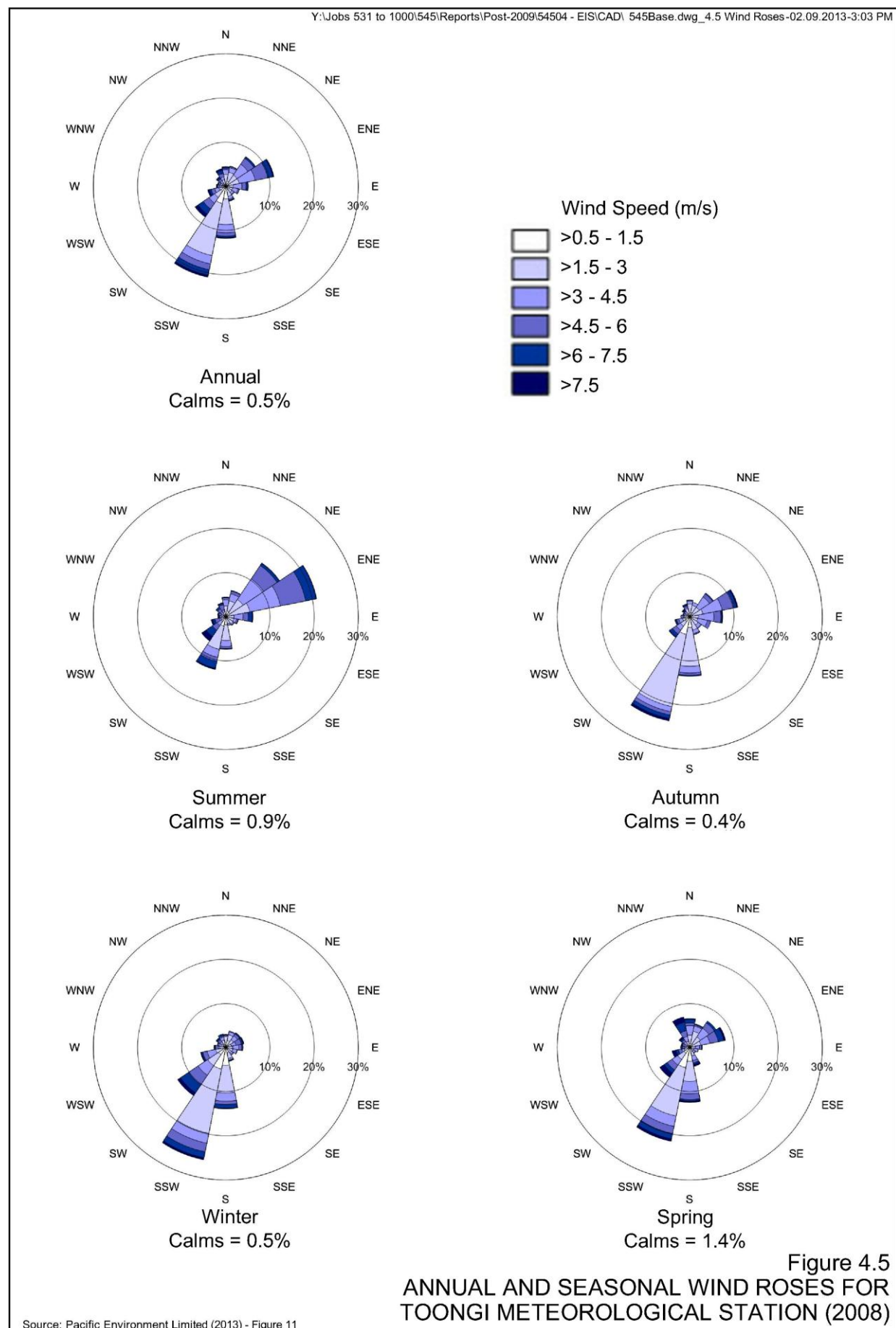
No data is available with respect to local inversion conditions, however, it is anticipated that inversions would form during the winter time over the DZP Site. Having assessed the meteorological data collected from the Toongi Meteorological Station, in particular sigma theta data which provides an indication of Pasquill Gifford stability categories¹, EMM (2013) have adopted the default inversion parameter for 'F' class stability (as opposed to the more stable 'G' Class) nominated in the Industrial Noise Policy (INP) (EPA, 1999). This considers a normal inversion for non-arid areas (rainfall > 500mm/yr) to have a strength of 3°/100m (EPA, 1999).

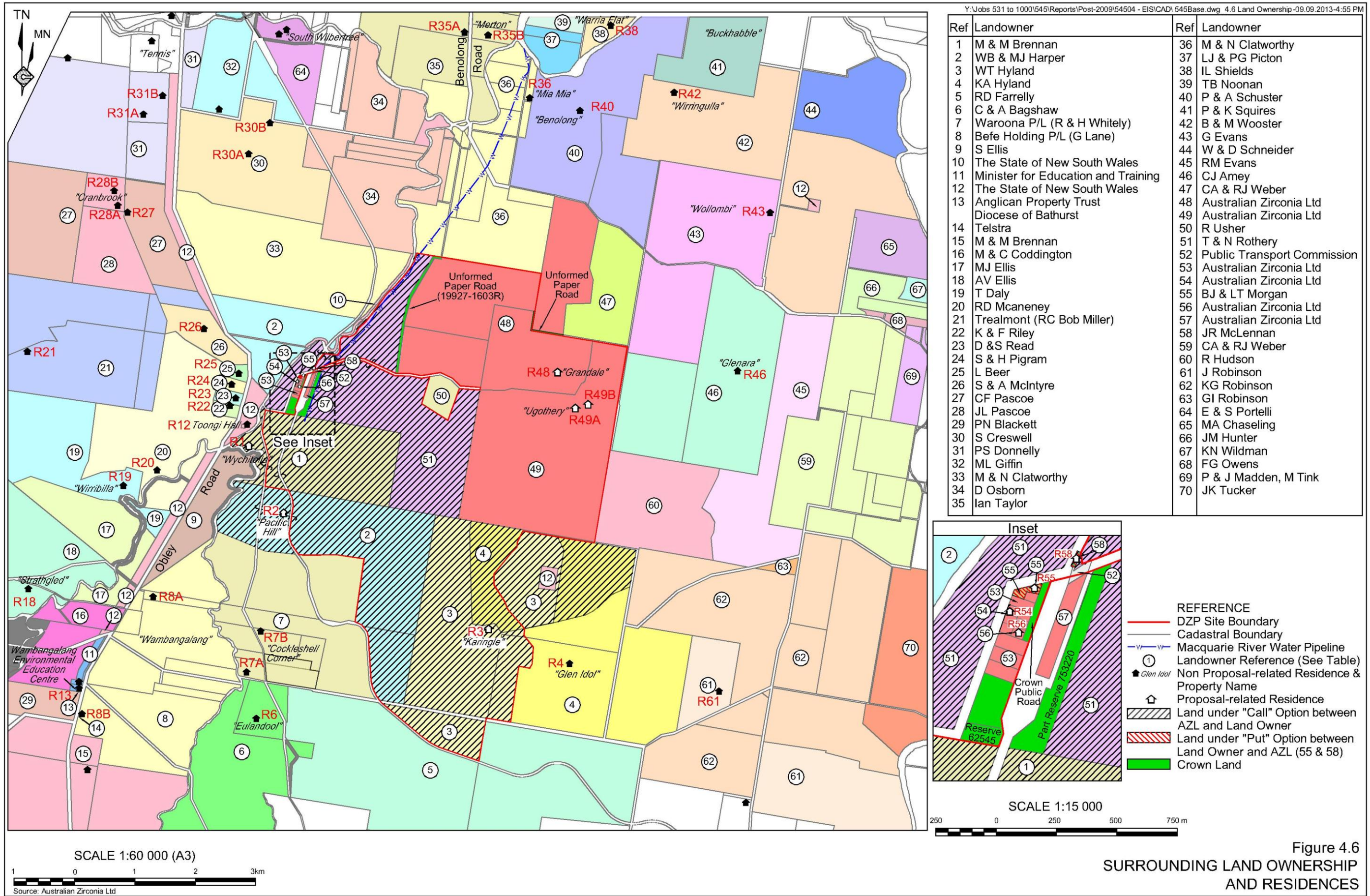
4.1.4 Surrounding Land Ownership and Residences

4.1.4.1 Land Ownership

Figure 4.6 displays the land ownership within and surrounding the DZP Site and Macquarie River Water Pipeline. The Applicant currently owns two properties, "Ugothery" and "Grandale" within the DZP Site and holds a 'Call' option to purchase the remaining land.

¹ Atmospheric stability is categorised as Class A (least stable) to Class G (most stable) with inversions generally forming under more stable conditions.





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Notable blocks of land not currently owned by or under purchase agreement are the following.

- Property 50. The Applicant is continuing to negotiate with the owners of Lot 312, DP595631 in relation to an option to purchase this land. It is understood that this property has entitlement to construct a dwelling, although no dwelling is constructed at the time of finalisation of this document.
- Crown Reserve 753220 (Lot 7300, DP1149010) (for future public recreation) is located to the east of the Dubbo-Molong Rail Line and adjoins the western boundary of the DZP Site. This land is currently licensed for grazing to the landowner of the adjoining land (T & N Rothery – Property 51). The Applicant has expressed an interest in acquiring this reserve and discussions with the Crown Lands division of the Department of Primary Industries – Catchment & Lands (DPI-C&L) have commenced and are ongoing.
- Unformed roads. The Applicant has commenced negotiations with DPI-C&L to acquire the land associated with the two unformed paper roads identified on **Figure 4.6**, one of which is within the DZP Site.

The village of Toongi is located on Toongi Road between Wambangalang Creek and the Dubbo-Molong Rail Line and contains a mixture of small and large residential lots, land previously owned by GrainCorp for siloing of grain and Crown Land reserves. The Applicant has purchased two of the residential properties and the former GrainCorp land. A ‘Put’ option is held by two of the remaining property owners which may be actioned by these landowners requiring the Applicant to purchase the properties at an agreed price. The remaining freehold land is owned by a single landowner with whom the Applicant intends to negotiate the acquisition of the land.

There are three parcels of Crown Land within the village of Toongi as follows.

- An unformed paper road runs to the east of the residential lots of Toongi parallel with the Dubbo-Molong Rail Line. This land is the subject of the previously identified negotiations to purchase the land from DPI-C&L.
- Crown Reserve 62545 (Lots 41 & 61, DP753220) (for public recreation) is located at the southern end of Toongi and adjoins the western boundary of the DZP Site. This land is currently licensed for grazing to the landowner of the adjoining land (M & M Brennan – Property 1). A Land Claim under the *Aboriginal Land Rights Act 1983* has been made over this reserve and a decision on this claim is pending. The Applicant has expressed an interest in acquiring this reserve and would formalise negotiations following determination over the Land Claim which would confirm who the Applicant is to negotiate with.

The Macquarie River Water Pipeline traverses Lots 1, 2, 3, 4, 27, 30, 62, 63 and 311 of DP753220, and traverses three agricultural properties: “Whychitella” (Property 1), “Toongi Valley” (Property 51) and “Mia Mia” (Property 36), as well as several road reserves. The Applicant is finalising negotiations with the landowner of the “Mia Mia” property for the creation of an easement across this property extending between the northern edge of the DZP Site and the Macquarie River. It would be possible to align the pipeline between the DZP Site and the Macquarie River on road reserves, however, by traversing the lots noted previously, the

length of the pipeline would be reduced and the requirement for severe direction changes avoided. The only notable road to be crossed would be Benolong Road, approximately 2km from the Macquarie River.

4.1.4.2 Residences and Sensitive Receptors

Residences and other sensitive receptors on and surrounding the DZP Site are identified on **Figure 4.6**. This includes the following Proposal-related residences².

- Five residences located on the DZP Site, three of which are owned by the Applicant (R48, R49A and R49B), with the remaining two the subject of “Call” options (R3 and R51).
- A further two residences are located on properties held under ‘Call’ option by the Applicant outside the DZP Site (R1 and R2).
- Four residences within Toongi (in which currently five people reside), are either owned by the Applicant or there is a ‘Put’ option for purchase in place. The Toongi Quilt Shop is a business run from a home in the village.

Figure 4.6 also identifies 32 non-Proposal-related residences and other sensitive receptors as follows.

- 30 residences within 5km of component disturbance areas of the DZP Site.
- The Toongi Hall (R12), located approximately 280m west of the DZP Site
- Wambangalang Environmental Education Centre (R13) located on Obley Road approximately 4.2km southwest of the DZP Site.

Both the Proposal- and non-Proposal related residential and other receptors are identified on **Figure 4.6** with the preface (R) followed by the property reference number, e.g. R26.

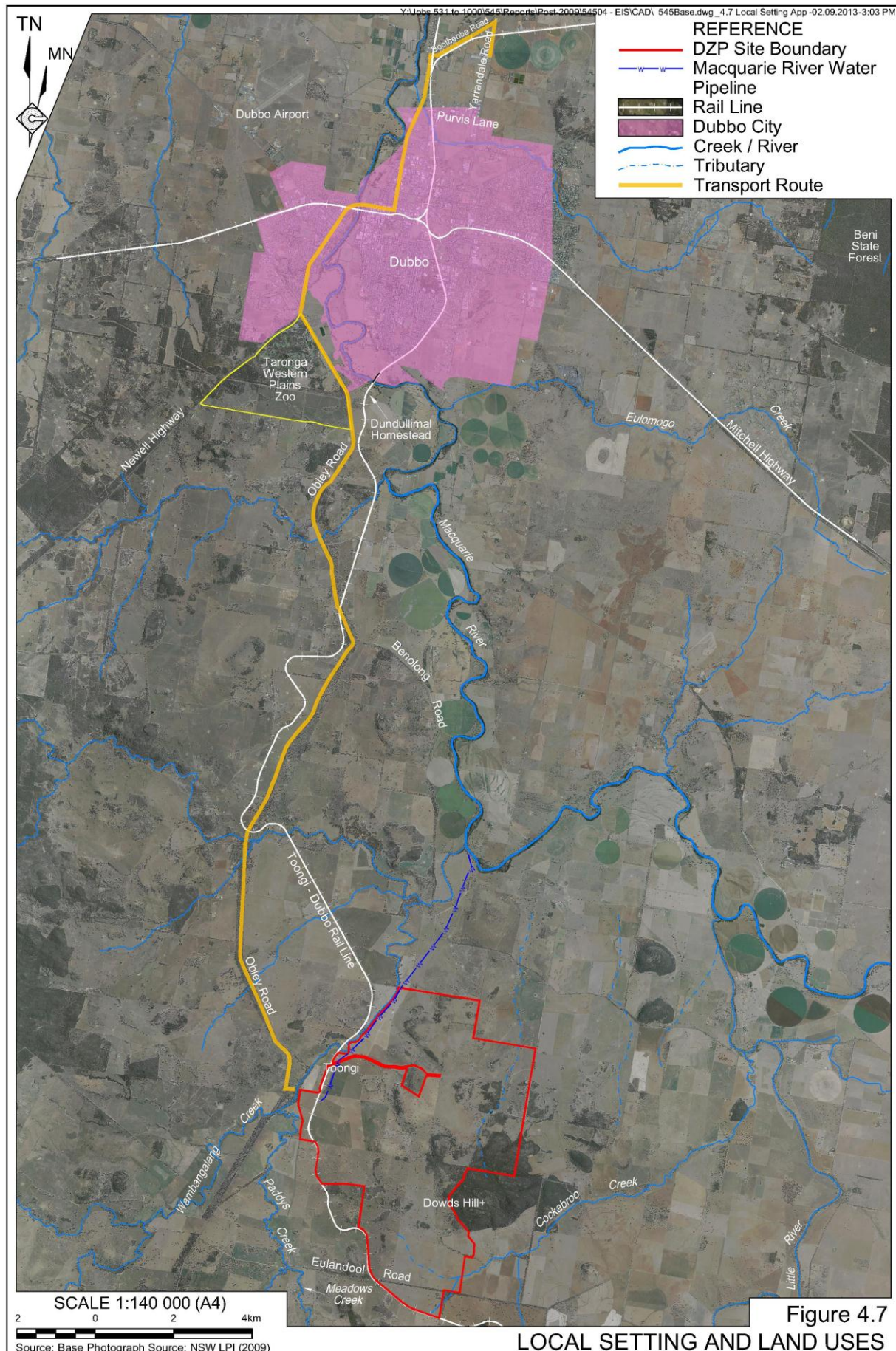
4.1.5 Land Use and Local Setting

Land use in the Macquarie-Bogan Catchment is dominated by extensive agriculture with over 80% of the catchment being used for grazing. Dryland cropping accounts for approximately 9% of land use and occurs predominantly in the middle and lower parts of the catchment. Forestry, conservation and other native landscapes together account for approximately 5% of the catchment area (NOW, 2011).

Figure 4.7 presents the DZP Site, Macquarie River Pipeline, Dubbo-Molong Rail Line and surrounding roads that would be used to access the DZP Site. In summary, the features of the local setting and land uses may be described as follows.

- Residential areas – associated with Dubbo City. Dubbo is a major regional centre with a population of over 41 000 (Section 4.15 provides an overview of the socio-economic setting, infrastructure and services of Dubbo).

² Proposal-related residences are considered those owned by the Applicant or for which a negotiated agreement is held between the landowner and the Applicant. Proposal-related residences are generally exempt from assessment against environmental criteria with the exception of criteria relating to 24hr PM₁₀ concentrations.

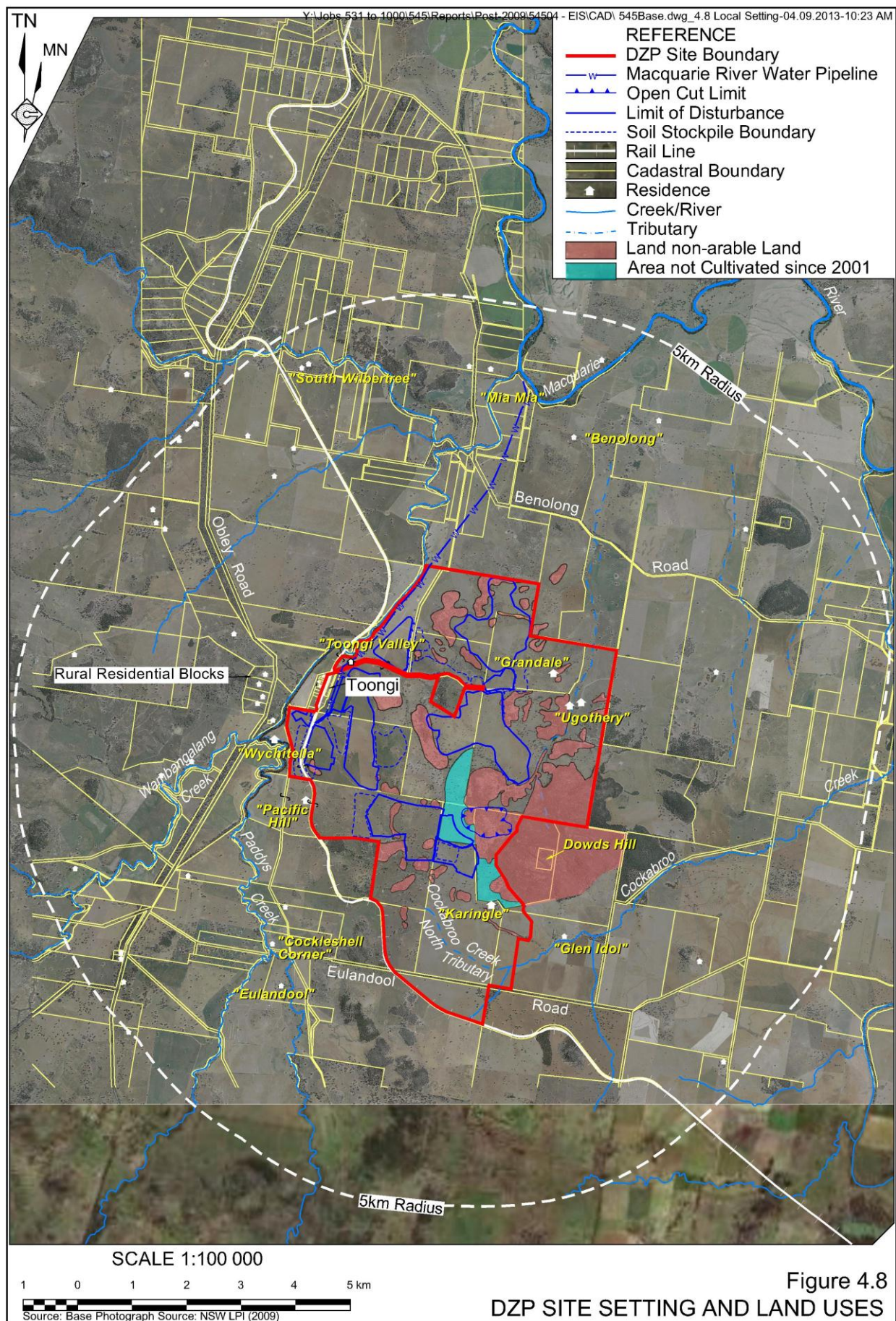


- Taronga Western Plains Zoo. The zoo is a major tourist attraction and conservation initiative.
- Transportation infrastructure – including Dubbo airport, Mitchell and Newell Highways and other regional and local roads and the Main Western Railway and associated branch lines, including the Dubbo-Molong Rail line.
- The Macquarie River – which flows in a generally northerly direction (through Dubbo). Major tributaries of the Macquarie River identifiable and include, Little River and Wambangalang Creek (see Section 4.1.2).
- Agricultural activities – identified by the extensive clearing of woodland vegetation, identifiable paddocks and irrigation features. Irrigation agriculture, dryland cropping and grazing of cattle and sheep are all established features of the local setting.

Figure 4.8 presents the setting and surrounding land uses surrounding the DZP Site. In summary, the features of the local setting and land uses surrounding the DZP Site may be described as follows.

- Agricultural activities – dry land cropping is the predominant land use surrounding the DZP Site, with some irrigation cropping also undertaken predominantly on land adjoining the Macquarie River.
- Community facilities – including a community hall, waste transfer, recreational facilities such as sports field, tennis courts and camping ground, all of which are located at Toongi and the Wambangalang Environmental Education Centre located approximately 4.2km to the southwest of the DZP Site.
- Transportation facilities – including local roads and the disused Dubbo-Molong Rail Line and associated sidings.
- Residential – including the four residences of Toongi and four smaller rural residential blocks located to the west of Obley Road approximately opposite its intersection with Toongi Road.

The Agricultural Impact Statement (AIS), presented as **Appendix 9** of the EIS, provides a more detailed review of the local agricultural land use on and surrounding the DZP Site.



4.2 NOISE AND VIBRATION

4.2.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "*Noise*" as a key issue for assessment including "*a quantitative assessment of potential:*

- *construction, operational and off-site transport noise impacts;*
- *reasonable and feasible mitigation measures, including evidence that there are no such measures available other than those proposed; and*
- *monitoring and management measures, in particular real-time, attended noise monitoring and predictive meteorological forecasting."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Environment Protection Authority (EPA) which requested that "*Potential impacts on the noise amenity of the surrounding area should be assessed in accordance with the NSW Government's Industrial Noise Policy (INP) (and other relevant guidelines mentioned below) accounting for all noise sources associated with the project*". Dubbo City Council requested that the EIS include a "*detailed analysis of any impact of rail noise on future residential development in this area (Southeast Residential Development) of the City.*"

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to noise and their risk rankings without the adoption of any mitigation measures are as follows.

- Noise levels associated with the construction of the Site and rail line, general operations and processing, product loading and rail or road traffic noise causing annoyance and/or distractions and impacts to amenity (high).
- Noise levels associated with the construction activities, general operations and processing and rail loading of product causing adverse effects on physical or mental health (medium to high).
- Adverse effects on the local fauna assemblage (low).
- Sleep disturbance as a result of maximum noise levels caused through rail loading of product, rail and road traffic (medium to high).
- Vibration from blasting causing structural damage to buildings and structures (low).
- Vibration from blasting and rail traffic causing reduced local amenity (low to medium).
- Vibration from blasting causing reduced biodiversity value of the site (low).
- Vibration from blasting causing reduced livestock productivity (medium).

The noise and vibration impact assessment for the Proposal was undertaken by Messrs Oliver Muller and Teanuanua Villierme of EMGA Mitchell McLennan (EMM). The resulting report is presented as Part 1 of the *Specialist Consultants Studies Compendium* and is referred to

hereafter as “EMM (2013)”. This subsection of the EIS provides a summary of the noise and vibration impact assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.2.2 Existing Environment

4.2.2.1 Introduction

Existing noise levels in the vicinity of the DZP Site are influenced by a range of sources including traffic on the Obley Road and local roads, agricultural equipment, stock, wind in trees, insects and birds. In order to characterise the local variation in noise levels, EMM (2013) undertook a review of a previous unattended and attended noise monitoring program which was undertaken by Richard Heggie & Associates Pty Ltd in 2001 (RHA, 2001) at five locations surrounding the DZP Site. To further extrapolate the data, EMM (2013) conducted further background attended noise surveys at three representative receptors in March 2012. This subsection provides an overview of the results of that monitoring.

4.2.2.2 Unattended Noise Monitoring

Unattended noise logging was conducted in 2001 (RHA, 2001) to quantify the ambient noise environment at surrounding receptors identified in **Figure 4.6**. **Table 4.2** reproduces the rating background levels (RBLs) from unattended noise logging undertaken over a ten day period at five locations on and surrounding the DZP Site.

Table 4.2
Historic Unattended Ambient Noise Environment

Receptor (Reference ¹)	Rating Background Level (RBL), dB(A)		
	Day	Evening	Night
Bye (R54)	30	30	27
Grandale (R48)	28	29	28
Pacific Hill (R2)	28	30	30
Wambangalang (R8A)	33	31	28
Wirribilla (R19)	30	33	30
Note 1: Refer to Figure 4.6			
Source: EMM (2013) - Table 1			

4.2.2.3 Attended Noise Monitoring

In order to supplement the unattended noise logger measurements and to assist in identifying the character and duration of the ambient noise sources, operator-attended 15 minute background noise surveys were conducted at three locations on 14 March 2012. **Table 4.3** presents the results of the attended noise monitoring program.

Table 4.3
Operator-attended Ambient Noise Survey Results

Receptor (Reference ¹)	Time (hrs)	Noise Descriptor (dB(A) ref 20Pµa)		Observations and typical maximum Sound Pressure Levels (SPL)dB(A))
		L _{Aeq} (15-min)	L ₉₀ (15 min)	
Bye (R54)	10:35	42	30	Rural background 30 to 32, wind 34 to 42
Karingle (R3)	11:18	44	31	Birds 32 to 46, rural background 30 to 32, wind 35
Cnr Toongi and Obley Road	13:03	48	28	Rural background 28 to 30, traffic 40 to 67, insects/wind 42
Note 1: Refer to Figure 4.6				
Source: EMM (2013) - Table 2				

4.2.2.4 Rating Noise Background Level

Based on the results of the attended and unattended noise monitoring programs, collected and processed in accordance with the requirements of the NSW *Industrial Noise Policy* (INP) (see Section 4.2.4.2), **Table 4.4** presents the Rating Background Noise Levels to be adopted.

Table 4.4
Adopted Rating Background Levels

Receptor	Time period	RBL (dB(A))
All Receptors	Day	30
	Evening	30
	Night	30
Source: EMM (2013) - Table 3		

4.2.3 Potential Noise and Vibration Impacts

There is potential for the various operations associated with the Proposal to generate noise and vibration which may be noticed at receptors within the Toongi and Dubbo localities. The following operations associated with the Proposal have been identified as sources of potential noise and vibration related impacts.

- Construction activities during the site establishment phase, both associated with the establishment of infrastructure on the DZP Site and various off-site components such as the Macquarie River Water Pipeline and Toongi-Dubbo Rail Line (daytime only).
- Mining and general earthworks processing operations on the DZP Site (daytime).
- Processing operations on the DZP Site (daytime, evening and night-time)
- Conveying, loading and despatch of product by road and rail (24 hours per day).
- Blasting-related air overpressure and ground vibration (daytime only).
- Rail operations from the Toongi-Dubbo Rail Line (from up to six rail movements per week).

Each of these sources of noise and potential impacts is considered in the following sections.

4.2.4 Assessment Criteria

4.2.4.1 Introduction

The following subsections summarise the noise criteria that were used by EMM (2013) to assess the noise impacts of the Proposal at privately-owned receptors and land within the local environment and at sensitive receptors within the Toongi and Dubbo localities. For the purposes of defining relevant criteria, the following periods define daytime, evening and night-time.

- Daytime.
 - 7:00am to 6:00pm (Monday to Saturday).
 - 8:00am to 6:00pm (Sunday and public holidays).
- Evening – 6:00pm to 10:00pm.
- Night-time.
 - 10:00pm to 7:00am (Monday to Saturday).
 - 10:00pm to 8:00am (Sunday and public holidays).

4.2.4.2 Operational Noise Assessment Criteria

The Environment Protection Authority released the NSW *Industrial Noise Policy* (INP) in January 2000 (EPA, 2000). The INP provides a framework and process for deriving operational noise criteria for project approvals and development consents under the EP&A Act and setting operational noise limits in environment protection licences under the POEO Act. The Proposal is a scheduled activity under Schedule 1 of this latter Act. The INP specifies two noise criteria, namely:

- an intrusiveness criterion which requires that the equivalent continuous noise level ($L_{Aeq,15min}$) from a specific industrial source at a privately-owned receptor should not exceed the background noise level by more than 5 decibels; and
- an amenity criterion which aims to maintain noise amenity throughout a community over the whole daytime, evening or night-time periods and considers cumulative noise from all industrial sources.

A fundamental difference between the intrusiveness and the amenity criteria is the time period over which the noise is measured and this is further discussed below.

Intrusiveness

The intrusiveness criteria require that $L_{Aeq(15min)}$ noise levels from a newly introduced source during the day, evening and night do not exceed the existing rating background level (RBL) by more than 5dB. This is expressed as $L_{Aeq(15min)} \leq RBL + 5 - K$, where $L_{Aeq(15min)}$ is the L_{eq} noise level from the source measured over a 15 minute period and K is a series of adjustments for various noise characteristics.

As a common RBL has been established for all residential receptors surrounding the DZP Site, a single intrusive criteria of 35dB(A) has been established for the Proposal.

Amenity

The amenity assessment is based on noise criteria specific to the land use. As there are no existing industries within the Toongi Village, the base amenity industrial criterion does not apply. For sensitive receptors located in and around the DZP, the rural residential category is suitable. For the Toongi Hall and tennis courts, the amenity criteria for passive and active recreation areas have been adopted respectively. For the Wambangalang Environmental Education Centre (WEEC) the school classroom criterion has been adopted. **Table 4.5** presents the base amenity criteria for the DZP Site.

Table 4.5
Amenity Criteria

Receptor	Indicative Area	Time Period	Recommended Noise Level Leq period (dB(A))	
			Acceptable	Maximum
Residential	Rural	Day	50	55
		Evening	45	50
		Night	40	45
Active Recreation Area	All	When in use	55	60
Passive Recreation Area	All	When in use	50	55
School Classroom	All	Noisiest 1-hour period	35 (internal)	40 (internal)

Source: EMM (2013) - Table 5

Proposal-Specific Noise Level

The project-specific noise level (PSNL) for the various receptors surrounding the DZP Site is the lower of the calculated intrusive or amenity criteria presented in **Table 4.6**. The intrusive criteria are therefore adopted as the PSNL for the Proposal.

Table 4.6
Proposal specific Noise Levels (PSNL)

Receptor	Time period	RBL dB(A)	Criteria dB(A)
Intrusiveness			
All receptors	Day	30	35
	Evening	30	35
	Night	30	35
Amenity			
Toongi Tennis Courts (R11)	When in use	N/A	55
Toongi Hall (R11)	When in use	N/A	50
WEEC (R13)	Noisiest 1-hour period	N/A	35

Source: Modified after EMM (2013) - Table 6

Assessment Zones of Impact

The INP states that an increase of 5dB(A) or less above the background noise levels would protect 90% of residents living in the vicinity of an industrial noise source from adverse effects of noise 90% of the time. In subjective terms, any exceedances of the PSNL can be generally described as follows.

- <1dB(A) Negligible noise level increase (Not noticeable by anyone).

- 1dB(A) to 2dB(A) Marginal noise level increase (Not noticeable by most people).
- 3dB(A) to 5dB(A) Moderate noise level increase (Not noticeable by some people but may be noticeable by others).
- >5dB(A) Appreciable noise level increase (Noticeable by most people).

While the INP does not specifically deal with acquisition, an acquisition criteria of greater than 5dB over the PSNL (40dB(A) $L_{Aeq(15-min)}$) for daytime, evening and night-time periods has been adopted in this assessment for privately owned dwellings. The acquisition zone for vacant lands has been considered for land parcels where more than 25% of the property is affected by an $L_{Aeq(15-min)}$ of greater than 40dB(A) for daytime, evening and night-time periods.

Exceedances less than 5dB over the PSNL, subject to demonstration that all reasonable and feasible mitigation measures have been implemented, may be considered acceptable under the INP.

4.2.4.3 Low Frequency Noise Criteria

Low frequency noise is typically defined as noise with frequencies below 100Hz, and includes infrasound, i.e. frequencies <20Hz. The INP states that where there is a difference of 15 decibels or more between C and A weighted noise levels³, then a correction factor of 5 dB is applicable.

4.2.4.4 Sleep Disturbance Criteria

In order to protect against sleep disturbance, the EPA recommends that the $L_{A(1min)}$ noise level (which is approximately the maximum noise level) from any activity should not exceed the RBL by more than 15dB(A) when measured or computed at one metre from a bedroom façade. The “sleep disturbance” criterion is only applicable to night-time operations.

Where the existing rating background level (RBL) is less than 30dB(A), the INP states that a minimum RBL of 30dB(A) should be adopted. Given this, the sleep disturbance criterion when assessed external to any residence is defined as 45dB(A) $L_{A(1min)}$. This level, on the outside of a residence, is equivalent to an internal noise level of <35dB(A).

The likely noise source from the DZP Site that has the potential to generate significant $L_{A(1min)}$ noise levels is associated with unloading/loading trains.

³ The A-Weighted noise level effectively cuts off the lower and higher frequencies that the average person cannot hear, i.e. it provides for the noise actually heard by the human ear. The C-Weighted noise level includes the higher and particularly lower frequency noise and is used to assess potential damage that may be caused by the imperceptible component of loud noise.

4.2.4.5 Construction Noise Criteria

The assessment and management of on-site construction works is governed by the requirements of the INP. Off-site construction works, namely the construction of the Macquarie River Water Pipeline, Toongi-Dubbo Rail Line, and upgrades to the public road network and various creek crossings is governed by the OEH's "Interim Construction Noise Guideline" (ICNG) (DECCW, 2009a). The ICNG recognises that higher levels of noise are likely to be tolerated by people in view of the relatively short duration of the works and recommends the following approaches to mitigating adverse noise impacts from construction sites.

The ICNG recommends that the $L_{Aeq(15min)}$ noise levels arising from construction activities, when measured at boundary or within 30m of the residence (whichever is the lesser), should not exceed the following levels.

- Standard hours (Monday to Friday – 7:00am to 6:00pm & Saturday – 8:00am to 1:00pm).
 - Noise affected⁴: RBL + 10dB(A).
 - Highly noise affected⁵: 75dB(A)
- Non-standard hours (Monday to Friday – 6:00pm to 7:00am, Saturday – 1:00pm to 8:00am, Sundays and public holidays).
 - Noise affected: RBL + 5dB(A)

These noise management levels are generally consistent with community reaction to construction noise.

Criteria for vibration generated by construction activities is discussed in Section 4.2.4.9.

4.2.4.6 Road Traffic Noise Assessment Criteria

Criteria for assessment of noise from traffic on public roads are set out in the NSW Road Noise Policy (RNP) (DECCW, 2011). Under this policy, the Newell Highway and Obley Road would be considered as the freeway / arterial / sub-arterial road types and therefore assessed against the criteria for the "arterial or sub-arterial road" category (see **Table 4.7**).

Table 4.7
Criteria for Traffic Noise – at Roadside Residences

Road Category	Type of development	Noise Level Criterion*	
		Day ¹	Night ²
Arterial or sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use development	$L_{Aeq,15hr}$ 60dB(A)	$L_{Aeq,9hr}$ 55dB(A)
Note 1: 07.00am to 10.00pm Note 2: 10.00pm to 07.00am Source: Modified after EMM (2013) - Table 3.5			

⁴ The noise affected level represents the point above which there may be some community reaction to noise.

⁵ The highly noise affected level represents the point above which there may be strong community reaction to noise.

The RNP also states that, where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2dB, which has been accepted as the threshold of perceptibility to a change in noise level.

4.2.4.7 Rail Noise Assessment Criteria

The *Rail Infrastructure Noise Guideline* (RING) has been issued by the EPA (2013) sets out the rail noise assessment criteria trigger values for airborne and ground-borne noise. The RING supersedes the *Interim Guideline for Assessment of Noise from Rail Infrastructure Projects* (IGANRIP) (EPA & DP&I, 2007) as well as the existing EPA policy on rail traffic generating developments.

Table 4.8 presents the RING airborne noise trigger levels⁶ relevant to the Proposal.

Table 4.8
Rail Noise Assessment Criteria

Type of development	Noise Trigger Level dB(A) (External) ³		Comment
	Day ¹	Night ²	
Redevelopment of existing rail line	65 L_{Aeq} (15-hr) 85 L_{max}	60 L_{Aeq} (9-hr) 85 L_{max}	These numbers represent external levels of noise that trigger the need for an assessment of the potential noise impacts from a rail infrastructure project. An 'increase' in existing rail noise levels is taken to be an increase of 2dB(A) or more in L_{eq} in any hour or an increase of 3dB(A) or more in L_{max} .
Note 1: 07.00am to 10.00pm Note 2: 10.00pm to 07.00am Note 3: The trigger levels presented in this table should be read with the technical notes of Tables 1 and 3 of the RING. Source: Modified after EMM (2013) - Table 3.7			

Furthermore, the Australian Rail Track Corporation (ARTC) Environment Protection Licence (EPL) 3142 provides rail noise emission criteria that are relevant to the Proposal, Condition L6.1 is reproduced below and was considered for the noise and vibration impact assessment:

"L6.1.1 General Noise Limits: It is an objective of this Licence to progressively reduce noise levels to the goals of 65dB(A) L_{eq} , (day time from 7am – 10pm), 60dB(A) L_{eq} , (night time from 10pm – 7am) and 85dB(A) (24 hr) max pass-by noise, at one metre from the façade of affected residential properties through the implementation of the Pollution Reduction Programs."

⁶ As the Proposal involves only the use of an above-ground rail network which would not generate ground-borne noise in a receiving building that is higher than airborne noise, ground-borne trigger levels are not considered.

4.2.4.8 Blasting Criteria

The EPA has adopted recommended airblast and ground vibration levels published by the Australian and New Zealand Environment and Conservation Council (ANZECC). These recommended levels, are based on prevention of human discomfort and have been adopted as the assessment criteria for the blasting assessment for residential receptors.

- The recommended maximum vibration level for airblast is 115dB linear peak. The vibration level of 115dB may be exceeded on up to 5% of the total number of blasts over 12 months, however, should not exceed 120 dB linear peak at any time.
- Peak particle velocity (PPV) from ground vibration should not exceed 5mm/s for more than 5% of the total number of blasts over 12 months, however, the maximum level should not exceed 10mm/s at any time.

4.2.4.9 Vibration Criteria

In the absence of an Australian standard for structural vibration damage threshold, the *German Standard DIN 4150: Part 3-1999 "Structural Vibration Part 3: Effects of Vibration on Structures"* has been adopted. The limits presented in this standard are recognised to be conservative with recommendations on residential type structure safe limits as low as 5mm/s, with limits increasing for frequency values above 10Hz.

4.2.5 Assessment Methodology

4.2.5.1 Introduction

This subsection presents the methods and base parameters used to model noise emissions from the Proposal, including the effect of prevailing meteorological conditions. The assessment was conducted in accordance with the following policies and guidelines.

- The NSW Industrial Noise Policy (EPA, 2000).
- The NSW Road Noise Policy (DECCW, 2011).
- The Rail Infrastructure Noise Guideline (RING) (EPA, 2013).
- German Standard DIN4150 - Part 3: 1999.
- Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZECC, 1990).
- The Interim Construction Noise Guideline (DECC, 2009a).

4.2.5.2 Operational Noise Modelling

Noise predictions were carried out by EMM (2013) using *Brüel and Kjær Predictor Version 8.11* noise prediction software. 'Predictor' calculates total noise levels at receptors from the concurrent operation of multiple noise sources.

Three scenarios were modelled, Year 1, Year 5 and Year 15 operations, considered to be representative of likely noise generation on the DZP Site throughout the life of the Proposal. **Figures 4.9 to 4.11** illustrate the locations of operating equipment included in each scenario. It is noted that the modelled scenario presented in **Figure 4.9** (Year 1) includes what could be considered construction activities associated with the Macquarie River Water Pipeline and Wambangalang Creek crossing upgrade.

Each scenario was modelled under prevailing meteorological conditions (as defined in the INP), determined following analysis of continuous weather data collected at a meteorological station operated by the Applicant on the “Wychitella” property (R1) over a two year period (2007 and 2008). **Table 4.9** presents the meteorological parameters used during the operational noise assessment which represent calm and prevailing conditions for the local area.

Table 4.9
Prevailing Meteorological Conditions

Period	Meteorological Condition	Wind Conditions		
		Wind speed (m/s)	Direction (degrees)	Inversion Class
Daytime	Calm	0	-	-
	Prevailing	1.8	270	-
Evening	Calm	0	-	-
Night-time	Calm	0	-	-
	Prevailing	2.6	All	-
	Inversion ¹	0	-	F
Note 1: Temperature inversion data was not available and the INP default inversion parameters have been adopted. Source: Modified after EMM (2013) –Table 4.2				

The following assumptions and inputs were used during the noise assessment.

- All items of equipment identified in *Tables 4.3 and 4.4* of EMM (2013) were assumed to be operating in the locations and at the times identified in **Figures 4.9 to 4.11**.
- Noise attenuation of the crushing plant and ore handling circuit provided by semi-enclosed barriers and screens located on the western side of the plant. The height of the barrier was modelled at 1m higher than the acoustic centre of the crushing plant and 3m higher than the acoustic centre of the ore handling circuit. *Figures 8 and 9* of EMM (2013) (Part 1 of the Specialist Consultant Studies Compendium) provide a detailed concept of the semi-enclosed barriers/screens that would be constructed.
- The rock breaker required occasionally to reduce the size or ROM ore to the crushing plant would be located within the open cut as opposed to the ROM Pad.
- All equipment to be used was assumed to be reasonably new, well maintained and fitted with manufacturer standard noise mitigation equipment.
- All equipment was assumed to be operating concurrently in order to simulate the overall maximum energy equivalent (i.e. $L_{Aeq(15min)}$) intrusive noise level.

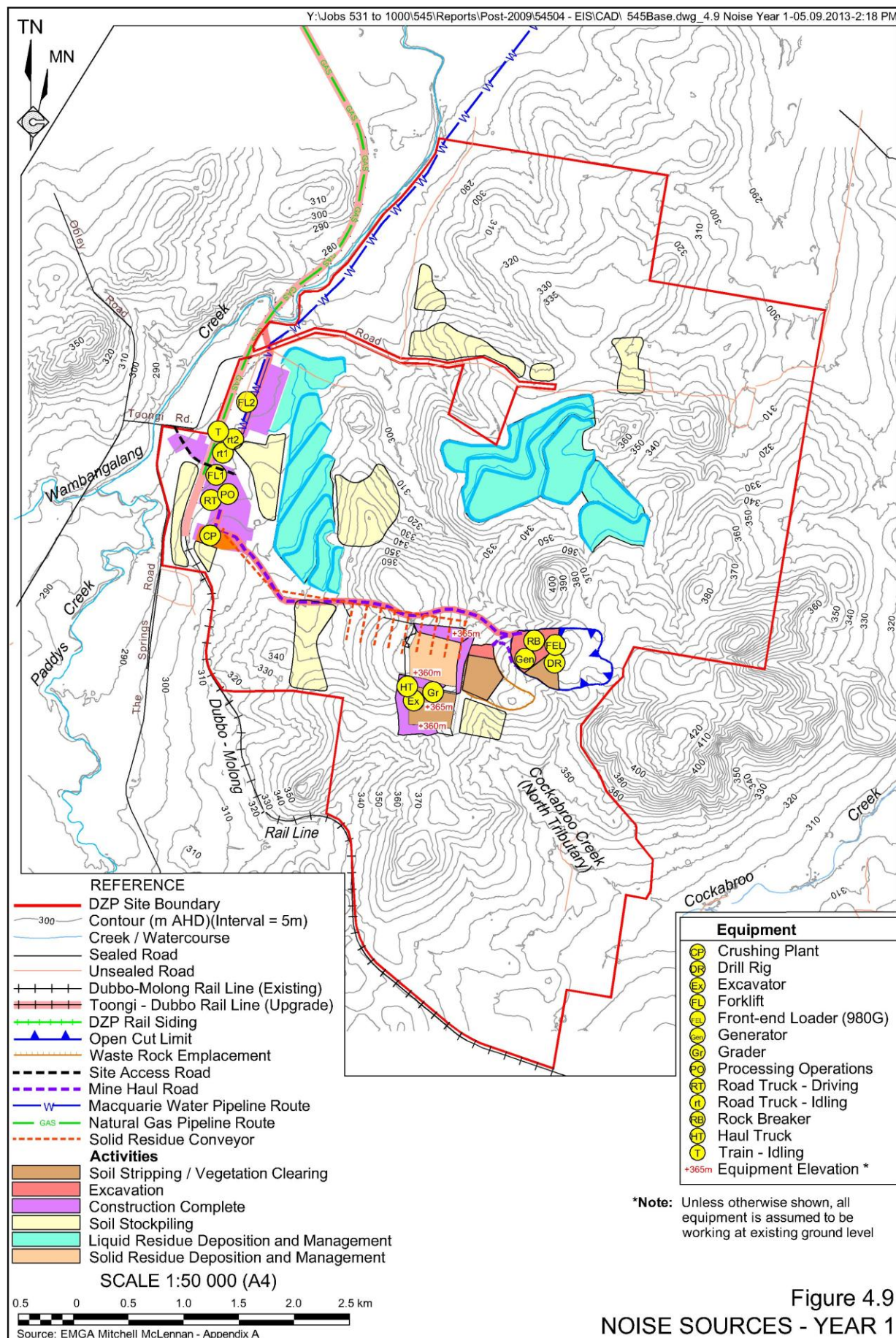
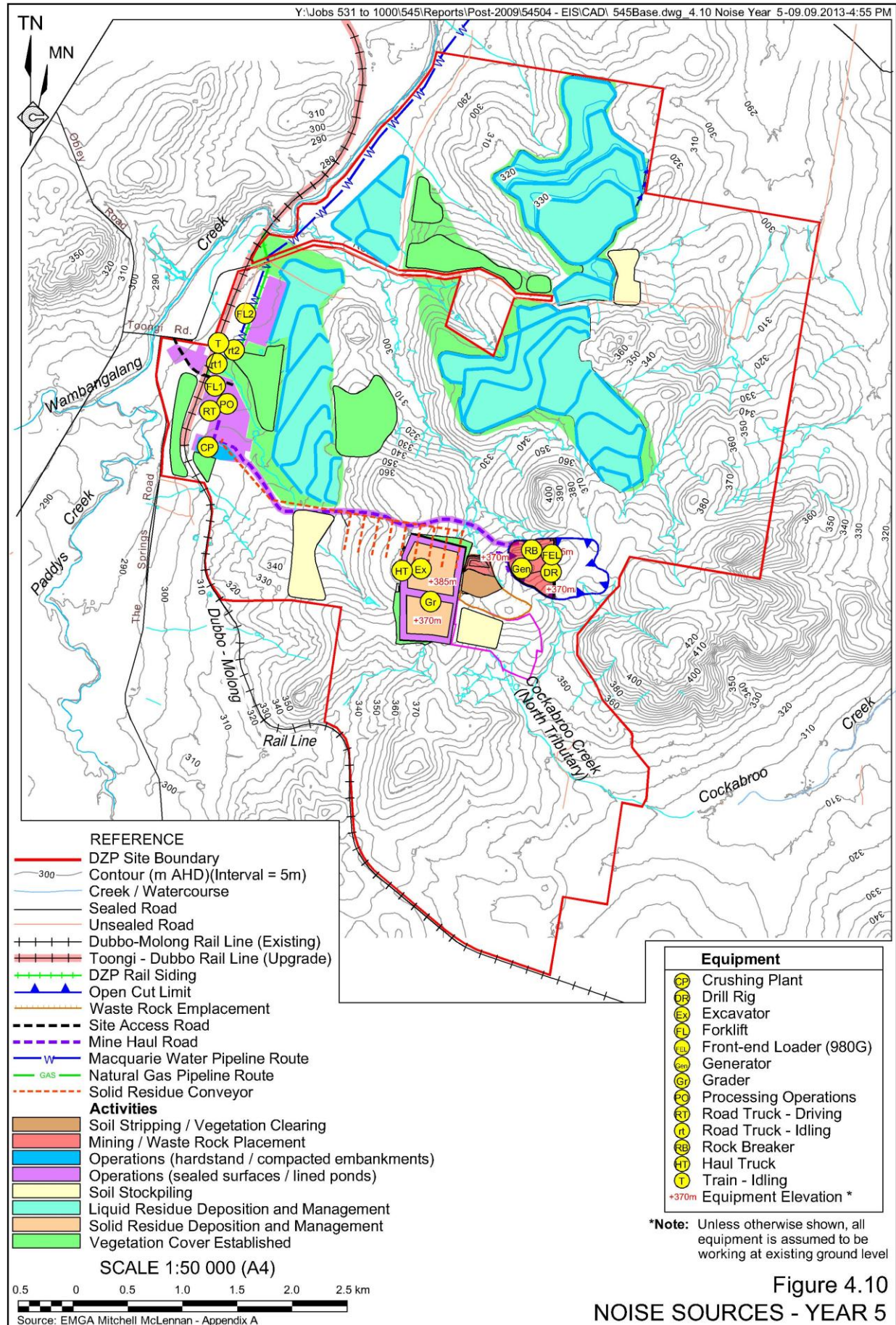
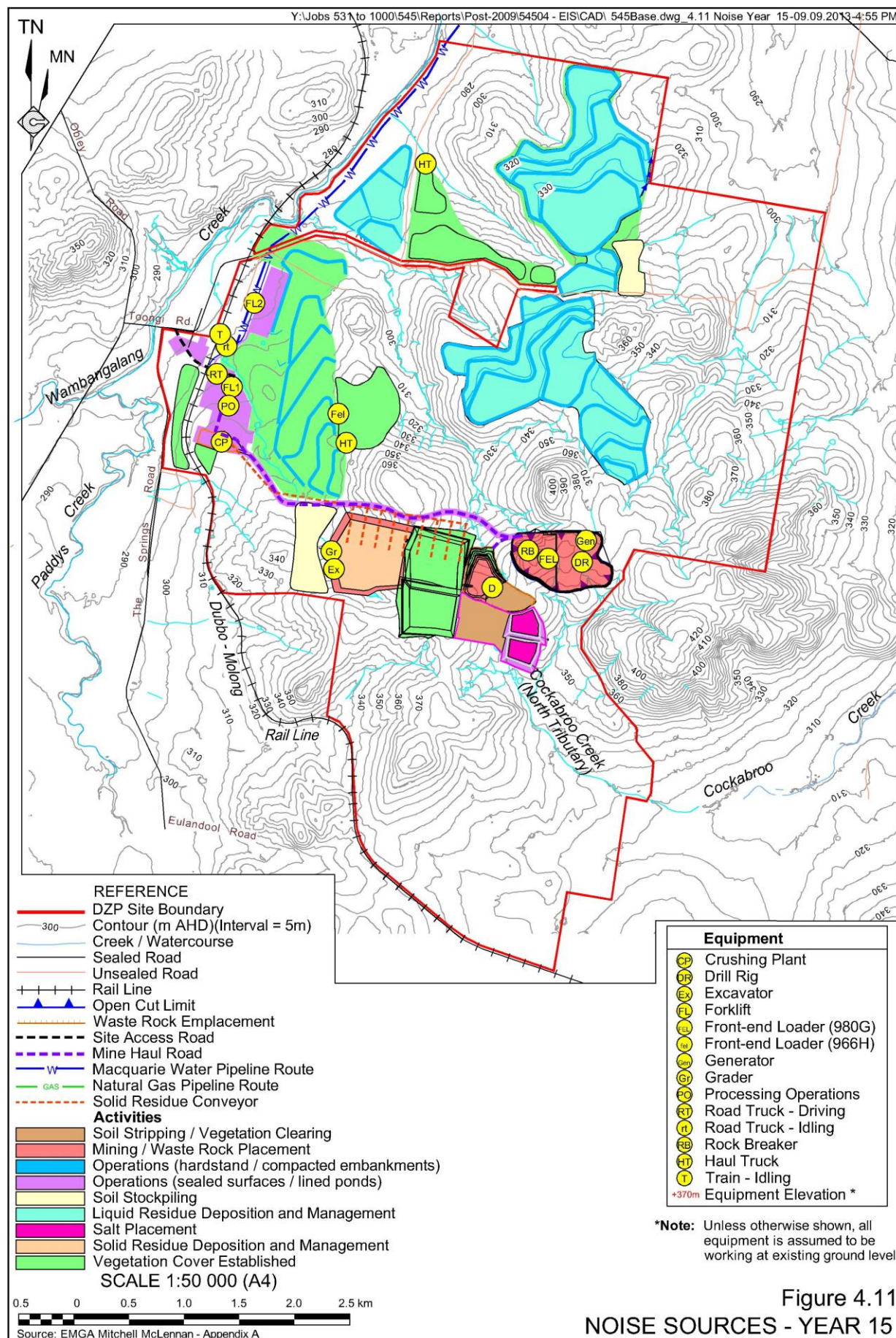


Figure 4.9
NOISE SOURCES - YEAR 1





4.2.5.3 Construction Noise Emissions

The ICNG provides methodology for calculating noise levels based upon source sound power levels and distance attenuation. This methodology was adopted by EMM (2013) to predict a range of noise levels which could be received at the most proximal residential receptor to specific individual construction activities during the 18 month to 2 year construction phase. A range of noise levels was predicted given the transitory and intermittent nature of equipment operation during construction, and to reflect the varying meteorological conditions that could be encountered.

The individual construction activities, nature and duration of the disturbance, typical equipment and distance to the nearest receptor for each are provided in **Table 4.10**. The sound power levels assumed for typical plant to be used in the construction phase of the Proposal are as presented in *Table 4.5* of EMM (2013).

Table 4.10
Project-related Noise Levels for Scenario 1 (Year 1)

Activity	Type / Duration	Typical Plant	Distance to Closest Receptor (m)
Gas Pipeline Corridor	Transient / 50 weeks	Backhoe/small excavator, dozer, grader, trencher, road truck and light vehicle	25
Rail Line upgrade	Transient / 50 weeks	Excavator, crane, FEL, tamping machine, welding truck, road truck and light vehicle	25
Water Pipeline	Transient / 40 weeks	Backhoe/small excavator, dozer, grader, trencher, road truck and light vehicle	70 (R36)
Obley Road upgrade	Transient / 40 weeks	Excavator, dozer, grader, vibrating roller, road truck and light vehicle	65
Wambangalang Creek Bridge	Static / 25 weeks	Excavator, crane, FEL, haul truck and light vehicle	780
Hyandra Creek Bridge	Static / 25 weeks	Excavator, crane, FEL, road truck and light vehicle	200
Twelve Mile Creek Bridge	Static / 25 weeks	Excavator, crane, FEL, road truck and light vehicle	235
Processing area	Static / 20 weeks	Compactor, trencher, jackhammer, pneumatic wrench, rock breaker, scrapers, dozer, grader, generators, road trucks	2 000
Haul road	Static / 20 weeks	Compactor, grader, water truck, FEL, haul truck, scraper and light vehicle	2 000
LRSF Embankments	Static / 20 weeks	Scrapers, dozers, water truck, excavator, grader and light vehicle	Area 2 – 2 000 Area 3 – 2 200 Area 4 – 3 800 Area 5 – 3 100
Open Cut Development	Static / 20 weeks	Drilling rig, dozer, FEL and haul trucks	1 900
WRE Development	Static / 20 weeks	Dozer and haul trucks	1 900
SRSF Embankments	Static / 20 weeks	Grader, scrapers, compactor, water truck, haul trucks and light vehicle	1 900

Source: Modified after EMM (2013) – Tables 5.4 and 5.5

Activities such as open cut and WRE development are included in the construction noise modelling to account for these operations during the 18 month to 2 year construction phase, i.e. prior to the commencement of processing. Notably, these activities are assessed against the INP intrusiveness criteria, as opposed to the construction noise criteria. It is also important to note that should construction activities such as LRSF embankment development coincide with DZP operations, the total fleet operated on the DZP Site would not be increased from that presented in the operational scenarios of **Figures 4.9 to 4.11**. Rather, equipment from areas such as the SRSF, open cut or WRE would be redeployed.

4.2.5.4 Road Traffic Noise Emissions

The road network that would be used, in both directions, includes the Newell Highway, Obley Road and Toongi Road. The nearest privately-owned receptor to these roads is at a distance of 65m.

The Calculation of Road Traffic Noise (CORTN) (UK Department of Transport) method was used to predict the L_{eq} noise levels at the closest receptor for additional traffic travelling along Obley Road. CORTN considers traffic flow volume, average speed, percentage of heavy vehicles and road gradient to establish noise source strength, and includes attenuation due to distance, ground, atmospheric absorption and screening from buildings or barriers. Traffic volumes determined by traffic counts on Obley Road in 2012 were used to calculate existing Obley Road noise levels.

4.2.5.5 Rail Noise and Vibration Emissions

Two transport options are available for rail usage (Preferred Option A and Contingency B in accordance with Section 2.12.1). Both options have the potential to generate off-site rail noise and have been assessed in accordance with the IGANRIP. It is noted that there would be a maximum of one train per 24hr period travelling along either the Toongi-Dubbo Rail Line or from Dubbo to other regional centres. The calculations adopted a typical sound exposure level (SEL) of 90dB(A) at 30m for mixed freight train pass-bys, while the L_{max} calculation was based on a typical train noise emission of 82dB(A) at 30m from the train line.

4.2.5.6 Blasting Emissions

Anticipated ground vibrations and air blast overpressure levels were determined using the blasting formulae presented in Australian Standard 2187.2-1993 *Explosives—Storage, transport and use - Part 2: Use of explosives* and the Orica (ex ICI) Explosives Blasting Guide. This method of determining blast emissions is considered conservative.

The relevant formulae are as follows:

$$\begin{aligned} \text{PVS} &= 500 (R/Q^{0.5})^{-1.6} \\ \text{dB} &= 164.2 - 24(\log_{10} R - 0.33 \log_{10} Q) \end{aligned}$$

where,

$$\begin{aligned} \text{PVS} &= \text{peak vector sum ground vibration level (mm/s)} \\ \text{dB} &= \text{peak airblast level (dB Linear)} \\ R &= \text{distance between charge and receptor (m)} \\ Q &= \text{charge mass per delay (kg) or maximum instantaneous charge (MIC)} \end{aligned}$$

4.2.6 Management and Mitigation Measures

4.2.6.1 Introduction

This subsection outlines the suite of measures that would be adopted both from a management perspective and through the use of specific mitigation measures to achieve the required noise levels at the surrounding privately-owned receptors. Emphasis has been placed upon designing the DZP Site to minimise noise levels for as much time as possible.

4.2.6.2 Construction Noise Mitigation

It is noted that construction noise predictions are provided as a range within which it is expected noise levels would be received at the most proximal receptor to the construction activities. In order to minimise this noise level, the Applicant would enforce a comprehensive range of noise mitigation measures as follows.

- Strict adherence to the INP nominated standard hours of operation.
- The equipment operated would have sound power levels equivalent to those nominated in *Table 4.5* of EMM (2013).
- If construction activities are to be undertaken coincident with operations, i.e. following the 18 month to 2 year construction phase, no additional equipment would be used to that presented on **Figures 4.9** to **4.11**, i.e. existing equipment would be re-deployed.
- Occupants of residences adjoining construction activities would be provided with details ahead of time regarding the type of activities, their duration and the specific measures to minimise noise during the period. Occupants would also be provided with contact details for personnel managing the construction activities.
- All mechanical plant and equipment would be silenced with appropriate mufflers and enclosures.
- Where possible, equipment would not be left idling unnecessarily.
- All contractors and personnel would be educated regarding the noise sensitivities by:
 - minimising the use of air brakes;
 - no queuing of vehicles adjacent to any residential receptor, or if unavoidable engines to be switched off;
 - parking of vehicles where appropriate to shield locations prior to being used for maintenance work undertaken outside standard hours of operation;
 - no warming of vehicles permitted before the nominated working hours;
 - accessing sites via entry point most remote to receptors;
 - conservative driving methods;
 - minimising the use of radios and loud voices;

- locating machinery to orientate direct noise away from closest sensitive receptors;
 - placement of mobile barriers/screens or extraction faces adjacent to static rock breaking sources to shield neighbouring receptors;
 - undertaking of regular maintenance of machinery to minimise noise emissions;
 - use of quietest suitable machinery reasonably available for selected work activities;
 - ensuring the coincidence of noise/plant machinery working simultaneously in close proximity to sensitive receptors is avoided, where practicable; and
 - awareness of the expectation of landowners and surrounding residents.
- Any legitimate complaints from surrounding landowners and occupiers would be responded to in a timely manner.
 - The areas for loading and unloading materials and equipment would be positioned as far away as possible from surrounding residences during the site establishment and construction phase.
 - Broadband (frequency modulated) reversing alarms would be used instead of tonal reversing alarms on all earthmoving equipment.

4.2.6.3 Operational Noise Mitigation

The INP states the following with respect to feasible and reasonable noise mitigation.

- Feasibility relates to engineering considerations and what is practical to build.
- Reasonableness relates to the application of judgment in arriving at a decision, taking into account the:
 - noise mitigation benefits (amount of noise reduction provided, number of people protected);
 - cost of mitigation (cost of mitigation versus benefit provided);
 - community views (aesthetic impacts and community wishes); and
 - noise levels for affected land uses (existing and future levels, and changes in noise levels).

Following the completion of initial noise modelling, the Applicant has committed to the following noise mitigation measures.

- Restriction of all but processing, transport and low noise maintenance activities to daytime only.
- Broadband (frequency modulated) reversing alarms would be fitted on all mobile equipment.
- The mining fleet would be operated with sound power levels equivalent to those nominated in *Table 4.3* of EMM (2013).

- Attenuation of noise generated by the crushing plant and ore handling circuit by construction of semi-enclosed barriers and screens (refer to Section 4.2.5.2).
- Placement of the rock breaker within the open cut as opposed to the ROM Pad
- Completion of a detailed review of potential enclosures, noise barriers and other attenuating measures would be completed prior to construction, taking into consideration the frequency and amplitude generated by the processing plant, to ensure (and demonstrate) that it provides sufficient acoustic attenuation.
- A *Noise Management Plan* would be prepared (refer to Section 4.2.6.6.1).

EMM (2013) notes that following mitigation of the processing plant, the noise levels generated from the DZP Site would be a function of the mobile equipment operated, including on-site road trucks, drills, conveyors, front-end loaders and haul trucks. Applying further noise suppression/mitigation to reduce the overall noise levels could be undertaken, however, the overall reduction would be limited to less than 3dB(A), which is generally imperceptible to most people. Given the high cost of noise suppression on the identified plant and equipment and the minor decrease in overall noise levels it would achieve, it is not considered reasonable or feasible to apply such a mitigation measure.

4.2.6.4 Maximum Noise Level (Sleep Disturbance) Mitigation Measures

On-site noise from loading and unloading trains could, if unmitigated or managed, generate L_{max} noise events above the sleep disturbance criteria at several privately owned receptors.

To reduce the potential occurrence of such sleep disturbing noise events, the Applicant would restrict train loading and unloading to after 6:00am and before 10:00pm unless the allocated rail path requires an overnight turn-around of the train.

To mitigate against these potentially sleep disturbing noise events during night-time loading and unloading, AZL would implement and enforce a noise management plan which requires operators to avoid high impact events, e.g. between container and wagon. Forklifts equipped with modern hydraulics are capable of all but eliminating impact noise of such activities. Operators unable to adhere to noise management requirements would be excluded from operating that equipment. This mitigation measure would eliminate the sleep disturbing noise source.

Other mitigation measures were considered by the Applicant and these are reviewed as follows.

- Construction of a 300m long barrier along the western boundary of the DZP Rail Siding.

This mitigation measure would be costly (>\$200 000), the effectiveness of this measure would be limited to 2dB(A) or less due to the slightly elevated location of the receptors that would be effected on the western side of Obley Road (R20 to R23). A reduction in L_{max} noise levels of this magnitude would not influence the sleep disturbing nature of the noise.

- Installation of duratray (or equivalent) lining on rail wagons.

This mitigation measure is considered impractical due to the limited number of rail movements required by the Proposal which would inevitably result in different trains and wagons being used to travel to and from the DZP Site. As a consequence, there would be no certainty that the treated wagons would travel to and from the DZP Site.

4.2.6.5 Blasting and Vibration Mitigation Measures

Section 2.4.3.3 provides a description of the proposed blasting operations. In summary, each blast would be designed to:

- achieve the required degree of fragmentation;
- satisfy all environmental criteria; and
- contain all fly rock within the nominated blast envelope.

The Applicant would implement the following blasting and vibration mitigation measures throughout the life of the DZP.

- Design and implementation of each blast by a suitably qualified blasting engineer or experienced shot-firer.
- Design each blast to ensure the assessment criteria described in Section 4.2.4.8 are complied with at all residential receptors in the vicinity of the DZP Site
- Identify the blast envelope during design of each blast.
- Modify blast designs, mitigation measures and operating procedures, if required, on the basis of monitoring results.
- Initiate blasts between the hours of 9:00am and 5:00pm Monday to Saturday only. No blasts would be initiated outside these hours, except for safety or emergency reasons.
- Establish and maintain an environmental complaints line and register of complaints in accordance with the requirements of the Environment Protection Licence, once issued.
- Respond promptly to any issue of concern or complaint raised by the community or a government agency.

4.2.6.6 Management Plans

4.2.6.6.1 Noise

Prior to the commencement of construction or mining related activity, a *Noise Management Plan* (NMP) would be prepared detailing activities to manage construction and operational noise emissions from project-related activities. The NMP would:

- provide training and awareness to contractors and employees regarding the statutory, construction and operational requirements for the Proposal;

- identify noise affected properties consistent with the environmental assessment and any subsequent assessments;
- outline mitigation measures to use to achieve the noise limits established;
- outline measures to reduce the impact of intermittent, low frequency and tonal noise (including truck reversing alarms);
- outline the procedure to notify property owners and occupiers that could be affected by noise from the mine;
- establish a protocol to handle noise complaints that includes recording, reporting and acting on complaints;
- specify procedures for undertaking independent noise investigations; and
- describe proactive and predictive modelling and real-time reactive management protocols for managing noise during adverse meteorological conditions.

4.2.6.7 Blasting and Vibration

A *Blast Management Plan* (BMP) would also be prepared detailing activities to manage blasting and vibration emissions from project-related activities. The BMP would:

- provide training and awareness to contractors and employees regarding the statutory, construction and operational requirements for the Proposal;
- identify potential blast and vibration affected properties consistent with the environmental assessment and any subsequent assessments;
- outline mitigation measures to use to achieve the blast limits established;
- outline the procedure to notify property owners and occupiers that could be affected by blasting and vibration from the mine;
- establish a protocol to handle blast and vibration complaints that includes recording, reporting and acting on complaints;
- specify procedures for undertaking independent blast investigations; and
- describe proactive and predictive modelling and real-time reactive management protocols for managing blasting during adverse meteorological conditions.

4.2.7 Assessment of Impacts

4.2.7.1 Construction Noise

The anticipated range of noise levels from construction works are presented in **Table 4.11**. The maximum noise level has been calculated (at the most proximal residence) with all plant operating simultaneously at 100% capacity for the entire 15 minute period. The minimum level represents the noise levels during reduced construction activities over a 15 minute period.

Results of the construction noise assessment identifies that the noise affected criteria, and in some instances the highly noise affected noise criteria (in **bold** on **Table 4.11**), may be exceeded when activities pass by receptors. While the noise associated with the proposed

construction would be highly transient and move away from the receptor within days, noise management and mitigation measures as described in Section 4.2.6.2 and 4.2.6.6.1 are considered critical in reducing noise emissions from these activities. EMM (2013) provides a summary of those receptors where all reasonable and feasible mitigation measures should be implemented and the Applicant has committed to doing so.

Table 4.11
Construction Noise Modelling Results

Construction Activity	Distance to Nearest Receptor (m)	Noise affected criteria dB(A)	Highly noise affected criteria, dB(A)	Modelled noise level range, dB(A)¹
Gas Pipeline Corridor	25	40	75	35-79
Toongi – Dubbo Rail Line Upgrade	25	40	75	34-72
Macquarie Pipeline	70 (R36)	40	75	35-77
Obley Road Upgrade	65	40	75	35-77
Wambangalang Creek Bridge	780	40	75	35-45
Hyandra Creek Bridge	200	40	75	35-52
Twelve Mile Creek Bridge	235	40	75	35-53
Processing Area	2 000	35	75	<30-52
Haul Road	2 000	35	75	<30-52
LRSF – Area 1	2 000	35	75	<30-52
LRSF – Area 2	2 200	35	75	<30-41
LRSF – Area 3	3 800	35	75	<30-49
LRSF – Area 4	3 100	35	75	<30-39
Open Cut Development	1 900	35	75	<30-43
WRE Development	1 900	35	75	<30-43
SRSF Embankments	1 900	35	75	<30-43

Note 1: Modelled level is to the nearest receptor from construction activities

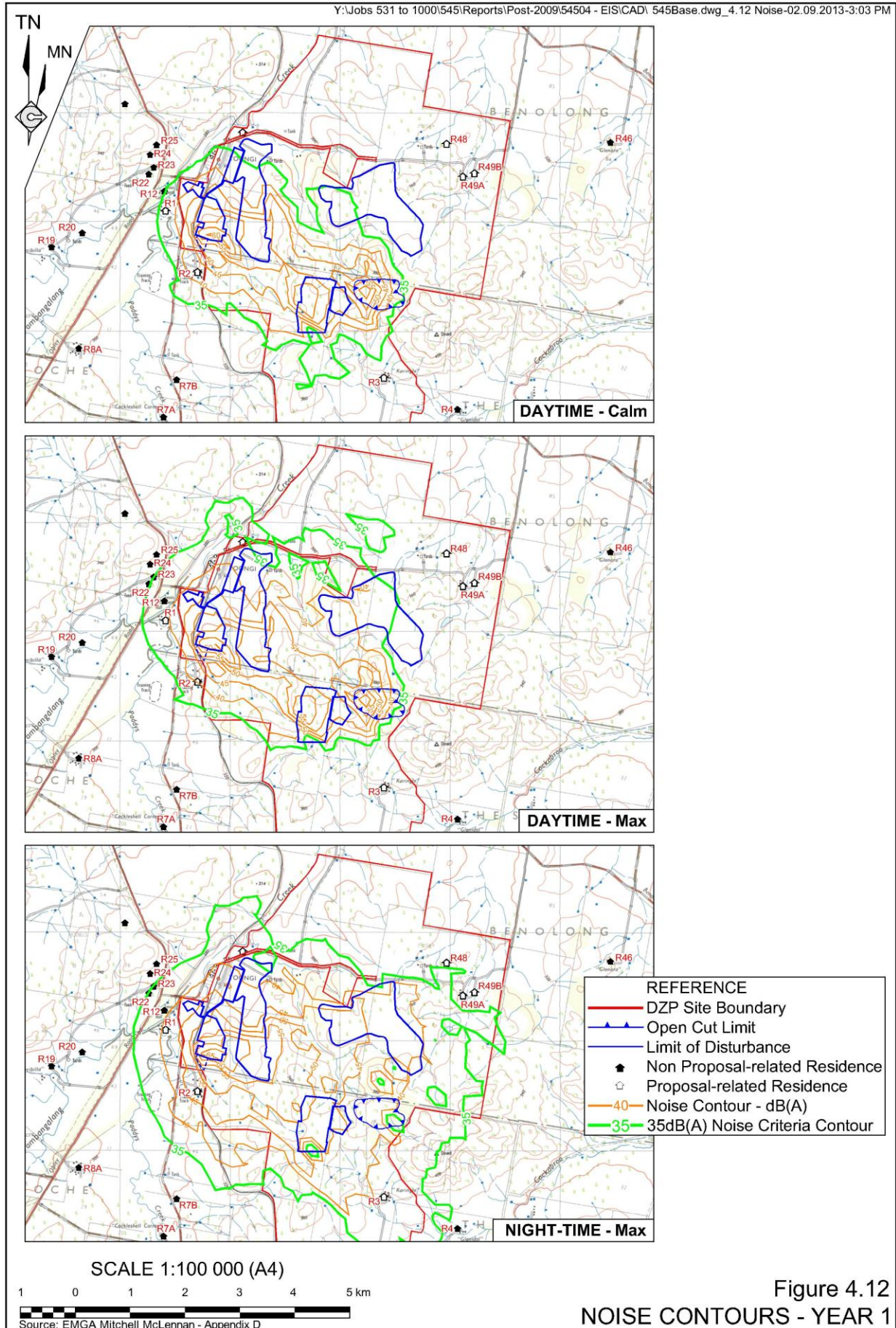
Source: Modified after EMM (2013) –Table 5.6

On the basis of the short duration and commitment of the Applicant to implement the mitigation and management measures, the exceedances are considered acceptable.

4.2.7.2 Operational Noise

The predicted noise levels for each scenario under the prevailing meteorological conditions for Scenarios 1 to 3 are provided in **Tables 4.12 to 4.14** for privately owned residential and recreational receptors, including receptors with a contractual agreement in place with the Applicant.

Figure 4.12 to 4.14 provide contour plots of the predicted noise levels for the three operational scenarios.



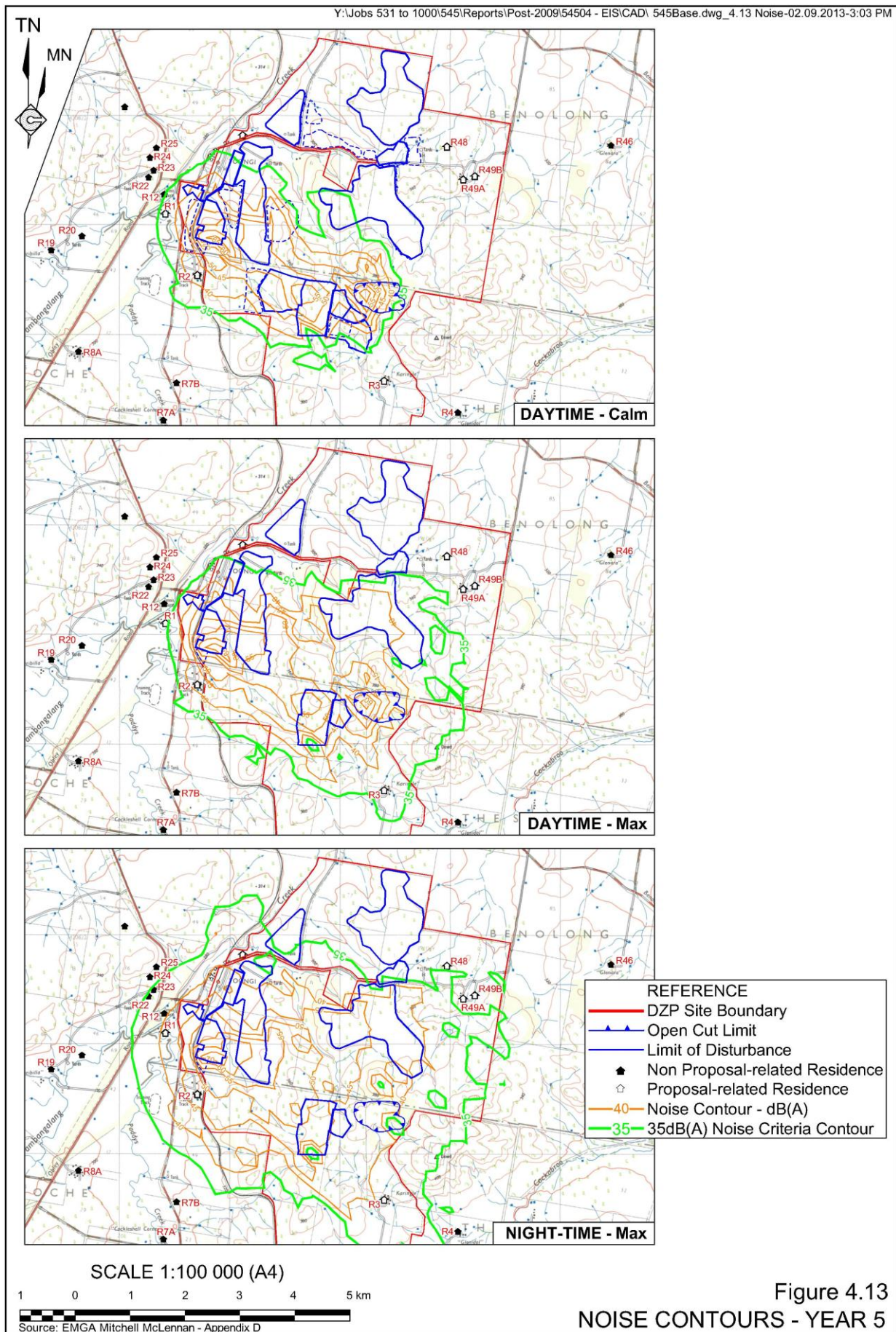


Figure 4.13
NOISE CONTOURS - YEAR 5

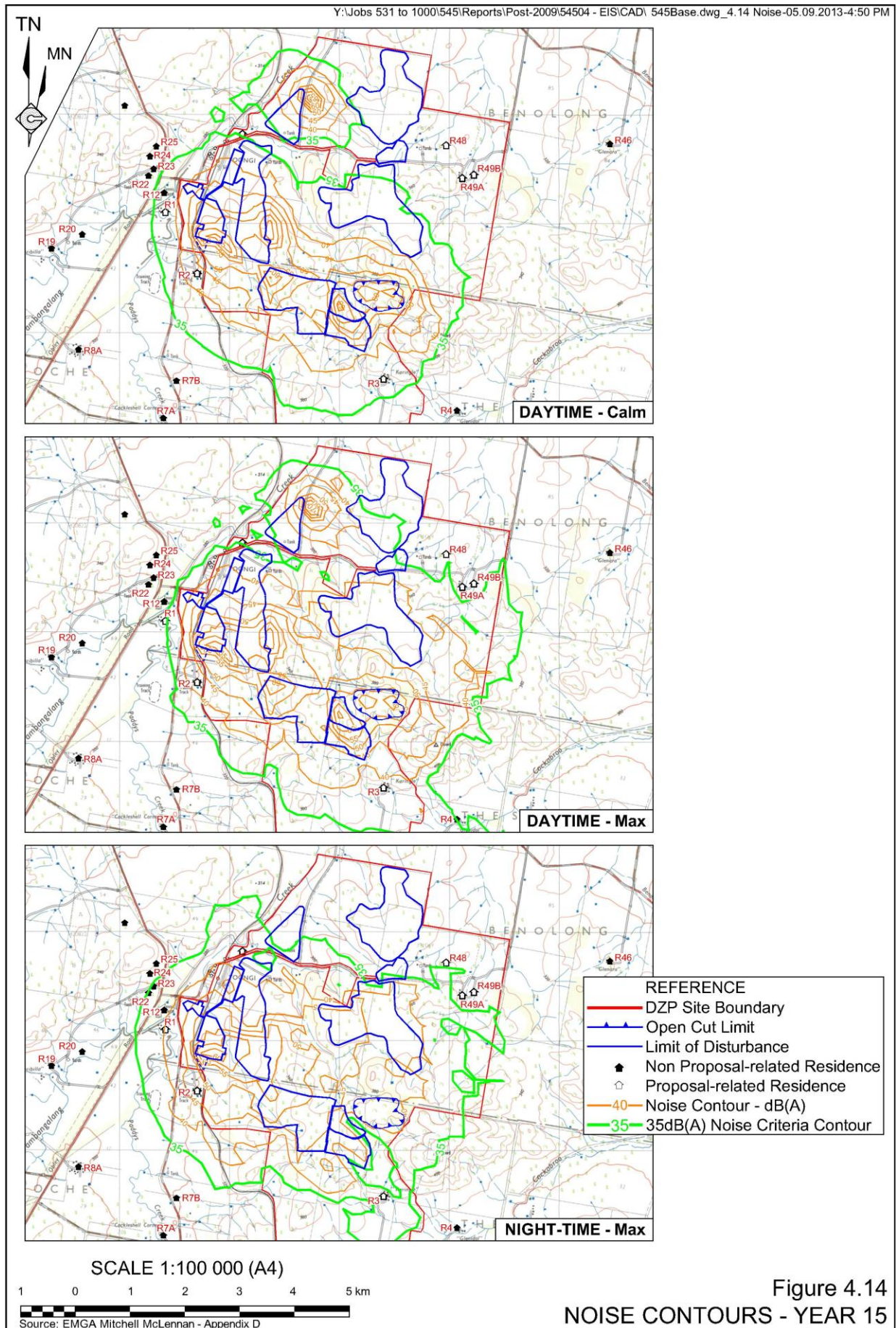


Table 4.12
Project-related Noise Levels for Scenario 1 (Year 1)

Receptor ID ¹	PSNL	Day		Night		
		Calm	Winds	Calm	Winds	Inversion
Privately owned receptors						
R12 (Hall)	50	35	38	≤35	39	37
R12 (Tennis court)	55	35	38	≤35	39	37
R13 (WEEC) ²	35 ³	≤35	≤35	≤35	≤35	≤35
All remaining private receptors	35	≤35	≤35	≤35	≤35	≤35
Receptors with a contractual agreement in place with the Applicant						
R1	35	36	38	36	40	38
R2	35	41	39	41	46	43
R3	35	≤35	≤35	≤35	39	39
R51	35	≤35	≤35	≤35	35	≤35
R55	35	≤35	37	≤35	38	36
R58	35	≤35	36	≤35	36	≤35

Note 1: refer to **Figure 4.6**

Note 2: Noise predictions are external to the WEEC

Note 3: Internal criteria apply when WEEC is in use

Bold value refers to exceedance ≤5dB(A) (Noise Management Zone)

Shaded value refers to exceedance >5dB(A) (Acquisition Zone)

Source: Modified after EMM (2013) – Table 5.1

Table 4.13
Project-related Noise Levels for Scenario 2 (Year 5)

Receptor ID ¹	PSNL	Day		Night		
		Calm	Winds	Calm	Winds	Inversion
Privately owned receptors						
R12 (Hall)	50	≤35	≤35	≤35	39	40
R12 (Tennis court)	55	≤35	≤35	≤35	39	40
R13 (WEEC) ²	35 ³	≤35	≤35	≤35	≤35	≤35
All remaining private receptors	35	≤35	≤35	≤35	≤35	≤35
Receptors with a contractual agreement in place with the Applicant						
R1	35	36	≤35	≤35	41	42
R2	35	41	40	≤35	46	46
R3	35	≤35	37	≤35	39	≤35
R51	35	≤35	≤35	≤35	36	40
R55	35	≤35	≤35	≤35	39	41
R58	35	≤35	≤35	≤35	36	40

Note 1: refer to **Figure 4.6**

Note 2: Noise predictions are external to the WEEC

Note 3: Internal criteria apply when WEEC is in use

Bold value refers to exceedance ≤5dB(A) (Noise Management Zone)

Shaded value refers to exceedance >5dB(A) (Acquisition Zone)

Source: Modified after EMM (2013) – Table 5.1

Table 4.14
Project-related Noise Levels for Scenario 3 (Year 15)

Receptor ID ¹	PSNL	Year 15 – Day		Year 15 – Night		
		Calm	Winds	Calm	Winds	Inversion
Privately owned receptors						
R12 (Hall)	50	≤35	≤35	≤35	39	37
R12 (Tennis court)	55	≤35	≤35	≤35	39	37
R13 (WEEC) ²	35 ³	≤35	≤35	≤35	≤35	≤35
All remaining private receptors	35	≤35	≤35	≤35	≤35	≤35
Receptors with a contractual agreement in place with the Applicant						
R1	35	36	≤35	36	40	38
R2	35	41	41	41	45	43
R3	35	37	39	≤35	37	≤35
R51	35	≤35	≤35	≤35	36	≤35
R55	35	36	35	≤35	39	36
R58	35	≤35	≤35	≤35	36	≤35
Note 1: refer to Figure 4.6						
Note 2: Noise predictions are external to the WEEC						
Note 3: Internal criteria apply when WEEC is in use						
Bold value refers to exceedance ≤5dB(A) (Noise Management Zone)						
Shaded value refers to exceedance >5dB(A) (Acquisition Zone)						
Source: Modified after EMM (2013) – Table 5.1						

During night time and prevailing wind conditions, it is predicted that all private receptors (which do not hold an agreement with the Applicant for purchase) would experience noise levels below the operational criteria for all assessment periods and all stages of the DZP.

Three of the receptors with a contractual agreement in place with the Applicant would experience noise levels above the operational criteria, i.e. >35dB(A) (R3, R51 and R58). Three of the receptors are predicted to experience noise levels above the likely acquisition criteria, i.e. >40dB(A) (R1, R2 and R55).

Noise predictions completed for three currently vacant lots were also completed by EMM (2013).

- Crown Reserve 753220 has been identified as likely to experience operational noise levels greater than 40dB(A) over 25% the land area. It is noted the Applicant is negotiating acquisition of this property with the Department of Primary Industries - Catchments and Lands.
- Properties (Receptors) 50 and 53 (Crown Reserve 62545) would not experience operational noise levels greater than 40 dB(A) over more than 25% of their land area. The Applicant holds an agreement with the owner of Property 53 to purchase this property. The Applicant has discussed the possible purchase of Property 50 with the landowner, however, the landowner has indicated they do not wish to sell.

4.2.7.3 Low Frequency Noise

The noise predictions of EMM (2013) include a 5dB modifying factor to the crushing plant for low frequency noise.

4.2.7.4 Sleep Disturbance Noise

The likely source of significant $L_{A(1min)}$ events is associated with unloading/loading trains. The maximum (at source) sound power level of a train being loaded/unloaded (on site) or a train shunting, have previously been measured to be typically 120dB(A).

Maximum noise levels at each residence within the Toongi locality were calculated for prevailing meteorological conditions. Exceedances of sleep disturbance criteria were predicted at four residences (see **Table 4.15**).

Table 4.15
Increased L_{max} Noise Levels at Privately-owned Residences

Privately-owned Residences	L_{max} criterion, dB(A)	Modelled $L_{A(1min)}$ noise level, dB(A)
R22	45	54
R23	45	55
R24	45	53
R25	45	53
Source: Modified after EMM (2013) –Table 5.3		

The proposed mitigation measures discussed in Section 4.2.6.4, would eliminate all but occasional high impact noise. It is also noted that while this occasional L_{max} noise would exceed the sleep disturbance criteria of 45dB(A), it would remain below levels that are likely to wake sleeping occupants indoors based on international research as published in the EPA's RNP.

4.2.7.5 Road Traffic Noise

Considering both construction and operational traffic (all three transport options) EMM (2013) determined that in combination with current and predicted future traffic on Obley Road, the relevant road traffic noise criteria would be met. Combined road traffic noise would not exceed:

- 50.7dB(A) during construction phase;
- 51.5dB(A) during the day time and 49.6dB(A) during the night time based on 2012 traffic levels; and
- 53.9dB(A) during the day time and 51.4dB(A) during the night time based on 2032 traffic levels.

4.2.7.6 Rail Noise and Vibration

Noise

Table 4.16 provides the calculated $L_{Aeq(15-hour)}$, $L_{Aeq(9-hour)}$ and L_{max} noise levels from proposed DZP rail movements between Newcastle and Dubbo.

Table 4.16
Existing and Potential Noise Increases Relating to DZP Rail Movements – Newcastle to Dubbo

Distance ¹ (m)	Existing Train Noise, dB(A) ²			DZP Train Noise, dB(A) ³			Total Train Noise, dB(A) ⁴		
	Day, $L_{Aeq(15-hour)}$	Night, $L_{Aeq(9-hour)}$	L_{max}	Day, $L_{Aeq(15-hour)}$	Night, $L_{Aeq(9-hour)}$	L_{max}	Day, $L_{Aeq(15-hour)}$	Night, $L_{Aeq(9-hour)}$	L_{max}
25	52	55	84	48	50	84	53	56	84
30	50	53	80	46	48	80	51	54	80
60	47	50	78	43	45	78	48	51	78
80	46	49	74	42	44	74	47	50	74
100	45	48	72	41	43	72	46	49	72
140	45	47	69	40	42	69	46	48	69
RING Criteria	65	60	85	65	60	85	65	60	85

Note 1: assumed distance to nearest privately owned receptor.

Note 2: based on six existing non-DZP train movements assumed for all periods.

Note 3: based on two DZP movements during any period.

Note 4: based on eight total movements during a 24hr period (i.e. existing trains + DZP trains).

Source: Modified after EMM (2013) - Table 5.15

The predicted noise level results of the maximum train movement are as follows.

- Day and night L_{eq} criteria would be met for all noise receptors at distances 15m (and greater) from the track.
- L_{max} criteria would be met for noise receptors situated 25m (and greater) from the railway.
- Rail noise as a result of the Proposal would only increase existing L_{eq} levels by 1dB(A), and no change to L_{max} levels would be expected, satisfying the IGANRIP recommended increase goals.

Table 4.17 provides the calculated $L_{Aeq(15-hour)}$, $L_{Aeq(9-hour)}$ and L_{max} noise levels from proposed DZP rail movements between Toongi to Dubbo.

Vibration

A review of potential structural vibration was completed by EMM (2013) for the Dundullimal Homestead located opposite Taronga Western Plains Zoo, within the vicinity of Obley Road and situated approximately 65m from the Toongi-Dubbo Rail Line.

EMM (2013) measured data from train pass-bys identified that vibration levels generated at this distance of 65m would be less than 0.5mm/s and would satisfy the sensitive structural criteria of 3mm/s in *German Standard DIN 4150*.

Table 4.17
Potential Noise Levels Relating to DZP Rail Movements – Toongi to Dubbo

Distance ¹ (m)	DZP train noise, dB(A) ²		
	Day, L _{Aeq} (15-hour)	Night, L _{Aeq} (9-hour)	L _{max}
25	48	50	84
40	46	48	80
50	43	45	78
80	42	44	74
100	41	43	72
140	40	42	69
RING Criteria	65	60	85
Note 1: Assumed distance to nearest privately owned receptor.			
Note 2: Based on two DZP movements during any period.			
Source: Modified after EMM (2013) - Table 5.14			

4.2.7.7 Blasting Emissions

The proposed blast parameters for the DZP identify a maximum instantaneous charge (MIC) of up to 68 kg (generally 30kg). **Table 4.18** presents the derived overpressure and vibration levels based on 68kg MIC for the closest privately-owned receptors.

The predicted blast overpressure and vibration levels identify that a maximum MIC of 68kg would comply with ANZECC criteria at distances of greater than 450m.

Table 4.18
Predicted Air Blast Overpressure and Vibration Levels at Privately-Owned Receptors

Approximate minimum distance from blast to privately-owned receptors (m)	Derived airblast overpressure (dB(L)peak)	Derived vibration PPV (mm/s)	Max MIC (kg)
2 200	98.5	0.1	68
Criteria	115	5	
Source: EMM (2013) - Table 5.16			

4.2.7.8 Taronga Western Plains Zoo

The breeding pens for several species held at Taronga Western Plains Zoo, including White Rhinoceros and African Wild Dogs, are located towards the northeastern property boundary along Obley Road. The potential for the proposed increase in heavy vehicle traffic, and specifically the associated noise, to impact on the behaviour of the animals has been raised as a possible issue.

It is noted that the movement of heavy vehicles is already a feature of Obley Road, with the frequency of movement varying throughout the year (most frequent in late spring and early summer during grain harvest, or other periods of elevated agricultural activity, and less frequent at other times).

On the basis that no new noise sources would be introduced which could result in ‘startle’ response and subsequent effects on behaviour, and that the proposed increase in traffic on Obley Road would not increase noise levels significantly and remain well below the road noise criteria, it is considered unlikely that the Proposal would impact on the breeding programs of the Taronga Western Plains Zoo. The Applicant is committed to maintaining communications with zoo management and modifying operations where practicable to further minimise the potential impacts. This could include scheduling road upgrades on Obley Road in the vicinity of the zoo outside of the proposed breeding period for the relevant species.

4.2.8 Monitoring

The Applicant would prepare and implement a *Noise Management Plan* (NMP) and *Blast Management Plan* as previously discussed in Section 4.2.6.6. The Applicant anticipates the requirements of a noise monitoring program for the Proposal would include:

- real-time noise and blast monitoring procedures and trigger levels;
- weather station monitoring procedures and adverse weather trigger levels;
- routine and complaint-driven attended noise and blast monitoring procedures;
- review and continual improvement procedures; and
- reporting procedures, including reporting to relevant government agencies and the surrounding community.

4.3 AIR QUALITY

4.3.1 Introduction

The Director-General’s Requirements (DGRs) issued by DP&I identified “*Air Quality*” as a key issue for assessment including “*a quantitative assessment of potential:*

- *construction and operational impacts, with a particular focus on dust emissions (including PM_{2.5} and PM₁₀ emissions) and processing emissions;*
- *reasonable and feasible mitigation measures to minimise, including evidence that there are no such measures available other than those proposed; and*
- *monitoring and management measures, in particular real-time air quality monitoring.”*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Environment Protection Authority (EPA) which requested that “*The goal should be to maintain existing rural air quality and protect sensitive receptors, both on and off site, from adverse impacts of dust and odour in particular and other relevant air pollutants*”. The Office of Environment and Heritage requested that the EIS include “*an assessment of, and report on, the project’s predicted greenhouse gas emissions (tCO₂e)*”.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to air quality and their risk rankings without the adoption of any mitigation measures are summarised as follows.

- Nuisance/amenity impacts from blasting and vehicle movements, product processing and local wind effects causing dust deposits on window sills, cars, surfaces etc. (low to medium).
- Adverse health impacts (if concentration of particulate matter less than 10µm in diameter (PM₁₀) are excessive) (medium to high).
- Dust generation causing decreased productivity of pastures (low).
- Increased contributions to greenhouse gases from the processing plant stacks and vents, as well as vehicle emissions (medium).
- Health related impacts (stock) due to consumption of contaminated pasture (high).
- Temporary reduction in local amenity due to odour and visible plume (medium).
- Acute health impacts associated with NH₃, SO₂ and SO₃ emissions (high).

The air quality and greenhouse gas impact assessment for the Proposal was undertaken by Ms Justine Firth and Mr Damon Roddis of Pacific Environment Limited (PEL). The resulting report is presented as Part 2 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “PEL (2013)”. This subsection of the EIS provides a summary of the air quality and greenhouse gas impact assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.3.2 Potential Sources of Air Contaminants

4.3.2.1 Particulate Matter and Dust Deposition

Particulate matter (PM) has the capacity to affect health and to cause nuisance effects and is categorised by its size and/or by chemical composition. The potential for harmful effects depends on both. Particulate size ranges are commonly described as follows.

- Total suspended particulates (TSP) – refers to all suspended particles in the air. In practice, the upper size range is typically 30µm to 50µm, as larger particles would usually remain in the air for only a few minutes and settle near the source.
- PM₁₀ – refers to all particles with equivalent aerodynamic diameters of less than 10µm, that is, all particles that behave aerodynamically in the same way as spherical particles with diameters less than 10µm and with similar unit density. PM₁₀ particles are a sub-component of TSP.
- PM_{2.5} – refers to all particles with equivalent aerodynamic diameters of less than 2.5µm. These are often referred to as the fine particles and are a sub-component of PM₁₀.

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including native vegetation and crops. Dust deposition can soil materials and property, and generally degrade aesthetic elements of the environment and are assessed for nuisance or amenity impacts.

Dust deposition includes all particle sizes however, as described for TSP, particles larger than 30µm to 50µm usually remain in the air for only a few minutes and settle near the source.

4.3.2.2 Oxides of Nitrogen, Sulphur Dioxide and Hydrogen Chloride

Oxides of nitrogen (NO_x) are produced when fossil fuels are combusted in internal combustion engines (e.g. motor vehicles, earthmoving equipment). NO_x emitted by fossil fuel combustion are comprised mainly of nitric oxide (NO) and nitrogen dioxide (NO_2). NO is much less harmful to humans than NO_2 and is not generally considered an air quality parameter at the concentrations normally found in urban environments. Trace emissions of NO_2 are expected from various stacks within the processing plant as well as being a result of the oxidation of ammonium nitrate during blasting.

Sulphur dioxide (SO_2) is formed when fuel containing sulphur (mainly coal and oil) is burned. SO_2 is a major precursor to acid rain, which is associated with the acidification of lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility. Emissions of SO_2 from diesel have been progressively declining in Australia as more stringent sulphur fuel standards have been introduced, however, trace emissions are expected from some stacks within the processing plant.

The plant includes a double absorption contact process to manufacture sulphuric acid. This involves burning sulphur to produce the intermediates, SO_2 gas, SO_3 gas and finally oleum liquid, which is diluted with water to produce concentrated sulphuric acid. Trace emissions of SO_2 gas and H_2SO_4 mist are expected from the acid plant stack, particularly during start up.

Hydrochloric acid (HCl) is not readily formed in the ambient environment, with the most significant source of ambient contributions derived from anthropogenic emissions released during industrial processes. Trace emissions from the processing operations are expected.

4.3.2.3 Radon

As discussed in Section 2, the ore to be mined and processed contains low levels of naturally occurring uranium and thorium, which when mined can result in the release of radon gas. Radon is an inert gas and a radioactive decay product of uranium and thorium. Radon itself is not a significant source of radiation exposure, however, as a decay product of uranium has a half-life of 3.8 days and therefore is able to move in air before decaying to the more hazardous shorter lived radon decay products (RnDP)⁷.

⁷ The Radon as a decay product of thorium has a half-life of only 1 minute and therefore it does not travel far in air before decaying. The decay subsequent decay products (Thoron Decay Products – ThDP) also have very short half-lives such that there are no long term decay products.

4.3.2.4 Greenhouse Gas Emissions

Greenhouse gases would be produced as a consequence of the Proposal, the primary source of which being through the combustion of fuel by hydrocarbon-powered equipment and vehicles. Greenhouse gas emissions would also be generated through combustion of natural gas for heating purposes, on-site electricity consumption and the movement of the vehicles to and from the DZP Site. Although carbon dioxide (CO₂) would be the principal gas produced, greenhouse gases emitted as a result of the Project would also include carbon monoxide (CO), methane (CH₄), oxides of nitrogen (NO_x), SO₂, NH₄ and non-methane volatile organic compounds (NMVOCs). For the purposes of the air quality assessment, all greenhouse gas levels are expressed in CO₂ equivalent units (CO₂-e).

4.3.2.5 Odour

An odour is perceived when chemicals in gaseous form stimulate the human olfactory system. Due to the diversity of the receptors within the nose, intensity of odour impacts can vary as reactions to odour are highly subjective. Odour is affected by climatic and seasonal conditions, with impacts increasing in intensity during calm conditions. The waste residues generated by the Proposal would have an odour and therefore assessment of impacts on surrounding landowners is required.

4.3.3 Existing Environment

4.3.3.1 Introduction

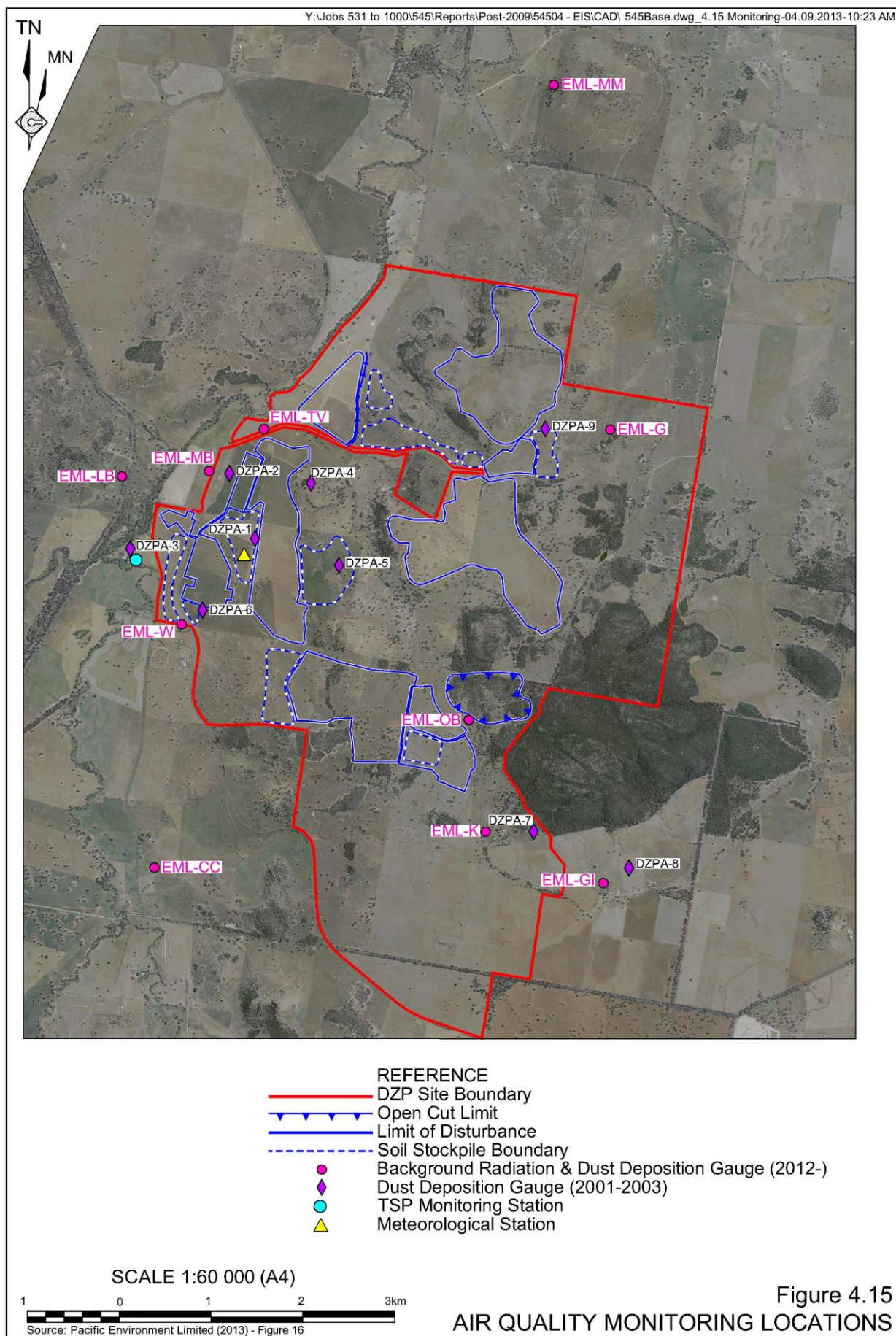
Historical dust deposition and TSP monitoring has been conducted in the Toongi area by the Applicant between 2001 and 2002. The historical monitoring network comprised nine dust deposition gauges (DDGs) and a single High Volume Air Sampler (HVAS) fitted with a sample head for TSP. Dust deposition monitoring resumed in November 2012 as part of a baseline radiation assessment. **Figure 4.15** identifies the location of the historic and current monitoring locations.

As there is limited monitoring data available for the DZP Site, EPA monitoring stations from further afield have been referenced. It is acknowledged that these monitoring locations are geographically distant from the DZP Site, however, the data is considered to be useful in providing an indicative (although conservatively high) estimate of background air quality for rural areas in NSW.

The EPA sites selected are based on distance from the DZP Site, land use in the vicinity of the monitoring station and site representation.

The following sources have been referenced to establish baseline air quality:

- current dust deposition monitoring (see **Figure 4.15**);
- historical dust deposition monitoring (see **Figure 4.15**);
- historical TSP monitoring (see **Figure 4.15**);
- PM₁₀ data from Bathurst, located 140km southeast of the DZP Site;
- PM₁₀ data from Tamworth, located 260km northeast of the DZP Site;
- SO₂ data from Bargo, located 280km southeast of the DZP Site; and
- NO₂ data from Beresfield, located 280km southeast of the DZP Site.



4.3.3.2 Deposited Dust

Dust deposition was monitored at nine Dust Deposition Gauges (DZPA-1 to DZPA-9) on and surrounding the DZP Site from March 2001 to February 2003 (see **Figure 4.15**). With the exception of November and December 2002, the monitored locations have reported dust deposition levels below the $4\text{g/m}^2/\text{month}$ dust fallout goal. The high dust levels recorded for November and December of 2002 is consistent with the low rainfall recorded for these months in the area. Furthermore, annual grain harvest occurs in November and December each year which coinciding with livestock grazing on crop stubble makes this a locally dusty time of year. The annual average dust deposition rate across all nine dust gauges was $1.0\text{g/m}^2/\text{month}$ for March 2001 to February 2002 and $1.2\text{g/m}^2/\text{month}$ for March 2002 to February 2003.

The current dust monitoring program commenced in September 2012 as part of a baseline radiation monitoring program and provides for the collection of dust deposition data quarterly at ten locations (prefaced as EML- on **Figure 4.15**). The quarterly data is then averaged to provide monthly and daily estimates for comparison against the NSW EPA criteria of $4\text{g/m}^2/\text{month}$. To date, only two months of data are available, however, this data show that the measured levels are well below the criterion. A background dust deposition level of $2\text{g/m}^2/\text{month}$ (annual average) has been adopted for this assessment.

4.3.3.3 Particulate Matter

Total Suspended Particulates

The 24-hour TSP concentrations recorded at DZPA-3 for the period from March 2001 to April 2002 are presented in **Table 4.19**. The annual average TSP concentration of $19\mu\text{g/m}^3$ for the monitored year is well below the EPA criterion of $90\mu\text{g/m}^3$.

Table 4.19
TSP Monitoring Results for March 2001 to February 2002

Averaged Period	Average TSP Concentration ($\mu\text{g/m}^3$)
Mar-01	14
Apr-01	19
May-01	12
Jun-01	5
Jul-01	6
Aug-01	4
Sep-01	10
Oct-01	12
Nov-01	24
Dec-01	41
Jan-02	63
Feb-02	17
Annual Average (Mar 2001- Feb 2002)	19
Source: PEL (2013) - Table 13	

The more elevated concentration in November to January is illustrative of local land use during these months, namely grain harvest and livestock grazing.

Particulate Matter less than 10 microns (PM₁₀)

There is no site specific PM₁₀ monitoring data available in the vicinity of the DZP Site. As indicated in Section 4.3.3.1, reference can be made to available monitoring data collected by the EPA in rural NSW. A time series of the 24-hour PM₁₀ concentrations recorded at Tamworth and Bathurst from January 2008 to February 2013 is presented in **Figure 4.16**. The annual average PM₁₀ for each site is shown in **Table 4.20**.

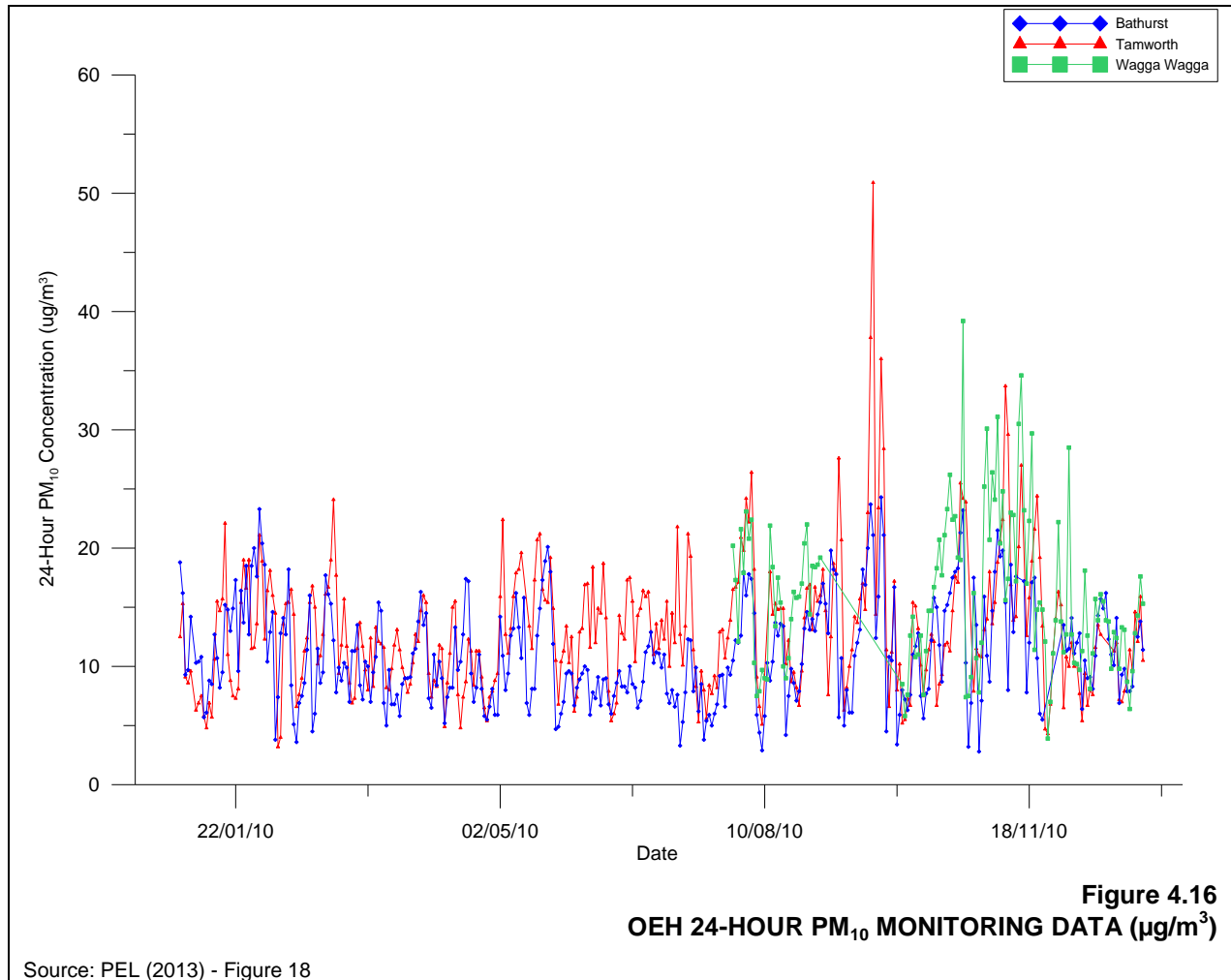


Table 4.20
Annual Average PM₁₀ Concentration for Rural NSW

Year	Tamworth (µg/m ³)	Bathurst (µg/m ³)
2008	16	14
2009	22	17
2010	12	9
2011	13	11
2012	16	13
2013 ¹	14	16
Average	16	13
Note 1: Data available to 20 February 2013		
Source: PEL (2013) - Table 14		

For scaling purposes, the 24-hour average PM₁₀ concentrations measured on the day of a significant dust storm that impacted much of the east of Australia on 23 September 2009 has been removed from the dataset. All other significant weather events have been included in the datasets.

The annual average data shows that 2009 experienced the highest annual average PM₁₀ concentration at both monitoring stations. This result is likely due to the prevailing drought conditions across NSW during this period. The average across both data sets is 16µg/m³ and has been adopted as the annual average PM₁₀ background for this assessment.

Particulate Matter less than 2.5 microns (PM_{2.5})

As with PM₁₀, there is no site specific PM_{2.5} monitoring data available in the vicinity of the DZP Site. The closest and most similar in environment to the DZP Site is the PM_{2.5} concentration data measured at Wagga Wagga North.

Data from this site is considered highly conservative and would provide a site representative dataset for the Proposal due to ongoing air quality issues in the area. The annual average PM_{2.5} concentration ranges between 7µg/m³ and 9µg/m³. The NEPM advisory reporting standard is 8µg/m³. An annual average PM_{2.5} concentration of 7µg/m³ has been conservatively adopted for this assessment.

4.3.3.4 Other Air Quality Parameters

Sulphur Dioxide

The 1-hour maximum SO₂ concentrations measured at the EPA's Bargo monitoring site between 2009 and 2012 are presented in **Table 4.21**. The maximum recorded 1-hour average concentration was 31µg/m³, well below the EPA criterion of 570µg/m³.

Table 4.21
1-hour maximum SO₂ concentrations for Bargo

Year	1-hour maximum (µg/m ³)
EPA criterion	570
2008	31
2009	23
2010	29
2011	26
2012	27
Average	27
Source: PEL (2013) - Table 15	

Nitrogen Dioxide

The annual average and 1-hour maximum NO₂ concentrations measured at the EPA's Bargo monitoring site between 2009 and 2012 are presented in **Table 4.22**. The annual average NO₂ concentrations range between 10µg/m³ and 12µg/m³, with the average across all years being 11µg/m³. The maximum recorded 1-hour average concentration was 126µg/m³, well below the EPA criterion of 246µg/m³. The daily varying values within this data set have been adopted for this assessment.

Table 4.22
Annual Average and 1-hour maximum NO₂ concentrations for Bargo

Year	Annual average (µg/m ³)	1-hour maximum (µg/m ³)
EPA criterion	62	246
2008	12	83
2009	10	103
2010	10	126
2011	10	98
2012	10	94
Average	11	101
Source: PEL (2013) - Table 16		

Hydrogen Chloride and Fluoride

There is no available monitoring data for hydrogen chloride (HCl) or hydrogen fluoride (HF) in the vicinity of the DZP Site or as part of the EPA monitoring network. In consideration of the predominantly agricultural surrounding land use and distinct lack of industry that would likely contribute to background HCl and HF baseline levels, it has been assumed that the respective air quality parameters would be present at very low levels, if not trace concentrations. In any event, the Approved Methods⁸ require that only the incremental (as opposed to the cumulative) impact requires evaluation.

4.3.3.5 Summary of Air Quality Parameters

Based on the available monitoring data described in Sections 4.3.3.2 to 4.3.3.4, **Table 4.23** provides a summary of the background concentrations to be adopted for the assessment.

Table 4.23
Adopted Background Contributions

Air quality parameter	Averaging period	EPA criteria	Adopted background concentration
Dust deposition	Annual	4g/m ² /month	2g/m ² /month
TSP annual	Annual	90µg/m ³	19µg/m ³
PM ₁₀	Annual	30µg/m ³	16µg/m ³
	24 hour	50µg/m ³	Daily varying
PM _{2.5}	Annual	8µg/m ³	7µg/m ³ ^B
	24 hour	25µg/m ³	n/a
SO ₂	Annual ^A	60µg/m ³	3µg/m ³
	24 hour ^A	228µg/m ³	11µg/m ³
	1 hour	570µg/m ³	27µg/m ³
	10 minute ^A	712µg/m ³	34µg/m ³
NO ₂	Annual	62µg/m ³	Daily varying
	1 hour	246µg/m ³	Daily varying
Note A: Pro-rated in accordance with the 1-hour monitoring data for SO ₂			
Note B: In consideration of the relatively higher PM ₁₀ concentrations measured at Wagga Wagga and Wagga Wagga North, the annual average PM _{2.5} background contribution has been assumed.			
Source: PEL (2013) - Table 17			

⁸ Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA, 2005)

4.3.3.6 Greenhouse Gases

Existing background concentrations of carbon dioxide and methane are recognised to be negligible and typical of a rural area.

4.3.4 Assessment Criteria

4.3.4.1 Particulate Matter and Dust Deposition

The Approved Methods (DEC, 2005) specify the air quality assessment criteria relevant for assessing impacts from air pollution. These criteria are in fact health-based (i.e. they are set at levels to protect against health effects) and are consistent with the *National Environment Protection Measure for Ambient Air Quality* (referred to as the Ambient Air-NEPM) (NEPC, 1998a, 2003). However, the EPA's criteria include averaging periods which are not included in the Ambient Air-NEPM. Conversely, the Ambient Air NEPM recognises it is realistic to accept up to five exceedances of the 24-hour PM₁₀ level per year.

Table 4.24 summarises the air quality criteria for concentrations of particulate matter that are relevant to the investigations undertaken by PEL.

Table 4.24
Air Quality Standards/Criteria for Particulate Matter Concentrations

Pollutant	Averaging Period	Standard/Goal	Agency
TSP	Annual mean	90µg/m ³	National Health and Medical Research Council.
PM ₁₀	Maximum 24-hour average	50µg/m ³	EPA impact assessment criteria; Ambient Air-NEPM reporting goal, allows five exceedances per year
	Annual mean	30µg/m ³	EPA impact assessment criteria.
PM _{2.5}	Annual Mean	8µg/m ³	Ambient Air-NEPM Advisory Reporting Standard.
	Maximum 24-hour average	25µg/m ³	
Note: µg/m ³ – micrograms per cubic metre.			
Source: PEL (2013) - modified after Tables 4 and 5			

It is noted that the Ambient Air-NEPM PM_{2.5} advisory reporting standards are not impact assessment criteria. Notwithstanding, and in the absence of any other relevant standard/goal, the advisory reporting standards have been used in this report for comparison against dispersion modelling results (Section 4.3.7).

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including vegetation. Referred to as dust deposition, this can soil materials and generally degrade aesthetic elements of the environment, and are assessed for nuisance or amenity impacts. **Table 4.25** shows the maximum acceptable increase and accumulation with other sources in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust deposition levels are set to protect against nuisance impacts (EPA, 2005).

Table 4.25
EPA Criteria for Dust (Insoluble Solids) Deposition

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 metre per month.			
Source: PEL (2013) - Table 6			

4.3.4.2 Gaseous Air Quality Parameters Assessment Criteria

Table 4.26 summarises the air quality criteria nominated in the Approved Methods (EPA, 2005) for concentrations of gaseous air quality parameters that are relevant to this assessment, i.e. contained within diesel fume and blast assessments.

Table 4.26
Air Quality Criteria for Gaseous Air Quality Parameters

Air quality parameter	EPA Impact assessment criteria	Averaging Period
Sulphur Dioxide	712 µg/m ³ (0.25 ppm)	10-minute
	570 µg/m ³ (0.2 ppm)	1-Hour
	228 µg/m ³ (0.08 ppm)	24-Hour
	60 µg/m ³ (0.02 ppm)	Annual
Nitrogen Dioxide	246 µg/m ³ (0.12 ppm)	1-Hour
	62 µg/m ³ (0.03 ppm)	Annual
Hydrogen Chloride	0.14 mg/m ³ (0.09 ppm)	1 hour
Source: PEL (2013) – Table 7 (after EPA, 2005)		

4.3.4.3 Odour

The Approved Methods include ground-level concentration (GLC) criterion for complex mixtures of odorous air compounds. They have been refined by the EPA to take account of population density in the area. **Table 4.27** lists the odour glc criterion to be exceeded not more than 1% of the time, for different population densities.

Table 4.27
Odour Performance Criteria for the Assessment of Odour

Population of affected community	GLC criterion for complex mixtures of odorous air quality parameters (OU)
~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2
Source: Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW (EPA, 2005)	

A conservative approach has been adopted in the determination of the odour impact assessment criteria by basing the criteria on the most densely populated area within the vicinity of the Proposal. There are five sensitive receptors⁹ located within a 1km² area to the immediate west of the DZP Site. On the basis that each receptor would be home to two people, it is appropriate to adopt an impact assessment GLC criterion of 6 OU (see **Table 4.27**).

4.3.5 Assessment Methodology

4.3.5.1 Modelling Methodology

The overall approach to the assessment undertaken by PEL (2013) follows the Approved Methods (EPA, 2005) using the Level 2 assessment methodology. The Approved Methods specify how assessments based on the use of atmospheric dispersion models should be completed. The atmospheric dispersion modelling conducted by PEL (2013) is based on an advanced modelling system using The Air Pollution Model (TAPM) and CALMET/CALPUFF.

4.3.5.2 Particulate Matter Emissions

Particulate matter emissions were calculated for the following.

- Particulate matter from the surface operations from the Proposal.
- Odour emissions from the SRSF and LRSF.
- Radon emissions from ore handling activities and exposed areas.
- Other air emissions released from the processing plant (SO₂, NO₂ and HCl).

The proposed operations were analysed and estimates of dust emissions for the key dust generating activities made by PEL (2013). Emission factors developed both in Australia, and by the US EPA, were applied to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most reliable, contemporary methods for determining dust generation rates.

The proposed development sequence of the Proposal has been analysed and detailed dust emissions inventories prepared by PEL (2013) for two key operating scenarios, namely Year 5 and Year 15 of operations. These years are considered to be representative of worst-case operations, i.e. where ore and waste rock production are highest, where extraction or wind erosion areas are largest and where operations are located closest to receptors.

Estimates of TSP, PM₁₀ and PM_{2.5} emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. Dust generating activities were represented by a series of volume sources situated according to the location of activities for the modelled scenarios.

⁹ The assessment has conservatively considered the residences of Toongi, which are Proposal-related, as sensitive for the purpose of the odour assessment.

4.3.5.3 Radon

The potential radon emissions that would be released during the operations of the Proposal have been assessed for Year 15, as PEL (2013) considers that Year 15 would result in the worst case radon emission based on the anticipated area of the LRSF that would be in use in that year.

The radon emission rates were provided by JRHC Enterprises, commissioned by the Applicant to complete a detailed radiation assessment for the Proposal (JRHC Enterprises, 2013). All radon emissions have been modelled as area sources, with the exception of emissions that would potentially be released from the processing plant. It has been assumed that all radon emissions from the processing plant would be released as a point source emission from the Ore Mill Exhaust Vent.

4.3.5.4 Other Air Quality Parameters

Other air quality parameters anticipated to be released during the operation of the Proposal include SO₂, NO₂, HCl and limited concentrations of SO₃. For the purposes of this assessment, SO₂, NO₂ and HCl are considered the principal air quality parameters of concern and were included in the dispersion modelling completed by PEL (2013), as point source emissions from various stacks and vents at the processing plant.

4.3.5.5 Odour Emissions

Based on the composition of the wastes produced as part of the ore processing operations, these would produce an odour which would be released when placed within the SRSF and LRSF.

- The liquid residues may contain ammonia.
- The solid residue would comprise a complex mixture of odorous compounds that may include H₂S.

Odour testing was completed for samples of each residue stream with the results presented in **Table 4.28**.

Table 4.28
Odour Testing Results

Sample	Sample Description	Date (Time)	Odour Concentration (OU)	Specific Odour Emission Rate (OU - m³/m²/s)	Odour Character
Liquid Residue	Prepared immediately prior to sampling	6/12/2012 (15:10)	256	0.15	Musty / Stale Water
Solid Residue	Prepared immediately prior to sampling	12/02/2013 (11:28)	128	0.08	Musty / Stale Water

Source: PEL (2013) – Table 19

Taking into account various factors influencing the odour of the residues, including the reduction in odour over time (assumed to be odourless after 7 days), odour emissions from the two waste streams were modelled by PEL (2013) as area sources with a vertical spread of 0.5m for the Year 15 scenario.

4.3.5.6 Greenhouse Gas Emissions

Greenhouse Gas (GHG) emissions have been estimated based on the methods outlined in the following documents.

- The World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) Greenhouse Gas Protocol *The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition* (WRI/WBCSD, 2004).
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008*.
- The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) *National Greenhouse Accounts (NGA) Factors 2012* (DCCEE, 2012).

The GHG Protocol establishes an international standard for accounting and reporting of GHG emissions. The GHG Protocol has been adopted by the International Standard Organisation, endorsed by GHG initiatives (such as the Carbon Disclosure Project) and is compatible with existing GHG trading schemes.

Three ‘scopes’ of emissions (scope 1, scope 2 and scope 3) are defined for GHG accounting and reporting purposes. This terminology has been adopted in Australian GHG reporting and measurement methods and has been employed in this assessment.

Inventories of GHG emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as global warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion. The estimated emissions are referred to in terms of carbon dioxide equivalent, or CO₂-e, emissions by applying the relevant global warming potential. The greenhouse gas assessment has been conducted using the NGA Factors, published by the DCCEE (2012).

Proposal-related GHG sources included in the assessment are as follows.

- Fuel consumption (diesel) during mining operations – Scope 1.
- Indirect emissions associated with on-site electricity use – Scope 2.
- Indirect emissions associated with the production of transport fuels – Scope 3.
- Indirect emissions associated with the production of electricity – Scope 3.

GHG emissions for the three transport options considered (see Section 2.12.1) were calculated by PEL (2013).

4.3.6 Management and Mitigation Measures

4.3.6.1 Introduction

The following subsections summarise management measures to be adopted by the Applicant for specific stages or features of the Proposal.

4.3.6.2 Dust Management – Site Establishment Stage

Prior to the commencement of construction, the Applicant would identify triggers and prepare procedures for dealing with unfavourable meteorological conditions, such as when it is dry and windy.

Procedures for controlling dust impacts during construction would include, but not necessarily be limited to the following.

- Adopting a Level 2 watering to achieve 75% control of dust from haul roads.
- Applying gravel to disturbed areas where possible.
- Establishing rehabilitation / cover crops where possible over exposed areas.
- Modifying working practices by limiting excavation during periods of high winds.
- Limiting the extent of clearing of vegetation and topsoil to the designated footprint required for construction and appropriate staging of any clearing.
- Confining all vehicles on site to designated routes with speed limits enforced.
- Controlling and reducing trips and trip distances where possible, for example by coordinating delivery and removal of materials to avoid unnecessary trips.

4.3.6.3 Dust Management - Operations

An *Air Quality Management Plan* (AQMP) would be prepared prior to the commencement of operations and would identify procedures for controlling dust impacts during operations including, but not necessarily limited to the following.

- Adopting a Level 2 watering to achieve 75% control of dust from haul roads.
- Implementing water injection during drilling of ore and overburden.
- Prevention of wind erosion on stockpiled material.

4.3.6.4 Processing Plant Controls

The following mitigation measures would be adopted to minimise emissions to atmosphere from the processing plant.

- The operation of a bag house to capture particulate matter from the grinding mill.
- Emissions from the stacks and vents would be regulated by operating within the prescribed in-stack concentrations limits. This would be initially determined through the detailed design phase and verified by in-stack monitoring.
- Periodic extractive monitoring would be undertaken to demonstrate compliance with in-stack limits (every 3 months for the first year of operation and then annually, thereafter if compliance is easily achieved).
- Implement a regular and documented maintenance and inspection program for all plant items where emissions to air are deemed likely.

4.3.6.5 Greenhouse Gas

The following mitigation measures are proposed to minimise greenhouse gas emissions from the Proposal.

- Maximise energy efficiency as a key consideration in the development of the mine plan. This includes electricity and process steam co-generation from the waste heat of the sulphuric acid plant.
- Implement an energy use and efficiency program.
- Undertake regular maintenance on diesel and electrically powered plant to ensure they operate efficiently.
- Develop targets for greenhouse gas emissions and energy use, and monitor and report against these.
- Dedicate a number of trucks for the excavator to minimise truck idling times.
- Ensure that haul trucks are fully loaded to maximise productivity and efficiency.
- Assess and periodically review lighting plant efficiency.

The effectiveness of these reasonable and feasible measures to reduce GHG emissions (and energy consumption) would be monitored and the Applicant would estimate its annual GHG emissions and energy consumption in accordance with its commitments under the National Greenhouse and Energy Reporting (NGER) scheme.

4.3.7 Assessment of Impacts

4.3.7.1 Introduction

The following subsections outline the modelling results for the following air quality parameters and averaging periods prepared by PEL (2013).

- TSP – annual average.
- Deposited dust – annual average.
- PM₁₀ – 24-hour and annual average.
- PM_{2.5} – 24-hour and annual average.
- SO₂ – 10 minute, 1-hour, 24-hour and annual average.
- NO₂ – 1-hour and annual average.
- HCl – 1-hour average.
- Odour – 99th percentile and 1-second average.

Particulate matter (including dust deposition) was assessed for Year 5 and Year 15 with the remaining parameters assessed for Year 15 only. Results of the radon modelling have been presented in Section 4.4.8.

Contour plots of air quality parameter concentrations and particulate matter deposition levels (Figures 24 to 35 and 38 to 44 of PEL, 2013) illustrate where different concentrations of the various air quality parameters are predicted to occur spatially. It is important to note that the contour figures are presented to provide a visual representation of the predicted impacts. To produce the contours, it is necessary to make interpolations, and as a result the contours do not always match exactly with predicted impacts at any specific location.

The actual predicted particulate concentrations/levels at nearby receptors are presented in tabular form throughout the following subsections, with those that are predicted to experience levels above the EPA's impact assessment criteria or NEPM advisory reporting goals identified in **bold**.

4.3.7.2 Annual Average TSP, PM₁₀, PM_{2.5} and Dust Deposition

Table 4.29 presents a summary of the Year 5 and 15 predicted annual average concentrations at each of the nearby receptors, due to the operation of the Proposal cumulatively with other sources/background predictions.

Contour plots for cumulative annual average TSP, PM₁₀, PM_{2.5} and dust deposition concentrations for Year 15 are presented in **Figure 4.17**.

Table 4.29
Annual Average TSP, PM₁₀, PM_{2.5} and Dust Deposition Concentration – Year 5 and 15

Page 1 of 2

Air Quality Parameter	TSP (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	Dust Deposition (g/m ² /month)	TSP (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	Dust Deposition (g/m ² /month)
Adopted Background	19	16	7	2	19	16	7	2
Criteria (µg/m³)	90	30	8	4g/m²/month	90	30	8	4g/m²/month
Receptor ^E	Cumulative Prediction Year 5				Cumulative Prediction Year 15			
R1 ^A	21.6	17.1	7.5	2	27.4	18.2	7.7	2
R2 ^A	23.7	17.4	7.5	2	30.3	18.9	7.8	3
R3 ^A	19.5	16.2	7.1	2	20.8	16.6	7.3	2
R4	19.2	16.1	7.0	2	19.6	16.2	7.1	2
R6	19.3	16.1	7.1	2	19.6	16.2	7.1	2
R7A	19.3	16.2	7.1	2	19.8	16.3	7.1	2
R7B ^G	19.3	16.2	7.1	2	19.8	16.3	7.1	2
R8A	19.4	16.2	7.1	2	20.0	16.3	7.2	2
R8B	19.2	16.1	7.1	2	19.4	16.1	7.1	2
R12 ^F	20.7	16.8	7.4	2	23.9	17.4	7.5	2
R18	19.2	16.1	7.1	2	19.6	16.2	7.1	2
R19	19.7	16.4	7.3	2	21.7	16.9	7.4	2
R20	20.0	16.6	7.5	2	22.9	17.3	7.7	2
R21	19.3	16.3	7.3	2	19.8	16.4	7.3	2
R22	20.1	16.6	7.4	2	22.2	17.0	7.5	2
R23	20.0	16.6	7.4	2	21.9	17.0	7.4	2
R24	19.9	16.6	7.4	2	21.6	16.9	7.5	2
R25	19.9	16.6	7.4	2	21.6	16.9	7.5	2
R26	19.4	16.4	7.3	2	20.2	16.6	7.4	2

Table 4.29 (Cont'd)
Annual Average TSP, PM₁₀, PM_{2.5} and Dust Deposition Concentration – Year 5 and 15

Page 2 of 2

Air Quality Parameter	TSP (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	Dust Deposition (g/m ² /month)	TSP (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	Dust Deposition (g/m ² /month)
Adopted Background	19	16	7	2	19	16	7	2
Criteria (µg/m ³)	90	30	8	4g/m ² /month	90	30	8	4g/m ² /month
Receptor ^E	Cumulative Prediction Year 5				Cumulative Prediction Year 15			
R27	19.1	16.1	7.1	2	19.4	16.2	7.1	2
R28A	19.1	16.1	7.1	2	19.4	16.2	7.1	2
R28B	19.1	16.1	7.1	2	19.3	16.2	7.1	2
R30A	19.1	16.1	7.1	2	19.4	16.2	7.1	2
R30B	19.1	16.1	7.1	2	19.3	16.2	7.1	2
R31A	19.1	16.1	7.1	2	19.3	16.2	7.1	2
R31B	19.1	16.1	7.1	2	19.3	16.1	7.1	2
R32	19.1	16.1	7.1	2	19.3	16.2	7.1	2
R35A	19.1	16.1	7.1	2	19.3	16.2	7.1	2
R35B	19.1	16.1	7.1	2	19.3	16.1	7.1	2
R38	19.1	16.1	7.1	2	19.3	16.1	7.1	2
R36	19.1	16.1	7.1	2	19.4	16.2	7.1	2
R40	19.1	16.1	7.1	2	19.4	16.2	7.1	2
R42	19.1	16.1	7.0	2	19.3	16.1	7.1	2
R43	19.1	16.1	7.0	2	19.4	16.1	7.1	2
R46	19.2	16.1	7.0	2	19.5	16.2	7.1	2
R48 ^A	19.5	16.2	7.1	2	20.2	16.4	7.2	2
R49A ^A	19.4	16.2	7.1	2	20.3	16.4	7.2	2
R49B ^A	19.4	16.1	7.1	2	20.1	16.4	7.2	2
R51 ^B	20.5	16.7	7.4	2	23.8	17.5	7.6	2
R54 ^B	21.4	17.2	7.6	2	27.1	18.4	7.9	2
R55 ^C	21.1	17.1	7.6	2	26.2	18.2	7.8	2
R56 ^A	21.9	17.4	7.7	2	28.9	18.9	8.0	2
R58 ^C	20.7	16.9	7.5	2	24.9	17.8	7.7	2
R61	19.1	16.0	7.0	2	19.2	16.1	7.0	2
R50 ^D	19.9	16.3	7.2	2	21.2	16.7	7.3	2

Note A: Residence owned by the Applicant

Note B: Negotiated 'Call' Option for the Residence between the Applicant and current owner (to be exercised by the Applicant)

Note C: Negotiated 'Put' Option for the Residence between the Applicant and current owner (to be exercised by the owner)

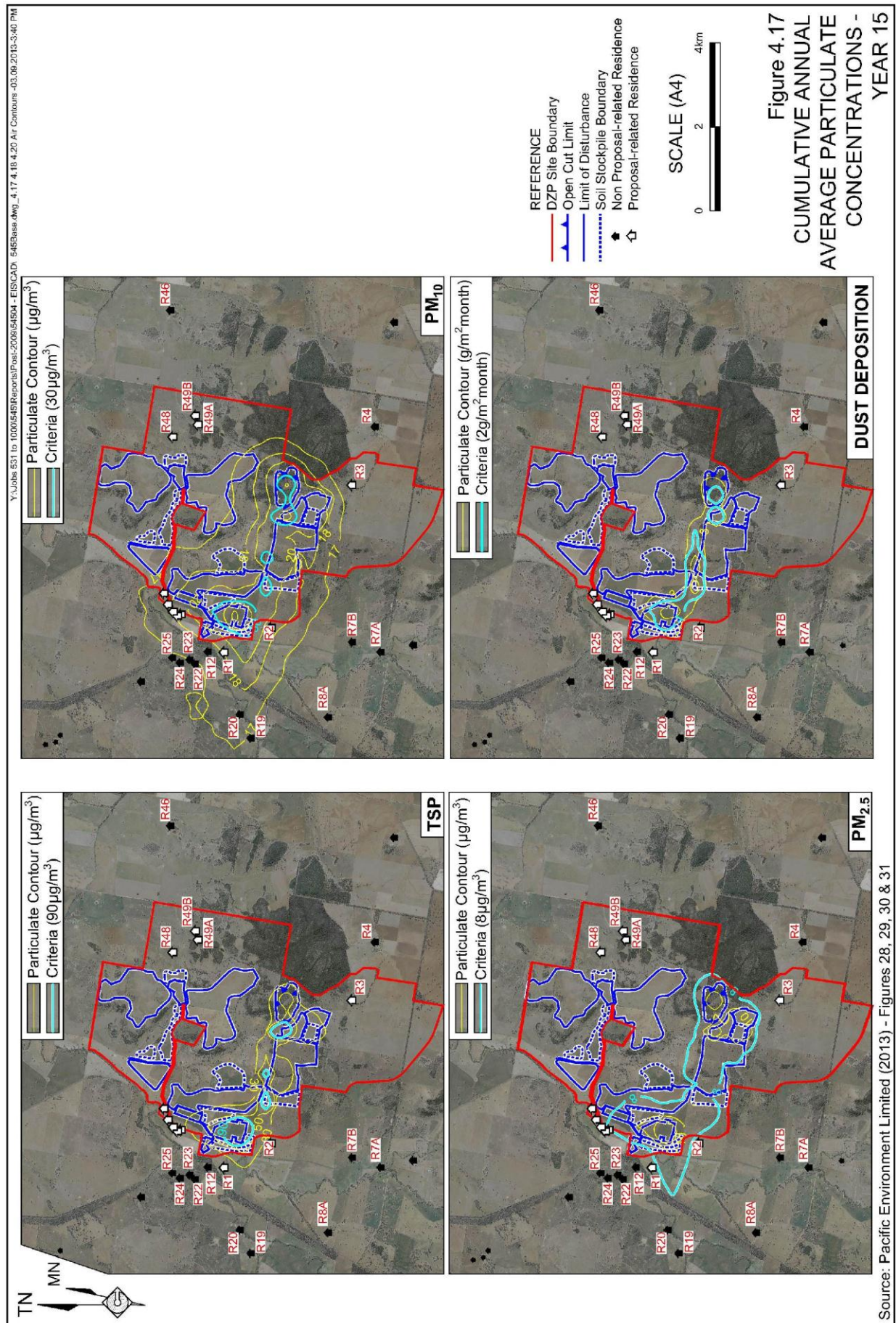
Note D: Allocated location for possible future residence (property has dwelling entitlement)

Note E: Refer to **Figure 4.6** Note F: R12 is referred to as Receptor 10 in PEL (2013)

Note G: Inferred from contour plot

Source: PEL (2013) – modified after Table 24 and 25

A review of *Tables 24 and 25* of PEL (2013) indicates that the incremental contributions of the proposed operations to the local air quality are relatively low compared to the contribution of background sources. Accordingly, the modelling results for Year 5 and 15 (see **Table 4.29**) predict no exceedance of the annual average TSP, PM₁₀, PM_{2.5} and dust deposition EPA criteria and NEPM advisory reporting standards, either for the Proposal alone (incremental prediction) (refer to PEL, 2013) or when considering the adopted background (cumulative prediction).



Review of the contour plots for TSP, PM₁₀, PM_{2.5} and dust deposition indicate that those areas predicted to experience the greatest particulate levels are the residences located to the west of the DZP Site, at the village of Toongi.

Incremental and cumulative particulate concentrations and deposition levels during the operation of the Proposal are thus not anticipated to result in adverse impacts at any of the receptors investigated in this assessment on an annual basis.

4.3.7.3 Incremental 24-hour Average PM₁₀ and PM_{2.5}

Table 4.30 presents the predicted maximum 24-hour PM₁₀ and PM_{2.5} concentrations due to the Proposal alone at the receptors investigated in this assessment. **Figure 4.18** shows the corresponding contour plots for Year 15. The 24-hour PM₁₀ and PM_{2.5} contours do not represent a single worst case day, but rather represent the potential worst case 24-hour average concentration that could be reached at any particular location across the entire modelling year.

The predicted PM₁₀ and PM_{2.5} concentrations during Year 5 and Year 15 indicate that the incremental contribution of the Proposal would not exceed the EPA criteria (50µg/m³ for PM₁₀) or NEPM advisory report standard (25µg/m³ for PM_{2.5}). The incremental PM₁₀ and PM_{2.5} concentrations are predicted to be higher in Year 15 than in Year 5 with R22 predicted to experience the highest PM₁₀ concentrations for both years (34µg/m³ in Year 15). R46 is predicted to receive the highest PM_{2.5} concentration (11µg/m³ in both Year 5 and Year 15).

Figure 4.18 indicates that those areas predicted to experience the greatest maximum 24-hour average PM₁₀ and PM_{2.5} concentrations are the residences located to the west of the DZP Site, within the village of Toongi.

4.3.7.4 Cumulative 24-hour Average PM₁₀

Given the daily varying nature of background 24-hour PM₁₀, PEL (2013) evaluated the likely cumulative maximum 24-hour PM₁₀ concentration at surrounding residences using a statistical approach known as a Monte Carlo Simulation. PEL (2013) focussed on the six non-Proposal related residences predicted to be most affected based on an incremental particulate matter assessment.

The Monte Carlo simulation method involves the individual 24-hour predictions for the Proposal being added to a random value from the background data set. This process is repeated many thousands of times yielding the 'cumulative' data set, which is then presented as a frequency distribution. The results of this analysis are presented graphically in **Figure 4.19** illustrating the statistical probability of 24-hour PM₁₀ concentrations being above the EPA 24-hour PM₁₀ criterion of 50µg/m³ and the cumulative probability with the measured background.

Table 4.30
Maximum 24-hour PM_{2.5} and PM₁₀ concentrations – Year 5 and Year 15

Air Quality Parameter Criteria (µg/m ³)	PM ₁₀ 50	PM _{2.5} 25	PM ₁₀ 50	PM _{2.5} 25
Receptor ^E	Year 5		Year 15	
R1 ^a	13	5	33	8
R2 ^a	17	7	34	10
R3 ^a	3	3	18	5
R4	2	2	6	2
R6	2	2	4	2
R7A	3	3	4	3
R7B ^G	3	3	4	3
R8A	3	3	5	3
R8B	1	2	2	2
R12 ^F	11	4	20	5
R18	1	2	3	2
R19	3	2	8	4
R20	5	4	10	5
R21	4	4	5	4
R22	18	3	34	6
R23	11	5	18	6
R24	10	5	17	6
R25	7	6	12	6
R26	6	6	9	6
R27	3	3	3	3
R28A	3	3	3	3
R8B	3	3	3	3
R0A	2	2	4	2
R30B	2	1	2	1
R31A	3	3	4	3
R31B	3	2	4	2
R32	2	2	3	2
R35A	2	2	3	2
R35B	2	1	2	2
R38	1	1	2	1
R36	2	2	3	2
R40	1	1	3	2
R42	1	1	2	1
R43	1	1	2	1
R46	1	1	2	1
R48 ^a	3	2	4	2
R49A ^a	3	2	4	3
R49B ^a	2	2	3	2
R51 ^b	7	4	17	6
R54 ^a	14	10	25	10
R55 ^c	8	4	18	6
R56 ^a	15	11	31	11
R58 ^c	11	5	23	8
R61	2	1	4	2
R50 ^d	4	3	8	4

Note A: Residence owned by the Applicant

Note B: Negotiated 'Call' Option for the Residence between the Applicant and current owner (to be exercised by the Applicant)

Note C: Negotiated 'Put' Option for the Residence between the Applicant and current owner (to be exercised by the owner)

Note D: Allocated location for possible future residence (property has dwelling entitlement)

Note E: Refer to **Figure 4.6** Note F: R12 is referred to as Receptor 10 in PEL (2013)

Note G: Inferred from contour plot

Source: PEL (2013) –Table 26

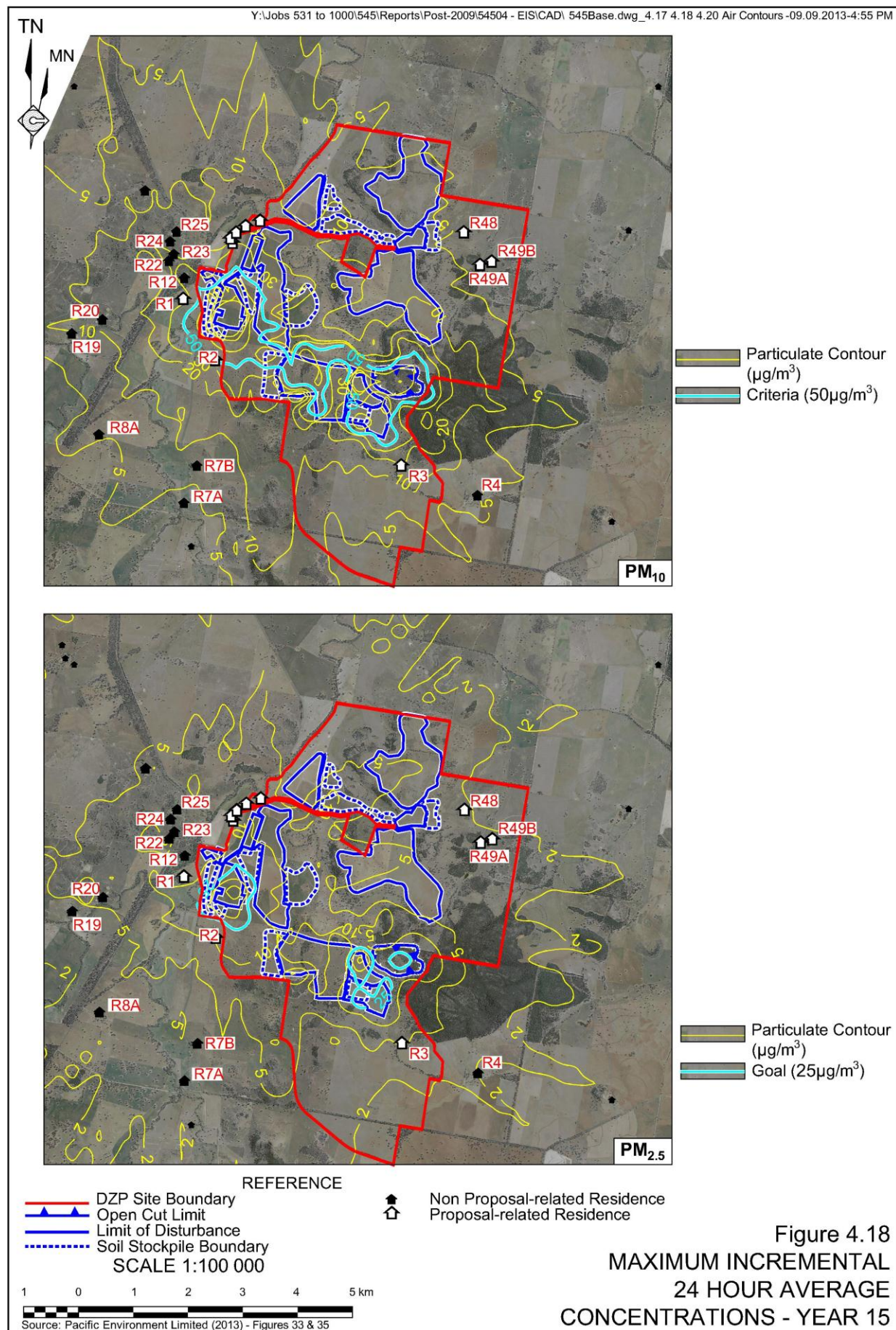


Figure 4.18
MAXIMUM INCREMENTAL
24 HOUR AVERAGE
CONCENTRATIONS - YEAR 15

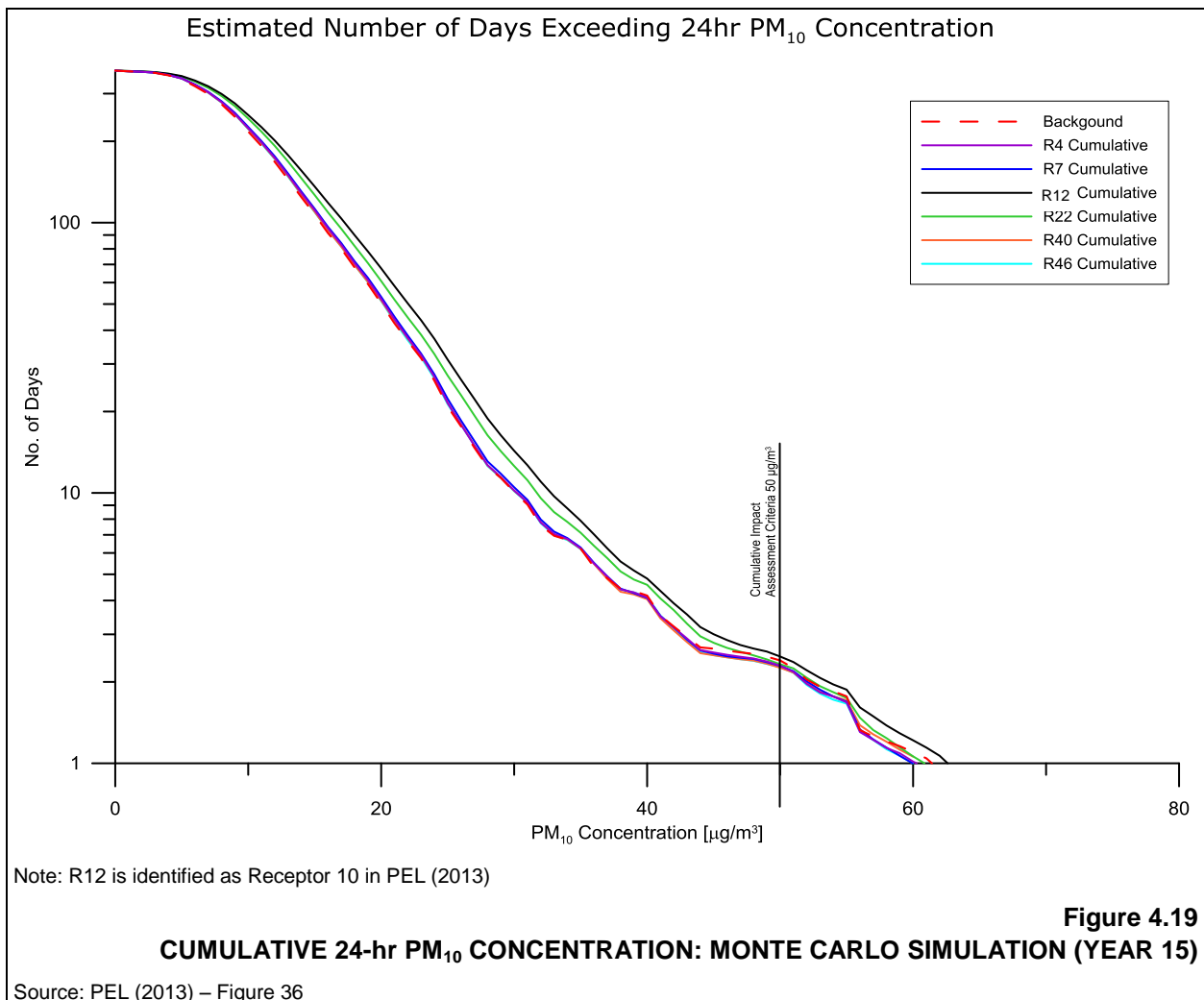


Figure 4.19 illustrates that R12 (Toongi Hall) is likely to be the most affected by PM₁₀ emissions of the Proposal. **Figure 4.19** also indicates that each of the assessed receptors would be subject to an exceedance of the cumulative PM₁₀ 24-hour criterion on 2 days. However, given the background data set already contains two exceedances of the EPA 24-hour criterion, the Proposal is not anticipated to contribute to any *additional* exceedances. On this basis, the Proposal is anticipated to satisfy the EPA criterion (PEL, 2013). Furthermore, it is noted that the line representing the background data set does not deviate from the lines representing cumulative impact to any great degree. The inference is, therefore, that the Proposal-related increment does not contribute significantly to the overall cumulative impact.

4.3.7.5 SO₂ Emissions

The dispersion modelling results for the predicted incremental and cumulative impacts for SO₂ are presented in **Table 4.31** for the maximum 10 minute average, maximum 1-hour average, maximum 24-hour average and annual average averaging periods, respectively.

Table 4.31
Predicted Incremental and Cumulative SO₂ Emissions

Averaging period	10 minute	1-hour	24-hour	Annual	10 minute	1-hour	24-hour	Annual
Adopted background	-	-	-	-	34	27	11	3
Criteria (µg/m³)	712	570	228	60	-	246	-	62
Receptor ^E	Incremental Prediction				Cumulative Prediction			
R1 ^a	971	679	29	1	1,005	706	40	3.9
R2 ^a	274	192	11	1	308	219	22	3.9
R3 ^a	141	98	9	0	175	125	20	3.3
R4	100	70	7	0	134	97	18	3.2
R6	67	46	6	0	101	73	17	3.2
R7A	58	41	5	0	92	68	16	3.2
R7B ^G	60	42	5	0	95	70	16	3.2
R8A	56	39	6	0	90	66	17	3.3
R8B	37	26	4	0	71	53	15	3.2
R12 ^F	610	426	18	1	644	453	29	3.7
R18	59	41	5	0	93	68	16	3.3
R19	57	40	7	1	91	67	18	3.7
R20	110	77	11	1	144	104	22	4.0
R21	56	39	12	1	90	66	23	3.7
R22	124	87	9	1	158	114	20	3.8
R23	182	127	8	1	216	154	19	3.8
R24	285	199	9	1	319	226	20	3.8
R25	255	178	13	1	289	205	24	3.7
R26	316	221	16	1	350	248	27	3.5
R27	70	49	5	0	104	76	16	3.2
R28A	56	39	5	0	90	66	16	3.2
R28B	64	45	5	0	98	72	16	3.2
R30A	75	53	4	0	109	80	15	3.2
R30B	59	41	3	0	93	68	14	3.2
R31A	40	28	4	0	74	55	15	3.2
R31B	62	43	4	0	96	70	15	3.2
R32	66	46	4	0	100	73	15	3.2
R35A	132	92	5	0	166	119	16	3.3
R35B	94	66	6	0	128	93	17	3.3
R38	58	41	3	0	92	68	14	3.2
R36	79	55	3	0	113	82	14	3.3
R40	72	50	5	0	106	77	16	3.3
R42	34	24	4	0	68	51	15	3.2
R43	80	56	3	0	114	83	14	3.2
R46	33	23	4	0	67	50	15	3.2
R48 ^a	91	63	7	0	125	90	18	3.3
R49A ^a	53	37	6	0	87	64	17	3.3
R49B ^a	45	32	6	0	79	59	17	3.3
R51 ^b	214	149	8	1	248	176	19	3.9
R54 ^a	261	182	12	1	295	209	23	4.0
R55 ^c	249	174	10	1	283	201	21	4.1
R56 ^a	303	212	11	1	337	239	22	4.1
R58 ^c	582	407	18	1	616	434	29	4.1
R61	27	19	2	0	61	46	13	3.1
R50 ^d	83	58	8	1	117	85	19	3.5

Note A: Residence owned by the Applicant

Note B: Negotiated 'Call' Option for the Residence between the Applicant and current owner (to be exercised by the Applicant)

Note C: Negotiated 'Put' Option for the Residence between the Applicant and current owner (to be exercised by the owner)

Note D: Allocated location for possible future residence (property has dwelling entitlement)

Note E: Refer to **Figure 4.6** Note F: R12 is referred to as Receptor 10 in PEL (2013)

Note G: Inferred from contour plot

Source: PEL (2013) –Table 27

Contour plots for the maximum 10 minute, 1-hour and 24-hour and annual average cumulative SO₂ impacts for Year 15 are presented in **Figure 4.20** (after *Figures 38 to 41* of PEL, 2013).

Exceedances of the 10 minute and 1-hour criteria are predicted at R1, which is under contract for purchase by the Applicant and is therefore considered Proposal-related. This notwithstanding, any future plans for occupation of this residence must consider the predicted health and amenity impacts associated with the predicted SO₂ emissions that could be received.

Exceedances are not predicted to occur at any other residence. R12 (Toongi Hall), located to the west of the DZP Site, is predicted to be the most greatly impacted Non-Proposal related residence for all of the SO₂ averaging periods for both the incremental and cumulative results.

As would be expected, the contour plots of **Figure 4.20** indicate that for the shorter term averaging periods (i.e. 10 minute, 1-hour and 24-hour) the most greatly impacted areas are located closest to the processing plant. Furthermore, there are some areas close to the processing plant and beyond the DZP Site boundary that are predicted to exceed the 10 minute EPA averaging period. For the annual averaging period, the areas predicted to experience the greatest SO₂ concentrations are predicted to be to the west of the DZP Site boundary, e.g. R12.

4.3.7.6 NO₂ Emissions

Table 4.32 presents the maximum 1-hour average and annual average dispersion modelling results for NO₂. PEL (2013) applied the Ozone Limiting Method (OLM) to predict NO₂ concentrations. The OLM assumes that all the available ozone (O₃) in the atmosphere would react with the NO (which generally makes up 90% of source NO_x emissions) in the plume until either all the O₃ or all the NO is used up. This approach provides an added level of conservatism to the estimated the NO_x to NO₂ conversion.

Table 4.32
Predicted NO₂ Emissions

Page 1 of 2

Receptor ^E	Cumulative Concentration (µg/m ³)	
	1-hour	Annual
Criterion	246	62
R1 ^a	208	50
R2 ^a	179	47
R3 ^a	107	33
R4	96	32
R6	139	34
R7A	151	35
R7B ^G	160	36
R8A	190	37
R8B	146	34
R12 ^F	162	48
R18	179	36
R19	173	46
R20	188	48
R21	164	45
R22	200	48
R23	148	46

Table 4.32 (Cont'd)
Predicted NO₂ Emissions

Page 2 of 2

Receptor ^E	Cumulative Concentration (µg/m ³)	
	1-hour	Annual
Criterion	246	62
R24	205	47
R25	200	48
R26	161	46
R27	132	37
R28A	153	37
R28B	138	37
R30A	123	37
R30B	114	36
R31A	110	36
R31B	111	35
R32	129	36
R35A	97	36
R35B	92	36
R38	102	34
R36	103	35
R40	111	34
R42	91	33
R43	110	32
R46	111	32
R48 ^a	123	35
R49A ^a	152	34
R49B ^a	149	34
R51 ^b	157	49
R54 ^a	201	55
R55 ^c	197	55
R56 ^a	198	57
R58 ^c	218	51
R61	100	31
R50 ^d	141	40

Note A: Residence owned by the Applicant

Note B: Negotiated 'Call' Option for the Residence between the Applicant and current owner (to be exercised by the Applicant)

Note C: Negotiated 'Put' Option for the Residence between the Applicant and current owner (to be exercised by the owner)

Note D: Allocated location for possible future residence (property has dwelling entitlement)

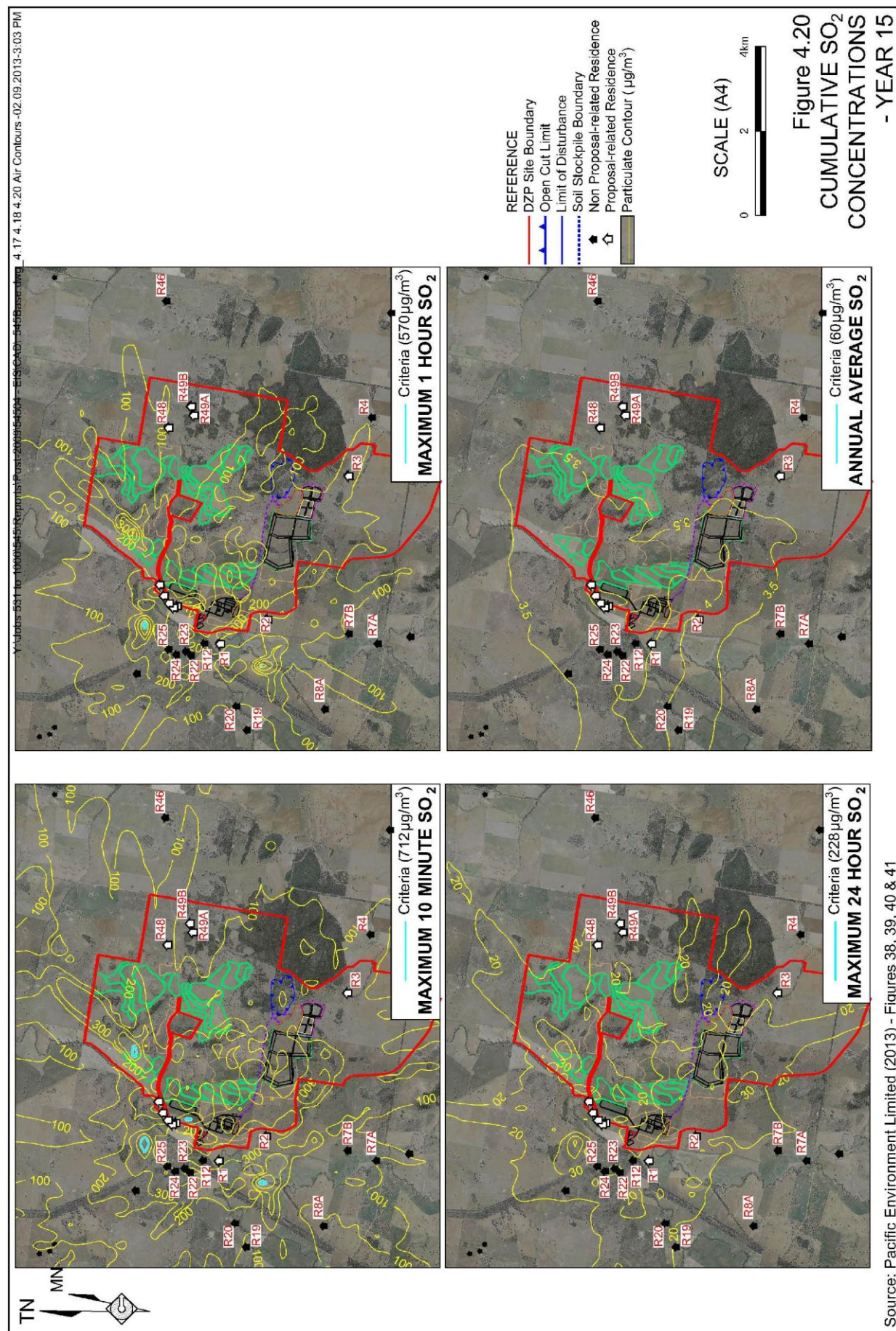
Note E: Refer to Figure 4.6

Note F: R12 is referred to as Receptor 10 in PEL (2013)

Note G: Inferred from contour plot

Source: PEL (2013) – Table 28

Residence 25 is predicted to be the most impacted private residence for the maximum 1-hour average NO₂, predicted to experience up to 200µg/m³, which is below the EPA criterion of 246µg/m³. Residence 22 is predicted to experience the highest annual average NO₂ concentration with results indicating an annual average concentration of 48µg/m³, which is also below the EPA criteria of 62µg/m³.



The predicted concentrations do not exceed the EPA criteria of $246\mu\text{g}/\text{m}^3$ and $62\mu\text{g}/\text{m}^3$ respectively.

4.3.7.7 HCl Emissions

The dispersion modelling results of PEL (2013) indicate that HCl emissions would not result in an exceedance of the EPA criterion of $0.14\text{mg}/\text{m}^3$ ($140\mu\text{g}/\text{m}^3$) at any receptor (refer to Table 29 of PEL, 2013).

4.3.7.8 Radon

Excluding Proposal-related, i.e. those which hold an agreement for purchase, PEL (2013) predicts a maximum annual average radon concentration of $0.09\text{Bq}/\text{m}^3$ at Receptors R18, R19 and R25. Table 30 and Figure 43 of PEL (2013) (Part 2 of the Specialist Consultant Studies Compendium) provide the predicted concentration at each receptor surrounding the DZP Site.

The predicted concentration of radon predicted by PEL (2013) has been used to assess potential impacts against radiation criteria by JRHC (2013) (refer to Sections 4.4.8.2 and 4.4.8.3)

4.3.7.9 Odour

The dispersion modelling results for the 1 second (nose response) average 99th percentile odour predictions of PEL (2013) are presented in Table 4.33.

The highest 1-second 99th percentile odour concentration (0.5 OU at R24 and R25) is well below the adopted odour criterion of 6 OU and also below the most stringent EPA odour criterion of 2 OU, typically applied to urban areas, schools and hospitals.

Table 4.33
Predicted Odour Impact

Page 1 of 2

Receptor ^E	99 th Percentile Prediction Odour Concentration (OU)	Receptor ^E	99 th Percentile Prediction Odour Concentration (OU)
NSW EPA criterion	6	NSW EPA criterion	6
1 ^a	0.4	30B	0.2
2 ^a	0.9	31A	0.2
3 ^a	0.3	31B	0.2
4	0.1	32	0.2
6	0.2	35A	0.2
7A	0.2	35B	0.2
7B ^G	0.2	38	0.1
8A	0.2	36	0.2
8B	0.1	40	0.2
12 ^F	0.4	42	0.1
18	0.4	43	0.1
19	0.4	46	0.1
20	0.2	48 ^a	0.3
21	0.1	49A ^a	0.5
22	0.4	49B ^a	0.4
23	0.4	51 ^b	1.0

Table 4.33 (cont'd)
Predicted Odour Impact

Page 2 of 2

Receptor ^E	99 th Percentile Prediction Odour Concentration (OU)	Receptor ^E	99 th Percentile Prediction Odour Concentration (OU)
NSW EPA criterion	6	NSW EPA criterion	6
24	0.5	54 ^a	0.6
25	0.5	55 ^c	0.7
26	0.4	56 ^a	0.6
27	0.2	58 ^c	0.8
28A	0.2	61	0.1
28B	0.2	50 ^d	1.2
30A	0.2		
<p>Note A: Residence owned by the Applicant Note B: Negotiated 'Call' Option for the Residence between the Applicant and current owner (to be exercised by the Applicant) Note C: Negotiated 'Put' Option for the Residence between the Applicant and current owner (to be exercised by the owner) Note D: Allocated location for possible future residence (property has dwelling entitlement) Note E: Refer to Figure 4.6 Note F: R12 is referred to as Receptor 10 in PEL (2013) Note G: Inferred from contour plot</p>			
			Source: PEL(2013) – Table 31

4.3.7.10 Greenhouse Gas Emissions

A summary of the total GHG emissions associated with the Proposal (for transport Option C) are presented in **Table 4.34**.

Table 4.34
Summary of GHG Emissions (t CO₂-e)

	Scope 1 Emissions (t CO ₂ -e)	Scope 2 Emissions (t CO ₂ -e)	Scope 3 Emissions (t CO ₂ -e)	Total (Scope 1 and Scope 2)	Total (All scopes)
Average Operational Year					
Option A	140 040	120 560	1 107	260 600	262 101
Option B	140 040	120 560	1 126	260 600	261 727
Option C	140 040	120 560	1 501	260 600	261 707
Life of mine					
Option A	2 800 807	2 411 200	1 277 650	5 212 007	6 497 532
Option B	2 800 807	2 411 200	1 278 032	5 212 007	6 490 040
Option C	2 800 807	2 411 200	1 285 525	5 212 007	6 489 657
Source: Modified after PEL (2013) – Table 32					

The Proposal's contribution to projected climate change, and the associated impacts, would be in proportion with its contribution to global GHG emissions. Average annual Scope 1 and Scope 2 emissions from the Proposal (0.26 million tonnes [Mt] CO₂-e) would represent approximately 0.04% of Australia's commitment for annual emissions under the Kyoto Protocol (591.5Mt CO₂-e/annum) and a very small portion of global greenhouse emissions, given that Australia contributed approximately 1.5% of global GHG emissions in 2005 (Commonwealth of Australia, 2011).

It is expected that the Proposal would exceed the facility threshold of 25 000t CO₂-e per annum for participation in the carbon pricing mechanisms, and as such Scope 1 and Scope 2 GHG emissions from the Proposal would be subject to the carbon pricing mechanism. As such, it is anticipated that the Applicant would directly contribute to the revenue generated by the carbon pricing mechanism.

4.3.8 Monitoring

The above assessment indicates that the concentrations of all potential contaminant levels associated with the Proposal are likely to be acceptable. However, in order to demonstrate compliance with the Proposal air quality goals (refer Section 4.3.4), the Applicant would undertake an air quality monitoring program to demonstrate compliance with the nominated air quality goals. This would include monitoring of deposited dust levels, TSP and PM₁₀ at surrounding residences and/or locations surrounding the processing plant, subject to landowner agreement. Monitoring of SO₂, NO₂ and HCl at residential receptors is not considered necessary due to the very minor incremental contributions to background predicted.

Periodic extractive monitoring for SO₂, NO₂, HCl and PM₁₀ would be undertaken to demonstrate compliance with in-stack limits. Initially this would be completed every 3 months (for the first year of operation) and then annually, if compliance is easily achieved.

The locations, frequency and implementation of the proposed monitoring program would be prepared in consultation with the DP&I and EPA following approval of the Proposal. In addition, the Applicant would monitor its diesel and electricity usage and report on greenhouse gas emissions as required under relevant State and Commonwealth regulations.

4.4 RADIATION

4.4.1 Introduction

Radiation was not mentioned within the Director-General's Requirements issued by the DP&I as an issue for assessment, however, the Applicant recognises that the ore body contains elevated concentrations of naturally occurring uranium and thorium which may result in radioactivity levels greater than average during operations. Therefore the Applicant has considered radiological impacts in the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to radiation and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Adverse health outcomes for workforce from low level radiation emitted by ore (low).
- Adverse health outcomes for surrounding landowners / residents during the period of mine operation (low).
- Long-term adverse health outcomes for surrounding landowners / residents following the completion of the Proposal (low).
- Degradation of local vegetation and/or reduced survival rates of local fauna during the life of the Proposal (low).

- Long-term degradation of local vegetation and/or reduced survival rates of local fauna following the completion of the Proposal (low).
- Adverse health outcomes for those exposed to the equipment or scrap (low).
- Adverse health outcomes for the customer or end user (low).

The Applicant commissioned JRHC Enterprises Pty Ltd to undertake a radiation assessment to define the risks associated with radiation. The radiation assessment (JRHC, 2013) utilises the air quality modelling undertaken by Pacific Environment Limited (PEL, 2013). JRHC (2013) is provided in full as Part 3 of the *Specialist Consultant Studies Compendium*. This subsection of the EIS provides a summary of the radiation assessment, concentrating on those matters considered to be of greatest potential impact based on the risk analysis.

4.4.2 Background to Radiation

All matter is made of atoms which themselves are made up of protons and neutrons in a nucleus, and electrons orbiting around the nucleus. Some atoms are unstable and breakdown, giving off energy in the form of radiation. These are known as radioactive atoms or radionuclides.

Different radionuclides emit radiation at different rates. The breakdown (or decay) of radionuclides reduces the number of protons and neutrons remaining, so that the amount of radiation emitted continually reduces. The time taken for one half of the radionuclides to decay away is known as the 'half-life'. Each radionuclide has its own half-life which can range from fractions of a second to billions of years.

When a radionuclide decays, the new atom formed may itself be radioactive, which in turn decays to another radionuclide, and this can continue until a stable element is reached. When this occurs, the chain of radioactive decays is called the 'decay series' or 'decay chain'.

Radionuclides are ubiquitous and naturally occurring, existing everywhere in the environment, in food, air, water, soils and rocks. For example, uranium is a naturally occurring heavy metal and is widespread in earth's crust, with an average concentration of about three parts per million (ppm). Since radionuclides exist naturally in all materials, it is usual to only define a material as "radioactive" when the concentration of a radionuclide in the material exceeds a certain level.

There are three types of radiation emitted by naturally occurring radionuclides.

- **Alpha radiation** consists of alpha particles (two neutrons and two protons) and has a very short range in air (a few centimetres), depositing their energy quickly. They are unable to penetrate the epidermis (outer layer of skin), but can be hazardous when inhaled or ingested.
- **Beta radiation** consists of high-energy electrons. They have moderate penetration, typically about one metre in air and a few millimetres in water or tissue.
- **Gamma radiation** is not a particle but an electromagnetic wave similar to light and X-rays but of much higher energy. Gamma rays are generally able to penetrate up to several centimetres of metal or 10cm of concrete, and usually pass right through the human body.

Exposure to radiation can only occur when there is an exposure pathway between the radioactive material and the exposed biota. This can occur in two ways:

- through the external exposure pathway: where the source of radioactivity is outside the body; and
- through the internal exposure pathway: where the source of radioactivity is inside the body, for example in inhaled air.

When describing radiation, there are two important concepts, namely: the amount of radioactivity in a material; and the resultant exposure from the radioactivity (this is also referred to as a “dose”).

The amount of radioactivity is described by its ‘activity’ and is measured in the unit of becquerel (Bq), which is the amount of radioactive material that produces one radioactive decay per second. The activity concentration is the amount of radioactivity in a unit mass (or volume) of material and is usually measured in becquerels per gram (Bq/g) or per litre (Bq/L).

Dose refers to the amount of radiation received at a point or to a person. Dose is also a relative measure of the effect (or ‘detriment’) of radiation on the human body and is measured in the units of Sieverts (Sv) and takes into account the different types of radiation and different exposure situations. The sievert is quite a large unit of measure, and doses are usually expressed in millisieverts (mSv), being thousandths of a sievert, or microsieverts (μSv), being one millionth of a sievert.

Due to radiation being very common in nature, everyone is exposed to natural radiation throughout their life. This radiation comes from the rocks and soil of the earth, the air we breathe, water and food we consume, and from cosmic radiation from space. Natural background can vary considerably in different places in the world. While the world average level of radiation is 2.4mSv/y, the typical range is quoted as 1 to 10mSv/y (UNSCEAR, 2000).

In addition to natural background exposure, some people around the world are regularly exposed to radiation in their work, and from leisure activities (such as flying) and in medical procedures. **Table 4.35** shows the average annual doses for a range of different activities.

Table 4.35
Radiation Exposures (in Addition to Natural Background Levels)

Source/Practice	Average Annual Effective Dose (mSv)
Working in the nuclear fuel cycle	1.8
Industrial uses of radiation	0.5
Medical uses of radiation (doctors/nurses)	0.3
Average public exposure to medical radiation	1.2
Air crew (from cosmic radiation)	3.0
Mining (other than coal)	2.7
Coal mining	0.7
Source: UNSCEAR (2000)	

4.4.3 Existing Environment

4.4.3.1 Background Radiation Monitoring

Background radiation monitoring was undertaken in 2001-2002, in the general area of the DZP Site. This included a regional gamma survey, radionuclides in dust in air and radionuclides in water. Results of this work are summarised in the following subsections.

4.4.3.2 Gamma Radiation

Background gamma radiation levels vary widely across Australia, with levels typically considered to be between 0.02 and 0.1 $\mu\text{Sv/h}$ (Mudd, 2002). The levels of gamma radiation primarily depend on the levels of natural radionuclides in soil, including radionuclides from the U^{238} , Th^{232} and K^{40} decay chains.

In 2002, the Applicant undertook a gamma survey across the DZP Site and in the broader Dubbo region (Hewson, 2002) the results of which are presented in **Table 4.36**.

Table 4.36
Background Gamma Monitoring

Location	Gamma Levels ($\mu\text{Sv/h}$)
Above mineralisation	1.0 – 3.5 (average 2.5)
Proposed Processing Plant Area	0.1
Proposed Waste Rock Emplacement	0.1 – 1.0
Western Plains Zoo Area	0.2 – 0.4
Macquarie River Bank	0.2 – 0.4
Source: Modified after Mason (2001) - Table 4	

4.4.3.3 Radionuclide Levels in Airborne Dust

Radioactive materials which occur naturally in soils and rocks can become airborne and form dusts. During 2001-2002, dust sampling was undertaken using a high volume sampler located at Wychitella (Radiation-Wise, 2002). The sampling involved drawing a high volume of air through a filter paper to collect particulate matter which was then analysed for its radionuclide content and the total amount of dust. The radionuclide was measured in Becquerel (Bq) which is a standard international unit of measurement of radioactive activity and defined as one radioactive disintegration per second. Sampling involved taking one 24-hour sample per month for 12 months. A summary of the results can be seen in **Table 4.37**.

Table 4.37
High Volume Dust Sampling Results

Month	Total Dust Mass Concentration ($\mu\text{g}/\text{m}^3$)	Total Alpha Concentration ($\mu\text{Bq}/\text{m}^3$)
Average	19	263
Maximum	56	728
Minimum	3.8	68
Source: Radiation-Wise (2002)		

Conversion of the results in bq to the equivalent exposure in Sv was undertaken as part of the impact assessment of JRHC (2013).

4.4.3.4 Radionuclide Concentrations in Water

Monitoring for uranium and thorium in surface water and groundwater was conducted in 2002 and a summary of the results are presented in **Table 4.38** (Golder, 2002). The Australian Government published guidelines for drinking water quality (NHMRC, 2011) and the levels (where available) have been included in **Table 4.38** for comparison purposes.

The low radionuclide content of the groundwater is an indication that uranium and thorium are not readily mobilised from the deposit.

Table 4.38
Radionuclides in Surface Water and Groundwater

Location	Concentration (µg/L)		Concentration (Bq/L)	
	Uranium	Thorium	Ra ²²⁶	Ra ²²⁸
Surface Water - Upstream of deposit ¹	<1	<1		
Surface Water - Downstream of deposit ¹	13	<1		
Groundwater ¹	<1 - 81	<1 - 79	<0.2	<0.2
Australian Drinking Water Guidelines 6 ²	17	N/A	>0.5Bq/L gross α/β triggers further investigation	
Source 1: Golder (2002)				
Source 2: NHMRC (2011)				

The mineralised material to be recovered from the open cut contains between 80-160 ppm uranium and between 250-500 ppm thorium, and contains radionuclides from the U²³⁸, U²³⁵ and Th²³² decay chains. For reference, the world average for soils is 3ppm for uranium and 6ppm for thorium (UNSCEAR, 2000).

The concentration of uranium and thorium in the mineralised material is not excessive, however, it is at the level at which it is just defined as radioactive. These levels of uranium and thorium necessitate the consideration of radiological impacts on workers, the public and on the environment.

4.4.4 Potential Impacts

The acute health effects of radiation exposure (both internal and external) are well known. At high doses (above 1 000mSv) significant numbers of cells may be killed, leading to the breakdown of the organ or tissue, and possibly resulting in death.

At moderate doses, chronic health effects may arise from cells that are damaged by the radiation but not killed. This may be the initiating event for development of a cancer with several studies finding an increased risk of cancer among people exposed to moderate doses of radiation. The studies show that the risk increases as the radiation dose increases.

In general, none of the studies has been able to measure increases in cancer risk from exposures to low doses of radiation (below about 50mSv), however, it is conservatively assumed that there is an increased risk.

The premier international body for radiation protection is the International Commission on Radiological Protection (ICRP). Using studies and their results as the basis of the setting of radiation standards for exposure of workers and the general public, the effective annual dose limits recommended by the ICRP are 20mSv for a designated radiation worker and 1mSv for a member of the public.

The limits recommended by the ICRP have generally been adopted around the world. Dose limits form only one part of the ICRP radiation protection system, with justification of the practice and minimisation of doses being the other two elements.

The radiological protection of the non-human living environment (being plants and animals) has, up until recently, been thought to be assured by ensuring that humans have been protected. In recent times, this approach has been changed and it is now appropriate for a radiological assessment of non-human biota (NHB) to be conducted. International standards exist to conduct this assessment.

4.4.5 Assessment Criteria

Radiation and its effects have been studied for almost 100 years and there is International consensus on its effect and controls. It is generally accepted that control of radiation is best achieved by following the recommendations of the ICRP.

In Publication 26 (ICRP, 1977), the ICRP recommends a “system of dose limitation” which has become the internationally accepted foundation for radiation protection and is universally adopted as the basis of legislative systems for the control of radiation and as the basis for standards. It is made up of three key elements as follows.

- “Justification”: this means that a practice involving exposure to radiation should only be adopted if the benefits of the practice outweigh the risks associated with the radiation exposure.
- “Optimisation”: this means that radiation doses received should be “As Low As Reasonably Achievable”, taking into account economic and social factors. This is also known as the ALARA principle.
- “Limitation”: this means that individuals should not receive radiation doses greater than the prescribed dose limits.

While the ALARA principle is recognised as the foundation for radiation protection, radiation dose limits have been established to provide an absolute level of protection and are;

- an annual limit to a worker of 20mSv , and
- an annual limit to a member of the public of 1mSv.

These limits have been adopted throughout Australia and would apply to the Proposal.

4.4.6 Assessment Methodology

4.4.6.1 Overview

The assessment of radiological impact follows the recognised methods outlined by the ICRP Publication 103 (ICRP, 2007) and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) publication *Recommendations for Limiting Exposure to Ionizing Radiation (1995)* (ARPANSA, 2002). This involves estimating the potential exposure doses from each of the exposure pathways and applying standard “dose conversion factors” which take into account the characteristics of the exposure. The doses from each of the exposure pathways are then added together to give an indication of the potential overall doses that workers or a member of the public may receive.

Details of the methods are provided in full in Part 3 of the *Specialist Consultant Studies Compendium* (JRHC, 2013). The following sections provide a summary of these methods.

4.4.6.2 Occupational Doses

When assessing occupational doses, the three main exposures are considered to be gamma radiation, inhalation of the decay products of radon and inhalation of radionuclides in airborne dust.

- Gamma Radiation. Gamma doses are estimated by considering the exposure geometry and the radionuclide content of the source materials.
- Inhalation of the decay products of radon. Radon decay product exposure is mainly a concern for personnel to be employed by the Proposal, so the exposures are determined by calculating the emanation of radon from the mineralised material into the open cut workings and calculating the residence time of the air (or how long it takes for air to change in the open cut).
- Inhalation of radionuclides in airborne dust. It is important to understand the radionuclides that exist in the dust because they interact differently when taken into the body. For the open cut, the radionuclides are assumed to be in secular equilibrium (where the quantity of radionuclides remains constant because the production rate is equal to the decay rate). For the processing plant, sampling and analysis was undertaken by ANTISO (ANSTO 2012a) to determine the radionuclide content of different materials and these results were used as the basis for estimating what may be inhaled by a worker. A conservative estimate of exposure conditions (that is, the amount of dust in air and the time a worker may be exposed) were made and used as the basis of the dust dose assessment.

4.4.6.3 Public and Environmental Radiological Impacts

For persons located outside the boundary of the DZP Site, the main exposure pathway is through airborne dispersion of dust containing radionuclides and radon.

As discussed in Section 4.3, Pacific Environment Limited (PEL) was commissioned to undertake air quality modelling to quantify the amount of dust and radon gas at various distances from the operating areas. This modelling was based on estimated emissions and provided “impact contour plots” outputs (PEL, 2013), which were used as the basis for the public and environmental radiological assessment. Details on the methodology and assumptions are provided in PEL (2013) and its application in JRHC (2013).

Impacts from radioactive air emissions were determined for:

- radioactive particulate emissions (leading to increased radionuclide concentrations in air and radionuclide deposition to soils); and
- radon emissions (leading to potential increases in radon decay product (RnDP) concentrations).

The air quality modelling provided estimates of the deposition of dusts and radionuclides into the environment, which provided the base data for conducting a non-human biota impact assessment.

4.4.7 Management and Mitigation Measures

The Applicant intends to manage and control radiation through good design and appropriate ongoing operational management systems. This is consistent with best practice as proposed by the recommendations and guidelines of the ICRP. The guidance provided in the ARPANSA publication *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA, 2005), would also be used to guide the management controls.

General site controls would include the following.

- Establishment of radiation design criteria, including:
 - design of the residue storage facilities as zero-discharge facilities with a geo-membrane lining and leak detection system;
 - ensuring that all heavy mining equipment is air conditioned to minimise impacts of dust to workers;
 - minimising dust using standard dust suppression techniques (wetting of materials before handling, wetting of roadways, provision of dust collection and extraction systems);
 - construction of a separate wash-down pad for vehicles that have come from any operating areas;
 - bunding to collect and contain spillages from tanks containing process slurries;
 - burial of, or bunding of the residue pipeline within defined corridor(s) to control spillage from residue pipeline failures;
 - providing sufficient access and egress for mobile equipment to allow clean-up where there is the possibility for large spillages;
 - leach and precipitation of radionuclides from ore prior to production of final compounds for despatch and disposal as solid or liquid residue;

- installation of a venturi scrubber and wet electrostatic precipitator (ESP) as part of the FeNb processing circuit to capture and remove volatilised Polonium 210 and Lead 210 prior to ventilation from the circuit; and
 - slurring and mixture of residues from the FeNb processing circuit scrubber and ESP with the solid residues to be disposed of in the SRSF.
- Classification of work areas and workers.
 - The Applicant has defined the whole of the Proposal within the fence-line as a “supervised area” (as defined in ARPANSA, 2005). Within this broader area, the open cut would be defined as a “controlled area” as would the milling and crushing areas, and the light rare earths processing area.
 - The Applicant has defined the FeNb processing circuit as a controlled area based on the capture and removal volatilised Polonium 210 and Lead 210 prior to ventilation from the circuit.
 - Employees working in the controlled areas would be defined as designated radiation workers. Other workers would be defined as “non-designated” radiation workers.
- Site Access Control
 - All visitors entering and departing the DZP Site would be required to report to the gatehouse or other nominated locations for registration including time of arrival and departure, and an induction, if required.
 - Vehicle access would be through the main boom gate, and exit from site would require all vehicles having trafficked the controlled area to pass through the wheel wash. Water from the wheel wash and wash-down areas would be collected and settled to remove solids, then treated for re-use at the on-site water treatment plant.
- Change Room Facilities
 - Workers in the “controlled area” (“designated workers”) would be required to change into work clothes at the commencement of their shift and then shower and change into “street clothes” at the end of their shift. This would be a general health and hygiene requirement (not just a radiation requirement) that would be implemented once the Proposal commences and would continue throughout the life of the Proposal.
 - Dirty clothes would be laundered on-site, with waste water sent to an on-site water treatment plant.
- Establishment of site-wide administrative controls including;
 - pre-employment and routine medical checks for workers;
 - inductions and regular training of all employees and contractors;
 - development of safe work procedures, which includes radiation safety aspects;
 - procedures to segregate, isolate and clean up contamination or contaminated equipment;

- procedures for equipment or materials leaving the controlled area;
 - mandatory use of personal hygiene facilities (wash facilities) at entrances to lunch rooms and offices;
 - employment of suitably qualified and experienced radiation safety professionals to assist during the final design, construction and the operational phases of the Proposal; and
 - use of a computer-based data management system to store and manage all information relating to radiation management and monitoring.
- Systems for managing potentially radioactive wastes.
 - Material such as contaminated equipment and wastes from operational areas, including discarded conveyor belts, rubber lining material, pipes, filter media and used protective equipment would be cleaned on-site and disposed in accordance with approved regulatory controls (see Section 2.11.2).
 - Spill management procedures (in the event a LRSF pipeline did leak/rupture).

4.4.8 Assessment of Impacts

4.4.8.1 Introduction

JRHC (2013) provides a detailed description of the potential radiological impacts of the Proposal, specifically in relation to occupational doses, public doses and radiological impacts to the environment. A summary of the impacts is provided as follows.

4.4.8.2 Occupational Doses

Potential doses have been calculated for mine workers and processing plant workers and have been based on determining the doses from the following exposure pathways;

- Gamma irradiation,
- inhalation of radioactive dust; and
- for miners, inhalation of radon decay products (RnDP) and thoron decay products (ThDP).

For the processing plant, initial dose estimates were made by ANSTO (2012a and 2012b) and these have been refined where appropriate.

A summary of the estimated doses for miners is provided in **Table 4.39**. A summary of the estimated doses for processing plant workers is provided in **Table 4.40**.

Table 4.39
Occupational Dose Estimates

Work Group	Average Annual Dose (mSv/y)					Dose Limit (mSv/y)
	Gamma	RnDP	ThDP	Dust	Total	
Miners	2.0	0.018	0.008	0.30	2.3	20

Source: JRHC (2013) – Table 8

Table 4.40
Processing Plant Work Area Doses

Processing Plant Work Area	Doses (mSv/y)			Dose Limit (mSv/y)
	Gamma	Dust Inhalation	Total	
Ore Milling/Handling /Roasting	2.0	0.4	2.4	20
Light Rare Earth processing	0.5	8.5	9.0	
Heavy Rare Earth processing	0.7	2.6	3.3	
Niobium Processing	0.8	1.2	2.0	
Source: JRHC (2013) – Table 9				

Initial indications from ANSTO (2012a) and ANSTO (2012b) are that light rare earth plant workers may receive up to 9mSv/y, however, it is not expected that doses would reach those levels due to operational controls. Similarly, controls within the FeNb processing circuit would effectively eliminate the potential dust inhalation dose. While the dose is well below the dose limit standard of 20mSv/y, dust controls would be implemented within the Processing Plant Area generally to minimise dose in accordance with the ALARA principle.

It should be noted that the occupational dose estimates are considered to be conservative and monitoring during operations would be conducted to provide more accurate assessments.

4.4.8.3 Public Dose Assessment

Public doses would arise when emissions from inside the DZP Site impact on areas outside the DZP Site.

Of the main exposure pathways, gamma radiation is not considered to be significant because sources of gamma radiation are well within the DZP Site and inaccessible. Therefore, gamma radiation levels from the Proposal beyond the boundary of the proposed plant would be negligible.

For the public, the only potential exposure pathways are via the airborne pathways being:

- inhalation of radioactive dust; and
- inhalation of radon and decay products (RnDP) and thoron and decay products (ThDP) (refer to JHRC, 2013 for further detail).

For this assessment, potential doses for occupants of the four residences located to the immediate west of Obley Road (R22 to R25 – see **Figure 4.6**) have been conducted as these are the closest potentially exposed non-Proposal related receptors. Other non-Proposal related receptors are located further from the emission sources and would receive less exposure.

To estimate doses to the occupants of the four residences (R22 to R25), standard methods are used (see JRHC, 2013) which are based on the results of the air quality modelling. A summary of the estimated doses for R22 to R25 is provided in **Table 4.41**.

Table 4.41
Predicted Public Dose

Residences	Dose From Pathway (mSv/y)				Public Dose Limit (mSv/y)
	Inhalation of RnDP (Rn ²²²)	Inhalation of Dust	Gamma Radiation	Total Dose	
R22 to R25	0.0075	0.020	0	0.028	1
Source: JRHC (2013) – Table 10					

It is noted that receptors within Toongi are located closer to the Processing Plant Area and therefore could receive greater exposure. These receptors are, however, Proposal-related and have not been included in the assessment for this reason.

4.4.8.4 Non-Human Biota Exposure

In ICRP publication 103 (ICRP, 2007), a system for the radiological protection of non-human biota was outlined, which included a method for assessing radiological impact to reference species. A software tool, called ERICA (Environmental Risk from Ionising Contaminants Assessment) developed under the European Commission, was used to determine a relative radiological risk factor to a species as a “dose rate” based on site specific data.

An assessment was conducted using the dust deposition outputs of the air quality modelling and showed that impacts to non-human biota outside the DZP Site would be negligible (JRHC, 2013 – *Appendix D*).

4.4.8.5 Public Dose Following Closure

The Applicant has developed closure and rehabilitation plans for the proposed activities. From a radiological perspective, the overall approach is to ensure that the radiation levels at the DZP Site are returned to levels consistent with those which existed prior to the Proposal. With the implementation of the closure and rehabilitation plans, there are, therefore, no reasonable pathways for public exposure, and doses are expected to be negligible and much less than the member of public dose limit of 1mSv/y (above natural background).

4.4.8.6 Summary

The radiation assessment of the Proposal shows that the impacts would be manageable and well below the recognised limits. A summary of the radiological impacts of the Proposal is presented in **Table 4.42**.

Table 4.42
Summary of Radiation Impacts for the Proposal

Dose Groups	Expected Dose/Impact (mSv/y)	Dose Limit/Standard (mSv/y)
Workers	2 to 9mSv/y*	20mSv/y
Member of Public	<0.1mSv/y	1mSv/y
Non-Human Biota	No impact	-
Note * depending on the work area		

4.4.9 Monitoring

As part of the ongoing management of radiation, an occupational and environmental monitoring program would be developed and implemented. An outline of the proposed occupational radiation monitoring is shown in **Table 4.43**.

Table 4.43
Dose Assessment Monitoring Program (Indicative Only)

Radiation Exposure Pathway & Monitoring Method	Open Cut	Processing Plant	Administration Area
Gamma radiation – Personal TLD badges	Quarterly TLD badges	Quarterly TLD badges on selected workers	NR
Gamma radiation – Survey with hand held monitor	Monthly area survey	Monthly area survey	Monthly area survey
Airborne dust – Sampling pumps with radiometric and gravimetric analysis of filters	Weekly personal dust sampling for; truck driver, loader operator, maintenance personnel, & miner	Fortnightly personal samples in selected work areas Weekly sampling in the Light Rare Earth Recovery and Refining circuit and FeNb processing circuit	Monthly area samples
Radon Decay Products – Rolle or Borak method	Monthly “grab” sampling in open cut.	NR	NR
Thoron Decay Products – Cote method	Monthly “grab” sampling in open cut.	NR	NR
Surface Contamination	Monthly survey	Monthly survey	Monthly survey
NR = Not Required		Source: Modified after JRHC (2013) – Table 11	

The Applicant has recently installed a network of environmental radiation monitors. **Figure 4.15** (in Section 4.3) identifies the locations of these Environmental Radiation Monitoring Locations (ERMLs) and **Table 4.44** details the ongoing monitoring that would be undertaken at these sites.

The occupational and environmental monitoring program would be reviewed after three years.

Table 4.44
Environmental Radiation Monitoring Program

Parameter	Monitoring	Location
Gamma radiation	Quarterly environmental TLD badges	ERML
	Handheld environmental gamma monitor	Annual survey at perimeter of operational area
Airborne dust	Passive dust sampling, with samples composited for one year then radiometric analysis	ERML
Radon Concentrations	Quarterly passive monitoring	ERML
Thoron Concentrations	Quarterly passive monitoring	ERML
Radionuclides in Soils	Sampled every 5 years	ERML
Radionuclides in Groundwater	Water sampled annually at monitoring bore locations	Refer to Section 4.6.6.3
Source: Modified after JRHC (2013) – Table 12		

4.5 SURFACE WATER

4.5.1 Introduction

The Director-General's Requirements identified "**Water Resources** as a key issue for assessment – including:

- *a detailed assessment of potential impacts on the quality and quantity of existing surface and groundwater resources, including:*
 - *impacts on affected licensed water users and basic landholder rights; and*
 - *impacts on riparian, ecological, geo-morphological and hydrological values of watercourses, including environmental flows.*
- *a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;*
- *an assessment of proposed water discharge quantities and quality/ies against receiving water quality and flow objectives;*
- *an assessment of proposed modifications to surface water management, including modelling the redistribution of waters and an assessment of the impact on neighbouring properties and the associated watercourse and floodplain;*
- *identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;*
- *demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);*
- *a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;*
- *a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Office of Water (NOW) which amongst others request that the EIS provide "*an assessment of any proposed modification to surface water management including modelling of redistribution of waters and an assessment of impact on neighbouring properties and the associated watercourse and floodplain*"; "*preparation of a surface water management plan to integrate the proposed water balance and management for the site and to identify adequate mitigating and monitoring requirements for both water quality and water volume*"; and "*identification of site water demands, water sources (surface and groundwater), water disposal methods and water storage structures in the form of a water balance*".

The NSW EPA and Central West Catchment Management Authority also provided detailed requirements for the assessment of surface water affected by the Proposal.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to surface water and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Reduced flows to Wambangalang Creek and other tributaries of the Macquarie River (medium).
- Reduced availability of water to downstream users (medium).
- Pollution of local and downstream waterways resulting in detrimental effects to flora and fauna (low).
- Contamination of local surface water (medium).
- Contamination of drinking water supply (medium).
- Increased erosion potential resultant from changed alignment of flow (low).
- Increased erosion potential within Wambangalang and Paddys Creek catchments (low).
- Detrimental impacts on surrounding properties as a result of changes to flooding regime (low).
- Increased sediment load in drains and/or waterways (medium).
- Increased siltation in drains and/or waterways (medium).

The surface water assessment for the Proposal was undertaken by Mr Mark Passfield of Strategic Environmental and Engineering Consulting (SEEC) Pty Ltd. The resulting report is presented as Part 4 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “SEEC (2013)”. This subsection of the EIS provides a summary of the surface water assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.5.2 Existing Environment

4.5.2.1 Introduction

An overview of the surface water environment within and surrounding the DZP Site is presented in Section 4.1.2. This subsection builds on that description and provides a description of the surrounding hydrological environment, water quality and surrounding water users.

4.5.2.2 Existing Flooding Regime

DZP Site

SEEC (2013) undertook a flood assessment for a 1 in 100 year Annual Recurrence Interval (ARI) rainfall event for Wambangalang and Paddys Creeks and Watercourses B, C and E. This assessment was undertaken using the HEC-RAS (Hydrologic Engineering Centres River Analysis System) flood modelling software. Peak flows were determined in accordance with the Rational Method as outlined in the document *Australian Rainfall and Runoff; A Guide to Flood Estimation* published by the Institute of Engineers Australia.

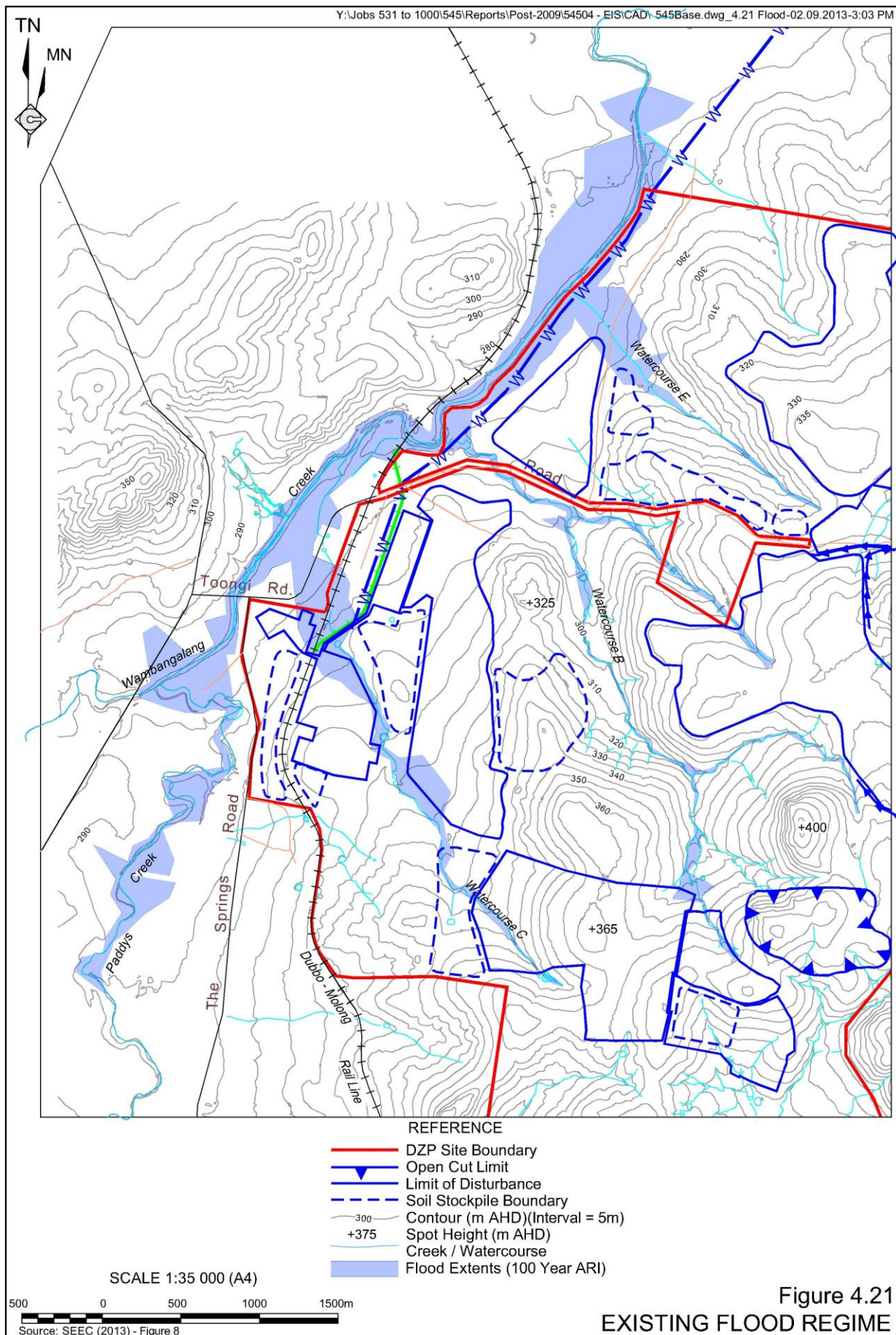
The results of the assessment are presented in **Figure 4.21**. In summary, the extent of flooding in the upper reaches of Watercourses B, C and E is expected to be limited because of the limited catchment and relatively more steeply sloped land. By contrast, a 1 in 100 year ARI event is likely to result in inundation of the land surrounding the lower reaches of those creeks, as well as Wambangalang and Paddys Creeks to a distance of up to approximately 300m from the centre line of the creek. In particular, **Figure 4.21** indicates that, in the absence of management and mitigation measures, sections of the Processing Plant Area may be inundated. Section 4.5.5.7 provides further assessment of the anticipated impacts associated with a 1 in 100 year ARI event, taking into account the management and mitigation measures identified in Section 4.5.4.

Toongi and Obley Roads

The Proposal would require an upgrade to Toongi and Obley Roads, including upgrading of several creek crossings. SEEC (2013) undertook an assessment of the following crossings to determine the existing flood levels using the methodology described previously.

- Toongi Road at Wambangalang Creek - this crossing currently comprises a low level concrete causeway (with six 1 050mm reinforced concrete low flow pipes) that is below the modelled 1 in 100 year ARI flood height of approximately 282.6m AHD.
- Obley Road at Cumboogle Creek – this crossing currently comprises a concrete bridge structure elevated above the local flood plain.
- Obley Road at Hyandra Creek - this crossing currently comprises a 12m span steel bridge, with the deck of the bridge below the 1 in 5 ARI flood event. The modelled elevation of the 1 in 100 year ARI flood height at this crossing is 285.2m AHD.
- Obley Road at Twelve Mile Creek - this crossing currently comprises a causeway with a single 450mm reinforced concrete pipe low flow causeway. The elevation of the causeway and the road for several hundred metres in each direction is below the 1 in 5 ARI flood event. The modelled elevation of the 1 in 100 year ARI flood height at this crossing is 285.81m AHD.

On the basis of these flood levels, Constructive Solutions (2013) prepared conceptual alignment and bridge deck designs for the Wambangalang Creek, Hyandra Creek and Twelve Mile Creek crossings (see *Appendix D(ii)* of Constructive Solutions, 2013). As noted in Sections 2.2.5.2 and 2.2.5.3, the Applicant proposes to upgrade these crossings to allow for passage of flood waters up to the 1 in 20 ARI flood event.



4.5.2.3 Surface Water Quality

Two surface water sampling programs have been undertaken by the Applicant within and surrounding the DZP Site. Details of the results of the sampling programs are presented in *Tables 1* and *2* of SEEC (2013). In summary, surface water quality within and surrounding the DZP Site may be described as follows.

- Salinity – the upper reaches of Cockabroo Creek (north Tributary) and Watercourse A recorded electrical conductivities between 95µS/cm and 330µS/cm. By contrast the lower section of Watercourses B and C and Wambangalang Creek recorded electrical conductivities between 1 830µS/cm and 3 800µS/cm. SEEC (2013) notes that the Toongi Catchment is recorded as being prone to significant salinity. Surface water salinities between 2 000 to 3 000µS/cm have been commonly recorded in this catchment, with some results of more than 6 000µS/cm.
- pH – results were recorded between 6.82 and 8.66, with more samples returning slightly alkaline results.
- Turbidity – varied between 2.6NTU and 100NTU.
- Nitrogen and phosphorous – were both elevated above ANZECC (2000) criteria.

Smithson (2001) identifies that the areas at greatest risk for dryland salinity are those where the groundwater table is within 5m of the natural ground surface. Based on mapping prepared by Smithson (2001 – *Figures 6* and *13*) there are no recorded areas of dryland salinity sites within the DZP Site. Less than 5% of the DZP Site is expected to have water tables within 5m of the natural ground surface. It is noted that *Appendix H* of EES (2013) (Part 5 of the *Specialist Consultant Studies Compendium*) provides a detailed summary of Smithson (2001) including the noted maps.

4.5.2.4 Surrounding Water Users and Availability

Surface water licences within the Wambangalang Whyandra Creek Water Source are described in the *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources*. In summary, the report identifies five existing licences within the boundaries of the water source, with a total entitlement of 165ML/year, of which 85% is used for irrigation and 15% for domestic or stock use. None of the five licences are located on either Paddys Creek or Wambangalang Creek. The Water Sharing Plan advocates no further licences are issued in this catchment and water may only be harvested when pools are at full capacity.

The DZP Site is within the Macquarie River Catchment upstream of Dubbo. The Macquarie River includes numerous water users, including the City of Dubbo which draws 85% of its town water supply from the river.

4.5.3 Potential Surface Water Impacts

The development and operation of the Proposal could have a range of potential surface water-related impacts. The principal potential impacts and the risks associated with each are identified in Section 3.5 and are described in more detail below. Each of the potential impacts

outlined below has been assessed in detail by SEEC (2013) in conjunction with the Applicant to ensure appropriate design and operational safeguards are in place to avoid or minimise potential adverse environmental impacts (see Section 4.5.5).

- Reduced flows to Wambangalang Creek and other tributaries of the Macquarie River and reduced availability of water to downstream users through a temporary or permanent reduction in catchment area or changes to the existing flow regime.
- Stress and possible reduction in viability of native flora or fauna or degradation of aquatic habitats as a result of reduced flows or changes to the existing flow regime or water quality.
- Contamination of soil resources and indirect impacts on future land use as a result of changes in water quality.
- Health-related impacts for people or stock due to consumption of contaminated water.
- Increased erosion or sedimentation potential from changes to the existing flow regime.
- Occurrence of dryland salinity on the DZP Site lands.

4.5.4 Management and Mitigation Measures

4.5.4.1 Introduction

The management of surface water to avoid or minimise the adverse impacts throughout the development and operation of the Proposal requires a coordinated and systematic approach that collectively addresses all potential surface water impacts. This subsection outlines how the Applicant would manage the quantity and quality of surface water encountered within each section of the DZP Site from the early stages of site establishment and construction through to completion of the final rehabilitation program.

Surface water would be managed on site according to quality, namely:

- clean water, namely runoff (typically upslope) that is not affected by any disturbed areas or Proposal-related activity(ies);
- dirty or sediment-laden water, namely runoff containing only sediment and originating from disturbed or bare areas within the DZP Site; or
- contaminated water, namely water with the potential to contain chemicals or salt.

This subsection concludes with an overview of the site water balance which outlines how the Applicant would prioritise the use of water within the DZP Site and ensure sufficient water is available for processing operation and dust suppression.

The management of surface water within the Site would be a continually evolving component of the overall management of the operation and be assessed against the *Water Management Plan* that is to be updated throughout the life of the Proposal.

4.5.4.2 Surface Water Management Plan

4.5.4.2.1 Introduction

Figure 4.22 presents the proposed indicative surface water controls for the DZP Site with **Figures 4.23** and **4.24** providing a more detailed illustration of the proposed indicative surface water controls around the processing plant and DZP Site Administration Area, and open cut, WRE and SECs respectively. The following presents a brief description of the management of surface water within each of the component areas of the DZP Site. Section 4.5.4.4 presents the indicative water balance for the Proposal, based in part on the following.

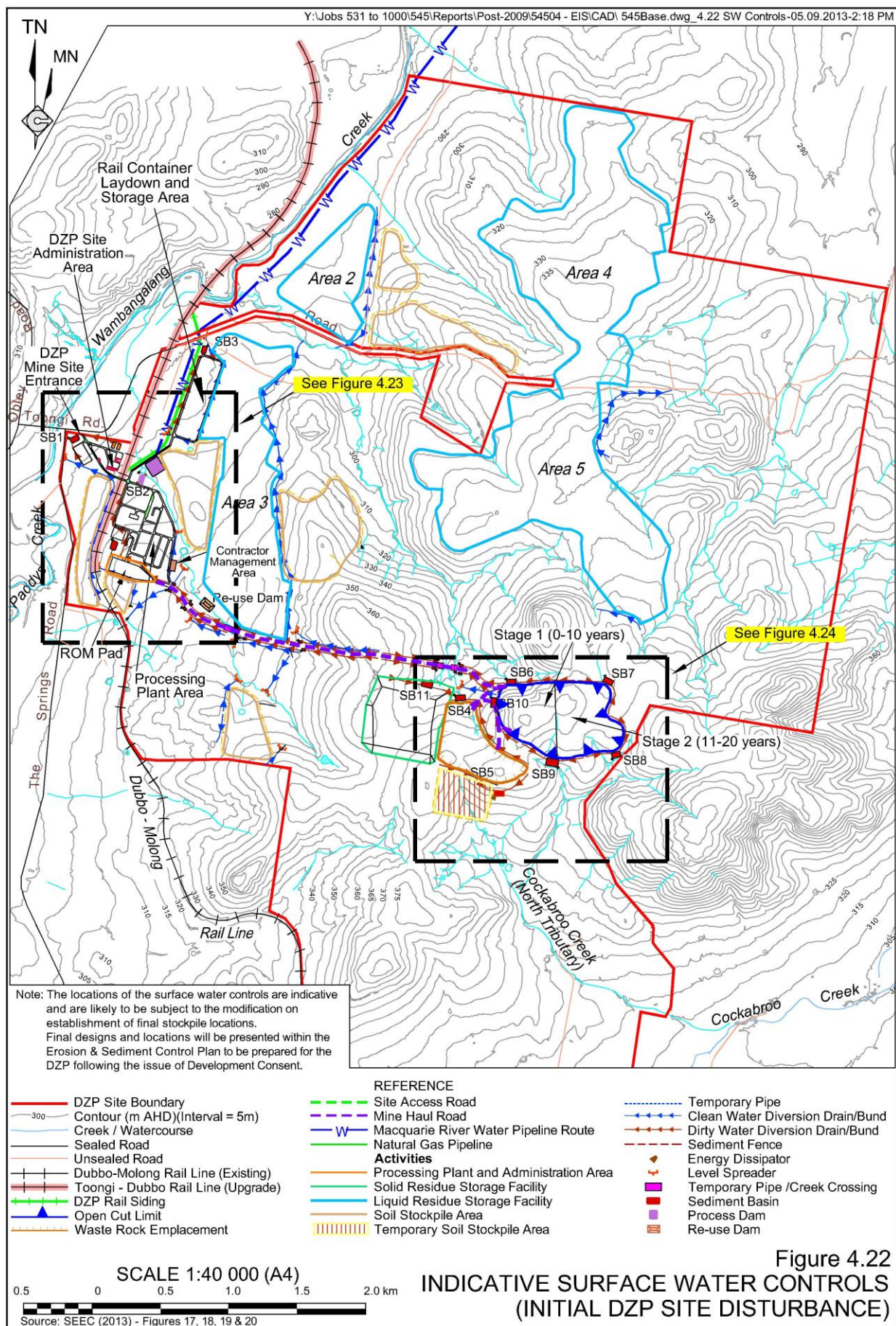
4.5.4.2.2 Overview of the Proposed Surface Water Management

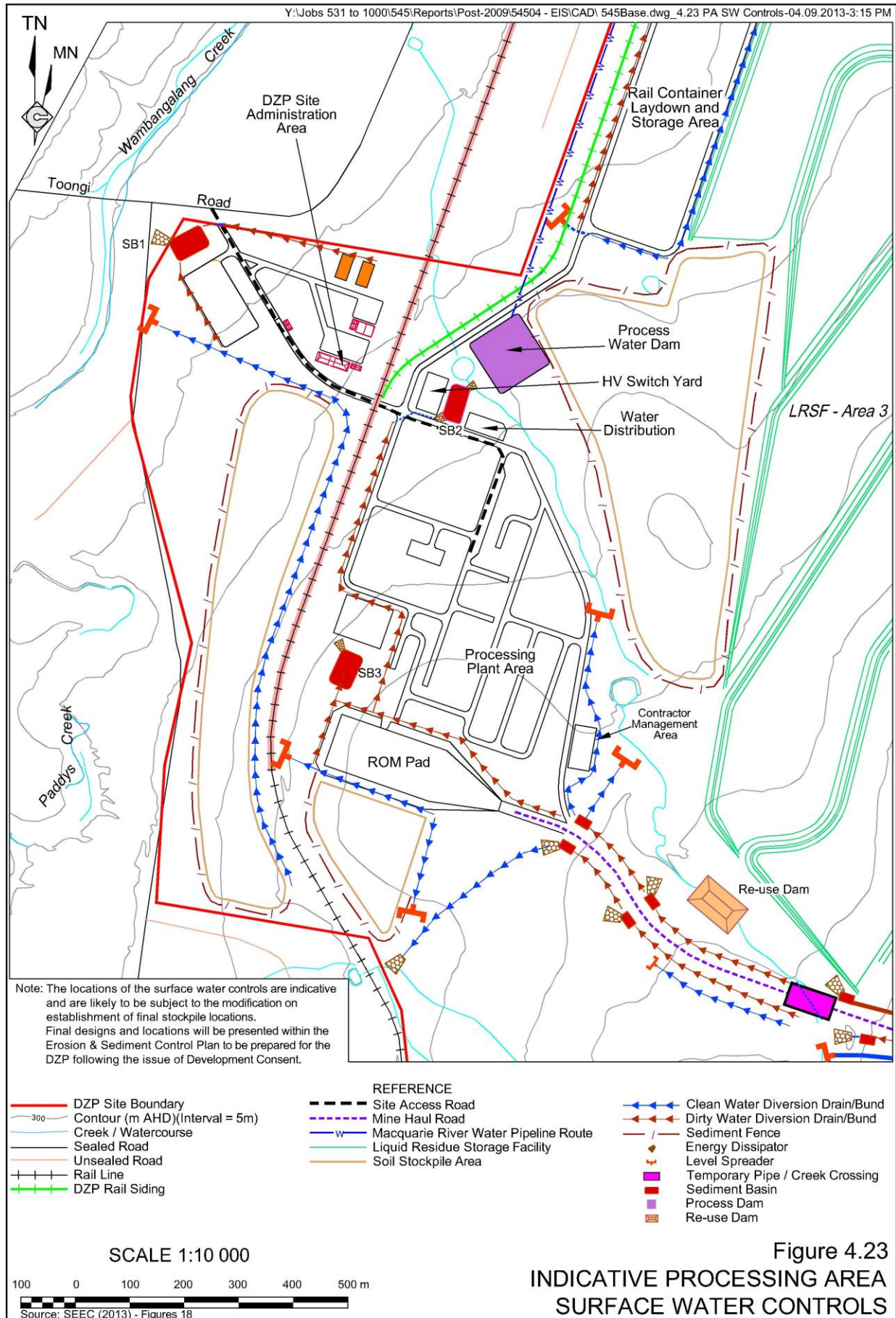
The soils of the DZP Site are moderately erodible and generally either fine grained or significantly dispersive (SSM, 2013). Areas of bare soil would be potential sources of erosion and subsequent sedimentation unless they are managed correctly.

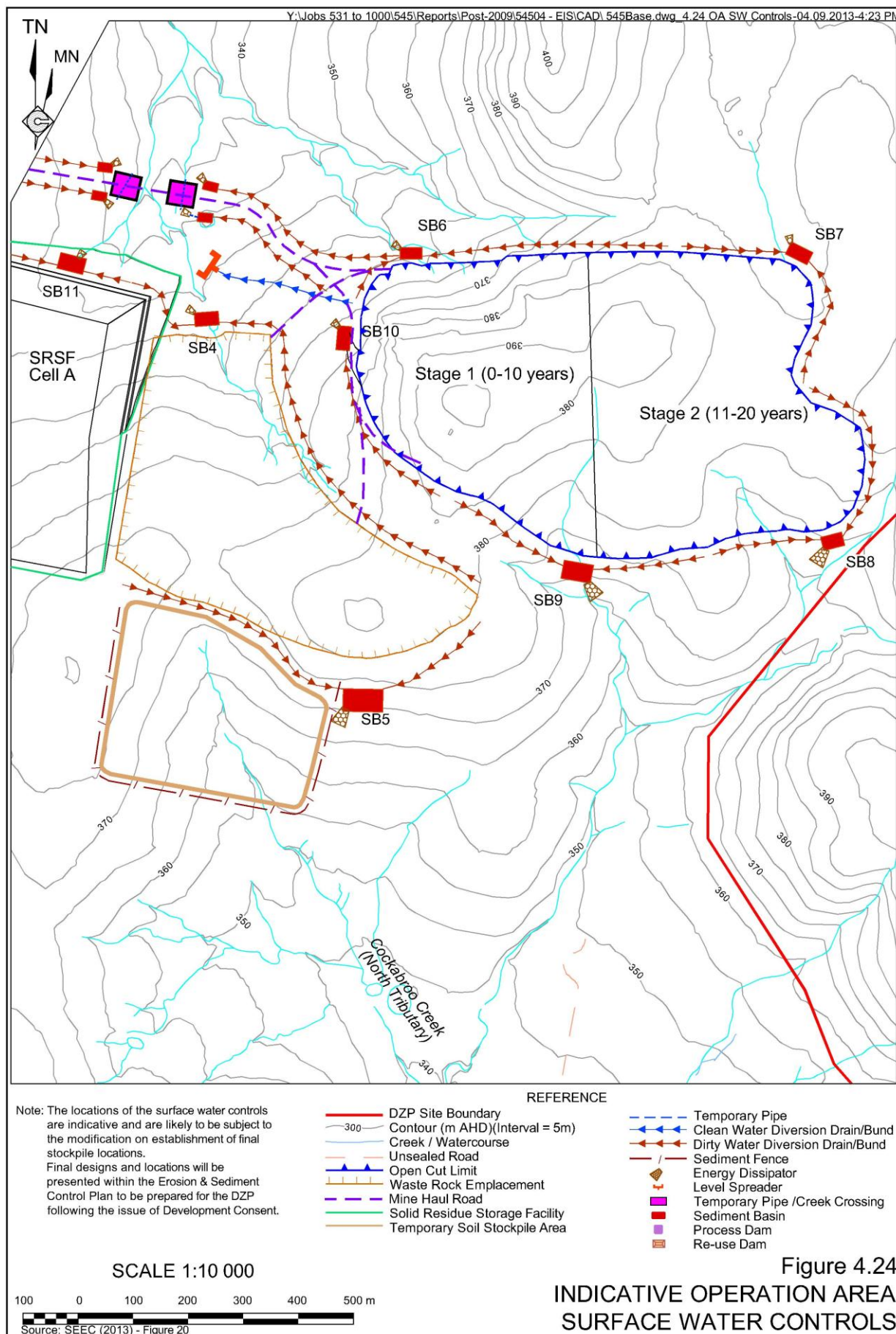
Erosion and sediment control for the DZP Site would be formalised in one or more *Erosion and Sediment Control Plans* (ESCP) for the DZP Site (and other component areas of disturbance) in accordance with the requirements of Landcom (2004), DECC (2008a) and DECC (2008d). The ESCP for specific components of the DZP would be prepared prior to the commencement of ground disturbing activities and would be updated progressively as the extent of earthworks increases or changes.

In summary, sediment loss would be controlled by a series of best management practices (BMPs) which would include:

- diverting surface water runoff away from active works areas;
- minimising areas of disturbed ground by:
 - only disturbing land when works are required;
 - delineating no-go areas; i.e. controlling access to only those areas that would be worked; and
 - effectively and promptly stabilising ground that has reached its final design form or land that would not be re-worked within 20 days;
- implementing ancillary or secondary measures such as:
 - reducing slope lengths on disturbed surfaces to control soil loss;
 - using sediment fence or similar sediment traps where necessary; and
 - using a series of “wet-type” sediment basins and actively managing them to the requirements of Landcom (2004) and DECC (2008d).
- Inspect all surface water control structures at least quarterly and following any rainfall event of more than 10mm in 24-hours to ensure their adequacy, and identify where remedial action is required.
- Ensure that all potentially salt or chemical-laden water is retained within the DZP Site and is used for processing operations or is pumped to the Liquid Residue Storage Facility.







- Ensure that all potentially sediment-laden water is directed to appropriately designed sediment basins and is either used for processing operations or dust suppression or, following testing to verify the quality of the water is acceptable, is discharged to natural drainage.
- Ensure that all surface water flows from undisturbed sections of the DZP Site are diverted around disturbed sections and permitted to flow to natural drainage.
- Ensure that all roads within the DZP Site are constructed in accordance with DECC (2008b).
- Ensure that the capacity of existing and proposed water storages to be constructed under the Applicant's harvestable rights does not exceed 182ML.
- Ensure that all areas where reagents or processing-related chemicals or by-products are sealed, bunded and, where appropriate, covered, with a suitable sump for the collection and removal of incident rainfall.
- Ensure that all areas of proposed disturbance, with the exception of the proposed open cut, are progressively rehabilitated and that surface water control structures are removed once the rehabilitated areas have achieved a 70% cover.

Specific areas of the DZP Site, namely the ROM Pad and WRE, would generate runoff potentially containing sediment with trace concentrations of uranium and thorium. Runoff from these areas of the DZP Site would be captured and discharged to the LRSF, i.e. not discharged to natural drainage. The Processing Plant and DZP Site Administration Area would be exposed to reagents which if spilled would be contaminating to the environment. Consequently, these areas have been designed for nil discharge.

The surface water management structures that would be constructed within the DZP Site would include the following.

- Clean water diversions to divert surface water run off from undisturbed sections of the DZP Site around areas of proposed disturbance.
- Dirty water diversions to divert sediment-laden water to sediment basins for settling prior to discharge to natural drainage or use for processing operations.
- Diversion of dirty water runoff from mineralised ore (ROM Pad) and waste rock (WRE) and collection within storage basins. As these basins fill, the water would be pumped to the LRSF to ensure no discharge from the DZP Site.
- Sealed and bunded areas for the retention of potentially contaminated runoff within the Processing Plant and DZP Site Administration Area. Runoff from areas not exposed to potentially contaminating reagents would be diverted to sediment basins for settling prior to discharge to natural drainage or use for processing operations.
- Twelve principal sediment and storage basins for the collection of sediment-laden or potentially contaminated water for transfer to the Water Re-use Dam, Process Water Pond or, following settling of suspended sediment, discharge to natural drainage via a stabilised spillway. A range of smaller sediment basins/stormwater retention structures would be constructed as required adjacent to the haul road and down-slope of the LRSF, SRSF and Salt Encapsulation Cells as constructed.

- A Water Re-use Dam for collection and storage of sediment-laden water for use for dust suppression, processing operations or discharge to natural drainage.
- A Process Water Pond for the storage of water from the water pipeline and other water sourced from onsite for use within the processing plant.

Table 4.45 presents the design volumes for each of the proposed sediment and storage basins. These volumes have been estimated based on the following.

- Design rainfall depth equal to the 90th percentile 5-day depth of 35.6mm (for sediment basins collecting runoff from all areas of disturbance not exposed to ore or waste rock: SB1 – SB3, SB6 – SB11).
- Design rainfall depth = Double the 1 in 100 ARI time of concentration (t_c) event (for sediment basins collecting runoff from ore stockpiles [ROM Pad] or waste rock [WRE]: SB4, SB5 & SB12).
- A rainfall erosivity factor (R-Factor) of 1 350.
- A soil erodibility factor (K-Factor) of 0.04.

Table 4.45
Proposed Sediment Basin Volumes

Sediment / Storage Basin	Catchment	Water Volume (m ³)	Sediment Volume (m ³)	Total Proposed Volume (m ³)
SB1	DZP Site Administration Area	1 900	100	2 000
SB2	Rail Container Laydown and Storage Area	4 850	150	5 000
SB3	Processing Plant Area	2 500	100	2 600
SB4	Waste Rock Emplacement	10 000	100	10 100
SB5	Waste Rock Emplacement	5 000	50	5 050
SB6	Open Cut	2 600	500	3 100
SB7	Open Cut	1 350	150	1 500
SB8	Open Cut	2 900	300	3 200
SB9	Open Cut	2 500	600	3 100
SB10	Open Cut	1 100	300	1 400
SB11	Solid Residue Storage Facility	5 100	500	5 600
SB12	ROM Pad	6 000	100	6 100

Source: SEEC (2013) – Table 4

A conceptual arrangement of the various diversion drains, dirty water collection drains and Sediment Basins on the DZP Site, for initial operations on the DZP Site¹, are shown in **Figures 4.22 to 4.24**. It is noted that the exact location and orientation of sediment basins would be defined in the ESCPs for the DZP following receipt of development consent and prior to commencement of construction.

¹ **Figures 4.22 to 4.24** consider disturbance associated with the DZP Processing and Site Administration Area, open cut, WRE, Cell A of the SRSF, Mine Haul Road and various soil stockpiles. Erosion and sediment control for the LRSF, additional cells of the SRSF, Salt Encapsulation Cells and other disturbance not illustrated would be included in a *Progressive Erosion and Sediment Control Plan* for the DZP Site.

Sediment Basins would also be required to accompany the construction of the various stages of the Liquid Residue Storage Facility, Cells B and C of the Solid Residue Storage Facility and Salt Encapsulation Cells. These basins would be designed in accordance with the above guidelines and would be described in progressive updates or new ESCPs before construction begins.

The following subsections consider the critical features of surface water management for the various components of the DZP Site.

4.5.4.2.3 DZP Site Administration Area

The DZP Site Administration Area would generate potentially sediment-laden water only. This area would be drained to SB1 (see **Figure 4.23**). Discharge of excess stormwater would be directed (ultimately) to Wambangalang Creek via engineered outlets.

4.5.4.2.4 Rail Container Laydown and Storage Area

The Rail Container Laydown and Storage Area would be concrete sealed and bunded and would include temporary storage areas for loaded and unloaded containers of reagents and other consumables. Each storage area would be individually bunded which would contain any spill should it occur. Surfaces between bunded areas and roofs would generate 'uncontaminated' stormwater runoff (sediment-laden only) and would drain to SB3 (see **Figure 4.23**). Should a spill of reagents occur outside the bunded bays, the outlet to SB3 would be closed and any accumulated water collected and transferred to the Liquid Residue Storage Facility. Discharge of excess stormwater would be directed (ultimately) to Wambangalang Creek via engineered outlets.

4.5.4.2.5 Processing Plant Area

This area would include a mixture of sealed and bunded areas, including the processing plant itself and all reagent and chemical storage areas (see **Figure 4.23**). In addition, a range of unsealed areas, including road ways and hardstand areas would be constructed.

Processing areas and storage areas for reagents would be bunded and sealed. All bunded areas would have a sump from which potentially-contaminated runoff would be drawn and either returned to the relevant component of the processing operation or neutralised (as required) and pumped to the LRSF for disposal distributed to either the Process Water Dam or the Liquid Residue Storage Facility. Bunded areas that are open to the weather would have sufficient volume to trap 110% of the volume of the largest storage tank plus a volume of $0.2 \times \text{area (m}^3\text{)}$ to allow for 200mm of incident rainfall. At no time would water sourced from these bunded areas be released to the environment. Spill containment kits would also be kept on site. Should a spill of reagents occur outside the bunded areas, the outlet to SB2 would be closed and any accumulated water collected and transferred to the Liquid Residue Storage Facility.

Surfaces between bunded areas and roofs would generate 'uncontaminated' stormwater runoff (sediment-laden only) and would drain to SB2, which would initially serve as the sediment basin during establishment of the Processing Plant Area. Discharge of excess stormwater would be directed (ultimately) to Wambangalang Creek via engineered outlets.

To the north of the Processing Plant Area is the Process Water Pond accepting and storing water sourced from the Macquarie River, groundwater sources and on-site surface water harvest (see Section 2.8.2). This pond would be constructed as a turkey's nest structure, i.e. isolated from surface flows, HDPE lined and would not accept any contaminated run-off from the Processing Plant Area, ROM Pad or WRE.

4.5.4.2.6 ROM Pad

SEEC (2013) identifies that the ore material is unlikely to leach metals or contaminants. However, detectable levels of some rare earth elements and radionuclides would be entrained in any sediment suspended within runoff. As a result, runoff from this area would be treated as contaminated and would be drained to a dedicated storage basin (SB12) designed to exceed the 100year t_c storm volume (3ML) by a factor of two (see **Figure 4.23**).

To prevent a large accumulation of such material, which could be subject to re-mobilisation, sediment would periodically (every three months) be removed and placed in the SRSF.

In addition a diesel pump(s) capable of 30kL/hour would be installed to pump water to one of the active LRSF cells. Trapped water in SB12 would be pumped as soon as practicable after in-flow commences and combined with the design storage capacity would ensure there could be no overflow in any 100 year storm event.

4.5.4.2.7 Haul Road

The haul road would be constructed to the standards identified in DECC (2008a) and would drain to a series of sediment basins (designed in accordance with DECC, 2008d). Markers would be placed in each basin to identify the minimum required water storage volume and the maximum permissible sediment storage volumes. When the maximum sediment storage is reached, the sediment would be removed and placed on the WRE. Within 5-days of the conclusion of a rainfall event resulting in accumulation of water over the minimum water storage marker, the water would be pumped or siphoned to the Re-use Dam, used directly for dust suppression or, following settling of the suspended sediment, discharged to natural drainage.

4.5.4.2.8 Open Cut

The open cut would initially be free draining and could produce potentially sediment-laden water. A range of dirty water diversion drains and temporary sediment basins would be constructed around the perimeter or within the footprint of the open cut (SB7 to SB11 illustrated on **Figure 4.24**) and water would be pumped to the Re-use Dam, Process Water Pond, used directly for dust suppression or, following settling of the suspended sediment, be discharged to natural drainage.

Following development of the open cut to the point where it is no longer free draining and becomes internally draining, the sediment basins would be decommissioned.

4.5.4.2.9 Waste Rock Emplacement

Runoff from the WRE would contain sediments with detectable concentration of metals, rare earths and radionuclides which would drain to two storage basins (SB4 and SB5) (see **Figure 4.24**). The storage capacity of the storage basins have been designed to exceed the 100year t_c storm volume (5ML and 2.5ML respectively) by a factor of two².

To prevent a large accumulation of such material, which could be subject to re-mobilisation, sediment would periodically (every three months) be removed and placed in the SRSF.

Pumps capable of transferring at least 100kL/hour (SB4) and 45kL/hour (SB5) would be installed to pump trapped water to one of the active LRSF cells. Trapped water in SB4 and SB5 would be pumped as soon as practicable after in-flow commences and combined with the design storage volume would ensure there could be no overflow in any 100 year storm event.

4.5.4.2.10 Solid Residue Storage Facility

During the construction of the SRSF, runoff would be diverted to one or more sediment basins constructed in accordance with Landcom (2004) and DECC (2008d). As the embankments for each cell of the SRSF are completed and revegetated, these sediment basins would be decommissioned.

As noted in Section 2.9.2.5, a clean water diversion drain would be constructed to the south of Cell C to divert runoff from the catchment of Watercourse C from accumulating against the southern embankment.

Once constructed, the SRSF would be double lined with HDPE or equivalent and would be internally draining (refer to Section 3.7 of **Appendix 6**). Incident rainfall on the SRSF would drain to a central collection point and then pumped to the LRSF for storage and evaporation.

It is unlikely that a phreatic surface would be developed within the SRSF even following heavy rainfall as the upper working surface of the residue would be compacted and have a very low permeability. In the unlikely event that a phreatic surface is developed within the SRSF, this would migrate under pressure to the slotted concrete tower section of the internal drainage system (refer to Section 3.7 of **Appendix 6**) before draining to a central collection point before being pumped to the LRSF.

4.5.4.2.11 Liquid Residue Storage Facility

During the construction of the LRSF, rainfall would be diverted around the exposed surfaces through the construction of diversion banks (in accordance with Landcom, 2004 and DECC, 2008d). Incident rainfall on the exposed surfaces during construction would be diverted to one or more sediment basins constructed in accordance with Landcom (2004) and DECC (2008d). As the embankments for each cell of the LRSF are completed and revegetated, these sediment basins would be decommissioned.

² And assuming 50% of the WRE is disturbed/impervious.

The LRSF would be constructed to accept, store and evaporate up to 2.5GL per year of saline water from the processing plant. Section 2.9.3 provides a detailed description of the design, construction and management of those facilities. In summary, each of the facilities would comprise a number of salt crystallisation cells which would be shaped to form a generally flat area. Each cell would be lined with a 1.5mm HDPE welded liner and would have an operating depth of 5m, with a minimum 1m freeboard.

During the operational life of each cell, water levels would be managed to ensure that the maximum rate of evaporation is achieved. The applicant anticipates that approximately 900t of salt per day would be transferred to the LRSF. As this material crystallises, cells would be progressively emptied and the accumulated salt removed, taking care not to damage the underlying liner.

The LRSF would be isolated from surface water flows and the only water that would accumulate in the cells would be incident rainfall and liquid residue pumped from the processing plant. Similarly, the facilities would not discharge to natural drainage. As a result, the only losses from the LRSF would be via evaporation.

SEEC (2013) undertook an assessment of the operational water balance for the LRSF using the software *Model for Urban Stormwater Improvement Conceptualisation* (MUSIC) developed by eWater. Three rainfall scenarios were assumed, based on daily rainfall records from the Bureau of Meteorology-operated Mentone weather station (Station Number 065030).

- Scenario 1 (1900 to 1921): representing a reasonable consistent rainfall pattern over the life of the Proposal. Mean annual rainfall over the modelled period was 579mm.
- Scenario 2 (1970 to 1991): representing a period starting off wet and then becoming dry. Mean annual rainfall over the modelled period was 579mm.
- Scenario 3 (1949 to 1970): representing a “worst case” model with mean annual rainfall over the modelled period of 731mm.

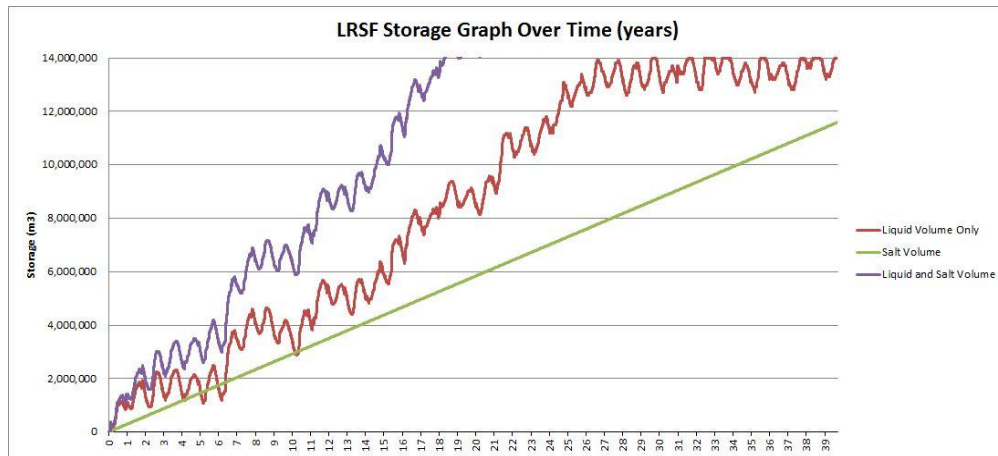
Monthly evaporation was based on an assumed evaporation rate equal to 72% of the measured pan evaporation rate at the Bureau of Meteorology-operated Wellington Agricultural Research Centre weather station (Station Number 065035).

Figure 4.25 and **Table 4.46** present the results of the modelling. In summary, taking into account the fact that salt would be harvested as it accumulates, the LRSF would have sufficient capacity to store and evaporate liquid residue for a period of 29 years (Scenarios 1 and 2) and 16 years (Scenario 3).

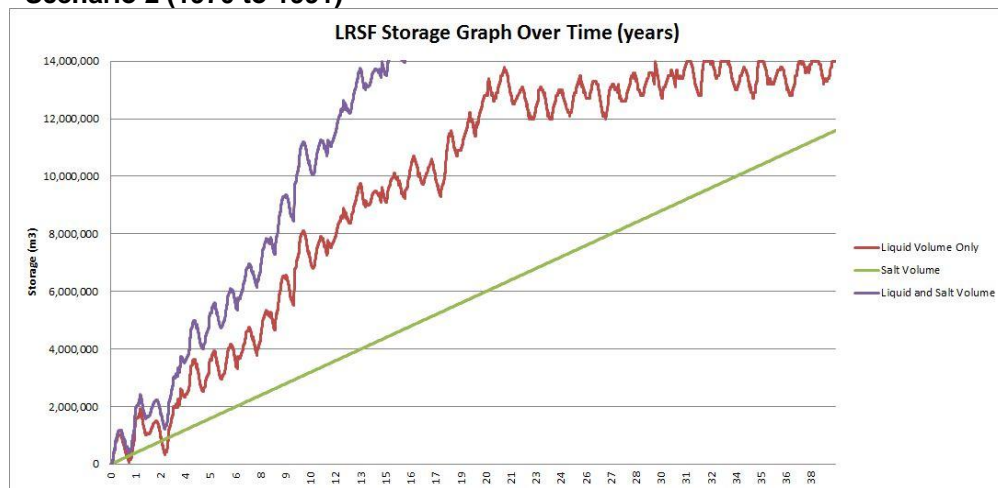
Table 4.46
Anticipated Time to Achieve Maximum Capacity

Model Number	Predicted Time to Maximum Capacity (Water Only)¹	Predicted Time to Maximum Capacity (Water and Salt)
1	29 years	18 years
2	29 years	15 years
3	16 years	13 years
Note 1: Assumes accumulated salt is removed periodically		
Source: SEEC (2013) – Table 6		

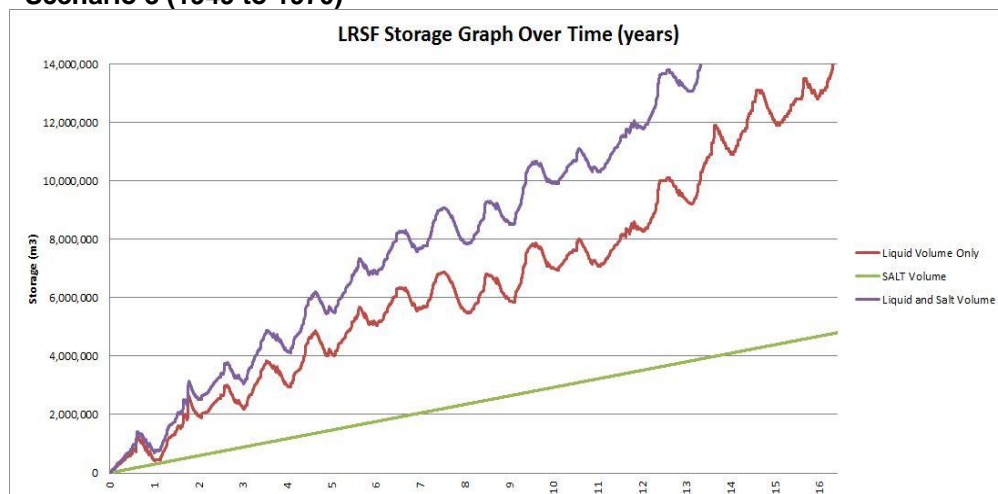
Scenario 1 (1900 to 1921)



Scenario 2 (1970 to 1991)



Scenario 3 (1949 to 1970)



Source: SEEC (2013) – Figures 23, 24 and 25

Figure 4.25
LIQUID RESIDUE STORAGE FACILITY PERFORMANCE

The Applicant would ensure that water and salt levels within the cells are monitored regularly and in the event that above average rainfall over an extended period results in accumulation of water within the LRSF at a rate that would result in the capacity being reached prior to the completion of the proposed processing operations, the Applicant would implement measures to either maximise the rate of evaporation through the use of sprinklers or foggers, maximise the storage volume through removal of accumulated salt or restriction of the rate of water transfer from the processing plant through a reduction in the rate of processing or similar means.

4.5.4.3 Harvestable Rights

Section 53 of the *Water Management Act 2000* permits landholders to harvest and use a portion of the total runoff from their land without requiring a licence, provided that:

- the total capacity of the harvestable rights water storages is less than the capacity permitted under the right; and
- that all storages are constructed either off-line or on first or second order, non-spring fed streams.

Water captured within harvestable rights dams may be used for any purpose, including mining-related purposes.

The Applicant would, following granting of development consent, own approximately 3 450ha within and surrounding the DZP Site. However, the Proposal would result in disturbance and isolation from the various surface water catchments of approximately 640ha. As a result, for the purposes of estimating the harvestable rights capacity, a landholding of 2 810ha has been assumed. Taking into account the relevant harvestable rights multiplier for the DZP Site of 0.065ML/ha, the harvestable right capacity for the land to be held by the Applicant would be approximately 182ML.

SEEC (2013) notes that there are approximately 64 existing farm dams on the DZP Site and surrounding properties which are or would be owned by the Applicant on issue of development consent with a total estimated volume of approximately 82ML. As a result, a further 100ML of storages could be built without exceeding the Applicant's harvestable right.

The Applicant proposes to use, where practicable, water collected within sediment basins for Proposal-related purposes, including dust suppression and processing operations. As a result, these basins are required to be included under the Applicant's harvestable right. SEEC (2013) estimates that SB1 to SB12 would have a combined capacity of approximately 34ML. As a result, the Re-use Dam would have a capacity of approximately 66ML.

Given that the capacity of the existing and proposed structures is within the harvestable right capacity, and that all proposed dams or sediment basins would be located off line or on first or second order streams, the Applicant contends that the proposed storages are compliant with the requirements of Section 53 of the *Water Management Act 2000*.

The Process Water Pond and other process-related water storages within the DZP Site would store potentially salt or chemical-laden water and would therefore not be included under the Applicant's harvestable right.

SEEC (2013) estimates that, assuming all water collected within sediment basins is transferred to the Re-use Dam, an average of 0.3ML per day or 109ML per year (approximately 0.4% of total annual demand), could be incorporated into the overall water supply strategy for dust suppression or processing operations.

4.5.4.4 Site Water Balance

Section 2.8 provides an overview of water requirements and sources for the Proposal. In summary, the Applicant anticipates that up to 4.05GL of make-up water per year for processing operations may be required. In addition, the Applicant estimates that an additional approximately 39.6ML of water would be required for dust suppression purposes.

The required water would be sourced from the following sources.

- Macquarie River (high security licences).
- Macquarie River (general security licences)
- Groundwater (Macquarie River alluvial aquifer).
- Groundwater (fractured rock aquifer).
- On-site surface water harvesting.

Figure 4.26 presents an overview of surface water flows within the DZP Site. In summary:

- all potentially contaminated water would either be re-used in the immediate process, or neutralised and then disposed of to the LRSF; or
- all potentially sediment-laden water would be directed to sediment basins where it would be either transferred to the Re-use Dam for use for dust suppression or processing operations, used directly for dust suppression or discharged following confirmation that the water quality is acceptable.

4.5.4.5 Decommissioning and Final Landform Water Management

As indicated in Section 2.17, progressive rehabilitation would occur throughout the life of the Proposal. However, as a result of the nature of the proposed mining operations, the majority of rehabilitation would be undertaken following the completion of mining and processing operations.

Section 2.17.4 provides an overview of the final landform. In summary, all infrastructure not required for future land use would be removed and the majority of the DZP Site would be returned to the original landform, with the exception of the open cut, SRSF and Salt Encapsulation Cells. The SRSF would initially be reshaped, covered and rehabilitated. The LRSF would be permitted to dry out and the accumulated salt, together with the liner, would be placed within the Salt Encapsulation Cells. The footprint of the LRSF would be progressively reshaped and rehabilitated as individual cells are decommissioned. Finally, the Salt Encapsulation Cells would be reshaped and rehabilitated. The Applicant anticipates that rehabilitation operations would require approximately 2 to 5 years to complete to a standard where the mining lease may be relinquished following the completion of mining and processing operations.



4.5.4.6 Additional Management Measures

The following presents an overview of the additional management and mitigation measures that the Applicant would implement to minimise the potential for adverse surface water-related risks associated with the Proposal.

- Inspect all surface water control structures at least quarterly and following any rainfall event of more than 10mm in 24-hours to ensure their adequacy, and identify where remedial action is required.
- Ensure that all potentially salt or chemical-laden water is retained within the DZP Site and is used for processing operations or is pumped to the LRSF.
- Ensure that all potentially sediment-laden water is directed to appropriately designed sediment basins and is either used for processing operations or dust suppression or, following testing to verify the quality of the water is acceptable, is discharged to natural drainage.
- Ensure that all surface water flows from undisturbed sections of the DZP Site are diverted around disturbed sections and permitted to flow to natural drainage.
- Ensure that all roads within the DZP Site are constructed in accordance with DECC (2008b).
- Ensure that the capacity of existing and proposed water storages to be constructed under the Applicant's harvestable rights does not exceed 182ML.
- Ensure that all areas where reagents or processing-related chemicals or by-products are sealed, banded and, where appropriate, covered, with a suitable sump for the collection and removal of incident rainfall.
- Ensure that all areas of proposed disturbance, with the exception of the proposed open cut, are progressively rehabilitated and that surface water control structures are removed once the rehabilitated areas have achieved a 70% cover.

4.5.5 Assessment of Impacts

4.5.5.1 Introduction

The proposed management and mitigation measures were taken into account by SEEC (2013) when assessing residual surface water impacts within and surrounding the DZP Site. An assessment of the residual impacts is outlined in the following subsections.

4.5.5.2 Surface Water Flow Volumes

During the Life of the Proposal

SEEC (2013) estimates that the runoff coefficient for the DZP Site is approximately 11%. Assuming an annual average rainfall of 643.7mm (Section 4.1.3.3) and an area for the DZP Site of approximately 2 864ha, SEEC (2013) estimates that the average annual runoff from the area is approximately 2 027ML.

The Applicant anticipates that approximately 640ha would be removed from natural catchments throughout the life of the Proposal. This would represent those areas where surface water may be potentially contaminated and where that water would not be permitted to flow to natural drainage. Based on this reduction in catchment area, SEEC (2013) states that 453ML per year of surface water flows would be lost to surrounding catchments. Overall, this represents a loss of approximately 22% compared to existing DZP Site flows.

Based on the areas of each catchment within the DZP Site and the assumptions identified previously, **Table 4.47** presents the anticipated losses on a catchment-by-catchment basis throughout the life of the Proposal.

Table 4.47
Reduction in Annual Surface Water Flows – During the Life of the Proposal

Catchment	Area	Estimated Existing Flow	Estimated Temporary Reduction in Flow	Loss
Wambangalang and Paddys Creek Catchments	36 8800ha ¹	26 100ML/year	338ML/year	1.3%
Cockabroo Creek catchment	590ha ²	420ML/year	20ML/year	5%
Macquarie River (undefined) Catchment	660ha ²	467ML/year	95ML/year	20%
Note 1: Area upstream of DZP Site entrance		Note 2: Area within DZP Site		
Source: SEEC (2013) – After Section 4.1.1				

The Applicant contends that the proposed reduction in surface water flows during the life of the Proposal would not be significant on the basis of the following.

- The small reductions in the Wambangalang Creek and Cockabroo Catchments would be difficult to detect and probably masked by any base flow.
- There are no existing water licences downstream of the DZP Site and so there would be no predicted impacts to licensed users.
- While there may be recreational users of Wambangalang Creek, it is unlikely they would be accessing the creek when rainfall is sufficiently high to cause runoff and therefore, it is unlikely they would be affected.

Following the Completion of the Proposal

Following completion of the proposed activities, the DZP Site would be reshaped, covered with soil and revegetated. Following completion of rehabilitation operations, the majority of surface water retention structures would be removed, with the exception of the open cut void which would remain and would continue to collect incident rainfall. Surface water flows would continue to be diverted away from the void. The area of the proposed open cut would be approximately 36ha. SEEC (2013) notes that this would result in a minimal impact on surface water flows within surrounding watercourses.

4.5.5.3 Surface Water Flow Rate

SEEC (2013) notes that while the Proposal would not result in significant reduction in surface water flows, the increase in the area of impervious surfaces has the potential to increase the rate at which stormwater would flow to natural drainage. SEEC (2013) notes that this risk would be managed through the construction of sediment and stormwater detention basins (see Section 4.5.4) and that, as a result, the Proposal would not result in significant increases in the rate of stormwater runoff.

4.5.5.4 Water Quality

A range of potential surface water contaminants would be used, stored or generated within the DZP Site.

Section 2.7 and **Figure 2.10** provide details on the management of reagents within the Processing Plant and DZP Site Administration Area, which effectively involve the containerised delivery to the DZP Site and storage and use on bunded concrete pads. Any water collected within the bunded areas would be collected and re-used in the process where possible, or neutralised and disposed of in the LRSF. Furthermore, should spillage occur within areas draining to the sediment basins of the Processing Area and Rail Laydown and Container Storage Area, the outlets to the sediment basins would be closed to prevent discharge. On this basis, storage and use of potential contaminants to water within the Processing Plant and DZP Site Administration Area is considered unlikely to result in any adverse impact to water quality within the Wambangalang Creek catchment.

SB4, SB5 and SB12 would collect and store potentially contaminated water as a result of runoff from mineralised ore and waste rock stockpiles. This would. To facilitate this, a sediment forebay would be designed into the dam's structure.

Assuming correct construction practices are adopted (including designing the spillway to handle the probable maximum flow) the risk of dam failure is considered very low. However, under exceptionally high rainfall (greater than any 100 year storm event) the dam could conceivably overtop.

In the unlikely event SB12 overtops, the flow to Wambangalang Creek would be diluted there by flows exceeding $479\text{m}^3/\text{sec}$ (the 100 year peak storm flow). By comparison, the peak flow in any 100 year storm from SB12 would be approximately $1.64\text{m}^3/\text{s}$ (0.3%).

Similarly, should SB4 or SB5 overtop, the flows to Wambangalang Creek and Cockabroo Creek would be diluted by the storm flows within these catchments. In the case of SB4, the flow from this basin under 1 in 100 ARI conditions ($3.6\text{m}^3/\text{s}$) represents only 0.75% of the equivalent condition flow within Wambangalang Creek.

Further reducing the impact of any overflow from SB4, SB5 and SB12, flows within the local catchments would continue to flow at a high volume after the pulse of water from the basins have completed (having a further dilution effect). Under such circumstances the dilution effect would ensure there would be no identifiable increase in isotope concentrations in the stream's sediment (which would have been significantly altered by the high flows anyway).

In light of those measures, SEEC (2013) states that the Proposal would not result in significant adverse surface water quality impacts.

4.5.5.5 Sediment and Erosion Control

Section 4.5.4.2 presents an overview of the sediment and erosion control measures that would be implemented. In light of the proposed controls, and the fact that they would be consistent with Landcom (2004) and DECC (2008a and 2008b), SEEC (2013) states that sediment and erosion-related impacts associated with the Proposal would not be significant.

4.5.5.6 Downstream Water Users

As identified in the preceding subsections, the Proposal is not expected to result in significant adverse impacts associated with altered surface water flow volumes or rates or surface water quality associated with contamination by chemicals or sediment. As a result, the Applicant contends that the Proposal would similarly not result in adverse impacts to downstream water users.

The Applicant also notes that of the five surface water licences within the *Wambangalang Hyandra Creek Water Source* of the *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources*, none are located on Paddys or Wambangalang Creeks and therefore would not be impacted by the minor reduction in total runoff predicted for these catchments.

Furthermore, the Applicant notes that the area of the DZP Site is insignificant compared with the catchment of the Macquarie River upstream of Dubbo. As a result, the Applicant contends that the Proposal would not have an adverse impact on water users within the Macquarie River Catchment, including the residents of Dubbo.

4.5.5.7 Flooding

Figure 4.21 presents the existing 1 in 100 year ARI flood extents. That modelling indicates that a section of the Processing Plant Area would be subject to inundation from Watercourse C in the event of an extreme rainfall event. As a result, those sections of the footprint of the Processing Plant Area closest to Watercourse C would be raised above the 1 in 100 year ARI flood level.

SEEC (2013) undertook an assessment of the impact of the proposed works. In summary, the footprint of the Processing Plant Area was assumed to be raised to approximately 295.9m AHD, an increase of between 1.0m and 1.5m. The construction of embankments within the flood zone of Watercourse C, to remain at least 20m from the top of the bank of Watercourse C, would result in a slight increase in flow. SEEC (2013) calculate that flows are predicted to increase by about 0.4 to 0.5 m/sec but would remain under 1.6m/s, which is below the accepted velocity for stability in naturally vegetated channels (Landcom, 2004). Flooding within Watercourse C would encroach slightly on the bottom embankment of LRSF – Area 3 (refer to *Figure 23* of SEEC, 2013). As recommended by SEEC (2013), this section of the embankment would be protected from erosion by placement of rock-pitching (150-300mm) over a geotextile fabric.

4.5.5.8 Waste Water Management

Waste water within the DZP Site would be treated using an aerated waste water treatment system. This water would be disposed of in accordance with Australian Standard *AS/NZS 1547:2012 - On-site domestic waste water management* or the requirements of Dubbo City Council. Indicatively, this water would be used to irrigate an area of vegetation a minimum of 100m from Paddys or Wambangalang Creek and 40m away from any other watercourse. Finally, the Applicant anticipates that a Section 68 application under the *Local Government Act 1993* and regular inspections by a qualified waste water contractor would be required.

In light of the above, the Applicant anticipates that there would be no adverse waste water-related impacts associated with the Proposal.

4.5.6 Monitoring and Contingency Management

4.5.6.1 Surface Water Quality Monitoring

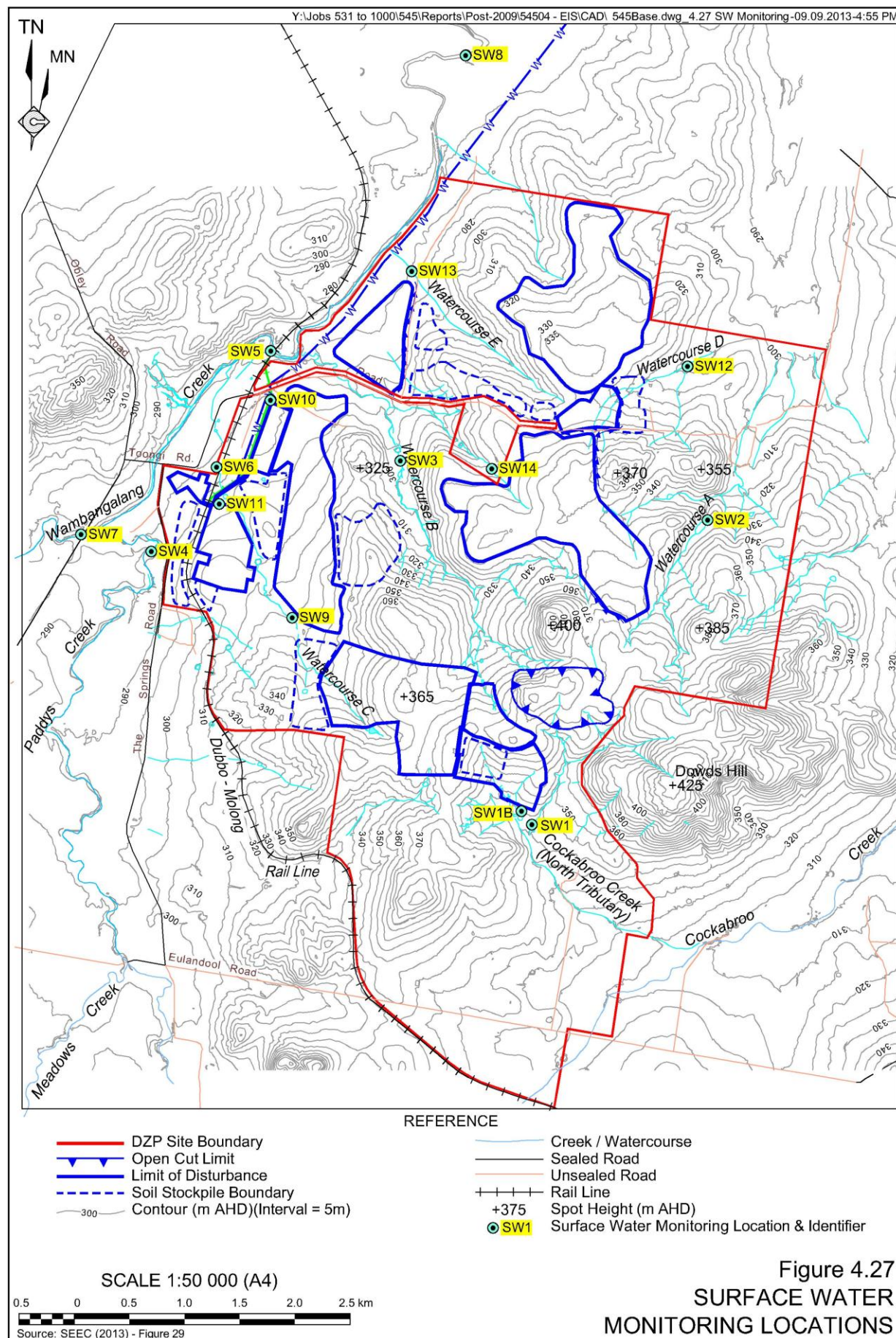
The Applicant would prepare a detailed *Water Management Plan* incorporating the proposed surface water quality monitoring program. In summary, that program would include monitoring at the following locations for the following purposes (**Figure 4.27**).

- SW1 to SW8 – monitoring of water quality in surrounding creeks and watercourses.
- SW9 – monitoring of water quality within the Re-use Dam.
- SW10 – monitoring of water quality within SB3 to determine if there are any contamination issues associated with the Processing Plant Area.
- SW11 – monitoring of water quality within SB2 to determine if there are any contamination issues associated with the Rail Container Laydown and Storage Area.
- SW12 to SW14 - monitoring of water quality down slope of the LRSF to determine if there are any leakage issues associated with those facilities.

Table 4.48 presents the frequency of monitoring for each of the above monitoring locations.

Table 4.48
Surface Water Quality Monitoring Frequency

Monitoring Location	Description	Monitoring Frequency
SW1 to SW8	Surrounding ephemeral creeks	Monthly or after rain, potentially with a rising flow sampler ¹
SW9	Re-use Dam	Monthly following input from other basins
SW10 and SW11	Processing Plant Area	Following rainfall (>10mm in 24 hours)
SW14 to SW16	Downslope of the Liquid Residue Storage Facilities	Monthly or when flow observed
Note 1: A rising flow sampler is a piece of equipment installed in a creek that collects an water sample automatically as the creek begins to flow.		
Source: SEEC (2013) – After Table 9		



4.5.6.2 Contingency Management

Table 4.49 presents the trigger values that would be implemented throughout the life of the Proposal.

Table 4.49
Surface Water Trigger Values

Physical and Chemical Stressors	Trigger Value
SW1 to SW8 – Surrounding Watercourses	
pH	<6.5 or >8.0
Electrical conductivity	>3 000µS/cm
Total Phosphorus	>20µg/L
Total Nitrogen	>250µg/L
Dissolved Oxygen	<90% or >110%
Turbidity	2-25 NTU
Aluminium	55µg/L
Arsenic (as Arsenic III)	24µg/L
Zinc	8µg/L
Copper	1.4µg/L
Lead	3.4µg/L
Silver	0.05µg/L
Nickel	11µg/L
Boron	370µg/L
Manganese	1 900µg/L
Cadmium	0.2µg/L
Radioactivity Gross Alpha	Any detectable
Radioactivity Gross Beta	Any detectable
SW9, SW12 and SW13 – Re-use Dam and Waste Rock Emplacement	
pH	>6.5 and <8.0
Salinity (EC)	<3 000µS/cm
TSS	<50mg/L ¹
Visible Oils	Any detectable ¹
SW10 and SW11 – Processing Plant and Rail Container Laydown and Storage Areas	
Applicable Solvents	Any detectable
Salinity (EC)	Total <3 000µS/cm
Salinity species ²	-
pH	>6.5 and <8.0
SW14 to SW16 – Downslope of the LRSF	
Salinity (EC)	Total <3 000µS/cm
Salinity species ²	-
Note 1: Applicable prior to discharge	
Note 2: Salinity species = sodium, calcium, magnesium, chloride, sulfate and carbonate	
Source: SEEC (2013) – After Tables 9 to 12	

In the event that any of the identified trigger values are exceeded, the Applicant would implement a detailed response plan that would be incorporated within the *Water Management Plan*. In summary, however, potential responses may include:

- implementation of further testing;
- retention of water in sediment basins on site; and
- further investigations to determine the nature and cause of the exceedance and, if Proposal-related, remedial actions to rectify the issue and prevent recurrence.

4.6 GROUNDWATER

4.6.1 Introduction

The Director-General's Requirements identified **Water Resources** as a key issue for assessment – including:

- *a detailed assessment of potential impacts on the quality and quantity of existing surface and groundwater resources, including:*
 - *impacts on affected licensed water users and basic landholder rights; ...*
- *identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;*
- *a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Office of Water (NOW) which requested that the EIS include, amongst other requirements: *Details of the predicted highest groundwater table at the development site; Details of any works likely to intercept, connect with or result in pollutants infiltrating into the groundwater sources; A description of the flow directions and rates and the physical and chemical characteristics of the groundwater source; Details of how the proposed development will not potentially diminish the current quality of groundwater, both in the short and long term; and An assessment of the potential for saline intrusion of the groundwater and measures to prevent such intrusion into the groundwater aquifer.*

The EPA, DTIRIS-DRE and Central West CMA also provided detailed requirements for the assessment of surface water affected by the Proposal.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to groundwater and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Reduction in groundwater quality (medium to high).
- Reduction in the beneficial uses of the water and therefore availability to existing groundwater users (medium to high).
- Contamination of Dubbo City water supply (medium).

- Health-related impacts (people) due to consumption of contaminated water (medium).
- Health-related impacts (stock) due to consumption of contaminated water (medium to high).
- Degradation of groundwater dependent ecosystems (low).
- Reduction in the volume of water contained within the affected groundwater aquifer (low).
- Reduced yields of local groundwater bores (medium).
- Reduced surface flows to Wambangalang and other creek catchments of the Macquarie River (low).
- Degradation of riparian or aquatic vegetation / ecosystems (low).

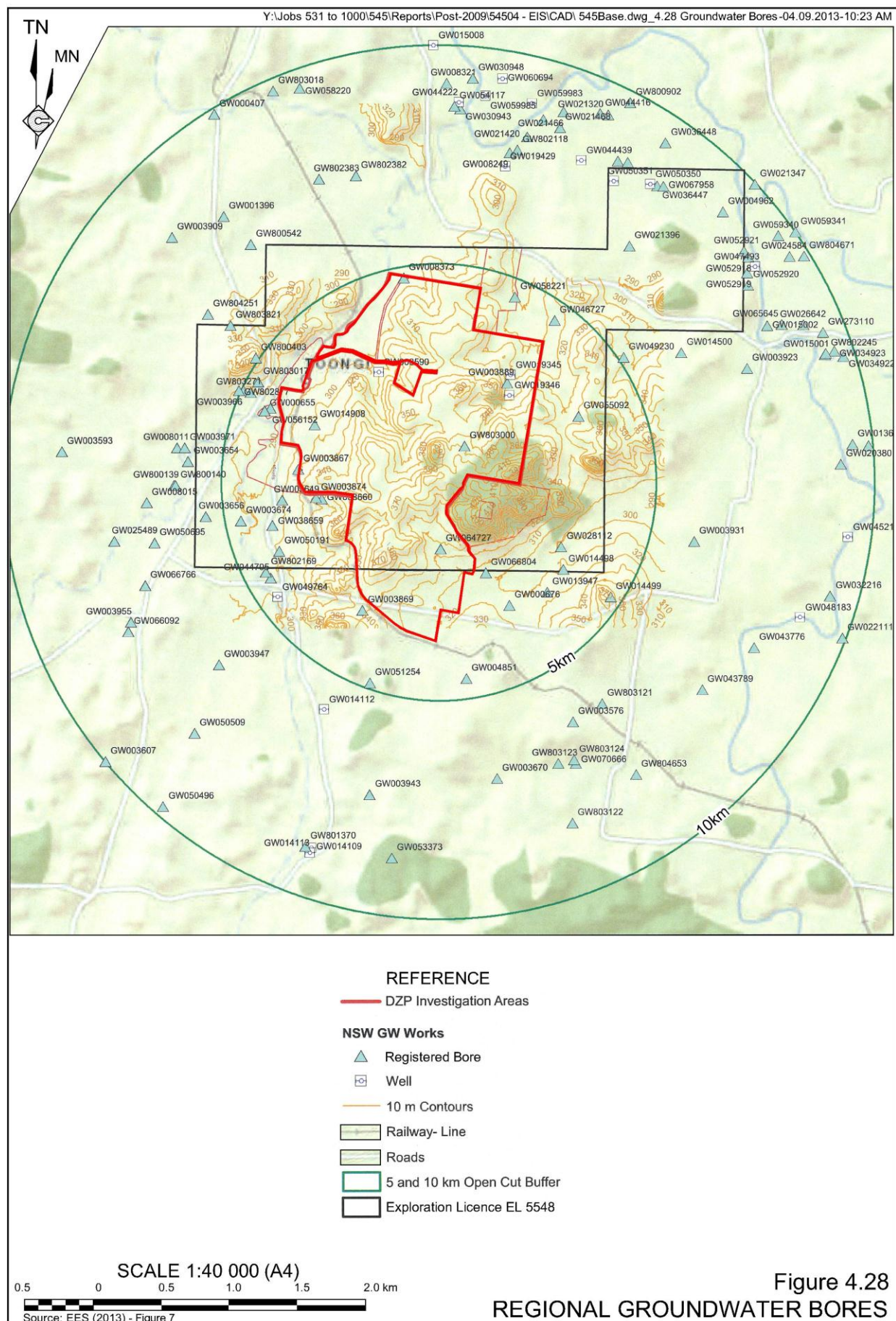
The groundwater assessment for the Proposal was undertaken by Messrs Mark Stuckey, Alan Wade and Stuart Brisbane of Environmental Earth Sciences Pty Ltd (EES). The resulting report is presented as Part 5 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “EES (2013)”. This subsection of the EIS provides a summary of the groundwater assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**. It is noted that surface water-related matters are addressed in Section 4.5 and aquatic ecology in Section 4.8.

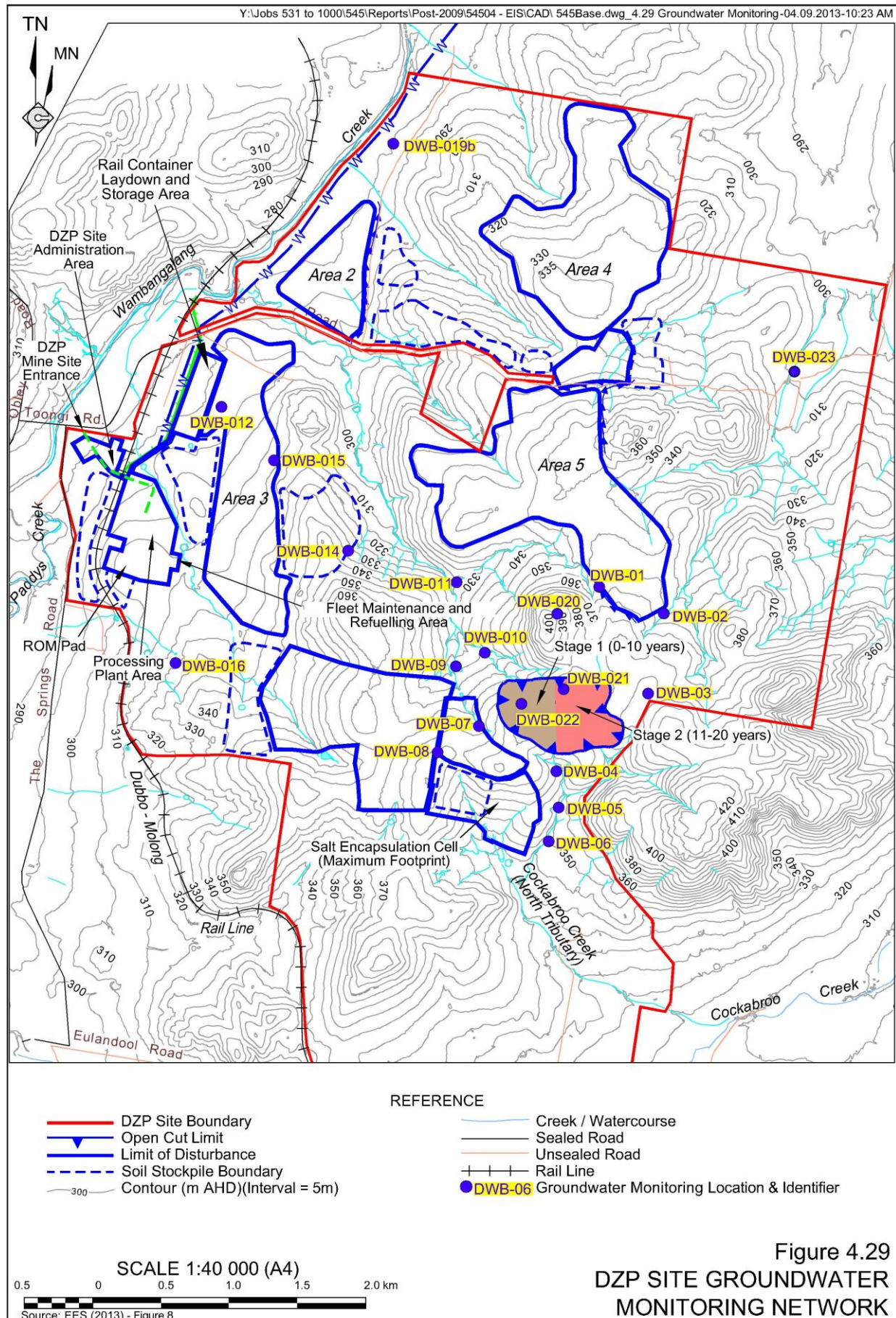
4.6.2 Existing Environment

4.6.2.1 Local Hydrogeological Setting

Considerable data has been assembled on the occurrence of groundwater below the DZP Site and immediate surrounds through a detailed groundwater investigations undertaken by Golder Associates Pty Ltd in 2001 and 2002 (Golder, 2002), and an investigation undertaken by Ann Smithson, of the Department of Land and Water Conservation in 2001 entitled *Hydrogeological Investigation of Dryland Salinity in the Toongi Catchment, Central West Region, NSW* (Smithson, 2001). These investigations have been supplemented by groundwater monitoring and testing completed by EES in 2012 and 2013 on bores on, and immediately surrounding the DZP Site (refer to EES, 2013 – Section 4.2), and a review of registered groundwater bore network database maintained by NOW.

Figure 4.28 displays the locations of the groundwater bores within both a 10km radius and a 5km radius of the open cut. As part of the Golder (2002) investigations, 23 groundwater monitoring bores were installed on and surrounding the DZP Site (DWB001 to DWB023). Of these, 21 have been monitored and/or tested in 2001/2002 and/or 2012/2013. In addition, monitoring and/or testing has been undertaken in two of the registered groundwater bores (GW008373 and GW058221) and three unregistered wells (two on the “Cockleshell Corner” property and one within Toongi). The network of groundwater monitoring bores within and surrounding the DZP Site is presented on **Figure 4.29**.





Section 4 and Appendix G of EES (2013) describe the bore installation, monitoring, sampling and testing undertaken on the 26 bore monitoring network presented in **Figure 4.29**.

4.6.2.2 DZP Conceptual Site Model

Based on the information obtained from this monitoring described above, evaluation of the information provided by Smithson (2001) and Golder (2002), the registered groundwater bore database, anecdotal evidence provided by local landholders, interpretation of geological maps supplied by the Applicant and review of other relevant specialist assessments (SSM, 2013, SEEC, 2013) a Conceptual Site Model (CSM) was generated by EES (2013) for the catchments of the DZP Site. A CSM is a two- to three-dimensional interpretation of the soil, geology and hydrogeology relationships within a catchment which identifies groundwater flow paths and environmental receptors. Through description of the hydrogeological environment by way of a CSM, areas of the DZP Site at greatest risk of impact or constraint are identified allowing for the design and implementation of appropriate management measures.

Section 5 of EES (2013) provides a detailed description of the CSM development. Critical features of the CSM as relevant to the assessment of the Proposal are provided as follows.

Groundwater Aquifers

Two connected groundwater systems occur in the Toongi catchment, namely, a consolidated fractured rock system and an unconsolidated sedimentary system consisting mostly of alluvium (with minor colluviums and aeolian deposits). The alluvium overlies the fractured rock system, mostly filling past valleys and watercourses beneath current day ephemeral creek lines (Smithson, 2001).

- **Fractured Rock System**

EES (2013) reports the fractured rock groundwater system as unconfined near the top of the aquifer (water-table surface) but confined at depth, resulting in variations in flow paths (local, intermediate or regional flow systems). These systems have been interpreted to be relatively saline due to longer time periods for geochemical interaction with the aquifer matrix (Smithson, 2001). Groundwater flow is controlled by fractures with preferential flow through formations with a relatively high density of open interconnected fractures. Recharge mechanisms to the fractured rock system have been identified where trachyte intrusions outcrop at the top of the catchment. Some local recharge is expected (and observed) along the alluvial valleys, either as direct rainfall recharge or recharge from the creeks during periods of flow.

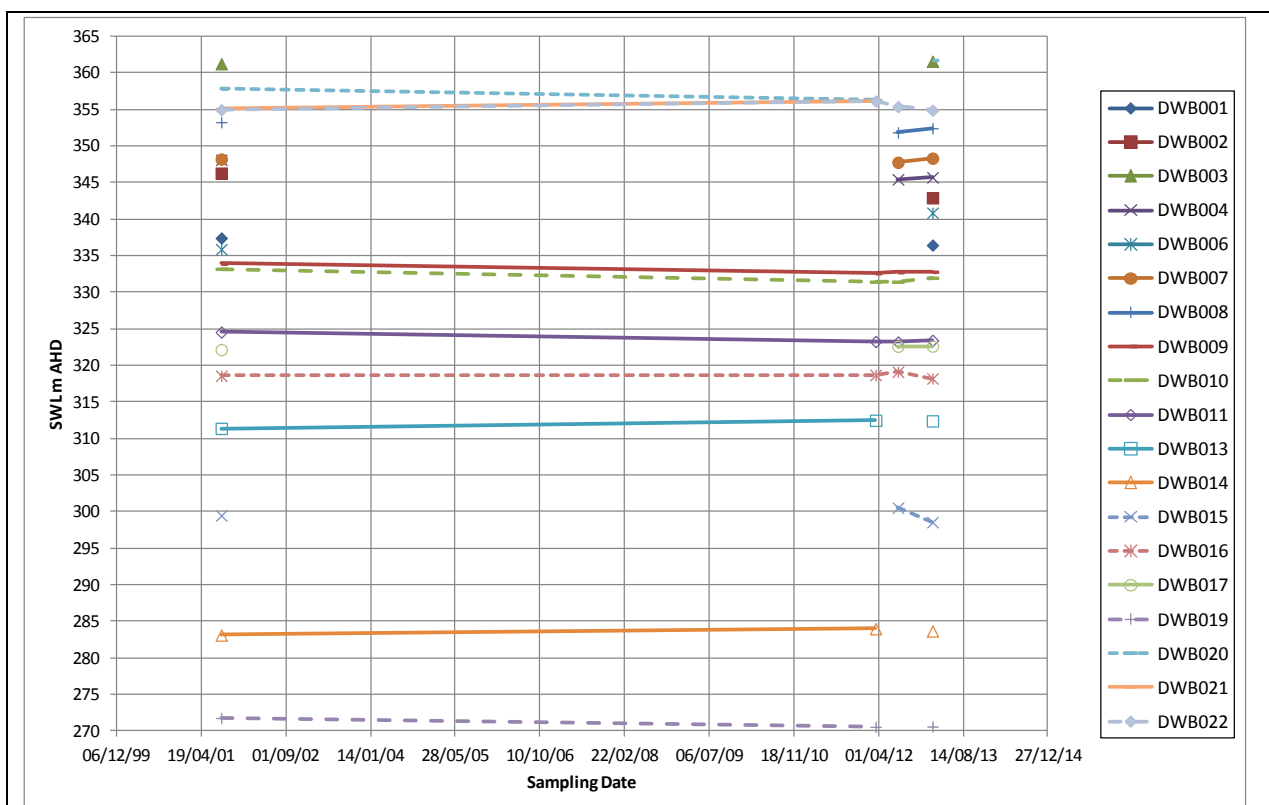
- **Alluvium System**

The alluvium system is associated with the filling of valleys and watercourses and displays thicknesses ranging from 3.5m below ground level to 43.5m below ground level with depth below surface typically between 16m to 20m. The alluvium system, being unconsolidated and relatively shallow and fresh, generally corresponds rapidly to recharge via rainfall. As such, groundwater flows from the topographic high points of the Jurassic trachyte intrusions of the DZP Site and Dowds Hill to the southeast towards the local creek systems of Wambangalang and Paddys to the west, Cockabroo to the south and the Macquarie River tributaries to the north.

Groundwater Levels and Gradient

A review of the groundwater monitoring programs described in Golder (2002) and EES (2013) illustrates some minor variation in standing water level (SWL) likely to correspond with rainfall (recharge conditions) (see **Figure 4.30**). Notably, monitoring in 2001 followed a period of average rainfall whereas monitoring in 2012/2013 followed a period of above average rainfall following an extended drought period (2001 – 2009). On the basis of the preceding rainfall conditions, it is considered that the groundwater levels recorded reflect SWLs at their more elevated levels.

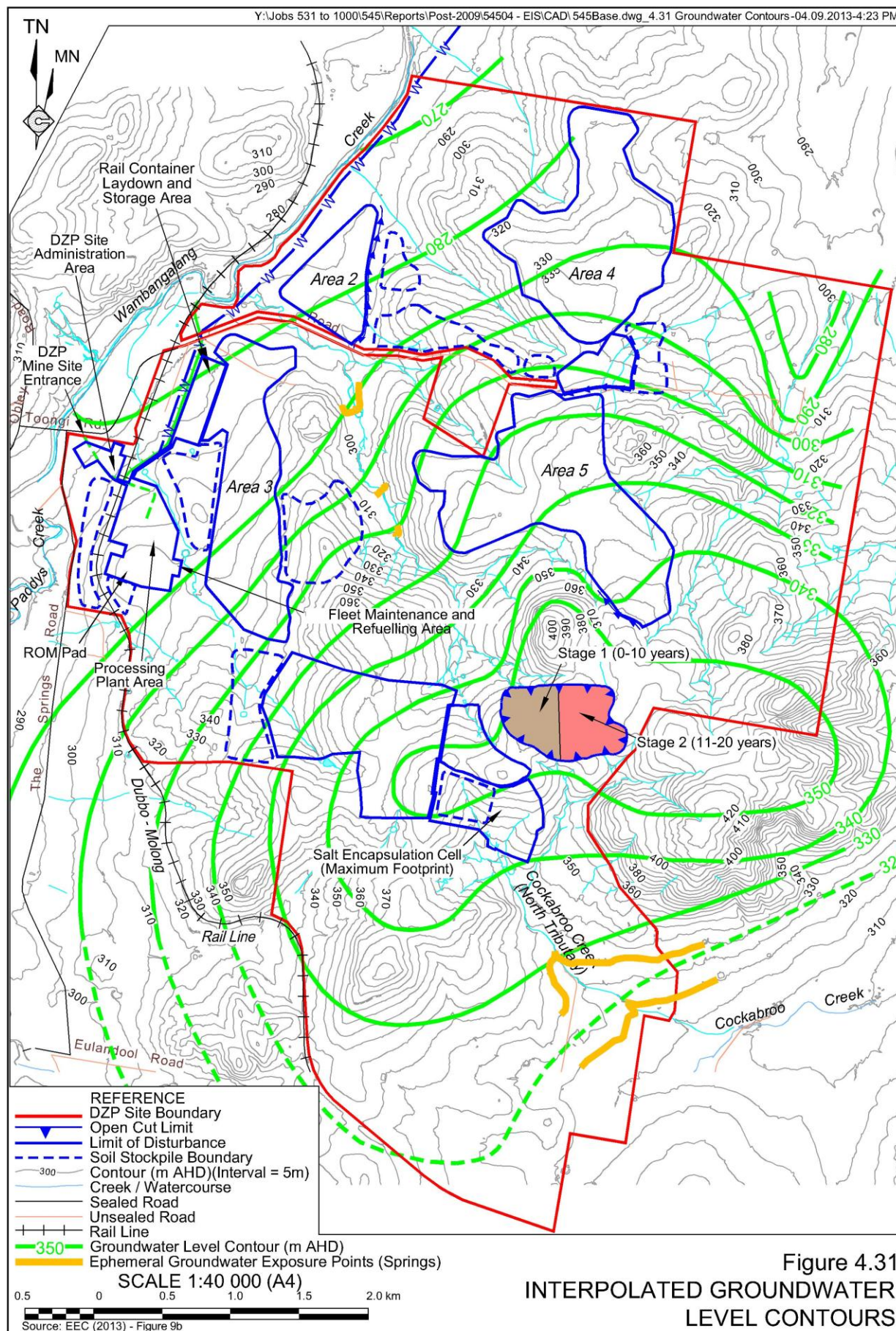
Figure 4.31 displays the indicative existing groundwater level contours (for 2013) based on interpolation of the SWLs and consideration of such factors as topography and geology.



Source: EES (2013) – Chart 1

Figure 4.30
MEASURED MONITORING BORE STANDING WATER LEVELS

From the review of the groundwater levels and monitoring bore locations, it has been determined that the groundwater contours and hence gradients are effectively a reflection of the overlying topography. Depths to groundwater are greatest in areas of groundwater recharge (trachyte intrusives, e.g. in the vicinity of the proposed open cut) and shallowest in areas of groundwater discharge. Groundwater flows radially from the high ground area of the proposed open cut to the surrounding valleys. EES (2013) interpret the groundwater flow system as continuing into the alluvium in the valleys around the edges of the bedrock, and within the colluvium and alluvium infilling gullies in the higher ground areas.



Groundwater – Surface Water Interaction

While no detailed mapping of springs has been undertaken, and EES (2013) observed no large-scale groundwater discharge features, a review of the interpreted groundwater contours indicates that the water table would, when elevated, be exposed in gullies, generally at the slope-break point (see **Figure 4.31**). The occurrence of these springs on the North Tributary of Cockabroo Creek and Watercourse B are a feature of these properties and have been observed flowing in the locations indicated on **Figure 4.31**.

However, while groundwater discharge occurs ephemeraly, the seepage rate is considered to be relatively low as the water passes through the colluvium in the base of the gullies and does not result in continuous surface expression.

The major creeks limit the extent of the groundwater flow from the DZP Site. The groundwater flow system radiating from the DZP Site is bounded to the west at Wambangalang Creek/Paddys Creek. Its extent is also limited to the south and north respectively by Cockabroo Creek and unnamed tributaries of the Macquarie River that drains the northeastern portion of the DZP Site. Conceptual cross sections representing hydrogeological processes across the site have been provided in *Figures 10a* and *10b* of EES (2013).

Groundwater Quality

Groundwater has been collected and analysed for the following analytes.

- pH, electrical conductivity (EC), dissolved oxygen (DO) and Total Dissolved Solids (TDS).
- Major Ions (Na, Ca, Mg, K, NH₄, Cl, SO₄ and F).
- Nutrients (HCO₃, NO₃, PO₄).
- Trace Elements (Sb, As, Ba, B, Cu, Cd, Cr, Fe, Mn, Mo, Ni, Pb, U, Zn).

The results of the analysis resulted in the groundwater being described as of generally good quality water with neutral pH ranges, low concentrations of most dissolved metals and being defined overall as fresh to slightly brackish but identified as not suitable for human consumption (drinking water).

It should be noted that minor changes of groundwater quality do occur (particularly TDS) across the DZP Site. Generally the salinity (EC) of the groundwater increases within the fractured rock aquifer the further from the recharge zone. A reduction in salinity is then observed within the alluvium aquifer, presumably in response to direct recharge of fresh water into this aquifer. This concept is further supported by ionic ratios and Na-Cl ratios with additional, in-depth analysis provided in EES (2103).

Groundwater Availability and Use

Eleven registered bores exist within the DZP Site (see **Figure 4.28** and **Table 4.50**) with groundwater yields generally low (<1L/sec). The identified water-bearing zones were found to be within unconsolidated alluvium and colluvial sediments in the lower to mid catchments and likely fracturing of basement rocks in the upper catchment areas. There are also several unregistered bores within the village of Toongi that intercept shallow groundwater within the alluvium system and are used for a mixture of stock and domestic purposes but there are no known large scale groundwater users within a 10km radius of the DZP Site.

As the groundwater quality is not suitable for human consumption, groundwater within the DZP Site is used primarily to support stock watering.

Additional, minor groundwater users include:

- the freshwater ecosystems within the local ephemeral creeks;
- recreational and aesthetic uses; and
- possible irrigation on alluvium adjacent to creek systems.

Table 4.50
Registered Groundwater Bores within the DZP Site

Bore ID	Use	Depth (m)	Water Bearing Zone(s) (m)			Yield (L/sec)	Geology
			From depth	To depth	Thickness		
GW000655	NK	45.10	32.30	35.30	3.00	0.30	Unconsolidated
GW003590	NK	37.50	34.40	34.40	0.00	0.46	Not Recorded
GW003867	Domestic stock	50.30	28.30	28.30	0.00	0.76	Not Recorded
GW003889	Stock	79.20	1.80	10.00	8.20	0.08	Not Recorded
			51.50	51.50	0.00	-	-
GW014908	Stock	28.00	19.50	20.10	0.60	0.06	Not Recorded
			22.60	23.80	1.20	0.30	Not Recorded
			24.10	26.20	2.10	0.61	Consolidated
GW019345	NK	7.80	-	-	-	-	-
GW019346	NK	27.70	-	-	-	-	-
GW056152	Domestic stock	27.40	-	-	-	-	-
GW064727	Domestic stock	51.00	30.00	34.00	4.00	0.32	Consolidated
			50.00	51.00	1.00	4.73	Consolidated
GW803000	Domestic stock	72.00	30	36	6.00	6.00	-
Note 1: Source: Groundwater Works Summary from Department of Natural Resources, NSW (March, 2012)							
Note 2: SWL – Static Water Level; NK – Not Known							
Source: EES (2013) – Table 5							

It should be noted, however, that groundwater within the vicinity of the DZP Site is noted as of marginal quality for irrigational use and as such, no current irrigation activities are undertaken.

In summary, groundwater within the DZP Site is unsuitable for human consumption but is used on a small scale for irrigation and domestic purposes primarily centred around the village of Toongi. The low yields and moderate quality water, as well as a lack of major groundwater users, results in groundwater being a little importance within the DZP Site with the exception of groundwater discharges providing water to the local ephemeral creek systems.

4.6.3 Assessment Methodology

Potential impacts to groundwater beneficial users, as a result of the proposed mining operations, have been assessed in the context of the local hydrogeological setting, i.e. the CSM (see Section 4.6.2.3) and the relevant legislation and guidelines.

The nature of the groundwater flow system, i.e. a local flow system discharging to the local creeks, means that all potential impacts of the Proposal are considered to be locally constrained. The area of potential impacts is constrained to the west by Wambangalang and Paddys Creeks and to the south by a tributary of Cockabroo Creek in the vicinity of bore DWB016 (see **Figure 4.29**).

All of the potential sources of impacts are currently planned to be located within the groundwater flow systems flowing to Wambangalang/ Paddys Creek and to Cockabroo Creek, with the exception of some of the LRSF which overlap the catchment divide between Wambangalang Creek and a tributary of the Macquarie River.

On the basis that the open cut would be developed so as to remain above the regional water table, and as such, dewatering and associated drawdown would not take place, groundwater flow or transport modelling was not undertaken. Rather, the assessment of impacts is based on the CSM and knowledge and experience of EES of flow systems in similar environments and for similar projects. The assessment of EES (2013) considers:

- the potential impacts on groundwater associated with the Proposal (refer to Section 4.6.4);
- the proposed operational safeguards, controls and management measures proposed by the Applicant to avoid, minimise or mitigate these impacts (refer to Section 4.6.4); and
- the risk associated with each potential impact based on likelihood and consequence along with nature of higher risk impacts (refer to Section 4.6.5).

4.6.4 Potential Impacts on Groundwater and Proposed Management and Mitigation Measures

4.6.4.1 Introduction

The following subsections provide a summary of the description of potential impacts presented in *Section 6* of EES (2013), along with the proposed impact avoidance, minimisation and mitigation.

4.6.4.2 Potential Physical Impacts During Operations and Post Closure

4.6.4.2.1 Introduction

Given the open cut would be developed above the groundwater table, no dewatering would be required and there would be no drawdown of groundwater levels associated with the Proposal. Physical impacts on local groundwater conditions would be associated with changes to recharge rates and flows resultant from the construction of various features of the DZP Site, each of which is considered as follows.

4.6.4.2.2 Open Cut**Potential Impacts**

During mining operations, standing water collected within the open cut would be removed and therefore there would be no major change to recharge rates. Under post closure conditions, enhanced recharge could be expected to be more significant resulting in an increase in groundwater levels in the vicinity of the open cut. This impact is not predicted to extend to the alluvial sediments surrounding the high ground.

EES (2013) notes that the net increase in the recharge rate would be expected to be balanced by a net increase in the discharge rate to the local gullies and possibly in new 'springs' which did not exist prior to the Proposal.

Any impacts are not considered of significant consequence and hence no mitigation measures other than ongoing SWL monitoring would be undertaken.

4.6.4.2.3 Waste Rock Emplacement**Potential Impacts**

As the WRE would not be lined, the rate of recharge over the impact area (approximately 20ha) is likely to increase both during the Proposal and on closure. However, given the impact area represents less than 1% of the total DZP Site, the effect on groundwater is expected to be minor.

4.6.4.2.4 Solid Residue Storage Facility**Potential Impacts**

The construction of the SRSF would reduce the rate of recharge over the footprint of the SRSF area (approximately 103ha) both during operations and post closure. Representing less than 5% of the total DZP Site, the effect on the total groundwater flux through the local groundwater flow systems within the Wambangalang Creek catchment and the Cockabroo Creek Catchment is expected to be minor. A moderate reduction in the level of the water table (in the order of 1m to 3m) beneath and in the vicinity of the SRSF cells is expected (EES, 2013).

Impact Mitigation

Groundwater monitoring bores would be installed around the SRSF, primarily to monitor for changes in water chemistry which could indicate a leak, however, would also confirm changes to SWL occur as predicted.

It is noted that given the potential increase in recharge resultant from the retention of the open cut void in the final landform, this reduction in recharge would act to minimise any impacts associated with this increase in recharge via the open cut post closure (refer to Section 4.6.4.2.2).

4.6.4.2.5 Salt Encapsulation Cells

Potential Impacts

As for the SRSF, the effect of the SECs would be to reduce the rate of recharge over the area of impact (approximately 35ha). This represents less than 2% of the total DZP Site, therefore the effect is expected to be minor. EES (2013) predicts a moderate reduction in groundwater level beneath and in the vicinity of the SECs due to the reduction in the recharge rate in this area both during the Proposal and post closure.

Impact Mitigation

Groundwater monitoring bores would be installed around the SECs, primarily to monitor for changes in water chemistry which could indicate a leak, however, would also confirm changes to SWL occur as predicted.

4.6.4.2.6 Liquid Residue Storage Facility

Potential Impacts

With liquid residue to be placed on an impermeable liner, the net effect would be to reduce the rate of recharge over the footprint of the LRSF (approximately 425ha) during operations. EES (2013) reports that the area of impact would result in a reduction in recharge of approximately 17% across the affected catchments within the DZP Site and it would be expected that there would be a moderate reduction in the water table beneath and in the vicinity of the LRSF. This reduction in recharge would be limited to the life of the Proposal as the LRSF is to be returned to agricultural use (following rehabilitation – see Section 2.17.6.6) on closure when the recharge rate is expected to return to close to the baseline rate and the SWL to pre-disturbance elevation.

It is possible that a breach or breaches of the LRSF liner could occur which would result in the infiltration of liquid from the LRSF to the underlying groundwater. Should such a breach / leak occur, the downward hydraulic gradient caused by the liquid level in the pond above the breach would initially infiltrate downwards, and subsequently laterally. The rate of migration of the liquid would be controlled by the hydraulic conductivity (k) of the underlying materials. Should leakage occur, EES (2013) notes that it is likely that the water table would rise beneath the cell until the ground became fully saturated.

EES (2013) considers the potential rate of discharge (Q) of the saline liquid from the areas of the LRSF area located over clay alluvium and fractured bedrock based on the following calculation.

$$Q = T \times i \times L$$

Where:

Q = rate of leakage (m³/day)

T = Lateral transmissivity (m²/day)

i = Maximum horizontal hydraulic gradient (m/m)

L = length of leak (m)

In reality, the likely size of any breach (leak) of the liner would be small and would limit the rate of discharge. Furthermore, the lateral transmissivity and hydraulic gradient of the low permeability clays below the LRSF would also be low further limiting the rate at which any small leak discharges and affects local groundwater.

In a worst case scenario, a breach of the liner would result in a rise in the water table and discharge as base flows within the local catchment or at surface adjacent to the outer LRSF embankment. *Figure 13* of EES (2013) presents the possible worst-case scenario in the event of a breach of the liner.

Impact Mitigation

Modern liners and installation techniques are such that the potential for these to be breached is almost certainly likely to be as a result of one of three factors.

1. Incorrect installation of the HDPE liner.
2. Installation over ground containing rocks or other objects capable of piercing the HDPE liner.
3. Operation of equipment directly on the liner.

Effectively, all three mechanisms for liner breach reflect poor operation or human error. The Applicant has committed to the following measures to avoid the potential for this occurrence.

- Adoption and implementation of a Cell and Liner Construction Protocol.
 - Certification of all lining material would be obtained from the manufacturer prior to delivery to the DZP Site.
 - The number of all individual batches of the lining material would be registered and the date and location of the use of each roll recorded by the contractor.
 - The foundations of each salt crystallisation cell would be constructed to the extents and grades shown on the final drawings.
 - The finished surface would be free of all roots, rocks and other matter which could impact on the liner. The area in each cell would be lightly tined, moisture conditioned and compacted prior to the placement of the lining.
 - Should there be a delay of more than 48 hours between the completion of the cell foundations and the application of the liner, the area would be proof rolled again prior to rolling out the lining.
 - A final inspection of each cell prior to liner rolling out would be performed by the supervising engineer. If the cell foundations are deemed unsuitable, for instance if surface rocks and sticks remain, a layer of compacted sand with a minimum depth of 150mm would be placed over the cell floor prior to constructing the liner.

- Adoption and implementation of a *Liner Integrity Testing Protocol*.
 - The HDPE lining of the LRSF cells would be completed by an experienced contractor who has a proven track record in the installation of large areas of lining.
 - All lining material and construction methods and testing would conform to the relevant Australian Codes and the contractor would be required to use the most up to date equipment. All equipment would require certification prior to the start of the project and at regular intervals (in accordance with the manufacturer's recommendation and the relevant Australian Codes) during the work.
 - The welding of the liner would be tested both by the contractor and by an independent testing organisation hired by the Applicant.
 - Small sections of the liner would be regularly removed for off-site laboratory testing in accordance with the relevant code. Should any test results return negative results, the work carried out between tests would be fully reviewed.
- The water balance within the salt crystallisation cells would be monitored.
 - Prior to the installation of the liner in each cell, the area would be surveyed and a depth/volume curve prepared. This would allow the volume of liquid residue in each cell to be determined by measuring the level of the liquid in each cell.
 - The volume of water delivered to each cell would be accurately monitored by reading the flow meters on each delivery pipe. Evaporation losses from the cells would be compared with that from several Class A Australian Standard Evaporation pans located adjacent to each group of cells. Rain gauges would also be positioned adjacent to each group of cells.
 - Data from the evaporation pans, rain gauges and flow meters would be fed back into the LRSF Water Balance Model from the early stages of the operation to enable a Pan Factor to be determined relating Class A pan evaporation to actual cell water loss.
 - On establishment of an evaporation rate for the liquid residue, continuous monitoring of liquid residue level, flow in, and evaporation loss out would enable any major water loss due to a liner failure to be identified and magnitude potentially quantified.
 - Identification of a liner leak would lead to the implementation of a *Leak Detection Response Strategy*.
- Water levels and quality would be monitored beyond the downstream toe of all external embankments.
 - Paired bores, one immediately downstream of the outer embankment and another up to 50m down gradient, would be installed and compared for signs of changing water quality or SWL which could be indicative of a liner breach.

- Identification of a liner leak would lead to the implementation of a *Leak Detection Response Strategy*.
- Design and implement a *Leak Detection Response Strategy*.
 - If changes in groundwater quality and/or level are identified, or if the LRSF Water Balance Model indicates anomalies suggesting loss of liquid residue by leakage, an investigation by a qualified hydrogeologist would be triggered.
 - Initial response would likely be the excavation of a series of test pits parallel to the downstream toe of the outer embankment of the cell from where the leak is suspected as having occurred.
 - Should collection of water in these pits suggest that there may be seepage coming from up gradient, a continuous trench would likely be excavated to a depth of 3m or to the water table (if less than 3m below surface). The trench would be backfilled with drainage material and a sump and pump installed to remove the accumulated water. Pumping would continue until the quality of the recovered water is the same as the background quality of the groundwater.
 - If seepage continues, indicated by the water quality not returning to that of the background, i.e. the paired bore, the liquid within the cell(s) would be transferred by pumping to an adjacent cell(s). If the removal of the water produces a noticeable change in water level in the monitoring bore(s) and/or trench, further investigations into the integrity of the liner would be undertaken, which could include:
 - total removal of liquid from the cell;
 - removal of any accumulated salts from the base of the cell;
 - inspection of the joins in the liner following cleaning by high pressure water;
 - testing of the joins to determine the area of failure;
 - cleaning of the liner and inspection; and/or
 - removal of the liner and inspection of the cell foundation.
 - If following identification of the leak, the liner is to be repaired, this would be subject to the same inspection standards as noted for the *Liner Integrity Testing Protocol*.
 - All contaminated material down to the water table (up to a maximum depth of 3m) would be removed and replaced with uncontaminated material prior to re-lining or installation of a new liner.
 - If the decision is made to abandon the cell (for a period or permanently), the cell would continue to be monitored but allowed to remain dry.

- Harvesting of precipitated salts would be undertaken in accordance with a *Salt Harvesting Protocol*.
 - Harvesting of precipitated salts would only occur on accumulation of greater than 1.5m of salt (determined by survey comparison to the original cell survey referenced in the *Cell and Liner Construction Protocol*).
 - Salt would only be harvested down to 1m of the surveyed level of the underlying liner in each cell.
 - The salt removal process would be surveyed by earthmoving equipment utilising GPS equipment for vertical accuracy to ensure the 1m buffer is maintained.
 - Should any part of the liner be compromised, in that instance the entire liner for the cell would be replaced and its integrity independently verified (in accordance with the *Liner Integrity Testing Protocol*) prior to recommissioning of the cell.
- The liner would be continuous (by welding) over the internal embankments.
 - This would ensure that lapping water caused by wind / wave action across the cells does not result in saline liquid leaking under the liner at the top of each embankment.

4.6.4.3 Potential Chemical Impacts during Operations and Post Closure

4.6.4.3.1 Introduction

The potential chemical impacts on groundwater are tied closely to the physical impacts, i.e. in assessing the potential chemical impacts, it is assumed that the relevant changes to recharge nominated in Sections 4.6.4.2 occur.

4.6.4.3.2 Open Cut

Potential Impacts

The various metals and other contaminants contained within the ore are not soluble in water and so would not leach into the groundwater. The solubility of most heavy metals is controlled by acidity. Notably, the ore contains only negligible sulphur concentration (<0.01%) which could be oxidised and lead to acidification of any accumulated water.

4.6.4.3.3 Waste Rock Emplacement

Potential Impacts

Due to the benign nature of the waste rock, there is not considered to be any opportunity for chemically impacted or acidic liquid to migrate into groundwater. Therefore potential chemical impacts to groundwater are predicted to be negligible, as is the potential for any impact to beneficial users and receptors

4.6.4.3.4 Solid Residue Storage Facility

Potential Impacts

Based on the design of the SRSF, double liner and leak detection system, there would be no opportunity for liquid to migrate into the groundwater from the SRSF. Therefore, chemical impacts to groundwater as a result of the SRSF are predicted to be negligible. It therefore follows that there is no perceived potential for the SRSF cells to impact any beneficial users of groundwater.

4.6.4.3.5 Salt Encapsulation Cells

Potential Impacts

As long as the liner remains intact, there would be no opportunity for liquid to migrate into the groundwater. Therefore, chemical impacts to groundwater as a result of the SECs are predicted to be negligible. However, the validity of this conclusion depends on continuous monitoring of the leak detection system for a period of decades following mine closure.

Impact Mitigation

The leak detection system would remain operational following the completion of the SECs until such time as leakage is deemed not likely.

4.6.4.3.6 Liquid Residue Storage Facility

Potential Impacts

On the basis of the liner remaining intact, there would be no chemical impacts on groundwater associated with the LRSF.

Should a leak occur, however, highly saline liquid (>62 500mg/L) could enter the groundwater below the LRSF potentially leading to the following impacts.

- **Groundwater Salinity**

The salinity impact would migrate at the average linear velocity of the groundwater flow and would ultimately extend as far as the point where the groundwater discharges to surface water. As such, if a leak was to continue, the salinity of the groundwater below and downstream of the LRSF could increase which would significantly compromise beneficial uses associated with ecosystems, stock watering, recreational (including direct contact and aesthetic) use, irrigation and drinking.

- **Land Salinisation**

If a leak was to occur and remain undetected and uncontrolled, the salinity of the soil adjacent to the outer embankment (where the groundwater level would intercept or rise to within 2m of the ground surface) would become saline, i.e. dryland salinity.

Impact Mitigation

The mitigation measures discussed in Section 4.6.4.2.6 apply equally to avoiding, minimising and mitigating chemical impacts associated with the LRSF.

4.6.4.4 Potential Impacts on Groundwater Availability

Groundwater users more than approximately 100m to the west of Wambangalang Creek are unlikely to be affected by the DZP Site as they are outside the local flow system.

The most sensitive users appear to be those within the Wambangalang Catchment including the unregistered bore usage in the village of Toongi and the cluster of bores around Cockleshell Corner (see **Figure 4.28**). EES (2013) reports that due to the localised nature of impacts on recharge around such structures as the SRSF, LRSF and SECs, there is unlikely to be any significant drawdown at these bores.

Salinization of the groundwater could potentially affect the ability of bore holders to use this water, however, this would only occur should the liner of the LRSF be breached (which is not considered likely given the proposed management measures to be implemented – see Section 4.6.4.2.6)

4.6.4.5 Potential Impacts on Groundwater Dependent Ecosystems

Potential Impacts

EES (2013) notes that based on groundwater dependent ecosystem (GDE) mapping prepared by BOM (2012) only, Paddys Creek to the west is listed as having a “high potential for groundwater interaction”. Groundwater interaction refers to a surface water system that is “reliant on surface expression of groundwater”. Potential physical and chemical impacts associated with the Proposal would not impact on base flows to Paddys Creek and therefore the Proposal would not impact on any GDEs.

Wambangalang Creek to the north of Obley Road and Cockabroo Creek to the north of Eulandool Road are both listed as having a “moderate potential for groundwater interaction”. As for Paddys Creek, the potential physical and chemical impacts associated with the Proposal on the Cockabroo Creek catchment would be limited to the immediate vicinity of the open cut, WRE and SRSF and therefore not impact on any GDEs.

In the event of leakage from the LRSF, there is a small possibility that saline water could impact on any GDEs contained within Wambangalang Creek between the DZP Site and Macquarie River.

Impact Mitigation

The proposed impact avoidance, minimisation and mitigation measures proposed in Section 4.6.4.2.6 would reduce the potential to almost nil.

4.6.4.6 Potential Impacts on Dryland Salinity

Potential Impacts

Dryland salinity was initially identified as a high salinity hazard rating within the Toongi catchment but additional studies (Smithson, 2001) identified no moderately or highly saline areas within the DZP Site or immediate surrounds (EES, 2013). Areas considered at greatest risk of dryland salinity by Smithson (2001) are those where the groundwater table is less than 5m below natural ground surface. Such areas occur in the vicinity of Wambangalang Creek and the village of Toongi which are associated with alluvial flats with the areas of disturbance for the Proposal located away from these areas of elevated groundwater table (see **Figure 4.31**). EES (2013 – *Appendix J*) also notes “*There was no indication that groundwater or salt has encroached the surface at these locations (groundwater discharge springs or where groundwater levels intercepted the ground) surface ... and there was also no indication of salinity or groundwater discharge on the alluvial flats where cropping and lucerne pastures were prominent.*”

The following contributors to dryland salinity in the vicinity of the DZP Site are identified Smithson (2001). The following provides an assessment of the anticipated impacts associated with each.

- Changes in slope angles.

The Proposal would require modifications to the existing landforms, in particular, for the LRSF. Each cell of the LRSF would be excavated approximately 3m into weathered material and would not intersect the bedrock. As groundwater in the vicinity of the four distinct areas of the LRSF is greater than 5m below surface (refer to Section 4.6.2), there would be no intersection or obstruction to sub-surface flows. As a result, in the absence of any leakage from the LRSF, there would be no change to hydrological processes that would lead to dryland salinity.

- Removal of native vegetation.

The native vegetation to be removed throughout the life of the Proposal would be predominantly derived grasslands or grassy woodlands where deep rooted trees occur as isolated paddock trees or in clumps over elevated hill tops of the DZP Site. This vegetation is principally located in elevated areas of the DZP Site on lands that are identified as having a low salinity risk.

- Leaky agricultural land uses.

This risk factor related to land uses that may result in excess groundwater recharge. The principal water storages within the DZP Site would be either lined (for example the LRSF) or would be maintained with limited water in storage (for example, the sediment basins or the Re-use Dam). As a result, there would be limited potential for discharge to groundwater from these structures. However, the open cut would collect incident rainfall. Throughout the life of the Proposal, entrained water would be removed from the open cut and the Proposal would not result in increased groundwater recharge.

Under post closure conditions, enhanced recharge is expected to be more significant and moderate increases in groundwater levels of several metres can be expected in the vicinity of the open cut (refer to Section 4.6.4.2). This could have the effect of locally increasing the hydraulic gradient away from the open cut which is likely to cause some groundwater discharge in incised gullies and creeks draining the high ground. These discharges are not expected to be saline, given the relatively short residence time between recharge and discharge, and so would not lead to increased salt load within the catchment. Furthermore, EES (2013) reports that changes in groundwater flux associated with any increased recharge would not extend to the alluvium aquifer and therefore not increase the dryland salinity.

On the basis of the above, in the absence of leakage from the LRSF (discussed in Sections 4.6.4.3.6), the construction and operation of the various features of the Proposal would not result in an increase in the groundwater table over the life of the Proposal and therefore not increase the dryland salinity risk during operations.

Impact Mitigation

The impact mitigation described with respect to avoiding, minimising and mitigating physical and chemical impacts associated with a breach or leaking LRSF apply to the management of dryland salinity. That is, by preventing or mitigating such occurrences, the salinization of the groundwater and surface soils would also be prevented.

In addition to these controls associated with the LRSF, the Applicant has committed to the implementation of a Biodiversity Offset Area which would result in the establishment of deep rooted vegetation between LRSF Areas 2 and 3. This vegetation would assist in maintaining the groundwater table in these areas.

The Applicant would also undertake additional plantings as required to positively influence local riparian corridors and respond to rising groundwater tables (not associated with a potential leak from the LRSF).

4.6.5 Assessment of Impacts

4.6.5.1 Risk-based Assessment of Impacts

As noted in Section 4.6.3, the assessment of EES (2013) has taken a risk-based approach to assessment. **Table 4.51** (modified after *Table 10* of EES, 2013) presents a summary of the potential groundwater impacts discussed in Section 4.6.4. EES (2013) considers each potential impact in terms of their likelihood and consequence, with a score attributed to both likelihood and consequence on a scale from 1 to 5 in each case. The overall risk was then identified based on the sum of the likelihood and consequence scores. A high score represents low risk and low score represents higher risk.

4.6.5.2 Low or Moderate Risk Sources

Sections 6.3 and 6.4 of EES (2013) review each of the potential impacts associated with the Proposal in detail. In most cases, the low likelihood or limited consequence associated with each potential impact is such that even using the conservative risk assessment of EES (2013), the risk level is low or moderate. On the basis of the proposed operational safeguards, management measures, monitoring practices and contingency management to be implemented, these levels of risk are assessed as reasonable and equivalent to those of other mining operations.

4.6.5.3 High Risk Sources

EES (2013) scored two potential impacts as high risk. These are considered in more detail as follows.

Chemical Impact to Groundwater Resulting from a Leakage of the LRSF Liner

On the basis that a breach of the LRSF liner is 'possible' resulting in a 'major' consequence, EES (2013) allocate a risk score of 5 (high). It is important to recognise, however, that having reviewed the safeguards, monitoring and contingency measures proposed by the Applicant (see Section 4.6.4.2.6), EES (2013) refer to the potential impacts as limited in extent and temporary in nature.

Table 4.51
Risk Associated with Potential Impacts

Page 1 of 3

Proposal Component	Aspect of Proposal Component	Potential Impacts to Groundwater	Likelihood of Impact	Consequence of Impact	Overall Level of Risk	Comments
LRSF	Leakage due to Breached Liner	Physical Impact to Groundwater	Possible (3)	Minor (4)	Moderate (7)	ALARP (localised risk). Refer to Section 4.6.5.3 for assessment
		Chemical Impact to Groundwater	Possible (3)	Major (2)	High (5)	
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Minor (4)	Low (8)	
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Major (2)	Moderate (6)	
		Ensuing Land Salinisation	Unlikely (4)	Major (2)	Moderate (6)	
	Negligible recharge due to Liner	Physical Impact to Groundwater	Likely (2)	Minor (4)	Moderate (6)	Planned outcome
		Chemical Impact to Groundwater	Very unlikely (5)	Minor (4)	Low (9)	
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Possible (3)	Minor (4)	Moderate (7)	
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Very unlikely (5)	Minor (4)	Low (9)	

ALARP = As Low As Reasonably Possible

Table 4.51 (Cont'd)
Risk Associated with Potential Impacts

Page 2 of 3

Proposal Component	Aspect of Proposal Component	Potential Impacts to Groundwater	Likelihood of Impact ¹	Consequence of Impact ²	Overall Level of Risk ³	Comments
SRSF or SEC	Leakage due to Breached Liner	Physical Impact to Groundwater	Very unlikely (5)	Minor (4)	Low (9)	ALARP (refer to EES, 2013)
		Chemical Impact to Groundwater	Very unlikely (5)	Major (2)	Moderate (7)	
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Very unlikely (5)	Minor (4)	Low (9)	
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Very unlikely (5)	Critical (1)	Moderate (6)	
		Ensuing Land Salinisation	Very unlikely (5)	Major (2)	Moderate (7)	
	Negligible recharge due to Liner	Physical or Chemical Impact to Groundwater	Likely (2)	Minor (4)	Moderate (6)	Planned outcome
		Ensuing Physical or Chemical Impact to Ecosystems or Groundwater Users	Possible (3)	Minor (4)	Moderate (7)	
Open Cut	Enhanced Recharge due to no runoff	Physical Impact to Groundwater	Likely (2)	Moderate (3)	High (5)	ALARP (localised post closure impact). Refer to Section 4.6.5.3 for assessment
		Chemical Impact to Groundwater	Unlikely (4)	Minor (4)	Low (8)	
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Minor (4)	Low (8)	
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Moderate (3)	Moderate (7)	
WRE	Enhanced Recharge	Physical Impact to Groundwater	Likely (2)	Minor (4)	Moderate (6)	ALARP (refer to EES, 2013)
		Chemical Impact to Groundwater	Unlikely (4)	Major (2)	Moderate (6)	
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Minor (4)	Low (8)	
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Major (2)	Moderate (6)	

ALARP = As Low As Reasonably Possible

Table 4.51 (Cont'd)
Risk Associated with Potential Impacts

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Proposal Component	Aspect of Proposal Component	Potential Impacts to Groundwater	Likelihood of Impact ¹	Consequence of Impact ²	Overall Level of Risk ³	Comments
Processing Plant Area	Leakage due to Cracks/ Breaches in Paved Area	Physical Impact to Groundwater	Very unlikely (5)	Minor (4)	Low (9)	ALARP (refer to EES, 2013)
		Chemical Impact to Groundwater	Very unlikely (5)	Critical (1)	Moderate (6)	
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Very unlikely (5)	Minor (4)	Low (9)	
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Very unlikely (5)	Critical (1)	Moderate (6)	
		Ensuing Land Salinisation	Very unlikely (5)	Major (2)	Moderate (7)	
	Negligible recharge due to Pavement	Physical or Chemical Impact to Groundwater	Likely (2)	Minor (4)	Moderate (6)	Planned outcome
		Ensuing Physical or Chemical Impact to Ecosystems or Groundwater Users	Possible (3)	Minor (4)	Moderate (7)	
ALARP = As Low As Reasonably Possible						
Note 1. Likelihood scale has five categories with scores from 5 to 1, i.e. Very Unlikely (5), Unlikely (4), Possible (3), Likely (2), Very Likely (1)						
Note 2. Consequence scale has five categories with scores from 5 to 1, i.e. Negligible (5), Minor (4), Moderate (3), Major (2), Critical (1)						
Note 3. Overall risk value = Consequence value + Likelihood value; consequence and likelihood are considered separately						
Source: Modified after EES (2013) – Table 10						

Based on the limited extent and temporary nature of any leak from the LRSF, it is suggested that EES (2013) has been overly conservative in their assessment of risk. Even if, despite the detailed and comprehensive quality control and management protocols, the likelihood of a breach is classified as 'possible' (a classification of 'unlikely' is considered more reasonable based on the proposed controls and management), the limited and temporary nature of the impact is such that classifying as a 'major' consequence is overstating the risk. If a 'moderate' consequence is assigned, the risk would be reduced to a 'Moderate' level (score of 7). The following quotes directly from EES (2013) (Section 6.4.3) and supports this assessment.

However, in the event of a breached liner, it can be expected that the leak would be detected by groundwater monitoring and repaired ... such that the leak would be temporary and its consequent effects would be minimised. Although it would be unlikely that a significant proportion of any brine that leaks into the groundwater could be effectively removed, it can be expected that the total volume of leakage would be small in comparison to the total volume of groundwater beneath and down-gradient from the LRSF.

Consider the example in which a leakage flux of 10m³/day is taking place from a LRSF over alluvium. For a leak of this order of magnitude, it can be expected that there would be a relatively rapid increase in groundwater levels in the monitoring bores such that the leak would be identified and the leaking liner would be repaired within a period of weeks to months. Therefore, the total volume of brine seeping into the groundwater would be expected to be less than 2,000m³ (based 10m³/day for 200 days).

For comparison, a volume of saturated alluvium which is 50m in width perpendicular to groundwater flow direction x 100m in length parallel to the flow direction x 30m thick beneath a LRSF can be expected to contain a volume of greater than 50,000m³ of water (based on a porosity of greater than 0.3).

Furthermore, EES (2013) notes that while the liquid residue in the LRSF would contain low levels of metals such as Al, Mn, U and Zr, and a significant portion (11.8%) as sulphur (S) species (DECA, 2013), the risk of acidification of the residue (from oxidation of S to form H₂SO₄) and subsequent release metals into solution is low. This is because all of the sulphur species would be in oxidised forms (such as SO₄) which would be neutralised by carbonates (lime and limestone) to precipitates such as gypsum (CaSO₄).

EES (2013) also considers the possibility for leakage from the LRSF to impact on down-gradient receptors such as Wambangalang Creek and associated groundwater dependent ecosystems or groundwater users to be unlikely as while groundwater flow could transport a plume of brine, dispersion through in-situ groundwater and the limited duration of the source would together have the effect of significantly reducing the concentration with distance from the LRSF.

It is therefore assessed, that while the potential for a leak of the LRSF liner cannot be discounted, the Applicant would implement and enforce controls and measures to reduce this possibility to *As Low As Reasonably Possible* (ALARP) given the proposed design of the LRSF. The subsequent impact on the aquifer would be minimised, such that in the event of a leak any impacts on groundwater quality would be prevented from extending beyond the DZP Site through the implementation of the proposed monitoring system and *Leak Detection Response Strategy*.

4.6.5.4 Altered Groundwater Flows due to Enhanced Recharge via the Open Cut

The risk of an increase in groundwater flux due to enhanced recharge associated with the open cut is interpreted to be 'high' by EES (2013), based on the assumption that an increased recharge through the open cut is 'likely' and that this would have a 'major' consequence. It is considered that EES (2013) overstates the likelihood of increased recharge through the floor of the open cut given:

- local evaporation rates significantly exceed rainfall rates (1 799mm vs 677mm) suggesting that under most rainfall conditions, there would be little standing water accumulated in the open cut to recharge the aquifer; and
- other features of the DZP Site within the same recharge catchments are assessed as reducing recharge.

Notably, EES (2013) reports that there would be a low risk of impact upon groundwater quality (see **Table 4.51**) given insolubility of trace metals and lack of any acid generating material (see Section 2.5.2.2).

The above notwithstanding, EES (2013) notes the following (Section 6.6) with respect to the potential impact.

Although this is scored as a high risk by this methodology, an interpreted “high risk” of enhanced groundwater flow is more a function of the itemised risk methodology than a true issue of concern. The most likely effect would be enhanced groundwater discharge/spring flow in the highland gullies, which could be considered to be a positive impact.

Considering the above statement of EES (2013), even in the event of increased recharge, any resultant impact is not considered to have any significant adverse environmental consequences.

4.6.5.5 Land Salinization

At any location where the water table is raised to within 2m of the ground surface there is the potential for land salinization to take place. EES (2013) do not predict this to occur either during or following mining operations based on the following.

- Assuming the liners of the LRSF are effective at preventing leakage, the elevation of the water table is not predicted to increase (it may in fact decrease as a result of reduced recharge) as a result of the Proposal.
- In the unlikely event of a breached liner, it can be expected that the leak would be detected and repaired within a period of a few weeks to months such that the leak would be temporary and its effect on groundwater quality would be localised. This also means that any increase in the water table as a result of a liner leak would be localised and temporary.
- Should a rise in the water table rise to within 3m of the ground surface near the toe of the lower embankment of a LRSF be detected by monitoring, trenching or an equivalent contingency measure would be implemented to intercept seepage and/or maintain the water table at more than 2m below ground level.
- On decommissioning, all salt would be removed from the LRSF and the ground surface returned to (approximately) its original level.

4.6.5.6 Conclusion

As for any site where potentially polluting materials are to be managed, or the landform is to be modified, the risk of altered flows or pollution of groundwater cannot be eliminated. An assessment of the relative risks associated with activities on the DZP Site (Table 4.51) has confirmed that there would remain some risk of impacts to groundwater as a consequence of the Proposal. However, on the basis of the proposed safeguards, operational controls, mitigation and management measure, monitoring programs and commitment to implementation of a contingency *Leak Detection Response Strategy*, both the likelihood and consequence of impact have been reduced to “As Low As Reasonably Possible”. On this basis, and the fact that as noted by EES (2013) any impact would be limited in extent and temporary in nature, it is assessed that any residual impacts are acceptable and would be minimised and mitigated, if observed.

4.6.6 Groundwater Management Plan

4.6.6.1 Aims

As indicated by the results of the risk analysis summarised in **Table 4.51** and discussion of Section 4.6.5, it is not possible to eliminate the risk of impact completely. The Applicant acknowledges that the preparation, implementation and continual review of a *Groundwater Management Plan* would be required to ensure the risks of impact are maintained as low as possible and impacts are identified and mitigated as quickly and effectively as possible should they occur.

4.6.6.2 Groundwater Management

The *Groundwater Management Plan* would formalise the impact avoidance, minimisation and mitigation measures nominated in Section 4.6.4, as well as any other measures required by the development consent or government agencies. The *Groundwater Management Plan* would be auditable and include criteria and key performance indicators for assessment of performance, and trigger levels for the implementation of the various mitigatory measures. The *Groundwater Management Plan* would be a 'live' document and require annual review and update at least every three years.

It is anticipated the *Groundwater Management Plan* would be prepared in consultation with the DP&I, NOW, EPA and Dubbo City Council.

4.6.6.3 Groundwater Monitoring Program

A key component of the *Groundwater Management Plan* would be the development and implementation of a groundwater monitoring program.

The monitoring program would consist of two separate components.

1. Shallow piezometers to be installed around the SRSF, LRSF and SECs which would monitor changes in water level and quality surrounding these structures as way of identifying leaks.
2. The existing groundwater bore network on and surrounding the DZP Site to monitor for any changes to local conditions as a result of the Proposal.

Shallow Piezometer Monitoring

Constructed to a depth of between 3m and 5m, these shallow piezometers would be constructed at intervals of between 150m and 300m around the SRSF, LRSF and SECs. An indication of the location of these bores surrounding LRSF Area 3 is provided by **Figure 2.13**, however, it is noted that the exact locations would be determined following approval of the Proposal and final engineering design of the LRSF.

As noted in Section 4.6.4.2.6, the piezometers installed around the LRSF would be paired to allow for localised changes in water level or quality to be identified.

It is proposed that each piezometer would be monitored at least monthly and tested for SWL, pH, EC and temperature with a field testing unit. Samples would be taken on a less frequent basis and sent to a NATA registered laboratory for analysis of parameters including but not necessarily limited to:

- pH, TDS, cations (Na, Ca, Mg, K) and anions (Cl, SO₄, HCO₃, PO₄, F);
- dissolved metals / metalloids including aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (B), bromide (Br), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), strontium (Sr), uranium (U), vanadium (V) and zinc (Zn).

Groundwater Bore Network

EES (2013) confirms that the locations of the existing bores within the DZP Site would be appropriate for ongoing monitoring, however, bores DWB001 to DWB011 would be replaced (due to a lack of seal installed in the original bores) to prevent possible pathways for contamination to enter the groundwater from the ground surface. In addition to the replacement of bores DWB001 to DWB011, it is proposed to install several new bores. These bores, summarised as follows, would be monitored on a quarterly basis.

- Background bores: DWB002, DWB003, DWB004 and DWB006.
- Open cut bores: GWB021 and DWB022 (until mining commences).
- Down-gradient of the open cut and up-gradient of the LRSF: DWB007, DWB010, DWB011 and DWB020.
- Lower catchment bores: bores DWB015, DWB016, DWB019 and DWB023.
- Additional bores to be placed down-gradient of the LRSF, SRSF and SECs:
 - in the vicinity of bore GW008373;
 - south of DWB019 between the LRSF and Wambangalang Creek;
 - north of DWB012 between the LRSF and Wambangalang Creek;
 - north of DWB015 between the LRSF and the processing plant;
 - between the processing plant and the confluence of Wambangalang and Paddys Creeks; and
 - south of each of the SRSF and the Salt Encapsulation Cells.

In total, 21 bores are proposed for assessing groundwater levels and quality within the DZP Site prior to mining operations, and 19 bores are proposed as part of mining operations monitoring. Each bore would be sampled quarterly and sent to a NAT accredited laboratory for analysis of:

- pH, TDS, cations (Na, Ca, Mg, K), anions (Cl, SO₄, HCO₃, PO₄, F) and nutrients (NH₃, NO₃ and NO₂);

- dissolved metals / metalloids including aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (B), bromide (Br), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), strontium (Sr), uranium (U), vanadium (V) and zinc (Zn).

Criteria, performance indicators and triggers for further actions would be documented in the *Groundwater Management Plan* for the Proposal.

4.7 TERRESTRIAL ECOLOGY

4.7.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "**Biodiversity** – as a key issue for assessment including:

- *measures taken to avoid, reduce or mitigate impacts on biodiversity;*
- *accurate estimates of proposed vegetation clearing;*
- *a detailed assessment of potential impacts of the development on any:*
 - *terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems; and*
 - *regionally significant remnant vegetation, or vegetation corridors; and*
 - *a comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Office of Environment and Heritage (OEH) which requested that biodiversity impacts be assessed using either the BioBanking Assessment Methodology or a detailed biodiversity assessment. OEH also made specific reference to the need for detailed survey and assessment of the Pink-tailed Worm-lizard, a threatened reptile species known from the location, and requested that assessment of the significance of direct and indirect impacts of the proposal be undertaken for threatened biodiversity known or considered likely to occur.

Further matters for consideration were provided by the Central West CMA who identified that "*the EIS should include identification of any Endangered Ecological Communities (EEC) vegetation and outline a Biodiversity Offset Strategy to compensate for the destruction of any mature trees with habitat values such as hollows*", DRE who requested that "*the flora, fauna and ecological attributes of the disturbed area should be recorded and placed in a regional context*" and NOW who requested the EIS "*identify any impacts on groundwater dependent ecosystems*".

Following determination of the Proposal as a Controlled Action (in accordance with the EPBC Act), Additionally, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) issued assessment requirements to the DP&I, to allow for bi-lateral assessment of the Proposal under the NSW State Significant Development assessment process. Supplementary DGRs issued by DP&I on 3 March 2012 included the assessment requirements of DSEWPaC, the most relevant of which was for the assessment of “*impacts on threatened species and ecological communities listed under Sections 18 and 184 of the Environment Protection and Biodiversity Conservation Act 1999*”.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to terrestrial ecology and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Loss of biodiversity and alteration to existing habitat (high).
- Direct adverse impact on threatened species, populations and communities (high).
- Local or regional reduction in distribution of threatened species, populations and endangered ecological communities (high).
- Reduced biodiversity value of the site (medium).
- Reduced local distribution of threatened species, populations and endangered ecological communities (medium).
- Detrimental health impacts on native fauna from ingestion of contaminated water (high).
- Injury or death of fauna from vehicle incidents (high).

The Terrestrial Ecology Assessment for the Proposal was undertaken by Mr Phillip Cameron and Ms Heidi Kolkert of OzArk Environment and Heritage Management Pty Limited (OzArk). Input and technical assistance was also provided by Dr Gilbert Whyte of Ecobiological and Dr Arthur White of Biosphere Environmental Consultants Pty Ltd (“BEC”). The resulting report is presented as Part 6 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “OzArk (2013a)”. The terrestrial ecology assessment of OzArk (2013a) was undertaken in accordance with the following guidelines.

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (DECC, 2004).
- *Draft Guidelines for Threatened Species Assessment* (DECC and DPI, 2005).
- *BioBanking Assessment Methodology (BBAM) and Credit Calculator Operational Manual* (DECC, 2008).
- *Threatened Species Assessment Guidelines: the Assessment of Significance* (DECC, 2007).
- *EPBC Act Policy Statement 1.1 Significant Impact Guidelines Matters of National Environmental Significance, May 2006* (DEWHA, 2006).

This subsection of the EIS provides a summary of the terrestrial ecology assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.7.2 Regional Setting

4.7.2.1 Central West Catchment

The DZP Site is located within the NSW Central West Catchment which comprises the Castlereagh, Bogan and Macquarie River valleys and covers approximately 92 000km². A wide diversity of landforms, vegetation species and communities occur within this catchment which is associated with two bioregions, namely:

- South-western Slopes Bioregion; and
- Brigalow Belt South Bioregion.

As a consequence of the confluence of the eastern and western influences, the Central West Catchment has a high level of biodiversity. At the time of European settlement, the catchment supported a complex mosaic of forests, temperate and semi-arid woodlands, wetlands, shrub lands, heaths and grasslands. Clearing and subsequent degradation have reduced this natural vegetation cover to a large number of small, isolated remnants on the less fertile and productive soils. For example, the Box and Ironbark woodlands which originally occupied large parts of the slopes and plains have been reduced by as much as 90%, and are now among the most significantly altered plant communities in NSW.

The Central West Catchment covers a wide diversity of landforms and vegetation, with more than 550 vertebrate species recorded in the catchment, 81 broad vegetation types (DEC, 2006) and 3 183 species of plants (CW CMA, 2013). There are 50 threatened flora species (22 endangered, 27 vulnerable and one species considered extinct) and 73 threatened fauna species (15 endangered and 58 vulnerable) listed in the schedules of the *Threatened Species Conservation Act 1995* (TSC Act) recorded in the Catchment or bioregion. Of these, five flora species (*Lepidium hysopifolium*, *Eucalyptus canobolensis*, *Zieria ingramii*, *Zieria obcordata* and *Rulingia procumbens*) and one fauna species (Purple Copper Butterfly – *Paralucia spinifera*) are considered endemic to the catchment. Of the remainder, many species would rely on retention, protection and enhancement of remaining woodland remnants, grasslands and wetlands.

The Central West CMA estimates that approximately 38% of the catchment is currently vegetated to some extent and 62% has been cleared (CW CMA, 2013).

4.7.2.2 Local Setting

The setting within which the Application Area is located has been highly cleared for agriculture with remnants of native vegetation largely restricted to the riparian corridors of the Macquarie River and tributaries, elevated hill tops and ridges and within road easements. OzArk (2013a) describes the local setting as supporting a mosaic of Box Gum Woodland, Fuzzy Box Woodland, Inland Grey Box Woodland, derived native grasslands and cleared / cropped land.

A review of the broad vegetation types of the Central West CMA mapped by *Reconstructed and Extant Distribution Native Vegetation in the Central West Catchment* (DEC, 2006) by OzArk (2013a) identified the following as occurring on and surrounding the proposed areas of disturbance (refer to *Figure 8* of OzArk, 2013a).

- Blakely's Red Gum – Yellow Box open woodland of the tablelands.
- Dry Woodland on rocky hills.
- Fuzzy Box woodland on flats and alluvial terraces.
- Inland Grey Box woodland.
- Mugga Ironbark – Box – White Cypress Pine woodland.
- River Red Gum riparian woodland/forest on floodplains.
- Tumbledown Red Gum – Black Cypress Pine – Red Box low woodland on hills.
- White Box – Kurrajong woodland.
- White Box – White Cypress Pine woodland.
- White Box woodland with a shrubby understorey.
- White Cypress Pine – Poplar Box – Bulloak woodland on footslopes and plains.
- Yellow Box woodland on flats and alluvial terraces of the slopes.

This diversity of vegetation communities is indicative of the varied landforms of the local setting, from alluvial flats and floodplains of the Macquarie River and tributaries through undulating plains and footslopes to steeper slopes, hills and ridges.

Dowds Hill, located on and to the east of the DZP Site, is one of the largest privately owned native vegetation remnants in the Central West CMA (approximately 800ha). While it is effectively an 'island' remnant within an agricultural landscape, some connectivity to smaller remnants of woodland is provided along fence lines, creek lines, roads and tree clumps to the Macquarie River.

Derived native grasslands, grazing country with scattered trees and tree clumps is the main vegetation community to be affected by the activity.

4.7.3 Assessment Methodology

4.7.3.1 Desktop Survey

Prior to the commencement of field survey, and again prior to completion, OzArk (2013a) reviewed various databases and previous investigations within the local and regional setting to gain an understanding of the biota that could be expected to occur within the DZP Site and associated areas of disturbance.

Table 4.52 identifies each of the database searches completed, the date of search and an overview of results.

Table 4.52
Biological Database Searches

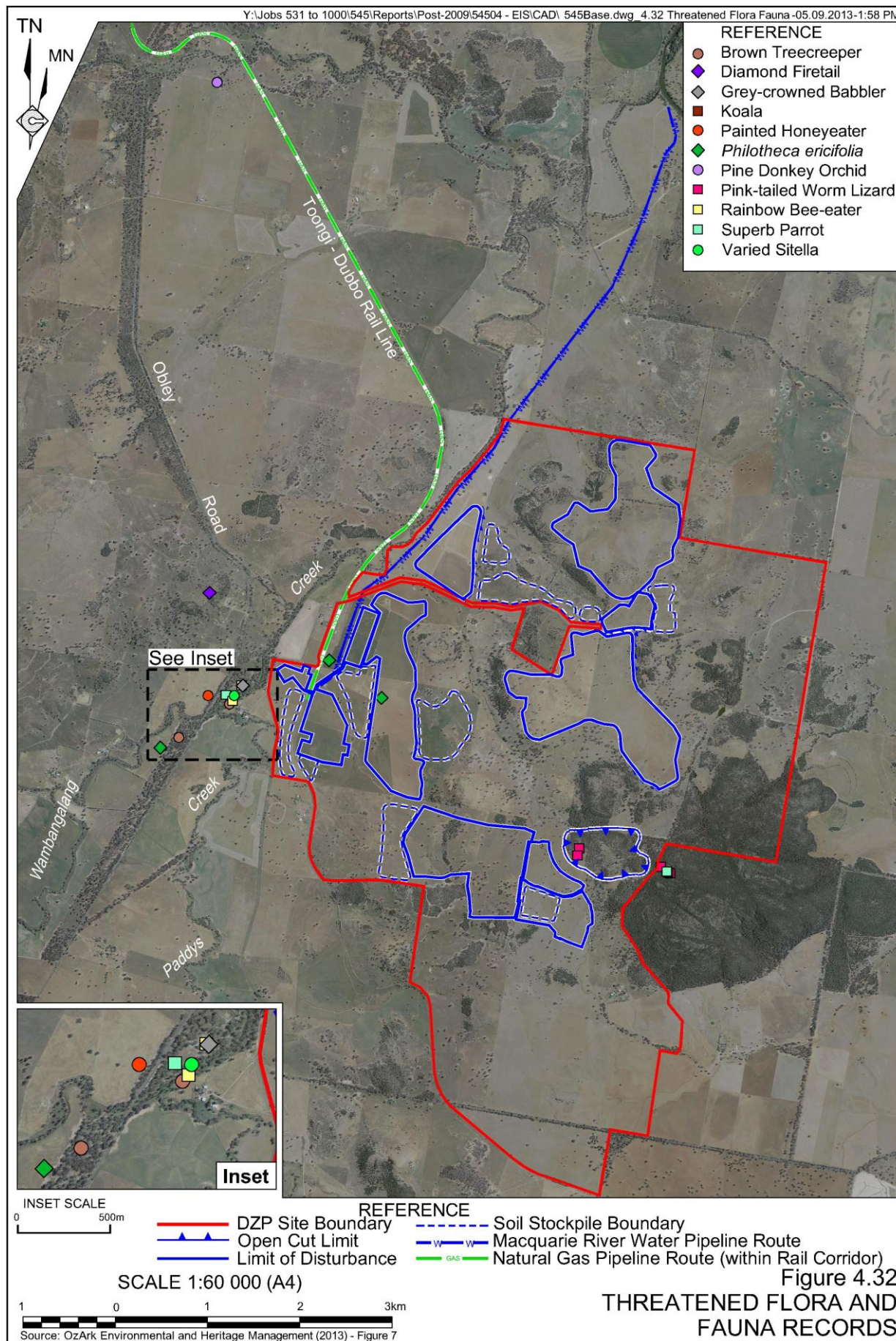
Database	Area searched (Date)	Results
NSW Government Wildlife Atlas	Central West - Talbragar Valley CMA (27 July 2012) Central West - Upper Slopes CMA (5 September 2012)	45 species within the Talbragar Valley subregion. 111 species within the Upper Slopes subregion. 4 threatened species identified within 10km of the Application Area.
Office of Environment and Heritage (OEH) Threatened Species online database	Central West (Upper Slopes) (22 August 2012)	104 species, populations or communities predicted or known to occur. Includes 52 species of threatened fauna, 10 species of threatened flora and 3 endangered ecological communities (EEC).
	Central West (Talbragar Valley) (30 August 2012)	94 items predicted or known to occur. Includes 48 species of threatened fauna, 10 species of threatened flora and 3 EECs.
DSEWPaC Register of Critical Habitat	Register of Critical Habitat (22 August 2012)	No habitats listed as 'Critical' are within the Application Area.
Office of Environment and Heritage – Critical Habitat Register	NSW Critical Habitat Register (22 August 2012)	No habitats listed as 'Critical' are within the Application Area.
Important Bird Areas (IBA)	Application Area (31 August 2012)	No IBA are located within the Application Area.
DSEWPaC Protected Matters (EPBC Act) Database	Dubbo LGA (31 August 2012)	5 Threatened Ecological Communities 23 Threatened Species 17 Migratory Species 17 Listed Marine Species
Atlas of Living Australia	5km radius centred on the Open Cut (31 August 2012)	9 threatened fauna species 2 threatened flora species.
NSW Department of Primary Industries – Fishing and Aquaculture Threatened and Protected Species Records Viewer	Dubbo LGA (31 August 2012)	Freshwater Catfish, Murray Cod and Trout Cod have been previously recorded in the Dubbo LGA.
Source: Modified after OzArk (2013a) – Table 3		

A full summary of the results of these searches is provided by *Appendices 1 and 2* of OzArk (2013a).

Based on the database searches, **Figure 4.32** provides a summary of the threatened flora and fauna identified on or immediately surrounding the DZP Site.

Records from the following field surveys completed locally were also reviewed by OzArk (2013a).

- Flora Study of the proposed Dubbo Zirconia Project, at Toongi via Dubbo, NSW, April 2002 (GCNRC 2002a).
- Flora Study of the proposed Dubbo Zirconia Project Railway Reserve Toongi, via Dubbo, May 2002 (GCNRC 2002b).
- Flora Study of the Proposed Dubbo Zirconia Project Toongi, via Dubbo. Proposed Water Pipeline Route, May 2002 (GCNRC 2002c).
- Vertebrate Fauna Study and Impact Assessment of the Proposed Dubbo Zirconia Project Area, at Toongi via Dubbo, NSW, April 2002 (Goldney, 2002).



The flora surveys of GCNRC (2002a, b, c) identified seven distinct vegetation communities on the areas of the DZP Site surveyed and along the alignments of the Toongi-Dubbo Rail Line and Obley Road reserve. Included was a community satisfying the classification as Box-gum Woodland, listed as critically endangered under the EPBC Act and as endangered under the TSC Act. No threatened flora species or populations were recorded.

The fauna survey of Goldney (2002) identified:

- 115 species of bird, including 11 threatened species listed under the TSC Act and 2 under the EPBC Act;
- 31 species of mammal (20 native) including 3 threatened microchiropteran bats;
- 21 species of reptile;
- 10 species of amphibian; and
- 3 species of fish (in Wambangalang Creek).

In particular, Goldney (2002) recorded several Pink-tailed Worm-lizards, the first record of this species in the Dubbo LGA.

4.7.3.2 Field Survey

4.7.3.2.1 Introduction

Although the studies and records summarised in Section 4.7.3.1 provide a valuable database of threatened species records within the vicinity of the DZP Site, additional field surveys were completed by OzArk in order to add to the knowledge of threatened species, populations and communities that could be affected by the Proposal.

By considering the likelihood of occurrence of the various threatened biota, OzArk (2013a) was able to tailor field surveys to maximise the potential to observe these species should they occur on DZP Site, other component areas of the Proposal or surrounds.

4.7.3.2.2 The Study Areas

The area of assessment considered by OzArk (2013a) comprised four study areas, coinciding with the four component areas of the Proposal, namely:

- the DZP Site;
- Macquarie River Water Pipeline Corridor;
- Toongi-Dubbo Rail Line and Natural Gas Pipeline Corridor; and
- Obley Road (sections for realignment).

4.7.3.2.3 Flora Survey

DZP Site

Following from the flora survey of GCNRC (2002a), which included 35 sample sites where species composition and species abundance data was recorded, and 50m x 50m quadrats were examined to record the occurrence of all ground cover species present, OzArk (2013a) completed a further 24 (20m x 20m) quadrats, and 24 x 50m transects through the native vegetation. The quadrats and transects were assessed in accordance with the BioBanking Assessment Methodology (BBAM) (DECC, 2009). In addition, approximately 30 hours of Random Meanders (following Cropper, 1993) were completed.

OzArk (2013a) reports that due to the homogeneity of the vegetation types within the DZP Site, plots were extrapolated and modelled, where appropriate. Additional plot data undertaken by Geoff Cunningham in 2001 was used to indicate the quality of vegetation where plots were not undertaken in 2012. OzArk (2013a) also applied Biometric benchmark data in areas where plots were not undertaken leading to conservative assessments of vegetation quality, i.e. the quality of some vegetation is likely to be overestimated.

Figures 16 and 17 of OzArk (2013a) present the locations of the vegetation plots and transects over the DZP Site (of both GCNRC, 2002a, and OzArk, 2013a).

Toongi-Dubbo Rail Line

Following GCNRC (2002b), who completed 12 long transects covering the entire length (between Toongi and Dubbo) and selected 50m x 50m quadrats, OzArk (2013a) completed 27 additional spot checks using the Random Meander Technique (Cropper, 1993) to locate rare or threatened species identified as having been previously identified or likely to occur based on the desktop analysis documented in Section 4.7.3.1.

Macquarie River Water Pipeline

Following GCNRC (2002c), who used stereoscopic interpretation of colour aerial photos to identify vegetation community features and boundaries followed by 13 transects covering the entire length of the alignment of the pipeline at that time and selected 50m x 50m quadrats, OzArk (2013a) completed random meanders at selected locations to locate rare or threatened species identified as having been previously identified or likely to occur based on the desktop analysis documented in Section 4.7.3.1.

Obley Road

OzArk (2013a) drove the entire length of Obley Road from Newell Highway to Toongi Road to map vegetation communities. The nine noted locations for road realignment were inspected on foot and aligned to a Biometric vegetation community (in accordance with BBAM). Individual trees in the zone of realignment were inspected for potential threatened species habitat. Two vegetation quadrats (20m x 20m), and two 50m transects through native vegetation within the road reserve was undertaken as per BBAM. As for the surveys of the Macquarie River Water Pipeline and Toongi-Dubbo Rail Line, the purpose of the survey was to locate rare or threatened species identified as having been previously identified or likely to occur based on the desktop analysis documented in Section 4.7.3.1.

Plant Identification

Plant identification was made according to recent nomenclature in Harden 1990 to 2002, Cunningham *et al.* 1992, and the PlantNet NSW Flora Online of the Royal Botanic Gardens and Domain Trust (RBG, 2011). The national conservation significance of flora was determined by referencing *Rare or Threatened Australian Plants* (ROTAP) (Briggs and Leigh, 2006) and the Schedules associated with the TSC Act or the EPBC Act.

Vegetation Mapping

Vegetation communities recorded by GCNRC (2002a,b,c) were transcribed into communities of 'best fit' in accordance with the BBAM (DECC, 2009) and incorporated into the vegetation maps generated by OzArk (2013a).

To further improve the accuracy of vegetation mapping, OzArk (2013a) collected Rapid Data Points (RDPs)³ across areas of intact vegetation in addition to plots collected in accordance with BBAM.

Targeted Surveys

OzArk (2013a) also undertook targeted surveys for the following flora groups.

- Terrestrial orchids. Undertaken during the relevant flowering periods, searches for two threatened orchids, Cobar Greenhood Orchid (*Pterostylis cobarensis*) (TSC and EPBC Acts) and Pine Donkey Orchid (*Diuris tricolor*) (TSC Act), were completed.
- Threatened (non-orchid) plant species. Searches for two species known to, or considered as likely to occur locally (*Philotheca ericifolia*, *Swainsona sp.*) were completed.
- Threatened Ecological Communities. Searches for five threatened ecological communities (TECs), considered as having the potential to occur locally, were completed. Assessment of the presence of any EEC was based on general reconnaissance of the Application Area, together with examination of detailed floristic plot survey as detailed above. Comparisons of delineated vegetation communities were made against species lists and descriptions provided in the relevant Final Determinations.

A more detailed description of the flora survey effort is provided by OzArk (2013a – Section 4.5).

³ Refer to Section 4.6.2.6 of OzArk 2013 for further description on the application of the RDP methodology.

4.7.3.2.4 Fauna Surveys

Following from Goldney (2002), OzArk completed various surveys of the DZP Site, Macquarie River Water Pipeline, Toongi-Dubbo Rail Line and Obley Road between February 2012 and May 2013. A complete record of the survey methods implemented is provided in *Sections 4.5.1 to 4.5.10* (and *Table 5*) of OzArk (2013a) which is summarised as follows.

- Echolocation: to identify the possible presence of any microchiropterans (small bats) that may be present. Sites were selected where habitats likely to be used by microchiropterans during their foraging and dispersal periods (i.e. woodlands and habitat ecotones) or as roosting sites (i.e. hollow-bearing trees where present) were present.
- Elliot Trapping: using Type A and Type B traps for small ground dwelling animals were positioned in suitable areas within and outside the proposed areas of disturbance in an attempt to capture an overview of locally occurring fauna.
- Hair Tube / Hair Funnel Traps: were placed in each of the fauna habitats present, particularly the woodland portions of the locality. Hair funnels were set out at 10m spaced intervals with collected hairs analysed by a specialist in the field.
- Call Playback: followed the methods described by Kavanagh and Peake (1993) and Debus (1995) targeting the following threatened species: Koala (*Phascolarctos cinereus*); Bush Stone Curlew (*Burhinus grallarius*); Malleefowl (*Leipoa ocellata*); Powerful Owl (*Ninox strenua*); Masked Owl (*Tyto novaehollandiae*); and Barking Owl (*Ninox connivens*).
- Bird Survey (Diurnal and Nocturnal): was undertaken in all vegetation types with targeted bird watching was undertaken near any habitat trees to identify possible nesting or roosting areas. Birds were identified via visual observation and characteristic call. Any incidental observations or records made whilst traversing the site or conducting additional surveys were noted.
- Spotlighting: undertaken either on foot or by motor vehicle for sessions lasted from 60 to 120 minutes, with tracks, clearings and access ways being targeted.
- Scat and Tracks: all scats and raptor pellets encountered during the course of the field survey were collected and examined to determine species presence.
- Herpetofauna Survey (Nocturnal and Diurnal): consisting of hand searches for frogs and reptiles under rocks, logs, bark, ground debris and other debris around watercourses and dams were conducted at the same time as the bird surveys and opportunistically during all other activities within the Application Area. The habitat of the Application Area was assessed in terms of its suitability for threatened herpetofauna species.
- Aquatic habitat survey / frog survey: of watercourses, creeks and water bodies within the DZP Site were assessed for the potential to provide habitat for threatened frogs. Tadpoles that were caught were transferred to a clear plastic container, identified and returned to the site of capture. Dr Arthur White of Biosphere Environmental Consultants Pty Ltd (BEC) assisted for species

identification when on site. A survey for threatened fish and other aquatic ecology was conducted by AHA (2013) Part 7 of the *Specialist Consultant Studies Compendium*).

- Wetland and Migratory Bird Census: was undertaken over those areas of the Wambangalang Creek floodplain, Macquarie River Water Pipeline and Toongi-Dubbo Rail Line associated with the Macquarie River floodplain. The census included a meandering walk for visual observations and acoustic noting of bird calls.
- Opportunistic sightings (Platypus): known to occur in Wambangalang Creek and the Macquarie River, survey included a general assessment for likely habitat in potential platypus habitat areas and a survey of banks for burrow structures in the of areas of river bank which may be impacted by the installation of the water pipeline and any waterway crossings.
- Habitat Assessment: in which an assessment of the relative value of the habitat present within the various components of the Application Area was undertaken. This assessment focused primarily on the identification of specific habitat types and resources on the site favoured by known threatened species from the region. Where areas had a combination of key habitat elements which were more likely to provide an environment in which a threatened plant would be recorded, it was given closer inspection.
- Pink-tailed Worm-lizard: Specialist targeted assessment for *Aprasia parapulchella* was undertaken by herpetofauna expert Dr Arthur White (of BEC). Dr White has completed five field survey campaigns, assisted by OzArk or members of Dubbo Field Naturalist & Conservation Society for some, between March 2012 and May 2013. Surveys included overturning surface rocks in areas of likely habitat to expose resident lizard (or sloughed skin) which are generally found within ant nests. Dr White also completed a habitat assessment based on a habitat scoring scheme developed for the purpose of assessing a proposed offset strategy for the species to satisfy the EPBC Act Offset Policy of DSEWPaC (DSEWPaC, 2012).
- Other surveys completed relevant to the Pink-tailed Worm-lizard included the field survey and observations of Goldney (2002) and survey of specific habitat parameters including soil type, vegetation coverage, slope and ant species present completed by Dr Gilbert Whyte of Ecobiological (Kleinfelder, 2013)⁴. The specific methodologies and results of the surveys by BEC and Ecobiological are included in separate reports appended to OzArk (2013a).

Figures 13 to 15 of OzArk (2013a) provide the locations of the various fauna survey effort over the DZP Site.

⁴ Provided as Appendix A of Pink-tailed Worm-lizard Plan Of Management (Appendix 13 of OzArk, 2013a)

4.7.4 Identified Flora and Fauna

4.7.4.1 Flora

4.7.4.1.1 Vegetation Communities

DZP Site

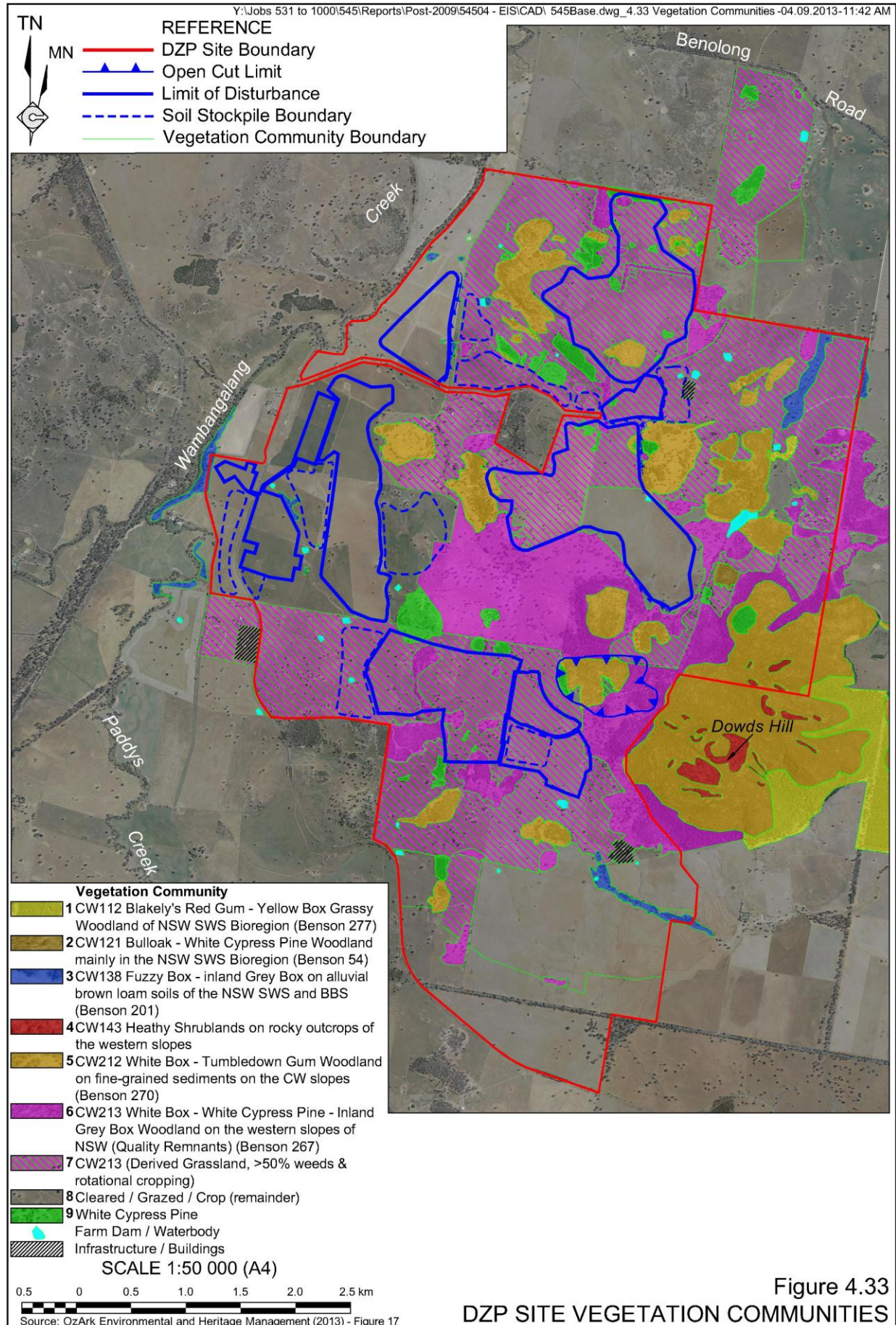
While a large proportion of the DZP Site has been cleared, OzArk (2013a) identified that significant areas retain native groundcover species with other areas providing remnant native woodland formations, generally in associated with watercourses or land unsuitable for tilling. The dominant canopy species are Fuzzy box, Inland grey box, Tumbledown gum, Black cypress pine, White cypress pine, Bulloak, White box and Blakely's red gum, with groundcover of generally poor diversity and structural complexity and very low levels of natural recruitment.

Considering the description of vegetation communities for the central west catchment under BBAM, OzArk (2013a) mapped the following six native vegetation communities within the DZP Site (see **Figure 4.33**). The New South Wales Vegetation Classification & Assessment Database Project (NSWVCA) reference of Benson et al. (2006) is also included where relevant.

- CW112: Blakely's Red Gum – Yellow Box Grassy Woodland of NSW South West Slopes Bioregion (Benson 277).
- CW121: Bulloak – White Cypress Pine Woodland mainly in the NSW South West Slopes Bioregion (Benson 54).
- CW138: Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion (Benson 201). This community is a component of the Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions EEC.
- CW143: Heathy Shrublands on rocky outcrops of the western slopes.
- CW212: White Box - Tumbledown Gum Woodland on fine-grained sediments on the Central NSW central western slopes (Benson 270).
- CW213: White Box - White Cypress Pine - Inland Grey Box Woodland on the western slopes of NSW (Benson 267). This community is a component of the White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland) EEC.

OzArk (2013a) further categorised this vegetation community on the basis of species diversity, formation and land use as follows.

- CW213 Quality Remnants: representing those areas with >50% native groundcover and / or possessing a native mid and upper stratum (and which have not been subject to cropping); or
- CW213 Derived Grasslands: as described by Benson (1996) and representing those areas with >50% weeds and which have and continue to be subject to rotational cropping.



Macquarie River Water Pipeline

OzArk (2013a) reports that the vegetation within the Macquarie River Water Pipeline easement is predominantly cropped and grazed paddocks. A BBAM equivalent community could not be correlated to the vegetation in the easement, however, tree clumps and scattered trees indicate that this area was once Fuzzy Box, Yellow Box, Inland Grey Box associated communities.

Toongi-Dubbo Rail Line

OzArk (2013a) reports that vegetation within the Obley Road reserve generally contains White Box, Yellow Box, Fuzzy Box Woodland or Inland Grey Box communities. Within those sections proposed for realignment, small areas of the following EECs were mapped.

- CW213: White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland).
- CW145: Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions.

4.7.4.1.2 Threatened Ecological Communities

DZP Site

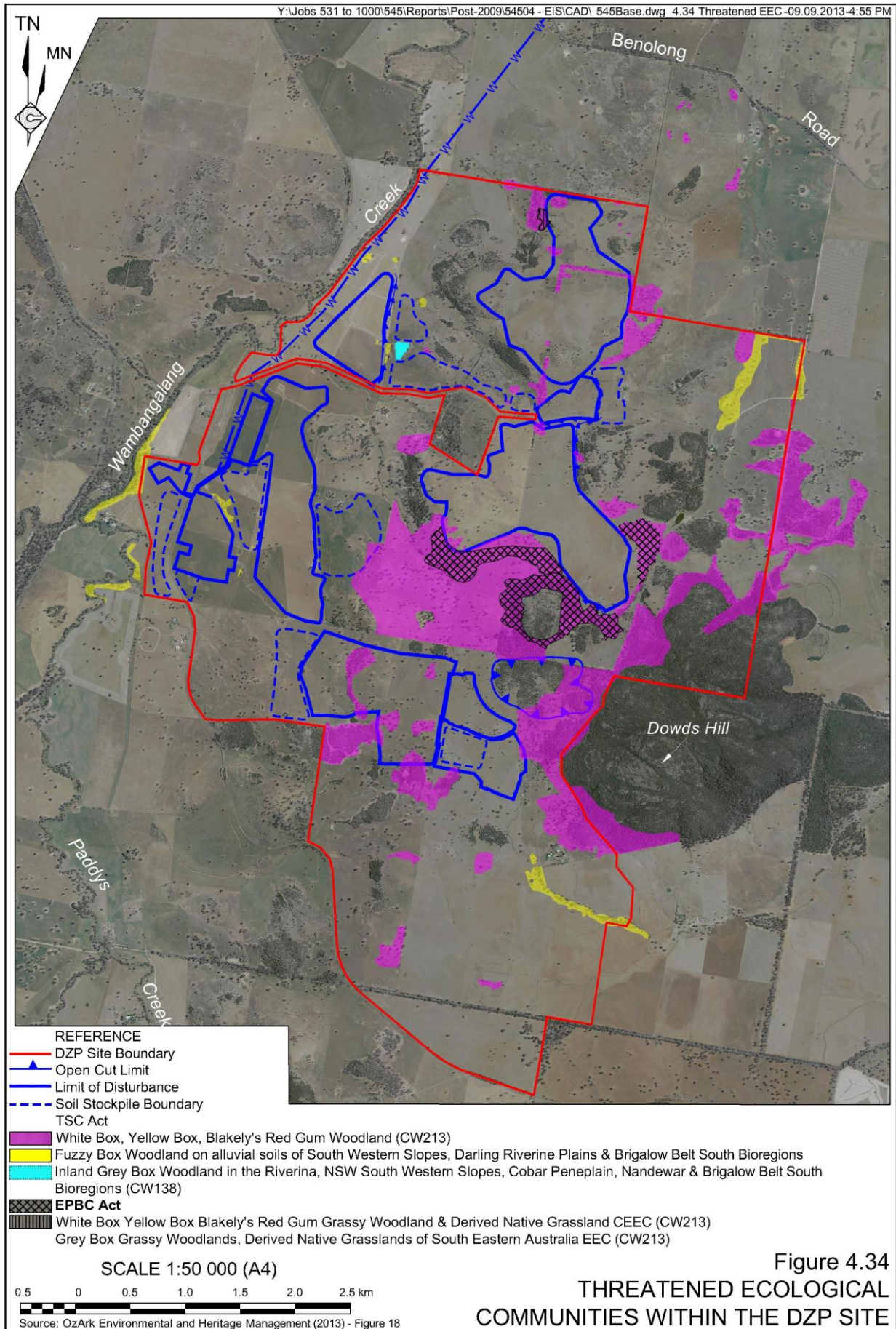
Two TSC Act listed EECs have been mapped by OzArk (2013a) within the DZP Site.

- White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland) (CW213).
- Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions (CW138).

Two communities meeting the classification of EPBC Act listed TECs were recorded by Ozark (2013a) within the DZP Site.

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Ecological Community (CEEC). The area of this community mapped occurs within the CW213 vegetation community and it is generally considered coincident with the Box-Gum Woodland EEC (under the TSC Act), although more stringent criteria apply to categorisation as a TEC under the EPBC Act.
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia EEC. The area of this community mapped on the DZP Site also classifies as part of the CW213 vegetation community (as it is likely that White Box would have been a dominant part of the canopy at one stage).

Figure 4.34 presents the mapped locations of the TECs of the DZP Site.



Obley Road Reserve

Along the alignment of Obley Road, two TSC Act listed EECs have also been identified by OzArk (2013a).

- White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland) (CW213).
- Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (CW145).

No threatened ecological communities are present within the proposed Macquarie River Water Pipeline easement or Toongi-Dubbo Rail Line and Gas Pipeline Corridor.

4.7.4.1.3 Flora Species

A complete list of the flora identified within the DZP Site is provided by OzArk (2011a), a summary of which is as follows.

DZP Site

A total of 234 species of vascular flora were recorded by OzArk (2013a), including 67 (28%) introduced species. This reflects the effect of a long history of grazing and ploughing in some areas within the DZP Site.

No threatened species were recorded within the DZP Site by OzArk (2013a), although it is noted that *Philotheca ericifolia* was recorded on Dowds Hill adjacent to the DZP Site by GCNRC (2002a). There is also a previous recording of *Philotheca ericifolia* approximately 1km south of Toongi collected in 1964, however, this location which is now a cropped paddock. The locations of both records are outside the DZP Site and proposed impact footprint.

Seven species of protected orchid species (under Schedule 13 – *National Parks and Wildlife Act*) were also recorded within the DZP Site.

Toongi-Dubbo Rail Line

GCNRC (2002b) recorded 260 plant species within the corridor including 115 (44%) introduced species. These introduced species account for the bulk of the ground cover and biomass present.

No threatened plants were recorded by either GCNRC (2002b) or OzArk (2013a), however the protected plant species (under Schedule 13 – *National Parks and Wildlife Act*), *Diuris* sp. and *Microtis unifolia*, were recorded.

Macquarie River Water Pipeline

A total of 94 plant species were recorded, including 49 (52%) introduced species, by GCNRC (2002c). Additional species were not recorded by OzArk (2013a). OzArk (2013a) states that current disturbance precludes threatened species of flora from occurring.

Obley Road Reserve

Vegetation within the Obley Road reserve generally contains White Box, Yellow Box, Fuzzy Box Woodland or Inland Grey Box Communities that form part of the State and/or national listed ecological communities.

4.7.4.2 Fauna

4.7.4.2.1 Fauna Habitats

Habitat Types

Five main habitat types were identified that are likely to be altered (impacted or enhanced) by the Proposal. These are as follows.

- Woodlands: which can be further defined as:
 - semi-closed woodland associated with trachyte hills;
 - dense woodland associated with the slopes of Dowds Hill;
 - open grassy woodland on undulating slopes (mainly within vegetation community CW213); or
 - riparian woodland associated with waterways.
- Heath Scrub.
- Woodland/Grassland Ecotone.
- Wetland and Dam Habitat.
- Derived Grassland / Cleared Areas and Improved Pastures.

Each habitat type would provide different features and resource materials important to the survival of native fauna. Refer to *Section 5.5.1* of OzArk (2013a) for a full description of these features and resources and the species most likely to utilise these.

Koala Habitat

While the Dubbo LGA is listed not listed in Schedule 1 of SEPP 44, and as such SEPP 44 does not apply to the Proposal, there are previous records of Koalas within the Application Area. OzArk (2013a) have therefore used the framework of SEPP 44 to identify whether the Application Area as "potential koala habitat" based on the presence of 'feed trees' species. The Applicant Area is not considered "core koala habitat given the lack of recent Koala records or presence of a breeding population. Due to clearing on the alluvial flats, it is unlikely that koala movement would be facilitated from the riparian regions to the east across the Application Area. Thus it is only considered possible that sporadic transient Koalas may occur in the Application Area.

Habitat Corridors

Regionally, the Application Area is likely to provide corridors for the movement of native fauna along vegetated remnants, such as Obley Road, Toongi-Dubbo Rail Line and various creeks, and islands of habitat, such as Dowds Hill, for more mobile species.

The vegetation in the DZP Site provides connectivity with the Macquarie River and large areas of remnant native vegetation including Dowds Hill (adjacent to the open cut), Goobang National Park (30km southwest) and Momo State Forest (20km west) via connection to the remnant vegetation associated with Obley Road reserve, Wambangalang Creek. Obley Road, in particular, has a wide vegetated road reserve where Travelling Stock Routes were once located.

The levels of existing disturbance combined with the thin, linear nature of the remnants within and surrounding the DZP Site and wider Application Area reduce the potential value of these remnants as wildlife corridors for ground dwelling animals within the Critical Weight Range, namely those species with a body mass of between approximately 35g and 5.5kg that are most likely to be threatened or in decline.

Pink-tailed Worm-lizard Habitat

Following confirmation of the occurrence of the Pink-tailed Worm-lizard on the DZP Site, further research has been commissioned by the Applicant to identify potential Pink-tailed Worm-lizard habitat and determine what represents low, moderate and high quality habitat for the species. The factors contributing to the quality of habitat are considered in greater detail in a preliminary *Pink-tailed Worm-lizard Plan of Management* prepared by Biosphere Environmental Consultants Pty Ltd (refer to *Appendix 13* of OzArk, 2013a), however, can be summarised as follows.

- Pink-tailed Worm-lizard has strong associations with sloping, well drained, open landscapes characterised by outcroppings of lightly embedded surface rocks (Wong, 2011).
- Pink-tailed Worm-lizard prefers a grassy ground layer with little to no leaf litter, and relatively low tree and shrub cover (Osborne et al, 1991; Osborne and McKergow, 1993; Michael and Herring, 2005; Robertson and Heard, 2008).
- Pink-tailed Worm-lizard prefers grassland with a high diversity and abundance of native grasses (Osborne and McKergow, 1993; Jones, 1999; Osborne, 1991).
- Pink-tailed Worm-lizard has been identified almost exclusively below lightly embedded surface rocks which are believed to be important for thermoregulation (Jones, 1992) and occurrence of ant nests (on which it feeds, Web and Shine, 1994; Wong, 2011).
- The occurrence of Pink-tailed Worm-lizards appears to be correlated to the underlying geology with most occurrences on intermediate volcanics, some occurrences on basalt, and almost never on sedimentary rocks and never on alluvial soils.
- The diet of Pink-tailed Worm-lizard consists almost exclusively of ant broods (Web and Shine, 1994; Wong, 2011).

On the basis of these habitat indicators, a habitat scoring scheme was developed and the available habitat of the DZP Site mapped. **Figure 4.35** presents the mapped habitat of the Pink-tailed Worm-lizard over the DZP Site. Strong correlation between areas mapped as high and moderate habitat and recorded occurrences of Pink-tailed Worm-lizard suggest the habitat scoring scheme is accurate.

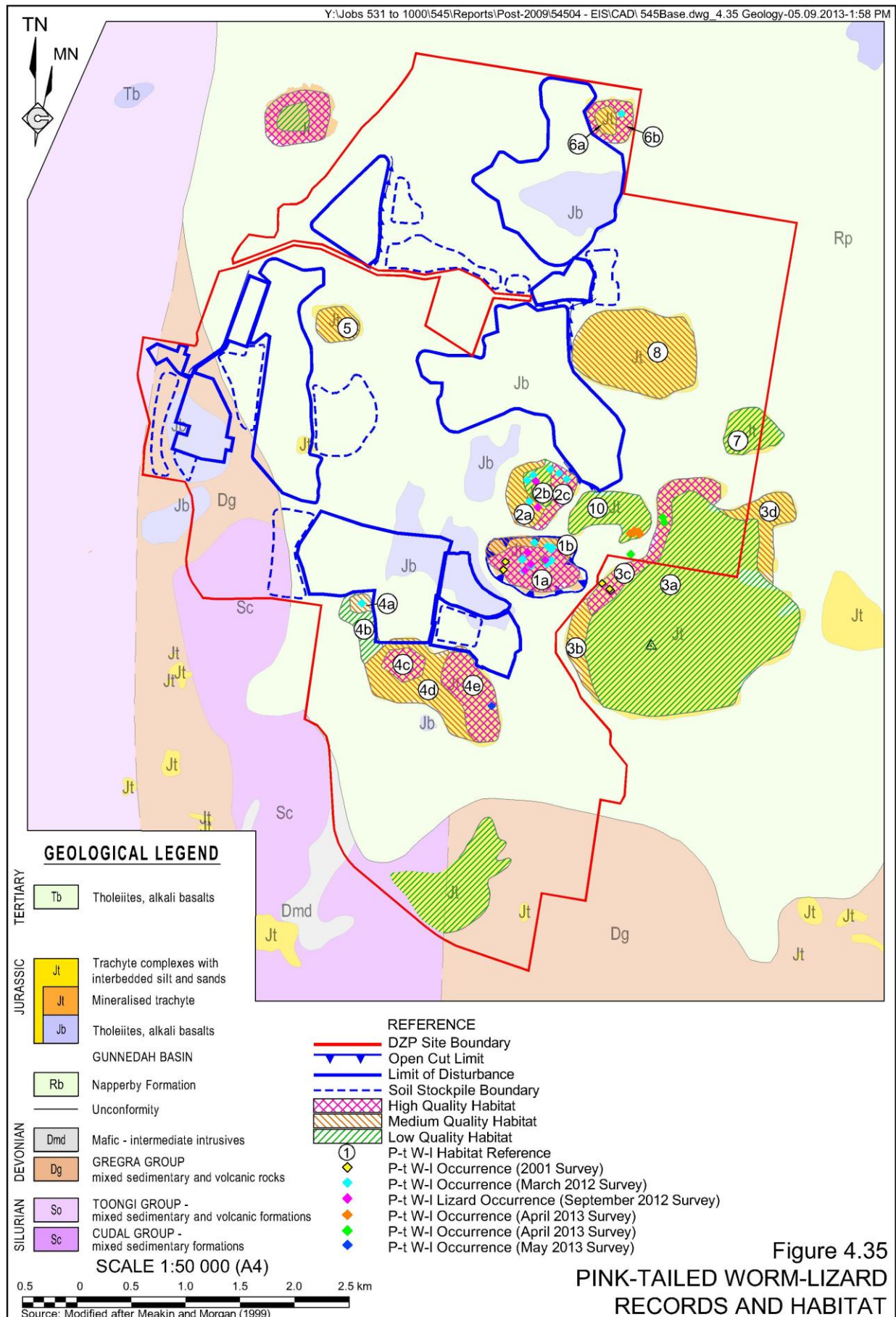


Figure 4.35
PINK-TAILED WORM-LIZARD
RECORDS AND HABITAT

4.7.4.2.2 Fauna Species

OzArk (2013a) records a total of 185 vertebrate fauna species (178 native and 7 introduced) within the Application Area comprising the following.

- 23 reptile species.
- 9 frog species.
- 117 bird species (115 native and two introduced).
- 36 mammal species (31 native and 5 introduced species).

OzArk (2013a – *Appendix 4*) provides a complete list of the fauna recorded.

4.7.4.2.3 Threatened Fauna

Table 4.53 provides a summary of the threatened fauna recorded on or adjacent to the Application Area by OzArk (2013a), Goldney (2002) or other sources (and registered on the NSW Wildlife Atlas (DECCW 2009b)). **Figure 4.36** presents the location of the recorded threatened species within the DZP Site.

Table 4.53
Biological Database Searches

Page 1 of 2

Species	Listing		Source		
	TSC Act	EPBC Act	OzArk (2013a)	Goldney (2002)	NSW Wildlife Atlas
Great Egret (<i>Ardea alba</i>)		Y	Y		
Superb Parrot (<i>Polytelis swainsonii</i>)	Y	Y	Y		
Pink-tailed Worm-lizard (<i>Aprasia parapulchella</i>)	Y	Y	Y		
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	Y	Y	Y		
Greater Long-eared Bat (<i>Nyctophilus timoriensis / corbeni</i>)	Y	Y	Y		
Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>)	Y		Y		
Little Eagle (<i>Hieraaetus morphnoides</i>)	Y		Y	Y	
Flame Robin (<i>Petroica phoenicea</i>)	Y		Y	Y	
Eastern Bentwing Bat (<i>Miniopterus schreibersii orianae oceanensis</i>)	Y		Y		
Barking Owl (<i>Ninox connivens</i>)	Y		Y	Y	
Brown Tree-creeper (<i>Climacteris picumnus</i>)	Y		Y	Y	
Diamond Firetail (<i>Stagonopleura guttata</i>)	Y		Y	Y	
Glossy Black Cockatoo (<i>Calyptorhynchus lathami</i>)	Y		Y		
Grey-crowned Babbler (<i>Pomatostomus temporalis temporalis</i>)	Y		Y	Y	
Hooded Robin (<i>Melanodryas cucullata</i>)	Y		Y	Y	
Little Pied Bat (<i>Chalinolobus picatus</i>)	Y		Y		
Speckled Warbler (<i>Pyrrholaemus saggitatus</i>)	Y		Y	Y	
Yellow-bellied Sheath-tail bat (<i>Saccolaimus flaviventris</i>)	Y		Y		
Swift Parrot (<i>Lathamus discolor</i>)	Y	Y		Y	

Table 4.53 (Cont'd)
Biological Database Searches

Page 2 of 2

Species	Listing		Source		
	TSC Act	EPBC Act	OzArk (2013a)	Goldney (2002)	NSW Wildlife Atlas
Koala (<i>Phascolarctos cinereus</i>)	Y	Y		Y	
Spotted Harrier (<i>Circus assimilis</i>)	Y			Y	
Square-tailed Kite (<i>Lophoictinia isura</i>)	Y			Y	
Rainbow Bee-eater (<i>Merops ornatus</i>)		Y			Y
Black-chinned Honeyeater (<i>Melithreptus gularis gularis</i>)	Y				Y
Masked Owl (<i>Tyto novaehollandiae</i>)	Y				Y
Grey Falcon (<i>Falco hypoleucos</i>)	Y				Y
Painted Honeyeater (<i>Grantiella picta</i>)	Y				Y
Varied Sittella (<i>Daphoenositta chrysoptera</i>)	Y				Y
Source: Modified after OzArk (2013a) – Section 5.4.3					

Of greatest significance is the occurrence of the Pink-tailed Worm-lizard, not previously known from the Dubbo region. To date, 35 individual lizards have been identified within five of the habitat areas identified over the DZP Site (see **Figure 4.35**). As illustrated by **Figure 4.35**, with the exception of those individuals recorded within Habitat Area 1 over the open cut, the site layout has been designed/arranged to avoid impact on this species and areas of high quality habitat.

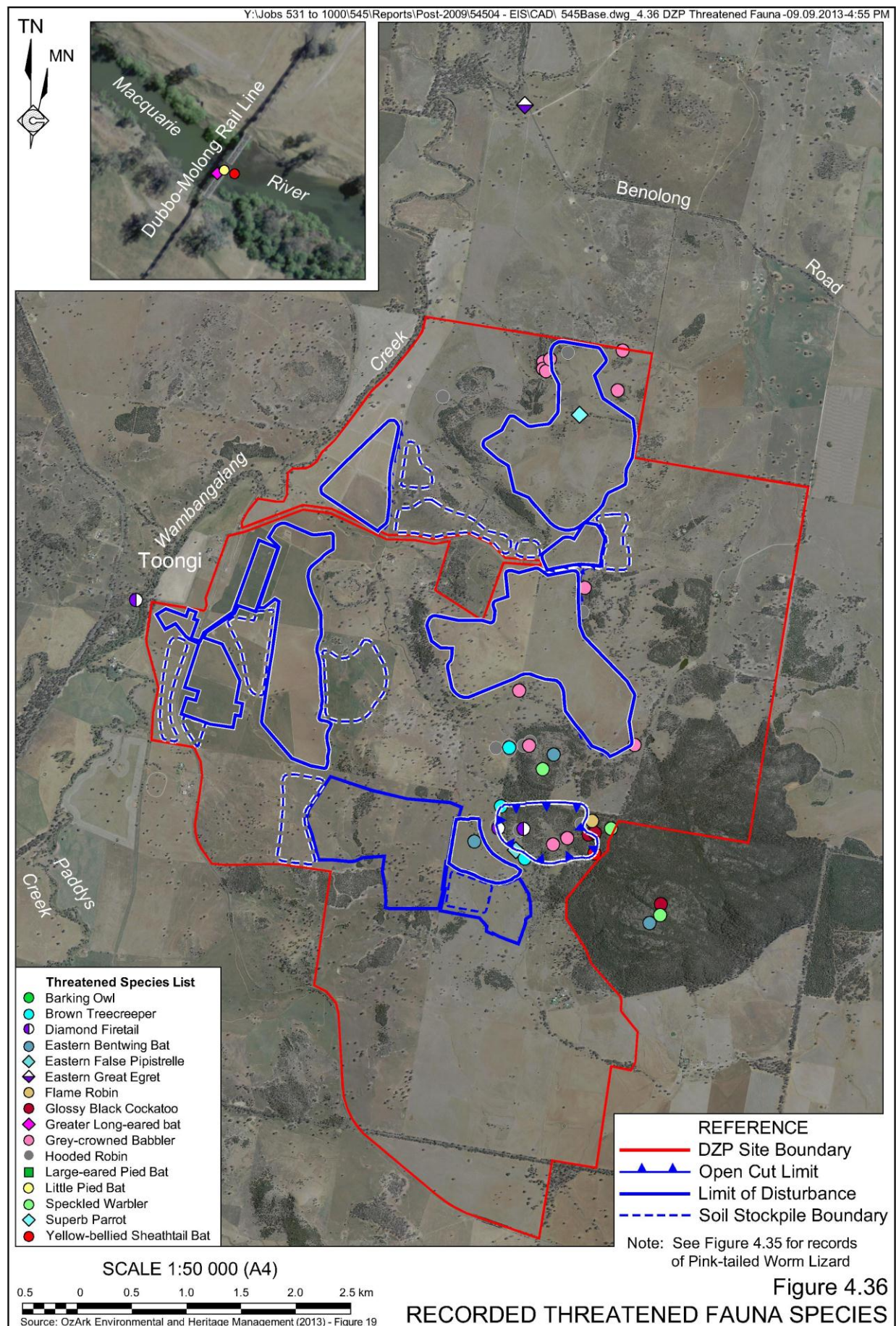
4.7.4.3 Subject Species and Communities

Subject species are those threatened species or communities identified on, or considered as having the potential to occur in the habitats present within the four study areas defined in Section 4.7.3.2.2 (DEC, 2004).

Based on the known records and predicted occurrences of threatened flora and fauna generated by these desktop studies, OzArk (2013a) considers the likelihood of each identified species or community to occur. Based on database or other records, presence or absence of suitable habitat, features of the defined study areas, results of the field survey (refer to Section 4.7.4) and professional judgement, the likelihood of occurrence was defined by OzArk (2013a) as follows.

- “Yes” = the species was or has been observed on the site.
- “Likely” = a medium to high probability that a species uses the site.
- “Potential” = suitable habitat for a species occurs on the site, but there is insufficient information to the species as likely to occur, or unlikely to occur.
- “Unlikely” = a very low to low probability that a species uses the site.
- “No” = habitat on-site and in the vicinity is unsuitable for the species.

Appendix 3 of OzArk (2013a) provides the detailed assessment of likelihood.



Of an original list of 97 threatened species and communities either previously recorded or predicted to occur within the local setting, OzArk (2013a) have refined this list to 70 species and communities including:

- 5 (of an original list of 6) threatened ecological communities (all of which have been identified);
- 9 (of an original list of 20) threatened plant species; and
- 56 (of an original list of 71) threatened and/or migratory fauna species (including 22 known to occur, 6 likely to occur and 28 species that may occur).

The complete list of 70 species and communities, along with their status as recorded, likely to occur, potentially occurring or unlikely to occur, is provided by *Table 4* of OzArk (2013a).

4.7.5 Management and Mitigations Measures

4.7.5.1 Introduction

In line with Step 4 of the *Draft Guidelines for Threatened Species Assessment* (DECCW and DoP, 2005), the Applicant has designed the Proposal to minimise impacts on threatened species by avoiding, then mitigating and finally offsetting impacts. The following subsections present the design features, operational controls and management measures proposed to avoid, then minimise and then offset impacts on local flora and fauna.

Given the proposed direct impacts on the Pink-tailed Worm-lizard, specific impact avoidance and mitigation measures are presented in Sections 4.7.5.2.2 and 4.7.5.4.2. Section 4.7.5.4.3 presents additional mitigation measures specific to other threatened species which could be potentially impacted by the Proposal.

4.7.5.2 Avoidance of Impacts

4.7.5.2.1 Native Vegetation

The following impact avoidance measures have been adopted by the Applicant.

- The site of the proposed processing operations and related infrastructure has been located over land which has been cleared of most trees for cropping and grazing and has been regularly cultivated for many years, i.e. there is no remnant native vegetation.
- The areas targeted for the positioning of disturbance associated with the management of waste materials and residues generated by the mining and processing operations considered local landforms and vegetation with efforts made to exclude the following areas.
 - Threatened ecological communities listed under the EPBC and TSC Acts.
 - The remnant vegetation of Dowds Hill, identified by OzArk (2013a) as a regionally significant remnant.

- Larger and intact remnants of native woodland vegetation, in particular, those wooded hill tops to the north of the open cut and north of Dowds Hill.
- Major watercourses, several of which contain the Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions.

It is noted that in identifying preferred areas for disturbance, areas of higher quality agricultural land was also attempted to be avoided.

- All areas suitable for listing as EPBC Act listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC have been avoided through re-design of the Proposal. Furthermore, 61.8ha of this community would be protected in perpetuity within the Biodiversity Offset Area.
- The size and location of the LRSF was redesigned to reduce the impact on the TSC Act Listed NSW Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions EEC to 0.1ha (on the margin of the Processing Plant Area). It is likely that in final design of the LRSF, this 0.1ha would be avoided along with the remaining 21.9ha which would be protected in perpetuity within the proposed Biodiversity Offset Area.

4.7.5.2.2 Pink-tailed Worm-lizard

In order to avoid as many known records of the Pink-tailed Worm-lizard (see **Figure 4.35**), and minimise the potential for impacts on additional species, the Applicant undertook the following impact avoidance.

- The design of the SRSF was modified to avoid a known occurrence of the species on moderate quality habitat (Habitat Area 4a).
- Several of the proposed cells of the Salt Encapsulation Cells have been modified to avoid impact on high quality habitat associated with a known occurrence of the species (Habitat Area 4e).
- The design of LRSF Area 4 was modified to avoid the known recorded and high quality habitat of Habitat Area 6.
- Several proposed soil stockpile locations have been discounted due to encroachment of areas of high or moderate quality habitat (in particular Habitat Area 4).

Impact on high and moderate quality habitat over the open cut is unable to be avoided given this represents the location of the ore body. Section 4.7.5.4.2 provides for proposed mitigation measures to be implemented to reduce the impact of this disturbance. An additional small area (1.6ha) of medium quality habitat (of Habitat Area 4) could not be completely avoided due to the large areas required for these structures and objective to locate these away from remnant native vegetation wherever possible. The proposed offsetting of these residual impacts is discussed in Section 2.17.8 and assessed in Section 4.7.6.2.

4.7.5.3 Minimisation of Impacts

In addition to the impact avoidance measures noted in Section 4.7.5.2, the following impact minimisation would be implemented by the Applicant.

- Noting the largest area of impact would be associated with the LRSF, the Applicant has, at significant cost, continued to modify the processing operations to improve water efficiency. Through this process optimisation, the water required has been reduced by approximately 20% since the Planning Focus Meeting, in turn reducing the area required for the LRSF.
- Further reducing the areas required for the LRSF, the Applicant has committed to the construction of a reverse osmosis water recycling plant to further reduce the volume of liquid residue discharged to the LRSF. The process and water recycling optimisation has reduced the overall liquid residue generation by 50%, in turn reducing the area required for the LRSF.
- As the area required for the LRSF has been reduced, the Applicant targeted exclusion of those LRSF Areas located on more ecologically sensitive areas. In particular, LRSF Area 7 to be located on the “Ugothery” property to the north of Dowds Hill would have impacted on areas of two EECs, White Box - Yellow Box - Blakely’s Red Gum Grassy Woodland EEC and Fuzzy Box Woodland EEC.
- Cell C of the SRSF has been modified to minimise the area of disturbance to the White Box - Yellow Box - Blakely’s Red Gum Grassy Woodland EEC.
- Ancillary areas of disturbance such as soil stockpiles have also been modified to minimise impacts on EECs. No soil stockpile area is now located over areas mapped as EECs.

4.7.5.4 Mitigation of Impacts

4.7.5.4.1 Vegetation Clearing

In order to mitigate the unavoidable impacts resulting from vegetation clearing, the Applicant would implement the following design features, operational controls and management measures.

- Induct and train employees and contractors on environmental requirements and procedures.
- Only clear sufficient vegetation for the subsequent 12 months operation only.
- Ensure that all areas of proposed disturbance are clearly marked on the ground prior to the commencement of clearing campaigns to minimise the potential for over clearing of vegetation.
- Install appropriate erosion and sediment control measures prior to vegetation clearing activities.

- Directly transfer stripped soil materials onto rehabilitation areas where practicable to maximise the opportunity for retention of the natural seed stock, and thereby maximise the revegetation of the final landform with endemic species.
- Spray weeds, where appropriate, prior to the topsoil stripping activities to avoid their proliferation on stockpiles or in subsequently rehabilitated areas.
- Undertake a program of weed control prior to soil stripping activities and following re-vegetation to ensure native plants are not overgrown during their early periods of growth.
- Undertake vegetation clearing operations, where practicable, between April and September to limit adverse impacts on tree dependent avifauna and microchiropteran bats.
- Engage a suitably qualified ecology expert to undertake a pre-clearance study of all areas to be disturbed and to relocate any identified threatened fauna to suitable habitat.
- Undertake all clearing of trees in accordance with a *Vegetation Clearing Protocol* (VCP). The VCP would require clearing of mature trees to be undertaken as follows.
 - Check all trees for the presence of nesting or roosting fauna before felling or pushing then start tree removal immediately after visual inspection.
 - When a tree with hollows requires removal, the tree is to be gradually nudged at intermittent intervals so that any animal occupying a habitat tree has the chance of vacating the area after the initial disturbance period.
 - Avoid leaving trees on ground unmanaged for more than two weeks as these would quickly become habitat for hollow dependent species.
- Familiarise⁵ staff undertaking pre-clearing assessments prior to the clearing campaign in order to:
 - ensure they understand the nature and extent of each stage clearing;
 - determine what habitats are to be affected, the species which could be effected and how to manage species that may be affected by the activity; and
 - orientate themselves with the location, nature and extent of unaffected habitat so that they would know the best locations to release relocated fauna.
- Salvage tree trunks, major limbs and, if practicable, minor branches for use in rehabilitation of the DZP Site or enhancement of the BOA. If material is stockpiled, signs would be erected noting the significance and importance of this material for future rehabilitation and habitat creation.
- Confine, where practicable, vehicular access to formed and marked roads and tracks.

⁵ The best seasonal timing for staff familiarisation and clearing plan preparation would be in spring when breeding hollows / nests are easier to detect.

- Limit vehicle speeds within the DZP Site to limit the potential for vehicle trauma to wildlife.
- Following completion of clearing operations, fence, as appropriate, sections of the DZP Site not required for ongoing operations to limit access by non-authorised personnel.
- Revegetate the DZP Site as described in Section 2.17 and in accordance with a *Mining Operations Plan*, or equivalent *Rehabilitation Management Plan* required by DRE, to be prepared prior to the commencement of activities on the DZP Site.
- Ensure species used during rehabilitation operations are consistent with vegetation community types located within the vicinity of the area to be rehabilitated and are suitable for the proposed final landform and land use.
- Monitor all areas of progressive and final rehabilitation and undertake remedial action in the event that rehabilitation does not comply with the relevant completion criteria.
- Fully implement the proposed *Biodiversity Offset Strategy*.
- Prepare an *Integrated Land Management Plan* (ILMP) (incorporating measures for application, measurement and management of the specific activities to be implemented within the proposed BOA) in consultation with the relevant government agencies. OzArk (2013a) has prepared a template for the preparation of the ILMP, following the standard format presented in the *Guide to Establishing a Biodiversity Offset Area*. Presented as *Appendix 17* of OzArk (2013a), the ILMP template provides a detailed outline of the standard and additional management actions to be defined within the ILMP following approval of the proposed BOA (refer to Section 2.17.8.5).

4.7.5.4.2 Pink-tailed Worm-lizard Management

Despite the proposed impact avoidance measures proposed, the Proposal would still result in disturbance to 25.5ha of high quality and 9.8ha of medium quality habitat, primarily over the site of the open cut.

A *Pink-tailed Worm-lizard Plan of Management* has been prepared by Biosphere Environmental Consultants Pty Ltd (refer to OzArk, 2013a – *Appendix 13*) which documents the proposed mitigation and management measures to be implemented to reduce the residual impacts. These measures can be summarised as follows.

- Conservation, Enhancement and Management of Known High-Quality Potential Habitat Areas.

In general, habitat areas to be created or enhanced would be on sites close to trachyte outcrops, where grass cover is extensive, where tree canopies are limited, where surface shelter rocks (or artificial shelter materials) are abundant, and where ant prey species are abundant.

The initial focus for habitat creation and enhancement would be between Habitat Areas 1, 2 and 3 (see **Figure 4.35**), an area that has the right lithology, meets most of the ideal habitat components (except that it lacks surface shelter rocks) and links two apparently isolated groups of Pink-tailed Worm-lizards (on Habitat Areas 1 and 3). Once established as linking habitat, it may serve as a corridor for any displaced Pink-tailed Worm-lizards seeking to move away from the open cut and Habitat Area 1 (whilst the western half of the open cut is developed) and investigate new habitat areas.

The *Pink-tailed Worm-lizard Plan of Management* provides further detail on:

- landscape surface preparation;
 - collection and re-use of surface rocks; and
 - use of artificial shelter materials (as surrogate surface rocks features when absent).
- Passive Relocation of Pink-tailed Worm-Lizards from the Eastern Half of the Open Cut.

To enable the passive (unassisted) relocation of Pink-tailed Worm-lizards from the impact area to safe conservation areas, the open cut would be developed in two stages. The western half of the open cut would be developed first, allowing time for habitat corridors to become established leading from the eastern side of the open cut towards Dowds Hill (Habitat Area 3) to the east and Habitat Area 2 to the northwest. Development of the eastern side of the open cut would not commence for at least 10 years, providing time for any unassisted translocation to occur.

- Assisted Relocation of Pink-tailed Worm-Lizards from the Western Half of the Open Cut.

In the twelve month period leading up to the commencement of open cut development, repeated searches of the area to be disturbed would be completed and any Pink-tailed Worm-lizards found collected, measured and relocated to established and conserved or new habitat areas created nearby. On identification, the rock that they were found under would also be relocated to the new habitat area (to discourage other Pink-tailed Worm-lizards to recolonise this site within the open cut impact area).

Field searches and collection would not be attempted during summer or winter when the lizards are deeper underground and generally inaccessible.

- Monitoring and Reporting.

Progress reports would be commissioned by AZL to follow each major survey and collection period, i.e. at the end of spring and the end of autumn. These reports would detail the areas surveyed, the animals collected and their relocation positions. It would also report on any modifications to the habitat areas that may be required.

An annual report would be prepared in June of each year to be submitted to both SEWPaC and OEH. This would contain the results of the two survey and collection periods for the year and recommend any changes to habitat modifications that may be required.

4.7.5.4.3 Other Threatened Species

Sandy creek and river banks in the Central West catchment are known breeding sites for the Rainbow bee-eater (Migratory EPBC Act). Given there would be some construction required within such habitats for bridge upgrades, the Applicant would implement the following mitigation measure.

- Plan all bridge upgrades outside the breeding period (between August to January).
- If this timing is not possible, inspect any creek bank to be affected for mouse size / snake sized horizontal holes in the expose incised creek bank.
- If suitable holes detected, commission an experienced ecologist to determine if Rainbow bee-eaters could be affected by the activity and manage them accordingly.

4.7.5.5 Offsetting of Impacts

In accordance with Step 4 of DEC and DPI (2005), the Applicant has proposed a Biodiversity Offset Area to offset the impact on biodiversity that cannot be avoided or mitigated. The primary objective when defining the area and composition of the BOA is to provide for at least a Tier 3 outcome as nominated by OEH (2011) (when the benefits of the BOA are compared to the impacts of the Proposal) and the minimum 90% direct offset benchmark of the EPBC Act Offsets Policy. Section 2.17.8, **Figure 2.23** and **Table 2.22** describe the proposed BOA and the implementation of an ILMP to define specific management activities to be implemented within the proposed BOA.

4.7.6 Assessment of Residual Impacts

4.7.6.1 Introduction

This subsection assesses the residual impacts of the Proposal on terrestrial ecology, and in particular considers the adequacy of the proposed BOS and residual impacts on threatened flora and fauna (in accordance with Step 3 of DEC and DPI, 2005). This step involves identifying not only the magnitude and duration of impacts, but also the significance of the impacts as related to the conservation importance of the habitat, individuals and populations likely to be affected.

4.7.6.2 Biodiversity Offset Strategy

4.7.6.2.1 NSW Offsets Policy (OEH, 2011)

OzArk (2013a) has used the BioBanking Assessment Methodology (BBAM) (DECCW, 2008), in accordance with the *NSW OEH Interim Policy on Assessing and Offsetting Biodiversity Impacts of Part 3A, State Significant Development (SSD) and State Significant Infrastructure (SSI) Projects* (OEH, 2011b) (“the OEH Interim Policy”), to quantify the nature and extent of offsets required for impacts within the Application Area (the BBAM ‘Development Site’) and provide within the proposed BOA (the BBAM ‘BioBank Site’).

Tables 2.21 and **2.22** of Section 2.17.8 provide the output generated by the BBAM credit calculator for the Development Site and BioBank Site.

The following reviews the matching of credits between the Development Site and BioBank Site considered against the Tier 1 (‘Improve or Maintain’), Tier 2 (‘No Net Loss’) or Tier 3 (‘Mitigated Net Loss’) benchmarks.

Tier 1 ‘Improve or Maintain’ Standard

Ecosystem Credits:

The proposed BOA does not achieve the “Improve or Maintain” as:

- Red flag⁶ assets would be cleared, namely, CW112, CW213, CW138, CW121 and CW145; and
- The credits generated by the BioBank Site for CW213 do not meet those required based on the Development Site disturbance.

It is noted that a Tier 1 outcome for CW212 could be achieved given this is not a red flagged community and the BioBank Site provides a surplus of 2 619 credits. Unfortunately, the surplus credits are not an ‘allowable type’ to transfer to deficits in other affected communities.

Species Credits:

As noted in Section 2.17.8.4.3, OzArk (2013a) report that only the following raptor species do not meet the Tier 1 credit requirements (347 credit deficit).

- Grey Falcon.
- Little Eagle.
- Square-tailed Kite.

Notably, OzArk (2013a) identifies that a significant surplus of credits would be available for several species considered important due to their actual rarity within the region.

- *Aprasia parapulchella* (Pink-tailed Worm-lizard). The records identified on the DZP Site are the only known occurrence of the species in the Dubbo region. A surplus of 148 credits is provided by the proposed BOA.

⁶ BBAM identified a Red Flag as an Endangered Ecological Community or a community with greater than 70% cleared within the affected catchment.

- *Philotheca ericifolia*. The recorded population of this species is within the proposed BOA. A surplus of 6 credits is provided by the proposed BOA.

Tier 2 'No Net Loss' Standard

'No Net Loss' is attained when a red flagged community is to be cleared but the credit requirements generated by the Development Site (disturbance area) are met or exceeded at the BioBank Site (proposed BOA). The following considers the three remaining impacted communities against the Tier 2 standard.

- CW138. A Tier 2 outcome is achieved for the CW138 community. A total of 17 ecosystem credits are generated by the Development Site and 238 credits are provided at the BioBank Site (a surplus of 221 surplus credits).

Notably, the surplus credits may be allocated against CW213 as this is an allowable vegetation type.

- CW213. Even with the transfer of surplus credits from CW138 and CW112 (an 'allowable' vegetation type against CW213), a credit deficit of 1 765 remains (refer to *Section 8.3.9.4* of OzArk, 2013a) and a Tier 2 outcome is not achieved.
- CW145. None of this community is present within the proposed BOA and as such a credit deficit of 62 means that a Tier 2 outcome is not achieved.

Tier 3 'Mitigated Net Loss' outcome

Ecosystem credits

"Mitigated Net Loss" considers when a red flagged community is to be cleared and the ecosystem credits generated by the Development Site cannot be provided for by the BioBank Site. Notably, under Tier 3 assessment, offsetting is managed by replacing effected vegetation in hectares at a 2:1 ratio.

The two communities which do not meet a Tier 2 outcome are considered as follows.

- CW213 White Box - White Cypress Pine - Inland Grey Box woodland on the western slopes of NSW.
 - Based on a 2:1 ratio, 915.4ha are required for offsetting but only 613.3ha are available in the Biodiversity Offset Area (241 hectare deficit).
 - However, if the Quality Remnants and Derived Grasslands components of CW213 are considered separately, the following is demonstrated.
 - CW213 Quality Remnants require 87.4ha at 2:1 ratio. There are 306.5ha in the proposed BOA. This can be achieved directly as a Tier 3 outcome.
 - CW213 Derived Grasslands require 823.9ha at 2:1 ratio. There are 306.8ha of Derived Grasslands in the proposed BOA plus and 221.8ha of CW213 Quality Remnants not allocated. The total available (528.6ha) falls short of the 2:1 ratio and a Tier 3 outcome cannot be directly achieved. 'Variation of the offset rules for using ecosystem credits' have been applied.

- CW145 Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions.
 - Based on a 2:1 ratio, 2.16ha are required. This community does not occur within the proposed BOA and therefore a Tier 3 outcome cannot be directly achieved. ‘Variation of the offset rules for using ecosystem credits’ have been applied.

‘Variation of the Offset Rules’, as described in the OEH Interim Policy, provide a structured approach to determining how Proposals may, in lieu of meeting the ‘improve or maintain standard’, meet one of two alternative standards established under the interim policy. OzArk (2013a – *Sections 8.3.9.4 and 8.3.9.5*) considers the following variations.

- The proposed BOA generates significant surplus credits for locally and regionally important species.
- The CW213 Derived Grasslands may be considered as non-threatened given they are greater than 50% weedy and rotationally cropped. Furthermore, this vegetation type does not have the ability to improve under existing management regimes. The proposed 306.8ha of CW213 Derived Grasslands to be contained within the proposed BOA and improved, together with the surplus 221.8ha of CW213 Quality Remnants, is considered a more than adequate offset.
- Alternatively, the CW213 and CW145 deficit can be met by the proposed management of the local population of *Aprasia parapulchella* (Pink-tailed Worm-lizard) within the proposed BOA. This conservation outcome is consistent with the National Recovery Plan and Threat Abatement and Recovery criterion and the NSW OEH Priority Actions and Listed Activities to assist the Pink-tailed Worm-lizard.

Species Credits

Raptors were the only species that have species credit deficits, however, OzArk (2013a) report this as a common outcome of the BBAM, given these species all have very large home ranges (50km² to 100km²) and can use a wide range of vegetation communities for feeding, breeding and roosting. ‘Variation of the Offset Rules’ are considered as follows.

- The ecosystem credits in the most productive habitats for these species would achieve a Tier 1 or Tier 2 outcome.
- The creation of a 1 021ha BOA would increase the habitat value of this land significantly by promoting the occurrence of favoured prey species (which would benefit the raptor species).

4.7.6.2.2 Evaluation against OEH Offset Principles

The following considers the adequacy of the proposed *Biodiversity Offset Strategy* against the 13 guiding "*Principles for the use of Biodiversity Offsets in NSW*" (DECC, 2008e).

- Principle 1: Impacts must be avoided first by using prevention and mitigation measures.

Section 4.7.5.2 considers the impact avoidance measures incorporated into the design of the Proposal. In particular, areas of TECs and better quality remnant woodland vegetation were avoided where ever possible. Further modifications were made to the design of the site layout response to the identification of Pink-tailed Worm-lizard and mapping of higher quality habitat.

Section 4.5.7.3 nominates the measures that would be implemented to further minimise the impact footprint of the Proposal and Section 4.7.5.4 nominates the measures that would be implemented to mitigate the residual impacts. These would include, amongst other measures and controls, implementation of vegetation clearing protocols to reduce the potential impact on threatened fauna species, progressive rehabilitation and the implementation of a *Pink-tailed Worm-lizard Plan of Management*.

- Principle 2: All regulatory requirements must be met.

The Applicant would meet all regulatory requirements related to the construction, operation and rehabilitation of the Proposal.

- Principle 3: Offsets must never reward ongoing poor performance.

The design of the DZP Site layout demonstrates the Applicant's ability to avoid and mitigate, as far as practicable, adverse impacts on biota (see Sections 4.5.7.2 to 4.5.7.4). In addition, the existing, voluntary environmental rehabilitation at the Peak Hill Gold Mine demonstrate the Applicant's willingness and capability to successfully complete rehabilitation of mine sites once mining operations have been completed.

OzArk (2013a) provides further discussion on the environmental performance of Alkane Resources Ltd (of which AZL is a subsidiary) and its key personnel.

- Principle 4: Offsets will complement other government programs.

The proposed BOA and implementation of a *Biodiversity Management Plan* would increase the biodiversity value of the DZP Site, conserve a regionally significant remnant within the Dubbo region, create corridors linking this remnant to other linear remnants in the landscape (Wambangalang Creek and Benolong Road), protect and enhance existing EECs, and address key threatening processes, all of which are in line with government programs.

- Principle 5: Offsets must be underpinned by sound ecological principles.

The calculation of ecosystem credit requirements (based on the type and condition of vegetation to be disturbed) and an assessment of the value (in terms of ecosystem credits) provided by the proposed BOA has been completed in accordance with the BBAM and the OEH Interim Policy. Section 4.7.6.2.1 (and OzArk, 2013a) provides a detailed summary of the application of the BBAM to the assessment of the proposed BOA. It is noted that OzArk consulted regularly with OEH personnel (Dubbo Office) in the preparation of BioBanking Credit Statements and those presented in *Appendix 8* of OzArk (2013a) represent the results of several iterations following review and advice from OEH personnel.

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

The area of vegetation protection, enhancement and conservation (approximately 1 021ha) is almost 2.1 times the area of native vegetation communities that would be disturbed by the proposal. If only considering the remnant native vegetation not subject to ongoing agricultural land use, i.e. excluding the Derived Grasslands component of CW213, this ratio increases to 14.4 times.

It is largely on this basis that it is considered the proposed BOA meets either the Tier 1 (CW212), Tier 2 (CW138) or Tier 3 (CW145 and CW213) outcome in accordance with the OEH Interim Policy.

The nominated species credits requirements would be achieved for all species except some raptors, however, as discussed in Section 4.7.6.2.1, the proposed BOA is likely to provide a net benefit to these species by encouraging the occurrence and viability of prey species.

- Principle 7: Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs.

At this time, there is no arrangement for the establishment of inclusion of land in the conservation estate, or covenanting arrangements over the DZP Site. However, once acceptance of the BOA is obtained from the consent authority, the Applicant would implement an ‘in perpetuity’ conservation arrangement.

- Principle 8: Offsets should be agreed prior to the impact occurring.

Approval of the BOA is expected as part of development consent for the Proposal⁷. As identified in the draft Statement of Commitments (Commitments 9.1 to 9.26), the Applicant would implement the native vegetation protection and enhancement measures of the BOA and prepare a *Biodiversity Management Plan* for monitoring and management of the offset areas within a nominated time frame.

⁷ It is possible that approval may be in principle with exact form of the BOA to be confirmed and approved within a nominated timeframe in consultation with OEH and DP&I.

- Principle 9: Offsets must be quantifiable – the impacts and benefits must be reliably estimated.

Figure 2.23 and **Table 2.21** quantify the total area of each vegetation community within the DZP Site and the areas of proposed disturbance. The condition of the vegetation to be disturbed has been classified and ecosystem credit requirements identified (using the BBAM) (see **Table 2.21**). The condition of each vegetation community to be incorporated into the proposed BOA has been identified, and ecosystem credits assigned to these on the basis of current community condition and proposed management (see **Table 2.22**).

- Principle 10: Offsets must be targeted – they must offset the impacts on a “like for like or better” basis.

The ecosystem credits generated by the proposed BOA have been assessed using BBAM and on the basis of meeting the Tier 1, 2 or 3 outcomes of the OEH Interim Policy are considered as providing “like for like or better” vegetation.

In particular, if only considering the vegetation not currently affected by ongoing agricultural use, “like for like” offsets achieve a Tier 2 or greater outcome for all but CW145 (of which only 1.08ha would be disturbed). The offset attributed to the CW213 Derived Grasslands include 221.8ha of CW213 Quality Remnants, considered “better” vegetation in this case.

- Principle 11: Offsets must be located appropriately.

The proposed BOA occurs within and immediately surrounding the DZP Site and would include the same vegetation communities to those disturbed (“like for like or better” as required by Principle 10).

- Principle 12: Offsets must be supplementary.

The proposed BOA is supplementary to proposed rehabilitation works on the DZP Site. Importantly, the proposed vegetation protection, enhancement and conservation are not already funded or have been funded or considered previously for funding.

- Principle 13: Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

The Applicant has committed to the proposed BOA and envisages this would be included as a condition of the development consent when granted. The Applicant’s commitments to the BOA in Part 9 of the draft Statement of Commitments (Section 5) would form part of development consent. In addition, it is anticipated that the conditions to the development consent would include a requirement for the Applicant to undertake an independent compliance audit of the Proposal against the conditions of the development consent.

4.7.6.2.3 Commonwealth Environmental Offsets Policy

Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (the ‘EPBC Offset Policy’) was applied as potential impacts on the Pink-tailed Worm-lizard were considered to significant enough to warrant determination of the Proposal as a Controlled Action’. The EPBC Offsets Policy was followed to address its five key aims.

- To ensure the efficient, effective, timely, transparent, proportionate, scientifically robust and reasonable use of offsets under the EPBC Act.
- To provide greater certainty and guidance on how the offset was developed.
- To deliver improved environmental outcomes.
- To outline the appropriate nature and scale of offsets and how it was determined.
- To provide guidance on acceptable delivery mechanisms for offsets.

OzArk (2013a – *Section 8.4.7*) provides a detailed review of the various parameters and factors required to be considered and quantified in accordance with the DSEWPac publication “*How to use the Offsets Assessment Guide*” (DSEWPac, 2012). In summary, the proposed BOA would protect and manage in perpetuity for conservation:

- 82.3ha of high quality habitat (76.3% of all mapped high quality habitat);
- 114.7ha of medium quality habitat (64% of all mapped medium quality habitat); and
- 42ha of low quality habitat (11.43% of all mapped low quality habitat).

The identified habitat would be protected, conserved and enhanced (through the application of various management and mitigation measures described in the *Pink-tailed Worm-lizard Plan of Management*, OzArk, 2013a – *Appendix 13*). As previously reported in Section 2.17.8.4.3, the proposed BOA would provide for direct offsetting to the value of 158.6% of the proposed impact, well in excess of the benchmark 90% requirement of the EPBC Offsets Policy.

4.7.6.3 Clearing of Native Vegetation

Clearing native vegetation is the main ecological impact that would result from the Proposal, as it would lead to a reduction in available habitat for a number of threatened species which currently utilise the DZP Site.

Magnitude of Impact

Table 2.21 summarised the approximate areas of each vegetation community within the Application Area to be cleared. Notably, remnant native vegetation in moderate to good condition has been avoided as far as practicable with approximately 85% of the mapped vegetation communities (not considered cleared / grazing land) of the DZP Site to be cleared identified as Derived Grasslands and are >50% weedy and subject to rotational cropping.

Clearing of TECs would be limited to:

- 0.1ha of the TSC Act listed *Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South bioregions* on the DZP Site;
- 43.7ha of the TSC Act listed *White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland)* on the DZP Site; and
- 1.08ha of the *Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions* along Obley Road.

Impacts on the EPBC Act listed *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* CEEC and *Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia* EEC would be avoided.

Duration of Impact

The duration of the impacts is a consideration of the permanence and reversibility of impacts and considers both the resilience of the vegetation cleared and proposed mitigation measures proposed.

The affected communities are likely to be moderately to highly resilient as remnants of each remain in the local area, upon which genetic material would be drawn in the expansion of these communities within the final landform and conservation and amelioration areas. The resilience of each community would be increased given the proposed mitigation measures nominated in Section 4.7.5.4 which include management of weeds, feral pests and grazing, and general habitat enhancement activities.

Given the resilience of the vegetation communities affected, and the proposed revegetation and habitat enhancement included as part of the conservation and amelioration strategy, the impacts are considered to be reversible and are therefore temporary only.

Significance of Impacts

The significance of impacts consider both aspects related to the vegetation communities themselves, i.e. relative distribution, importance as habitat to threatened species, regional and local representation, as well as the mitigation and offset measures proposed.

The vegetation of the DZP Site to be cleared is typical of the vegetation found elsewhere in the region. Notably, clearing of EECs would be restricted to a combined area of 1.18ha from two separate EECs which would be offset through conservation and enhancement within the DZP Site. Section 4.7.6.2.1 provides an evaluation of the proposed BOA using BBAM. Critically, the proposed BOA has been assessed as meeting Tier 1, 2 or 3 (based on variations) outcomes for each of the impacted communities.

4.7.6.4 Impacts on Habitat Corridors

Existing cleared areas within the DZP Site are a significant barrier to connectivity and movement in the landscape. The cleared areas have been targeted for the construction of the LRSF, SRSF, SECs and WRE and as such the impacts on existing linkages via remnant native

vegetation would be minimised. Nine sections of Obley Road Reserve would be impacted as a result of road widening activities. The road reserve would not, however, be reduced in size nor connectivity severed. Thus, clearing of this habitat is unlikely affect a local fauna movement pathway or reduce. Connectivity is unlikely to be affected as a result of impact related to the construction of the Macquarie River Water Pipeline or Toongi-Dubbo Rail Line, as these easements are located within very disturbed and cleared environments.

In fact, through the establishment of the proposed BOA, the connectivity between local remnants is likely to improve with the remnant vegetation of Dowds Hill connected to that of Wambangalang Creek (a regional biodiversity link) and Benolong Road (a local biodiversity link). Furthermore, through the establishment of the proposed BOA and implementation of the *Pink-tailed Worm-lizard Plan of Management*, connectivity between current discrete areas of high quality Pink-tailed Worm-lizard habitat would be created. This would reduce the potential for one or more of these discrete sub-populations to become extinct as a result of events such as fire, agricultural disturbance, disturbance by feral animals (pigs) or other events.

4.7.6.5 Key Threatening Processes

The Proposal is likely to exacerbate the following key threatening processes listed under the TSC Act and EPBC Acts:

- Alteration to the natural flow regime of streams and their floodplains.
- Bush rock removal.
- Clearing of native vegetation.
- Loss of hollow-bearing trees.

OzArk (2013a) assess that the potential impacts on threatened species as a result of these key threatening processes would be minimised through implementing the environmental mitigation and management measures presented in Section 4.7.5.4, the establishment of the proposed BOA described in Section 2.17.8 and 4.7.5.5, and the implementation of the *Pink-tailed Worm-lizard Plan of Management* presented as *Appendix 13* of OzArk (2013a).

4.7.6.6 Critical Habitat

Critical habitat has not been declared under the TSC Act or EPBC Act for any species, population or community that occurs within the Application Area. Critical habitat has been broadly defined in the *National Recovery Plan* White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (DECCW 2011b) as occurring on the moderate to highly fertile soils of the western slopes of NSW. The Application Area occurs within this region and consequently all remnant areas identified as Box-Gum Woodland EEC are considered critical habitat under the draft recovery plan.

Impacts on the Box-Gum Woodland have been limited to 43.7ha, with these impacts considered unavoidable and restricted to the smallest area possible. The Proposal would result in the rehabilitation of disturbed areas with species indicative of this community. Areas of critical habitat for Box-Gum Woodland are also included within proposed BOA (306.5ha), within these areas to be protected and enhanced.

4.7.6.7 Impacts on Threatened Species, Populations and Communities

4.7.6.7.1 Introduction

The following subsections consider the significance of impacts on those threatened species and communities identified on, considered likely to occur, or considered as having the potential to occur on the DZP Site or other impacted areas of the Application Area (refer to OzArk, 2013a – *Appendix 3*). The significance of the impacts has been assessed in accordance with the requirements of Section 5A of the EP&A Act and (where relevant) the *Significant Impact Guidelines 1.1* for Matters of NES under the EPBC Act by OzArk (2013a) based on:

- the importance of individual species, populations and/or plants and/or subpopulations that are likely to be affected by the Proposal in maintaining the long-term viability of the species, population or ecological community; and
- the importance of habitat features that are likely to be affected by the Proposal in maintaining the long-term viability of the species, population or ecological community.

A summary of the assessment for each species completed by OzArk (2013a) is provided in the following subsections. Where relevant, and based on reliance on similar habitat features, some species are grouped together. The complete assessment for each can be viewed as *Appendix 10* of OzArk (2013a).

4.7.6.7.2 Koala

Koalas are known to periodically occur around Dubbo, specifically along the Macquarie River. Koala scats were identified within the DZP Site in 2001, however, no signs of Koalas have been found during extensive survey in 2012. The previous record is considered to represent a sporadic record of a transient individual(s).

The vegetation of the DZP Site and Obley Road to be impacted is not considered as core habitat critical to the survival of these species. Furthermore, habitat would not become further fragmented or isolated and in fact the proposed BOA would likely improve habitat connectivity.

As a known locally occurring population of Koalas does not occur in the DZP Site or the Dubbo LGA, the Proposal is unlikely to cause impact to a locally occurring population of this species such that it is placed at risk of local extinction.

4.7.6.7.3 Superb Parrot, Swift Parrot and Regent Honeyeater

Both parrot species have been recorded feeding and perching on the DZP Site and the Regent Honeyeater is considered as having the potential to occur (refer to *Table 4* of OzArk, 2013a). Breeding habitat does not occur in the Dubbo LGA for any of these species, however, due to the abundance of Box-Gum Woodland and diverse habitats associated with Dowds Hill, the DZP Site is considered habitat for all three species during the non-breeding period. Clearing as a result of the Proposal is unlikely to affect the life cycle of the species such that a viable local population is likely to be placed at risk of extinction.

The Proposal would not result in further habitat fragmentation given the nomadic and opportunistic ecology of this species. Furthermore, the proposed BOA and rehabilitation of the DZP Site is likely to improve connectivity with isolated remnants in the DZP Site.

While the Proposal would reduce the extent of feeding resources within the DZP Site during initial clearing, resources suitable for these species would be increased and improved over time as a result of the proposed BOA and rehabilitation of the DZP Site. Furthermore, due to the nomadic and migratory nature of these species, such a small area of feeding habitat cannot be considered critical to their survival. The Proposal is therefore unlikely to cause impact to a locally occurring population of this species such that it is placed at risk of local extinction.

4.7.6.7.4 Flame Robin, Hooded Robin, Brown Tree-creeper, Varied Sittella, Speckled Warbler and Diamond Firetail

With the exception of the Varied Sittella, which is considered as having the potential to occur (refer to *Table 4* of OzArk, 2013a), all have been recorded within the DZP Site. On the basis of identification and presence of relevant habitat features (shrubby vegetation with tree hollows), OzArk (2013a) considers it likely that viable local populations of all six species occur on or immediately surrounding the DZP Site. The impact on shrubby vegetation would be limited to the open cut and based on the small area and presence of significant areas of this vegetation on Dowds Hill removal of this is unlikely to affect the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

Connectivity to large native remnants of suitable habitat in the locality is likely to be improved through the proposed BOA. Furthermore, rehabilitation and habitat enhancement of the proposed BOA would increase structural complexity, providing the shrubby habitat that is particularly important to these species.

It is possible that the Proposal would reduce the extent of feeding and breeding resources within the DZP Site on initial clearing, however, this is not considered likely to cause a significant impact on the local populations of these species. Over time, the availability of suitable habitat on the DZP Site and within the proposed BOA is likely to increase. These local populations are unlikely to be placed at risk of extinction due to the large amount of surrounding analogous habitat adjoining the DZP Site.

4.7.6.7.5 Black-chinned Honeyeater, Painted Honeyeater and Grey-crowned Babbler

The Grey-crowned Babbler is known to have feeding and breeding habitat associated with vegetation in the DZP Site. This species also frequents several of the homestead gardens across the DZP Site. This species is recorded in numerous locations throughout NSW and in fact, the Dubbo LGA is a stronghold for this species which is very common in the locality. The Black-chinned Honeyeater and Painted Honeyeater have not been recorded in the DZP Site, however, based on habitat parameters are considered as having the potential to utilise habitat in the DZP Site during some portion of their lifecycle (refer to *Table 4* of OzArk, 2013a). The habitat provided by the DZP is not considered critical to the survival of the species and therefore viable local populations of these species are unlikely to be placed at risk of extinction.

All three species have large feeding territories and are locally nomadic. Therefore relatively small areas of foraging, breeding and roosting habitats cannot be considered critical to the survival of the species in context with the broader landscape. Furthermore, it is unlikely that the Proposal would isolate and decrease the availability of quality habitat to the extent that the species is likely to decline.

Local populations of these species are unlikely to be placed at risk of extinction due to the large amount of surrounding analogous habitat adjoining the DZP Site and the mobile nature of these birds.

4.7.6.7.6 Little Eagle, Spotted Harrier, Square-tailed Kite and Grey Falcon

All have been recorded within the DZP Site. Due to the mobile nature of these species, hunting grounds in the DZP Site (open agricultural land) cannot be considered critical to the survival of this species, as open agricultural land within a similar woodland matrix is abundant in the locality. Breeding sites for these birds are more likely to occur in tall trees associated with riparian environments outside the DZP Site. Viable local populations of these species are unlikely to be placed at risk of extinction.

Some mature eucalypts (mainly isolated trees) would be removed, however, these are unlikely to be roost sites for these species (given more preferable roost sites exist outside the impact area). It is therefore unlikely that the Proposal would isolate and decrease the availability of quality habitat to the extent that the species is likely to decline.

It is unlikely that local populations would be placed at risk of extinction due to the large amount of analogous habitat adjoining the DZP Site.

4.7.6.7.7 Barking Owl and Masked Owl

Barking Owls have been identified within the DZP Site and Masked Owls are considered to have potential to occur in the DZP Site. Breeding hollows are known to occur on Wambangalang Creek and the Macquarie River, however, as no impact would occur to suitable riparian large hollow-bearing trees, the Proposal is unlikely to disrupt a local population of Barking Owls.

It is unlikely that local populations would be placed at risk of extinction due to the large amount of analogous habitat adjoining the DZP Site.

4.7.6.7.8 Glossy Black Cockatoo

Small families of Glossy Black Cockatoos were recorded daily on the DZP Site, and preferred feed species (*Allocasuarina* sp.) occur over the open cut and on land adjacent to Dowds Hill. The Glossy Black Cockatoo is dependent on large hollow-bearing eucalypts for nest sites. Due to the nomadic nature of this species, removal of feed trees and isolated hollow-bearing trees is unlikely to affect the life cycle of the species such that a viable local population is likely to be placed at risk of extinction.

The Proposal would not result in further habitat fragmentation given the nomadic and opportunistic ecology of this species. Furthermore, the proposed BOA and rehabilitation of the DZP Site is likely to improve connectivity with isolated remnants in the DZP Site.

It is possible that the Proposal would minimally reduce the extent of a feeding resource within the DZP Site. However, it is unlikely that a local population of the Glossy Black Cockatoos would be placed at risk of extinction due to the large amount of analogous habitat adjoining the DZP Site.

4.7.6.7.9 Greater Long-eared Bat, Eastern False Pipistrelle and Yellow-bellied Sheathtail bat

All three species, which generally roost in eucalypt hollows, but has also been found under loose bark on trees or in buildings, have been recorded on the DZP Site. Given the discrete nature of impacts predominantly on cleared agricultural land, viable local populations of these species are unlikely to be placed at risk of extinction.

The mobile nature of microchiropteran bats enables them to occupy foraging and roosting resources outside the DZP Site that are adequate for the species survival. As such, while it is possible that the Proposal would reduce the extent of feeding, roosting and/or breeding resources, a local population of either species being placed at risk of extinction is unlikely due to the large amount of surrounding analogous habitat adjoining the DZP Site

4.7.6.7.10 Large-eared Pied Bat, Eastern Bentwing Bat and Little Pied Bat

All three species were recorded within the DZP Site. Based on the occurrence of small rock outcrops over the DZP Site, it is possible that all three species have roost sites located in the DZP Site. However, the removal of small cracks and fissures are unlikely to affect the life cycle of the species such that a viable local population is likely to be placed at risk of extinction. Furthermore, pre-clearing checks of hollow-bearing trees would ensure that all animals are relocated.

No breeding habitat (caves or similar subterranean habitats) would be removed by the proposed works although more suitable rocky crevices occur on Dowds Hill to be included in the proposed BOA. If used at any time, the potential foraging habitat that occurs within the DZP Site is a very minor component of the habitat available and species mobility would enable them to relocate easily to alternative habitats.

It is possible that the Proposal would reduce the extent of a feeding resource within the DZP Site, however, it is unlikely that a local population of any of the bat species would be placed at risk of extinction due to the large amount of analogous habitat adjoining the DZP Site.

4.7.6.7.11 Pink-tailed Worm-lizard

Originally identified by Goldney (2002) over the open cut (Habitat Area 1) and on the slopes of Dowds Hill (Habitat Area 3), a further 35 records of this species have been identified on the DZP Site.

Currently the records of the species within the separate Habitat Areas are considered separate sub-populations, as these are generally separated by areas of non-suitable habitat. Therefore, as the sub-population identified on Hill 1 occurs within the impact footprint of the proposed open cut, it could be considered likely to be disrupted such that this sub-population is placed at risk of extinction. OzArk (2013a) reports, however, that this sub-population is most likely not isolated and abuts (or is continuous with) the sub-population within Habitat Area 2 which would remain undisturbed. Furthermore, the proposed staging of disturbance over the open cut and enhancement of habitat between Habitat Areas 1, 2 and 3 would allow for both passive and active relocation of the species to occur before Habitat Area 1 is removed in its entirety.

A Recovery Plan for the Pink-tailed Worm-lizard was published for Canberra in 1995. Habitat removal is not consistent with this plan, however, the various mitigation and offset measures proposed by the Applicant (and incorporated into the *Pink-tailed Worm-lizard Plan of Management*) (see Sections 4.7.5.2 to 4.7.5.4) would provide for local protection and recovery of the species.

A local population of this species would be impacted by the Proposal. However, through targeted impact avoidance and mitigation, preparation and implementation of a *Pink-tailed Worm-lizard Plan of Management* and development of the proposed BOA which includes specific conservation and enhancement of Pink-tailed Worm-lizard habitat, the impacts are assessed as acceptable. Notably, the proposed BOA meets the required benchmarks for both the OEH Interim Policy and EPBC Act Offset Policy.

4.7.6.7.12 Fuzzy Box on Alluvials of South West Slopes, Darling Riverine Plains and the Brigalow Belt South EEC

The very small area of this EEC to be impacted (0.1ha) consists of isolated trees in highly disturbed agricultural land. The remaining occurrence of this EEC on the DZP Site has been avoided, with 21.9ha contained within the proposed BOA. The Proposal would not place this EEC at risk of local extinction.

While the Proposal would result in a small area of this EEC being removed, this is unlikely to cause impact such that it is placed at risk of local extinction. In fact, the inclusion of this EEC in the proposed BOA is likely to improve connectivity of isolated remnants of this EEC.

4.7.6.7.13 White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland)

Areas of this EEC to be impacted (43.3ha) consist of isolated trees in highly disturbed agricultural land. This area has been reduced as far as practicable by modifications to the DZP Site layout with significant areas to be included in proposed BOA (305.8ha) This EEC occurs elsewhere in the locality in various remnants and would not be placed this at risk of local extinction.

A Draft National Recovery Plan exists for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland. In line with the aims and objectives of this plan, the proposed BOA would provide for a significant habitat corridor connecting Dowds Hill to Wambangalang Creek.

While the Proposal would result in a small area of this EEC being removed, this is unlikely to cause impact such that it is placed at risk of local extinction. In fact, the inclusion of this EEC in the proposed BOA is likely to improve connectivity of currently isolated remnants of this EEC.

4.7.6.7.14 Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions

The very small area of this EEC to be impacted (1.08ha) occurs within a long linear remnant within the Obley Road reserve. Significant areas of this EEC would remain such that the Proposal would not place this EEC at risk of local extinction.

While the Proposal would result in a small area of this EEC being removed, this is unlikely to cause impact such that it is placed at risk of local extinction.

4.7.6.7.15 Migratory Species Listed under the EPBC Act

The Great Egret, Cattle Egret, White-bellied Sea-Eagle, Australian Painted Snipe, Latham's Snipe, White-throated Needletail, Fork-tailed Swift, Rainbow Bee-eater and Australasian Bittern could be transitory visitors to the Application Area, however, there is little evidence to suggest that the DZP Site supports 'important habitat' for migratory species. The proximity of wetlands of international importance downstream on the Macquarie River (Narran Wetlands, Macquarie Marshes) also reduces the likelihood that habitat in the DZP Site is 'important habitat'.

Given the DZP Site is not considered to be an area of 'important habitat' for migratory birds, whether they are wetland or terrestrial species, and considering the relatively restricted areas to be cleared for the Proposal, it is assessed as unlikely that any of these migratory birds would rely on habitat in the DZP Site.

4.7.6.8 Other Indirect Impacts on Biodiversity

Indirect ecological impacts of the Proposal may include the following.

- Loss of habitat and wildlife corridors due to vegetation removal.
- Increased competition for resources from introduced species or increased predation from changes in habitat.
- Changes in hydrology, erosion or sedimentation which could lead to changes in vegetation assemblages.
- Disruption to essential behavioural patterns because of noise, artificial lighting, dust, road traffic or human interference.
- Mortality due to drinking polluted waters.
- Mortality due to uncontrolled bush fires.

The following presents an assessment of each of the potential indirect impacts.

Loss of Habitat

No critical fauna habitat occurs in the vicinity of the DZP Site as designated by the Register of Critical Habitat held by the Commonwealth Minister of the Environment, Heritage and Arts and the Register of Critical Habitat held by the Director-General of the OEH.

The planned removal vegetation for the Proposal does not significantly increase the fragmentation of the retained vegetation. In fact, the proposed BOA would increase habitat linkages and the quality of the habitat contained within these linkages.

Increased Competition / Predation

Existing edge effects associated with the encroachment of weeds and feral species from paddocks adjoining the existing native woodland remnants are a feature of the local setting. The creation of additional disturbed land could attract introduced species such as House Mouse, Red Fox, Rabbit and Cat to the area. However, with the implementation of a waste management and pest control strategy, the impact of introduced species would be minimal. Furthermore, the Applicant is committed to a feral pig control program within the Dowds Hill component of the proposed BOA which would reduce the potential for impacts on species such as the Pink-tailed Worm-lizard.

An additional increase in edge effects in the vicinity of the proposed residue storage facilities may result in hydrological changes and weed invasion. However, none of these local changes would result in any of the species or communities of conservation significance being placed at risk of extinction.

Changes in Hydrology

The Applicant would implement the sediment and erosion control measures identified in Section 4.5.4.2. As a result, the Proposal would not result in significant changes to the hydrology of watercourses within the DZP Site and indirect impacts on vegetation communities would not be significant.

Disturbance by Noise and Dust

Excessive dust generation can impact on the health and viability of surrounding vegetation and indirectly affect fauna populations. Such an impact would be limited and any dust effects would be mitigated by a rigorous suppression regime through regular watering of roads and soil stockpiles, emplacements and other active areas within the DZP Site.

While it is acknowledged that excessive and sudden noise can affect the presence and breeding ability of some fauna species, it is also accepted that many species adapt to human activities and readily habituate to noise. A range of fauna species are known to inhabit land within and surrounding the DZP Site that have adapted to human activities and it is expected that such species would continue to occupy the general area.

As a result, indirect impacts associated with disturbance by noise and dust are considered unlikely to be significant.

Artificial Lighting

Artificial lighting for the Proposal has the potential to affect the behavioural patterns of some fauna species, for example, attracting birds and bats to feed upon insects attracted to lights. Although such situations can result in increased predation, there is no evidence of this phenomenon within existing lighting set-ups at similar mines in the region and it is unlikely that the impacts from artificial lighting within the DZP Site would have an adverse impact.

Lighting at the DZP Site would be concentrated close to the existing village of Toongi.

Mortality due to Ingestion of Polluted Water

Potential exists for fauna to drink water ponded within the LRSF. However, while saline, this water would not contain poisons or other contaminants likely to result in fauna mortality. In any event, given the brine to be discharged to the LRSF would have a salinity of over 60 000µS/cm, it is not expected that fauna would attempt to drink the water. As a result, impacts associated with mortality due to ingestion of polluted water are not expected.

Bush Fire

The potential for a change in the frequency of fires due to the Proposal would be reduced through implementation of the measures identified in Section 4.14.3.5. As a result, bush fire frequency and intensity, within and surrounding the DZP Site is not expected to change as a result of the Proposal.

4.8 AQUATIC ECOLOGY

4.8.1 Introduction

The Director-General's Requirements issued by DP&I identified "**Biodiversity**" as a key issue for assessment – including:

- *measures taken to avoid, reduce or mitigate impacts on biodiversity;*
- *a detailed assessment of potential impacts of the development on any:*
 - *terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems;*
- *a comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Department of Primary Industries (DPI) which requests that "*the EIS should specifically address the impacts on the aquatic ecology, waterway crossings, off-site impacts, threatened species and proposed offsets and compensatory habitats*". The DPI also requests specific assessment of the impact of proposed waterway crossings and the extraction of water from the Macquarie River on the aquatic environment and aquatic species, populations and communities.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to aquatic ecology and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Reduced surface flows to Wambangalang and other creek catchments / tributaries of the Macquarie River (low to medium).
- Degradation of riparian or aquatic vegetation / ecosystems (low).
- Degradation of aquatic habitats through reduced environmental water flows (low).
- Pollution of local and downstream waterways resulting in detrimental effects to flora and fauna (low).
- Increased sediment load in drains and/or waterways (medium).
- Direct adverse impact on threatened species, populations and communities (high).
- Local or regional reduction in distribution of threatened species, populations and endangered ecological communities (high).

The aquatic ecology assessment for the Proposal was undertaken by Dr Alison Hunt of Alison Hunt & Associates Pty Ltd (AHA). The resulting report is presented as Part 7 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “AHA (2013)”. This subsection of the EIS provides a summary of that report, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**. It is noted that surface water is addressed in Section 4.5 and groundwater in Section 4.6.

4.8.2 Local Setting

The DZP Site is located within the Central West region and Central West CMA which includes the Castlereagh, Bogan and Macquarie River valleys. The catchment covers an area of 92 000 km², from the central tablelands around Oberon, Bathurst and Rylstone to the western plains around Nyngan and Coonamble. Ephemeral drainage on the DZP Site radiates from a roughly central location coinciding with the open cut and flows to the Macquarie River via three catchments, Wambangalang Creek, Cockabroo Creek (via Little River) and an unnamed drainage line which flows directly into the Macquarie River. Section 4.1.2 provides an overview of the hydrological conditions of these catchments and **Figures 4.1 to 4.3** provide the regional, local and DZP Site hydrological setting.

A reduction in water quality has occurred in almost all streams throughout the catchment with increasing trends in chemical contamination (nutrients and pesticides), temperature, bacteria levels, heavy metals, turbidity, salinity and pH. Due to the nature of the Macquarie River, most salt generated in the uplands and slopes is deposited back into the landscape through irrigation or floodplain entrapment or it is deposited in the wetlands and effluent systems of the western areas. Reduced water quality impacts detrimentally on aquatic habitat.

The “State of the Catchments 2010” report of DECCW (2010b) reports that the overall fish condition, an indicator of aquatic ecological conditions, in the Central West region ranged from poor in the Bogan River lowlands, to very poor in the Macquarie River lowlands, slopes and

uplands and extremely poor in the Bogan slopes, Macquarie highlands and all zones in the Castlereagh catchment. DECCW (2010b) also reports that the proportion of the fish assemblage that is native versus introduced was poor in the Macquarie slopes and Bogan lowlands, very poor on the Bogan and Castlereagh slopes and in the Macquarie and Castlereagh uplands and Macquarie highlands, and extremely poor in the Macquarie and Castlereagh lowlands.

The Macquarie Marshes (approximately 210 km northwest of the DZP Site) is one of the largest remaining inland semi-permanent wetlands in south-eastern Australia. It is recognised as an area of international importance for waterbird breeding and was listed as a Ramsar site in 1986.

4.8.3 Aquatic Ecology Survey

4.8.3.1 Introduction

For the purposes of the assessing the potential impacts of the Proposal, the aquatic ecology study area comprises the DZP Site, as well as Wambangalang Creek upstream and downstream of the DZP Site, Hyandra Creek to the northwest of the DZP Site and Cockabroo Creek, Little River and Macquarie River downstream of the DZP Site. These additional areas were included in investigations to provide a broader view and baseline information on the status of aquatic ecosystems beyond the DZP Site.

Within the context of this study area, and the broader local setting described in Section 4.8.2, the desktop and field survey completed by AHA (2013) included:

- a review of available literature and databases to assist with the identification of the values of the DZP Site and locality, especially in relation to threatened aquatic species, populations and endangered ecological communities (EECs), and groundwater dependent ecosystems (GDEs);
- a scoping assessment of the DZP Site and local setting to allow development of a detailed methodology; and
- field surveys to ascertain the current condition and the presence or likely presence of threatened or protected species within the DZP Site and study area.

The following subsections provide further an overview of this survey, a more detailed description of which is provided by AHA (2013).

4.8.3.2 Literature Review and Consultation

AHA (2013) reviewed the following guidelines, databases and search tools primarily focussing upon identifying the threatened aquatic species, populations and communities which may occur within the Central West CMA and which could be affected by the DZP,.

- The NSW Department of Primary Industries - Fisheries *What is Currently Listed?* Online resource.
- Office of Environment and Heritage (OEH) threatened species database records.

- DSEWPaC Online protected matters search tool for Matters of National Environmental Significance.
- DSEWPaC online species profile and threats database.
- DSEWPaC online register of critical habitat.
- DSEWPaC Survey guidelines for Australia's threatened fish. Guidelines for detecting fish listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*.
- *Status of Vertebrate Fauna and Their Habitat in the Central West Catchment* (Goldney et al., 2007).
- Little River Catchment Management Plan. Stage 1 Report. Riverine Environment (Little River Landcare Group, 2001).

In addition, Mr Dave Ward of NSW DPI Fisheries was consulted regarding the likely suite of threatened communities, populations and species which would be targeted by field survey. Mr Matt Hansen, a local fishing identity, was also consulted about species known from the area, preferred local habitat types and recent fish sightings and capture.

4.8.3.3 Classification of Watercourses

Strahler stream order and Industry & Investment (I&I NSW) classifications were used to broadly categorise watercourses within the DZP Site and study area. **Table 4.54** provides the I&I NSW fish habitat classification system.

Table 4.54
Fish Habitat Classification in NSW Waterways

Classification	Characteristics of Waterway Type
Class 1 Major fish habitat	Major permanently or intermittently flowing waterway (e.g. river or major creek). Habitat of a threatened fish species or 'critical habitat'.
Class 2 Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.
Class 3 Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
Class 4 Unlikely fish habitat	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).

4.8.3.4 Preliminary Assessment and Site Selection

In February 2012, an initial site inspection and preliminary investigation into the condition of watercourses, habitat available and adjacent land use was completed. The preliminary assessment had two objectives.

1. To identify habitat likely to be suitable habitat for those threatened species, population and communities identified as potentially occurring within the study area following literature review (see Section 4.8.3.2).
2. To confirm and establish suitable survey and sampling sites.

A total of 22 sites were evaluated with 10 of these selected for more detailed assessment. **Figure 4.37** provides the locations of the 10 survey sites. For further detail on each site, refer to *Table 3* and *Appendix B* of AHA (2013).

4.8.3.5 Field Survey

A four day field assessment was undertaken between 19 to 23 February 2012 incorporating the following surveys/assessments.

Aquatic Health Assessment

Aquatic health assessments were undertaken for all survey sites to identify the habitat type available, the quality of habitat, the overall health of the waterway and the potential for these areas to provide habitat for species, populations and communities listed under the FM Act, TSC Act and EPBC Act.

Habitat Assessments

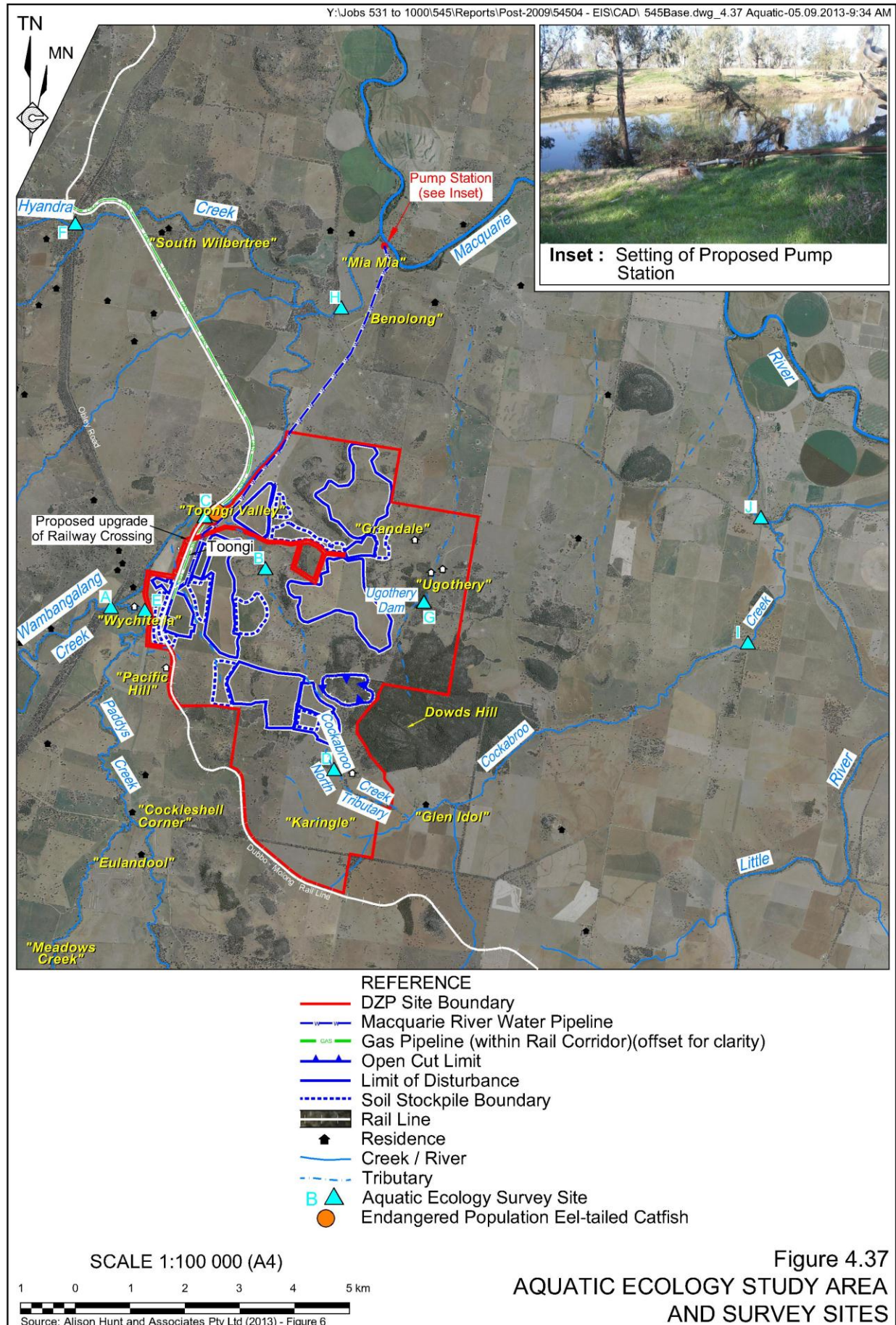
Habitat assessments undertaken were based on NSW AUSRIVAS protocols using FNARH Field Datasheets. Habitat variables such as benthic substrate, water depth and vegetation / water % coverage (including shading) were recorded.

Field Water Quality

A YEO-KAL YK611 hand held, multi-probe water quality meter was used to record in situ water quality at each site. Parameters measured include pH, turbidity (NTU), conductivity ($\mu\text{S}/\text{cm}$), temperature ($^{\circ}\text{C}$), dissolved oxygen (% saturation and mg/L). The water quality data were analysed against the Australian and New Zealand Marine and Fresh Water Quality Guidelines (ANZECC, 2000).

Macrophyte and Emergent Vegetation

At each site, the emergent vegetation and macrophytes were recorded. The emergent vegetation and macrophyte surveys were undertaken to record species abundance and richness, and was quantitatively surveyed using 5m wide, 25m long transects which provided stratified mapping of communities.



Targeted Threatened Species Surveys

Based on the threatened aquatic species and populations identified as potentially occurring within the study area following literature review and consultation (see Section 4.8.3.2), a range of survey techniques were implemented.

Table 4.55 presents the survey techniques used to sample aquatic fauna species at the ten survey sites to increase the probability of sampling a wider range of species and size classes.

Table 4.55
Fauna Survey Techniques

Technique	Site									
	A	B	C	D	E	F	G	H	I	J
Bait Trap	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Opera house trap	✓	✓	✓			✓	✓	✓		
Fyke net		✓	✓					✓		
Seine net								✓		✓
Active searches	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Source: Modified after AHA (2013) - Table 3

Other Surveys

Timed active searches for snails and other notable invertebrates were undertaken at each of the survey sites. Dead branches and rocks were overturned and macrophytes and emergent vegetation were also searched for the presence of invertebrate fauna.

4.8.4 Survey Results

4.8.4.1 Desktop Survey

In total, 24 fish species are known from the Central West CMA (Goldney et al, 2007) with 17 of these being native. Of the 7 introduced, three are identified as noxious under the FM Act, namely:

- Redfin Perch, *Perca fluviatilis*: Class 1.
- Eastern Gambusia, *Gambusia holbrooki*: Class 1.
- Common Carp, *Cyprinus carpio*: Class 3.

Table 4.56 presents the threatened species, populations, communities other aspects of conservation significance that are known to occur within the Central West CMA.

Table 4.56
Aquatic Biota and Other Features of Conservation Significance of the Central West CMA

Scientific Name	Common Name	Status	
		FM Act	EPBC Act
Species			
<i>Ambassis agassizii</i>	Olive Perchlet	E	
<i>Bidyanus bidyanus</i>	Silver Perch	V	
<i>Maccullochella macquariensis</i>	Trout Cod	E	E
<i>Maccullochella peelii</i>	Murray Cod		V
<i>Mogurnda adspersa</i>	Purple Spotted Gudgeon	E	
Populations			
<i>Tandanus tandanus</i> – Eel-tailed Catfish in the Murray/Darling Basin		E	
<i>Western NSW population of the Olive Perchlet, Ambassis agassizii</i>		E	
Endangered Ecology Community			
Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River		E	
Wetlands of International Significance			
Macquarie Marshes			L
FM Act = <i>Fisheries Management Act 1994</i> EPBC Act = <i>Environment Protection and Biodiversity Conservation Act 1999</i> V = <i>Vulnerable</i> E = <i>Endangered</i> L = <i>Listed</i>			
Source: AHA (2013) – Sections 5.1 and 5.2			

4.8.4.2 Strahler Stream Order and Waterway Classification

Waterways within the DZP Site and aquatic ecology study area range from 1st order streams at the headwaters of Cockabroo Creek Catchment, Macquarie (Undefined) River Catchment, Wambangalang Creek Catchment to the Macquarie River which is classified as a 4th order stream.

Table 4.57 presents the Strahler Stream Order and the Waterway Classification for the watercourses located in the aquatic ecology study area.

Table 4.57
Strahler Stream Order and Waterway Classification for the Aquatic Ecology Study Area

Waterway	Strahler Stream Order ¹	Waterway Classification ²
Macquarie River	4	Class 1 – Major fish habitat
Little River	3	Class 1 – Major fish habitat
Wambangalang Creek	3	Class 1 – Major fish habitat
Hyandra Creek	2	Class 2 – Moderate fish habitat
Cockabroo Creek	2	Class 2 – Moderate fish habitat
Paddys Creek	2	Class 3 – Minimal fish habitat
Headwaters of creeks on the DZP Site	1	Class 4 – Unlikely fish habitat
Source: Modified after AHA (2013) – Table 10		

While the Macquarie River is known to provide habitat for a range of fish species, some of which are listed as threatened under State and Commonwealth legislation, headwaters of the catchments are unlikely to provide fish habitat due to their undefined channels and lack of water.

4.8.4.3 Aquatic Habitat

A standardised description of adjacent land and condition of riverbanks, channel and bed was recorded using the “Riparian, Channel and Environmental Inventory” (RCE), developed by the EPA, a method used to scale and quantify the environmental state of particular locations based on surrounding land use, geomorphology, channel bed forms, and riparian and in-stream vegetation. The highest possible score (52) is assigned to streams with no obvious physical disruption while the lowest score (13) is assigned to heavily disturbed streams.

Table 4.58 presents the RCE Score and qualitative water quality results.

Table 4.58
Aquatic Habitat RCE Scores

Site¹	Waterway	RCE Score	Water Quality
A	Wambangalang Creek (Obley Road)	26	Very high salinity and low dissolved oxygen
B	Watercourse B tributary of Wambangalang Creek	19	High salinity and high turbidity
C	Wambangalang Creek (Toongi)	26	High Salinity
D	Unnamed tributary of Cockabroo Creek	23	Freshwater, high turbidity
E	Paddys Creek	21	High salinity, low dissolved oxygen
F	Hyandra Creek	33	High salinity
G	Watercourse A Ugothery Dam	29	Freshwater
H	Wambangalang Creek (Benolong Road)	25	High salinity
I	Cockabroo Creek (Nubingerie Road)	22	Very low salinity
J	Little River (Terrabella Road)	24	High salinity
Note 1: Refer to Figure 4.37			
Source: Modified after AHA (2013) – Tables 11 and 12			

Paddys Creek, Wambangalang Creek and Cockabroo Creek have been substantially altered and have experienced impacts due to upstream and adjacent land use practices including, roads, clearing, weed invasion, alteration of flows, cropping, erosion, sedimentation and salinization. This is reflected in RCE scores for upstream sites of the Proposal, Site B – unnamed tributary of Wambangalang Creek (RCE 19), Site E – Paddys Creek (RCE 21) and downstream sites of Site I Cockabroo Creek Nubingerie Road (RCE 22) and Site J – Little River (Terrabella Road) (RCE 24). Site F – Hyandra Creek, not to be impacted by the Proposal, represented a moderate aquatic habitat value of RCE 33. More detailed descriptions of the aquatic habitat and water quality of each site are provided in AHA (2013) (Part 7 of the Specialist Consultant Studies Compendium).

4.8.4.4 Aquatic Fauna

Table 4.59 presents the aquatic fauna species recorded at each of the survey sites (see **Figure 4.37**).

Table 4.59
Recorded Aquatic Fauna

Scientific Name	Common Name	Survey Sites									
		A	B	C	D	E	F	G	H	I	J
<i>Carassius auratus</i> ¹	Goldfish					✓					
<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle		✓	✓					✓		
<i>Cherax destructor</i>	Common Yabby	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<i>Cyprinus carpio</i> ¹	Common Carp										✓
<i>Gambusia holbrooki</i> ¹	Eastern Minnow	✓	✓	✓		✓	✓		✓		
<i>Hypseleotris klunzingeri</i>	Western Carp Gudgeon								✓		✓
<i>Tandanus tandanus</i> ²	Eel-tailed Catfish			✓							
Note 1: Noxious fauna under the FM Act (see Section 4.8.4.1)						Note 2: Endangered Population (FM Act)					
Source: Modified after AHA (2013) - Table 14											

With the exception of the Eel-tailed Catfish (recorded at Site C – see **Figure 4.37**), all native fauna species recorded are considered relatively common within the Central West Catchment area (Goldney, 2007). The Eel-tailed Catfish is non-migratory and can live in a wide range of habitats and can adapt to increased levels in salinity and turbidity. Remnant populations of the Eel-tailed Catfish occur within the Macquarie catchment upstream of Warren, the Castlereagh catchment upstream of Mendooran, the Namoi catchment upstream of Wee Waa, the Gwydir catchment upstream of Moree and the Border Rivers catchment upstream of Goondiwindi.

4.8.5 Potential Impacts on Aquatic Ecology, Mitigation and Management

4.8.5.1 Introduction

Considering the proposed activities and receiving environment, AHA (2013) has identified a number of potential impacts of the Proposal on aquatic ecology. The following considers each along with the proposed mitigation or management to be implemented to avoid or minimise impacts.

4.8.5.2 Alteration of Natural Surface Flows

Potential Impact

Up to 650ha of the DZP Site would be excluded from the headwaters of the upper reaches and headwaters of tributaries to the Wambangalang Creek, Cockabroo Creek and Macquarie River catchments. This could result in some minor changes to flow patterns and volumes which could alter abundance and distribution of aquatic fauna and flora.

The estimated loss from each catchment and the overall reduction in flows within the catchment are shown in **Table 4.60**.

Table 4.60
Estimated Loss of Surface Water Runoff

Catchment	Estimated Loss (MLpa)	Estimated Reduction in Flow (%)
Wambangalang Creek	337	1
Watercourse A (Macquarie River)	95	17
Cockabroo Creek	20	5
Source: Modified after AHA (2013) – Table 17		

Mitigation

Iterative refinement of the footprint of the DZP, in particular reduction in the size and number of storage areas and alteration of the shape of Liquid Residue Storage Facility, has reduced this loss in upper catchment to the smallest area practical. Notably, the estimated loss within the Wambangalang Creek catchment, which would experience the most substantial alteration to flows from surface water runoff, is only 1%.

4.8.5.3 Obstruction of Fish Passage due to In-stream Structures

Potential Impact

The construction and operation of the DZP has the potential to obstruct movement of aquatic biota as a consequence of the construction of road and rail crossings and laying of pipelines. The disruption of movement patterns along streams can effectively isolate populations resulting in their gradual decline and in some cases local extinction.

Mitigation

All new structures across watercourses would be designed and constructed in line with the *Guidelines and Policies for Aquatic Habitat Management and Fish Conservation* (NSW Fisheries, 1999) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge, 2003).

Pipelines across perennial watercourses would be installed by directional drilling (under-boring) methods or possibly hung below the rail line for larger bridge crossings such as that of the Macquarie River. Pipelines across ephemeral watercourses would be installed by trench excavation during periods of no flow within the channels and in accordance with *Controlled Activities on Waterfront Land Guidelines 2012* for laying pipes and cables in watercourses on waterfront land.

4.8.5.4 Removal and Disturbance of Riparian Vegetation

Potential Impact

Riparian vegetation provides important habitat and aides in the management of water quality within downstream aquatic habitats. The Proposal would require some minor areas of clearing along local watercourses.

Mitigation

The DZP impact footprint has been designed with due regard to the retention of floodplain areas and riparian vegetation and this has reduced the potential for impacts. In particular, the location of components such as the solid and liquid residue storage facilities were chosen to remain at least than 200m from the Wambangalang Creek and 50m from other major watercourses through the DZP Site, thereby avoiding remnant riparian vegetation.

To ensure that the remaining riparian corridors are not further impacted by the Proposal, the Applicant would implement the following measures.

- Mark exclusion zones around riparian vegetation to avoid potential impacts.
- Exclude stock from the riparian corridor within the DZP Site.

Management measures to protect riparian areas from off-site impacts would include an *Erosion and Sedimentation Control Plan* prepared for construction and operation of the DZP. This would include the provision for minimising clearing of vegetation across the DZP Site and the appropriate location of silt fences and sediment traps.

It is also noted that the proposed *Biodiversity Offset Strategy* for the DZP includes habitat enhancement between Dowds Hill and Wambangalang Creek, incorporating Watercourse B. This would provide for improved water quality discharging to Wambangalang Creek upstream of the identified population and subsequently improvement in the habitat quality of Wambangalang Creek more generally.

4.8.5.5 Mobilisation of Sediment During Construction

Potential Impact

The Proposal would involve significant earthworks which has the potential to mobilise sediments into watercourses. The mobilisation of sediments into watercourses can result in:

- smothering of vegetation and an increase in light attenuation which can decrease the productivity of in-stream vegetation and increase mortality;
- an increase in nutrients which can cause eutrophication;
- infill of habitat refugia and smothering of spawning habitat; and
- decrease in growth rates and mortality as suspended particles can obstruct gills and feeding structures of fish.

Mitigation

An *Erosion and Sediment Control Plan* would be implemented by the Applicant for all phases of the Proposal to minimise the discharge of sediment from the DZP Site and other areas of construction, e.g. water pipeline installation, road upgrades.

4.8.5.6 Changes in Water Quality

Potential Impact

Construction and operational activities across the DZP Site have the potential to reduce water quality through contamination of watercourses as a consequence of runoff of contaminants from the site during construction and operation.

Mitigation

All hazardous and potentially contaminating materials would be contained within bunded areas and on impermeable surfaces (see **Figure 2.11**).

4.8.5.7 Water Extraction

Potential Impact

The extraction of up to 4.05GL of water from the Macquarie River could impact on aquatic biota through:

- entrainment and loss of eggs, larvae, and juvenile fish (including threatened species) extracted via the pump and pipeline system;
- mechanical damage and fish mortality from pumps;
- impacts on refuge pools, key fish habitats and threatened species habitat due to extraction during low flows; and
- alterations to the existing hydrology within the Macquarie River as a result of extraction.

Mitigation

To mitigate against entrainment of aquatic biota, the intake system would be fitted with a Johnson Screen with a maximum 2mm mesh size and ideally have an approach velocity no greater than 0.4m/s. The screen would be placed parallel, or at a slight angle to the direction of flow, to assist fish that come into contact with the screen to brush gently against the screen and continue on downstream. Pumping protocols would require that pumping rates gradually increase and decrease at the commencement and cessation of pumping cycles.

Water would be extracted from the Macquarie River under licence and in accordance with instructions regarding allocations provided by the NSW Office of Water. The extraction point has been located at an existing pump take-off point on the “Mia Mia” property where the river is at its deepest (see inset of **Figure 4.37**).

The Applicant has committed to monitoring water and aquatic biota conditions (in accordance with AUSRIVAS) to ensure that the extraction activities do not result in detrimental outcomes. The Applicant completed an initial monitoring campaign in March 2013 which will be repeated in spring 2013, to provide baseline conditions against which future monitoring can be assessed.

4.8.5.8 Disturbance of Freshwater Eel-tailed Catfish Habitat at Toongi

Potential Impact

The recorded Eel-tailed Catfish and habitat at Toongi occurs within a relatively deep pool (approximately 1.5m deep), approximately 50m upstream from the wooden rail bridge which crosses Wambangalang Creek. While the Eel-tailed Catfish appears to be adapted to increased levels of salinity and turbidity, and therefore unlikely to be affected by any minor changes to hydrology resultant from the Proposal, the potential for bridge upgrade activities to directly impact on this population remains.

Mitigation

Reconstruction of the bridge across Wambangalang Creek would be undertaken in such a manner so as to not to impact upstream habitat or change the current habitat regime. The design principles outlined in the *Guidelines and Policies for Aquatic Habitat Management and Fish Conservation* (NSW Fisheries, 1999) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge 2003) would be incorporated into the design of the bridge. During construction works, flows would be maintained within the creek reflecting the conditions at the time of construction.

Ultimately, the proposed habitat enhancement proposed between Dowds Hill and Wambangalang Creek along Watercourse B would provide for improved water quality discharging to Wambangalang Creek upstream of the identified population and subsequently improvement in the habitat quality of Wambangalang Creek more generally.

4.8.5.9 Removal and Disturbance to an Endangered Ecological Community

Potential Impact

The Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River EEC is present along all watercourses in the study area up to 500m AHD. While direct impacts from the Proposal on this EEC are likely to be minimal, some indirect impacts may occur as a result of:

- altered floodplain and wetland inundation as a result of in-stream structures; and
- degradation of the riparian zone through clearing of native vegetation and stock access, leading to loss of shelter and increased sedimentation.

This community would be susceptible to changes in the hydrology of the catchments in the study area and impacts on this community could be far reaching as several components of this EEC (e.g. macroinvertebrates and terrestrial insects) provide important resources in the aquatic food chain.

Mitigation

Measures proposed to manage other potential impacts on aquatic habitat and water quality would also mitigate against impact on this EEC. Furthermore, the monitoring program commenced in March 2013 would provide clear evidence if the Proposal is adversely impacting the aquatic habitat or water quality within the study area, which includes this EEC. In the event of evidence of adverse impacts, the Applicant would implement additional mitigation measures to be developed in consultation with the appropriate government agency(ies).

4.8.6 Assessment of Residual Impacts

4.8.6.1 Introduction

Considering the potential impacts of the DZP, and proposed mitigation measures to be implemented, the following provides an assessment of the Proposal with respect to:

- Aquatic habitat management generally (Section 4.8.6.2); and
- The aquatic ecology of conservation significance noted in **Table 4.56** as having been identified or potentially occurring with the study area (Section 4.8.6.3).

4.8.6.2 General Impact Assessment

Streams, creeks and watercourses within the boundaries of the DZP Site, across the study area and locality have been degraded through clearing, agriculture and water abstraction over many years. These impacts have resulted in:

- changes in water quality from erosion and sedimentation, increased inputs of nutrients and increased salinisation of the study area;
- clearing of vegetation and in-stream snags, which has resulted in the simplification of habitat structure as in-stream vegetation and overhanging vegetation has largely been removed and weeds have become established; and
- changes to drainage patterns through the construction of farm dams, bridges and causeways, which has disrupted dispersal patterns.

Although the development of the DZP would be undertaken across aquatic ecosystems that are stressed and degraded, the watercourses still provide habitat for aquatic biota. This includes habitat for threatened species, populations and endangered ecological communities such as the Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River and *Tandanus tandanus* – Eel-tailed Catfish in the Murray/Darling Basin Endangered Population. AHA (2013) has reviewed the potential impacts and concludes that through an iterative reduction in the impact footprint, and adoption of the mitigation, management and offset measures noted in Section 4.8.5, these impacts would be reduced to acceptable levels.

4.8.6.3 Aquatic Ecology of Conservation Significance

4.8.6.3.1 Threatened Species, Populations and Communities

AHA (2013) completed assessments of significance for the species, populations and communities listed in **Table 4.56** in accordance with the Significant Impact Criteria of the *EPBC Act Policy Statement 1.1 – Significant Impact Guidelines: Matters of National Environmental Significance* (DEWHA, 2009) and the *Threatened Species Assessment Guidelines: The Assessment of Significance* (DECC, 2007b).

The following provides a brief summary of these assessments, which are provided in full as *Appendices E and F* of AHA (2013).

Trout Cod (*Maccullochella macquariensis*)

Listed as Endangered under the FM Act and EPBC Act, Trout Cod are often found close to cover and in relatively fast currents, especially in fairly deep water close to the bank, and often congregate around snags. Given its propensity for relatively fast currents and fairly deep water, it is unlikely that this species would be present due to lack of habitat and therefore the potential for direct impacts on this species is very unlikely. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Trout Cod.

Murray Cod (*Maccullochella peelii peelii*)

Listed as Vulnerable under the EPBC Act, Murray Cod is generally found in areas sheltered by rocks, wood or overhanging banks, with wood debris being an essential habitat feature used for sheltering from currents. Whilst Murray Cod are known from the Macquarie River, and anecdotal reports suggest from the Little River, it is unlikely that any of the smaller tributaries would regularly provide habitat for this species. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Murray Cod.

Western NSW population of the Olive Perchlet (*Ambassis agassizii*)

Listed as an Endangered Population under the FM Act, this species is usually found in slow-flowing or still waters, often near overhanging vegetation or amongst logs, dead branches and boulders. They often congregate around suitable shelter (e.g. large woody debris (snags) and vegetation) during the day but disperse during the night to feed on micro-crustaceans and insects, including larvae (Fisheries Scientific Committee, 2009; McNeil et al, 2008). It is considered unlikely that this species would occur in the waterways of the DZP Site as the waterways are ephemeral headwaters and / or highly degraded creeks suffering from many of the recognised threats for this species. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Olive Perchlet.

***Tandanus tandanus* – Eel-tailed Catfish in the Murray/Darling Basin**

Eel-tailed Catfish of this Endangered Population (under the FM Act) were recorded within the Wambangalang Creek at Site C. This species may also be present in other sections with suitable habitat (e.g. deep pools and snags) of the creek as well as the Macquarie and Little Rivers. The Eel-tailed Catfish is non-migratory and lives in a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons, and although it inhabits flowing streams, it prefers sluggish or still waters. It can be found in clear to turbid waters, and over substrates ranging from mud to gravel and rock. AHA (2013) concludes that assuming the implementation of stringent environmental management of the upgrade of the wooden rail bridge across Wambangalang Creek, this population could be adequately protected to such an extent that this Proposal would be unlikely to significantly impact this endangered population.

Purple Spotted Gudgeon (*Mogurnda adspersa*)

Listed as Endangered under the FM Act, this species is generally found in slow-moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks or large snags. The only known naturally occurring population in the Central West is 47km southeast of the DZP Site in a small tributary that flows into the Macquarie River downstream from the Burrendong dam wall. There is potential habitat present in Macquarie and Little Rivers and some very marginal habitat in sections of Wambangalang Creek. However, this species is extremely vulnerable to competition from Eastern Gambusia which occurs throughout the DZP Site and study area, making it less likely that a population of this species would occur. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Purple Spotted Gudgeon.

Silver Perch (*Bidyanus bidyanus*)

Listed as Vulnerable under the FM Act, Silver Perch are thought to prefer fast-flowing, open waters, especially where there are rapids and races, however they also inhabit warm, sluggish water with cover provided by large woody debris and reeds (NSW DPI Fisheries, 2005). There

are some pockets of potential habitat for this species in the Little River, Wambangalang Creek and Hyandra Creek, however, was not recorded during the surveys. AHA (2013) considers it unlikely that the Proposal would impact any local or regional population of Purple Silver Perch.

Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River

Listed as an Endangered Ecological Community (EEC) under the FM Act, this EEC is known to occur within the region. Aquatic communities of the Macquarie River, Little River, Wambangalang Creek, Cockabroo Creeks including the DZP Site, DZP study area and locality all support this EEC. It is unlikely that the Proposal would impact on this community due to the mitigation measures that are proposed to be implemented which minimises natural river flows and the degradation of riparian zones. AHA (2013) concludes that the DZP would be unlikely to substantially impact this EEC within the local catchment as flows would not significantly change from current levels, woody debris removed during construction would be replaced or relocated and riparian areas would be rehabilitated.

4.8.6.3.2 Wetlands of International Significance (Macquarie Marshes)

Under the Significant Impact Guidelines (DEWHA, 2009) an action is likely to have a significant impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it would result in:

- *“areas of the wetland being destroyed or substantially modified;*
- *a substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland;*
- *the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected;*
- *a substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health; or*
- *an invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.”*

The Proposal would not impact directly on the Macquarie Marshes and therefore not ‘destroy or substantially modify’ any area of wetland. Furthermore, the Proposal would not promote the establishment or spread of any ‘invasive species that is harmful to the ecological character of the wetland’.

The potential for the Proposal to impact on the Macquarie Marshes revolves around any reduction in flow, or reduction in the quality of water reporting, to the Macquarie River upstream of the marshes and the possible impact this may have on the ‘hydrological regime of the wetland’, ‘the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland’, and/or ‘water quality of the wetland’.

The following considers the proposed extraction of water, controls in place to regulate this extraction and the likely impacts of this extraction on the Macquarie Marshes.

DZP Water Extraction

Water to supply the processing operations of the Proposal would be extracted from the Macquarie River from the “Mia Mia” property approximately 40km upstream of the Dubbo Gauging Station (No. 421001), 200m upstream of the confluence of Wambangalang Creek and 11km downstream of the confluence of the Little River. A maximum of 4.05GL of water would be drawn from this location each year.

The water drawn from the Macquarie River would be pumped to a storage dam and then to storage tank(s) within the processing plant from which a relatively constant supply would be provided to the various processing operations within the plant. Due to the reliance of the processing operations on a consistent supply of water, the extraction from the river would be similarly consistent and in the order of 10ML to 15ML per day.

Regulation of Water Extraction

The regulation of these rivers is governed by the *Water Sharing Plan for the Macquarie and Cudgong Regulated River Water Source 2003* (the WSP). The WSP provides water for environmental needs and directs how much water is available for extraction and how it is to be shared. While the Macquarie Marshes are not part of the WSP area, the WSP includes rules about the release of flows to improve environmental outcomes for the Macquarie Marshes.

The WSP limits the long term annual average extraction from the Macquarie-Cudgong system to 391GL/year. All flows above this are reserved for the environment. In the long term, approximately 73% of the average annual flow within the regulated river system is protected for environmental health. Water extraction is managed to ensure that these long-term environmental flows occur.

NOW undertakes resource assessments to determine what water allocations can be announced for consumptive users. The resource assessment ensures that water for the environment, river transmission losses and town water supply is assured prior to making other allocations available. Water is supplied to domestic and stock access licences and local water utility access licences before it is supplied to the high and general security water access licences (WALs) (which provide for the consumptive use of water other than for town water, domestic and stock watering purposes). Part 9, Division 3, Clause 46 of the WSP states:

“Where extraction components of access licences do not specify the rate as a share of supply capability or a volume per unit of time, the following priority of extractions shall apply whenever supply capability is insufficient to satisfy all orders for water in any section of this water source:

- a) water shall be supplied to domestic and stock access licences, local water utility access licences and regulated river (high security) access licences that have placed an order for water, then to regulated river (general security) access licences, and*
- b) then any remaining supply capability shall be shared between regulated river (general security) access licences that have placed an order for water, in proportion to the share components specified on the access licences.”*

Furthermore, there is currently an embargo on the allocation of new WALs within the WSP (other than for gazetted exemptions such as town water supply, cultural uses and others). Therefore, future allocations of water from the Macquarie River must be drawn from those WALs currently issued and held, i.e. there would be no increase in the total extraction limit of the WSP.

The 4.05GL of water to be drawn from the Macquarie River would be in accordance with the allocation allowed by a combination of high and general security WALs to be purchased from within the Macquarie River WSP. Based on the rules of the WSP and the enforcement of the WM Act, therefore, the delivery of water within the Macquarie River to town water supply and environmental flows would always take priority over other consumptive water uses. The DZP would not receive any allocation until the entire allocation for town water supply and environmental flows is assured.

It follows therefore, that the WALs obtained by the Applicant from within the area covered by the WSP would not change the total amount of water in the system or the amount of water reaching the Macquarie Marshes.

Impacts

On the basis that extraction of water from the Macquarie River is regulated under the WSP to maintain environmental flows, and extraction of up to 4.05GL of water is undertaken in accordance with the allocation defined for the general and high security WALs which have or would be acquired, this would have no impact on the volume of water flowing into the Macquarie Marshes.

As discussed in Section 4.8.5.2, the Proposal would result in a reduction in runoff to the three sub-catchments of the Macquarie River of approximately 452ML per year. Considered against the runoff generated by the total Macquarie River catchment to the Macquarie Marshes (~1 250 000ha), this is likely to represent less than 0.02% of total runoff.

The quality of water reporting to the creeks and their tributaries from the DZP Site and other component areas would be protected through implementation of environmental controls, in particular the implementation of an *Erosion and Sediment Control Plan* and containment of all liquid residues in a lined and appropriately designed LRSF. Furthermore, the quality of any discharged water would be regulated by an environment protection licence issued under the NSW *Protection of the Environment and Operations Act 1997* (POEO Act). The licence would protect the environmental health of downstream rivers including the Little and Macquarie Rivers.

Conclusion

The DZP Site and Macquarie River extraction point is remote from the Macquarie Marshes and would not result in any direct physical impacts. It would not measurably impact the hydrological regime of the marshes or the quality of water entering the marshes. Given that the hydrological regime of the marshes would not be affected, there is unlikely to be any significant impact on wetland dependent species, wetland vegetation, waterbird habitat, aquatic ecological communities and waterbird breeding sites. Furthermore, no mechanisms can be identified that could cause the DZP to affect the habitat or lifecycle of native species associated with the Macquarie Marshes or that could introduce or spread an invasive species.

On the basis of the above, it is concluded that the DZP would not have any significant impact on this wetland of international significance.

4.8.7 Monitoring

While the design of the Proposal indicates that impacts to aquatic ecosystems are negligible and can generally be managed through design and implementation of water management planning, it remains important that specific aquatic ecological factors are monitored throughout the life of the Proposal.

It is proposed that the monitoring program commenced by AHA in accordance with AUSRIVAS would be continued to assess impacts of the Proposal on aquatic ecology and conditions.

In addition, a monitoring program for Eel-tailed Catfish would be undertaken during suitable conditions throughout the life of the Proposal to identify whether the species utilises the areas of suitable habitat within Wambangalang Creek.

4.9 ABORIGINAL HERITAGE

4.9.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "**Heritage**" as a key issue for assessment – including:

- an Aboriginal cultural heritage assessment (including both cultural and archaeological significance) which must:
 - demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, and developing and selecting mitigation options and measures; and
 - outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures)."

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Office of Environment and Heritage (OEH) which requested that the EIS provide information addressing nine key points which would allow OEH to assess the impact of the Proposal on Aboriginal heritage. The Central West CMA also identified that "*the assessment must include the impacts on Aboriginal cultural heritage. information to demonstrate the impacts on Aboriginal heritage values, both archaeological and culturally in the broader sense*" and the Heritage Council of NSW advised that the EIS "*must include a heritage impact assessment that addresses the heritage significance of the site and any impacts the development may have upon this significance should be assessed*".

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to Aboriginal heritage and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Destruction of identified or currently unidentified Aboriginal sites and/or artefacts (medium to high).
- Cumulative reduction of the in-situ archaeological record through removal or destruction of identified or currently unidentified Aboriginal sites and/or artefacts (medium to high).

The Aboriginal Heritage Assessment for the Proposal was undertaken by various archaeologists of OzArk Environment and Heritage Management Pty Limited (OzArk) under the direction of Dr Jodie Benton. The resulting report is presented as Part 8 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “OzArk (2013b)”. This subsection of the EIS provides a summary of the Aboriginal heritage assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**. It is noted that non-Aboriginal (historic) heritage is addressed in Section 4.10.

4.9.2 Aboriginal Heritage Study Area

The Aboriginal heritage assessment considered a research study area for the Dubbo regional area to determine the ethno-history regional and local context. Additionally, a study area was considered for the surveys and included the following four areas.

- The DZP Site: comprising all areas of proposed Project-related disturbance associated with the open cut mining operations and related activities.
- The Macquarie Water Pipeline study area: a 7.6km long and approximately 20m wide corridor for the proposed water pipeline from the Macquarie River to the Project Site.
- The Toongi-Dubbo Rail Line and Gas Pipeline study area: a 30km long and approximately 10m wide area for the proposed upgrade of the rail line crossing over Wambangalang Creek.
- The Obley Road Alignment Area: a 22km long and approximately 20m wide corridor for the proposed realignment of portions of Obley Road between the DZP Site and Dubbo.

4.9.3 Assessment Methodology

The Aboriginal heritage assessment was undertaken in the following stages.

- Stage 1 – Consultation and Community Involvement.
Stakeholder identification and registration was completed in accordance with the Aboriginal Cultural Heritage Consultation requirements for Applicants (ACHCRs) (DECCW, 2010). Consultation with each of the registered Aboriginal parties was then undertaken in accordance with the ACHCRs. Section 4.9.4 provides further detail on the consultation undertaken as part of OzArk (2013).

- **Stage 2 – Background Research and Literature Review.**
An understanding of the archaeological context of the regional, local and DZP Site was obtained through a review of historic records of the local area, previous archaeological studies and the Aboriginal Heritage Information Management System (AHIMS) register of Aboriginal sites. This information is further discussed in Section 4.9.5.
- **Stage 3 – Development of a Predictive Model for Site Location.**
Based on the background research and experience of OzArk, the archaeological sensitivities of landforms within the study areas were determined to predict the likely type and frequency of site types that may be identified. This allowed for the development of a more targeted field survey methodology. Section 4.9.6 provides further detail on the predictive model for site location and distribution.
- **Stage 4a – Field Survey (Site Identification).**
Eight field surveys of the Study Area were undertaken between May 2012 and February 2013. Section 4.9.7 presents further detail on the site inspection methodology, coverage and results.
- **Stage 4b – Field Survey (Test Excavations).**
Following the site identification stage of field survey, test excavations of Potential Archaeological Deposits (PADs) identified within the proposed impact footprint were completed. The objective of the test excavations is to confirm the nature and extent of archaeological deposits such that informed and appropriate management options may be developed for the sites. Section 4.9.7 presents further detail on the methodology, coverage and results of two test excavations completed.
- **Stage 5 – Development of Management Strategies for the Identified Aboriginal Sites.**
Based on the relative cultural, scientific and public significance of the identified Aboriginal sites, management strategies have been recommended. These strategies have also been provided to the registered Aboriginal parties for consideration and comment. Section 4.9.8 presents further detail on the management strategies to be implemented for the identified Aboriginal sites.
- **Stage 6 – Assessment of Impacts**
Considering the adoption of the proposed management strategies, the residual impact of the Proposal on Aboriginal cultural heritage was assessed. This took into account not only the direct impact on the identified Aboriginal sites, but also potential cumulative impacts on the regional archaeological record. Section 4.9.9 provides further details in relation to the assessment of impacts.

4.9.4 Consultation and Community Involvement

4.9.4.1 Consultation

4.9.4.1.1 DZP Site, Macquarie River Water Pipeline, Toongi-Dubbo Rail Line and Obley Road

Aboriginal community consultation for the Proposal was undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements* (ACHCRs) (DECCW, 2010). An expression of interest (EOI) advertisement was placed in the Daily Liberal to appear in the publication on the 7 January 2012. Additional letters were also sent to the following agencies or organisations.

- Office of Environment & Heritage (OEH).
- Dubbo City Council.
- Native Title Services Corporation Limited (NTSCORP).
- Central West Catchment Management Authority (CMA).
- National Native Title Tribunal (NNTT).
- Dubbo Local Aboriginal Land Council (LALC).
- Register of Aboriginal Owners.

In addition, letters were sent to known Aboriginal stakeholders associated with previous projects in the vicinity of the study areas, so that these individuals / organisations could be advised of the Proposal and invited to register interest.

A second round of letters was sent to additional groups identified as a consequence of the agency contact. At the conclusion of the Stage 1 notification phase of this process, four Aboriginal stakeholders registered an interest and were confirmed as Registered Aboriginal Parties (RAPs) in accordance with the ACHCRs.

- Binjang Wellington Wiradjuri Heritage Survey (BWWHS).
- Wirrimbah Direct Descendants (WDD).
- Diane Stewart.
- Dubbo LALC.¹

Further letters presenting information regarding the Proposal and describing the proposed heritage assessment methodology (Stage 2 / 3 of the ACHCRs), were sent to all stakeholders with a request for input on the methodology proposed. Included with this correspondence was an invitation to attend an inception meeting on 24 April 2012 to introduce the Proposal and discuss the proposed methodology for the Aboriginal surveys and assessment.

Feedback from the consultation meeting and Stage 2 / 3 letters were incorporated into the methodology prior to fieldwork being initiated. Several positions were made available for Aboriginal community members to allow all stakeholders to be represented during the fieldwork and assessment period.

¹ It is noted that Mr Charlie Trindall registered interest on behalf of Dubbo LALC in early September 2012 (outside the nominated period for registration).

Section 4.9.4.2 presents the details of Aboriginal community involvement and further consultation during and following field survey.

4.9.4.1.2 Macquarie River Water Pipeline Test Excavations

Following the field survey of the Macquarie River Water Pipeline (see Section 4.9.7.2.1), two potential archaeological deposits (PADs) were identified on the alignment of the proposed water pipeline. OzArk (2013b) identified the need for a test excavation of these PADs. An invitation to attend an Aboriginal Focus Group Meeting (AFGM) to discuss the test excavations was sent to all RAPs on 13 May 2013. The proposed test excavation methodology was sent to the RAPs on 20 May 2013. The AFGM held on 29 May 2013, was attended by Darren Toomey of Dubbo LALC who confirmed the proposed methodology as appropriate. Minutes generated following the AFGM were distributed to all RAPs, however, no feedback on the proposed methodology was received.

Section 4.9.4.2 presents the details of Aboriginal community involvement during the field survey.

4.9.4.2 Aboriginal Community Involvement

The involvement of the Aboriginal community in fieldwork is summarised in **Table 4.61**, which presents the survey dates, survey locations and persons involved.

Table 4.61
Aboriginal Community Involvement in Field Surveys

Survey Date(s)	Aboriginal Representative (of RAP)	Survey Area
22 May 2012	Ashley Hill (WDD), Eric Fernando (BWWHS), Jamie Gray (BWWHS)	DZP Site: Wychitella
23 May 2012	Ashley Hill (WDD), Eric Fernando (BWWHS), Jamie Gray (BWWHS)	DZP Site: "Karingle"
24 and 25 July 2012	Ashley Hill (WDD), Brett Hill (BWWHS), Gary Riley, Jamie Gray (BWWHS)	DZP Site: "Grandale" and "Toongi Valley"
7 and 8 August 2012	Ashley Hill (WDD), Brett Hill (BWWHS), Jamie Gray (BWWHS), Robert Hill (WDD)	DZP Site: "Glen Idol", "Toongi Valley", and "Ugothery"
11 to 13 September 2012	Ashley Hill (WDD), Brett Hill (BWWHS), Michael Toomey	DZP Site: "Pacific Hill" MRWP: "Mia Mia" / Waterline, and Wychitella
18 and 19 October 2012	Brett Hill (BWWHS), Michael Toomey (DLALC), Robert Hill (WDD)	ORA: Obley Road, Rail Bridges, and Wychitella
17 to 19 December 2012	Robert Hill (WDD), Ashley Hill (WDD), Jamie Gray (BWWHS), Edward Ryan (DLALC), Terry Toomey (DLALC), Fonua Havili (BWWHS), Tim Stewart (BWWHS), Ray Smith (DLALC)	DZP Site: "Grandale", "Karingle", "Pacific Hill", "Toongi Valley", and "Ugothery"
5 February 2013	Brett Hill (BWWHS) and Malcolm Burns (WDD)	DZP Site: "Karingle" and "Grandale"
25 and 26 June 2013	Malcolm Burns (WDD) and Terry Toomey (DLALC)	Test excavations of TS-OS3 and TS-OS5 within the Macquarie River Water Pipeline corridor

MRWP = Macquarie River Water Pipeline ORA = Obley Road Alignment

Source: Modified after OzArk (2013b) – Table 3

During the period over which the surveys were undertaken, additional meetings were held and are described as follows.

- A meeting was held on 10 August 2012, to which all RAPs were invited, to discuss the management of the identified and previously recorded sites and obtain any cultural knowledge that may be associated with the DZP Site.
- Following the registration of Dubbo LALC, by Mr Charlie Trindall, an informal meeting was held with representatives from the Applicant, OzArk and Dubbo LALC. The aim of this meeting was to familiarise Dubbo LALC with the Proposal and provide up-to-date information about the assessment process.
- Over the course of the entire fieldwork program, discussions were held on site each day regarding the findings of the field survey. The topics covered included cultural significance, management options and recommendations.
- Following the February 2013 fieldwork, Wirrimbah Direct Descendants submitted a brief report which documented the result of this one day assessment.
- During the course of the field survey, Coral Peckham of WDD raised a request to hold a meeting with the Applicant and OzArk to discuss the cultural heritage values and proposed management of identified sites. This request was agreed to by the Applicant, however, it was determined that the meeting be scheduled to follow the completion of two test excavations along the alignment of the Macquarie River Water Pipeline corridor (refer to Sections 4.9.4.1.5 and 4.9.7.2.2) and finalisation of the assessment phase of OzArk (2013b).

It was agreed by all Aboriginal stakeholders present during the heritage surveys that the cultural significance and the management of each archaeological site identified would be included in an archaeological report to be prepared by OzArk. In June 2013, a draft version of the Aboriginal Heritage Assessment was distributed to all RAPs with an invitation extended to attend an AFGM meeting to discuss the document, and in particular, the results of the surveys and management recommendations.

The AFGM was held on 13 August 2013 and was attended by Darren Toomey and Willie Carr (of DLALC), and Ray Smith and Geoff Ryan (of WDD). Apologies were received from Jamie Gray and Dot Stewart (of BWVHS), and Diane Stewart. The AFGM included an inspection of a number of sites that would be impacted and discussion as to cultural values and management of the various sites. Potential for future employment of Aboriginal people was also discussed.

A revised Aboriginal Heritage Assessment, incorporating the results of discussions completed during the AFGM, was distributed to the RAPs on 19 August 2013. Feedback was received from all RAPs between 20 August and 22 August 2013.

- WDD: Geoff Ryan approved of the report and the minutes of the recent AFGM.
- BWVHS and Diane Stewart: Requested inclusion in the formation of the Care Agreement to clarify the destination of the objects salvaged from impacted sites. A proposal to relocate salvaged items to Wiradjuri Park and exhibit with a plaque and aerial photograph was nominated.
- Dubbo LALC: Darren Toomey approved of the report and the minutes of the recent AFGM.

OzArk (2013b) provides further details on the specific feedback received from the RAPs.

4.9.5 Background Research and Literature Review

4.9.5.1 Regional Archaeological Context

The Dubbo locality lies within the northern limits of Wiradjuri country, as defined by the limits of the Wiradjuri language group. Bordering to the west is Wongaibon country, and to the north Kawanbarai country. Dubbo City itself lies within the traditional territory of the Dubba-ga (Thubba-ga) people who were part of the broader Wiradjuri tribe and were thought to have comprised of groups of approximately 30 to 40 people. The territory of these people generally lies to the east of the Macquarie River, south of the Talbragar River and north of Eulomogo Creek, although, there is some conjecture that the group inhabited both sides of the Macquarie River.

Patterns of Aboriginal and early European settlement in the region (of Dubbo and surrounds) have been analysed as part of broad regional studies (Koettig, 1985; Balme, 1986). Based on these analyses, Koettig (1985) makes the following conclusions with regard to the Aboriginal occupation of the region.

- Evidence of Aboriginal occupation may be expected throughout all landscape units, with the most frequently occurring examples of occupation being open artefact scatters, scarred trees and grinding grooves.
- Aboriginal occupation of specific areas within the region would be determined by various factors, predominantly environmental and social. Although social factors cannot be explained through archaeological research, some of the environmental issues may be. These are as follows.
 - Proximity to water - the largest camp sites were located close to permanent water.
 - Geological formation - certain sites require specific conditions, e.g. grinding grooves occur where appropriate sandstone outcrops.
 - Availability of food resources - the widest range of potential foods was found along the main water courses due to the supply of permanent water.

Koettig (1985) suggested that larger and more constantly occupied sites are likely to occur along permanent watercourses, while less intense and sporadic occupation evidence is seen along ridge tops or temporary water sources e.g. creek headwaters.

4.9.5.2 Local Archaeological Context

OzArk (2013b) records that Lloyd Nolan (2000) states that the Toongi locality is within the 'Dundullimal' territory, a sub group of the Thubba Gah-Wiradjuri nation. "The Springs" property (Heritage listed with local significance), approximately 4km south of the DZP Site, is a location of early contact between Aboriginal and European people in the Dubbo region. It is likely that Aboriginal people remained active in the vicinity of Toongi into the historical period with many being employed by local landowners as station-hands and/or helpers.

A review of the past and present land use patterns within the Toongi locality demonstrates that substantial parts of the landscape, especially along flats and low slopes (particularly associated with creek lines) have undergone significant physical modification as a result of agricultural activities, particularly cropping, grazing and alteration of pre-European fire regimes.

These activities have disturbed or destroyed ecological niches that may have been located in the resource rich creek areas in prehistory. Other processes have also been responsible for the modification/destruction of the environment, including increased erosion and soil movement as a result of white and black cypress pine monocultures and tree removal as well as the altered hydrological impacts of flooding, both of which may have contributed to the disturbance and/or redistribution of topsoils.

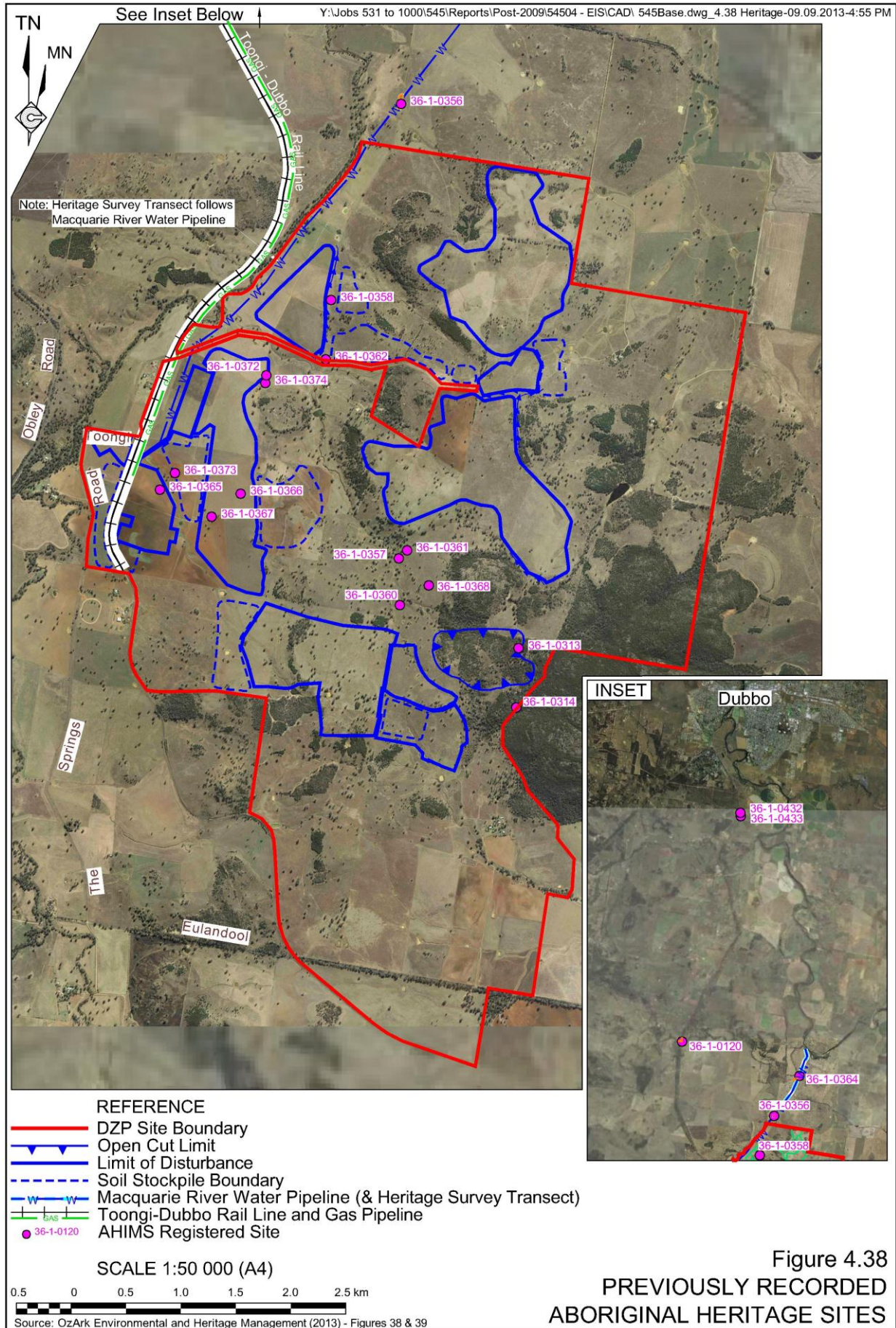
4.9.5.3 Local Archaeological Record

Significant sites that are registered in the Toongi – Dubbo locality include the following.

- Indigenous Place at ‘Brocklehurst’ – bora ground (Australian Heritage Database/ Register of the National Estate)
- Indigenous Place at ‘Toongi Valley’ – carved tree (Australian Heritage Database/ Register of the National Estate)
- The ‘Springs’ at Toongi – while the significance of this Australian Heritage Database listing is based primarily on historic occupation, it is noted that the place is also important for its relationship to Aboriginal and early settler contact (NSW Heritage, 2012).
- Dundullimal Homestead near Dubbo – while the significance of this Australian Heritage Database listing is based on historic occupation and not Aboriginal occupation, it is included here as there is a known extensive Aboriginal site located on the property, Aboriginal people were employed there in 1891 (NSW Heritage 2012b), and there is an ethnographic report of a corroboree held there in the 1840s, attended by 600-800 people (OzArk 2006: 33). The Aboriginal site located on the “Dundullimal” property is reported to have had Aboriginal ceremony and dreaming components, a ceremonial ring, a hearth, grinding grooves, and artefacts associated with an open camp site/ artefact scatter (AHIMS site #36-1-0021).

OzArk (2013b) identified that previous Aboriginal heritage assessments have been undertaken within the locality of the DZP Site as follows.

- i) In 2000, Mr Lloyd Nolan undertook a survey of 6ha which overlaps the current open cut impact footprint for resource drilling related to the current Proposal. Two Aboriginal sites were recorded during this assessment, namely, an isolated artefact and a grinding groove site, respectively (see **Figure 4.38**).
- ii) In 2002, Mr Lloyd Nolan undertook an assessment for an earlier version of the DZP Proposal. As a result of his assessment, 22 Aboriginal sites were recorded with 11 scarred trees, six open artefact scatters, three grinding groove sites and two isolated artefacts (see **Figure 4.38**).



- iii) Other assessments have been undertaken over the years on Obley Road, primarily for environmental impact assessments for road alignment projects. Kelton (1997), Nolan (2000), OzArk (2003) as well as amateur archaeologist Warren Bluff, among others, contributed to the recorded total of 33 AHIMS-listed sites on the edges of Obley Road between the DZP Site and town of Dubbo. The overwhelming majority of these sites are scarred trees.

No previous assessments have been undertaken within the impact footprint of the Toongi – Dubbo Rail Line.

Table 4.62 and **Figure 4.38** present the 19 previously recorded Aboriginal heritage registered AHIMS sites that have been recorded within or adjacent to the component disturbance areas of the Proposal.

Table 4.62
Registered AHIMS Sites

Site Number	Description	Landform
DZP Site		
36-1-0373 (TS-ST-03)	Aboriginal scarred tree with no associated artefacts. Scar has closed since its initial recording in 2002	Gently Undulating
36-1-0365 (TS-ST-04)	Aboriginal scarred tree with no associated artefacts	Gently Undulating
36-1-0366 (TS-ST-05)	Aboriginal scarred tree with no associated artefacts. Scar has closed slightly since its initial recording in 2002	Gently Undulating
36-1-0367 (TS-ST-06)	Aboriginal scarred tree with no associated artefacts	Gently Undulating
36-1-0368 (TS-ST-07)	Aboriginal scarred tree with no associated artefacts	Gently Undulating
36-1-0313 (TS-IF-01)	Isolated artefact. Original artefacts of a chert flake could not be located however, a new artefact of pinkish chert piece of flake shatter was recorded	Gently Undulating
36-1-0314 (TS-GG-01)	Grinding grooves located adjacent, however, outside the impact footprint	Creek
36-1-0374 (TS-ST-01)	Aboriginal scarred tree with the scar almost completely closed. Scar was located very low to the ground and was questionable if it was of Aboriginal origin	Gently Undulating
36-1-0372 (TS-ST-02)	Aboriginal scarred tree with the scar almost completely closed. Scar was not uniform in shape and very low to the ground and was questionable if it was of Aboriginal origin	Gently Undulating
36-1-0357 (TS-OS-01 with PAD)	Artefact scatter with a new recording of possible grinding grooves	Floodplain
36-1-0361 (TS-GG-02 with PAD)	Grinding grooves with several new grooves identified	Creek/ Floodplain
36-1-0360 (TS-GG-03)	Grinding grooves	Floodplain
36-1-0358 (TS-OS-02)	Artefact scatter could not be located and may have been destroyed by vehicle movement	Gently Undulating
36-1-0362 (TS-IF-02)	Isolated artefact of orange chalcedony flake	Gently Undulating
Obley Road Realignment		
36-1-0432 (ORWM-ST1)	Aboriginal scarred tree	Gently Undulating
36-1-0433 (ORWM-ST2)	Aboriginal scarred tree	Gently Undulating
36-1-0120 (H2 with PAD)	Aboriginal scarred tree and artefact scatter	Floodplain
Macquarie Water Pipeline Area		
36-1-0356 (TS-OS-03 with PAD)	Artefact scatter	Floodplain
36-1-0364 (TS-OS-05 with PAD)	Artefact scatter	Floodplain

Source: Modified after OzArk (2013) – Table 9

4.9.6 Predictive Model

Predictive modelling aims to establish a theoretical model for site location and distribution within a given area. The predictive model considers proximity to permanent water, availability of resources for shelter and tool making, and availability of food. Based on these factors, archaeological context and the landform potential, OzArk (2013b) makes the following predictions in relation to the nature of sites and their potential location within the study areas.

- Open sites may be found on elevated terraces and low spurs close to water such as Wambangalang Creek. These sites may be complex and/or extensive.
- Scarred trees are frequently found close to creeks and rivers but also found further afield. Most of the old-growth woodlands have been removed from the landscape, although some isolated old-growth trees which may bear scars occur in the cleared paddocks and along the drainage lines, as well as along the road corridor of Obley Road.
- Natural mythological or cultural/ceremonial sites may occur anywhere.
- Shelter sites with art and/or deposit may occur wherever there are appropriate sandstone overhangs. The Study Area does not contain escarpments, and the only locality within the Study Area with potential for suitable rocky overhangs is on the “Glen Idol” property (proposed open cut).
- Grinding groove sites would only occur where there are appropriate outcropping sandstone formations, usually near water, and therefore may be found near any of the waterways in the study areas.
- Isolated finds may occur anywhere, especially in disturbed locations near water sources or in areas close to ephemeral water, i.e. headwaters.

4.9.7 Field Survey Methodology and Results

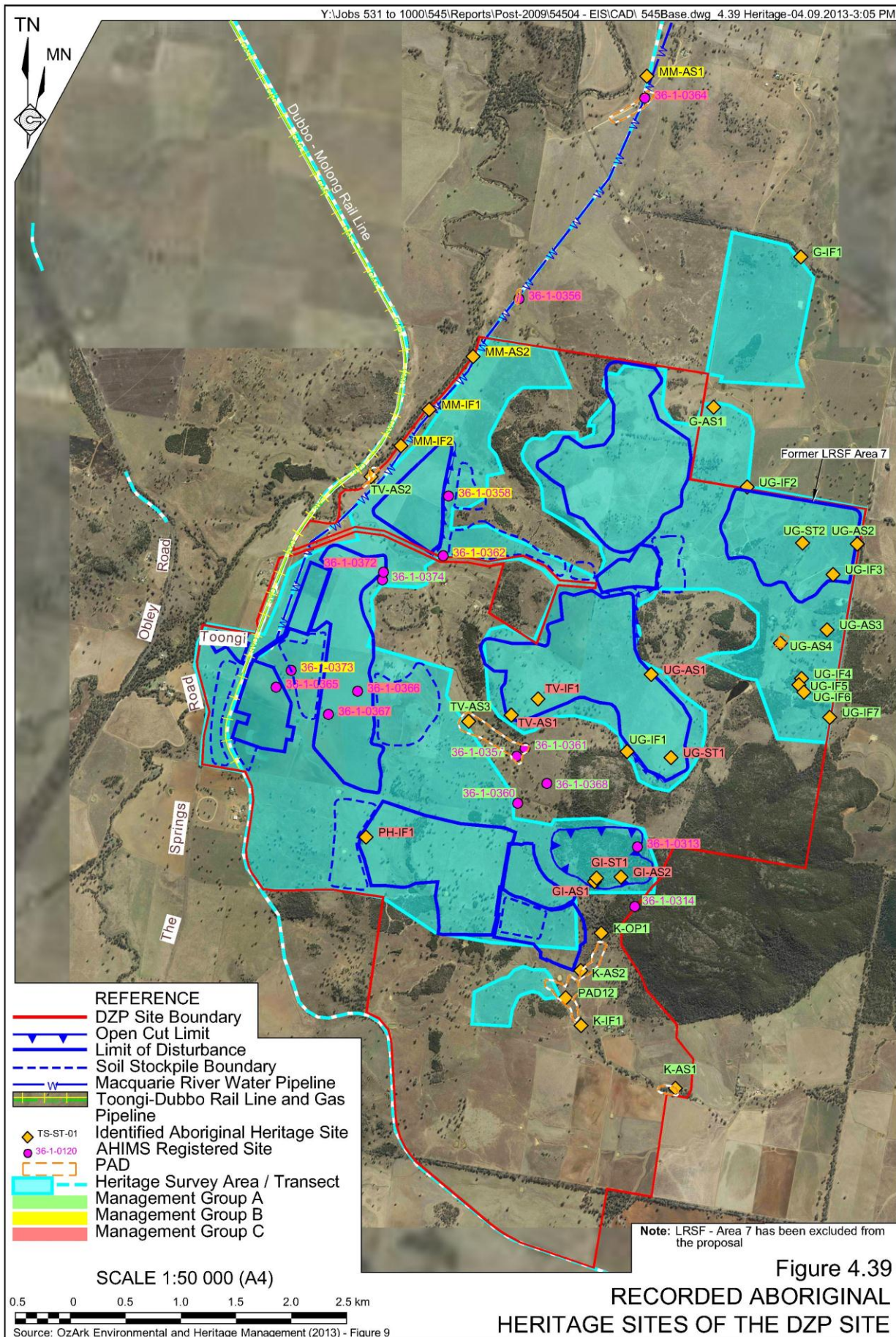
4.9.7.1 Methodology

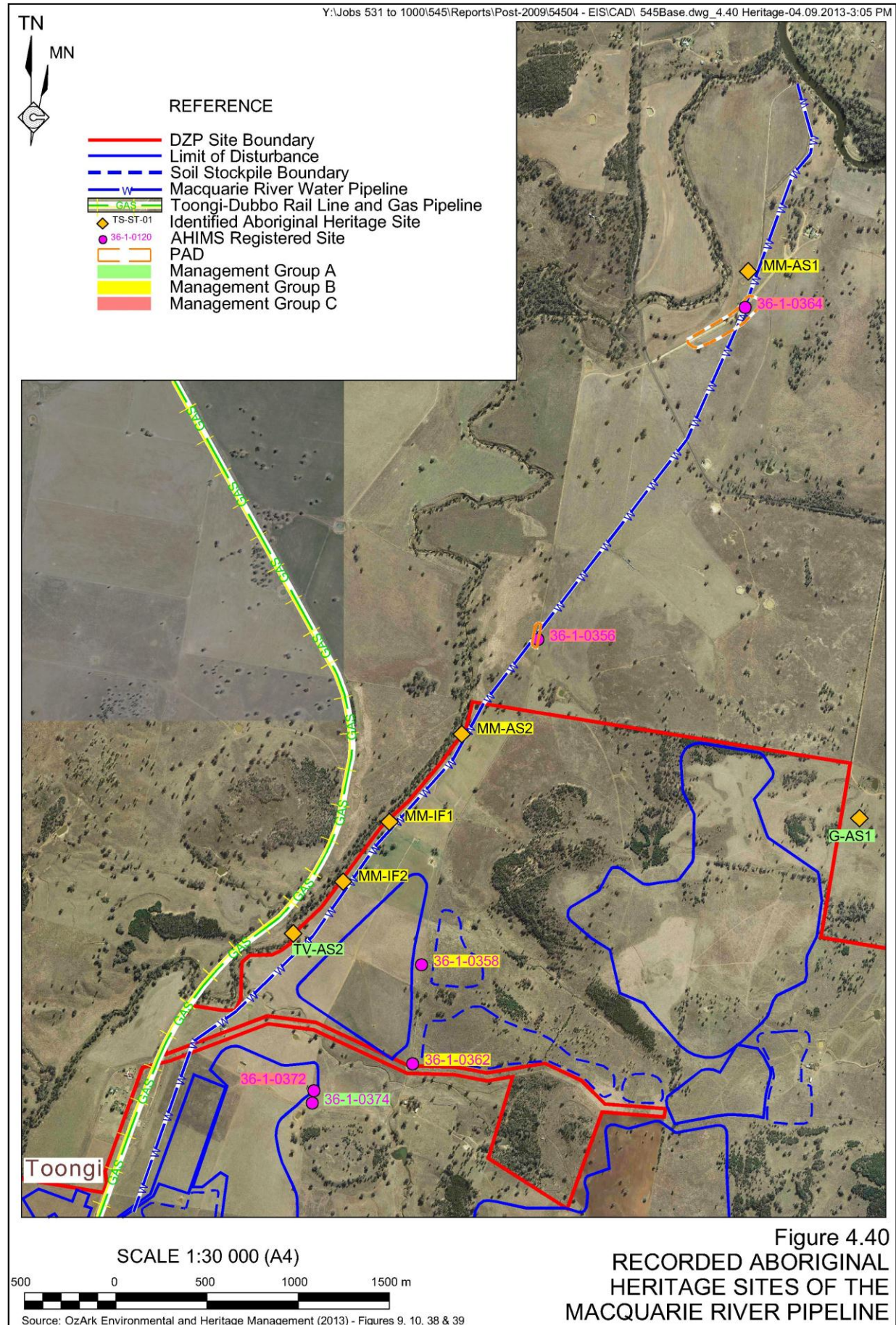
4.9.7.1.1 Overview

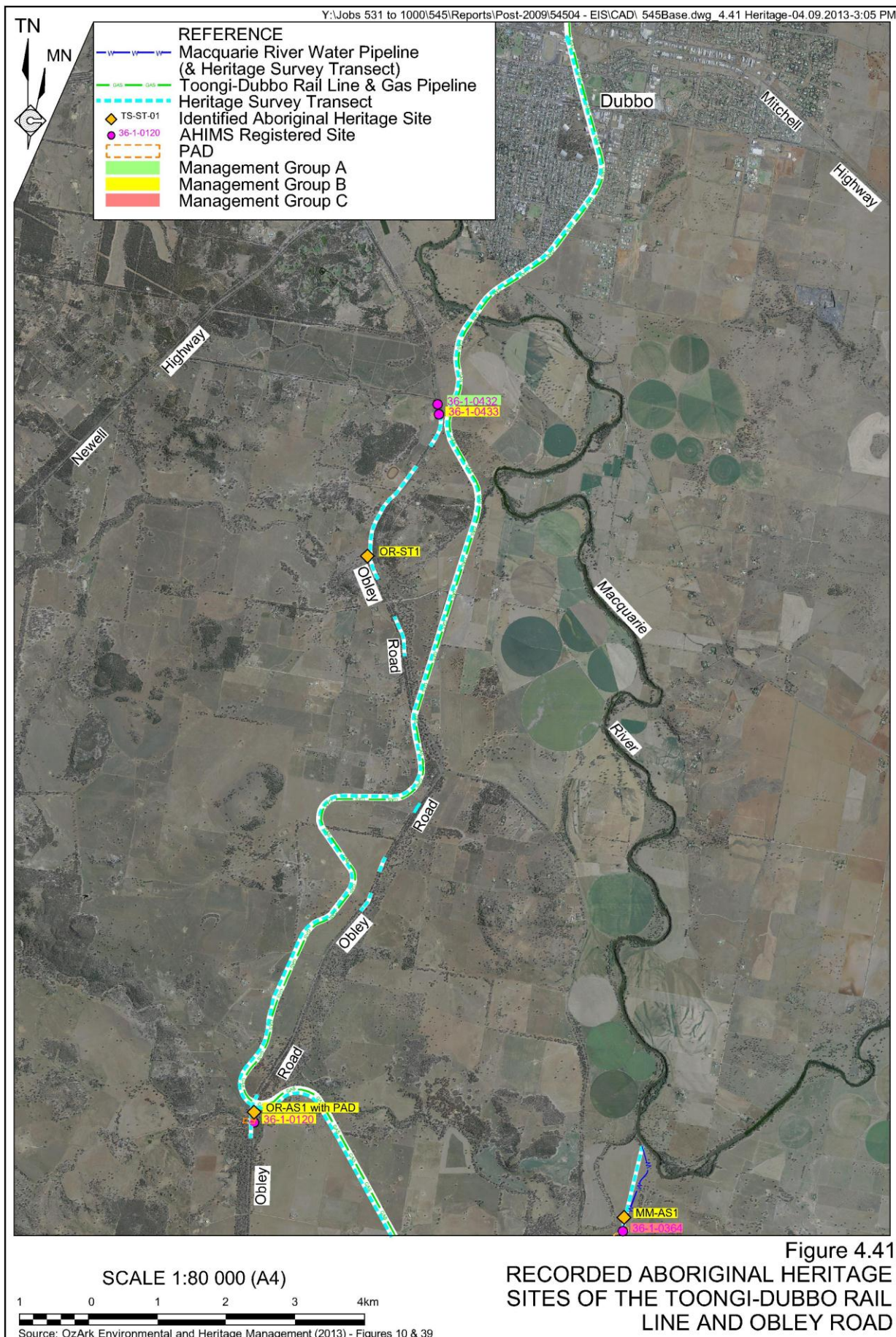
Separate field surveys were conducted for the four study areas (see Section 4.9.2) with coverage displayed on **Figures 4.39 to 4.41**. Details of the survey dates and locations are provided in **Table 4.61**. During the field surveys, discussions were held on site regarding the findings of the field survey and the topics covered included cultural significance, management options and recommendations.

4.9.7.1.2 DZP Site Study Area

The DZP Site study area was surveyed with a combination of pedestrian transects and spot checks. Transects were walked at variously spaced intervals, dependent on ground visibility and archaeological potential. These intervals ranged from 5m distance in areas with narrow impact zones, to approximately 20m intervals in areas with moderate potential for site occurrence.







Areas with high potential for archaeological sites were targeted by implementing more closely spaced transects. Areas that were more closely examined consist of terraces adjacent to creeks and the creeks themselves, and areas of exposure, such as road cuts and areas of erosion. All trees old enough to bear scars of Aboriginal origin were inspected with rocky outcrops examined for grinding grooves.

Cleared paddocks were surveyed with wider transects. When ground visibility was zero, pedestrian transects were abandoned in favour of vehicle transects with spot checks at exposures and old-growth trees capable of bearing scars of Aboriginal origin.

Cropped paddocks having a negligible likelihood of revealing open sites were not surveyed due to the following limitations.

- Paddocks had been recently ploughed.
- Paddocks were cropped and access was not possible.
- Zero ground visibility due to high grasses.

4.9.7.1.3 Macquarie Water Pipeline and Obley Road Alignment

Obley Road Alignment and Macquarie Water Pipeline impact footprints were surveyed to approximately 20m from the centreline of the road or pipeline corridor or if restricted to private property boundary fences.

4.9.7.1.4 Toongi-Dubbo Rail Line

Each of the Toongi-Dubbo Rail Line crossing upgrade locations were inspected and pedestrian surveys completed.

4.9.7.1.5 Macquarie River Water Pipeline Test Excavations

The primary objectives of the test excavations were to:

- assess the nature, extent and integrity of two PADs that occur within the Macquarie River Water Pipeline corridor (TS-OS-03 with PAD and TS-OS-05 with PAD – refer to Section 4.9.7.2.1); and
- inform further management of the sites (such as the possibility of salvage excavation).

Appendix 7 of OzArk (2013b) provides a detailed description of the methodology for the test excavations which is summarised broadly as follows.

- Transects were excavated through the PADs, intersecting areas displaying greater concentrations of artefacts.
- Representative sample of artefacts were retrieved to characterise each PAD in terms of raw material utilisation, use of particular artefacts, the presence or otherwise of stone tool manufacture, and methods of subsistence employed.
- Provision to expand around areas of higher artefact density or notable features was included.

4.9.7.2 Survey Results

4.9.7.2.1 General Survey of the Application Area

The combined field surveys undertaken by OzArk and RAPs resulted in 52 sites being identified within the DZP Site, Toongi-Dubbo Rail Line and Obley Road Realignment Study Areas. These sites include 19 sites previously recorded on the AHIMS database.

Each of the newly identified sites have been either assigned a prefix representing the relevant property name “UG” (Ugothery), “K” (Karingle), “GI” (Glen Idol), “PH” (Pacific Hill), “TV” (Toongi Valley) or “G” (Grandale) or “MM” in the case of the Macquarie River Water Pipeline Study Area and “OR” in the case of the Obley Road Realignment Study Area. These are then followed by a sub-prefix of either AS (Lithic Scatter), IF (Isolated Find), ST (Scarred Tree), OP (Ochre Processing Area) or PAD (Potential Archaeological Deposit) by OzArk, (2013b).

Figures 4.39 to 4.41 display the locations of all sites identified by OzArk throughout the field surveys, together with the 19 AHIMS registered sites. **Table 4.63** provides a brief description of each of the newly recorded sites (see *Section 5.3* of OzArk, 2013b for more detailed descriptions) and **Table 4.64** provides a brief description of each of the re-recorded AHIMS registered sites (see *Section 5.4* of OzArk, 2013b for more detailed descriptions).

Table 4.63
Recorded Aboriginal Heritage Sites

Page 1 of 2

Site Reference	Description	Landform Context
DZP Site		
UG-AS1	Lithic scatter consisting of flakes and flake shatter	Gently undulating in a ploughed paddock near a farm dam with sub-surface deposits unlikely
UG-AS2	Lithic scatter consisting of four flakes covering an area of 50m x 5m	Floodplain in a vehicle track exposure with subsurface with sub-surface deposits unlikely due to the impacts to the area
UG-AS3	Lithic scatter consisting of broken axe head, hammerstone and three flakes with 80m x 5-10m area	Gently undulating with subsurface deposits unlikely due to the artefacts being moved by past erosion and agricultural impacts
UG-AS4	Lithic scatter consisting of core and seven flakes over a 45m x 10m area	Gently undulating adjacent to a 2 nd order stream
UG-ST1	Scarred tree with scar 80cm x 13cm oblong shape approximately 30cm from base of tree and oriented to the southwest	Gently undulating with a single box eucalypt tree in a cleared paddock
UG-ST2	Scarred tree with scar approximately 75cm x 35cm elongated shape approximately 105cm above the ground with 1-2 axe marks and oriented to the north	Gently undulating and approximately 50m of large ephemeral drainage course
UG-IF1	Isolated lithic artefact consisting of a tertiary flake	Floodplain, gently undulating
UG-IF2	Isolated lithic artefact consisting of a flake of uncertain material possibly rhyolite	Gently undulating northeast of a prominent unnamed hill and in a small drainage line
UG-IF3	Isolated lithic artefact consisting of a single hammerstone	Floodplain and due to impacts by agriculture it is unlikely that intact subsurface deposits would be present
UG-IF4	Isolated lithic artefact consisting of a large basal flake	Gently undulating within an erosion exposure disturbed by land clearing
UG-IF5	Isolated lithic artefact consisting of a quartz flaked piece	Gently undulating in an erosion exposure disturbed by land clearing activities
UG-IF6	Isolated lithic artefact consisting of a tertiary mudstone flake	Gently undulating within an exposure with agricultural disturbances present in the area

Table 4.63 (Cont'd)
Recorded Aboriginal Heritage Sites

Page 2 of 2

Site Reference	Description	Landform Context
DZP Site (Cont'd)		
UG-IF7	Isolated lithic artefact consisting of quartz tertiary flake	Gently undulating within an erosion exposure and vehicle track with subsurface deposits unlikely
K-AS1 with PAD	Lithic scatter consisting of ten lithic artefacts covering an area approximately 15m x 10m	Gently undulating adjacent to Cockabroo Creek
K-AS2 with PAD	Lithic scatter consisting of several flakes and a scarred tree	Floodplain and watercourse impacted by agricultural activities
K-OP1	Ochre processing area consisting of a small mound of multi-coloured pigmented clay measuring approximately 1m x 1m.	Floodplain within gently undulating with unknown provenance
K-IF1	Isolated lithic artefact consisting of a silcrete secondary flake	Floodplain adjacent to dry watercourse
PAD 12	Potential archaeological deposit, no sites could not be located in this area however visibility was poor	Floodplain adjacent to a dry watercourse with occasional water pooling
GI-AS1	Lithic scatter consisting of two artefacts	Gently undulating adjacent to a third order water course
GI-AS2	Lithic scatter consisting of two lithic artefacts	Gently undulating on skeletal soils impacted by erosion and recreational activities
PH-IF1	Isolated lithic artefact consisting of a chert flake	Gently undulating, adjacent to ephemeral creek impacted by vehicle track and agricultural activities
TV-AS1	Lithic scatter consisting of two artefacts	Gently undulating impacted by agricultural activities with sub-surface deposits unlikely
TV-AS2 with PAD	Lithic scatter consisting of six artefact adjacent to Wambangalang Creek with extent unknown	Floodplain not inside impact foot print
TV-AS3 with PAD	Lithic scatter consisting of core, flakes and grinding stone with a density of four per square metre	Floodplain, gently undulating and adjacent to a 2 nd order watercourse
TV-IF1	Isolated lithic artefact consisting of a flake	Gently undulating impacted by agricultural activities with sub-surface deposits are unlikely
G-AS1	Lithic scatter consisting of two artefacts	Gently undulating with moderate erosion impacted by agricultural activities and unlikely sub-surface deposits
G-IF1	Isolated lithic artefact consisting of a single quartz flake	Gently undulating impacted by agricultural activities
Toongi-Dubbo Rail Line		
No Aboriginal sites have been recorded in the impact zone for the Toongi-Dubbo Rail Line in the areas assessed.		
Macquarie Water Pipeline		
MM-AS1	Lithic scatter consisting of 11 artefacts of flake and flake shatter	Floodplain heavily impacted by agricultural activities
MM-AS2	Lithic scatter consisting of four artefacts of flakes and cores	Floodplain on the edge of heavily impacted agricultural land
MM-IF1	Isolated lithic artefact either a test cobble or lightly used core	Floodplain impacted by agricultural activities
MM-IF2	Isolated lithic artefact consisting of a core	Floodplain heavily impacted by agricultural activities with sub-surface deposits unlikely
Obley Road Alignment		
OR-AS1 with PAD	Lithic scatter of three artefacts consisting of core and flakes	Floodplain adjacent to Hyandra Creek
OR-ST1	Scarred tree with a scar length of 172cm x 70cm, oriented to the south-southeast and approximately 34cm from the ground	Floodplain and unlikely sub-surface deposits
Source: Modified after OzArk (2013) – Table 8		

Table 4.64
Re-recorded AHIMS Registered Sites

Site Reference	Description	Landform Context
DZP Site		
#36-1-0373 (TS-ST-03)	Aboriginal scarred tree	gently undulating
#36-1-0365 (TS-ST-04)	Aboriginal scarred tree	gently undulating
#36-1-0366 (TS-ST-05)	Aboriginal scarred tree	gently undulating
#36-1-0367 (TS-ST-06)	Aboriginal scarred tree	gently undulating
#36-1-0368 (TS-ST-07)	Aboriginal scarred tree	gently undulating
#36-1-0313 (TS-IF-01)	Isolated artefact	gently undulating
#36-1-0314 (TS-GG-01)	Grinding grooves	Creek
#36-1-0374 (TS-ST-01)	Aboriginal scarred tree	gently undulating
#36-1-0372 (TS-ST-02)	Aboriginal scarred tree	gently undulating
#36-1-0357 (TS-OS-01 with PAD)	Artefact scatter	floodplain
#36-1-0361 (TS-GG-02 with PAD)	Grinding grooves	creek/ floodplain
#36-1-0360 (TS-GG-03)	Grinding grooves	floodplain
#36-1-0358 (TS-OS-02)	Artefact scatter	gently undulating
#36-1-0362 (TS-IF-02)	Isolated artefact	gently undulating
Macquarie River Water Pipeline		
#36-1-0356 (TS-OS-03 with PAD)	MM-6	floodplain
#36-1-0364 (TS-OS-05 with PAD)	MM-2	floodplain
Obley Road Alignment		
#36-1-0432 (ORWM-ST1)	Aboriginal scarred tree	gently undulating
#36-1-0433 (ORWM-ST2)	Aboriginal scarred tree	gently undulating
#36-1-0120 (H2 with PAD)	Aboriginal scarred tree and artefact scatter	floodplain
Source: Modified after OzArk (2013b) – Table 9		

4.9.7.2.2 Macquarie River Water Pipeline Test Excavations

Five artefacts were retrieved at site TS-OS-03 with PAD, however, no subsurface artefacts were recorded at TS-OS-05 with PAD. OzArk (2013b) conclude that the lack of artefacts has been influenced by local disturbance such as ploughing, flooding and stock/vehicle movements. As a result the landforms are degrading and artefacts are not being buried by natural deposition of soils.

4.9.7.3 Potential Impacts

4.9.7.3.1 Impacted Sites

During the planning process for the Proposal, modifications to the layout of various features were made based on the identification and potential impact on Aboriginal sites (including Potential Archaeological Deposits [PADs]). Following the implementation of efforts to avoid direct impact on the identified sites, potential impact on Aboriginal heritage has been reduced as follows.

- 26 sites are outside the impact footprint of the Proposal.

- 12 sites are located adjacent to the impact footprint of the Proposal and would require careful management in order to avoid indirect impacts.
- 14 sites occur either partially or completely within the impact footprint.

4.9.7.3.2 Significance of Sites

The NSW Office of Environment and Heritage policy is to safeguard all sites, Aboriginal places and archaeological material of significance, wherever possible. This requires that some means of assessing the significance of the sites is necessary. The significance of a site can be assessed in the following five ways.

- Cultural / Social significance: the importance of a site to the relevant cultural group, in this case the Aboriginal community.
- Aesthetic significance: the aspects of sensory perception which can demonstrate the cultural setting for a site.
- Public significance: the importance of a site to educate people about the past.
- Historic significance: encompasses the history of aesthetics, science and society, and therefore to a large extent underlies all other values.
- Scientific significance: the importance of a site in view of current archaeological discourse based on a site's condition (integrity), content and representativeness.

OzArk (2013b) reviewed the relative significance of the sites identified, a summary of which is as follows.

Social or Cultural Significance

The social or cultural value of Aboriginal sites is generally determined through consultation with Aboriginal people. Generally considered, however, any site recorded is likely to be reflective of the widespread use of the land by Aboriginal people over time. The sites provide a tangible, continued cultural connection with the land, and have elevated importance due to the diminishing knowledge of Aboriginal culture since white settlement. In this way, all sites have some level of cultural value.

Throughout the field investigations, as well as during the AFGM conducted to review the proposed management of sites, cultural values were discussed with the RAPs. It was noted by the RAPs that the variety of site types present reflect the range of ways the landscape was used by Aboriginal people. A result of the AFGM was to attribute a moderate social/cultural value to all sites.

Aesthetic Significance

None of the Aboriginal sites recorded have significant aesthetic value as the integrity of the sensory landscape has been altered in historic and modern times. Additionally, the artefacts themselves are generally not remarkable and have been assessed as holding low aesthetic value.

Historic Significance

None of the Aboriginal sites recorded have an apparent direct relationship to known historical Aboriginal sites such as missions or massacre sites. It is likely that the area saw some of the earliest contact between Aboriginals and non-Aboriginal settlers, however, none of the recorded Aboriginal sites display evidence that they constitute 'Contact' or 'Post-Contact' Aboriginal sites. To that end, all are assessed as holding low historic value.

Scientific Significance

Of the 52 identified Aboriginal sites, OzArk (2013b) assigned the following scientific values (see also **Table 4.65**).

- 36 are of low value.
- 5 are of low-moderate value.
- 9 are of moderate value.
- 2 are of moderate-high value.

4.9.7.3.3 Summary of Impacts and Significance

Figures 4.39 to **4.41** identify the location of each of the sites and **Table 4.65** summarises the potential impact.

Table 4.65
Potential Impacts and Significance of Aboriginal Sites

Page 1 of 2

Reference	Potential Impact	Significance (Scientific)
Impact Avoided		
UG-AS2	No potential impact	No loss of value
UG-AS3	No potential impact	No loss of value
UG-AS4	No potential impact	No loss of value
UG-ST2	No potential impact	No loss of value
UG-IF1	No potential impact	No loss of value
UG-IF2	No potential impact	No loss of value
UG-IF3	No potential impact	No loss of value
UG-IF4	No potential impact	No loss of value
UG-IF5	No potential impact	No loss of value
UG-IF6	No potential impact	No loss of value
UG-IF7	No potential impact	No loss of value
K-AS1 with PAD	No potential impact	No loss of value
K-AS2 with PAD	No potential impact	No loss of value
K-IF1	No potential impact	No loss of value
K-OP1	No potential impact	No loss of value
PAD 12	No potential impact	No loss of value
TV-AS2 with PAD	No potential impact	No loss of value
TV-AS3 with PAD	No potential impact	No loss of value
GI-IF1	No potential impact	No loss of value
36-1-0368 (TS-ST-07)	No potential impact	No loss of value

Table 4.65 (Cont'd)
Potential Impacts and Significance of Aboriginal Sites

Page 2 of 2

Reference	Potential Impact	Significance
Impact Avoided (Cont'd)		
36-1-0374 (TS-ST-01)	No potential impact	No loss of value
36-1-0357 (TS-OS-01 with PAD)	No potential impact	No loss of value
36-1-0361 (TS-GG-02 with PAD)	No potential impact	No loss of value
36-1-0360 (TS-GG-03)	No potential impact	No loss of value
36-1-0432 (OR-WM-ST1)	No potential impact	No loss of value
Direct Impacts		
UG-AS1	Liquid Residue Storage Facility	Low-Moderate scientific value
UG-ST1	Liquid Residue Storage Facility	Low scientific value
GI-AS1	Open Cut	Low scientific value
GI-AS2	Open Cut	Low scientific value
GI-ST1	Open Cut	Low scientific value
PH-IF1	Solid Residue Storage Facility	Low scientific value
TV-AS1	Liquid Residue Storage Facility	Low scientific value
TV-IF1	Liquid Residue Storage Facility	Low scientific value
36-1-0365 (TS-ST-04)	Processing Plant and Administration Area	Low scientific value
36-1-0366 (TS-ST-05)	Liquid Residue Storage Facility	Low scientific value
36-1-0367 (TS-ST-06)	Liquid Residue Storage Facility	Low scientific value
36-1-0372 (TS-ST-02)	Liquid Residue Storage Facility	Low scientific value
36-1-0313 (TS-IF-01)	Open Cut	Low scientific value
36-1-0356 (TS-OS-03 with PAD)	Defined PAD traversed by the Macquarie River Water Pipeline	Partial loss of value. Moderate scientific value
36-1-0364 (TS-OS-05 with PAD)	Defined PAD traversed by the Macquarie River Water Pipeline	Partial loss of value. Moderate scientific value
Adjacent to Impact Footprint (Management Required)		
OR-AS1 with PAD	Obley Road Realignment	Moderate scientific value
MM-AS 1	Adjacent to Macquarie River Water Pipeline	Low scientific value
MM-AS2	Adjacent to Macquarie River Water Pipeline	Low scientific value
MM-IF1	Adjacent to Macquarie River Water Pipeline	Low scientific value
MM-IF2	Adjacent to Macquarie River Water Pipeline	Low scientific value
36-1-0373 (TS-ST-03)	Between processing plant and soil stockpile area	Low scientific value
36-1-0314 (TS-GG-01)	Adjacent to Open Cut	Moderate scientific value
36-1-0358 (TS-OS-02)	Adjacent to Liquid Residue Storage Facility – Area 2	Low scientific value
36-1-0362 (TS-IF-02)	Adjacent to Liquid Residue Storage Facility – Area 2	Low scientific value
36-1-0433 (OR-WM-ST2)	Close to road realignment, however, can be avoided with management measures	Low scientific value
OR-ST1	Within Obley Road easement.	Low scientific value
36-1-0120 (H2 with PAD)	Within Obley Road easement	Moderate scientific value

Source: Modified after OzArk (2013b) – Table 13



4.9.8 Management and Mitigation Measures

4.9.8.1 Introduction

Recognising the relatively large impact footprint of the Proposal, the Applicant has followed the principles of 'avoid, minimise, mitigate' to reduce the impact of the Proposal on local heritage values.

4.9.8.2 Avoid Impact

The site of the proposed processing operations and related infrastructure has been located over land which has been regularly cultivated over many years. The areas targeted for the positioning of disturbance associated with the management of waste rock and residues generated by the mining and processing operations considered local environmental considerations and heritage values with efforts made to exclude the following areas with higher archaeological potential.

- The remnant vegetation of Dowds Hill.
- Larger and intact remnants of native woodland vegetation.
- Major drainage lines.

In developing the initial impact footprint, the Applicant noted the locations of previously-identified Aboriginal sites and attempted to avoid these where practical. Seven sites, those being, 36-1-0358 (TS-OS-02), 36-1-0362 (TS-IF-02), 36-1-0374 (TS-ST-01), 36-1-0360 (TS-GG-03), 36-1-0357 (TS-OS-01 with PAD), 36-1-0361 (TS-GG-02 with PAD) and 36-1-0314 (TS-GG-01) were specifically identified and the relevant impact area modified as required to avoid.

The survey of the initially-designed impact footprint yielded a number of new sites. Following considerations of these sites and environmental factors, sixteen of the newly-recorded sites were excluded in the re-design of the impact footprint. These were UG-AS2, UG-AS3, UG-AS4, UG-ST2, UG-IF2, UG-IF3, UG-IF4, UG-IF5, UG-IF6, UG-IF7, K-OP1, K-IF1, PAD 12, MM-AS1, MM-AS2, and OR-AS1. Furthermore, the re-design also avoided previously-recorded sites 36-1-0120 (H2 with PAD) and 36-1-0433 (OR-WM-ST2).

The Applicant also recognised that Aboriginal heritage values are strongly linked to the natural environment. Not only does a largely-unmodified landscape provide a setting that enhances the value of a site, but it has value in itself to Aboriginal heritage.

4.9.8.3 Minimise Impact

Noting the largest area of impact would be associated with the Liquid Residue Storage Facility (LRSF), the Applicant has, at significant cost, continued to modify the processing operations to improve water efficiency. Through this process optimisation, the water required has been reduced by approximately 20%, in turn reducing the area required for the LRSF.

When determining which of the LRSF Areas to exclude from the disturbance footprint, the occurrence of heritage sites was considered. The density of Aboriginal sites on the “Ugothery” property where LRSF – Area 7 was originally located is far higher than on those sections of the “Grandale”, “Ugothery” and “Toongi Valley” properties on which LRSF – Areas 4 and 5 are located. As such, greater heritage benefit was derived from excluding LRSF – Area 7 (see **Figure 4.39**).

4.9.8.4 Mitigate / Manage Impacts

Within the context of the proposed impacts, the identified sites have been grouped as follows.

Group A: Avoidance

Impact on the 26 sites located outside the impact footprint and at no direct or indirect risk of harm would be avoided.

The locations of these sites would be clearly marked on mine plans and the areas avoided by all activities associated with the construction and operation of the mine and related infrastructure.

Group B: Avoidance with Management

Eleven sites are located adjacent to component disturbance areas and face possible indirect impacts. These specific sites (TS-ST-03 [36-1-0373], TS-IF2 [36-1-0362], TSA-OS-02 [36-1-0358], MM-AS1, MM-AS2, MM-IF1, MM-IF2, OR-AS1 with PAD, OR-ST1, ORWM-ST2 [36-1-0433] and H2 with PAD [36-1-0120]) would be managed as follows.

- DZP personnel would be alerted to their location and the location of the sites would be shown on mine plans.
- Each site would be revisited by a suitably qualified archaeologist before construction, resurveyed and temporarily fenced until earthworks in the general vicinity is complete.
- Work crews in the vicinity of any of these sites would be informed by way of an induction as to the site’s location and its legislative protection under the NPW Act. All work crews would be informed that the fenced area remains a “no-go” area for the duration of the works.
- If, at the time of construction, it becomes obvious that a site in this category would be impacted by the proposed works, the site would be managed as a Group C site with specific management recommendations formulated following the site visit by a suitably qualified archaeologist.

One site (TS-GG-01) could suffer over time from modification of the drainage coming from the proposed open cut. Once the eastern half of the open cut has begun, a condition assessment schedule would be implemented to ensure that the site is not being harmed.

Group C: Sites Requiring Management

This group includes sites either partially or completely within the impact footprint where cultural material was identified but where sub-surface archaeological deposits are considered unlikely.

- Group C(i): Surface collection of artefacts

Nine sites fall into this group: UG-AS1, GI-AS1, GI-AS2, PH-IF1, TV-AS1, TV-IF1, TS-IF-01 (36-1-0313), TS-OS-03 with PAD (36-1-0356) and TS-OS-05 with PAD (36-1-0364). Detailed recording and collection of surface artefacts would be the primary management approach for these sites.

- Group C(ii): Relocation of cultural heritage items

Including five Aboriginal scarred trees (UG-ST1, TS-ST-04 [36-1-0365], TS-ST-05 [36-1-0366], TS-ST-06 [36-1-0367] and TS-ST-02 [36-1-0372]), the Applicant would consult with the RAPs to determine the best method to relocate these sites to a place of safekeeping.

Following discussions with the RAPs in the AFGM of 13 August 2013 (refer to Section 4.9.4.2), it has been agreed that collected surface artefacts be transferred to the custody of the RAPs via a Care Agreement which would be drafted and included in the *Aboriginal Cultural Heritage Management Plan* for the DZP. The transfer of custody of the scar-bearing portions of the scarred trees to be impacted would also be subject of a Care Agreement. This arrangement would also be formalised within the *Aboriginal Cultural Heritage Management Plan* for the DZP.

4.9.8.5 Cultural Heritage Management – General

In recognition of the fact that 38 sites are to remain undisturbed on the DZP Site and infrastructure corridors (with management in the case of 12 of these), there remains potential for sites not identified by OzArk (2013) to occur, and acknowledging the Applicant's obligations in relation to Aboriginal cultural heritage management under the NPW Act, the Applicant would abide by the following general management principles.

- Disturbance on the DZP Site, unless appropriately cleared by the RAPs, would remain within the limit of disturbance nominated in this EIS.
- Should any other objects or Aboriginal sites be identified during the course of construction, the Applicant would implement an *Unanticipated Finds Protocol*, as presented in *Appendix 5* of OzArk (2013b).
- An *Aboriginal Cultural Heritage Management Plan* (ACHMP) would be prepared, including a Statement of Commitments with respect to the management of the identified (any as yet unidentified) sites. The ACHMP would incorporate the proposed management of sites included in this EIS, measures which have been reviewed by the RAPs for the Proposal.

- The site induction process for all personnel would include Aboriginal cultural heritage as a core component. The information presented would include:
 - artefact recognition and implementation of the correct procedure if artefacts are recognised;
 - the procedure(s) that must be followed if artefacts are identified; and
 - the penalties if the procedure is not followed.

4.9.9 Assessment of Residual Impacts

4.9.9.1 Assessment of Study Area Impacts

OzArk (2013b) identifies that the Proposal would avoid impact on 38 of the 52 identified sites. Impact on the remaining 14 sites is considered unavoidable, despite the efforts of the Applicant to modify the site layout to avoid these.

OzArk (2013b) states that, taking into consideration the fact artefact salvage and/or relocation would be undertaken for the impacted sites in accordance with the management measures and operational safeguards nominated in Section 4.9.8 (to be formalised within an ACHMP prepared in consultation with the Aboriginal community), the impact of the proposed disturbance would be acceptable.

Salvaging the artefacts would effectively destroy the *in situ* sites but would ensure the safety of the artefacts which, if retained in a suitable keeping place such as a museum or Aboriginal Land Council office, would become far more accessible than they would be if not salvaged but destroyed. Following the receipt of development consent, and the approval of the ACHMP, a qualified archaeologist and Aboriginal stakeholders would revisit the 14 sites to identify on the ground all sites, recover artefacts from identified sites to be disturbed and remove any other artefacts within the footprint of disturbance.

Further site management measures may follow after the conclusion of test excavations to be completed for two sites with associated PADs. It is further noted that the residual impact on Aboriginal heritage following the adoption of the management measures and operational safeguards of Section 4.9.8 represents the minimum impact practically achievable for the Proposal.

4.9.9.2 Impact Assessment in a Regional Context

When considering whether or not to salvage certain artefacts, a further consideration is the extent to which the removal of the artefacts has a cumulative impact on the archaeological record, given that other sites in the region may have been destroyed previously.

A total of 52 sites (comprising 19 previously registered AHIMS sites and the additional 33 sites identified during the current survey) exist within the study areas. Of the sites to be impacted, only one was confirmed as having moderate scientific value (all sites were assessed as having moderate cultural value) with a further two being allocated a preliminary moderate scientific value to be reviewed following the completion of test excavations (OzArk, 2013b). With the appropriate salvaging, recording and preservation of the open scatter and isolated finds, it is anticipated that there would be minimal impact on the wider representation of historic Aboriginal habitation throughout the area.

4.9.10 Conclusion

Appropriate consultation has been, and would continue to be undertaken with the relevant stakeholders in the development of an *Aboriginal Cultural Heritage Management Plan*. That document would provide for the further collection of information in relation to the sites through the collection, salvage, recording and relocation of the identified artefacts to an appropriate keeping place determined in consultation with all stakeholders and management of sites that may be identified throughout the life of the Proposal.

As a result, the Applicant contends that the impact of the proposed activities on Aboriginal cultural heritage has, to the greatest extent practicable, been minimised.

4.10 HISTORIC HERITAGE

4.10.1 Introduction

The Director-General's Requirements (DGRs) issued by the DP&I identified "*Heritage*" including as a key assessment requirement as one of the key issues "*an historic heritage assessment (including archaeology)*". The DGRs also require that the historic heritage assessment "*must*:"

- *include a statement of heritage impact (including significance assessment) for any State significant or locally significant historic heritage items; and,*
- *outline any proposed mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures)."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Heritage Council which request that the EIS "*include a heritage impact assessment*" that addresses issues including:

- the identification of non-Aboriginal heritage items within the area affected by the Proposal;
- the heritage significance of the site and any impacts the development may have upon this significance; and
- consideration of the relics provisions in the *Heritage Act 1977*.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to historic heritage and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Loss or destruction of items of heritage significance due to proposal activities (medium).

The historic heritage assessment for the Proposal was undertaken by various archaeologists of OzArk Environment and Heritage Management Pty Limited (OzArk) under the direction of Dr Jodie Benton. The resulting report is presented as Part 9 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as "OzArk (2013c)". This subsection of the EIS provides a summary of the historic heritage assessment, concentrating on those matters

raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.10.2 Assessment Methodology

The historic heritage assessment was undertaken in the following stages.

- **Stage 1 – Background Research and Literature Review.**
An understanding of the archaeological context of the regional, local and DZP Site was obtained through a review of historic records of the local area, previous archaeological studies, review of archaeological databases and consultation (refer to Section 4.10.3).
- **Stage 2 – Field Survey**
Eight field surveys were undertaken between May 2012 and February 2013. Section 4.10.4 presents further detail on the site inspection methodology, coverage and results.
- **Stage 3 – Development of Management Strategies for the Identified Historic Heritage Sites.**
Based on the relative cultural, scientific and public significance of the identified sites, management strategies have been recommended (refer to Section 4.10.5).
- **Stage 4 – Assessment of Impacts**
The significance of any sites identified or re-recorded was completed in accordance with the relevant assessment criteria and considering the adoption of the proposed management strategies, the residual impact of the Proposal on historic heritage was assessed (refer to Section 4.10.6).

4.10.3 Historic Context and Background Research

4.10.3.1 Historic Heritage Study Area

The historic heritage assessment of OzArk (2013c) considers a research study area for the Dubbo regional area to determine the historic regional and local context. The following study areas specific to each of the four main components of the Proposal were adopted by OzArk for the purposes of impact assessment.

- **The DZP Site:** comprising all areas of proposed mining, processing and associated disturbance. This study area is larger than the DZP Site reflecting the changes to the site layout that have occurred since the commencement of the historic heritage assessment.
- **The Macquarie Water Pipeline:** a 7.6km long and approximately 20m wide corridor for the proposed water pipeline from the Macquarie River to the DZP Site.

- The Toongi-Dubbo Rail Line: approximately 30km long and approximately 10m wide area for the proposed upgrade of the Toongi to Dubbo section of the Dubbo-Molong Rail Line.
- The Obley Road Alignment: approximately 22km long and 20m wide corridor for the proposed realignment of portions of Obley Road between the DZP Site and Dubbo.

4.10.3.2 Regional Context

European involvement in the Dubbo region has been recorded since the grant of land in the 1820s for pastoral enterprises with the first successful and permanent run occupied approximately 8km south of the current city of Dubbo. With the gold rushes of the 1850s, the area was opened up to new cattle markets with long-distance droving routes being established. Following the demise of the gold rush, the subsequent increasing labour supply saw sheep and wool production overtake the area. Dubbo prospered throughout the late nineteenth century and in particular during the 1880s following the arrival of the railway in 1881 making it a central hub for transport routes.

Five recorded items of State Heritage Significance are situated in the vicinity of the proposed rail upgrade (OzArk, 2013c), however, not within the impact footprint of the DZP Site.

- Dubbo Railway Precinct.
- Dubbo RAAF Stores Depot (used during Second World War).
- “Dundullimal” property.
- Dubbo Showground.
- “Holmes” Property.

OzArk (2013c) provides a discussion of these and other historic features of the region.

4.10.3.3 Local Context

The area to the south of Dubbo was predominantly pastoral country during the nineteenth century with “The Meadows”, a pastoral property, located adjacent to the western margin of the DZP Site, being recognised as one of the earliest pastoral runs during European settlement in the region. This property was consequently subdivided with “The Springs” property being taken up in 1846 and named by Scottish immigrants Arthur Campbell Baird and his wife, Isabella. “The Springs” is of Local Historic Significance as it represents a location for early contact between Aboriginal and European people in the Dubbo region.

Additionally, another pastoral run within the locality, the Cumbooglecumbong holding / Whylandra Run, supported sheep and cattle. Slab huts on the run housed 94 people, many of whom were likely to have been convicts. The first homesteads built on the Cumbooglecumbong run are no longer extant, having been destroyed by flooding in 1867 and 1874. This holding was eventually sub-divided in approximately 1897 into a number of properties including “Cockleshell Corner”, “Pacific Hill”, “Glen Idol”, “Karingle”, “Wychitella”, “Toongi Valley”, “Grandale” and “Ugothery”. All those properties, with the exception of “Cockleshell Corner”, lie within the DZP Site.

OzArk (2013c) provides a detailed review of the historic record of the local setting, considering Toongi and surrounding properties, the rail line between Toongi and Dubbo and adjoining properties and the city of Dubbo more generally. The following provides a brief overview of the historic record / context of the village of Toongi, “Dundullimal” property and homestead, and Dundullimal Rail Bridge, being those sites most likely to be impacted by the Proposal or holding most heritage significance.

Toongi Village

The Toongi Village itself was settled relatively late in comparison to other areas in the district with a ‘Settlement Lease’ taken up by James Ower on 4 November 1897. The village of Toongi was notified on 6 March 1931. At that time, the village notification consisted of a recreation reserve and school site, with village lots opened up for purchase on 17 April 1931 (Hickson and Kass 2002a). The Wambangalang School, opened in 1928, continues to provide educational services (as the Wambangalang Environmental Education Centre).

A government-operated grain storage and distribution location was previously located on the Dubbo-Molong Rail Line which runs adjacent to the village. It is likely that operations on that location have involved grain bagging, storage and bulk loading on to trains. Operations ceased in 1993 following the closure of the rail line (circa 1987). Dismantling of the southern grain storage occurred between 1988 and 1995 and dismantling of the northern storage occurred between 1995 and 2000. In 2012, the site consisted of a concrete floor remnant of the northern storage and an asphalt floor remnant of the southern storage.

As part of the Dubbo City Rural Areas Community based Heritage Review completed for the State Heritage Inventory (Hickson and Kass, 2002b) it is noted that Toongi holds nil heritage significance (OzArk, 2013c)².

Dundullimal (Property and Homestead)

“Dundullimal” is a pastoral property located on Obley Road on the southern bank of the Macquarie River, ~2.3km south of the Obley Road intersection with the Newell Highway. The homestead (see **Figure 4.42**) is regarded as holding national and state heritage significance. It is one of few surviving early pastoral homesteads and is the oldest building in Dubbo (c. 1842) and may be the oldest existing house outside Governor Darling’s original Nineteen Counties.

The homestead portion of “Dundullimal” was granted to the National Trust of Australia (NSW) in 1985 (OzArk, 2013c).

Dundullimal Rail Bridge

The Dundullimal Rail Bridge traverses the Macquarie River and is one of two J.W. Roberts standard design steel Pratt truss railway bridges built during 1925 on the now-disused Dubbo-Molong Rail Line. The bridge is approximately 300m in total length and approximately 5m in maximum width. The heritage significance of the bridge was previously assessed by OzArk (2010) and afforded local heritage significance.

² The ‘Assessed Significance’ field of the SHI inventory sheet is blank.

4.10.3.4 Background Research

OzArk (2013c) reviews the following primary resources to identify the relevant historic heritage significance within the study areas.

- Archived historical newspapers located at the National Library of Australia's (NLA) Trove.
- Archived historical parish maps located at the NSW Land and Property Information's (LPI) Parish Maps Preservation Project and Pixel websites.
- The National Archives of Australia's (NAA) 'Your story, our history' collection of defence service records.

Secondary resources used to identify the relevant historic heritage significance within the study areas include the following.

- Dormer's two-volume history of the Dubbo region (Dormer 1987, Dormer, 1988).
- Community heritage studies commissioned by the Dubbo City Council (Hickson and Kass, 2002a, 2002b, 2002c, 2002d; Christo Aitken & Associates, 2007).

OzArk (2013c) reviewed the following heritage registers and databases on the 15 October 2012 to identify sites of historic heritage significance within the Dubbo LGA.

- Australian Heritage Database: 24 places were identified within the Dubbo LGA.
- NSW Heritage Office State Heritage Register: five items within the vicinity of the proposed upgrades to the crossings of the Toongi-Dubbo Rail Line were identified.
- State Heritage Inventory: eight places were identified at Toongi, however none within the DZP Site.
- Department of Sustainability, Environment, Water, Population and Communities Protected Matters Database: no places of historic heritage were identified.
- *Dubbo Local Environmental Plan 2011*: 260 places were identified within the Dubbo Local Government Area (LGA).

Consultation was also undertaken with current landowners of Toongi area, including Megan Brennan, Kevin Hyland, John Hyland, Gwen Harper, John Tucker, the Rotherys of "Toongi Valley" and the Greys of "Grandale", regarding property histories and other information that would assist with the surveys.

4.10.4 Field Survey Methodology and Results

4.10.4.1 Survey Methodology

A survey for historic heritage sites was undertaken concurrently with the survey for Aboriginal heritage involving a combination of pedestrian and vehicle transects (see Section 4.9.7). All structures within the DZP Site, Macquarie River Water Pipeline Corridor, Obley Road Realignment and the proposed upgrade of crossings for the Toongi-Dubbo Rail Line were recorded together with observations of the overall historical significance of the wider agricultural landscape where relevant.

4.10.4.2 Survey Results and Significance Assessment

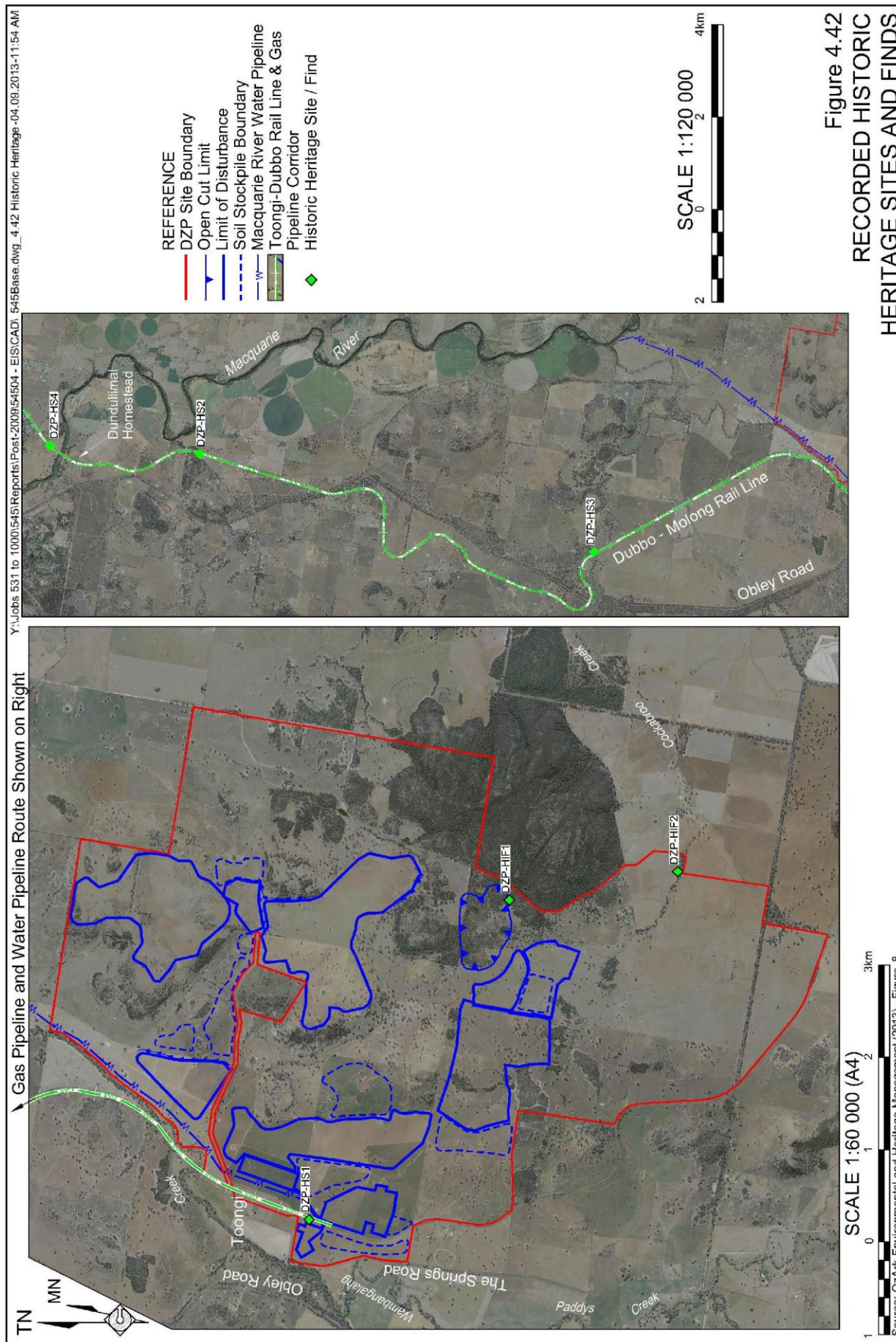
In total, six new historical heritage items in addition to the Dundullimal Rail Bridge, were identified during the surveys. Of these, four were described as historical sites (HS) and two were described as historical isolated finds (HIF) as follows (**Figure 4.42**).

- DZP-HS1 Brick and concrete footings. This site consists of frogged bricks and stamped bricks with 'IFB' or 'CRITIX' and concrete footings approximately 10m from the existing rail line.
- DZP-HS2 Cumboogle Rail Bridge. This rail bridge consists of metal and concrete supports with wooden railroad tiles embossed with '1970'.
- DZP-HS3 Hyandra Rail Bridge. This railway bridge is constructed entirely of timber with metal fasteners and rails which obstructs fallen timber within the watercourse.
- DZP-HS4 Dundullimal / Miriam Timber Rail Bridge. This rail bridge is constructed entirely of timber with metal fasteners and rails and has been assessed as in fair condition as a result of fire and neglect.
- DZP-HIF1 Brown glass bottle. This bottle is embossed with '1926' and 'The Bottle Company'.
- DZP-HIF2 Rail piece with two holes.

4.10.5 Management and Mitigation Measures

The following management and mitigation measures would be implemented to minimise the potential for adverse Proposal-related impacts on historic heritage sites within and surrounding the DZP Site.

- Identify on relevant plans all identified sites and ensure that activities in the vicinity of those sites are appropriately managed.
- Avoid impacts on sites DZP-HIF1 and DZP-HIF2 by establishing a fence and buffer zone around the sites.
- Unless unavoidable due to rail line upgrade, avoid DZP HS1.
- Document and record sites DZP-HS2, DZP-HS3 and DZP-HS4, prior to dismantling, and provide this record to Dubbo City Council and the NSW State Archives. Site DZP-HS2 is not recorded as having significance, however, would be documented together with the timber railway crossings to be dismantled and replaced.



- If items of suspected historic heritage significance are identified throughout the life of the Proposal, the following procedures would be implemented.
 1. Step 1 – No further earth disturbing works would be undertaken in the vicinity of the suspected item of historic heritage significance.
 2. Step 2 – A buffer of 20m x 20m would be established around the suspected artefact. No unauthorised entry or earth disturbance would be allowed within this buffer zone until the area has been assessed.
 3. Step 3 – A qualified archaeologist would be contacted to make an assessment of the discovery. Mitigation procedures would then be developed and implemented based on the assessment.

4.10.6 Assessment of Residual Impacts

4.10.6.1 Residual Impacts

Based on the proposed layout of the DZP Site and upgrade of the Toongi-Dubbo Rail Line, disturbance to four recorded sites (DZP-HS2, DZP-HS3, DZP-HS4, and the Dundullimal Rail Bridge) would be unavoidable. Impact to Site DZP-HS1 would be avoided subject to rail upgrade requirements.

4.10.6.2 Significance of Identified Historic Sites and Items

OzArk (2013) undertook an assessment of the significance of the identified sites based on the principles identified in the Heritage Council of NSW significance criteria. **Table 4.66** summarises the overall heritage significance of the identified historic sites and items.

Table 4.66
Heritage Significance of Historic Sites and Items

Site	Heritage significance	Comments
DZP-HS1	Nil	Does not yield new information relating to railways or settlement within the region within the region.
DZP-HS2	Nil	Common and well understood bridge building techniques. Does not yield new information relating to railways within the region.
DZP-HS3	Local	Does not yield new information relating to railways within the region.
DZP-HS4	Local	Associated with the previously assessed Dundullimal Rail Bridge and therefore the Dubbo-Molong Rail Line. Derives significance from this association.
DZP-HIF1	Nil	Ordinary item unable to yield new information about settlement within the region.
DZP-HIF2	Nil	Ordinary item unable to yield new information about railways within the region.
Dundullimal Rail Bridge	Local	Significance assessed by OzArk (2010).
Source: Modified after OzArk (2013c) – Table 10		

Tables 11 to 14 of OzArk (2013c) provide more detailed assessment of each of these sites against the seven criteria of the Heritage Council of NSW's manual *Assessing Heritage Significance* (Heritage Council of NSW, 2001).

4.10.6.3 Assessment of Regional Historical Context

As recognised on the Dubbo LEP 2011, the Dubbo Railway Precinct is listed as having State historical significance. While the Toongi-Dubbo Rail Line upgrade in the Study Area has not been listed, the Applicant has demonstrated the appropriate mitigation measures to ensure the integrity of the line is maintained, and as required, the documented archival of the relevant bridges prior to any works being undertaken. There would be negligible residual impact on the regional historical context by the Proposal.

4.10.6.4 Assessment of Local Historical Context

As discussed in Section 4.10.6.1, four recorded historical heritage sites (DZP-HS2, DZP-HS3, DZP-HS4 and the Dundullimal Rail Bridge) would be impacted by the Proposal. As a result of the proposed mitigation measures to upgrade the Dundullimal Rail Bridge keeping the historical integrity of the structure, and the documented archival recording prior to the other crossings being dismantled, there would be negligible residual impact on the local historic context by the Proposal.

4.10.7 Conclusion

The Applicant has taken all historic heritage sites into consideration for the planning of the Proposal. The required upgrades to the Toongi-Dubbo Rail Line to transport materials from the DZP Site would result in the improvement of the line, which has not been used since 1984. The rail crossings, to be dismantled and replaced as part of the line upgrade, are currently not listed on any Commonwealth, State or Local registers as having any historical significance. Despite this, the Applicant would provide a documented record of the structures prior to dismantlement to be appropriately archived for future historical research. As a result, OzArk (2013c) conclude that there would be negligible impacts on historic heritage.

4.11 SOILS AND LAND CAPABILITY

4.11.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "*Land Resources*" as a key assessment requirement including "*a detailed assessment of the potential impacts on soils and land capability (including salinisation and contamination)*".

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Environment Protection Authority (EPA) which requested that the EIS provide “*an assessment of potential impacts on soil and land resources*”; the Central West Catchment Management Authority which requested that the EIS “*outline the soil types covered in the proposed site and outline how the operation will mitigate risks in regard to the removal of the topsoil, storage of the overburden, replacement of the waste material and rehabilitation of the area upon completion of operation*”; and the Division of Resources & Energy (DRE) of DTIRIS which requested that the EIS “*outline and map soil characteristics across all proposed areas of surface disturbance and assesses their value and limitations for rehabilitation*”. DRE also requested that:

- *significant limitations need to be addressed in terms of their impact on rehabilitation; and*
- *land capability and agricultural suitability mapping also needs to be undertaken and presented.*

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to soils and land capability and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Rehabilitation outcomes not meeting objectives (high).
- Reduced productivity on final landform (high).
- Increased erosion on the final landform (high).

The soils and land capability assessment for the Proposal was undertaken by Messrs Pat Hulme and David Duncan of Sustainable Soils Management Pty Ltd (SSM). The resulting report is presented as Part 10 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “SSM (2013)”. This subsection of the EIS provides a summary of the soils and land capability assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.11.2 Existing Environment

4.11.2.1 Regional Soil Environment

4.11.2.1.1 Soil Landscapes and Soil Types

The former Department of Land and Water Conservation prepared the Soil Landscapes of the Dubbo 1:250 000 Sheet (Murphy and Lawrie, 1998) which records nine soil landscapes as occurring within the DZP Site. SSM (2013) has divided these into the five classes as presented in **Table 4.67**.

Table 4.67
Summary of Soil Landscapes in the Soil Survey Area

Soil Class	Landscape	Landscape Summary
Alluvium	Mitchell Creek (Mi)	Recent alluvial deposits with highly variable soils including sandy Stratic Rudosols and loamy alluvial soils (Brown Dermosols) along Wambangalang Creek. Land Class 2 (6 in drainage lines).
Chromosols (Duplex, but not acidic)	Arthurville (Ar)	Gently undulating rises and undulating low hills with mixed sedimentary and volcanics in Cowra Trough. Red Chromosols with Yellow Sodosols along drainage lines. Land Class 3 to 5.
	Ballimore (Bm)	Undulating low hills on flat lying Napperby formation of sandstone, conglomerates ferruginous material and siltstone. Red Chromosols with Siliceous Sands on steeper scarps and Yellow Sodosols on lower slopes and depressions. Land Class 3 to 5.
Red Podzolics (Duplex and Acidic)	Belowrie (Bi)	Rises and low hills Jurassic trachyte. Red Chromosols Land Class 4 with Red Kandosols and Brown Chromosols on more stable lower slopes Class 3 and Yellow Sodosols on flatter lower areas. Shallow Rudosols and Tenosols on rocky crests. Hard setting and acidic surfaces.
	Splitter Hill (Sh)	Undulating and rolling hills on Silurian vertically bedded shale and sandstone. Mainly Red Chromosols but a variety of others depending on parent material. If sandstones are present the soils can be very acidic and have aluminium toxicity. Land Classes range from 3 to 6 depending on geology.
Euchrozems (Clayey soil with little shrink/swell capacity)	Bald Hill (Bh)	Low hillocks with moderately steep slopes. Basalt rock outcrop and shallow Red Ferrosols Land Class 6 and Brown Ferrosols Class 4 & 5 on lower slopes.
	Wongarbon (Wg)	Gently undulating and low hills with minor basaltic hillocks. Red Ferrosols and Red & Brown Vertosols with linear gilgais. Fertile soils.
	Nubingerie (Nb)	Undulating low hills mainly andesites from Cowra trough. Red Ferrosols Land Class 3 and Red & Brown Vertosols Class 2.
Shallow Soils	Dowd (Dw)	Hills of rock pavements and scarps. Trachyte volcanic plugs may be sodic. Shallow soils Leptic Rudosols low fertility not suitable for stripping. Land Classes 7 & some shallow Red Chromosols Class 6.
Source: Modified after SSM (2013) – Table 1		

Three of these five classes, Chromosols, Red Podzolics and Shallow Soils form a continuum from deeper soil in the footslopes and depositional parts of the landscape through strongly leached soil (Red Podzolics) in mid and upper slopes to the shallow soil on the crests of hills. The more clayey Euchrozems appear to be associated with the Jurassic basalts in the northern part of the soil survey area, and older volcanic rocks near the southeastern corner of the soil survey area. The alluvial Mitchell Creek landscape was mapped only along the Wambangalang Creek floodplain.

4.11.2.1.2 Land and Soil Capability

Land and soil capability assessment is based on the slope, wind hazard, soil pH, surface structural stability, salinity, rocky outcrop, waterlogging potential and existing erosion of a landform. SSM (2013) based its determination of land capability on the NSW Office of Environment and Heritage Land and Soil Capability Assessment Scheme (OEHL, 2012). **Table 4.68** summarises the appropriate land use for each capability class.

Table 4.68
Land and Soil Capability Classes

Land Capability Class	Most Intensive Use	Land Definition
Class 1	Regular Cultivation including intensive crops	Prime agricultural land and the best cropping country in the catchment
Class 2	Regular Cultivation	Very good cropping land with fertile soils and short, gradual slopes
Class 3	Regular cultivation, but must be consciously managed to prevent degradation	Moderate limitations that can be managed by more intensive management practices
Class 4	Grazing, intermittent cultivation with specialised practices	Moderate to severe limitations for more intensive use (e.g. cropping). Limitations more easily managed for grazing
Class 5	Grazing, very occasional cultivation for pasture establishment	Severe limitations for cropping and other high impact land management. Moderate limitations for grazing
Class 6	Grazing only	Severe limitations for wide range of land uses
Class 7	Unsuitable for rural production	Includes steep (slope 33% to 50%) or extremely erodible, or saline or shallow
Class 8	Unusable for any agricultural purpose	Extremely severe limitation, includes precipitous slopes (>50%), areas with large proportion of rock outcrop and frequently inundated
Source: OEH (2012), (Central West CMA, 2008)		

Considering the soil landscape units mapped over the DZP Site, the majority of the soil survey area was described as having moderate (Class 3) to severe (Class 5) limitations for agriculture according to the Central West CMA (2008) system (SSM, 2013). The land most suitable for agriculture is contained within the landscapes of the Alluvium and Euchrozems soil classes.

4.11.2.1.3 Dryland Salinity Considerations

Dryland salinity is the build up of salts in the soil surface in non-irrigated areas and is usually the result of three broad processes, namely, groundwater recharge, groundwater movement and groundwater discharge. Effectively, dryland salinity occurs as a result of saturation and drying cycles within the soil or at surface resultant from rising and falling of brackish or saline groundwater. The accumulated salts that remain following evaporation or evapotranspiration increase the salinity of the soil.

A regional scale groundwater and dryland salinity investigation carried out in 2001 by the then NSW Department of Land and Water Conservation (DLWC) identified the Toongi Catchment as prone to significant salinity (Smithson, 2001). The occurrence of dryland salinity in the Toongi Catchment typically occurs in the upper and mid-slopes and along drainage lines. Potential groundwater discharge and saline sites within and surrounding the DZP Site have been identified as surface drainage lines, break of slope and on the valley floors or alluvial flats (Smithson, 2001). Areas at greatest risk of dryland salinity are those where the groundwater table is within 5m of the natural ground surface.

Known areas of dryland salinity have been mapped for the Toongi Catchment, which includes the DZP Site, and based on *Figure 6* in Smithson (2001) there are no recorded saline sites within the DZP Site. *Figure 13* in Smithson (2001) indicates that less than 5% of the DZP Site is expected to have water-tables within 5m of the natural ground surface, situated within the alluvium of Paddys, Wambangalang and possibly Cockabroo Creeks. This is supported by the assessment of groundwater conditions prepared by EES (2013) (see Section 4.6.5.5) which also identifies local discharge points ('springs') on several drainage lines of the DZP Site where the groundwater incises surface topography when the groundwater table is elevated.

Noting the dryland salinity potential of parts of the DZP Site, SSM (2013) uses the Hydrogeological-Landscape framework (HGL)³ to assess salinity hazard of the local setting. SSM (2013) map seven hydrogeological landscape units (HGLU)⁴ over the DZP Site and immediate surrounds (refer to *Figure 6b* of SSM, 2013). SSM (2013) considers the greatest salinity hazard is associated with the Napperby Formation (HGL 37) which occupies the majority of the DZP Site (excluding the elevated hill tops and ridges over Jurassic volcanic geology and some areas of the lower alluvial flats). Consistent with the discussion of dryland salinity above, SSM (2013) notes that the most likely landscape position for salinity to develop is near the break of slope between the steep midslope of hillsides and the flatter foot-slopes.

Section 2 of SSM (2013) provides additional information in relation to the regional soil setting and geological and hydrogeological features.

4.11.2.2 Assessment Methodology

Figure 4.43 illustrates the study area of the SSM (2013) assessment of soils ("soil survey area") which incorporates the DZP Site, as well as the land surrounding the DZP Site that would be acquired by the Applicant on approval of the Proposal (see also **Figure 1.2**).

Initially, SSM (2013) undertook a preliminary soils assessment using two slightly different electromagnetic geophysical surveys, namely an EM31 survey and EM38 survey. These survey techniques use magnetic fields to induce electrical currents in the soil materials which in turn induce a secondary magnetic field which is detected by an instrument at the surface. The strength of the induced electrical current, and therefore the secondary magnetic field, would vary depending on the nature of the soil material in the vicinity of the transmitter. As a result, variation in the detected secondary magnetic field would reflect variation in the physical properties of the underlying soil material. The EM38 survey method detects variation in soil materials to a depth of approximately 1.5m, while the EM31 survey method detects variation in soil materials to a depth of approximately 6m.

Using the results of the preliminary EM survey, 24 soil test pits were excavated to a maximum depth of approximately 3m to expose the soil profile. These test pits were supplemented by a further 29 core samples to depths of 1.5m (or refusal) (see **Figure 4.43**) and five documented soil observations. Selected soil properties in each pit were described and field measurements taken. Further laboratory soil chemical analysis of selected profiles was then undertaken.

³ The Hydrogeological-Landscape framework builds on the groundwater flow system framework (Coram, 1998; Walker et al, 2003) that was developed to assist in the management of groundwater salinity.

⁴ Hydrogeological-Landscape Units integrate information on lithology, bedrock structure, regolith (including soils), landforms, climate (including rainfall, seasonality, and evaporation) and vegetation. These components all influence the recharge, transmission, storage and discharge characteristics of a particular hydrological system.

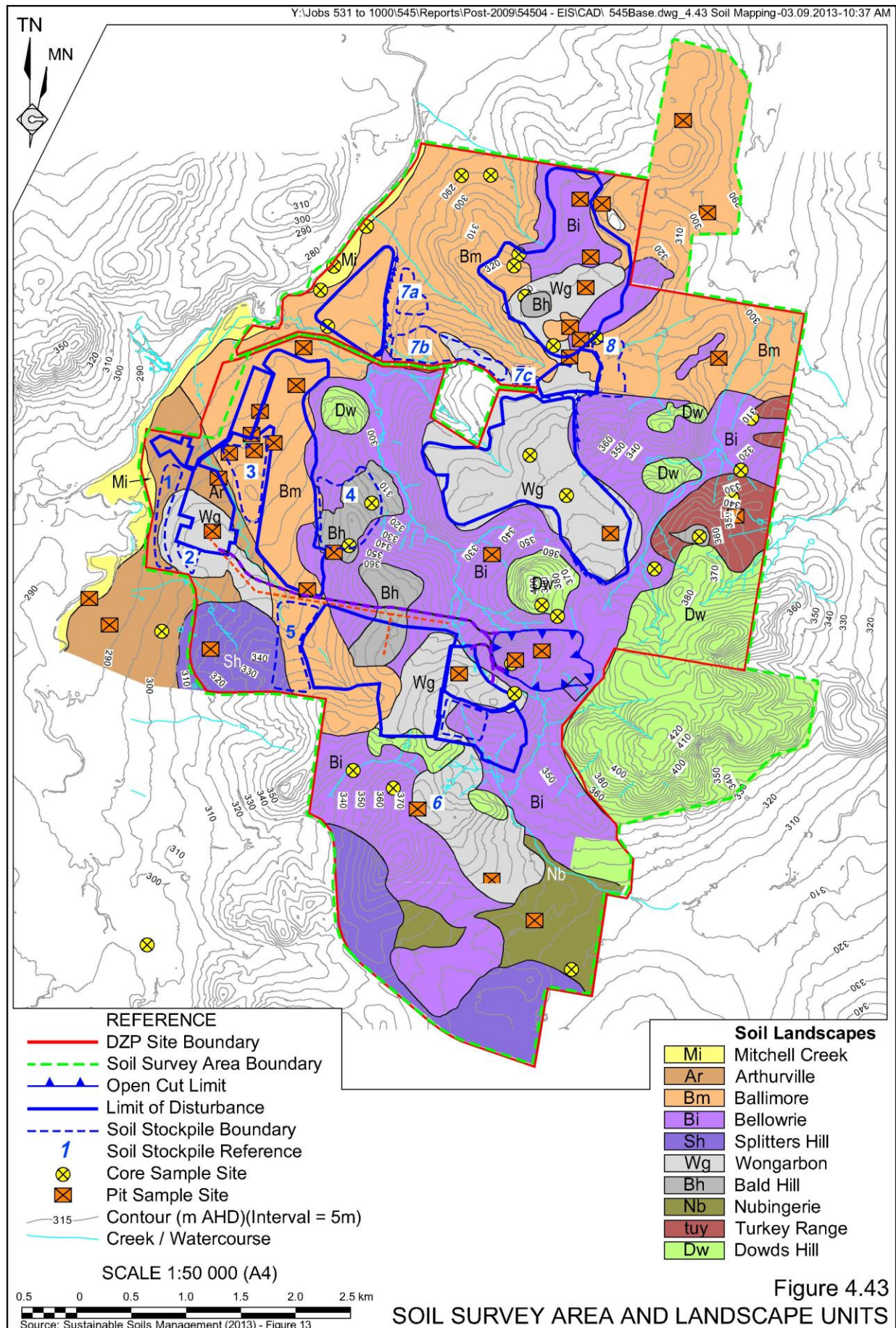


Figure 4.43
 SOIL SURVEY AREA AND LANDSCAPE UNITS

This information was reviewed in conjunction with nine soil profile descriptions and lithological logs from 23 piezometers recorded during previous investigations in 2002, regional soil setting detail and aerial imagery to define the soil units and accurately define the soil landscape boundaries. Specific emphasis was placed on assessing the geotechnical properties of the different soil landscape units and suitability for the construction of the LRSF.

Detailed descriptions of the assessment methodology are presented in Section 3 of SSM (2013).

4.11.2.3 Survey Area Soils

Based on the results of the survey, the soil landscape boundaries identified in the 1:250 000 regional mapping have been adjusted by SSM (2013) and ten soil landscapes identified within the Soil Study Area (see **Figure 4.43**). The soil landscapes were generally correlated with the underlying geology. A summary of the properties of the identified soil landscape units is provided as follows.

Belowrie (Bi) Soil Landscape

The Belowrie Soil Landscape covers an area of 960ha (28%) of the soil survey area and comprises undulating, occasionally rolling, rises and hills on weathered Jurassic trachyte. The crests are dominated by shallow, rocky Rudosols, with shallow to moderately deep Red Chromosols on gentle midslope positions and shallow to deep Red and Yellow Sodosols on footslopes and along drainage lines.

Soil testing indicated that the soils have a relatively low to moderate capacity to store nutrients, neutral topsoil with moderate organic carbon content, low nutrient levels, low salinity in surface layers and moderate salinity in the subsoil. The soil was moderately to strongly dispersive throughout the profile and the calculated soil erodibility factor is between 0.036 (moderate) to 0.046 (high).

Areas of this soil landscape at the northern end of the DZP Site present flatter landforms and deeper soils and are considered suitable for the construction of the LRSF.

Ballimore (Bm) Soil Landscape

The Ballimore Soil Landscape covers an area of 940ha (27%) of the soil survey area and comprises footslopes and some undulating low hills located on the Triassic Napperby Formation, principally sandstone, conglomerates, ferruginous material and siltstone. The Ballimore Soil Landscape is dominated by deep Red Chromosols with possible localised very deep Yellow Sodosols on lower slopes and depressions.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acid topsoil and neutral subsoil with moderate organic content in the surface 10cm, low nutrient levels and low salinity. The surface layers were moderately dispersive with deeper layers only slightly stable. The calculated soil erodibility factor for two test pits was 0.041 (high) and for a third 0.026 (moderate).

The combination of relatively coarse particle size, low shrinkage, and low dispersion indicate that the material sampled in the Ballimore Landscape is likely to be suitable for use in the construction of embankments.

Wongarbon (Wg) Soil Landscape

The Wongarbon Soil Landscape covers an area of 450ha (13%) of the soil survey area and comprises gently undulating low hills with minor basaltic hillocks, often with linear gilgai. The Wongarbon Soil Landscape contains moderately deep Red Ferrosols and deep Red and Brown Vertosols with occasional very deep Vertic Red Dermosols (possible Ferrosols) where soil is deep but drainage is impeded below the soil.

Soil testing indicated that the soils have a moderate capacity to store nutrients, neutral topsoil with moderate organic carbon content, moderate nutrient levels and low salinity (but measurable in some subsoil samples). Minimal dispersion tendency and calculated soil erodibility factor between 0.013 and 0.020 (low).

Presenting a plastic clay layer, these soils from this landscape unit are considered suitable for the construction of the LRSF (subject to additional and engineering specific testing). The shrinking and swelling nature of the soil indicate that care should be taken to thoroughly compact material used in embankments to avoid degradation of embankments by tunnelling.

Dowd (Dw) Soil Landscape

The Dowd Soil Landscape covers an area of 445ha (13%) of the soil survey area and comprises hills of rock pavements and scarps on weathered Jurassic trachyte volcanic plugs. The soils are very shallow Leptic Rudosols, with pockets of shallow Red Kandosol.

Field tests indicate the soils are non dispersive and would likely be suitable for stripping. Due to the shallow nature of the soils and minimal area of proposed disturbance within this landscape chemical properties were not assessed.

This soil landscape presents a thin soil layer and is located on landforms unsuitable for construction of the LRSF.

Splitters Hill (Sh) Soil Landscape

The Splitters Hill Soil Landscape covers an area of 193ha (6%) of the soil survey area and comprises undulating and rolling hills located on Silurian vertically bedded shale and sandstone. The Splitters Hill Soil Landscape contains mainly Red Chromosols although a variety soils occur depending on parent material.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, low nutrient levels and low salinity. The soil was moderately dispersive and has a calculated soil erodibility factor of 0.031 (moderate).

The soil profile of this soil landscape unit is considered too shallow to be suitable for the construction of salt crystallisation cells as part of the LRSF.

Arthurville (Ar) Soil Landscape

The Arthurville Soil Landscape covers an area of 168ha (5%) of the soil survey area and comprises gently undulating rises and undulating low hills. The Arthurville Soil Landscape is located on Silurian sedimentary and volcanic units, and contains very deep Red Chromosols with Yellow and Brown Sodosols along drainage lines.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, moderate nutrient levels and low salinity. The surface layers were moderately dispersive with soil deeper than 30cm strongly dispersive. The calculated soil erodibility factor is 0.026 (moderate).

Presenting a deep clay layer below silty sand, the soils from this soil landscape unit are considered suitable for the construction of the LRSF (subject to additional and engineering specific testing).

Nubingerie (Nb) Soil Landscape

The Nubingerie Soil Landscape covers an area of 101ha (3%) of the soil survey area and comprises undulating low hills located on Silurian andesites and metasediments. The Nubingerie Soil Landscape is dominated by moderately deep to very deep Red and Yellow Chromosols but also contains Red and Brown Vertosols.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, adequate phosphorous but other nutrients at low levels and low salinity. The calculated soil erodibility factor is 0.021 (moderate). The relatively low K value indicates the soil is relatively stable.

Presenting a moderate clay layer below sandy soil and over weathered andesite, the soils from this soil landscape unit are considered suitable for the construction of the LRSF (subject to avoiding the drainage lines which dissect the landform on which this soil occurs).

Bald Hill (Bh) Soil Landscape

The Bald Hill Soil Landscape covers an area of 84ha (2%) of the soil survey area, comprises low hillocks with moderately steep slopes on basalt rock outcrop and is dominated by shallow to moderately deep Red Ferrosols.

Soil testing indicated that the soils have a moderate capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, adequate phosphorous but other nutrients at low levels and low salinity. The surface layers were moderately dispersive, while the subsoil layers were more stable. The calculated soil erodibility factor is 0.019 (low).

The moderately high shrink and swell capacity of the material, along with the undulating nature of the landform on which it occurs, are such that it is not considered suitable for the construction of the LRSF.

Mitchell Creek (Mi) Soil Landscape

The Mitchell Creek Soil Landscape covers an area of 72ha (2%) of the soil survey area and comprises Quaternary alluvial deposits on floodplains along Wambangalang Creek. The Mitchell Creek Soil Landscape has highly variable soils including sandy Stratic Rudosols and very deep Brown Dermosols.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, adequate phosphorous but other nutrients at low levels and low salinity. The surface layers were moderately dispersive with soil deeper than 30cm strongly dispersive. The calculated soil erodibility factor is 0.031 (moderate).

This soil landscape is located too close to Wambangalang Creek to be considered as a course of materials for the construction of the LRSF.

Turkey Range (Tr) Soil Landscape

The Turkey Range Soil Landscape covers an area of 68ha (2%) of the soil survey area and comprises undulating to rolling low hills and hills on Jurassic Purlewaugh Formation sandstones, shales, lutite and mudstones with broad crests and gently sloping upper footslopes. The Turkey Range Soil Landscape is dominated by shallow to moderately deep Brown Kurosols and Yellow Sodosols.

Soil testing indicated that the soils have a relatively small capacity to store nutrients, moderately acidic topsoil with moderate organic carbon content, low nutrient levels and low salinity. All layers were moderately dispersive and the calculated soil erodibility factor is 0.032 (moderate).

The soils of this soil landscape are fragile and not considered suitable for the construction of the LRSF.

4.11.2.4 Soil Stripping Suitability

The stripping suitability of each soil landscape unit varies based on depth of soil and specific physical or chemical properties. **Table 4.69** presents the stripping suitability of each soil landscape unit as recommended by SSM (2013).

Table 4.69
Soil Stripping Suitability

Soil Landscape Unit	Maximum Stripping Depth (cm)		Comments
	Topsoil	Subsoil	
Belowrie	15	50	Generally no restrictions for stripping (to depths nominated), however, soil may be variable and each locations should be assessed prior to stripping.
Ballimore	25	75	Careful handling of topsoil required to avoid compaction. Mottling of subsoil observed and stripping would not be undertaken once mottled soils observed.
Wongarbon	25	75	Clayey soil is less susceptible to structural degradation if it is worked when it is moderately dry.
Dowd	10	10	Shallow soil profile.
Splitlers Hill	10	40	Shallow soil profile.
Arthurville	30	70	Generally no restrictions for stripping (to depths nominated).
Nubingerie	10	35	Mottling of subsoil observed and stripping would not be undertaken once mottled soils observed.
Bald Hill	15	75	Shallow soil profile, however, generally no restrictions for stripping (to depths nominated).
Mitchell Creek	25	75	Mottled subsoil may be present and stripping would not be undertaken once observed.
Turkey Range	-	-	Fragile soil

Source: Modified after SSM (2013) – Section 4.2.2

4.11.2.5 Land and Soil Capability

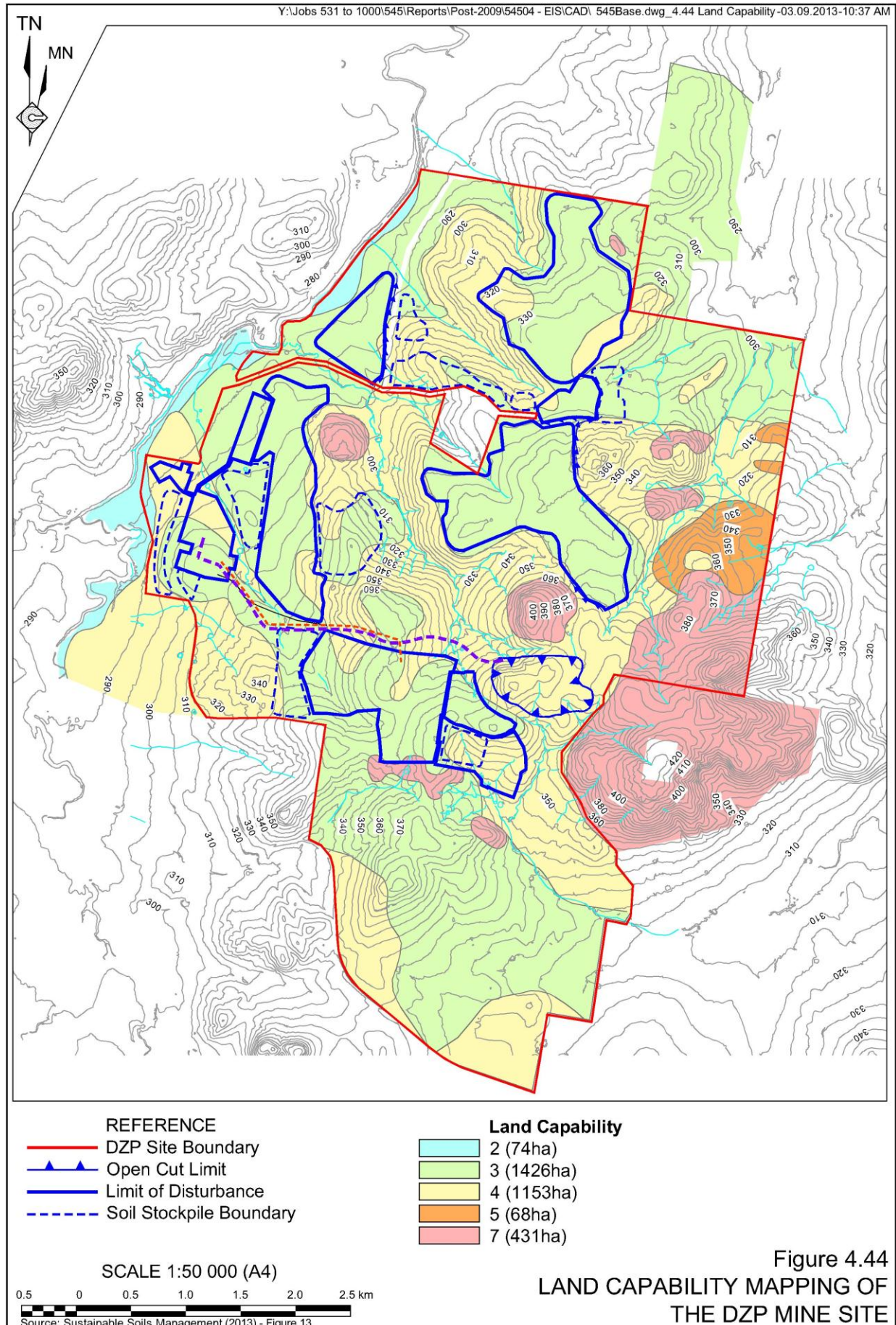
SSM (2013) allocated each soil landscape unit discussed in Section 4.11.2.3 a range of land and soil capability classes and then identified a dominant class (see **Figure 4.44**). The dominant land and soil capability classes are 3 (grazing and regular cultivation) and 4 (grazing and sufficient cultivation to establish improved pasture), which together account for 83% of the soil survey area. However, it is noted that, due to the broad scale of the assessment, patches of lower capability land (higher land and soil capability class number) would occur within the classified areas.

Observations by SSM (2013) during the assessment indicated that most of the land that is classified as Class 2, 3 and 4 has been cultivated at some time. Cultivation has been most frequent in the better parts of the Class 3 land, and principally in the Ballimore, Wongarbon and Nubingerie Soil Landscapes. Cultivation has been less frequent in the steeper and more rocky parts of these landscapes.

Table 4.70 provides the land and soil capability of those areas of the DZP Site to be disturbed. Approximately 75% of this land is Class 3 with the remainder Class 4 or Class 7. Notably, of the 613.1ha of higher Class 3 land to be disturbed, the majority (503ha) would be subject to disturbance where a return to this land and soil capability is considered possible. The remaining 110.1ha (18%) would be subject to disturbance where the landform would be so altered as to make a return to this class unlikely, e.g. WRE, SRSF and Salt Encapsulation Cells. There would be greater disruption to the Class 4 land with approximately 45% being subject to the major disturbance of the open cut, WRE, SRSF and Salt Encapsulation Cells.

Table 4.70
Land Capability of the DZP Site to be Disturbed

Infrastructure Type	3	4	7	Total
Open Cut	0.0	40.3	0.0	40.3
Waste Rock Emplacement	18.8	1.6	0.0	20.4
Solid Residue Storage Facility	85.5	16.2	1.1	102.8
Liquid Residue Storage Facility	381.0	44.4	0.0	425.4
Salt Encapsulation Cells	5.8	28.7	0.1	34.6
Haul Road	2.9	4.4	0.0	7.3
ROM Pad	4.2	0.0	0.0	4.2
Processing Plant	26.5	16.8	0.0	43.3
Soil Stockpiles	88.4	41.0	0.0	129.4
Total	613.1	193.4	1.2	807.7
Source: Modified after SSM (2013) – Table 28				



4.11.3 Management and Mitigation Measures

The Applicant would implement the following soil management and mitigation measures. It is noted that a number of these measures have been identified in Section 2.3.3 and are repeated here for the sake of completeness.

Soil Stripping

- Strip soil material to the depths identified in Section 2.3.3.3 and **Tables 2.1 and 2.2**.
- Ensure that soil material to be stripped is maintained in a slightly moist condition during stripping. Material would not be stripped in either an excessively dry or wet condition.
- Grade or push soil into windrows using graders or dozers for later collection by elevating scrapers or loading into trucks by front-end loaders to minimise compaction of soil materials.
- Use soil materials immediately in areas undergoing progressive rehabilitation, where practicable. Where this is not practicable, place soil transported by truck directly into storage or place soil transported by scrapers in thick “lifts” to minimise compaction.

Soil Stockpiling

- Construct the stockpiles as wind rows within each area, avoiding the construction of a single stockpile covering the entire area.
- Use bulldozers or other equipment to push soil dumped by scrapers into stockpiles (to avoid tracking over previously laid soil by the scraper) whenever possible. If material is deposited directly by scrapers it would be deposited in thick “lifts” to minimise compaction.
- Minimise, as far as practicable, the operation of machinery on soil stockpiles to minimise compaction.
- Ensure that soil stockpiles have a maximum height of 3m for subsoil and 2m for topsoil material.
- Leave the surface of the stockpile with an even but roughened surface to assist in erosion control and seed germination and emergence.
- If long term storage (>3 months) is planned, fertilise and establish an appropriate vegetative cover as soon as possible on all soil stockpiles to be retained for more than 3 months.
- Where practical and when conditions are suitable, allow occasional grazing on the vegetated stockpiles to encourage natural return of organic material, e.g. manure. When grazing livestock on stockpiles, livestock would be removed when the soil is wet enough that stock cause poaching of the soil. Livestock would also be removed when groundcover is less than 60% to encourage survival and growth of the pasture species.

Soil Respreading and Rehabilitation

The aim of soil respreading is to construct a layered material with properties that can perform similar functions to the undisturbed soil. Topsoil provides a path for entry of water and air, storage of nutrients and water, and plant support. The respread subsoil would be dense enough to support plants, but not so dense that it forms a barrier to water movement. Subsoil has a larger role in storage of water than nutrients, and is important in supporting plants. The soil would not have large differences between the properties of layers as the discontinuities at these boundaries can slow water movement. The following management measures for the respreading of soil would provide for the achievement of these aims.

- Test the subsoil to ensure that it is not toxic to plant growth. Major threats are salinity that has built up from adjacent liquid residue storage facilities, and elevated levels of some micronutrients from prolonged reducing (waterlogged) conditions.
- Ensure that subsoil to be worked is moist or dry, but not wet.
- Form sub-grade to desired shape prior to application of subsoil.
- Tyne sub-grade (approximately 60cm deep) to provide an undulating boundary and disrupt barriers to water movement from compaction.
- Place subsoil to achieve similar density (or slightly less) than natural subsoil. This would be achieved by placing subsoil in relatively thick lifts (20 cm) with an elevating scraper and minimising further traffic on areas where material has been placed.
- Lightly tyne the surface between lifts to reduce creation of slowly permeable layers.
- Prior to respreading, the topsoil would be tested to determine the ameliorants required to achieve the desired level of plant growth.
- Tine the surface of underlying subsoil material below the depth of compaction to minimise formation of a dense layer at the top the subsoil / growth material.
- Ensure that topsoil is not respread when either excessively dry or wet.
- Minimise, as far as practicable, the operation of machinery / vehicles on respread topsoil material to minimise compaction.
- Place the soil material with only a few lifts from an elevating scraper or similar with sufficient regrading to create a density similar to natural soil.
- Establish vegetation on topsoiled areas as quickly as possible to minimise the risk of erosion from wind or water.

Sections 2.17.6.3 to 2.17.6.7 provide the general soil stripping, stockpiling and respreading strategies to be implemented by the Applicant for each rehabilitation domain. These strategies are drawn from the recommendations provided by *Section 6.2* of SSM (2013), which follow a review of best practice land management and rehabilitation techniques.

4.11.4 Assessment of Impacts

4.11.4.1 Soils

The topsoil and subsoil inventories presented in **Tables 2.1** and **2.2**, incorporate soils depths recommended by SSM based on the properties of the soils, the specific activity proposed for that area and the required volume of topsoil and subsoil necessary to undertake the soil replacement proposed in Section 2.17.6.9.

The proposed management measures of Section 4.11.3 are based on the recommendations provided by SSM (2013) aimed at maximising the recreation of a soil profile that provides a topsoil layer for the entry and storage of water, air and nutrients for plant support and a subsoil layer for retention of water and deep root penetration.

On the basis that the volume of soil to be stripped would be minimised to that required for rehabilitation, and managed to maximise the potential re-use in the rehabilitation of the disturbed areas of the DZP Site, impacts on the soils of DZP Site are assessed as likely to be effectively mitigated and limited to the life of the Proposal.

4.11.4.2 Land and Soil Capability

The Proposal would have significant effects on the land and soil capability of the DZP Site. At present (pre development) the majority of the land beneath those areas of the DZP Site to be disturbed is Class 3 or Class 4 (Figure 4.44 and Table 4.69) which can support cultivation and high intensity grazing (OEH, 2012). During the life of the Proposal, the majority of the disturbance footprint would be removed from agricultural use and would therefore be rated as Class 8. If the soil stockpiles are sown with pasture immediately after stockpiling and used for rotational grazing, these areas would provide Class 4 land over the life of the Proposal.

The land and soil capability of the rehabilitated landform would be determined by properties of the reconstructed land slope for areas subjected to the greatest disturbance. The final capability of areas disrupted less would be determined by both the extent of disturbance and properties of the underlying landscape. Based on the proposed final landform and implementation of the noted management and mitigation measures, SSM (2013) considers the final landform land and soil capabilities of the DZP Site to be as presented in Table 4.71.

Some further reduction in higher capability class land would occur as a result of the development of the proposed BOA (refer to Section 2.17.8). Based on the proposed areas to be incorporated into the BOA (see Section 2.17.8 and Figure 2.23), approximately 190.4ha of Class 3 land and 400.8ha of Class 4/5 land would be reduced to Class 6 (for occasional grazing but no cultivation). The area of higher land and soil capability has been included within the BOA for two reasons.

1. These areas represent (predominantly) derived native grassland of an Endangered Ecological Community (EEC). As such, significant benefit to local biodiversity would be provided by returning this land to its original vegetation community type.
2. The area provides for a habitat corridor between two native vegetation remnants within the local setting, Dowds Hill and Wambangalang Creek. Again this would provide a significant benefit to local biodiversity values.

Noting the relatively low productivity of this land currently (refer to *Section 5.3* the AIS – **Appendix 9**) and significant biodiversity benefits to be achieved by the proposed BOA in its current form, the removal of this area of Class 3 land is reasonable.

Table 4.71
Land and Soil Capability Class of the Rehabilitated Final Landform

Infrastructure Type	2	3	4	6	7	8	Total
Open Cut	0	0	0	0	0	40.3	40.3
Waste Rock Emplacement	0	0	0	20.4	0	0	20.4
Solid Residue Storage Facility	0	0	0	102.8	0	0	102.8
Liquid Residue Storage Facility	0	0	425.4	0	0	0	425.4
Salt Encapsulation Cells	0	0	0	0	34.6	0	34.6
Haul Road	0	2.9	4.4	0	0	0	7.3
ROM Pad	0	4.2	0	0	0	0	4.2
Processing Plant	0	26.5	16.8	0	0	0	43.3
Soil Stockpiles	0	88.4	41.0	0	0	0	129.4
Total	0	122.0	487.6	123.2	34.6	40.3	807.7
Source: Modified after SSM (2013) – Table 29							

There would be an overall reduction in the area of Class 3 land, however, as the majority of this would be rehabilitated to Class 4 land, there would be no major reduction in overall land capability. Those areas of the DZP Site to remain undisturbed by the Proposal would retain the same pre-Proposal land capability (unless incorporated into the proposed Biodiversity Offset Area). **Table 4.72** provides a summary of the land capability of those areas of the DZP to be disturbed or modified prior to, during and following the operation and rehabilitation of the DZP.

Table 4.72
Range of Land and Soil Capability Classes over the Life of the Proposal

Infrastructure Type	Current	During Mine Operation	Post Rehabilitation
Open Cut	4	8	8
Waste Rock Emplacement	3, 4	8	6
Solid Residue Storage Facility	3, 4, 7	8	6
Liquid Residue Storage Facility	3, 4	8	4
Salt Encapsulation Cells	3, 4, 7	8	7
Haul Road	3, 4	8	3, 4
ROM Pad	3	8	3
Processing Plant	3, 4	8	3, 4
Soil Stockpiles	2, 3, 4, 7	4	2, 3, 4, 7
Biodiversity Offset Area	3, 4, 7	6, 7	6, 7
Source: Modified after SSM (2013) – Table 27			

4.11.4.3 Agricultural Suitability

The reduction in soil and land capability resultant from the proposed activities of the Proposal and establishment of a Biodiversity Offset Area are likely to restrict the range of agricultural enterprises that the land would support beyond the life of the Proposal. Overall, therefore the agricultural suitability of the DZP Site would be reduced. SSM (2013) provides a summary of the likely post-Proposal suitability of the DZP Site to agricultural activities. A more detailed analysis of current and future agricultural productivity of the DZP Site is provided in an Agricultural Impact Statement prepared by RWC and Diana Gibbs & Associates Pty Ltd and provided as **Appendix 9** of the EIS.

4.12 TRAFFIC AND TRANSPORTATION

4.12.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "*Traffic and Transport*" as a key issue requiring that the "*EIS provide:*"

- *accurate predictions of the road and rail traffic generated by the proposal;*
- *an assessment of the capacity of the rail network to accommodate the transport of ore;*
- *an assessment of the potential traffic impacts on the safety and efficiency of the road network; and*
- *a detailed description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road and rail networks in the surrounding area over the life of the proposal."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Roads & Maritime Services (RMS) which requested that a "*traffic study is to be undertaken which includes, but is not limited to origin-destination of vehicles, including staff, contractors, construction, and maintenance personnel during both the construction and operation phases of the development*". Also appended to the DGRs is correspondence from Dubbo City Council that requested detailed information and assessment primarily related to the impact of the proposed rail line reopening on local traffic and proposed upgrades to local road infrastructure to cater for the proposed increase in traffic.

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to traffic and transport and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Temporary inconvenience to commuters if stopped for road works and loss of productivity (medium to high).
- Elevated risk of accident/incident on local roads (high).
- Hydrocarbon or other pollutant contamination of surface water from chemical spill or heavy vehicle movements (medium to high).

- Chemical spills from road or rail accidents causing a broad dispersion of chemicals (medium to high).
- Loss of life/property damage through collision with train (high).
- Increased traffic creating pressure on existing road and infrastructure function (high).
- Accelerated road pavement deterioration (very high).
- Contamination of local water resources by leaking or spilt chemical reagent (medium).

The traffic impact assessment for the Proposal was undertaken by Mr Ben Rossiter of Constructive Solutions Pty Ltd. The resulting report is presented as Part 11 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “Constructive Solutions (2013)”. This subsection of the EIS provides a summary of the traffic impact assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.12.2 Existing Environment

4.12.2.1 Introduction

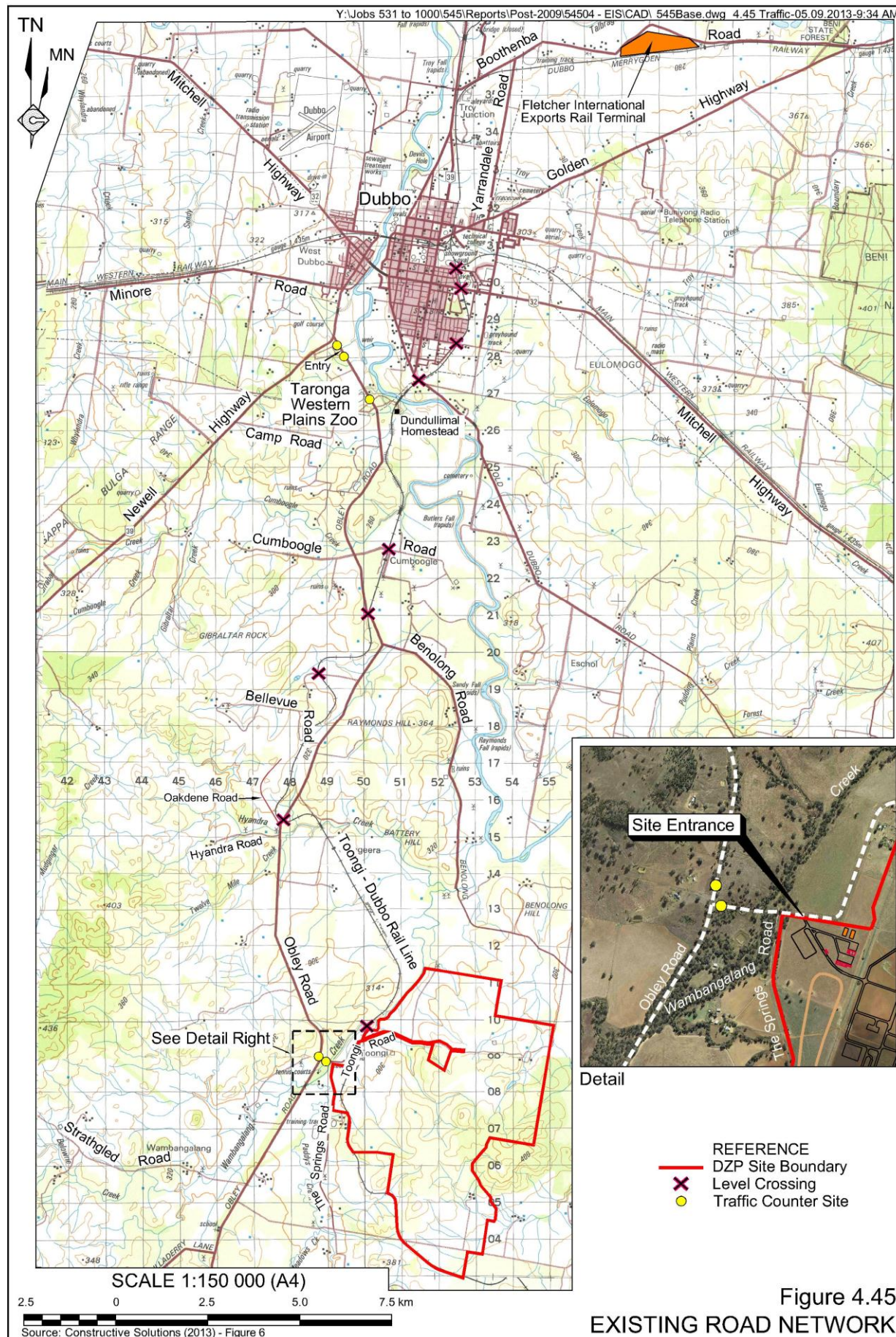
The following provides an overview of local road conditions, intersections, railway level crossings, traffic volumes and crash data sufficient to enable an appreciation of local conditions and to provide context to the impact assessment.

4.12.2.2 Local Roads

The following describes the roads proposed for use by Proposal-generated traffic, namely, Toongi Road, Obley Road (between the Newell Highway and Toongi Road), Boothenda Road and Yarrandale Road (see **Figure 4.45**). The information presented is based on the inspections undertaken by Mr Doug Seymour and Mr Ben Rossiter of Constructive Solutions in February 2012 (Obley Road and Toongi Road) and March 2013 (Boothenda Road and Yarrandale Road). Additional information on the pavement condition of Obley Road is based on Falling Weight Deflectometer (FWD) testing completed along Obley Road in 2012 by GR Webb Consulting Pty Ltd.

Toongi Road

Toongi Road is a two-lane, two-way road with a central 4.5m sealed carriageway at the intersection with Obley Road (see **Plate 4.1**), narrowing to 3.0m to 3.5m after The Springs Road intersection (see **Plate 4.2**). Toongi Road is a no-through road which services several rural properties along its length and ends after crossing the Dubbo-Molong Rail Line approximately 1.6km from Obley Road. The alignment is good with the exception of two right angle bends which have no warning or speed advisory signage.





Toongi Road crosses Wambangalang Creek on a causeway with six 1 050mm reinforced concrete low flow pipes (see **Plate 4.3**) approximately 260m from the intersection of Obley Road. Toongi Road forms a T-intersection with The Springs Road a further 85m from Wambangalang Creek and forms the first of two right angle bends approximately 280m beyond The Springs Road.

Dubbo City Council is the authority responsible for Toongi Road.

Obley Road

Obley Road, which is aligned between the Newell Highway south of Dubbo and the Mitchell Highway at Molong, is a two-lane, two-way road with a central sealed carriageway varying in width (see **Plate 4.4**). Obley Road primarily services the existing properties along its length, however, it is also used as an alternative route to Dubbo from the south for vehicles choosing to avoid the Mitchell Highway.

There are three major creek crossings on Obley Road.

- Hyandra Creek: a 12m span, timber bridge providing a low flow crossing. Flood modelling completed by SEEC (2013) indicates that the elevation of the bridge is below the 1 in 5 ARI flood event.
- Cumboogle Creek: a concrete bridge structure with 7m pavement (corresponding to the width of the bridge) elevated above the local floodplain. The bridge deck is well above the channel below.
- Twelve Mile Creek: a single 450mm reinforced concrete pipe low flow causeway. Flood modelling completed by SEEC (2013) indicates that the elevation of the causeway and the road for several hundred metres in either direction is below the 1 in 5 ARI flood event.

There are several existing intersections, and one proposed new intersection (to Taronga Western Plains Zoo opposite the Dundullimal Homestead), between the Newell Highway and the DZP Site, namely:

- Taronga Western Plains Zoo (existing);
- Hyandra Road;
- Oakdene Road;
- Bellevue Road;
- Benolong Road;
- Cumboogle Road;
- Belowrie Road;
- Camp Road; and
- Toongi Road.

The first 9.5km of Obley Road from the Newell Highway towards Toongi Road is relatively flat with good horizontal and vertical alignment. The seal width is approximately 9m and is in good condition although general pavement deformation was evident at the time of inspection. From 9.5km to 19.9km, no centre lines are marked and the seal narrows with pavement in average condition. From 19.9km to Toongi Road, line marking returns and the seal widens again. In certain sections the alignment is sub-standard for the sign-posted speed of 100km/hr.

The age, quality and depth of the existing pavement were found to vary significantly and **Table 4.73** summarises the existing pavement conditions.

Table 4.73
Existing Pavement – Obley Road

Characteristic	Maximum	Minimum
Pavement Thickness (mm)	440	110
Subgrade CBR* (%)	43.6	3.7
Source: Modified after Constructive Solutions (2013) – Table 4		
*CBR = California Bearing Ratio (a measure of mechanical strength)		

Falling weight deflectometer (FWD) results were also completed to assist in determining the suitability of the existing pavement with deflections up to 2.3mm evident. The deflection in the pavement, combined with the CBR results, were utilised to determine suitable pavement designs.

Obley Road forms part of the Western Plains Tourist Circuit, is currently used by cyclists (including for annual events) and there is a shared pedestrian / cycle way from the Newell Highway to Taronga Western Plains Zoo. There are known school bus stops adjacent to the intersections with Camp Road and Oakdene Road and two at properties between them. At least another two stops are located between Oakdene Road and Strathgled Road (approximately 3.8km south of Toongi Road – see **Figure 4.45**). As is common on rural school bus routes, stop locations are likely to change over time as younger children begin school and older children finish.

Obley Road is currently designated as a State B-Double route from the Newell Highway to Benolong Road (a distance of 9.3km) according to the RMS Restricted Access Vehicle (RAV) maps. It is noted, however, that Obley Road is a local road and therefore Dubbo City Council is the relevant authority for road maintenance and authorising multi-combination vehicle access.

Boothenba Road

Boothenba Road is a two-way, two-lane undivided sealed local road on the northern periphery of the Dubbo urban area that links the Newell Highway to Yarrandale Road. It has line-marking for only a short distance east of the Newell Highway. The alignment is generally straight and flat. The road has wide unsealed shoulders suitable for heavy vehicles to pull off.

One school bus service is known to operate in the morning westbound along Boothenba Road to Yarrandale Road (and therefore not on the subject length of road). In the afternoon, it only uses Boothenba Road to return empty to the depot.

Yarrandale Road

Yarrandale Road is a two-way, two-lane undivided sealed local road on the northern periphery of the Dubbo urban area. It terminates at Boothenba Road at the north and links it to the access to the Fletcher International Exports rail terminal. It is consistently line marked along the section to be incorporated into the proposed transport route and has 1m wide sealed shoulders south of the railway crossing which is located approximately 150m south of Boothenba Road.

One school bus service is known to operate in the morning southbound along Yarrandale Road from Boothenba Road to Purvis Lane, however, there are no known school bus stops along Yarrandale Road.

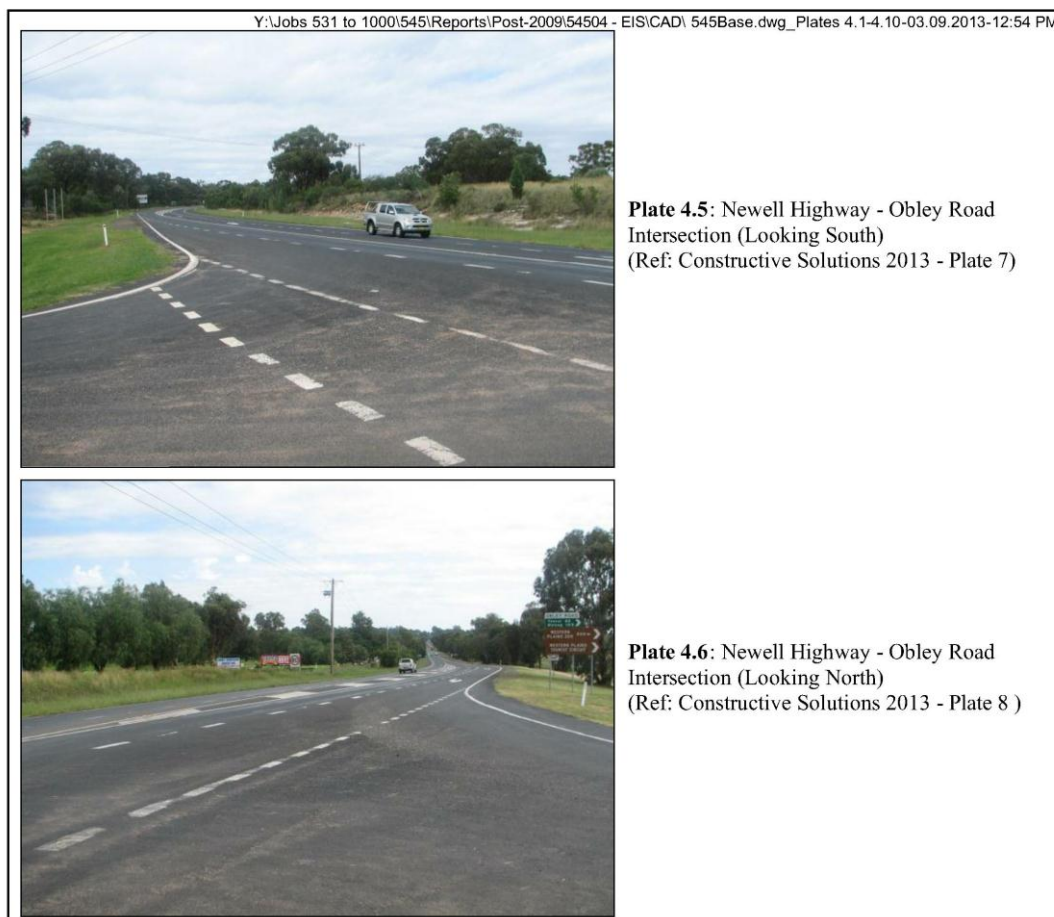
4.12.2.3 Intersections

4.12.2.3.1 Newell Highway to the DZP Site

Newell Highway and Obley Road

Obley Road approaches the Newell Highway at an acute angle, however, the intersection is dimensionally adequate for 26m B-Doubles. The Newell Highway includes a channelised right turn (CHR) and an auxiliary left turn treatment (AUL) for movements into Obley Road. Give way controls include a give way sign and a hold line on Obley Road. A sight screen is been located opposite the T-junction and there is no street lighting. Both the Newell Highway and Obley Road are signposted at 80km/hr at the intersection.

Sight distance is estimated to exceed 500m to the north and to be approximately 310m to the southwest (see **Plates 4.5** and **4.6**). These are greater than the minimum desirable sight distance of 126m at 80km/hr calculated in accordance with the Austroads Safe Intersection Sight Distance (SSID).



Obley Road and the Entrance to Taronga Western Plains Zoo

The access road to Taronga Western Plains Zoo forms a T-junction with Obley Road. Obley Road has been widened at this intersection to include a Channelised Right Turn (CHR). Give way controls consist of a give way sign and a holding line on the Zoo access road. Obley Road is signposted at 80km/hr at this location. There is no street lighting at the intersection.

Sight distance exceeds 500m in both directions which exceeds the minimum desirable sight distance of 126m at 80km/hr.

Obley Road and Dundullimal Homestead

The driveway to the homestead (receiving an average of 223 visitors per week) is unsealed, however, the mouth of the intersection is sealed. There are no give way controls and no sight screen opposite the T-Junction. There is no street lighting at the intersection. Obley Road is signposted at 100km/hr at this location. Constructive Solutions (2013) report that sight distance is good in both directions.

In 2013 Taronga Western Plains Zoo constructed an entrance to the Zoofari Lodge (overnight accommodation), intersecting with Obley Road directly opposite the Dundullimal Homestead access road. This intersection comprises a Basic Right Turn (BAR) and Auxiliary Left Turn (AUL) and includes modifications to the Obley Road alignment to improve the available sight distance. There are no associated improvements to the Dundullimal Homestead intersection.

Obley Road and Camp Road

Camp Road is a through road which links Obley Road and the Newell Hwy and also forms part of the 'Western Plains Tourist Circuit'. A T-junction joins Camp Road with Obley Road and is basic in configuration. Give way controls consist of a hold line but no give way sign. A sightscreen is located opposite the intersection. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions. To the north, it is 500m and to the south 290m, with both distances greatly exceeding the minimum desirable sight distance of 179m at 100km/hr.

Obley Road and Belowrie Road

Belowrie Road forms a T-junction with Obley Road, providing access to the Morris Park Raceway, and is basic in configuration. There are no give way controls. A small sightscreen is located opposite the intersection. Obley Road is signposted at 100km/hr at this location.

Sight distance is good to the north at 500m but only 140m to the south on Obley Road, which is less than the minimum desirable sight distance of 179m at 100km/hr, due to the horizontal and vertical alignment.

Obley Road, Cumboogle Road and Belmont Road

Cumboogle and Belmont Roads form a cross intersection with Obley Road. Both Cumboogle and Belmont Roads are no-through roads that provide access to various rural properties along their length. Give way controls consist of give way signs on both minor roads but no holding lines are present. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions at 500m to the north and south exceeding the minimum desirable sight distance of 179m at 100km/hr. A school bus stop and shelter is located immediately south of the intersection on the western side of Obley Road.

Obley Road and Benolong Road

Benolong Road forms a T-junction with Obley Road on the outside of a curve. Benolong Road is a through road that provides access to various rural properties along its length. An Auxiliary Right Turn (AUR) and an AUL have been constructed on Obley Road at the intersection. Give way controls consist of a give way sign and hold line. A sight screen is located opposite the intersection. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions, at 190m to the south and 280m to the north, therefore exceeding the minimum desirable sight distance of 179m at 100km/hr.

Obley Road and Bellevue Road

Bellevue Road forms a T-junction with Obley Road and is basic in configuration. The road provides access to a rural property. There are no give way controls, no sight screen, and the mouth of the intersection is unsealed. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions, at 240m to the south and 300m to the north exceeding the minimum desirable sight distance of 179m at 100km/hr.

Obley Road and Oakdene Road

Oakdene Road forms a T-junction with Obley Road and is basic in configuration. It is a no-through road that provides access to various rural properties. There are no give way controls and no sight screen at the intersection. Obley Road is signposted at 100km/hr at this location.

Sight distance is good to the south at 500m, exceeding the minimum desirable sight distance of 179m at 100km/hr. However, sight distance to the north is limited to 110m due to the horizontal and vertical alignment at the nearby rail crossing.

Obley Road and Hyandra Road

Hyandra Road forms a T-junction with Obley Road and is basic in configuration. Hyandra Road provides access to a rural property. There are no give way controls, no sight screen, and the mouth of the intersection is unsealed. Obley Road is signposted at 100km/hr at this location.

Sight distance is good in both directions, being 500m to the south and 300m to the north, therefore exceeding the minimum desirable sight distance of 179m at 100km/hr.

Obley Road and Toongi Road

Toongi Road forms a T-junction with Obley Road and is basic in configuration. The shoulders on Obley Road have been widened to form a basic right turn (BAR) and a basic left turn (BAL). Give way controls consist of a hold line but no give way sign. A sight screen is located opposite Toongi Road but it has been set low. Obley Road is signposted at 100km/hr at this location. The geometry of the intersection is adequate for B-Double movements, and the pavement is in good condition.

Sight distance is reasonable to the north at 240m and average to the south at 220m due to the horizontal and vertical alignment. Therefore, sight distance in both directions exceeds the minimum desirable sight distance of 179m at 100km/hr (see **Plates 4.7** and **4.8**).

Toongi Road and The Springs Road

The Springs Road forms a T-junction with Toongi Road approximately 70m east of the Wambangalang Creek causeway and is basic in configuration. There are no give way controls. A small sight screen is positioned opposite The Springs Road approach.

The existing sight distance to the west is estimated to be less than 50m due to the proximity of the Wambangalang Creek crossing.

4.12.2.3.2 Fletcher International Exports Rail Terminal to the Newell Highway

Fletcher International Exports and Yarrandale Road

The access to the Fletcher International Exports rail terminal meets Yarrandale Road approximately 950m south of Boothenda Road. It is approximately 50m south of the railway level crossing on Yarrandale Road.

A concrete median is located in the access roadway where it meets Yarrandale Road but without give way controls (see **Plate 4.9**).

Boothenda Road and Yarrandale Road

Yarrandale Road forms a T-intersection with Boothenda Road approximately 1.9km east of the Newell Highway (see **Plate 4.10**). Traffic controls consist of a give way sign and holding line on Yarrandale Road. There are no turning lanes for traffic either entering or exiting Yarrandale Road. The geometry of the intersection is adequate for B-Doubles to turn left or right in to or out of Yarrandale Road.

Sight distance at the intersection is good in both directions at 340m to the west and 300m to the east, therefore exceeding the minimum desirable sight distance of 126m at 80km/hr.

Newell Highway and Boothenda Road

Boothenda Road is the eastern leg of a cross-intersection with the Newell Highway, with the western leg opposite Boothenda Road known as Troy Bridge Road. The intersection includes a channelised right turn (CHR) and an auxiliary left turn treatment (AUL) for movements into Boothenda Road. Give way controls include a give way sign and holding line on Boothenda Road. Lighting is provided along the Newell Highway on both approaches.

There is an active railway level crossing located on Boothenda Road approximately 35m east of the give way holding line at the Newell Highway. Dubbo City Council has secured State funding to realign the railway line so it crosses Boothenda Road further to the east. This would increase the total queue length to approximately 150m from the Newell Highway to the relocated level crossing. This would provide for up to three B-Triple (road train) heavy vehicles to queue westbound on Boothenda Road without any encroachment onto the Newell Highway.



Plate 4.7: Obley Road - Toongi Road Intersection (Looking South)
(Ref: Constructive Solutions 2013 - Plate 25)

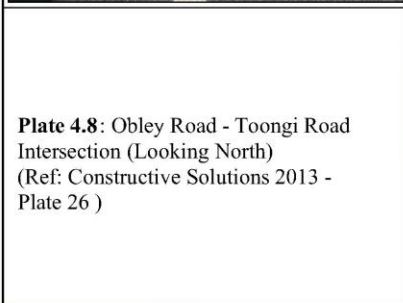


Plate 4.8: Obley Road - Toongi Road Intersection (Looking North)
(Ref: Constructive Solutions 2013 - Plate 26)



Plate 4.9: Fletcher International Rail Terminal Access - Yarrandale Road Intersection
(Ref: Constructive Solutions 2013 - Plate 28)



Plate 4.10: Looking South along Yarrandale Road from the Intersection with Boothenba Road
(Ref: Constructive Solutions 2013 - Plate 29)



The available sight distances to the south and north are estimated to be greater than 500m in each direction which exceeds the minimum desirable sight distance of 151m at 90km/hr (see **Plates 4.11** and **4.12**).



4.12.2.4 Railway Level Crossings

The re-opening of the Toongi-Dubbo Rail Line would require the re-opening of four level crossings within the Dubbo urban area and five level crossings between Dubbo and Toongi. The rail line consists of one track at all locations.

Plates 4.13 to **4.21** depict the following nine railway level crossings to be re-opened. Each of these is identified on **Figure 4.45**.

Dubbo City Limits

- Wingewarra Street (**Plate 4.13**).
- The Mitchell Highway (**Plate 4.14**).
- Boundary Street (**Plate 4.15**).
- Macquarie Street (Old Dubbo Road) (**Plate 4.16**).



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Plate 4.13: Looking East on Wingewarra Street from the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 32)

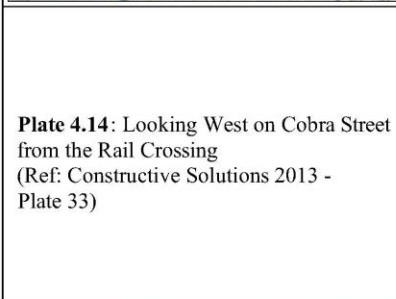


Plate 4.14: Looking West on Cobra Street from the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 33)



Plate 4.15: Looking West on Boundary Street from the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 34)



Plate 4.16: Looking West on Macquarie Street from the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 35)



Dubbo to Toongi

- Obley Road (Crossing 1) (**Plate 4.17**).
- Obley Road (Crossing 2) (**Plate 4.18**).
- Cumboogle Road (**Plate 4.19**).
- Bellevue Road (**Plate 4.20**).
- Toongi Road (**Plate 4.21**).

The rail line also crosses numerous rural property driveways and farm tracks along its length.

4.12.2.5 Traffic Levels

Existing traffic levels were established by examining and analysing the following.

- Historic traffic count data published by the RTA (now RMS).
- Data collected from four specifically placed traffic counters on Obley Road and one on Toongi Road at the locations identified on **Figure 4.45**.
- Manual intersection traffic counts.

Table 4.74 summarises the traffic data available for the Newell Highway and estimates traffic volumes for 2016 and 2036 assuming a growth factor of 1.5% per annum as recommended by Dubbo City Council.

Table 4.74
Traffic Volumes (Newell Highway)

Station No.	Road (Location)	1992 AADT	1996 AADT	1999 AADT	2002 AADT	2005 AADT	2016 AADT (est.)	2036 AADT (est.)
93.046	Newell Hwy, SH17 - 1.5km south of Victoria St (Mitchell Hwy, SH7), Dubbo	5 928	6 443	6 774	6 863	5 153	6 070	8 175
93.61	Whylandra St, (Newell Hwy, SH17) - south of Victoria St (Mitchell Hwy, SH7), Dubbo		16 257	17 550	18 448	18 363	21 631	29 133
93.861	Newell Hwy SH17 - 13 Mile Ck, Narromine/Dubbo Boundary	3 103	3 715	4 044	4 314	4 304	5 070	6 828
Source: RMS, 2005 (modified after Constructive Solutions 2013 – Table 6) AADT = Annual Average Daily Traffic								

Table 4.75 summarises the traffic data obtained from the placement of traffic counters on Obley Road and Toongi Road, and made available by Dubbo City Council for Boothenda Road and Yarrandale Road, along with estimates of 2036 traffic volumes (assuming a growth factor of 1.5% per annum).

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Plate 4.17: Looking North on Obley Road from Rail Crossing 1
(Ref: Constructive Solutions 2013 - Plate 36)



Plate 4.18: Looking South on Obley Road from Rail Crossing 2
(Ref: Constructive Solutions 2013 - Plate 37)



Plate 4.19: Looking East on Cumboogle Road at the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 38)

Plate 4.20: Looking West on Bellevue Road at the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 39)



Plate 4.21: Looking East on Toongi Road at the Rail Crossing
(Ref: Constructive Solutions 2013 - Plate 40)



Table 4.75
Current and Forecast Traffic Volumes: Obley Road, Toongi Road, Boothenba Road and Yarrandale Road

Site	Year	AADT	Heavy Vehicles %	Max peak/hr vehicles	AADT 2036 (est.)	AADT 2036 HV (est.)
Obley Road (between Newell Hwy & Zoo entry)	2012	2 330	10.9	332	3 331	363
Obley Road, 100m East of Zoo entry	2012	1 257	11.2	166	1 797	201
Obley Road (250m north of Dundullimal Homestead)	2012	1 201	18.0	178	1 717	309
Obley Road (100m north of Toongi Road)	2011	390	21.0	47	566	119
	2012	388	38.0	51	555	211
Toongi Road (Immediately east of Obley Road)	2011	105	23.0	18	152	35
	2012	91	17.0	16	130	22
Boothenba Road (East of Yarrandale Road)	2001	750	24.1	NA	-	-
	2016 equivalent	938	24.1	NA	1 263	304
Boothenba Road (50m west of Saleyards entry)	2002	1 436	20.7	NA	-	-
	2016 equivalent	1 768	20.7	NA	2 382	493
Yarrandale Road (200m north of Purvis Lane)	2010	2 701	39.3	NA	-	-
	2016 equivalent	2 953	39.3	NA	3 978	1 563
Source: Modified after Constructive Solutions 2013 – Tables 7 and 8 AADT = Annual Average Daily Traffic						

Table 4.76 summarises the traffic data made available by Dubbo City Council at the locations of the disused railway crossings within Dubbo, along with estimates of 2036 traffic volumes (assuming a growth factor of 1.5% per annum).

Table 4.76
Traffic Volumes at Rail Crossings

Road	Location	Year of Data	Average Total Daily Volume	Max peak vehicles/hr	AADT 2036 (Est)
Wingewarra Street	Between Chelmsford & Kokoda St	2008	9 703	1 173	-
		2016 equivalent	10 930	1 245	14 722
Mitchell Highway (Cobra Street)	Near Apex Oval	2011	19 575	2 052	-
		2016 equivalent	21 088	2 083	28 402
Boundary Street	West of Wheeler's Lane	2007	3 146	341	-
		2016 equivalent	3 597	367	4 845
Macquarie Street (Old Dubbo Road)	North of Margaret Cres intersection	2010	1 386	164	-
		2016 equivalent	1 516	169	2 041
Source: DCC (modified after Constructive Solutions (2013) – Table 9)					

4.12.2.6 Accident Statistics

Detailed crash reports were obtained from NSW Transport Centre for Road Safety. The data obtained summarised crashes on the subject roads between 1 January 2007 and 30 June 2011. A summary of the data is provided in **Table 4.77**.

Table 4.77
Crash Data 2007 - 2011

Road	Extent		Fatal	Injury	Non Casualty
Obley Road	Newell Highway	Toongi Road	0	6	8
Toongi Road	Toongi Road	The Springs Road	0	0	0
Boothenda Road	Newell Highway	Yarrandale Road	0	5	6
Yarrandale Road	Boothenda Road	Fletcher International Exports Access	0	0	0
Source: Constructive Solutions (2013) – Table 14					

Obley Road

Fourteen crashes were recorded on Obley Road between the Newell Highway and Toongi Road. Eleven were single-vehicle accidents and three were collisions between two vehicles. Thirteen were cars, three were light trucks and one a single motorcycle. No heavy vehicles over 4.5t GVM featured in the crash profile.

Non-road environment factors contributed significantly to Obley Road crashes, with five featuring speeding, four fatigue and two alcohol. Avoiding an animal contributed to two crashes, one struck an animal, whilst a driver disobeying a traffic control contributed to another crash. Loose gravel on road shoulders contributed to three crashes.

No clusters of multiple crashes at one location were identified, other than two separated by 50m just north of Oakdene Road. Constructive Solutions (2013) considers that this appears coincidental rather than related to the road environment of the location. One crash involved a motorcyclist leaving the carriageway to the left of a right-hand curve, with loose gravel identified as a hazardous factor, whilst the other involved a car leaving a straight length of road.

Obley Road – Newell Highway Intersection

One crash occurred when a northbound vehicle turning right into Obley Road colliding with a southbound vehicle on the Newell Highway. Alcohol was identified as a contributing factor.

Boothenda Road

Eleven crashes were recorded on Boothenda Road. Four were single-vehicle accidents and seven were collisions between two vehicles. Eleven vehicles were cars, six were light trucks and one was a heavy vehicle over 4.5t GVM (semi-trailer). Two crashes on Boothenda Road involved fatigue, one speeding and one alcohol. Another involved a driver disobeying a traffic control.

Two clusters of multiple crashes were identified on Boothenda Road, namely the intersections with the Newell Highway and Yarrandale Road.

Boothenda Road – Newell Highway Intersection

All three crashes at this cross-intersection were cross traffic, right-angle two-vehicle collisions. There were two injury crashes resulting in three injuries and one non-injury crash. Four of the vehicles involved were cars, the other two were light trucks. No speeding, fatigue or alcohol contributed to any of the collisions although two had a contributing factor of the driver disobeying the Give Way traffic control.

Boothenda Road – Yarrandale Road Intersection

Two crashes at this T-intersection featured single northbound vehicles running off the end of Yarrandale Road where it terminates at Boothenda Road. One of these accidents involved driver fatigue. Both resulted in no injuries. A third crash at this location involved a semi-trailer eastbound on Boothenda Road turning right into Yarrandale Road, colliding with a car, resulting in seven injuries.

4.12.3 Changes to Traffic Levels Resultant from the Proposal

4.12.3.1 Construction Traffic

As discussed in Section 2.12, the construction phase of the Proposal would occur over a period of approximately 18 months to 2 years. During this period, a peak workforce of between 300 and 400 employees would be required, of which virtually all would be accommodated in Dubbo.

Heavy vehicle deliveries of construction materials and equipment are expected on a daily basis including occasional oversize vehicles.

Constructive Solutions (2013) has assumed the following range of vehicle movements per day (where 1 return trip generates 2 movements) during construction in order to account for the variability in generated traffic volumes generally experienced during construction activities.

- Light Vehicle Movements: 300 – 400
- Heavy Vehicle Movements: 5 – 60

It is noted that traffic levels generated during the construction phase of the Proposal would be equivalent to levels generated during operations (although with a greater proportion of light vehicle movements). On the basis of the similar traffic levels, operational traffic levels (see Section 4.12.3.2) have been utilised for assessment purposes.

4.12.3.2 Operational Traffic

Heavy Vehicles

As discussed in Section 2.12, three options are being considered for the transportation of reagents to, and despatch of products from, the DZP Site. The estimated daily heavy vehicle movements on local roads within the proposed transport route for each option is outlined in **Table 4.78**.

For assessment purposes, the transport option likely to generate the greatest number of heavy vehicles (Option B) has been utilised.

Table 4.78
Worst Case Heavy Vehicle Scenario Based on Reagent Transport Options

	Largest Haulage Vehicle	Option A	Option B	Option C	HV AADT (worst case)
Obley Road	B-double / single	88	158	138	158
Toongi Road	B-double / single	88	158	138	158
Boothenba Road	Single	28	98	0	98
Yarrandale Road	Single	28	98	0	98
Source: Constructive Solutions (2013) – Table 11					

Light Vehicles

Once fully operational, the Proposal would employ up to 250 personnel in operational and management roles. It is anticipated that the majority of employees would reside locally in Dubbo with only a small percentage of the workforce beginning their journey south of Toongi. Using the assumption that the majority of employees would commute to and from the DZP Site in their own vehicle, with the remainder travelling to and from in a car pool arrangement, a maximum of 150 light vehicles per day (300 movements) are anticipated on the route between Dubbo and Toongi. The likely increase in vehicles originating south of Toongi has been considered to be negligible.

A further 10 miscellaneous light vehicles (20 movements) has been assumed on any given day to allow for visitors.

Combined Traffic Generation

The DZP is expected to begin construction in 2014 and operations in 2016. Under the current application, an operational life of 20 years is proposed. The AADT without Proposal-related traffic for 2036 was therefore forecast using a conservative growth factor of 1.5%. The increase in AADT levels due to the Proposal on Obley Road and Toongi Roads is shown in **Table 4.79**.

Table 4.79
Forecast Background and Combined Traffic Volumes

Road	Site	Forecast Traffic (2036)*		DZP Traffic		Combined Traffic (2036)		Increase	
		LV	HV	LV	HV	LV	HV	TOTAL	%
Obley Road	Between Newell Hwy & Zoo Entry	2 968	363	320	158	3 288	531	3 809	14%
	100m North of Toongi Road	344	211	320	158	664	379	1 033	86%
Toongi Road	East of Obley Road	108	22	320	158	428	190	608	368%
Boothenba Road	50m west of Saleyards	1 889	493	0	98	1 889	591	2 480	4%
Yarrandale Road	200m North of Purvis Lane	2 415	1 563	0	98	2 415	1,661	4 076	2.5%
Source: Constructive Solutions (2013) – Table 13									
LV = light vehicles HV = heavy vehicles									
* Forecast background traffic is based on the most recent counts available (see Table 4.74)									

4.12.4 Mitigation and Management Measures

General Measures

The following general management and mitigation measures as recommended by Constructive Solutions (2013) would be implemented to ensure the impacts of both construction and operational traffic are acceptable.

- Preparation and implementation of a *Construction Traffic Management Plan* which addresses the following.
 - Road and bridgeworks during the construction phase and potential impacts for existing road traffic and for vehicles accessing the DZP Site.
 - Utility upgrades adjacent to or across public roads.
 - Consideration of the respective intersections including temporary speed limits and other controls.
 - Significant deliveries including any oversize and overmass loads and the suitability of the existing road to accommodate them. In particular, consideration of constraints posed by the existing causeway over Wambalang Creek would be required prior to its upgrade.
 - Traffic interaction at key intersections where there is a marked increase in traffic.
 - Arrangements for employees to have suitable access to and from the DZP Site.
 - Impacts on other road users during the construction phase including the school bus, cyclists and pedestrians.
 - Impacts on the operation of the Zoo.
 - Avoidance of traffic delays during busy periods such as public holidays, Easter and Christmas holidays.
- Construction of all road and intersection upgrades in accordance with Austroads Standards and Council specifications with suitable dimensional capacity to accommodate the anticipated oversized loads.
- Intersection upgrades to provide simplified traffic interaction and provide appropriate warning(s) relating to the increased volume of heavy vehicles.
- Preparation and implementation of a Code of Conduct for contractors / employees travelling to and from the DZP Site. The code would:
 - identify the designated access routes;
 - cover the Applicant's expectations with respect to drivers' behaviour, management of speed and fatigue;
 - require the avoidance (wherever practical) of school bus operating periods;
 - specific driving protocols when avoidance of school bus periods is not practical; and
 - include disciplinary responses in the event of non-compliance with the code.

- Regular discussions with the school bus company(ies) to ensure that information regarding school bus routes, times and pick-up / drop-off locations remains up to date.
- The use of car pooling and buses where practical.
- Communication with organisers of “Zoo to Zoo” road cycling-type annual events to minimise impacts on construction activities, mine operations and the events.
- Education of the workforce through inductions, toolbox talks etc.
- Scheduling of shift changes to avoid peak traffic periods in Dubbo by at least 1 hour.
- Payment of a road maintenance contribution to Dubbo City Council commensurate with traffic volumes generated by the Proposal. Any maintenance contribution would take into consideration the road upgrades that are proposed by the Applicant.

In addition to the general management and mitigation measures, a range of specific road and intersection upgrade works are proposed. These are detailed in Sections 2.2.4 to 2.2.6 whilst a summary of specific considerations for specific roads are provided as follows.

Newell Highway

- Consultation with Council and RMS in relation to moving the 60km/hr speed zone on the Newell Highway to the south of the Obley Road intersection (currently located approximately 1km north).

Obley Road

- Provision of additional school bus stop pullover areas in consultation with the school bus operator(s) and Council.
- Consultation with the relevant cycling groups to provide specific consideration of safety aspects associated with their use of the road, particularly where sight distance is limited.
- Consultation with Council and RMS in relation to moving the 60km/hr speed zone on Obley Road to the south of the Dundullimal Homestead access road.

Toongi Road

- Ensuring that a suitable access point is established for the existing waste transfer station.
- Consultation with the relevant cycling groups to provide specific consideration of safety aspects associated with their use of the road, particularly where sight distance is limited.

- Consideration of intersection design for the DZP Site Entrance from Toongi Road to address the risk posed by complacency of DZP traffic turning in and out of the DZP Site Entrance into Toongi Road (which has very low background traffic).

Boothenba Road

- Reviewing and addressing the lack of controls at private accesses and other roads intersecting with Boothenba Road.
- Ensuring the relocation of the rail crossing is complete prior to haulage. If the relocation has not been completed prior to haulage, specific measures would be determined in consultation with Dubbo City Council and RMS to minimise the risks of queuing onto the Newell Highway.

Rail Crossings

- Where possible, scheduling trains outside the peak traffic periods (8:00am to 9:00am and 3:00pm to 4:00pm) to reduce the impact of traffic delays at rail crossings.

4.12.5 Impact Assessment

4.12.5.1 SIDRA Analysis

Based on the higher volume of background traffic relative to other intersections along the expected access routes to the DZP Site, the Obley Road and Boothenba Road intersections with the Newell Highway are considered to be the key intersections for performance assessment. The performance of these intersections was modelled using the intersection performance simulation software SIDRA. The remaining intersections along the nominated access route were not modelled as the peak traffic at these intersections is significantly less than the corresponding effective capacity and any SIDRA modelling would provide no additional value to the assessment (Constructive Solutions, 2013).

The purpose of the intersection analysis was to determine whether the existing intersections have the capacity to perform satisfactorily at peak times with the additional traffic anticipated during the operational phase of the Proposal.

Manual counts were taken to determine the peak periods of the day and a peak 15 minute period for analysis. The performance of the two intersections, assuming existing and forecast background traffic, is summarised in **Table 4.80**.

The results indicate that the two intersections modelled would still operate far below their capacity, even in Year 2036 with applied traffic growth of 1.5% per annum. The worst level of service¹ is anticipated to be C based on the worst anticipated delay although it should be recognised that the transport of reagents is not significantly exacerbating the situation.

The results clearly indicate that the introduction of traffic by the Proposal, which represents only a relatively minor percentage, would not significantly impact upon the performance of the intersections.

Table 4.80
Modelled Future Traffic Conditions – Peak Operation

Intersection	Scenarios	Peak Flow	DoS*	Delays (Sec)	LoS* (worst)	Queue (m)
Newell Highway and Obley Road	Background Traffic (2036)	905	0.312	15.0	B	10.3
	Background Traffic (2036) + DZP Traffic	939	0.339	15.1	B	11.8
Newell Highway and Boothenna Road	Background Traffic (2036)	1,217	0.500	32.4	C	20.6
	Background Traffic (2036) + DZP Traffic	1,238	0.508	33.8	C	20.8
*DoS = Degree of Saturation *LoS = Level of Service ⁵						
Source: Constructive Solutions (2013) – Table 16						

4.12.5.2 Obley Road

The additional traffic that would occur on Obley Road as a result of the Proposal represents a significant increase above existing and forecast background traffic, particularly near Toongi Road (86% increase) where existing traffic volumes are low. The relative increase between the Newell Highway and the Zoo and Dundullimal Homestead is less (14% increase) due to the significant volume of tourist traffic generated by these attractions. Notwithstanding this, the additional traffic would not result in traffic volumes beyond the effective capacity of Obley Road (Constructive Solutions, 2013).

It is noted that the additional traffic would exacerbate issues associated with the current road standard which include sections of poor road geometry, inadequate stormwater drainage and inadequate pavement. However, the Applicant has committed to a range of road upgrades to address these issues (see Section 2.2.5.2 and **Figure 2.4**).

Major road and stormwater drainage upgrades have been discussed with Council and have received in-principle support, however, it is noted that the specific designs and schedule for these works is to be confirmed as part of a planning agreement or similar with Council.

With the implementation of the proposed upgrade measures, the road standard would significantly improve and increase the effective capacity of Obley thereby mitigating the effects of the Proposal on road capacity.

4.12.5.3 Toongi Road

Toongi Road is a low trafficked road and would be upgraded to the same standard as Obley Road to the DZP Site Entrance. Proposed upgrade works are discussed in Section 2.2.5.3 and Section 2.2.6.

With the implementation of the proposed upgrade measures, the road standard would significantly improve and increase the effective capacity of Toongi Road thereby mitigating the effects of the Proposal on road capacity.

⁵ Level of Service is a qualitative measure describing operational conditions within a traffic stream and takes into account service measures such as speed and travel time, freedom to manoeuvre, traffic interruptions, safety, comfort and convenience. There are six levels of service, designated A (best – free flow) to F (worst – breakdown in flow) (Austroads, 2005)

4.12.5.4 Newell Highway

Use of the Newell Highway varies significantly between the various reagent transportation options (see Section 2.12.1). Under all options the principal impact would occur at the Obley Road intersection followed by the Bootherba Road intersection. At both intersections, the volume of turning traffic would increase as a result of the Proposal.

Manual counts undertaken by Constructive Solutions (2013) showed a peak period in the morning and afternoon between 8:00am and 9:00am and 3:00pm and 4:00pm respectively. Consequently, the Applicant has committed to schedule shift changes outside these peaks. Therefore it is not anticipated that shift change traffic would affect the performance of either intersection.

Analysis of the intersections using SIDRA demonstrated that the worst case additional traffic generated by the Proposal would have a negligible impact (see Section 4.12.5.1). Furthermore, Constructive Solutions (2013) concludes that the need for an acceleration lane for merging traffic turning right out of Obley Road is not justified and that delays would not be significantly exacerbated by the Proposal.

The Bootherba Road intersection is also of a suitable standard to accommodate the transport of reagents. As discussed in Section 4.12.2.3.2, Dubbo City Council has secured funding to relocate the railway to cross Bootherba Road further east. This would increase the road traffic queuing capacity during train passage to approximately 150m prior to encroachment of queued traffic onto the Newell Highway.

4.12.5.5 Yarrandale Road

If bulk reagent transport Option A or Option B are adopted for the transport of reagents, a short section of Yarrandale Road between the Fletcher International Exports rail terminal and Bootherba Road would be utilised. Yarrandale Road currently has a high volume of heavy vehicle traffic associated with the prevailing land uses it serves.

This section of road is generally considered suitable for the increase in heavy vehicle movements given the road and associated intersections have been constructed to a suitable standard and therefore appear to have reasonable dimensional capacity and associated controls at both the intersection with the rail terminal and Bootherba Road.

The introduction of additional heavy vehicle movements, associated with the transport of reagents is not anticipated to have a significant impact on the capacity of Yarrandale Road or the associated intersections which are proposed for use.

4.12.5.6 Bootherba Road

Bootherba Road is of a reasonable standard and currently caters for a significant number of heavy vehicles accessing the Fletcher International Exports rail terminal and the Dubbo Saleyards. The road is generally straight and is in reasonable condition.

An assessment of the pavement was not undertaken, however, it is considered that the pavement has a reasonable residual life.

There are a number of intersecting accesses and roads which have limited controls and/or advanced warning. The proposed installation of additional controls including give way and/or stop signs and associated hold lines is considered appropriate to improve awareness.

4.12.5.7 Rail Level Crossings

There are seven public road crossings that would require probable treatment as outlined in Section 2.2.4.4. The impact on road traffic as a result of re-instating the level crossings is largely dependent on two parameters, namely the time(s) of day trains travel through the crossings and their likely speed.

Assuming an average train length of 500m and a travel speed of 10km/hr (in town) and a total of 50 seconds for advanced warning and departure time, the delay to traffic at the intersections equates to approximately 4 minutes. As a worst case scenario, Constructive Solutions (2013) have assumed a delay of 5 minutes to calculate the associated queue lengths as shown in **Table 4.81**.

Table 4.81
Predicted Queue Lengths at Rail Crossings

Road	2036 Equiv. Max Peak Vehicles/hr	Vehicles in Each Direction	Max 5 Minute Queue length (Vehicles)
Wingewarra Street	1,411	706	59
The Mitchell Highway (Cobra Street)	2,307	1,153	96
Boundary Street	511	256	21
Macquarie Street (Old Dubbo Road)	200	100	8
Source: Constructive Solutions (2013) – Table 18			

Notably, the maximum delay would only be incurred by the first car to arrive at the level crossing, with cars arriving as the crossing re-opens incurring a much reduced delay (<1 minute). Assuming a consistent flow of traffic on local roads, the average delay for vehicles would be 2.5 minutes.

It has been assessed that an average 2.5 minute delay (maximum 5 minute delay) six times per week is unlikely to have a significant impact on traffic movement within the Dubbo urban area provided the number of movements during peak hour traffic are limited and that trains do not need to be held at the associated rail crossings waiting to obtain access to the main lines.

In the event trains movements do occur during peak hour, it is anticipated approximately 96 and 59 vehicles would queue at the Mitchell Highway and Wingewarra Street crossings respectively. The associated queue lengths would be significant and likely have some impact at the following intersections (during peak hour).

- Chelmsford Street and the Mitchell Highway.
- Chelmsford Street and Wingewarra Street.
- Hakea Place and Wingewarra Street.
- Kokoda Place and Wingewarra Street.
- Strickland Street and Wingewarra Street.

- Grevillea Close and Wingewarra Street.
- Hampden Street and Wingewarra Street.

Although traffic counts for these roads have not been obtained, significant volumes out of the listed side roads are considered to be unlikely during the 5 minute delay.

Delays at the associated rail crossings with Obley Road and Toongi Road would have a negligible impact as there is significantly less traffic than there is in the Dubbo urban area, and the delays are likely to be less than they are in town given that the train speeds would be greater than 10km/hr.

4.12.5.8 Other Road Users

The Applicant acknowledges that roads to be used for the transportation of reagents and products are used by a range of other stakeholders, including cyclists, school buses, residents and visitors to the locality and pedestrians. The proposed road upgrades would ultimately improve the standard of the road and several intersections and creek crossings, which in their current form do not conform to the minimum standards as set out in the *Guide to Road Design* and other RMS and Austroads publications. Furthermore, the Applicant has outlined various management measures aimed at informing other road users of the increased volume of traffic, managing periods of greatest risk to other road users, e.g. during road construction works, and enforcing safe and courteous driver performance.

Ultimately, the risk of a traffic incident cannot be completely removed, however, it is assessed that, with the implementation of the proposed management measures, these risks would not increase and in fact be significantly reduced.

4.13 VISUAL AMENITY

4.13.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "**Visual**" as a key issue for assessment including "*a detailed assessment of the:*

- *changing landforms on the site during the various stages of the project;*
- *potential visual impacts of the project on private landowners in the surrounding area as well as key vantage points in the public domain, including lighting impacts; and*
- *a detailed description of the measures that would be implemented to minimise the visual impacts of the project."*

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to visual amenity and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Decreased visual amenity from changes to visual characteristics of the site (high).
- Reduced amenity of night sky from night lighting (medium).

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

4.13.2 Existing Visual Amenity

The existing visual amenity surrounding the DZP Site is typical of rural areas in the central west of NSW, with the outlook from most rural residences and other vantage points including land used for agriculture, transportation or other infrastructure, as well as remnant native vegetation. Outlooks from residences within the local setting, i.e. those identified on **Figure 4.6**, include views of agricultural paddocks, irrigation infrastructure, remnant vegetation (predominantly within the road easement of Obley Road, the riparian corridor of Wambangalang Creek and on Dowds Hill), occasional buildings and local roads.

The rural landscape surrounding the DZP Site is flat to moderately undulating and has been largely cleared of remnant native vegetation. In cleared areas, visual amenity changes with the seasons from red-brown fallowed paddocks to green growing crops and straw coloured harvest residues (stubbles). Livestock, predominantly sheep, are a common feature depending availability of feed. Remnants of native vegetation remain in the landscape, generally associated with road easements, the riparian corridor of local creeks and on Dowds Hill. These corridors of native vegetation limit the extent of views that may be obtained surrounding the DZP Site.

Typical views of the local setting from more elevated locations, including sections of the DZP Site, are provided by **Plates 4.22 to 4.29**.

Construction activities within the Macquarie River Water Pipeline Corridor may be visible from some rural residences and local roads, however, as the pipeline would be buried this would not be visible following installation. An 11kV ETL to be constructed within the corridor may be visible from some residences and rural roads. The upgraded rail line between Toongi and Dubbo would be visible from properties, residences and roads adjacent to the rail easement.

With the exception of vehicle movements on local roads, there are virtually no night-time activities planned in the vicinity of the DZP Site. As a result, lighting-related impact(s) on the existing night-time visual amenity are likely to be an important consideration.



Plate 4.22: View of Toongi Valley from
 Obley Road (Property 34)
 (Ref: E545V_001)

Plate 4.23: View towards the DZP Site
 and Dowds Hill from 200R Obley Road
 (R27)
 (Ref: E545V_002)



Plate 4.24: View towards the DZP Site
 from 215R Obley Road (R25)
 (Ref: E545V_003)

Plate 4.25: View over Toongi Valley
 from 216R Obley Road (R24)
 (Ref: E545V_004)





Plate 4.26: View towards the DZP Site from 218R Obley Road (R23) (Ref: E545V_005)

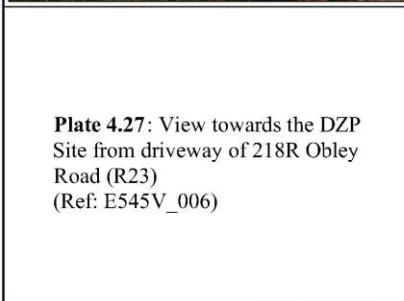


Plate 4.27: View towards the DZP Site from driveway of 218R Obley Road (R23) (Ref: E545V_006)



Plate 4.28: View towards the DZP Site from Obley Road (South of Wambangalang Creek crossing) (Ref: E545V_007)



Plate 4.29: View towards the DZP Site from "Strathgled" (R18) (Ref: E545V_008)



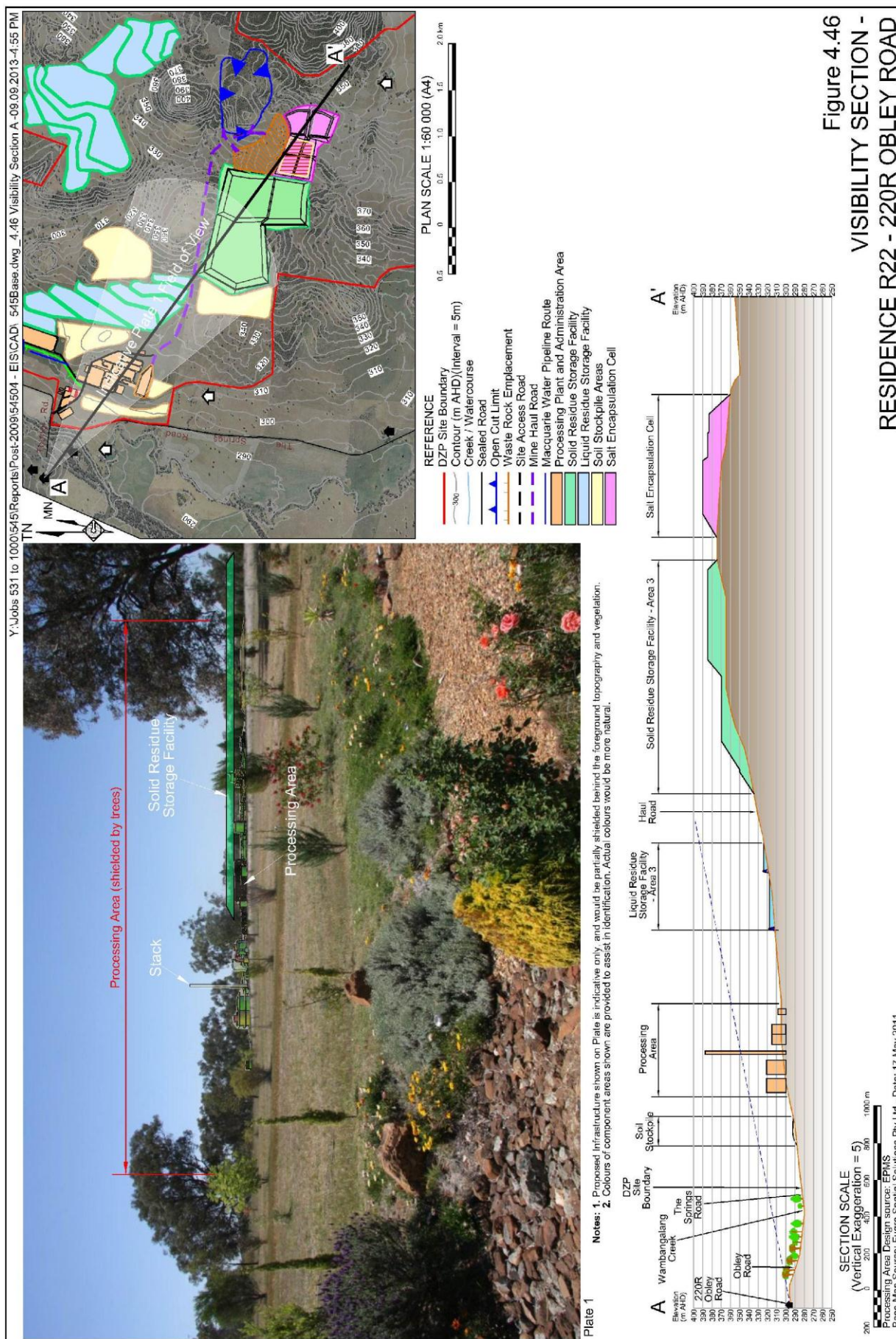
4.13.3 Management and Mitigation Measures

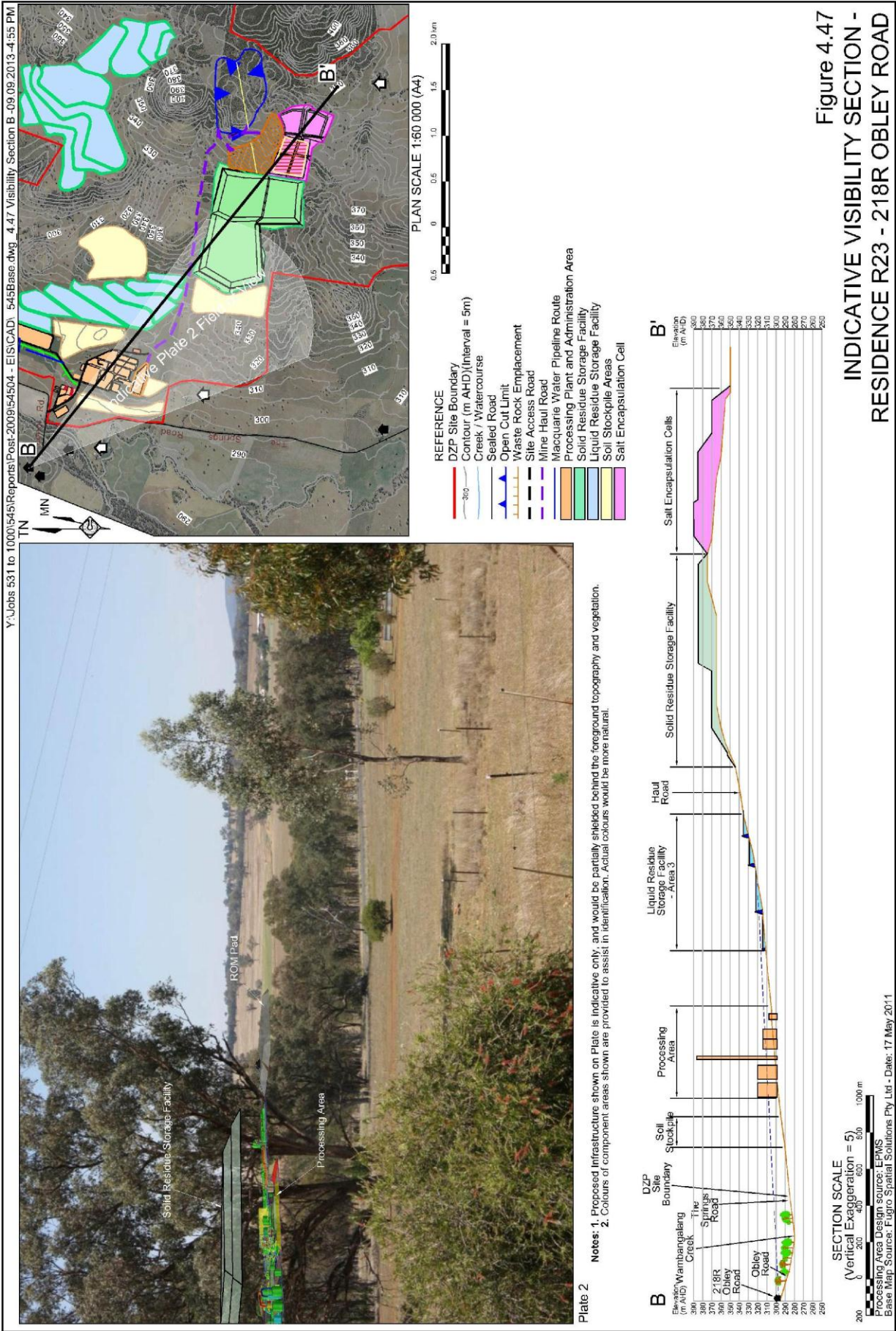
Managing the visual impact of the Proposal, in particular the construction of the processing plant, other infrastructure and various waste management facilities on the DZP Site, offers a variety of challenges and requires a range of solutions. The Applicant proposes the following measures to manage the impact of its activities on the visual amenity surrounding the DZP Site.

- Stockpile Area 1 (refer to **Figure 2.6**) has been designed to be oriented along the western side of the rail easement and would be vegetated with fast growing tree and shrub species to create a vegetated amenity bund.

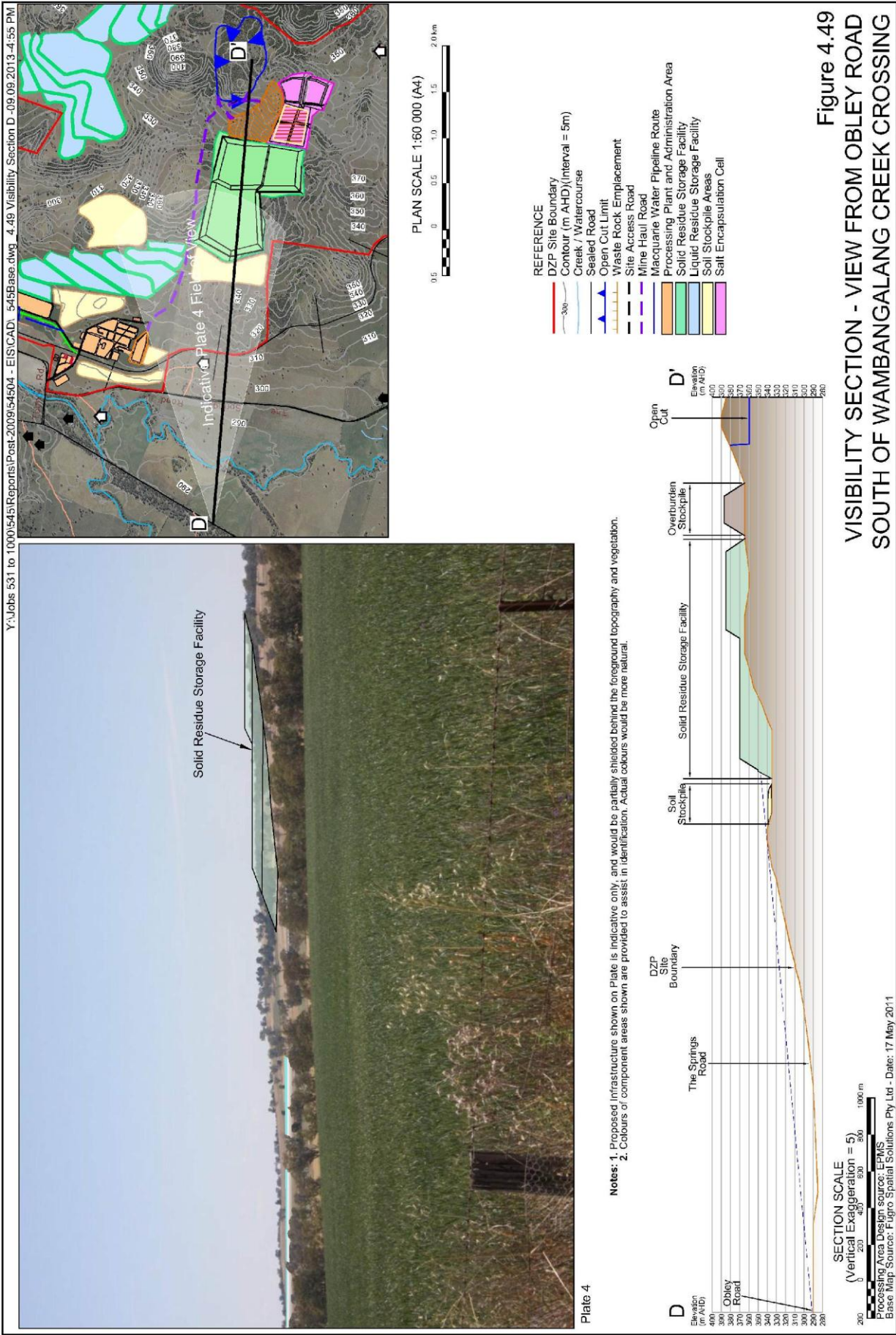
The amenity bund would provide screening of the processing plant operations from vantage points on Toongi Road, The Springs Road and to a lesser extent Obley Road. As establishment of the processing plant would be one of the initial construction activities to be undertaken on the DZP Site, the vegetation cover and trees on the soil stockpiles would have 18 months to 2 years to establish prior to commencement of operations.

- The outer embankments of the LRSF, SRSF, WRE and Salt Encapsulation Cells would be progressively rehabilitated. The establishment of a grass cover over these outer embankments would reduce the contrast between the surrounding agricultural paddocks and these structures.
- Implementation of the proposed BOA, which would incorporate the protection and enhancement of native vegetation across and surrounding the DZP Site (see Section 2.17.8).
- Construction of the processing plant and other infrastructure within the DZP Site from non-reflective, neutral coloured material. (It is noted that the colours used for the indicative processing plant infrastructure in the visual collages of **Figures 4.46 to 4.49**) are not representative of the colouring of this infrastructure but used to assist the viewer in differentiating between different items of the plant).
- Selection and placement of permanent and temporary lights that:
 - are not directed towards, and therefore do not impact on the vision of motorists using, the Newell Highway;
 - do not point towards surrounding residences; and
 - minimise the ‘lume’ created by the lights.
- The Applicant would consider any reasonable request by a potentially affected resident for assistance to create a visual screen adjacent to their residence through planting of fast growing vegetation and/or landscaping, where such a screen would effectively reduce the visual impact of activities throughout the life of the Proposal.









The Applicant does not propose any visual amenity-specific measures in the vicinity of the Macquarie River Water Pipeline as the proposed pipeline would be buried and the pumping infrastructure located away from local vantage points.

The Applicant does not propose any visual amenity-specific measures in the vicinity of the Toongi-Dubbo Rail Line as the rail line is an established feature of the local setting and it is considered that visual controls such as screens within the rail easement adjacent to Margaret Crescent and other locations within the Dubbo City Limits would be more visually intrusive than the one train per day proposed.

4.13.4 Assessment of Impacts

4.13.4.1 DZP Site

During the life of the Proposal, various features of the DZP Site would be visible from various private and public vantage points surrounding the DZP Site. Those features of the DZP Site likely to be most prominent would be as follows.

- The Processing Plant and DZP Site Administration Area: due to its proximity to Obley Road and rural residential dwellings to the west and the overall size and nature of these facilities, e.g. various stacks, tanks and industrial buildings.
- The LRSF: due to its large size and the contrast that could be created between the standing water or crystallised salt and surrounding grassy paddocks.
- The SRSF, WRE and Salt Encapsulation Cells: due to the large size and location of these features over relatively elevated sections of the DZP Site. It is noted that the nearest non-Proposal related residential vantage points to this complex would be at least 3km away, with the closest public vantage point (the very lightly trafficked The Springs Road) approximately 1.5km away. Eulandool Road, Obley Road and Benolong Road would be approximately 1.9km, 2.4km and 5.4km away.

The open cut itself would be screened from vantage points by other features of the DZP Site and the local topography.

Photographs were taken by the Applicant in November 2012 and the layout of the DZP Site overlaid to generate a collage of the likely visibility of the DZP from these locations. **Figures 4.46 to 4.49** present five such collages at locations to the north, west and southwest of the DZP Site considered to be indicative of the visibility of the Proposal operations within the local setting. It is re-iterated that the colours used to illustrate the various features of the DZP Site are not representative of the actual colouration of these features. In the case of the LRSF and SRSF, colours approximating that which could be expected have been chosen. In the case of the processing plant, the colours have been chosen to assist in the viewer in differentiating between different items of the plant. As noted in Section 4.13.3, non-reflective, neutral coloured material would be used for the tanks, stacks and buildings of the processing plant.

Whilst it is acknowledged that the features of the DZP Site noted above would be visible from both private and public vantage points, it is assessed that due to the natural screening provided by local topography and vegetation, as well as the implementation of the mitigation and management measures proposed in Section 4.13.3, the visual impact over the life of the Proposal would be minimised to greatest extent reasonable and feasible.

The proposed final landform within the DZP Site is described in detail in Section 2.17.4. In summary, however, the final landform would comprise the following.

- A single bunded and fenced open cut.
- A shaped and rehabilitated above ground structure combining the waste rock emplacement, SRSF and Salt Encapsulation Cells. At its most elevated point (between 380m and 390m AHD) this complex would be of equivalent height to the pre-disturbance landform (390m AHD over the open cut).
- Very mildly undulating grassy paddocks over the land where the LRSF would be constructed.
- A return to the pre-disturbance landform over the area of the Processing Plant and DZP Site Administration Area (unless nominated for retention for a land use to be developed at the completion of the Proposal and subject to separate approval).
- A range of retained and revegetated surface water control structures, e.g. contour banks, drainage channels and sediment basins.

The only components of the final landform that would be visible from outside the DZP Site would be the SRSF, WRE and Salt Encapsulations Cells complex. It is noted that each of these structures would be revegetated using species representative of vegetation communities that occur within the DZP Site. On the basis of the successful rehabilitation of the DZP Site, it is assessed that the visual impact of the Proposal on local visual amenity would be restricted to the life of the Proposal.

In summary, the visual amenity in the vicinity of the DZP Site would be altered through the construction of a variety of structures not associated with the local setting. However, the impacts of that change to the existing visual amenity (which would be limited to the life of the Proposal) would be minimised as far as practicable through the implementation of the proposed mitigation and management measures, rehabilitation of the DZP Site and development and implementation of a *Biodiversity Offset Strategy*. Furthermore, the Applicant would seek to address individual concerns in relation to impacts on visual amenity through discussions and negotiations with individual residents.

4.13.4.2 Macquarie River Water Pipeline Route

The water supply line would be buried and would have no impact on visual amenity.

4.13.4.3 Toongi-Dubbo Rail Line

It is assessed that the small number of rail movements proposed (one per day / six per week) does not warrant the construction of visual screens within the rail easement (which would block the current views over grassed paddocks and woodland beyond the rail easement along Margaret Crescent).

4.14 HAZARDS

4.14.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "***Hazards and Risks***" as a key issue for assessment including "*a screening of potential hazards off and on site to determine the potential for offsite impacts and if a Preliminary Hazard Analysis (PHA) is required. If required, a PHA must be prepared in accordance with the Department's Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis...*"

The hazards assessment of the Proposal encompasses potential hazards caused by operation of the processing plant, bush fires, traffic incidents and assessment of potential contaminated lands within the DZP Site prior to commencement of the Proposal. This section has been compiled based on the following assessments.

- An assessment of the applicability of *State Environmental Planning Policy 33 – Hazardous and Offensive Development* (SEPP 33) was undertaken by Sherpa Consulting Pty. The full assessment is presented as **Appendix 4** of the EIS and is referenced throughout this subsection as Sherpa (2013).
- The assessment of potential bush fire hazard undertaken by R.W. Corkery & Co. Pty Limited in consultation with Applicant.
- The traffic impact assessment of the Proposal was undertaken by Constructive Solutions Pty Ltd, referenced throughout this subsection as Constructive Solutions (2013). The full assessment is presented in Part 11 of the *Specialist Consultant Studies Compendium*. Potential traffic and transportation impacts are assessed in greater detail in Section 4.12.
- A Contaminated Lands assessment for a property adjoining the DZP Site and Dubbo-Molong Rail Line, which is considered the only likely source of land contamination locally was carried out by Ground Doctor Pty Ltd. The full assessment is present as **Appendix 10** and is referenced throughout this section as Ground Doctor (2012).

4.14.2 Reagent and Product Management

4.14.2.1 Potential Hazards

Table 4.82 identifies the potentially hazardous materials and their hazard type that would be present at the DZP Site, if the Proposal is approved. Sherpa (2013) developed a range of incident scenarios and rules to determine which materials could possibly pose an increased risk outside the boundary of the DZP Site and thereby requiring a Quantitative Risk Assessment (QRA) (see Sherpa, 2013). A detailed description of the Incident Scenarios and assumptions used to determine inclusion in the QRA are provided by Sherpa (2013) (**Appendix 4**).

Table 4.82
Hazardous Materials

Material	Hazard Type	Incorporated into QRA	Scenario
Hydrochloric acid (33%)	Corrosive/Toxic	Yes	Release of hydrochloric acid from storage tank Release of hydrochloric acid in loading bay
Sulphuric acid (98%)	Corrosive	No	
Sodium sulphide	Corrosive	No	
Sodium hydroxide	Corrosive	No	
Anhydrous ammonia	Toxic/Flammable	Yes	Breakthrough of ammonia from aqua ammonia production Release of ammonia from storage vessels Release of ammonia in anhydrous ammonia and transfer area Release of ammonia in loading bay
Chlorine (potable water treatment chemicals)	Toxic	Yes	Release of chlorine from G cylinders (70kg)
SX organic	Irritant	No	
Diesel fuel	Combustible	No	
Aluminium powder	Produces hydrogen (flammable gas)	No	
Tributyl phosphate	Combustible	No	
Automotive LPG	Flammable	No	
Petrol	Flammable	No	
Source: modified after Sherpa (2013) – Table 5.1 and Table 5.2			

Sherpa then undertook the QRA to calculate the risks in terms of the following.

- Individual Fatality Risk: which provides the likelihood of fatality to notional individuals at locations around the source, as a result of the defined fire/explosion and toxic gas release scenarios. This is shown as contours on a map of the area. The units for individual risk are probability (of fatality) per million per year.

By convention it is assumed that people are located outdoors, are always present and take no evasive action if an incident occurs. The results are presented cumulatively for all toxic impacts.

- Injury and Irritation Risk: which provides the likelihood of injury or irritation to individuals at locations around the source as a result of the same scenarios used to calculate individual fatality risk. Similarly to individual fatality risk, injury/irritation risk contours represent probability of injury or irritation experienced by a person located permanently at a particular location, assuming no mitigating action such as escape.

4.14.2.2 Safeguards and Controls

The dangerous goods classifications, storage quantities and locations for reagents to be imported to the DZP Site have previously been provided in Section 2.7 and on **Figure 2.10**. **Table 4.83** consolidates this information and provides the nominated design standards to be applied for each material.

Table 4.83
Reagent Storage

Reagent	DG Class	Storage Capacity	Storage Location	Design Standard	Comments
Sulphuric Acid	Class 8 (Corrosive)	10 000m ³	Two above ground mild steel tanks on concrete bunded surface	AS 3780-1994	Tanks to be maintained within bunded area designed and constructed in accordance with Section 5.7 of AS 3780-1994 (Bunds and Compounds)
Caustic Soda		20 Isotainers	Temporary storage in isotainers within Rail Container Laydown and Storage Area	AS 3780-2008	
		1 400t	Bulk storage tanks concrete bunded surface		
Hydrochloric Acid		7 Isotainers (140 000L)	Temporary storage in isotainers within Rail Container Laydown and Storage Area		
		1 600t	Bulk storage tanks concrete bunded surface		
Sodium Sulphide		220t	Bulk storage tanks concrete bunded surface		
Anhydrous Ammonia	Class 2.3 (Toxic Gas)	200t	Storage vessels maintained within an enclosed structure on a bunded concrete pad	AS 2202-1983	<p>The storage area would be secured when not in use.</p> <p>The storage area would be well ventilated. The storage vessels not exposed to direct sunlight, sparks or flame.</p> <p>The storage vessels would be securely closed when not in use.</p>
Aluminium powder	Class 4.1 (Flammable solid)	65t	Bulk storage tank within an enclosed facility on a bunded concrete pad.	-	<p>The storage area would be kept cool, dry and well ventilated and out of direct sunlight.</p> <p>The storage tank would be kept away from sources of heat or ignition and out of direct sunlight.</p> <p>The following materials would not be kept near the storage tank:</p> <ul style="list-style-type: none">– Strong oxidising agents.– Water.– Acids.

Note 1: see **Figure 2.10** for storage locations

Note 1: see **Figure 2.10** for storage locations

All other reagents would be transported, stored, handled and used in accordance with the relevant Material Safety Data Sheet for that material.

The Applicant has generated MSDS's for all products of the Proposal and would adhere to the management and contingency measures nominated (see **Appendix 11**).

In order to prevent the escape of liquid materials, the following measures would be taken.

- All chemicals would be stored within concrete bunded areas.
- Tanker deliveries would occur over sealed areas with kerbing and drainage design preventing any runoff to the environment if a spill occurs.
- Spill kits would be provided as appropriate, enabling recovery of small quantities of spilt materials.

Gaseous or volatile materials handled at the processing plant (including ammonia, chlorine, hydrogen chloride fumes) have toxic effects that are primarily health and safety-related. Long-term or continuous emissions that may arise from plant operations would be addressed via an Environment Protection Licence (EPL) and occupational health and safety management systems.

4.14.2.3 Assessment of Impact

4.14.2.3.1 Preliminary Hazard Analysis

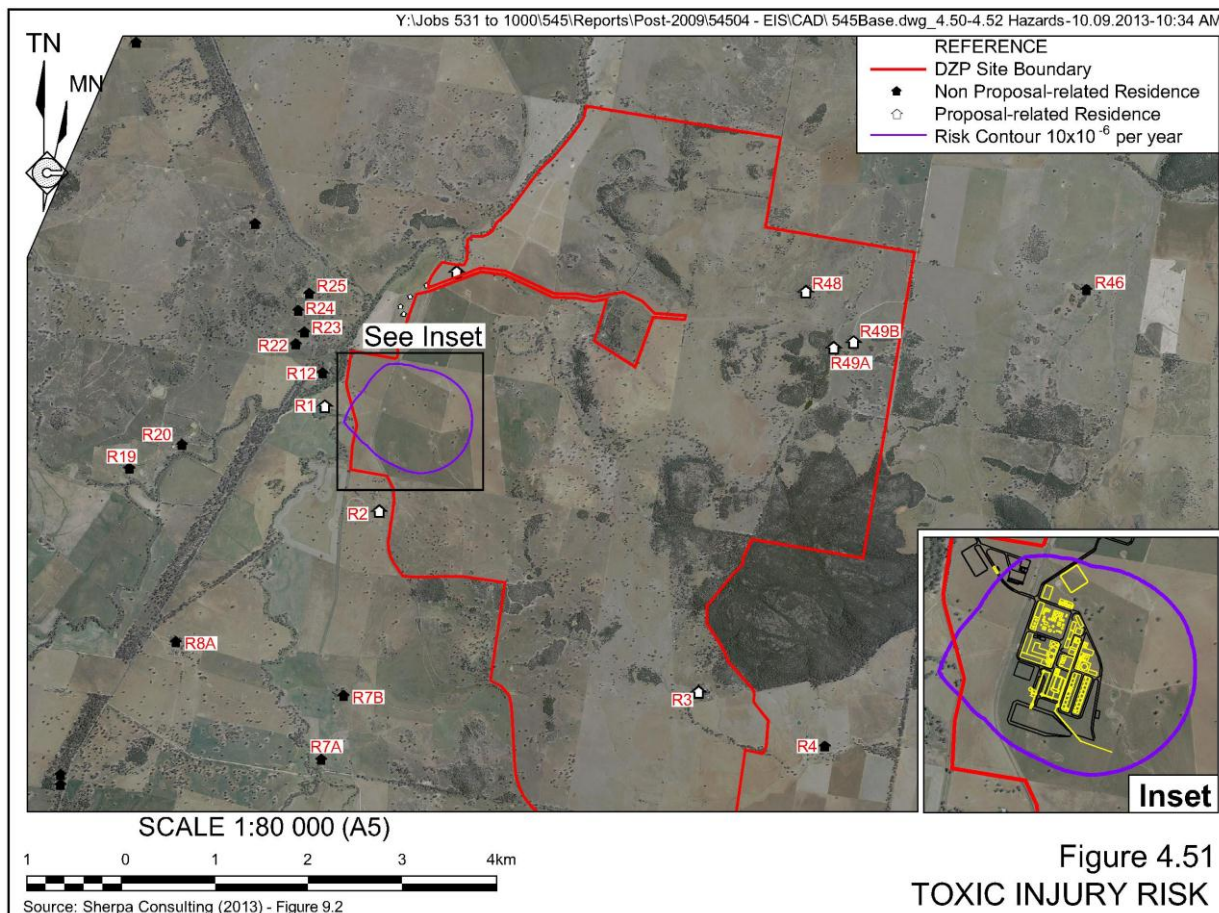
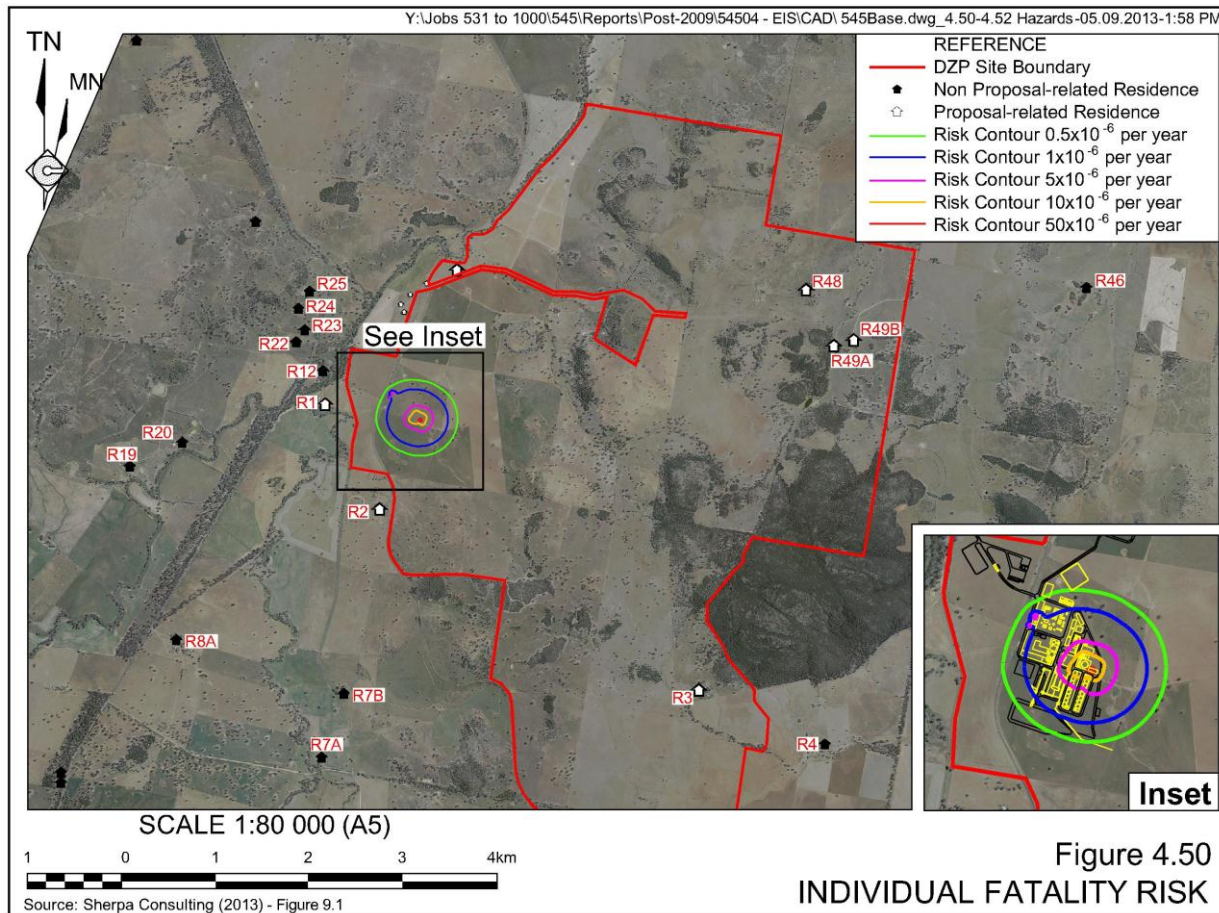
The results of the QRA identified that individual fatality and injury and irritation risk levels comply with the all criteria defined in the QRA. **Figures 4.50 to 4.52** show the risk contours for individual fatality risk, toxic injury risk and toxic irritation risk.

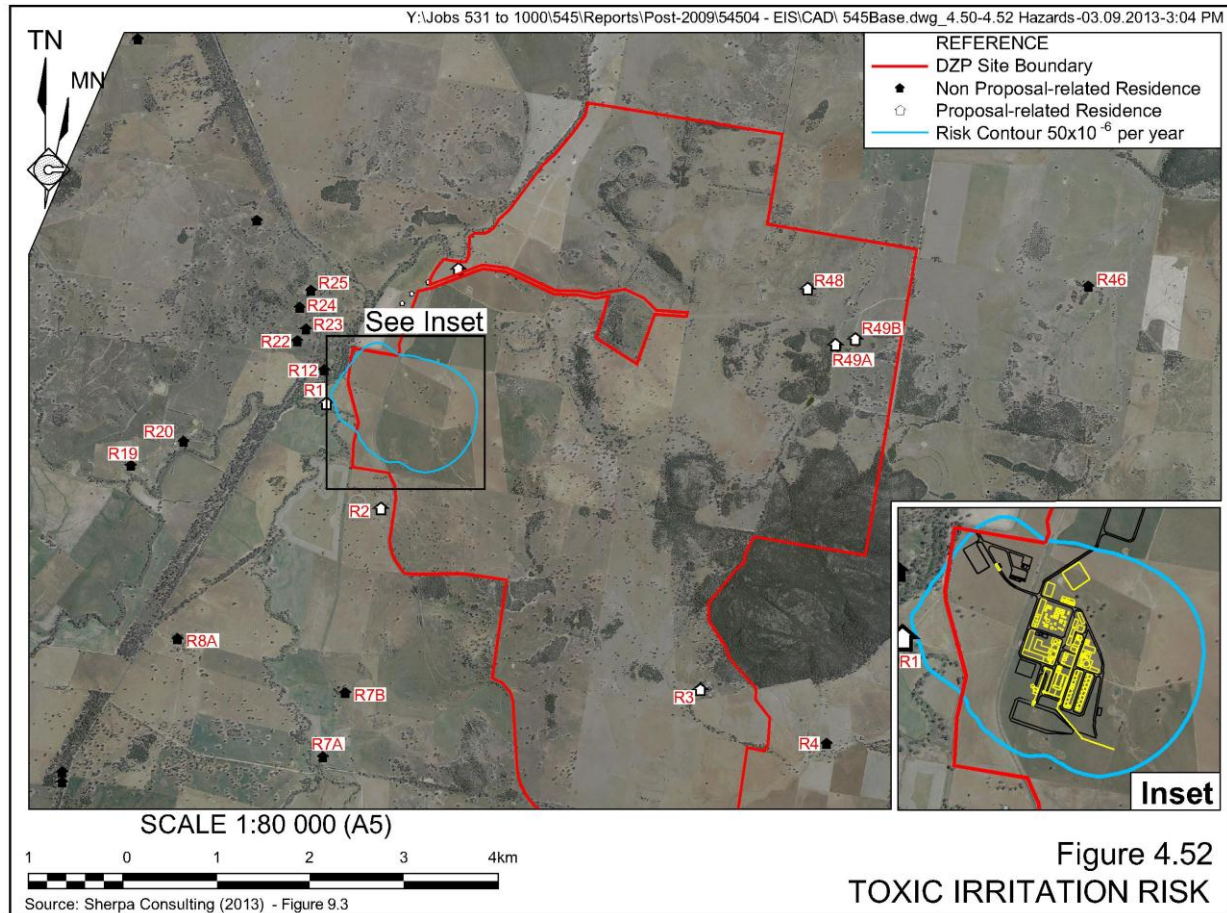
As the individual fatality risk contours do not extend beyond the DZP Site boundary, there are no significant off-site populations potentially affected by the Proposal. Societal risk levels are therefore minimal and were not quantified.

The main concern relating to environmental risk from accident events is generally with effects on whole systems or populations. The *NSW Hazard and Industry Planning Advisory Paper No. 4* (HIPAP 4) provides the following qualitative guidance for assessment of environmental risk due to accident events.

- Industrial developments should not be sited in proximity to sensitive natural environmental areas where the effects (consequences) of the more likely accidental emission may threaten the long-term viability of the ecosystem or any species within it.
- Industrial developments should not be sited in proximity to sensitive natural environmental areas where the likelihood (probability) of impacts that may threaten the long-term viability of the ecosystem or any species within it is not substantially lower than the background level of threat to the ecosystem.

Potential hazardous incident scenarios identified for the processing plant were toxic releases of ammonia, hydrogen chloride and chlorine. These releases have toxic impacts mainly on human health and safety. No accidental emissions were identified with the potential to threaten the long term viability of an ecosystem.





4.14.2.3.2 Reagent Spills and Other Incidents

On the basis of the proposed safeguards and controls for the storage, handling and transport of the various reagents and products, and assuming effective implementation of contingency measures (as identified on MSDS' for the relevant reagent or product), the impact on human health and the surrounding environment would be reduced to a risk level that is as low as reasonably possible.

4.14.3 Bush Fire Hazard

4.14.3.1 Introduction

This section identifies the dominant vegetation type(s) within and surrounding the DZP Site in order to determine the potential bush fire hazard associated with the Proposal. In identifying the bush fire hazard, the document produced by the Rural Fire Service (RFS) for DP&I entitled "*Planning for Bush Fire Protection*" (RFS, 2006) has been used. The Dubbo City Council *Development Control Plan 2013* (DCC, 2013) has also been utilised to determine the bush fire hazard within the local region. The Dubbo City Council *Development Control Plan 2013* identifies the following objectives for all land identified wholly or partly as bush fire-prone on the Bush Fire Prone Land Map.

- (1) *To minimise the risk to property and the community from bush fire and to minimise the impact of fire protection measures on the regions biodiversity;*

- (2) *To ensure bush fire protection is afforded to all new allotments and to minimise the impact of bush fires; and*
- (3) *To ensure bush fire protection can be afforded to existing settlement areas on a manner that does not limit future growth.*

The Dubbo City Council *Development Control Plan 2013* stipulates that all development is to comply with the provisions of the Rural Fire Service's *Planning for Bush Fire Protection 2006*.

The bush fire assessment was prepared by R.W. Corkery & Co. Pty Limited based, in part, on information on local vegetation provided in OzArk (2013a).

4.14.3.2 Bush Fire Management Objectives

The objectives of RFS (2006), considered in this assessment of bush fire management of the Proposal, are to:

- afford occupants of any building adequate protection from exposure to a bush fire;
- provide for a defensible space to be located around buildings;
- provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
- ensure that safe operational access and egress for emergency service personnel and residents is available;
- provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the Asset Protection Zone (APZ); and
- ensure that utility services are adequate to meet the needs of fire fighters (and others assisting in bush fire fighting).

4.14.3.3 Existing Bush Fire Hazard

Figure 4.53 identifies existing bush fire prone land status of the Site and surrounds as nominated in the Dubbo City Council *Bush Fire Prone Land Map*. The mapping indicates that the eastern portion of the Site is currently classed as bush fire-prone, corresponding generally to the slopes of Dowds Hill. The mapping also shows that the bush fire prone land is not linked to large areas of bush fire-prone land, but is geographically isolated.

The results of the bush fire vegetation category zone mapping, requires the Proposal to be assessed against the specifications and requirements of the RFS (2006), with particular reference to the APZ and construction requirements.

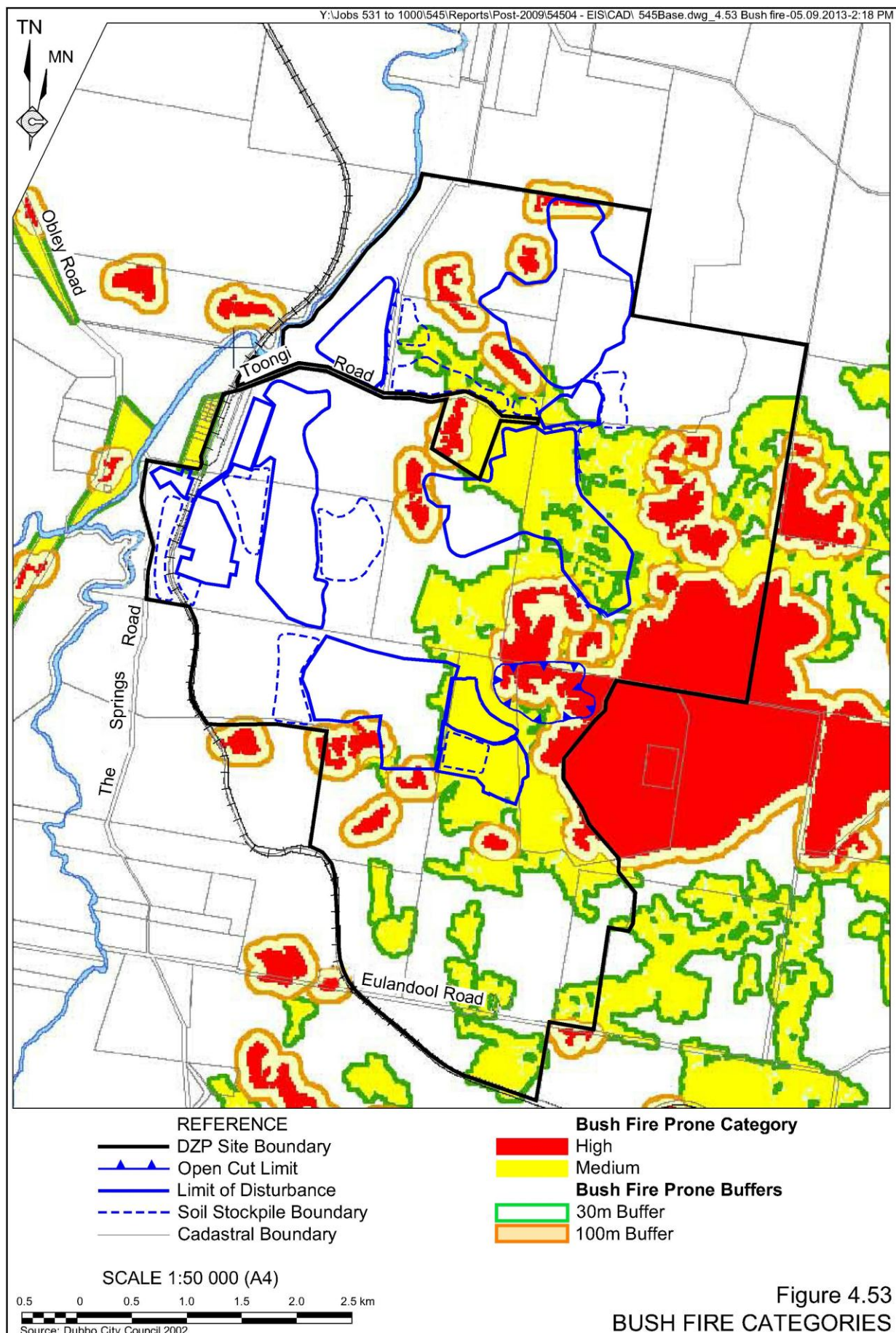


Figure 4.53
 BUSH FIRE CATEGORIES

4.14.3.4 Bush Fire Classification

Vegetation Classification

Significant sections of the DZP Site have been cleared of large trees and shrubs and are now dominated by open, cleared grazing lands. However, some vegetated areas remain. Additionally, Section 2.17.8 identifies the Biodiversity Offset Area and strategies which may include planting of local provenance species in all of the overstorey, mid-storey, shrub and ground layers. **Figure 4.54** provides the classification of the vegetation within and surrounding the DZP Site based upon the classifications provided in RFS (2006). Vegetation formations within the Biodiversity Offset Area are assumed to be mature as those in the proposed offsets, and vegetation formations outside the Biodiversity Offset Area have been mapped as existing.

The vegetation has been classified into the following three formations based on the classifications provided in RFS (2006).

- Dry Sclerophyll Forest (open forest) – maximum fuel load of 25t/ha.
- Heathlands (shrublands) – maximum fuel load of 15t/ha.
- Grasslands – maximum fuel load of 6t/ha

The vegetation surrounding the DZP Site is similar to the vegetation occurring within the DZP Site as it is dominated by cleared agricultural land interspersed with woodland and open forest vegetation, predominantly along drainage lines, elevated land or areas with greater topographic relief.

Slope Classification

Slopes within the DZP Site vary from approximately 1:60 (V:H) in the vicinity of Wambangalang Creek to approximately 1:5 (V:H) on the flanks of the higher hills. The steepest slopes occur around Dowds Hill to the southeast of the DZP Site.

Fire Danger Index (FDI)

Table A2.3 of RFS (2006) nominates Dubbo LGA as occurring within the Lower Central West Plains NSW Fire Area which is designated a Fire Danger Index (FDI) of 80. This FDI is a number that has been determined by the NSW Rural Fire Service based upon assumed forest fuels within certain geographical regions (usually based upon local government area boundaries). The FDI, a combination of air temperature, relative humidity, wind speed and drought, is used to determine the Fire Danger Rating on a particular day. A FDI of 1 (low-moderate) means that a fire will not burn or will burn so slowly that it can be easily controlled, whereas an FDI of 100 (Catastrophic) means that the fire will burn so fast and hot that it is uncontrollable. An FDI of 80 (Extreme) means that a fire will likely be uncontrollable, unpredictable and fast moving with flames in the tree tops and embers likely to start spot fires up to 6km ahead of the main fire.

Hazard Assessment

It is possible to calculate the bush fire hazard (referred to as the bush fire attack category in RFS, 2006) from a combination of the FDI, vegetation formation, the maximum slope and the proximity of activities to the bush fire hazard, as is displayed within **Table 4.84**. It should be noted that the bush fire hazard assessment takes into account not only the vegetation and associated bush fire hazard within the Site, but also the vegetation immediately surrounding the DZP Site and the general local area.

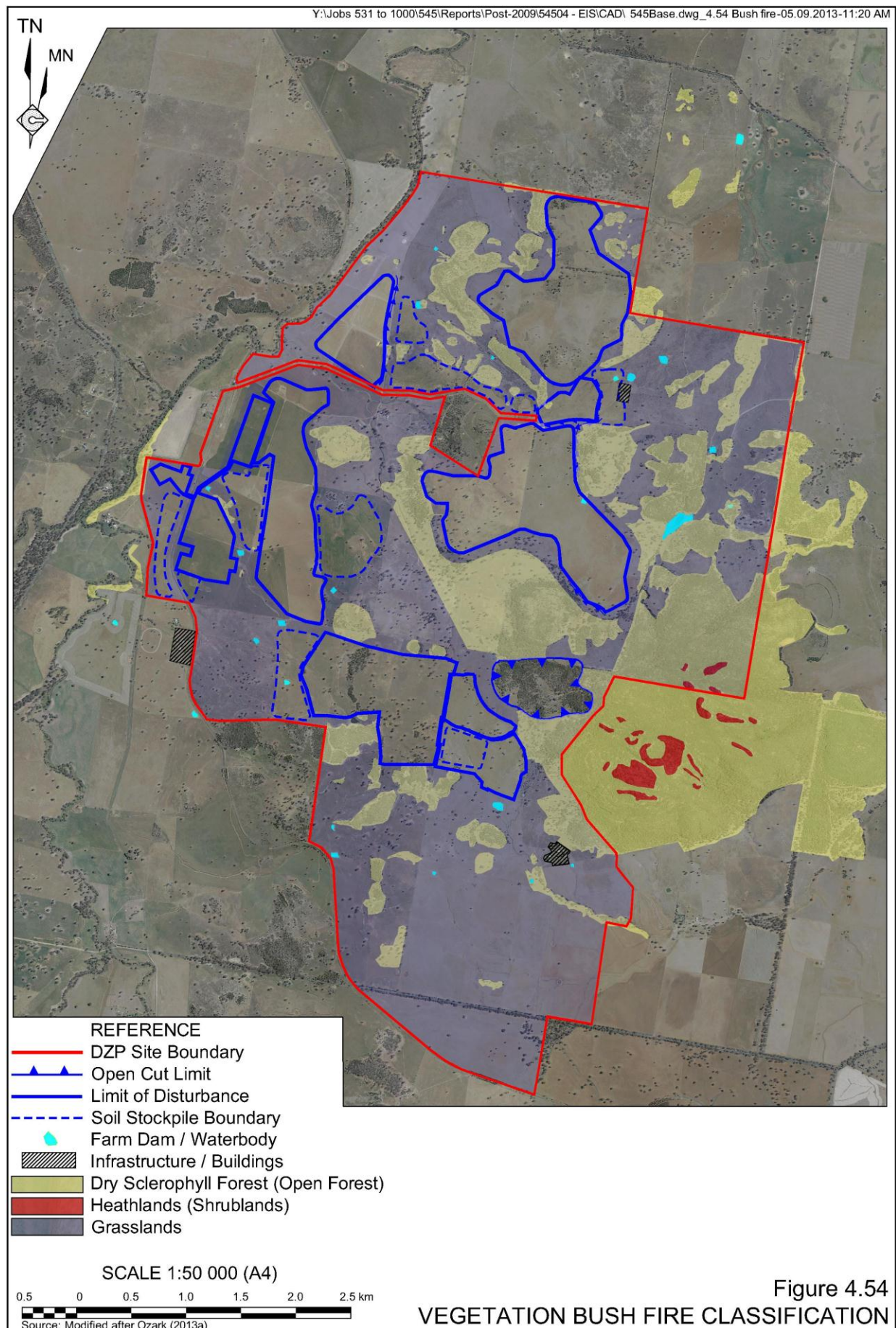


Table 4.84
Bush Fire Hazard Assessment

Vegetation Classification	Slope	Distance to Activities	Category of Bush Fire Attack
Dry Sclerophyll Forest (Open Forest)	>15 ° to 18°	>100m	Low
	>5 ° to 10°	52 – 100m	Medium
Heathlands (shrublands)	>15 ° to 18°	>100m	Low
Grasslands	0 ° to <5°	<20m	Low
Sourced: Based on Appendix 3.3 of RFS (2006)			

From the consolidated information and the matrix provided in *Appendix 3.3* of RFS (2006), the “Category of Bush Fire Attack” (or bush fire hazard) throughout the DZP Site is generally classified as low due to the distance of the more heavily vegetated areas on steep slopes from proposed activities. The notable exception being the construction of the open cut which would require clearing of open forest from the upper slopes, putting the personnel in proximity to the wider hazard.

4.14.3.5 Safeguards and Controls

Specific bush fire management measures to manage a local bush fire event would be prepared should approval be granted for the Proposal and would incorporate the following.

- An APZ of at least 50m would be maintained around the open cut. As defined by *Appendix 2* of RFS (2006) the APZ would provide for:
 - minimal separation for safe fire fighting (access to fire front);
 - reduced radiant heat;
 - reduced influence of convection driven winds; and
 - reduced ember viability thereby limiting the impact of ember attack.
- Fuel loads within the APZ would be monitored and reduced as required, i.e. no re-growth of shrub or tree vegetation would be allowed, grass growth would be monitored and cut back as necessary. Specialist advice would be sought, either from the NSW RFS or Dubbo City Council in relation to appropriate fuel load management within the APZ.
- The mine haul road to the open cut would be regularly maintained to ensure safe access and egress from the open cut in the event an evacuation is called.
- Water infrastructure located within the Processing Plant Area would be accessible for management of ember attack on the buildings of the Processing Plant and DZP Site Administration Area.
- Training would be provided to site personnel in relation to specific fire fighting tasks and procedures.
- Emergency and Evacuation Management Procedures would be developed.
- In the event of a local bush fire event, all personnel would be required to assemble at the designated Emergency Assembly Area (likely to be within the car park of the Processing Plant and Office Area). A head count would be undertaken to

confirm all site personnel and visitors are accounted for. At this time, instructions as to specific procedures to be followed, i.e. site protection or evacuation, would be provided in accordance with the Emergency and Evacuation Management Procedures and advice provided by the NSW RFS.

The preparation and implementation of the above notwithstanding, the Applicant would ensure that all personnel recognise the authority of the NSW RFS and other emergency services, e.g. NSW Police, and adhere to any and all instructions provided by these authorities. Furthermore, access to all DZP Site facilities and water storages would be provided to the RFS and any reasonable assistance offered.

The Applicant would implement the following management and mitigation measures to minimise risks associated with starting of bush fires within the DZP Site.

- Ensure refuelling is undertaken within designated fuel bays or within a cleared area of the DZP Site.
- Ensure vehicles are turned off during refuelling.
- Ensure no smoking policy is enforced in designated areas of the DZP Site.
- Ensure fire extinguishers are maintained within site vehicles and refuelling areas.
- Ensure a focus on housekeeping by mine management.
- Ensure that a water cart is available to assist in extinguishing any fire ignited.

4.14.3.6 Assessment of Impacts

The proposed operations would increase the number and type of ignition sources in the local area. However, the proposed management and mitigation measures, in conjunction with general clearing activities associated with the Proposal would ensure that an acceptable bush fire hazard is maintained within the DZP Site.

4.14.4 Traffic Incident

4.14.4.1 Potential Incident(s)

Mine traffic (road registered semi-trailers and light vehicles) would enter and exit the DZP Site from Toongi Road via Obley Road. The proposed major route for all inbound heavy vehicles to the DZP Site would originate from Dubbo via the Newell Highway, and could potentially result in an accident involving an over size or other Proposal related vehicle and a vehicle driven by a member of the public.

In addition, a list of expected types and quantities of hazardous materials transport movements to and from the DZP Site has been identified in Sherpa (2013), and a risk screening against relevant SEPP 33 screening thresholds has been undertaken. Sherpa (2013) identified that the transport screening thresholds are exceeded by the proposed number of hazardous material movements due to the number of ammonia truck movements, and that consequently a Transport Route Selection study is required.

4.14.4.2 Safeguards and Hazard Reduction Strategies

A Transport Route Selection Study would be undertaken prior to the commencement of operations that would identify the hazardous materials required to be transported to and from the DZP Site, quantities and locations where the materials would be transported from and to. The study would identify the preferred transport route to minimise risk to appropriate levels.

Material Safety Data Sheets (MSDS) have been produced for each of the products to be despatched from the DZP Site. The MSDS' document the relevant hazards and mitigatory responses to follow in the event of a spill of these materials and are included as **Appendix 11**.

While the risk associated with an incident between a Proposal-related vehicle (over size truck, road registered heavy vehicle or light vehicle) and a vehicle driven by a member of the public would be managed through the upgrading of roads and intersections to ensure these meet appropriate standards, the following hazard reduction measures or strategies would be implemented to further manage residual risks.

- Give way signs would be erected at the exit of the DZP Site to Toongi Road, and the exit of Toongi Road onto Obley Road.
- All truck drivers would be advised of the potential conflict between Proposal-related traffic and the general public and would be required to sign a Driver's Code of Conduct identifying minimum standards for driver behaviour.
- Appropriate traffic management controls would be implemented during the road and intersection upgrades. The Applicant would implement a comprehensive *Transport Management Plan* for construction and mine operation.

4.14.4.3 Assessment of Impacts

Risks associated with the transportation of hazardous materials to and from the DZP Site would be managed through the implementation of preferred routes to be identified through a Transport Route Selection Study.

Risks associated with an incident between a Proposal-related vehicle (over size truck, road registered heavy vehicle or light vehicle) and a vehicle driven by a member of the public are considered low given the proposed hazard reduction measures and strategies.

4.14.5 Land Contamination

4.14.5.1 Introduction

Prior to the purchase of Lot 1 DP 818802, Toongi, the Applicant identified the potential for contaminated land on a portion within that lot. Ground Doctor Pty Ltd (Ground Doctor) was commissioned to undertake a preliminary contamination assessment (*Preliminary Contamination Assessment- GrainCorp Operations Limited Rail Siding, Lot 1 DP818802, Toongi, NSW* [Ground Doctor, 2012], **Appendix 10**) with the following objectives.

- Assess the site setting, subsurface conditions beneath the subject land and the environment surrounding the subject land.
- Identify past and present land uses of the subject land.

- Identify potential sources of land contamination associated with past or present use of the subject land and potential contaminants of concern.
- Quantify potential contamination on the subject land through collection of preliminary field data.

The following subsections present the results of this assessment.

4.14.5.2 Methodology

To achieve the objectives outlined in Section 4.14.5.1, Ground Doctor completed the following work.

- Conducted a site inspection to establish current site conditions, surrounding land uses and potential human and environmental receptors located at/near the subject land.
- Reviewed and presented aerial photography held by NSW Land and Property Management Authority (LPMA). Aerial photographs reviewed were photographs taken in 1959, 1964, 1971, 1980, 1988, 1995, 2000 and 2004.
- Conducted various database searches to obtain as comprehensive a record of previous land use as possible.
- Reviewed available geology and soil landscape maps to assess sub-surface conditions beneath the subject land.
- Conducted preliminary soil sampling to quantify any potential sources of contamination identified at the subject land. Soil samples were collected at 12 locations which were analysed in a laboratory for organochlorine pesticides (OCPs), heavy metals and asbestos.

The following provides a summary of the preliminary contamination assessment prepared by Ground Doctor (2012) following the completion of these tasks.

4.14.5.3 Results

The subject land is believed to have been vacant and/or used for grazing purposes prior to 1921. In 1921, the subject land was acquired by the NSW Government as part of a rail corridor and Toongi siding. The land is believed to have been used as a grain storage and loading facility by the NSW Government up until 1991. In 1991, the NSW Government privatised grain operations and land ownership was transferred to the NSW Grain Corporation Limited. The subject land remained operable as a grain storage and loading facility until circa 1993 and has been vacant since. OCPs were commonly used to protect grain against insects between the 1940s and 1980s and were likely to have been used to protect former grain storages on the land.

Ground Doctor collected six near surface samples immediately adjacent to the former grain storages to assess them for the presence of OCPs and heavy metals. Some OCPs were detected in near surface soil samples. Reported concentrations of OCPs were well below the adopted commercial and/or industrial land use assessment criteria adopted for the site. Concentrations of heavy metals adjacent to the former grain storages were also well below the adopted assessment criteria.

Land immediately to the west of the subject land was a railway corridor which featured a main line and a siding which was believed to have been used for grain loading. Ground Doctor collected five near surface soil samples along the western boundary of the subject land (adjacent to the former railway siding). Some of these samples were analysed for commonly encountered contaminants of concern associated with former railway sites. The reported concentrations of PAHs, OCPs and heavy metals in these samples were less than the adopted assessment criteria. Asbestos was not identified in any near surface sample collected adjacent to the railway siding. Ground Doctor did not assess soil for petroleum hydrocarbons. Given the proximity to Dubbo of the subject land, it is unlikely to have ever been used for bulk storage and loading of liquid fuels.

Some filling was identified at the site. Synthetic inclusions were not identified on the surface within the filled areas. The location of the land is such that the imported fill was likely to have been imported from a nearby quarry and was likely to have met the current definition of virgin excavated natural material. Fill on the subject land was unlikely to have come from a contaminated site as industry in the surrounding area at the time of filling was limited, and remains limited. Fill on the land was not assessed for these reasons.

Based on the results of this preliminary contamination assessment, the subject land is considered suitable for ongoing commercial and/or industrial use.

4.15 SOCIO-ECONOMIC SETTING

4.15.1 Introduction

The Director-General's Requirements (DGRs) issued by DP&I identified "*Social and Economic issues*" as key issues that require assessment. The principal assessment matters from DP&I relating to socio-economic factors include:

- *"potential direct and indirect economic benefits of the project for local and regional communities and the State;*
- *potential impacts on local and regional communities, including:*
 - *increased demand for local and regional infrastructure and services (such as housing, childcare, health, education and emergency services); and*
 - *impacts on social amenity;*
- *a detailed description of the measures that would be implemented to minimise the adverse social and economic impacts of the project, including any infrastructure improvements or contributions and/or voluntary planning agreement or similar mechanism; and*
- *a detailed assessment of the costs and benefits of the development as a whole, and whether it would result in a net benefit for the NSW community."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the Central West CMA which requested that the EIS "*outline the social benefits to the local community as well as identifying the social impacts and mitigation strategies for the project.*"

Based on the risk analysis undertaken for the Proposal (Section 3.5), the potential impacts relating to socio-economic factors and their risk rankings (in parenthesis) without the adoption of any mitigation measures are as follows.

- Strain/drain on local skilled workforce due to transfer from other industries (high).
- Strain on local (Dubbo) housing and other community infrastructure and services from influx of additional workforce (medium).
- Reduced property values due to perceived and real reduction of local amenity (low-medium).
- Reduced amenity value of landholdings (medium).
- Loss of income associated with the removal of stock from the railway corridor (medium).

The socio-economic impact assessment for the Proposal was undertaken by Mrs Diana Gibbs of Diana Gibbs and Partners. The resulting report is presented as Part 12 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “DGP (2013)”. This subsection of the EIS provides a summary of the socio-economic impact assessment, concentrating on those matters raised in the DGRs and submissions to the DGRs provided by various government agencies. A consolidated list of the identified requirements and where each is addressed in the EIS is presented in **Appendix 3**.

4.15.2 Existing Socio Economic Setting

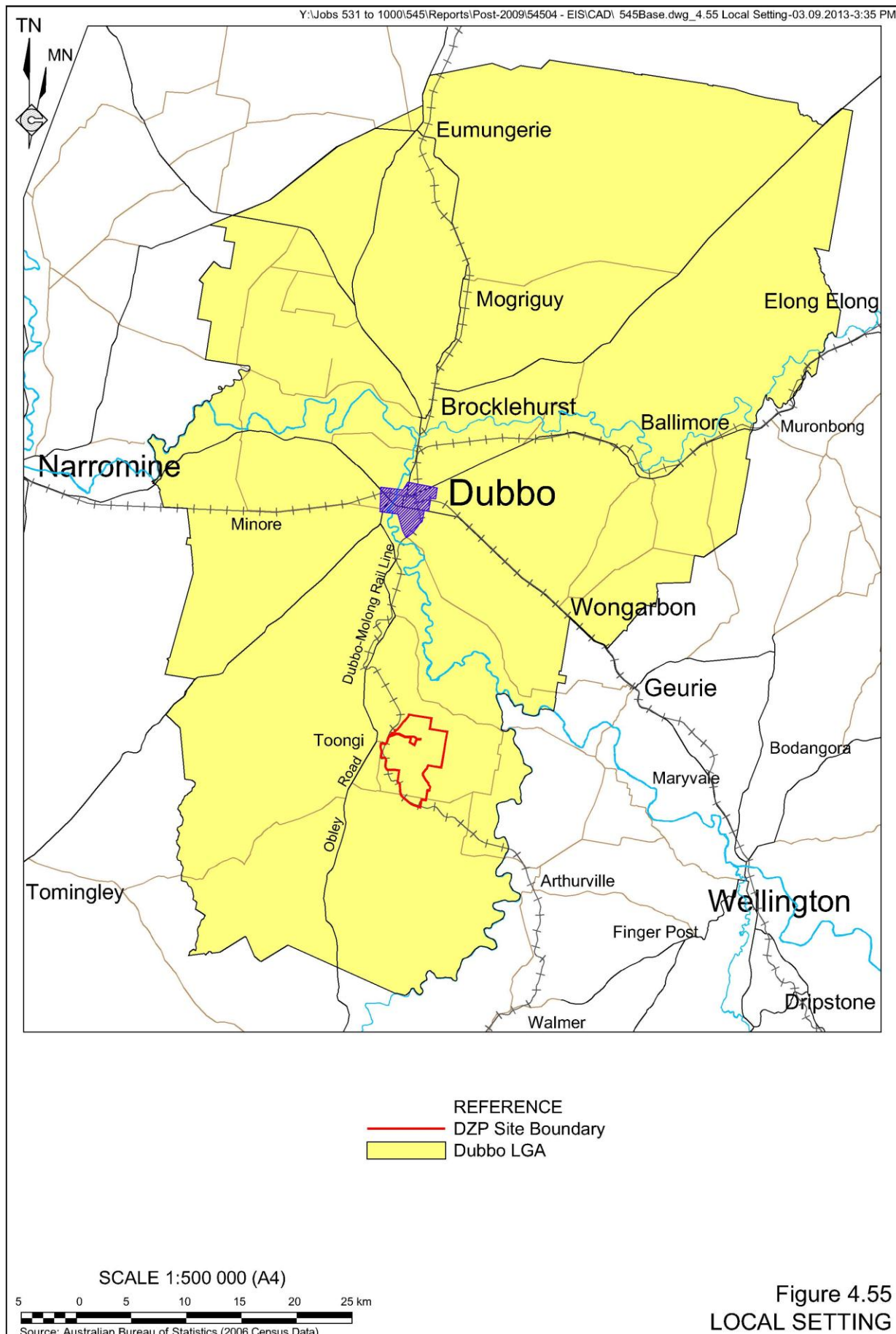
4.15.2.1 Overview

The location of the proposed activities is adjacent to the village of Toongi, approximately 25km south of the City of Dubbo, within the Local Government Area of Dubbo City, see **Figure 4.55**. The following subsections describe existing socio-economic setting of the Dubbo Region (the Dubbo City LGA) and the local setting (Toongi and surrounding agricultural properties).

4.15.2.2 Dubbo

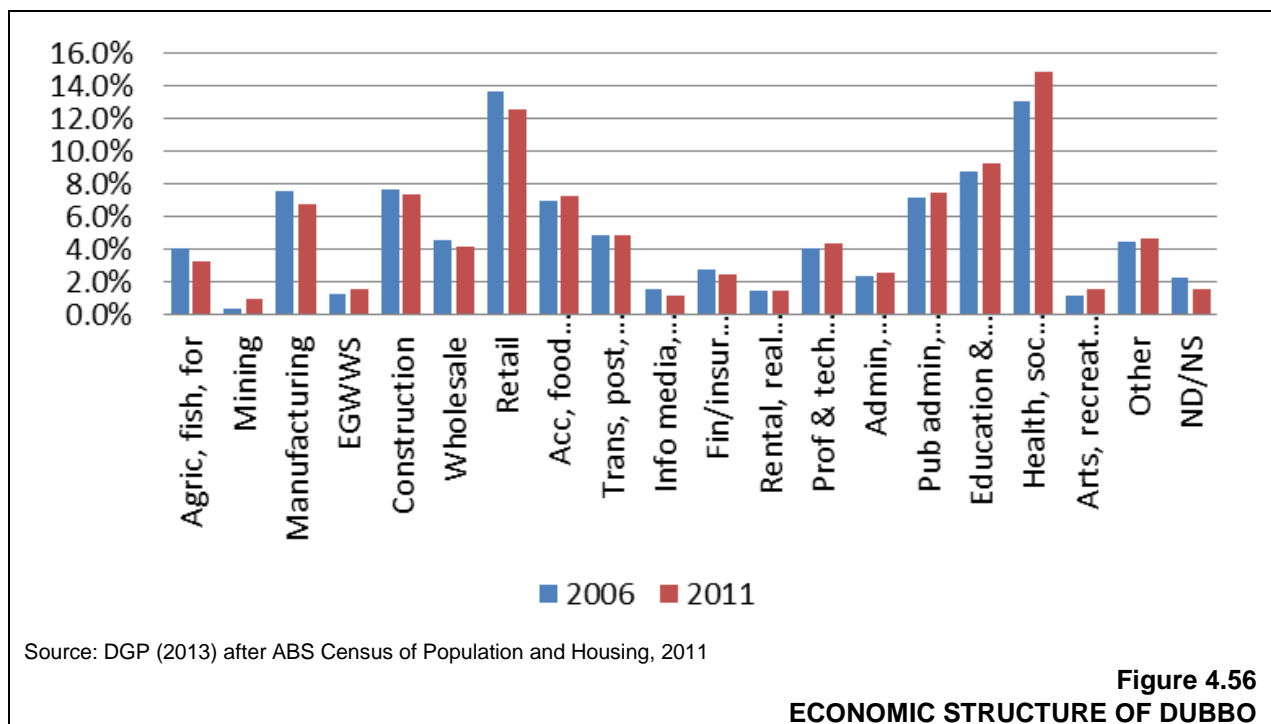
The population of Dubbo has expanded by an average of 0.8% per annum in recent years, to reach over 41,000 in 2009. The population is projected to increase to 46 500 by 2036 (DoP, 2011). Dubbo is the established service centre for the wider Orana region, and was estimated (by Dubbo City Council) to have had a Gross Regional Product (GRP⁶) of \$2.1 billion in 2008-09. The main sources of this economic activity were the construction and wholesale sectors, health care and social services, and public administration/safety. The agricultural sector contributed \$43.7 million to this value of output, representing 2.6% of the total Dubbo GRP (compared to 10.2% of the total output for the Orana region). Largest growth has been observed in the wholesale sector, which expanded by over 130% in recent years to \$149.4 million, due to the provision of services to regional agriculture, mining, and other industry.

⁶ GRP can be considered to be the net wealth created within the region



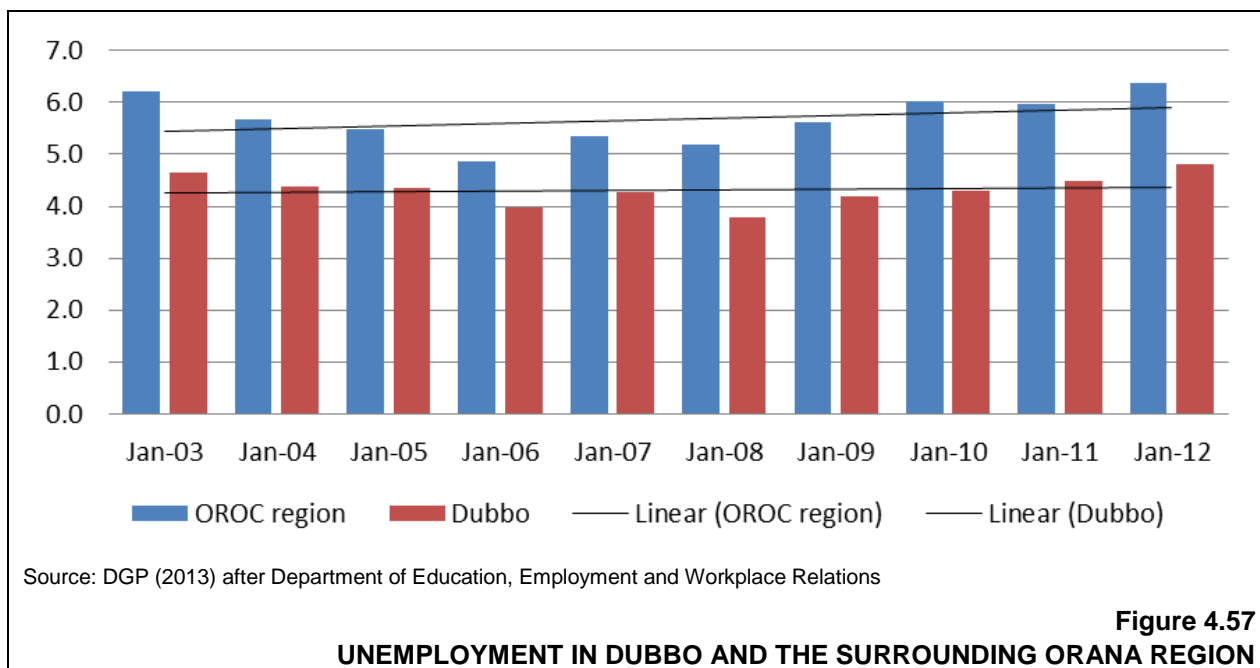
Confirming Dubbo as a growth centre of NSW, economic growth has averaged 8.5% pa over the last 3 years. This growth has been driven by expansion in leading service and industrial sectors, highlighting growth in both provision of services and industrial activity.

Agriculture still supports 18% of all businesses in Dubbo, however, only accounted for around 3.3% of total employment in Dubbo in 2011, declining from around 4% in 2005 (see **Figure 4.56**). Currently the mining sector contributes only 0.8% to the Dubbo GRP, compared with 15.8% to the wider region (which includes the established mines at Cobar and Mudgee). With average wage rates in the agricultural sector of \$649/week, compared to rates of \$1 219/week in mining (and average Dubbo wages of \$753/week), the attraction of agricultural employment can be expected to decline in the future. The relative importance of the agricultural sector as a whole is expected to continue to decline in the Dubbo region. By contrast, the relative importance of the mining sector is likely to increase with Dubbo City Council identifying the development of a Mining and Mining Services sector as one of ten key strategies of the recently adopted *Dubbo City Economic Development Strategy* (DCC, 2012).



Dubbo has a relatively young working age population (compared to the State of NSW as a whole), suggesting the need for a significant education and training infrastructure based locally to support skilling and development of this growing workforce. As indicated in **Figure 4.57**, unemployment rates in Dubbo have been relatively low (4.8% in June 2012), compared to the wider region covered by the Orana Regional Organisation of Councils (OROC) (6.4%).

The total labour force in the Dubbo region has increased by almost 2 500 in the past 5 years (reaching over 20 000 in 2012). This growth in the labour force, combined with relatively low unemployment rates, is evidence of strong employment opportunities in an expanding economy. Despite fluctuations in economic conditions between 2003 and 2012 (contributed to by an abnormally dry period from 2001 to 2009 and the global financial crisis), the trend in unemployment rates over this ten year period is flat.



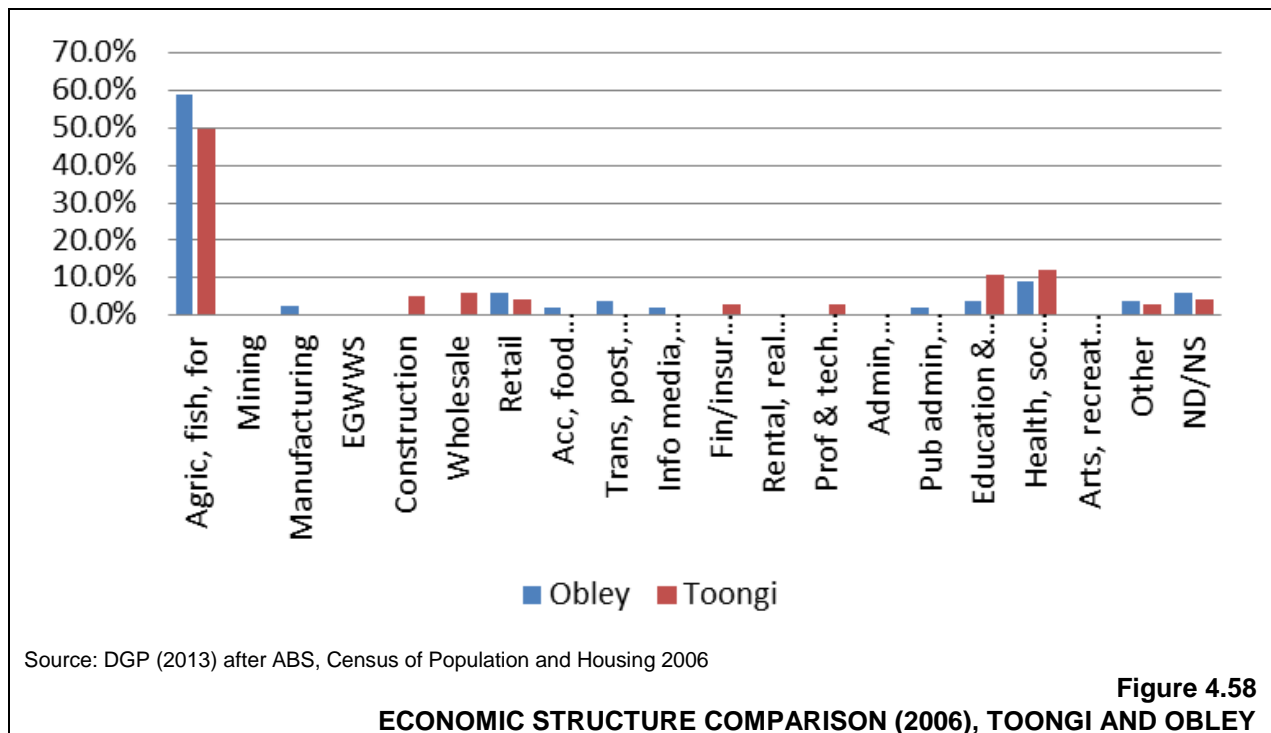
4.15.2.3 Toongi (Obley District)

Toongi is located within the LGA of Dubbo City. There are just four dwellings in the former railway village and, with the exception of ‘The Little Quilt Shop’, no commercial premises. Given the proximity of the village to the DZP Site, AZL has either purchased or has negotiated to purchase on approval of the Proposal, all freehold land within Toongi. At the time of the last Census for which specific published data is available for Toongi (2006), the Toongi community (including the surrounding agricultural properties and four smaller rural residential blocks on Obley Road opposite the intersection with Toongi Road) had a total resident population of 183 persons.

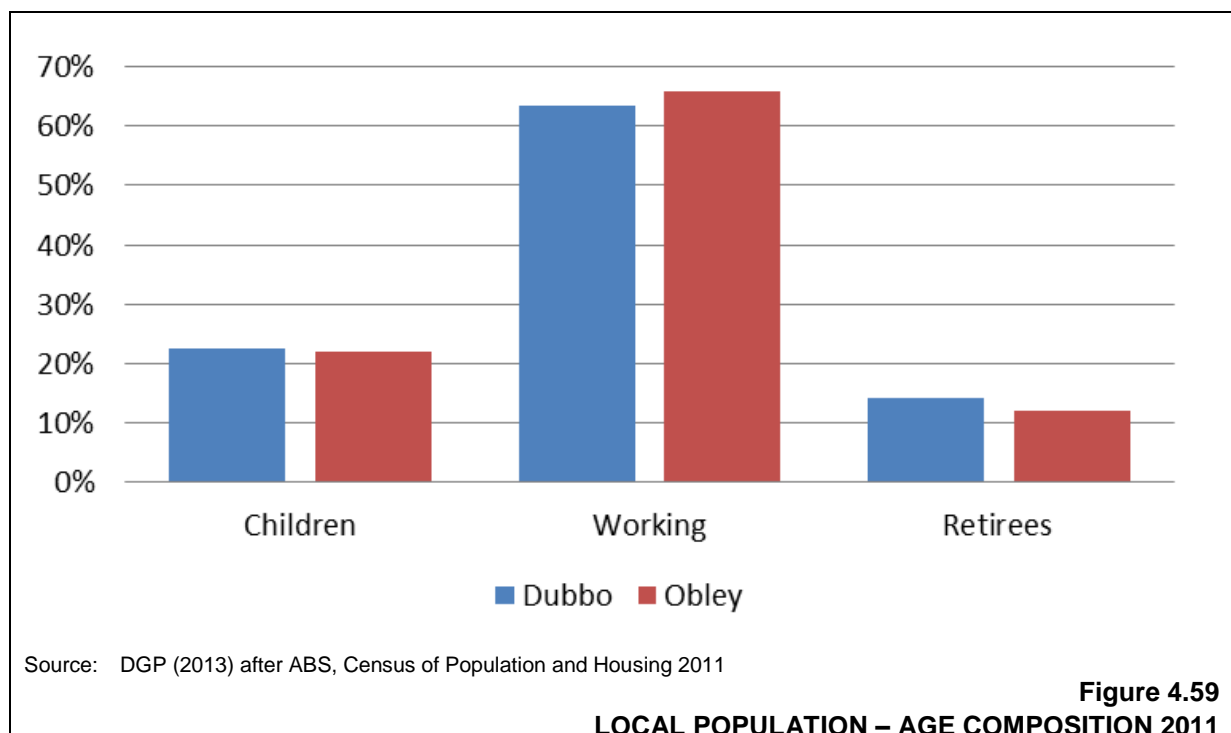
While Census data for 2011 is now available, collections for the Toongi locality are no longer made available by the ABS. To enable comparison between the socio-economic setting and demographic characteristics of 2006 and 2011, DGP (2013) considers the larger district of Obley. Through comparison of the 2006 Census datasets for Toongi and Obley, DGP (2013) confirms the larger Obley district provides for similar demographic data to the smaller Toongi locality (see **Figure 4.58**). DGP (2013) concludes therefore that changes in data for Obley, between 2006 and 2011, will reflect changes likely to have occurred in Toongi over the same time frame.

Both Toongi and Obley were heavily dependent on agriculture in 2006, with between 50% and 60% of all employment being in this sector (see **Figure 4.58**).

When compared to Dubbo, the population of the Obley district is concentrated more in the “working” age group (those aged 15-64), with a relatively lower proportion of children and those aged 65 and over (see **Figure 4.59**). This is consistent with the anecdotal evidence that residents of Toongi commute to jobs in Dubbo, or otherwise are occupied in the management of their own properties in the locality. Operators of rural holdings, in particular, tend to “retire into town” and leave Toongi in favour of a closer location to services and facilities in Dubbo.



The local area economy is heavily concentrated in the agricultural sector with nearly 40% of the local area labour force employed in agriculture (compared with just 4% in the Dubbo LGA). As a relative component of the local area economy, agriculture has declined from 60% in 2006 to 40% in 2011, presumably as a result of the increasing role of the local area as a “dormitory” for individuals holding jobs in Dubbo. Other sectors to make a notable contribution to overall employment for the local area residents are the public service sectors such as education and health care.



4.15.2.4 The DZP Site

The DZP Site is located on land either owned or to be purchased by the Applicant on approval of the Proposal. The total landholding (3 452ha) is currently used for grazing (sheep and cattle) and for the production of both grain and fodder crops. Significant parts of this area are covered with native woodland, with some use for grazing and/or shelter. The areas involved in these land uses are:

- Cropping: 1 696ha (assessed as being 49.1% of the total area); and
- Grazing: 1 325ha (assessed as being 38.4% of the total area).

The remaining 431ha (12.5% of the total area) is considered to be of virtually no commercial use, being heavily timbered.

4.15.3 Management and Mitigation Measures

In addition to the mitigation measures and management procedures described previously throughout Section 4, the Applicant would implement the following management and mitigation measures to ensure that DZP-related benefits for the community surrounding the DZP Site are maximised and adverse impacts are minimised. Where possible, these measures have been categorised to reflect the particular aspect that would be addressed by each.

Social and Community

- Engage the community surrounding the Proposal in regular dialogue in relation to the proposed and ongoing operation of the Project and maintain an “open door” policy for any member of the community who wishes to discuss any aspect of the Proposal. The Applicant already has a demonstrated record of community engagement, including consultation completed for the current Proposal, community engagement for the recently commenced Tomingley Gold Mine and community engagement at the former Peak Hill Gold Mine (which operated between April 1996 and October 2002, with processing operations continuing until June 2005).
- Proactively and regularly consult with those residents most likely to be adversely impacted by the Proposal.
- Continue to support community organisations, groups and events, as appropriate, and review any request by a community organisation for support or assistance throughout the life of the Proposal.
- Consult with residences adjoining the Toongi-Dubbo Rail Line to ensure that all reasonable expectations related to local amenity are met, e.g. fencing or no fencing of the rail easement along Margaret Crescent.
- Implement a comprehensive and targeted environmental monitoring program, provide the local community with access to the results of monitoring and use these results, in consultation with the local community, to improve environmental performance at the DZP Site. It is again noted that the Applicant has a proven

record of managing mining operations in close proximity to local communities (at the former Peak Hill Gold Mine and currently at the Tomingley Gold Mine) without unacceptable impacts on this community.

The Applicant intends to use the lessons learnt, both in terms of environmental management of issues such as blasting and dust as well as community engagement at Peak Hill and Tomingley, to minimise adverse impacts (both actual and perceived) on the local community.

- Form and maintain a Community Consultative Committee (CCC), including representative members of the local community and Dubbo City Council. The CCC would be an important forum for reviewing and discussing environmental monitoring and performance, and discussing possible improvements that could be made to operations to improve environmental (and social) performance).
- Regularly brief the CCC on activities within the DZP Site and seek feedback in relation to Proposal-related impacts whether real or perceived. In addition, seek advice in relation to the most appropriate manner in which to provide assistance to the community in an effective, fair and equitable manner.
- Advertise and maintain a community complaints telephone line.

Employment and Training

- Give preference when engaging new employees, where practicable, to candidates who live within the Dubbo Local Government Area over candidates with equivalent experience and qualifications based elsewhere and ensure that the mining and other contractors do so as well. The Applicant has set a target of 80% of the start-up workforce to be drawn from the Dubbo and surrounding LGAs.
- Encourage the involvement of the local Aboriginal community in the workforce.
- Encourage and support participation of locally based employees and contractors in appropriate training or education programs that would provide skills and qualifications that may be of use throughout and following completion of the DZP.

Economic Contribution and Development

- Give preference, where practicable, to suppliers of equipment, services or consumables located within the Dubbo Local Government Area.
- Assist community members and others, as appropriate, to establish complementary businesses in the vicinity of the Proposal where those businesses would provide a benefit to the community through increased economic activity or development.
- Assist Dubbo City Council to promote and encourage economic development that would continue beyond the life of the DZP in the area surrounding the DZP Site.

- Enter into an agreement, possibly in the form of a *Voluntary Planning Agreement* (VPA) with Dubbo City Council, to assess any net costs to Council and to establish a fund to meet community needs identified as arising from the Proposal.

Infrastructure and Services

- Ensure that infrastructure and services installed for the Proposal, including the gas pipeline, electricity transmission line, appropriate buildings and hardstand areas, remain available for alternative uses following completion of the Proposal (provided that such uses are consistent with the final land uses identified in this document or any subsequent approval).
- Encourage and support, in consultation with the local community, the provision of services to the community (through a VPA). These may include health, education, transportation and other services.

Agricultural Lands

- Manage DZP Site drainage as described and discussed in Section 4.5.4.2 so as to minimise any changes to downstream water quantity, quality and flooding regime.
- Maintain agricultural operations on land not required for active mining or biodiversity offsetting purposes.
- Continue to appropriately manage weeds, pests and bush fire risks on land held by the Applicant in consultation with surrounding landowners.
- Undertake final landform construction and rehabilitation as nominated in Section 2.17 (so as to return all but 1 200ha of the DZP Site to agricultural production post-DZP).
- Ensure that the land capability of those sections of the final landform to be used for agricultural purposes is similar to the current land capability. Any agricultural land that forms part of the final landform would be more heavily treed than it is at present due to proposed biodiversity and screen plantings.

General

- Adhere to all operating conditions, e.g. restrictions on hours of operation and the required standard of facility.
- Prepare and make available detailed indicative illustrations of the proposed infrastructure and other facilities to be constructed on the DZP Site.
- Implement the recommendations provided in each of the specialist assessments of the Proposal.

4.15.4 Assessment of Economic Impacts

4.15.4.1 Introduction

The Proposal represents a new and relatively large business for Dubbo and New South Wales, one which provides many economic opportunities. The following subsections review the predicted economic and associated impacts of the Proposal on the local and regional setting.

4.15.4.2 Employment

One of the most significant impacts for the local community would be the creation of jobs. As a result of the location of the ore body and processing facility relative to Dubbo, it is likely that the majority of the operational jobs would be filled by existing local residents.

The construction workforce would consist of both local residents (employed as short term contracts are issued to local construction operators), and members of the permanent workforces of specialist contractors who may be required for particular tasks associated with the Proposal. As a consequence of the proposed 300 to 400 personnel, to be accommodated (predominantly) in Dubbo, DGP (2013) suggests it is likely there would be a small increase in demand for temporary housing. Based on the short-term nature of many of the roles filled by the construction workforce, it is likely that the specialist contractors required would be accommodated in the extensive tourist facilities available in Dubbo.

During operations, the DZP would create approximately 250 permanent jobs. Notably, a large number of job applications have already been received by the Applicant, even though positions have not as yet been advertised. A residential workforce is proposed, i.e. no mining camp or fly-in/fly-out arrangements, and an 85% target for local employment (those currently resident in the Dubbo City and surrounding LGAs) has been set. DGP (2013) suggests that through the creation of employment generated by the Proposal, the unemployment rate of Dubbo could conceivably drop from the current 4.5%, to 3.6%. In reality, the creation of new employment opportunities is likely to create 'pull' factors to Dubbo whereby the labour market increases and as such the unemployment rate does not reduce as greatly as predicted.

The creation of new employment opportunities within the mining sector (with far higher than average weekly wages (see Section 4.15.2.2)), is likely to increase total wage payments across the Dubbo City LGA with flow-on affects to other businesses and sectors of the economy.

4.15.4.3 Regional Value of Output

The annual output from the Proposal is estimated to have a gross value of approximately \$500 million, to be delivered for 20 years. This new output would deliver a 23% addition to Gross Regional Product (GRP), currently estimated by Dubbo City Council at \$2.1 billion per annum. Over the 20 year "life" of the Proposal, this output is estimated to have a present value (PV) of \$4 257 million (at 10% discount rate). The Proposal would deliver a major stimulus to the output of the Dubbo region and would increase the contribution of mining to the Gross Value Added (GVA)⁷ of the Dubbo City LGA (which is currently only 0.8% - DGP, 2013).

⁷ Gross value added (GVA) is a measure of the value of [goods](#) and [services](#) produced in an area, industry or sector of an [economy](#). It is calculated as gross output (sales price) minus [intermediate consumption](#) (costs to generate output).

The expenditure of some \$47.4 million per annum on locally-supplied goods and services (including utilities) is also expected to be generated by the Proposal, with around \$34 million of this consisting of wages and salaries paid to the operational workforce. This expenditure would add to GVA for the Dubbo City LGA and Orana region, both via increased demand for local services, and via the consumption spending of income by employees.

4.15.4.4 Impact on Adjacent Activities

The impact of the Proposal on adjacent activities would be minimal. As the Applicant would own significant areas of surrounding land, the impact on neighbours would be minimised. Further discussion of the land use issues relating to the Proposal are set out in Section 4.15.5.7.

An *Agricultural Impact Statement* (AIS) has been completed for the Proposal (see **Appendix 9**) considering the current value of agriculture on the DZP and immediate surrounds, and the impact on this value during the life of the Proposal and on completion of the DZP and rehabilitation of the DZP Site. **Table 4.85** summarises the results of the analysis presented in the AIS.

Table 4.85
Estimated Effects of Land Use Changes

Indicator	Current	Mining	After Rehabilitation
Area available for agriculture use (ha)	3 452	1 623	2 233
Area lost to production (ha)	-	1 829	1 219
Value production from area (\$/yr)	1 464 000	789 000	1061 000
Loss of production (\$/yr)	-	674 000	403 000
Average Gross Margin (\$/ha)	424	486	475
Present Value (PV) loss at 10% discount* (\$)	-	5 779 000	6 251 000
Note: * assumes 20yr life of mine, then 20yrs after rehabilitation completed.			
Source: Modified after DGP (2013) – Table 3			

It is expected that the total annual value of agricultural production could drop by \$674,000 per year as a result of mining activities. However, following rehabilitation after mining ceases, all but 1 220ha would be returned to agriculture, and the value of production from the site is likely to be approximately \$400,000 per year lower than current levels.

When modelled over a 40 year period (i.e. assuming a mine life of 20 years, with a further 20 years following rehabilitation), the Present Value (PV) of the total loss of agricultural production (using a discount rate of 10%) is \$6.25 million. This represents 0.15% of the estimated PV of the total value of production of \$4 257 million (at 10% discount rate) from the proposed 20 years of operation of the DZP.

The Proposal requires up to 4.05GL of water per annum which would be drawn from entitlements obtained within the surface water and groundwater water sharing plans nominated in Section 2.8.2. It is noted that while the draw of water under entitlement would be in accordance with the rules and regulations of the relevant water sharing plan, the change in use of this water (a finite resource) could impact on the economic output of other industries, e.g. agriculture. Section 5.3.3 of the AIS (**Appendix 9**) considers this, drawing reference from an analysis of water availability within the nominated water sources by Hennessy Water (2013)

(Appendix 7), and concludes that the entry of the Applicant to water market would not restrict access to this tradable commodity to agriculture and therefore the impact of the Proposal on agricultural production (as related to water) would not be significant.

4.15.4.5 Public Sector Revenues

The operation of the DZP would make significant contributions to the public sector via a range of payments made to the national, State, and local governments under existing legislative arrangements.

At a national level, corporate tax would be paid by the Applicant to the Australian Tax Office. Assuming a corporate tax rate of 30%, then the steady state annual average corporate tax payment from the Proposal would be in the order of \$70 million.

Royalties would also be paid to the NSW State Government. Based on planned production levels, and current royalty rates (4% of revenue), approximately \$10.5 million (steady state annual average) would be paid annually to the NSW Government. Annual payroll costs are estimated at around \$34 million, and payroll tax would be levied on this amount, also accruing to the State Government.

The Applicant has had initial discussions with Dubbo City Council regarding the establishment and implementation of a *Voluntary Planning Agreement* and to assess the net impact on Dubbo City Council infrastructure and services resulting directly or indirectly from the DZP. Dubbo City Council has requested that negotiations follow assessment of the EIS and socio-economic study.

Based on the above, the operation of the DZP is likely to contribute at least \$115.5 million each year to the public sector. Additional to this sum would be income tax and local rates paid by employees of the Proposal, as well as fuel tax paid by road transport contractors employed to deliver raw materials to the DZP Site and to deliver products produced.

4.15.4.6 Adverse Economic Impacts

It is acknowledged that while the economic benefit for the local area, wider region, many businesses and individuals, there is the potential for some adverse economic impacts as well.

Land Value

DGP (2013), having consulted with local real estate agents, notes that there could be some minor (and one-off) loss of value for some properties which adjoin the rail line. DGP (2013) also notes, however, that all purchasers of affected houses would have known that the rail line had not been closed, but merely dis-used for a time. It is also considered likely that the value of properties on and surrounding the DZP Site, including those in Toongi Village would be affected by the Proposal. The Applicant has either; purchased, entered into contract to purchase or attempted to purchase those properties most likely to be affected by the DZP and therefore incur a reduction in land value. Landowners of properties located further from the DZP Site where impacts are not expected to be significant when compared against established impact assessment criteria, e.g. noise, air emissions, vibration, have been regularly consulted over the proposed operations and a general level of acceptance over the Proposal has been indicated (acknowledging the overall benefits the DZP would bring to the local area and region).

Costs to Other Industry / Employers

With the addition of 250 new jobs, and the proposed objective of the Applicant to employ 85% of the start-up operational workforce from those currently residing in Dubbo or surrounding areas, it is considered likely that individuals would leave existing employment in Dubbo to take up positions with the DZP. DGP (2013) reports that anecdotal evidence is available of Mid-Western Regional Council losing staff to new coal mines within the local area. In other areas of the State, agricultural workers appear to have been attracted by the higher pay and perceived better conditions associated with mining (and construction) jobs, leading to shortages of agricultural workers. Should this occur, the original employer would incur the cost associated with recruitment and training for new (replacement) staff.

While the exact number of 'transferring' employees cannot be accurately estimated, it is considered some of these vacated positions would be filled by existing Dubbo residents who are currently unemployed, underemployed, new to the labour market (e.g. school leavers) or returning to the labour market (e.g. parents returning from maternity/paternity leave). This would reduce the burden on the employer as the prospective employee already resides within the local area.

It is also likely that, in a labour market the size of Dubbo's, this economic impact on local employers would be a one-off as the market adjusts to the entry of a new employer. Furthermore, the potential for business stimulus (an economic benefit) generated by an increase in GVA within the Dubbo LGA is likely to partially offset the impact in the short-term and ultimately provide net benefit in the medium to long-term.

Finally, the Applicant has already engaged with Regional Training Organisations (RTOs) and local educational institutions to create pathways for school leavers and others in the community to reduce the pressure that may otherwise be placed on other established employers (see Section 3.2.2.5). A review of an increased demand for education and training services is discussed further in Section 4.15.5.4

4.15.5 Assessment of Social Impacts

4.15.5.1 Introduction

In addition to the economic impacts that have been assessed for the Proposal, there could be some social impacts on the regional and local community. These impacts could relate to local traffic, demand for infrastructure and services, and amenity values held by the community.

4.15.5.2 Transport

The final decision on the arrangement of transport to and from the DZP Site remains to be confirmed and a range of specialist consultant reports have considered logistical options, costs involved, and construction/rehabilitation requirements of three various combinations of road and rail transport.

Rail

The incorporation of the Toongi-Dubbo Rail Line would have social benefits associated with a reduction in the volume of heavy vehicles using the State Highway and local road network.

Impacts associated with this option include the following.

- Access to the rail easement along Margaret Crescent Dubbo would be restricted. Notably, the rail line has never been officially closed, however, local residents have become accustomed to using this easement for passive recreation pursuits.
- Residents living adjacent to the rail easement would be subjected to rail noise and vibration. As discussed in Section 4.2.7.6, both rail noise and vibration would remain well within the nominated criteria and would only occur a maximum of six times per week (three return trips). Furthermore, modern engineering design and construction of railway line and rolling stock facilitates much quieter train operation than was the case several decades ago. Nonetheless, it is a new noise source which could impact on the amenity of those affected.
- The re-opening of the rail line would necessitate the construction and operation of level crossings within Dubbo. While these would only be closed six times per week, there could be some initial annoyance generated amongst local commuters not accustomed to the closure of these crossings.

The use of the rail line is not considered to have any major impact on future residential land developments in southern parts of Dubbo as the easement has existed since early last century.

Road

Regardless of the incorporation of rail transport, various reagents and other materials and consumables would be transported to the DZP Site by road. To mitigate potential impacts on road condition and safety, the Applicant has committed to a road upgrading program to widen and deepen the pavement and realign various bends along Obley Road. The works would be undertaken in accordance with relevant road design and construction standards and in consultation with Dubbo City Council.

Despite the road upgrade, however, there could be some residual social costs as a result of increased heavy vehicle traffic along the 22km of the Obley Road between Dubbo and Toongi. Such costs could include:

- possible increased travel times;
- possible increase in traffic accidents;
- environmental costs associated with air and noise pollution; and
- potential reduction in property values along the route.

The “tax” component of fuel prices and heavy vehicle registration charges is designed to compensate the general community for such costs. Furthermore, the Applicant’s proposed road re-alignment and pavement upgrades (expenditure of approximately \$15 million) would minimise impacts on road users and property owners adjoining the route. DGP (2013) also reports that the impact of the Cadia Valley Operations (CVO) mine near Orange has not led to a fall in property prices despite the increased traffic and minimal road upgrade.

4.15.5.3 Demand for Infrastructure

4.15.5.3.1 Housing and Accommodation

Construction Phase

The construction workforce is likely to consist of both local residents (employed as short term contracts are issued to local construction operators), and members of the permanent workforces of specialist contractors who may be required for particular tasks associated with the Proposal. The construction workforce would be accommodated (predominantly) in Dubbo and as such there would be a small increase in demand for temporary housing. The specialist contractors who are required to come to the site for short periods would be accommodated in the extensive tourist facilities available in Dubbo. It is noted that the (indefinite) postponement of the Cobbora Coal Project should lessen the potential for excessive demand for temporary accommodation over the construction period.

A consequence of the creation of some longer-term construction positions, could be an increase in demand for rental accommodation for periods of between 12 and 18 months. This could place upward pressure on rents charged by landlords in response to increased demand. DGP (2013) reports that data available from the Real Estate Institute of NSW (REINSW), in a submission to DCC in January 2013, indicates that although there have been public expressions of concern over rising rents in Dubbo, trends in rents, sales, and bonds indicate a broad decline in all housing sectors. REINSW suggests this reflects a “deep seated structural decline in the Dubbo economy”. DGP (2013) reports that a recent trend of increasing rental prices, observed by REINSW, suggests a lack of sufficient residential housing choices for investors. The Proposal could, in fact, provide a stimulus for future land releases which would provide for the residential housing choices currently lacking or restricted in the current market and potentially result in reduced rental prices as more accommodation becomes available.

Operations Phase

The Applicant has targeted 85% local employment and as such the Proposal would generate some new, but not significant, ‘direct’ demand for housing. As local residents transfer from existing employment in Dubbo to take up positions with the DZP, some of these vacated positions would be filled by existing Dubbo residents who are currently unemployed, underemployed, new to the labour market (e.g. school leavers) or returning to the labour market (e.g. parents returning from maternity/paternity leave). However, a proportion of these positions would have to be filled by new residents attracted to move to Dubbo to fill these vacancies, resulting in a subsequent increase in demand for new housing via this “flow-on” effect.

DGP (2013) notes that this increased demand is likely to be created over an extended period, i.e. there will be a progressive rather than immediate filling of vacated positions. DGP (2013) also reports that discussion with representatives of the Orana Division of REINSW indicates that around 550 to 660 houses are sold, on average, each year in Dubbo. This pattern of sales suggests that the Dubbo housing market could accommodate up to 10 new purchasers each month, more than sufficient for the likely increase generated by the Proposal.

There could also be a potential impact on rental accommodation and pricing, in part due to an increase in demand driven by new residents to Dubbo taking up positions at the DZP or positions vacated by Dubbo residents. However, it is considered that the Proposal would only be a minor contributor to any added pressure on rental accommodation (given the overall size

of Dubbo and the Dubbo rental market). The primary factor affecting rental accommodation and prices is likely to be the availability of residential housing choices for investors. While this is beyond the control of the Applicant, the Proposal could ultimately have a beneficial impact as a stimulus for future land releases which could ease any reduction in available rental accommodation.

It is therefore considered likely that any new demand for housing could be accommodated within existing stock. Furthermore, the Proposal could provide a stimulus for greater investment in rental accommodation which would ultimately be beneficial for those currently in or seeking rental accommodation within Dubbo.

4.15.5.3.2 Other Social Infrastructure

For similar reasons as discussed for accommodation,, no big increase in demand is expected for other social infrastructure such as schools and hospitals. With the Cobbora Coal Project having been placed on hold, there is no other new project of a comparable size planned for the Dubbo area that would attract new residents. Existing residents (within 70km of the DZP Site) would fill most of the operational jobs created by the DZP, and new residents (coming in to fill vacancies in other sectors where people have opted to leave employment to take up positions with the DZP) would be gradually absorbed into the community. It is also noted that the Applicant has committed to the development and implementation of a VPA with Dubbo City Council, which would include upgrades to Obley and Toongi Roads of at least \$15 million, to offset or compensate for any increased demand on local services and infrastructure.

4.15.5.3.3 Industrial Infrastructure (Utilities)

Operation of the DZP would require utility infrastructure such as power (electricity) and potable water. Easements to establish these services to the DZP Site have been identified as a component of the Applicant's development application. The volumes of water required for operations of the DZP would be purchased via acquisition of entitlements, drawn from the Macquarie River. As discussed in Section 4.15.4.1, and the AIS (see **Appendix 9**), there is not expected to be any impact on neighbouring water users as a result of the DZP.

Electricity would be purchased from the NSW grid and delivered via a proposed new 132kV electricity transmission line from Geurie (which would be assessed and approved separately under Part 5 of the EP&A Act).

Compressed natural gas would be delivered to the DZP Site via a spur line to be developed, under licence issued in accordance with the *Pipelines Act 1967*.

4.15.5.4 Demand for Services

Based on the employment target of 85% local residents established by the Applicant, the Proposal would be unlikely to cause a major inflow of new residents to the area which could have the potential to increase demand for services.

An exception could be an increase in demand for local educational or training services within the region so that school leavers, or those wishing to transfer from current employment to the mining sector, obtain the appropriate skills. In recognition of this, the Applicant has engaged

with Regional Training Organisations (RTOs) and local educational institutions over several years with the aim of preparing Dubbo to supply a locally skilled workforce.

- During 2012 and 2013 the Applicant has engaged with Region 21 Governing Committee which facilitates partnerships between schools, business and community so that communities are empowered and have access to quality education, training and employment opportunities.
- The Applicant has also consulted with the Central West Mining Steering Committee, coordinated by Tony Fuller (Regional Coordinator Aboriginal Affairs – DEC). The Applicant's General Manager NSW also met with Regional Vocational Education Consultant, Mr Wade Greenwood on 30 July 2013 to discuss methods to ensure information on future job opportunities to be provided by the Proposal and skills requirements could be best disseminated to both prospective employees and training providers.
- The Applicant also hosted a visit to the pilot plant at the ANSTO Lucas Heights facility, with representatives of RTOs attending to gain an understanding as to the likely skills required of the workforce.

It is also noted that NSW TAFE (Dubbo Campus) currently provides targeted training to satisfy the requirements for the Applicant's workforce at the Tomingley Gold Mine and the technical training requirements specific to the industrial processing operations of the Proposal have been discussed on several occasions.

The above illustrates that the Applicant recognises the potential increase in demand for education and training tailored to the mining sector and has commenced negotiations with appropriate RTO's to ensure that relevant education and training is available locally. This notwithstanding, any costs borne by the local economy for training would likely be offset, at least partially, by the added economic stimulus the Proposal is likely to provide to the region (see Section 4.15.4).

Furthermore, any increased pressure on local services generally, generated by the Proposal, would be considered and included in negotiations with Dubbo City Council as part of the development of a VPA.

4.15.5.5 Amenity Values

Toongi

The Proposal would result in the construction of processing facilities and a rail laydown and container storage area adjacent to the rail line at Toongi. This would cause some change in visual amenity for local residents, particularly the few houses located on the western side of Obley Road near the Toongi turn-off. Section 4.13 provides a detailed review of the likely impact of the Proposal on visual amenity, including representative views of the operations. These residents have been interviewed during the preparation of the EIS, and have expressed an understanding of the nature of the operations. Furthermore, the Applicant has either purchased or entered into agreement to purchase the properties of Toongi, recognising the large change in setting to be created by the Proposal.

The acceptance of changes to visual amenity notwithstanding, the Applicant would construct earth bunding and undertake tree plantings west of the processing plant to minimise visual impacts from the Obley Road.

Obley Road

An increase in road traffic would have the greatest impact on the current amenity of the properties west of the Toongi Road intersection with the Obley Road. The Applicant is committed to managing the transport contractors to ensure that a fuel efficient and quietly operated fleet is engaged for the freight tasks.

Residents along Obley Road further north from Toongi would experience an increased volume of heavy vehicles along this road. To the extent that some residences may have views of the road, there could be some loss of visual amenity, and some noise impacts. However, major expenditure by the Applicant in upgrading this road, with accompanying increased amenity for local residents in terms of road safety and travel times, could be seen as providing some compensation for any such loss.

Margaret Crescent

Residents in the Margaret Crescent area adjoining the Dubbo-Molong Rail Line may also consider that they would experience some amenity loss as a result of the Proposal. These residents have become accustomed to using the rail corridor as a walking track, and in some cases have planted trees and other vegetation to attract birds to the area. In addition to noise impacts, this ready access to the corridor would be restricted should the rail transport option be selected by the Applicant. Efforts would be made to restrict train movements (should rail be used) to acceptable hours to minimise noise disturbance for these residents. While the Applicant acknowledges that some residents could be unhappy with this perceived amenity loss, it should be noted that:

- a) the rail line has never been de-commissioned, so use of the line was always possible and residents should have been aware of this when they purchased their properties; and
- b) use of the rail would reduce the need for heavy vehicle traffic moving through Dubbo.

4.15.5.6 Land Use

The Proposal would undoubtedly represent a major change in local land use. However, by providing opportunities for those likely to be most affected to move following purchase of their properties, and mitigating impacts on local amenity, the impact of this change in land use would be minimised.

Furthermore, the Applicant has aimed to maximise the potential for the DZP Site and surrounding lands for ongoing agricultural activities. The Agricultural Impact Statement, provided as **Appendix 9**, provides a detailed analysis of the impact of the proposal on this industry.

4.15.5.7 Cumulative Impacts

It is noted that the proposed Cobbora Coal Project (planned to supply coal to NSW power stations in 2015/2016) could place additional pressure on the delivery of services and infrastructure within Dubbo if developed concurrently with the DZP. However, the NSW government recently placed the Cobbora Coal Project on hold with Treasurer Mike Baird quoting the high cost of development (\$1.5 billion) (Dubbo Daily Liberal, 12 November 2012) as the determining factor.

As a result, the potential for excessive demand for accommodation and other services and infrastructure (most relevant during construction when the total workforce and proportion requiring temporary accommodation would be at its highest) would be lessened and more gradual given construction for the Cobbora Coal Project would be more likely to coincide with the operations phase of the DZP.

4.15.6 Conclusion

This assessment of the social and economic impacts of the Proposal has indicated that the overall impact on the regional community would be beneficial. Jobs would be created for local residents, and a mineral resource accessed that would allow Australia to enter into the global market for raw materials required by a range of “high tech” industries.

There would be a change in land use (temporary for part of the DZP Site, and permanent for a smaller area) in the local area, with a corresponding loss in the value of agricultural production. This loss would be off-set by a very much greater increase in the value of output from the DZP Site, and this would assist in meeting the economic development goals of the Dubbo region. Negative socio-economic impacts would also be off-set, to varying degrees according to personal values and circumstances, by the acquisition of houses and farms affected by the Proposal.

It is acknowledged that converting a relatively quiet rural setting into an industrial scale mineral processing facility is a significant change. Change by its nature impacts every person in different ways. Students at school may look at the DZP as a long term career opportunity, local workers may see an opportunity to re-train and take on new skills and retirees may see the proposal in an entirely different light. Negative impacts would be concentrated more in the local area, but would be out-weighed by the larger regional benefits. In addition, the Applicant proposes to take steps to minimise local socio-economic costs via major expenditure on local road upgrade, the purchase of affected local houses and farms, and the use of landscaping measures to minimise visual impacts.

A new intensive industry and employer (AZL) in the Dubbo LGA would increase the level of diversification in the local economy, in accordance with the defined goals of Dubbo City Council’s economic development strategy (DCC, 2012).

On balance, the Proposal is assessed as providing significant net economic and social benefits to the region.