MOOLARBEN COAL PROJECT

SECTION 5

Existing Environment and Interactions

SECTION 5

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5 EXISTING ENVIRONMENT AND INTERACTIONS

5.1 Introduction

This section of the EA report provides an overview of the existing environment associated with the MCP. The general identification, analysis of impacts (including cumulative impacts) and mitigation measures proposed for the MCP are contained in this section.

For those persons seeking a greater understanding of particular aspects associated with the MCP and the environment, your attention is drawn to the specialist studies contained in **Volumes 1, 3, 4** and **5**.

5.2 Climate

A summary of the area's climatic conditions is provided below. Detailed information on the area's climate is contained in **Appendix 3 – Air Quality**.

5.2.1 Rainfall

Rainfall in the area is variable, with an average of 610mm per annum at Ulan. Rainfall occurs throughout the year with a slightly higher seasonal distribution in summer. Intense showers, particularly in summer, characterize much of the rainfall and account for falls of up to 130mm in 24 hours.

5.2.2 Temperature

Hot weather is experienced in the area from October to April, with average maxima ranging from the high twenties to the low thirties. During the summer months, very hot conditions occur with temperatures ranging from 32^{o}C to more than 38^{o}C are not uncommon during these periods.

Conditions during the other months of the year are milder, with average winter maxima about 10^{o}C cooler than summer temperatures. Overnight temperatures occasionally drop below freezing point.

5.2.3 Winds

On an annual basis, the most common winds for the area are generally from the west and east with some winds from the northeast and east-northeast near Ulan and from the southwest in the south of the MCP area. This pattern of winds is evident in all seasons with winds from the west being more common in winter and spring.

5.2.4 Frosts

Frosts may occur from mid-April through to September and as late as mid-November. For the Ulan area, the average frequency of frosts is about 45 days per annum.

5.2.5 Sunshine and Evapotranspiration

The average number of hours of bright sunshine per day in summer months is 9 hours and in the winter months 6 hours. The average annual evapotranspiration of the Ulan area is about 1730mm.

5.2.6 Humidity

The average relative humidity varies throughout the year, the winter months are typically about 20% more humid then in the summer months, most likely due to the hot dry winds during summer. During the daytime humidity varies significantly between 60 to 80% in the mornings and 40 to 60% in the afternoons for summer and winter respectively. There is little change in the relief of the humidity from mornings to afternoons throughout the year.

5.2.7 Weather Stations

Having regard to the local topographic, climatic conditions and elongated north-south extent of EL 6288 a decision was made to install two weather stations, one in the village of Ulan (WS1) and the other in the southern portion of the area on the Rayner property (WS2).

Both the weather stations have been installed to Australian Standard (AS) 2922. Each station measures and records wind speed and direction, temperature at 2m and 10m, atmospheric pressure and inversions, sigma theta, rainfall and total solar radiation at 10m.

The two weather stations form an integral component in the assessment of baseline environmental conditions prevailing in the area. Baseline monitoring of air quality, surface waters, ground waters, and acoustical conditions have been on-going since December 2004 for the MCP. The monitoring locations are shown in **Figure 5.1** and **Plan 13** in **Volume 2**.

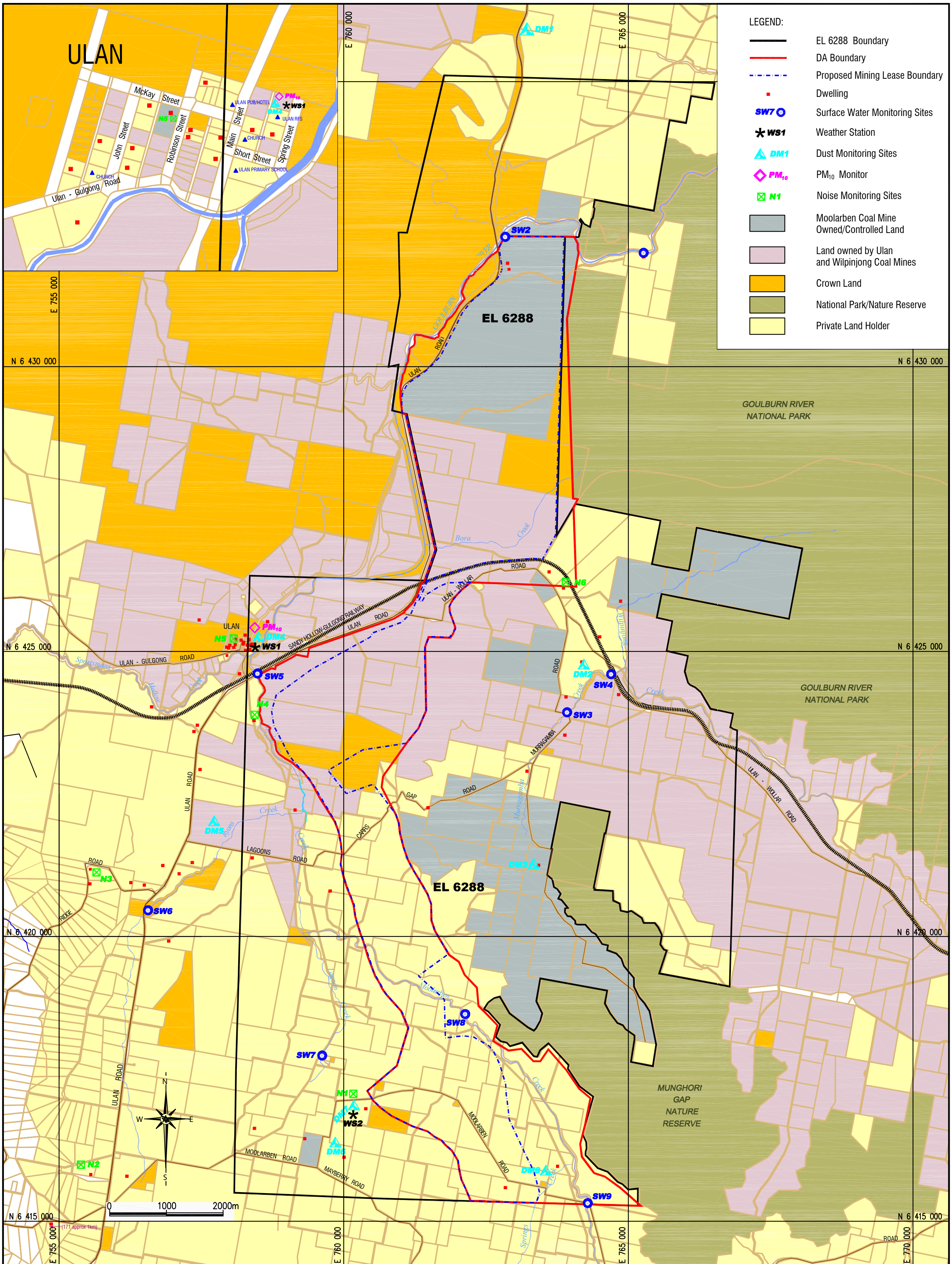
5.3 Air Quality

5.3.1 Existing Air Quality

Air quality in the area around the MCP has been monitored since January 2005 using a network of eight dust deposition monitors operated in accordance with Australian Standard 2222 and a PM_{10} monitor operated in accordance with Australian Standard 2222. The locations of the monitoring sites are shown in Figure 5.1.

These monitors measure the existing dust deposition and PM_{10} concentration levels in the air due to emissions from all sources that contribute to dust in the air. These sources would include emissions from existing mining at the Ulan open cut and underground mines and emissions from agriculture, gravel quarries and natural emission sources in the area.

The results of monitoring show that dust deposition is low and taken to be 1.4g/m^2/month. Total Suspended Particulates (TSP) measured by Ulan Coal Mines Pty Limited at property R46(a) had an annual average of 39μg/m^3, whilst PM_{10} concentrations averaged 13.3μg/m^3 and the maximum concentration was 15.6μg/m^3.



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Environmental Baseline Monitoring Locations

Figure 5.1

CAD FILE: Figure 5.1

5.3.2 Statutory Guidelines and Goals

This section provides information on the air quality criteria used to assess the impact of the MCP air emissions. The assessment criteria provide benchmarks, which if met, are intended to protect the community against adverse effects of air pollutants.

Table 5.1 and **Table 5.2** summarise the air quality goals that are relevant to the MCP. The air quality goals relate to the total dust burden in the air and not just the dust from the project.

Table 5.1: Air quality standards/goals for particulate matter concentrations

Pollutant	Standard / Goal	Averaging Period	Agency
Total suspended particulate matter (TSP)	90μg/m^3	Annual mean	NHMRC
Particulate matter < 10μm (PM_{10})	50μg/m^3	24-hour maximum	NSW EPA
	30μg/m^3	Annual mean	NSW EPA (long-term reporting goal)
	50μg/m^3	(24-hour average, 5 exceedences permitted per year)	NEPM
μg/m^3 – micrograms per cubic metre μm - micrometer			

Table 5.2: DEC criteria for dust (insoluble solids) fallout

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

5.3.3 MCP Air Quality Impacts

5.3.3.1 Approach to Dust Modelling

MCM engaged Holmes Air Sciences to undertake an assessment of the MCP on air quality, greenhouse gas emissions and human health. Copies of the reports are contained in **Appendix 3** and **Appendix 3A**.

Holmes Air Sciences undertook modelling of the MCP based on a modified version of the US EPA ISC model. For the study, the MCP operations were represented by a series of volume sources relative to the location of mining activities for the modelled scenario or year. Modelling also had regard to background air quality data, dust emission rates for each activity, climate and location of receptors.

Air modelling was undertaken for the MCP for years 2, 5, 8 and 10, which represent the most significant dust generation activities for the MCP. These years cover impacts arising for a range of product coal and overburden qualities for various mining activities in a range of locations. The estimated emissions (used within the model) take account of proposed air pollution controls, including passive controls such as those inbuilt into the mine plan, e.g. stockpile size and alignment and length of haul roads, and active controls, which include dust suppression, watering and rehabilitation. A qualitative assessment was undertaken for the construction phase of the project.

5.3.3.2 Dust

An air quality impact assessment for the MCP area has been undertaken for years 2, 5, 8 and 10 for:-

- Maximum 24-hour PM_{10} concentrations;
- Annual average PM_{10} concentrations;
- Average TSP concentrations; and
- Annual average dust (insoluble solids) deposition rates.

The significance of the predicted levels has been assessed by comparing the values to the air quality standards and goals contained in Tables 5.1 and 5.2 above.

All residences located in areas where annual average concentration or deposition levels are predicted to exceed the DEC assessment criteria have been assessed as being impacted by the MCP and MCM will seek to enter into negotiated agreements with the owners.

There are a significant number of residences that are predicted to experience 24-hour average PM_{10} concentrations above the DEC's 50µg/m^3 assessment criterion. In principle, short-term impacts can be managed by real-time management strategies in which modifications to mining operations will be made to accommodate changing weather conditions. It is proposed that a plan be established for the MCP.

Figures 5.2, 5.3, 5.4 and **5.5** and **Plans 14, 15, 16 and 17** in **Volume 2** display the results of modelling, whilst a summary is provided below for each of the modelled years.

Year 2

In Year 2 mining will be occurring in Open Cut 1. Open Cut 1 will be advancing to the north and overburden emplacement will be occurring behind the environmental bund and in the pit on the southern edge.

Modelling has predicted that 33 residences may experience some days where the 24-hour average PM_{10} concentration exceeds the DEC's 50µg/m^3 assessment criterion (refer to **Table 5.3**). Two residences (R25 and R46a) are predicted to exceed the DEC's annual average PM_{10} criterion of 30µg/m^3. No other assessment criteria are predicted to be exceeded.

Table 5.3: Summary of Predicted Air Quality Exceedances for Year 2.

ID No.	Project in isolation				Project with background (cumulative)			
	24-hour PM_{10} (µg/m^3)	Annual average PM_{10} (µg/m^3)	Annual average TSP (µg/m^3)	Annual average (insoluble solids) dep. (g/m^2/mth)	24-hour PM_{10} (µg/m3)	Annual average PM_{10} (µg/m^3)	Annual average TSP (µg/m^3)	Annual average (insoluble solids) dep. (g/m^2/mth)
R46A	**74.3**	14.9	30.3	1.5	n/a	**31.5**	70.3	2.9
R49	**63.3**	9.5	17.5	1.0	n/a	26.1	57.5	2.4
R9	**115.9**	6.9	10.9	0.5	n/a	23.5	50.9	1.9
R22	**60.7**	2.6	3.3	0.1	n/a	19.2	43.3	1.5

ID No.	Project in isolation				Project with background (cumulative)			
	24-hour PM_{10} (μg/m^3)	Annual average PM_{10} (μg/m^3)	Annual average TSP (μg/m^3)	Annual average (insoluble solids) dep. (g/m^2/mth)	24-hour PM_{10} (μg/m3)	Annual average PM_{10} (μg/m^3)	Annual average TSP (μg/m^3)	Annual average (insoluble solids) dep. (g/m^2/mth)
R46B	**71.2**	4.8	7.8	0.3	n/a	21.4	47.8	1.7
R23	**54.0**	2.3	2.9	0.1	n/a	18.9	42.9	1.5
R20	**56.6**	2.8	3.5	0.1	n/a	19.4	43.5	1.5
R160A	**78.5**	9.8	18.7	0.8	n/a	26.4	58.7	2.2
R25	**156.9**	28.0	60.9	3.6	n/a	**44.6**	**100.9**	**5.0**
R7	**74.2**	3.4	5.4	0.3	n/a	21.0	46.4	1.7
R46E	**70.2**	6.7	12.0	0.5	n/a	23.3	52.0	1.9
R162	**77.5**	8.3	15.1	0.6	n/a	24.9	55.1	2.0
R26	**62.8**	10.4	19.6	1.1	n/a	27.0	59.6	2.5
R161	**78.1**	9.0	16.8	0.7	n/a	25.6	56.8	2.1
R160B	**77.4**	9.9	18.9	0.8	n/a	26.5	58.9	2.2
R148	**79.3**	9.0	17.0	0.7	n/a	25.6	57.0	2.1
R167	**78.9**	8.8	16.5	0.7	n/a	25.4	56.5	2.1
R165	**75.7**	8.0	14.5	0.6	n/a	24.6	54.5	2.0
R159	**77.1**	9.0	16.5	0.7	n/a	25.6	56.5	2.1
R41C	**77.3**	8.7	15.9	0.7	n/a	25.3	55.9	2.1
R157	**76.1**	8.6	15.6	0.6	n/a	25.2	55.6	2.0
R154	**74.4**	8.8	15.7	0.7	n/a	25.4	55.7	2.1
R155	**74.8**	9.4	17.1	0.7	n/a	26.0	57.1	2.1
R156	**74.4**	9.9	18.0	0.8	n/a	26.5	58.0	2.2
R153	**73.5**	9.7	17.5	0.8	n/a	26.3	57.5	2.2
R150	**72.8**	10.0	18.0	0.8	n/a	26.6	58.0	2.2
R168	**78.7**	9.1	17.0	0.7	n/a	25.7	57.0	2.1
R151	**73.3**	10.1	18.2	0.8	n/a	26.7	58.2	2.2
R158	**71.7**	11.6	21.1	1.0	n/a	28.2	61.1	2.4
R46F	**65.4**	8.1	12.9	0.5	n/a	24.7	52.9	1.9
R169	**51.9**	8.2	14.2	0.7	n/a	24.8	54.2	2.1
R41A	**61.6**	2.5	3.2	0.1	n/a	19.1	43.2	1.5
R57	**61.6**	2.5	3.2	0.1	n/a	19.1	43.2	1.5
*Residences in bold are predicted to exceed the DEC's air quality criteria.								

Year 5

In Year 5 mining will be occurring in the northern end of Open Cut 1. The pit will be advancing to the north and overburden emplacement will be occurring in pit and out of pit.

Modelling has predicted that 33 residences will experience some days where the 24-hour average PM_{10} concentration exceeds the DEC's 50μg/m^3 assessment criterion (refer to **Table 5.4**). One residence (R12) is predicted to experience annual average PM_{10} concentrations marginally above the DEC's assessment criterion of 30μg/m^3. No other assessment criteria are predicted to be exceeded.

Table 5.4: Summary of predicted air quality impacts for Year 5.

ID No.	Project in isolation				Project with background (cumulative)			
	24-hour PM_{10} (µg/m³)	Annual average PM_{10} (µg/m³)	Annual average TSP (µg/m³)	Annual average (insoluble solids) dep. (g/m²/mth)	24-hour PM10 (µg/m³)	Annual average PM_{10} (µg/m³)	Annual average TSP (µg/m³)	Annual average (insoluble solids) dep. (g/m²/mth)
R46A	**95.5**	5.4	8.3	0.4	n/a	22.0	48.3	1.8
R49	**82.9**	3.5	4.6	0.2	n/a	20.1	44.6	1.6
R9	**95.1**	3.0	3.8	0.1	n/a	19.6	43.8	1.5
R46B	**54.5**	2.3	2.7	0.1	n/a	18.9	42.7	1.5
R160A	**65.3**	7.1	12.2	0.7	n/a	23.7	52.2	2.1
R25	**149.5**	5.1	6.9	0.2	n/a	21.7	46.9	1.6
R16	**61.6**	4.3	6.8	0.3	n/a	21.9	47.8	1.7
R46C	**69.9**	3.1	4.9	0.2	n/a	20.7	45.9	1.6
R46D	**65.7**	3.9	6.2	0.3	n/a	21.5	47.2	1.7
R14	**68.2**	4.7	7.1	0.4	n/a	22.3	48.1	1.8
R12	**171.0**	12.7	18.7	0.8	n/a	**30.3**	59.7	2.2
R13	**126.8**	9.3	14.1	0.7	n/a	25.9	54.1	2.1
R15	**65.0**	4.6	7.1	0.4	n/a	22.2	48.1	1.8
R46E	**86.2**	12.0	21.8	1.2	n/a	28.6	61.8	2.6
R162	**57.9**	8.0	13.9	0.8	n/a	24.6	53.9	2.2
R26	**83.5**	3.6	4.9	0.2	n/a	20.2	44.9	1.6
R161	**58.8**	7.3	12.6	0.7	n/a	23.9	52.6	2.1
R160B	**63.0**	6.8	11.5	0.6	n/a	23.4	51.5	2.0
R148	**63.9**	7.8	13.6	0.7	n/a	24.4	53.6	2.1
R167	**60.9**	7.8	13.5	0.7	n/a	24.4	53.5	2.1
R165	**57.2**	8.1	14.1	0.8	n/a	24.7	54.1	2.2
R159	**56.4**	7.2	12.4	0.7	n/a	23.8	52.4	2.1
R41C	**55.2**	7.3	12.7	0.7	n/a	23.9	52.7	2.1
R157	**55.1**	7.5	12.9	0.7	n/a	24.1	52.9	2.1
R154	**55.0**	7.4	12.6	0.7	n/a	24.0	52.6	2.1
R155	**56.3**	6.9	11.7	0.6	n/a	23.5	51.7	2.0
R156	**57.8**	6.7	11.3	0.6	n/a	23.3	51.3	2.0
R153	**55.6**	6.7	11.3	0.6	n/a	23.3	51.3	2.0
R150	**55.6**	6.5	10.8	0.6	n/a	23.1	50.8	2.0
R168	**61.6**	7.6	13.1	0.7	n/a	24.2	53.1	2.1
R151	**56.6**	6.5	10.8	0.6	n/a	23.1	50.8	2.0
R158	**59.7**	5.6	9.1	0.5	n/a	22.2	49.1	1.9
R169	**52.9**	3.0	4.3	0.2	n/a	19.6	44.3	1.6
*Residences in bold are predicted to exceed the DEC's air quality criteria.								

Year 8

In Year 8 mining will be occurring in Open Cuts 2 and 3. Overburden emplacement will be occurring within both pits and in and out of pit emplacement areas, together with ROM coal haulage.

Modelling has predicted that two residences will experience some days where the 24-hour average PM_{10} concentration exceeds the DEC's 50µg/m³ assessment criterion. In addition, it is predicted that one residence (R5) will exceed the 30μg/m^3 annual average PM_{10} criterion (refer to **Table 5.5**. No other assessment criteria are predicted to be exceeded.

Table 5.5: Summary of predicted air quality impacts for Year 8.

ID No	Project in isolation				Project with background (cumulative)			
	24-hour PM_{10} (μg/m^3)	Annual average PM_{10} (μg/m^3)	Annual average TSP (μg/m^3)	Annual average (insoluble solids) dep. (g/m^2/mth)	24-hour PM_{10} (μg/m^3)	Annual average PM_{10} (μg/m^3)	Annual average TSP (μg/m^3)	Annual average (insoluble solids) dep. (g/m^2/mth)
R5	**91.7**	15.8	33.3	1.9	n/a	**32.4**	73.3	3.3
R7	**54.9**	6.3	9.1	0.3	n/a	23.9	50.1	1.7
*Residences in bold are predicted to exceed the DEC's air quality criteria.								

Year 10

In Year 10 mining will be occurring at Open Cut 3. Overburden emplacement will be occurring in pit and out of pit emplacement areas, together with ROM coal haulage.

Modelling has predicted that six residences will experience some days where the 24-hour average PM_{10} concentration exceeds the DEC's 50μg/m^3 assessment criterion (refer to **Table 5.6**). In addition it is predicted that two residences (R29A and R29B) will be severely impacted in terms of air quality criteria.

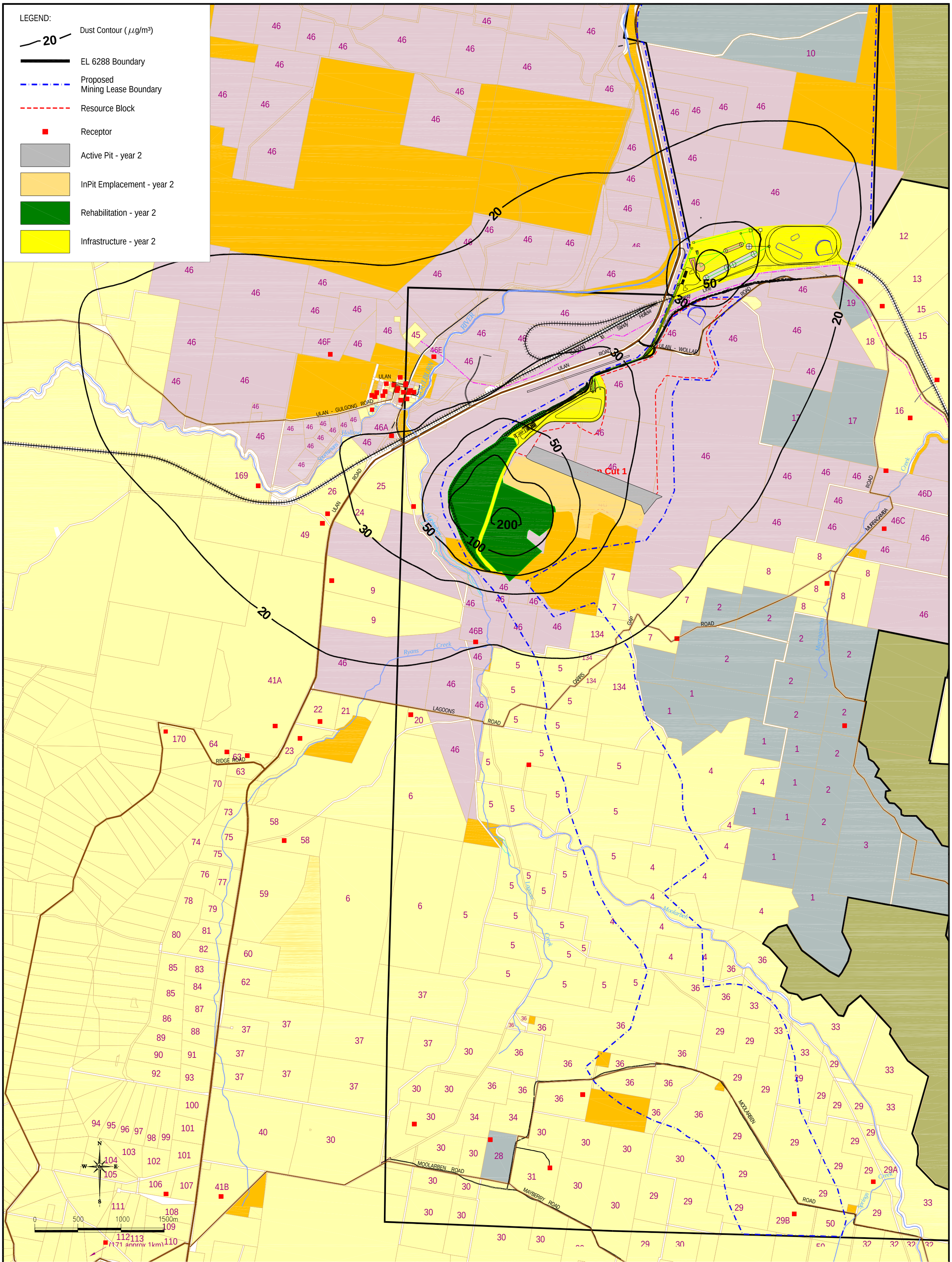
Table 5.6: Summary of predicted air quality impacts for Year 10

ID No.	Project in isolation				Project with background (cumulative)			
	24-hour PM_{10} (μg/m^3)	Annual average PM_{10} (μg/m^3)	Annual average TSP (μg/m^3)	Annual average (insoluble solids) dep. (g/m^2/mth)	24-hour PM_{10} (μg/m^3)	Annual average PM_{10} (μg/m^3)	Annual average TSP (μg/m^3)	Annual average (insoluble solids) dep. (g/m^2/mth)
R31	**75.4**	6.3	12.1	0.8	n/a	22.9	52.1	2.2
R36	**68.6**	11.0	19.0	1.0	n/a	27.6	59.0	2.4
R30	**50.7**	4.4	7.7	0.5	n/a	21.0	47.7	1.9
R29A	**246.3**	19.1	44.3	**3.2**	n/a	**35.7**	84.3	**4.6**
R29B	**468.4**	59.9	128.3	**7.2**	n/a	**76.5**	**168.3**	**8.6**
R28	**64.9**	5.4	10.3	0.7	n/a	22.0	50.3	2.1
*Residences in bold are predicted to exceed the DEC's air quality criteria.								

5.3.3.3 Greenhouse Gas Emissions

The most significant gases for the MCP are carbon dioxide (CO_2) and nitrous oxide (N_2O), which will be liberated when fuels are burnt in diesel powered equipment, and in the generation of electrical energy that will be used by the project.

The MCP will also give rise to emissions of methane (CH_4) and CO_2 that are currently held or trapped in the coal in the open cut mines and from the underground mine ventilation air. The gases are released as fugitive emissions as the coal is mined.



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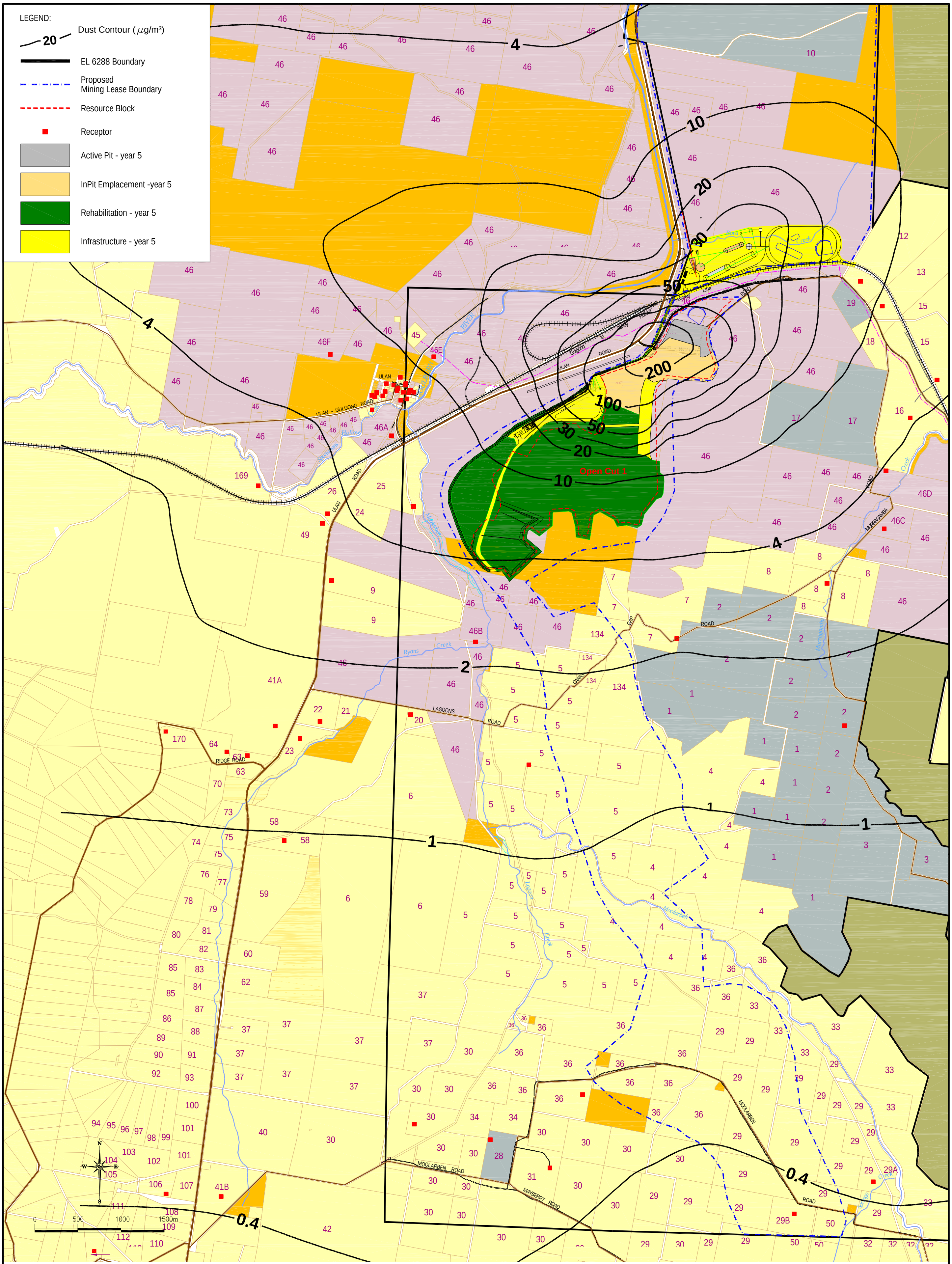
Moolarben Coal Project

Year 2 - Predicted Annual Average PM10 Dust Emissions

HOLMES AIR SCIENCE

Figure 5.2

CAD FILE:Figure 5.2



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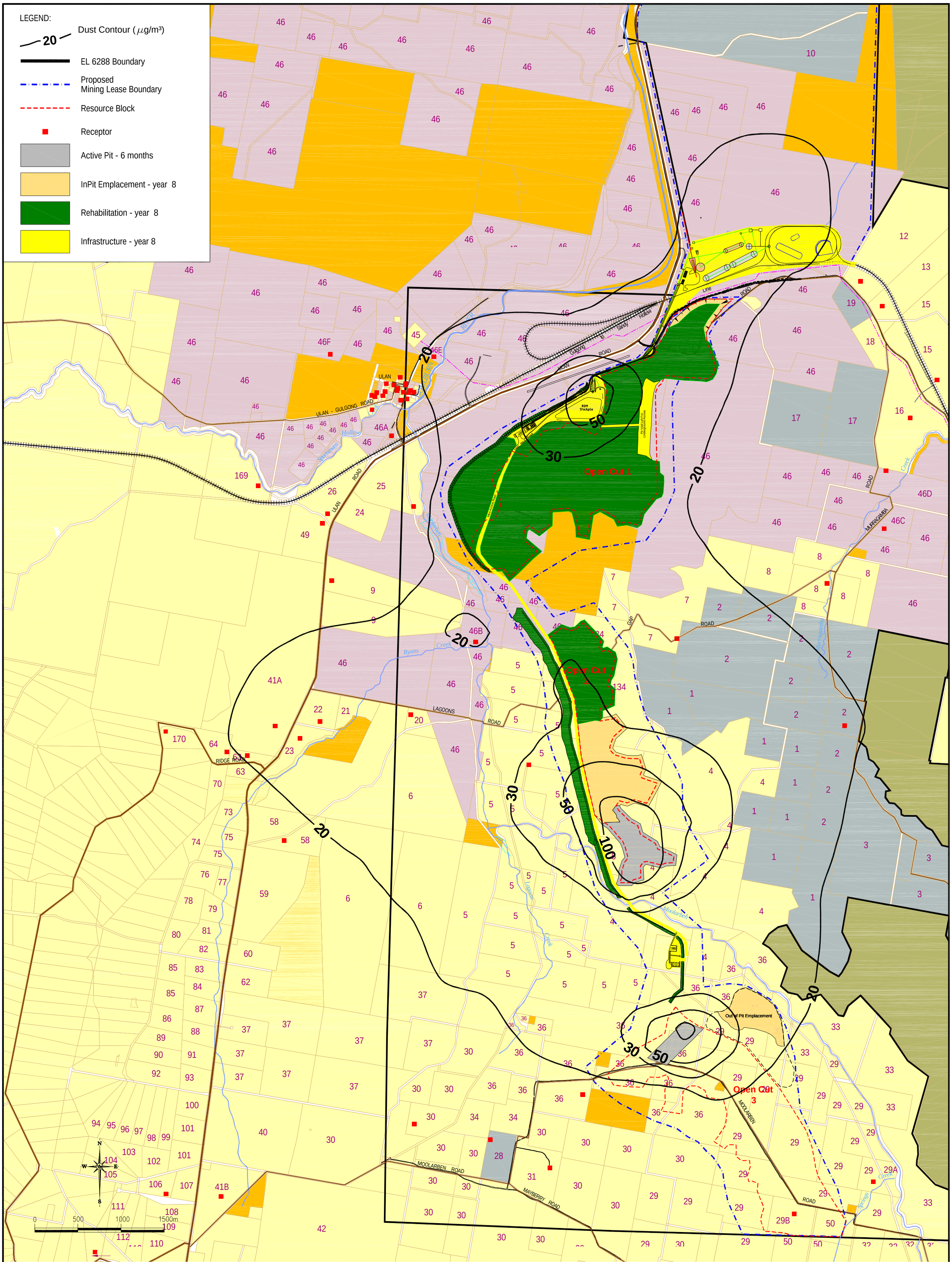
Moolarben Coal Project

Year 5 - Predicted Annual Average PM10 Dust Emissions

HOLMES AIR SCIENCE

Figure 5.3



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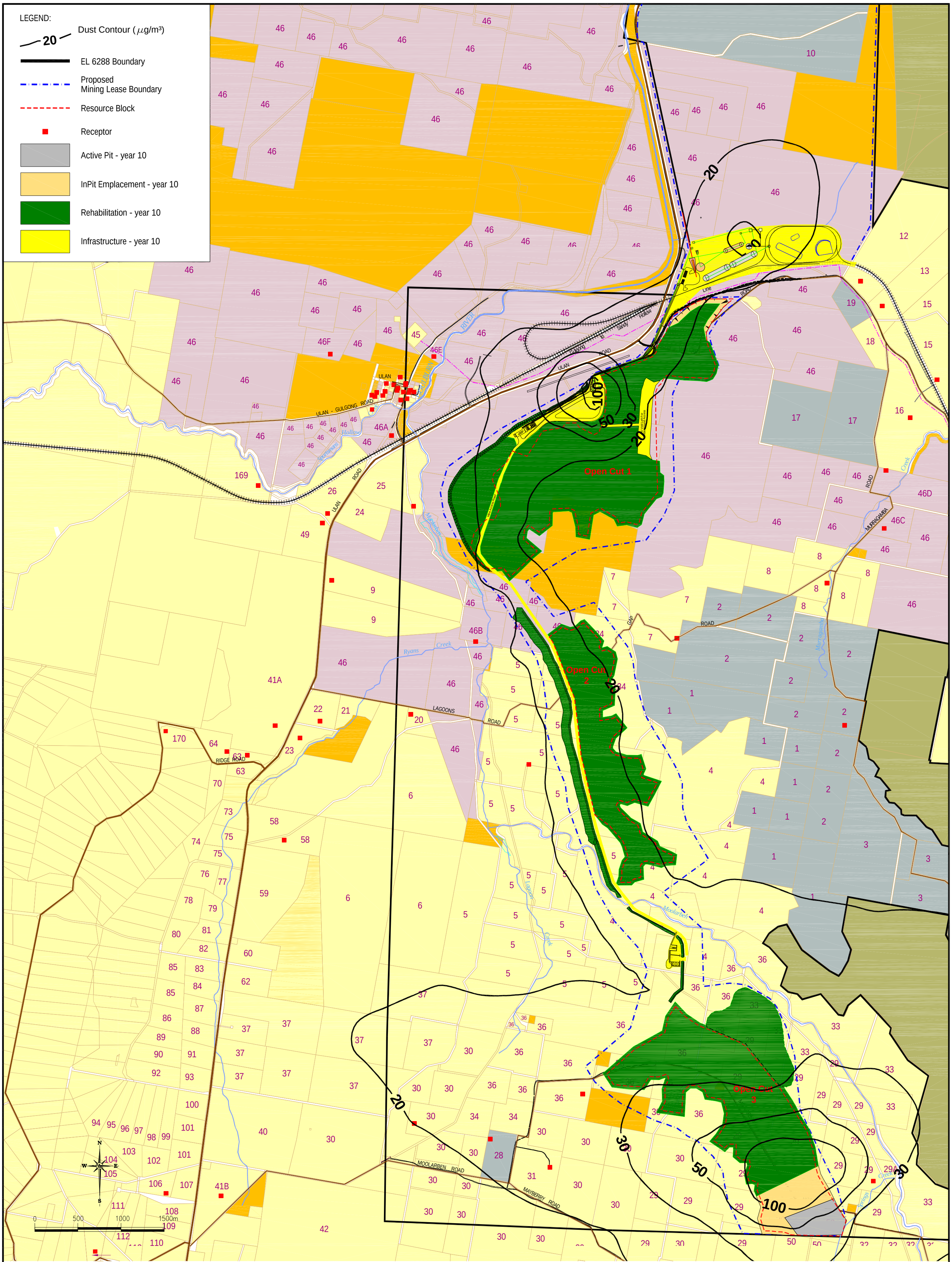
Moolarben Coal Project

Year 8 - Predicted Annual Average PM10 Dust Emissions

HOLMES AIR SCIENCE

Figure 5.4



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Moolarben Coal Project

Year 10 - Predicted Annual Average PM10 Dust Emissions

HOLMES AIR SCIENCE

Figure 5.5

CAD FILE: Figure 5.5

The project will liberate greenhouse gases as a result of the combustion of diesel fuel to power earthmoving equipment and the use of electrical energy. The MCP will consume approximately 12ML/year of diesel and approximately 74,000MWh of electrical energy per year.

Greenhouse gas emissions from the consumption of energy for mining will be 112,220,000kg of CO_2-equivalent per year. The average annual greenhouse gas emissions from methane (CH4) liberated as the coal is mined is 272,400,000kg of CO_2 equivalent per year. Total annual emissions of CO_2 equivalent will be approximately 384,620,000kg/year.

5.3.3.4 Spontaneous Combustion

Coal reacts with atmospheric oxygen even at ambient temperatures and this reaction is exothermic. If the heat liberated during that process is allowed to accumulate, the rate of the above reaction increases exponentially and there is a further rise in temperature. When this temperature reaches the ignition temperature of coal, the coal starts to burn and the phenomena is described as spontaneous combustion.

Spontaneous combustion can occur when the coal is still in the ground or after it has been extracted, either in stockpile or in reject materials. Spontaneous combustion of insitu coal results in hazardous conditions for mining due to the production of noxious gases, odour and fire in extreme cases.

5.3.4 MCP Air Quality Safeguards and Mitigation

5.3.4.1 Dust

The Ulan village and Ridge Road rural-residential areas are located in close proximity to the MCP and are in the direction of prevailing winds. As such, it is necessary that dust emissions are kept to a minimum practicable level.

Dust generated during the construction phase of the project will not be significant and can be controlled by water spray from water carts.

Potential air quality impacts for the MCP will be reduced through mine design, management and through the selection of appropriate operational processes.

Mine design and management considerations for the MCP include:

- Refinement to limits of Open Cut 1 to incorporate out of pit emplacements and infrastructure, to maintain set back from Ulan Village;
- Limiting production for the first three years of Open Cut 1 to 7mtpa of ROM coal; and
- Identifying potentially impacted receptors and placement within management zones or entering into negotiated agreements.

Operational processes for the MCP to reduce dust emissions include:

- Disturb only the minimum area necessary for mining;
- Adoption of progressive rehabilitation of mining operations, to minimise exposed soils;
- Ensure coal handling facilities employ appropriate dust suppression methods;
- Use water carts on all trafficked areas to minimise dust generation as necessary;

- Use of constructed roads only, minimisation of access roads and removal of obsolete access roads;
- Keeping disturbed active mining areas to a minimum as far as practicable;
- Maintain coal-handling areas and stockpiles in a moist condition using water carts and water sprays;
- Dust suppression systems will be fitted to stationery and mobile plant (such as the dump hopper, transfer stations, drill rigs) to reduce dust levels and to minimise fugitive dust; and
- Establishment and operation of a real time environmental monitoring network to ensure mining operations are compatible with prevailing climatic conditions relative to the location of sensitive receptors.

The MCP monitoring program necessary to verify environmental performance will incorporate the following: -

- Two meteorological stations (continuation of existing arrangements);
- Two high volume PM_{10} monitors (1 additional to existing arrangement); and
- The current network of deposition gauges, or as otherwise approved by the DEC, would be used to monitor dust fallout.

In addition, in the early years it will be necessary to employ real-time management procedures to minimise the incidence of short term high concentrations of PM_{10} in the rural-residential areas to the west of Open Cut 1. This will involve the continuous monitoring of PM_{10} concentrations and contingency plans to reduce emissions should monitoring indicate that the 24-hour average PM_{10} concentrations exceed the NEPM criterion of 50µg/m^3 due to emissions from the MCP.

The current air quality monitoring regime for the MCP will be continued. With the assistance of adjoining coal mines, it would be possible to rationalise the monitoring and reporting of air quality for the Ulan area.

5.3.4.2 Greenhouse Gases

Energy consumption is a significant cost in mining operations. The MCP is designed to achieve minimum fuel consumption compatible with efficient operation of the mine and efficient use of capital.

Measures to minimise and mitigate greenhouse emissions include: -

- The regular maintenance of plant and equipment;
- Promotion of car pooling;
- Responsible use of energy;
- Consideration of energy efficiency in the purchase of plant and equipment;
- The planting of vegetation for carbon sequestration; and
- The use of alternate forms of power (where appropriate) for site specific applications around the site.

5.3.4.3 Spontaneous Combustion and Odour

The Ulan coal has a susceptibility to spontaneous combustion. A Spontaneous Combustion Management Plan (SCMP) will be prepared and implemented for the MCP in conjunction with the MOP with the aim to eliminate the hazard. The SCMP will apply to the underground and surface operations of the MCP and would include:

- An adequate number of intake and return main development roadways will be provided to minimise ventilation pressures in the underground workings;
- No loose coals will be stored underground;
- Minimisation of coal fracturing, to avoid leakage paths and heating sites;
- Goafs of worked out longwall panels will be unventilated and when the individual panels are completed the walls will be sealed off and the pressure around the seals equalised;
- Longwall panels will be developed initially in discrete blocks which will be monitored by atmosphere analysis;
- Coal will not be left in stockpiles for any length of time; and
- The implementation of corrective actions should spontaneous combustion occur.

Effective control of the hazard of spontaneous combustion should ensure that odours do not adversely impact local air quality.

5.4 Acoustic Environment

MCM engaged Spectrum Acoustics to undertake a noise and vibration impact assessment of the MCP. A copy of the report is contained in **Appendix 4**.

5.4.1 Existing Acoustical Quality

Background noise monitoring was conducted at six residential receivers located throughout the project area during the period 12 July 2005 to 27 July 2005. **Figure 5.1** shows the location of the six (6) noise monitoring sites. The results of the noise monitoring are expressed as L_{Aeq} (equivalent continuous noise level) and L_{A90} (the noise level which is exceeded for 90% of a given monitoring period). The L_{A90} percentile is called the background noise level. Existing background levels are summarised in **Table 5.7**.

Table 5.7: Existing L_{Aeq} and L_{A90} (Rating Background levels, RBL) levels.

Location	L_{Aeq}, period			L_{A90}, period		
	Day	Evening	Night	Day	Evening	Night
P. Renshaw	49	48	46	29	31	29
G. Tuck-Lee	55	44	44	33	36	34
D. Rayner	43	37	42	28	26	24
M. Power (Ulan)	55	53	51	42	41	40
T. Roberts	49	45	39	34	33	32
B. Reid	47	40	37	27	24	23

For the purposes of setting noise criteria relative to ambient noise levels, the DEC NSW Industrial Noise Policy (INP) considers a Rating Background Noise level which is equal to: -

- The measured background noise level if this is greater than or equal to 30dB(A), L_{A90}; or
- 30dB(A) if the measured level is less than 30dB(A), L_{A90}.

Table 5.8 provides a summary of measured Rating Background Noise levels and L_{Aeq} noise levels from industrial noise sources for numerous receivers in proximity to the MCP.

Table 5.8: Estimated industrial noise levels and Rating Background Levels.

Location	LAeq (industrial) , period			RBL (L_{A90}), period		
	Day	Evening	Night	Day	Evening	Night
R13 Renshaw N6	N/A	N/A	N/A	30	31	30
R25 Tuck-Lee N4	35	35	35	33	35[1]	34
R36 Rayner N1	N/A	N/A	N/A	30	30	30
R157 Power (Ulan Village) N5	42	42	42	42	41	40
R46A Flannery Centre	41	41	41	41	40	39
R49 "Olive Lea"	35	35	35	33	35[1]	34
R26 Robinson	35	35	35	33	35[1]	34
R169 "Primo Park"	34	34	34	32	34	33
R170 Roberts N3	33	33	33	33[1]	33	32
R106 Reid N2	N/A	N/A	N/A	30	30	30
Note: The measured levels have been reduced by 1dB so as not to exceed the estimated LAeq contribution from Ulan Coal Mine.						

Both the Department of Planning and Department of Environment and Conservation have requested that the village of Ulan be assessed as a rural noise amenity area. The INP recommends Acceptable Noise Levels (ANL) for rural residential receivers which should generally not exceed the values shown in **Table 5.9** for the MCP.

Table 5.9: Recommended Acceptable Noise Levels for Receivers within Ulan Village.

Noise Amenity Area	Time of day	Acceptable noise level from industrial sources, dB(A),Leq(period)
Rural	Day	50
	Evening	45
	Night	40
School Classroom (internal)	Noisiest 1-hour period when in use	40
Church (internal)	When in use	40

5.4.2 Acoustical Statutory Guidelines and Goals

Spectrum Acoustics calculated (refer to **Table 5.6**) the project specific noise levels for receivers at various locations around the MCP consistent with the INP.

Table 5.10: INP derived Project-specific noise levels.

Receiver/Location	Project-specific noise levels, dB(A),$L_{eq(15min)}$		
	Day	Evening	Night
R13 Renshaw	35	35	35
R12 M & J Transport	35	35	35
R25 Tuck-Lee	35	35	35
R157 Power (Ulan Village)	40	39	38
R46A Flannery Centre	39	38	37
R49 "Olive Lea"	35	35	35
R26 Robinson	35	35	35
R169 "Primo Park"	35	35	35
R170 Roberts	35	35	35
R106 Reid	35	35	35
R5 Swords	35	35	35

Receiver/Location	Project-specific noise levels, dB(A),$L_{eq(15min)}$		
	Day	Evening	Night
R20 Williamson	35	35	35
R30 Cox "Moolarben"	35	35	35
R31 Cox "Barcoo"	35	35	35
R28 Chinner	35	35	35
R36 Rayner	35	35	35
R29A Mayberry	35	35	35
R20Mayberry "Croydon"	35	35	35
All other receivers	35	35	35

Noise criteria for the generation of additional traffic on public roads generated by the MCP were sourced from the DEC Environmental Criteria for Road Traffic Noise (ECRTN). Considering Mudgee-Ulan Road and Ulan-Gulgong Road as collector roads, the ECRTN criteria are shown in **Table 5.11**.

Table 5.11: MR214 and MR 598 ECRTN criteria.

Category	Day (7am-10pm)	Night (10pm to 7am)
Land use development with potential to create additional traffic on collector roads.	60dB(A),Leq(1hr)	55dB(A),Leq(1hr)

The operation of the MCP will result in additional train movements to the east on the Gulgong-Sandy Hollow Rail Line between the site and Muswellbrook and to the west between the site and Lithgow.

Noise criteria for trains are specified within Chapter 163 of the DEC's Environmental Noise Control Manual (ENCM) and are reproduced in **Table 5.12.**

Table 5.12: DEC-ENCM Train Noise Criteria

Descriptor	Planning Levels	Maximum Levels
L_{eq}, 24 hours	55dB(A)	60dB(A)
Lmax	80dB(A)	85dB(A)

The Australian Rail Track Corporation (ARTC) operates the Gulgong-Sandy Hollow and Main Northern Railways. The ARTC's Environment Protection Licence No. 3142 does not contain environmental noise limits but states the objective of progressive reduction of noise levels from rail lines through Pollution Reduction Programs (PRP's). EPL 3142 (as shown by **Table 5.13**) provides train noise goals.

Table 5.13: ARTC train noise goals for EPL 3142.

Descriptor	Design Goal
L_{eq}, (15 hour), day	65dB(A)
L_{eq}, (9 hour), night	60dB(A)
Lmax (24 hour)	85dB(A)

Both sets of train noise criteria are to be considered in the assessment of cumulative train noise levels as a result of the MCP.

5.4.3 Noise Impact Assessment Modelling

Spectrum Acoustics has modelled the MCP using RTA Technology's Environmental Noise Model. All major noise producing items and plant were modelled at their known or most exposed positions and noise contours and or point calculations were generated for the area surrounding the MCP based on sound levels and source heights for different plant items.

Modelling was conducted for the following atmospheric conditions:-

- Day time lapse – Air temperature 20°C, 70% relative humidity (R.H), no wind, -1°/100m vertical temperature gradient (boundary layer adiabatic lapse);
- Prevailing wind (spring/summer) – Air temperature 20° , 70% R.H, 3m/s wind from the east north-east;
- Prevailing wind (autumn/winter) – air temperature 20°C, 70% R.H, 3m/s from the south east; and
- Inversion – Air temperature 5°C, 70% R.H. + 3^{oc}/100m vertical temperature gradient with 2m/s draining flow.

Inversion conditions are only applicable to night time in winter, as per the INP.

5.4.4 MCP Acoustical Impacts

5.4.4.1 Construction and Operations

The construction of the MCP surface facilities and environmental bund will occur during day time hours for a period of at least 12 months. All activities on site would be subject to the operational noise criteria established under the INP.

The construction of an environmental bund 15 metres in height along with the western edge of the out of pit emplacement will take 6 months to construct but will result in up to 7dBA noise level reduction of future mining noise within the village of Ulan. Constructing the environmental bund will result in some exceedences of the INP criteria.

The construction of the surface facilities will take a further 6 months to complete prior to first coals being produced. MCM seek formal approval for construction noise criteria and project specific noise levels at various receivers as shown by **Table 5.10.**

Table 5.14: MCP Bund Construction Criteria and Project Specific Noise Levels for Day Time Construction Activities

Receiver	Description	Proposed noise criteria dB(A),$L_{eq(15min)}$	
		0-6 mths	6 – 12 mths
R2	S.E. Birt & K.M. Hayes	35	35
R8	C.N. & H.L. Davies	35	35
R46G	UCML (Mitchell)	35	35
R16	D.J. Little & A.K. Salter	35	35
R7	Wallis	35	35
R13	P.F. Renshaw	35	35
R12	M. & J. Transport	35	35
R157	Ulan (residences)	47	47
R160A	Ulan School	50	50
R168	Ulan Church	50	50

Receiver	Description	Proposed noise criteria dB(A),$L_{eq(15min)}$	
		0-6 mths	6 – 12 mths
R46A	Flannery Centre	46	46
R169	"Primo Park"	40	37
R49	"Olive Lea"	43	38
R26	G.F. Robinson	43	38
R25	G.G. Tuck-Lee	Noise affectation zone	
R5	M. & P. Swords	35	35
R20	A.J. & N.N. Williamson	40	35
R41A	P.P. Libertis	35	35
R170	T. Roberts	35	35
R58	M.L & J.L Bevege	35	35
All other receivers		35	35

Day, evening and night time operational criteria are based upon formal application of the INP under the current acoustic environment which is dominated by noise from the Ulan Coal Mine operations.

Noise criteria for 24 hour mining operations are based on noise levels resulting from completion of a noise reduction program at Ulan Coal Mine. These criteria are summarised in Table 5.6 above.

Noise models (refer to Appendix 4) were generated under worst case situations for six months (Open Cut 1), Year 1 (Open Cut 1 with bund), Year 2 (Open Cut 1 continuing), Year 6a (Open-Cut 2 starting), Year 6b (Open Cut 2 continuing), Year 8 (Open Cut 3 north) and Year 10 (Open Cut 3 south). **Table 5.15**, **Table 5.16**, **Table 5.17**, **Table 5.18** and **Table 5.19** show predicted noise levels for the MCP receivers for representative years, and project specific noise levels.

Table 5.15: Predicted Year 1 (Open Cut 1 with bund) noise levels, dB(A),$L_{eq(15min)}$.

Receiver	Description	Lapse	ENE wind	SW wind	Inversion	Project Specific Noise Level		
						D	E	N
R2	S.E. Birt & K.M. Hayes	<25	<25	<25	30	35	35	35
R8	C.N. & H.L. Davies	<25	<25	<25	25	35	35	35
R46G	UCML (Mitchell)	<25	<25	25	26	35	35	35
R16	D.J. Little & A.K. Salter	<25	<25	25	25	35	35	35
R7	Wallis	<25	30	<25	31	35	35	35
R13	P.F. Renshaw	25	25	35	38	35	35	35
R12	M. & J. Transport	26	27	37	**40**	35	35	35
R157	Ulan (residences)	28	37	29	38	40	39	38
R160A	Ulan School	28	37	29	38	50	50	50
R168	Ulan Church	28	37	29	38	50	50	50
R46A	Flannery Centre	28	38	29	39	39	38	37
R169	"Primo Park"	<25	35	<25	35	35	35	35
R49	"Olive Lea"	25	38	<25	38	35	35	35
R26	G.F. Robinson	25	38	<25	38	35	35	35
R25	G.G. Tuck-Lee	31	**40**	30	**40**	35	35	35
R5	M. & P. Swords	<25	36	<25	37	35	35	35
R20	A.J. & N.N. Williamson	25	38	<25	38	35	35	35

Receiver	Description	Lapse	ENE wind	SW wind	Inversion	Project Specific Noise Level		
						D	E	N
R41A	P.P. Libertis	<25	35	<25	35	35	35	35
R170	T. Roberts	<25	29	<25	28	35	35	35
R58	M.L & J.L Bevege	<25	32	<25	32	35	35	35
All other		<< 35				35	35	35
All exceedences of the night time criteria are shaded grey and major exceedences are shown in bold type.								

Table 5.16: Predicted Year 2 (Open Cut 1) noise levels, dB(A),$L_{eq(15min)}$.

Receiver	Description	Lapse	ENE wind	SW wind	Inversion	Project Specific Noise Level		
						D	E	N
R2	S.E. Birt & K.M. Hayes	<25	<25	<25	31	35	35	35
R8	C.N. & H.L. Davies	<25	<25	<25	25	35	35	35
R46G	UCML (Mitchell)	<25	<25	25	26	35	35	35
R16	D.J. Little & A.K. Salter	<25	<25	25	29	35	35	35
R7	Wallis	<25	30	<25	31	35	35	35
R13	P.F. Renshaw	25	25	35	35	35	35	35
R12	M. & J. Transport	Noise affectation zone – rail loop				35	35	35
R157	Ulan (residences)	35	39	35	**44**	40	39	38
R46A	Flannery Centre	35	40	34	**45**	39	38	37
R169	“Primo Park”	25	33	25	**40**	35	35	35
R49	“Olive Lea”	30	36	28	**43**	35	35	35
R26	G.F. Robinson	30	36	28	**43**	35	35	35
R25	G.G. Tuck-Lee	Noise affectation zone – Pit 1				35	35	35
R5	M. & P. Swords	<25	33	<25	**40**	35	35	35
R20	A.J. & N.N. Williamson	25	36	<25	**40**	35	35	35
R41A	P.P. Libertis	<25	32	<25	37	35	35	35
R170	T. Roberts	<25	25	<25	30	35	35	35
R58	M.L & J.L Bevege	<25	29	<25	35	35	35	35
All other receivers		< 35				35	35	35
All exceedences of the night time criteria are shaded grey and major exceedences are shown in bold type.								

Table 5.17: Predicted Year 6 (Start Open Cut 2) noise levels, dB(A),$L_{eq(15min)}$.

Receiver	Description	Lapse	ENE wind	SW wind	Inversion	Project Specific Noise Level		
						D	E	N
R2	S.E. Birt & K.M. Hayes	<20	<20	30	<20	35	35	35
R8	C.N. & H.L. Davies	<20	<20	35	23	35	35	35
R46G	UCML	<20	<20	25	25	35	35	35
R16	D.J. Little & A.K. Salter	<20	<20	30	24	35	35	35
R7	Wallis	27	28	34	30	35	35	35
R13	P.F. Renshaw	25	24	**41**	32	35	35	35
R157	Ulan Village	28	35	28	40	40	39	38
R46A	Flannery Centre	28	36	28	40	39	38	37
R169	“Primo Park”	25	35	25	36	35	35	35
R49	“Olive Lea”	29	37	27	39	35	35	35
R26	G.F. Robinson	29	37	27	39	35	35	35
R5	M. & P. Swords	35	**42**	35	**40**	35	35	35
R20	A.J. & N.N. Williamson	35	**43**	35	**43**	35	35	35

Receiver	Description	Lapse	ENE wind	SW wind	Inversion	Project Specific Noise Level		
						D	E	N
R41A	P.P. Libertis	30	36	28	36	35	35	35
R170	T. Roberts	20	30	<20	30	35	35	35
R58	M.L & J.L Bevege	25	35	25	35	35	35	35
R30	R Cox “Moolarben”	<30	<30	<30	<30	35	35	35
R28	D Chinner	<30	<30	<30	<30	35	35	35
R31	M Cox “Barcoo”	<30	<30	<30	<30	35	35	35
R36	D & Y Rayner	<30	<30	<30	<30	35	35	35
R29B	Mayberry	<30	<30	<30	<30	35	35	35
R29A	Mayberry “Croydon”	<30	<30	<30	<30	35	35	35
R47	Herbert	<30	<30	<30	<30	35	35	35
R32	D. & J. Stokes	<30	<30	<30	<30	35	35	35
All other receivers		<< 35				35	35	35
All exceedences of the night time criteria are shaded grey and major exceedences are shown in bold type.								

Table 5.18: Predicted Year 8 (Open Cut 3) noise levels, dB(A),$L_{eq(15min)}$.

Receiver	Description	Lapse	ENE wind	SW wind	Inversion	Project Specific Noise Level		
						D	E	N
R5	M. & P. Swords	30	38	30	**40**	35	35	35
R20	A.J. & N.N. Williamson	27	35	25	36	35	35	35
R41A	P.P. Libertis	23	32	22	35	35	35	35
R170	T. Roberts	20	29	<20	30	35	35	35
R58	M.L & J.L Bevege	22	31	20	33	35	35	35
R171	Railway Museum	<20	22	<20	22	35	35	35
R106	T.B & J.H. Reid	<20	27	<20	28	35	35	35
R41B	P. Libertis	<20	28	<20	29	35	35	35
R30	R Cox “Moolarben”	23	36	20	37	35	35	35
R28	D Chinner	23	36	20	35	35	35	35
R31	M Cox “Barcoo”	20	30	<20	25	35	35	35
R36	D & Y Rayner	29	36	27	**40**	35	35	35
R29B	Mayberry	25	25	25	26	35	35	35
R29A	Mayberry “Croydon”	23	23	28	25	35	35	35
R47	Herbert	<20	30	<20	23	35	35	35
R32	D. & J. Stokes	<20	20	<20	20	35	35	35
All exceedences of the night time criteria are shaded grey and major exceedences are shown in bold type.								

Table 5.19: Predicted Year 10 (Open Cut 3) noise levels, dB(A),$L_{eq(15min)}$.

Receiver	Description	Lapse	ENE wind	SW wind	Inversion	Project Specific Noise Level		
						D	E	N
R5	M. & P. Swords	30	35	29	39	35	35	35
R20	A.J. & N.N. Williamson	26	35	25	35	35	35	35
R41A	P.P. Libertis	22	31	21	34	35	35	35
R170	T. Roberts	<20	26	<20	29	35	35	35
R58	M.L & J.L Bevege	21	30	20	31	35	35	35
R171	Railway Museum	<20	20	<20	20	35	35	35
R106	T.B & J.H. Reid	<20	26	<20	26	35	35	35
R41B	P. Libertis	<20	26	<20	26	35	35	35

Receiver	Description	Lapse	ENE wind	SW wind	Inversion	Project Specific Noise Level		
						D	E	N
R30	R Cox "Moolarben"	<20	32	<20	35	35	35	35
R28	D Chinner	<20	34	<20	35	35	35	35
R31	M Cox "Barcoo"	<20	29	<20	35	35	35	35
R36	D & Y Rayner	25	30	24	30	35	35	35
R29B	Mayberry	**52**	**55**	**50**	**>55**	35	35	35
R29A	Mayberry "Croydon"	**50**	**46**	**55**	**55**	35	35	35
R47	Herbert	<20	30	<20	25	35	35	35
R32	D. & J. Stokes	20	25	20	25	35	35	35
All exceedences of the night time criteria are shaded grey and major exceedences are shown in bold type.								

Noise contours for each of the above modelled years are shown by **Figure 5.6** and **Plan 18** in **Volume 2**, **Figure 5.7** and **Plan 19** in **Volume 2**, **Figure 5.8** and **Plan 20** in **Volume 2**, **Figure 5.9** and **Plan 21** in **Volume 2** and **Figure 5.10** and **Plan 22** in **Volume 2**.

Cumulative noise impact assessment with existing noise emissions from Ulan and predicted Wilpinjong Coal Mines was undertaken by Spectrum Acoustics.

Receivers that experience noise levels between 1dBA and 5dBA in excess of the assessment criteria, under worst case meteorological and operational conditions, will be placed within a Noise Management Plan. Whilst for dwellings that experience noise levels greater than 5dBA above the criteria, MCM will seek to enter into discussions with the owners to secure negotiated agreements for noise impacts associated with the MCP.

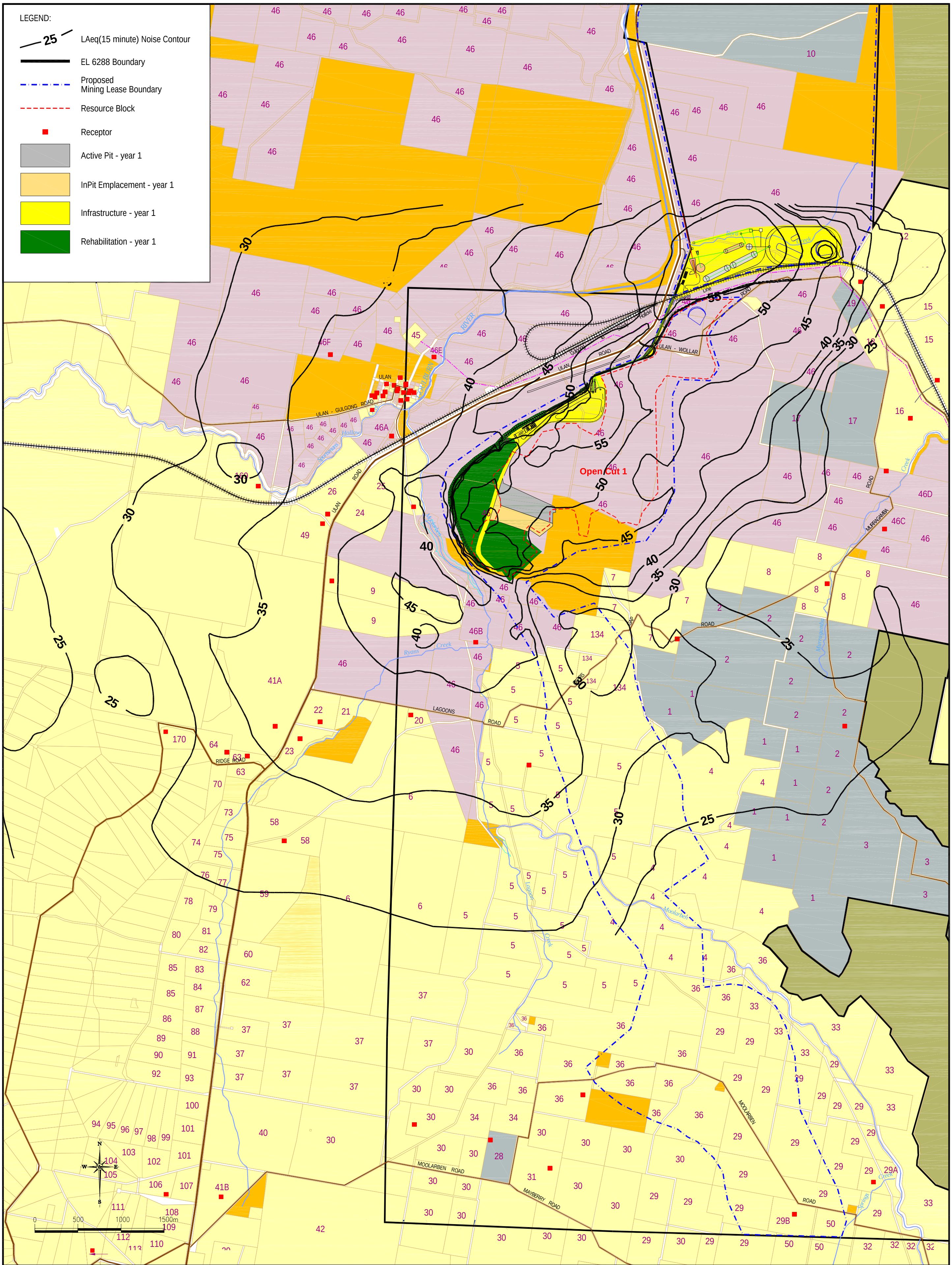
In summary, exceedences of adopted noise criteria for sensitive receptors, under worst case meteorological and operational conditions include:-

- Open Cut 1 and Main Infrastructure Areas - Year 1 with bund and dumping behind 15m high bund. 2 dwellings will be subject to negotiated agreements, whilst 6 dwellings will be within a Plan of Management zone.

  Open Cut 1 and Main Infrastructure Areas - Year 2 with bund and dump trucks operating at 15m height. Under all modelled conditions except inversions indicates that high level overburden emplacement may occur on out of pit 1 emplacement without creating more than 1dB exceedence at four residences and residences within the village of Ulan.

  A Noise Management Plan will be prepared which will require low level (behind the bund or in-pit) dumping locations, and the high level areas to be utilised only when there is no temperature inversion present or east north-east wind. In this way, out of pit emplacement can be completed without producing exceedences of the project specific noise levels.
- Open Cut 2 – Year 6 with 10m high bund. 3 dwellings will be subject to negotiated agreements. There are 2 receptors associated with Open Cut 2 that would be placed in a Noise Management Plan; and
- Open Cut 3 – 3 dwellings will be subject to negotiated agreements, whilst 2 dwellings will be within a Noise Management Plan zone.

Once the acoustical bunds for Open Cuts 1 and 2 have been constructed there will be little scope for further substantial reduction of overall noise emissions. Noise Management Plans pertaining to dumping operations under modelled climatic conditions for each of the Open Cut operations would assist in mitigation exceedences in the 1dBA to 5dBA range.



Pegasus Technical

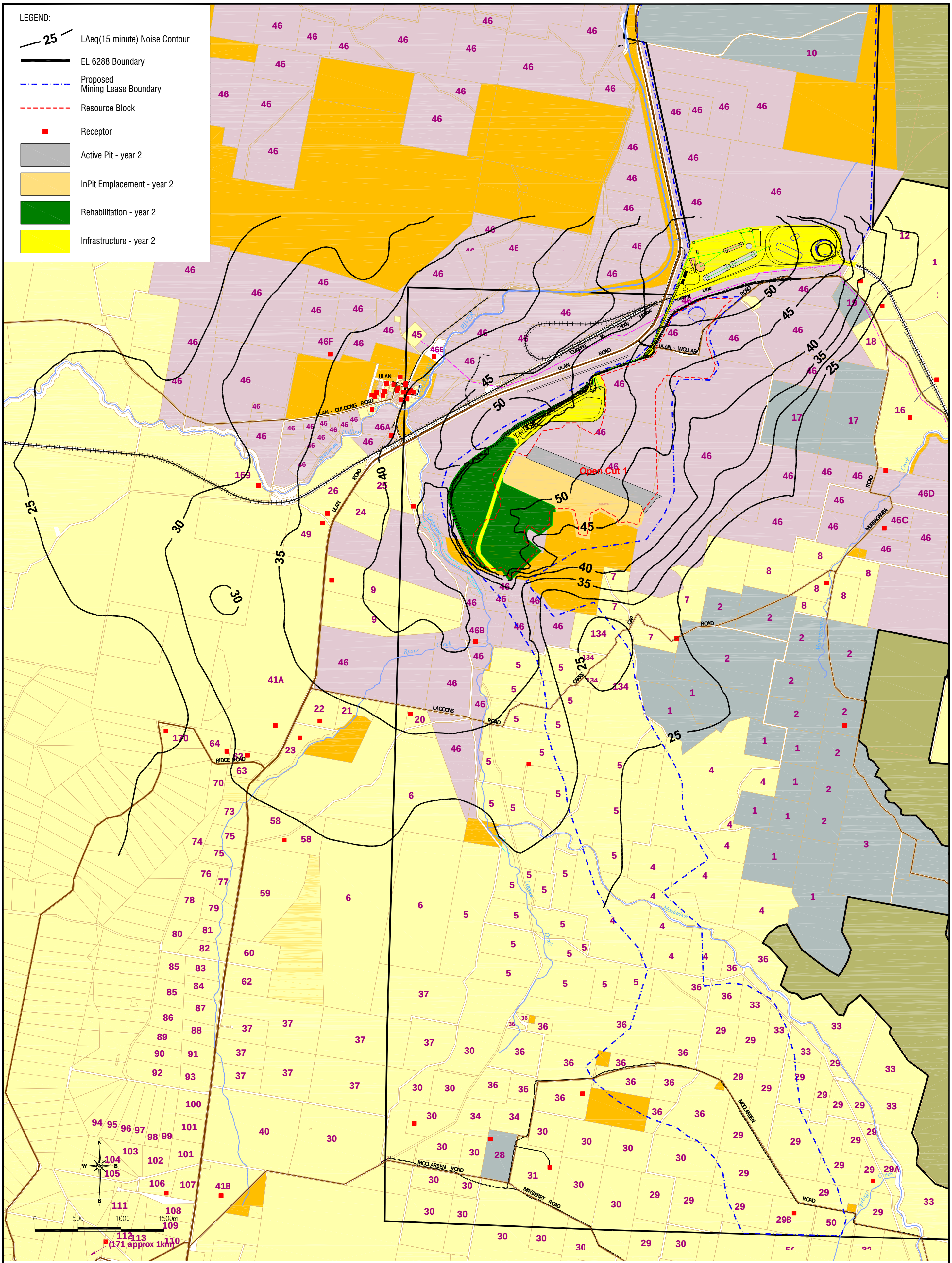
CAD FILE: Figure 5.6

Moolarben Coal Project

Year 1 - Predicted LAeq(15 minute) noise levels - ENE wind

SPECTRUM ACOUSTICS

Figure 5.6



Pegasus Technical

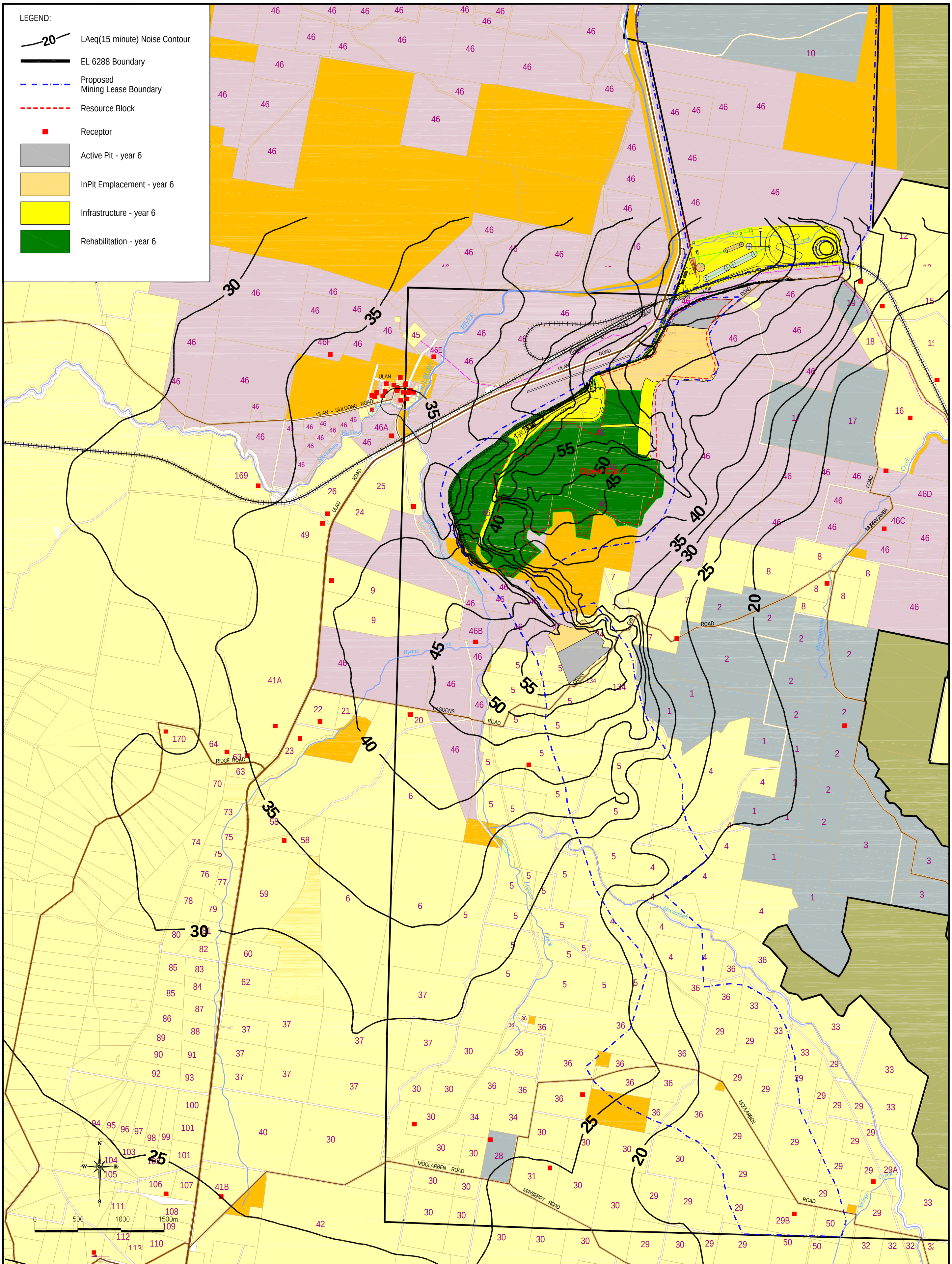
Moolarben Coal Project

Year 2 - Predicted LAeq(15 minute) noise levels - ENE wind

SPECTRUM ACOUSTICS

Figure 5.7

CAD FILE: Figure 5.7



Pegasus Technical

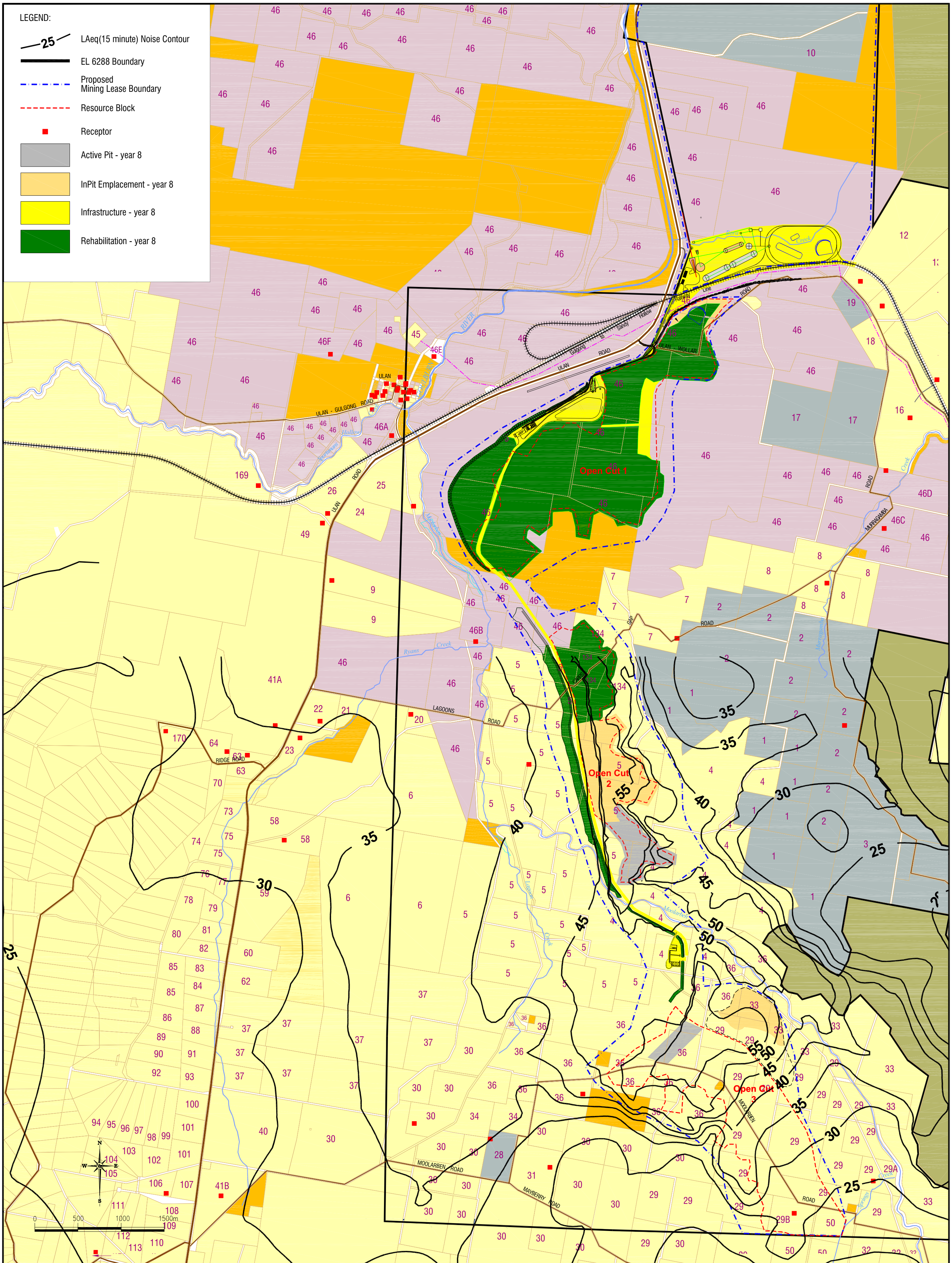
Moolarben Coal Project

Year 6 - Predicted LAeq(15 minute) noise levels - ENE wind

SPECTRUM ACOUSTICS

Figure 5.8

CAD FILE: Figure 5.8



Pegasus Technical

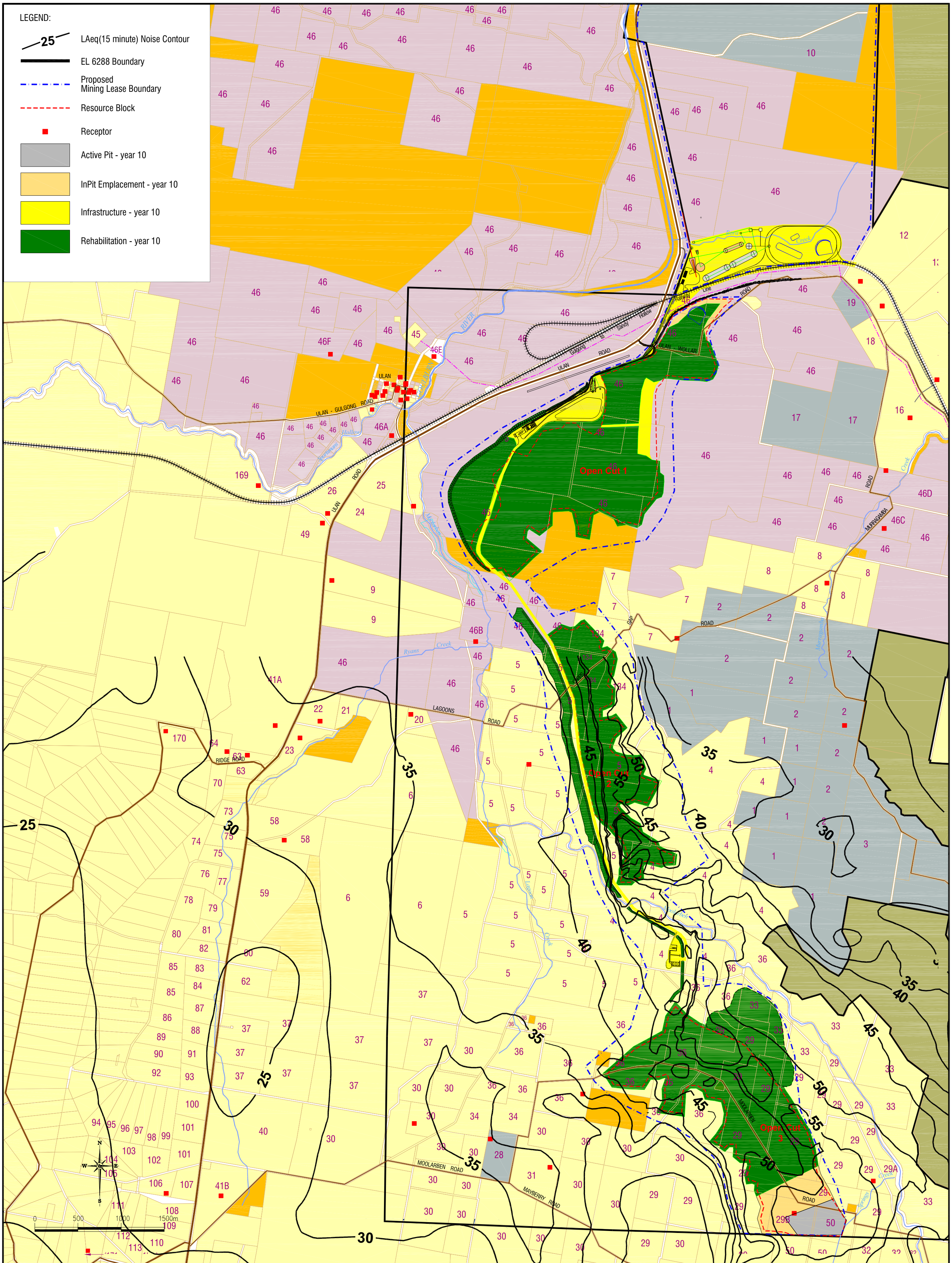
CAD FILE: Figure 5.9

Moolarben Coal Project

Year 8 - Predicted LAeq(15 minute) noise levels - start of Pit 3 (inversion)

SPECTRUM ACOUSTICS

Figure 5.9



Pegasus Technical

Moolarben Coal Project

Year 10 - Predicted LAeq(15 minute) noise levels - end of Pit 3 (inversion)

SPECTRUM ACOUSTICS

Figure 5.10

CAD FILE: Figure 5.10

5.4.4.2 Transportation Noise

Road

Noise impacts assessment associated with increased traffic as a result of employee vehicle movements at shift change was undertaken, assuming worst case that all MCM employees would use either the Ulan to Gulgong or the Ulan to Mudgee Roads. The assessment concluded that the night time 55dB(A),Leq(1hr) traffic noise criteria would not be breached.

Rail

An assessment was undertaken to identify potentially impacted dwellings as a result of increased rail traffic from the MCP between the site and Muswellbrook, and the site and Wallerwang Power Station near Lithgow. Once the trains leave the MCP rail loop and pass onto the Gulgong – Sandy Hollow Railway Line the train noise becomes the responsibility of the ARTC and relevant rail authorities. In terms of the trains servicing the MCP, these trains are subject to the ARTC's EPL No. 3124.

The noise impact assessment found that 22 receivers (being within 70m of the rail line) east of the site and 16 receivers (being within 30m of the rail line) west of the site may be close enough to the train line to receive noise levels from coal trains that would exceed the ARTC EPL No. 3124 goals. Approximately 175 residences (being within 70m of the rail line) west of the site may receive noise levels higher than the more stringent DEC recommended train noise levels.

5.4.5 MCP Acoustical Safeguards and Mitigations

The most important physical feature of the MCP to safeguard the areas acoustical quality is the construction of the environmental bunds associated with the Open Cuts 1 and 2. Fixed plant and machinery will need to be acquired and operated in accordance with the sound power levels detailed in the Spectrum Acoustics report.

Design and management mitigation measures for the MCP include:

- Refine limits of Open Cut 1 to incorporate out of pit emplacements and infrastructure, to maintain set back from the village of Ulan;
- Build environmental bunds on western and northern sides of Open Cut 1 and facilities, and Open Cut 2;
- Work south to north-east moving away from the village of Ulan;
- Design overburden emplacement to shield mining operations;
- Locate open cut ROM hopper and primary crusher below ground level in box cut;
- Undertake attended monitoring to enable refinement of the acoustical model; and
- Identify potentially impacted receptors and place within noise management zones or enter into negotiated agreements.

The properties identified which will experience sound power levels 5dBA above the noise criteria will be subject to negotiated agreements with MCM. Noise mitigation for the residents could potentially range from practical solutions such as air conditioning of the dwelling, double glazing of windows or acquisition of the property.

Those identified properties that will experience sound power levels between 1dBA to 5dBA above the criteria will be placed within a Noise Management Plan with monitoring of noise levels. Where monitoring identifies an exceedence, acoustical mitigation measures for the residence will be negotiated with the land owner.

Prior to the start of construction MCM will prepare a Construction Noise Management Plan, to minimise construction noise impacts. Prior to the start of operations MCM will prepare an Operational Noise Management Plan.

5.5 MCP Blasting and Vibration

MCM engaged Spectrum Acoustics to undertake a blasting and vibration impact assessment of the project and to consider cumulative impacts and safeguards. A copy of the report is contained in **Appendix 4**.

5.5.1 MCP Blasting and Vibrations Assessment Criteria

Table 5.20 summarises the noise and blasting goals that are relevant to the MCP.

Table 5.20: Blast Overpressure and Vibration

Descriptor	Design Goal
Maximum blast overpressure	115dBL
Maximum peak particle vibration velocity	5mm/sec
Blasting generally restricted to the hours 9.00am to 5.00pm Monday to Saturday. The limits for overpressure and ground vibration are to be measured within one metre of any affected residence boundary or other sensitive location such as a school. The above criteria should be met for all but 5% of blasts, and in no case should the blast overpressure exceed 120dBL or the peak particle velocity exceed 10 mm/sec.	

The Australian and New Zealand Environment and Conservation Council (ANZECC) have adopted criteria which are supported by the DEC for assessing disturbances caused as a result of blasting. These criteria are:-

- The recommended maximum overpressure level for air blast is 115dB;
- The level 115dB may be exceeded for up to 5% of the total number of blasts over a 12 month period, but should not exceed 120dB at any time;
- The recommended maximum vibrations velocity for blasting is 5mm/s Peak Vector Sum;
- The Peak Vector Sum level of 5mm/s may be exceeded for up to 5% of the total number of blast over a 12 month period, but should not exceeded 10mm/s at any time;
- Blasting should generally only be permitted during the hours of 9am and 5pm Monday to Saturday; and
- Blasting should generally take place no more then once per day, however blasting may be conducted outside of the times in accordance with the blast emission assessment criteria contained in the DEC Environmental Noise Control Manual.

Building damage assessment criteria are nominated in Australian Standard (AS) 2187.2-1993 "Explosives – Storage, Transport and Use. Part 2: Use of Explosives" and summarised in **Table 5.21**.

Table 5.21: Blasting criteria to limit damage to buildings (as 2187)

Building Type	Vibration Level (mm/s)	Airblast Level (dB re 20 µPa)
Sensitive (and Heritage)	5	133
Residential	10	133
Commercial/Industrial	25	133

In addition to the above criteria, a vibration limit of 20mm applies to bridges for the Gulgong-Sandy Hollow Railway Line and Ulan-Mudgee Road infrastructure.

5.5.2 MCP Blasting and Vibration Impacts

Blasting will be required for mining in Open Cuts 1, 2 and 3. Exceedences of overpressure and vibration criteria at nearby sensitive receptors and structures as a result of blasting are: -

- 1 dwelling will be impacted at Open Cut 1 – no impacts to the village of Ulan;
- 1 dwelling will be impacted at Open Cut 2; and
- 3 dwellings at Open Cut 3.

There is the potential for "flyrock" to occur from a mishap associated with blasting. Public roads, Ulan Airstrip and Gulgong – Sandy Hollow Railway Line will be temporarily closed during blasting events occurring within 500 metres of transport infrastructure. The blast impact assessment concluded that there would be no impact to the Gulgong – Sandy Hollow Railway, Moolarben Dam or rock shelters above Open Cut 2.

5.5.3 Blasting and Vibration Safeguards and Mitigations

Design and management mitigation measures for the MCP include:

- Model maximum instantaneous charge weights to predict impacted residents;
- Adjust charge weights to minimise impacts where possible;
- Identify potentially impacted receptors and place within management zones or enter into negotiated agreements;
- Develop blasting site law; and
- Prepare Blasting Management Plan.

5.6 Groundwater

Peter Dundon and Associates Pty Ltd was engaged to undertake a groundwater investigation to develop an understanding of the groundwater environment in the vicinity of the proposed MCP, and to make an assessment of the potential impacts of the project on the groundwater resources and existing groundwater users including groundwater dependent ecosystems. A copy of the report is contained in **Appendix 5**.

5.6.1 Investigations

The groundwater investigation commenced with a census of bores, wells, springs/soaks and groundwater-fed dams, and a search of the Department of Natural Resources groundwater bore database, to establish existing groundwater use in the area.

The field census of existing known bores, wells, springs, soaks and possible spring-fed dams included landholders within the range of potential impact from the project to determine any current or past use of groundwater, and other natural expressions of groundwater on their properties, such as springs. The small holdings west of the Mudgee-Cassilis Road were not included within the study, as these are considered to be well beyond the potential for groundwater impacts from the project. However, a number of probable bores, pumps and windmills observed on these properties from the roadside have also been identified.

A network of 42 piezometers was installed across the study area, establishing an effective geographic spread of monitoring points in the major hydrogeological units. The number and locations of the piezometers was designed to ensure consistency with DNR's groundwater monitoring guidelines for mine sites in the Hunter catchment (DIPNR, 2003). An ongoing baseline monitoring program was implemented, comprising monthly measurements of water levels and three-monthly sampling of groundwater for NATA-registered laboratory analysis from all piezometers. Finally, four test production bores were constructed, and extended pumping tests carried out to determine aquifer hydraulic properties. Short pumping tests were also carried out on the piezometers.

The groundwater investigation has been integrated with parallel studies undertaken by other specialists, especially those relating to surface water, terrestrial and aquatic ecology, and underground mine subsidence.

The locations of all investigations (piezometers, test bores, surface water sampling sites and census locations) are shown on **Figures 5.11**, **5.12, 5.13,** and **Plans 23**, **24,** and **25** in **Volume 2**.

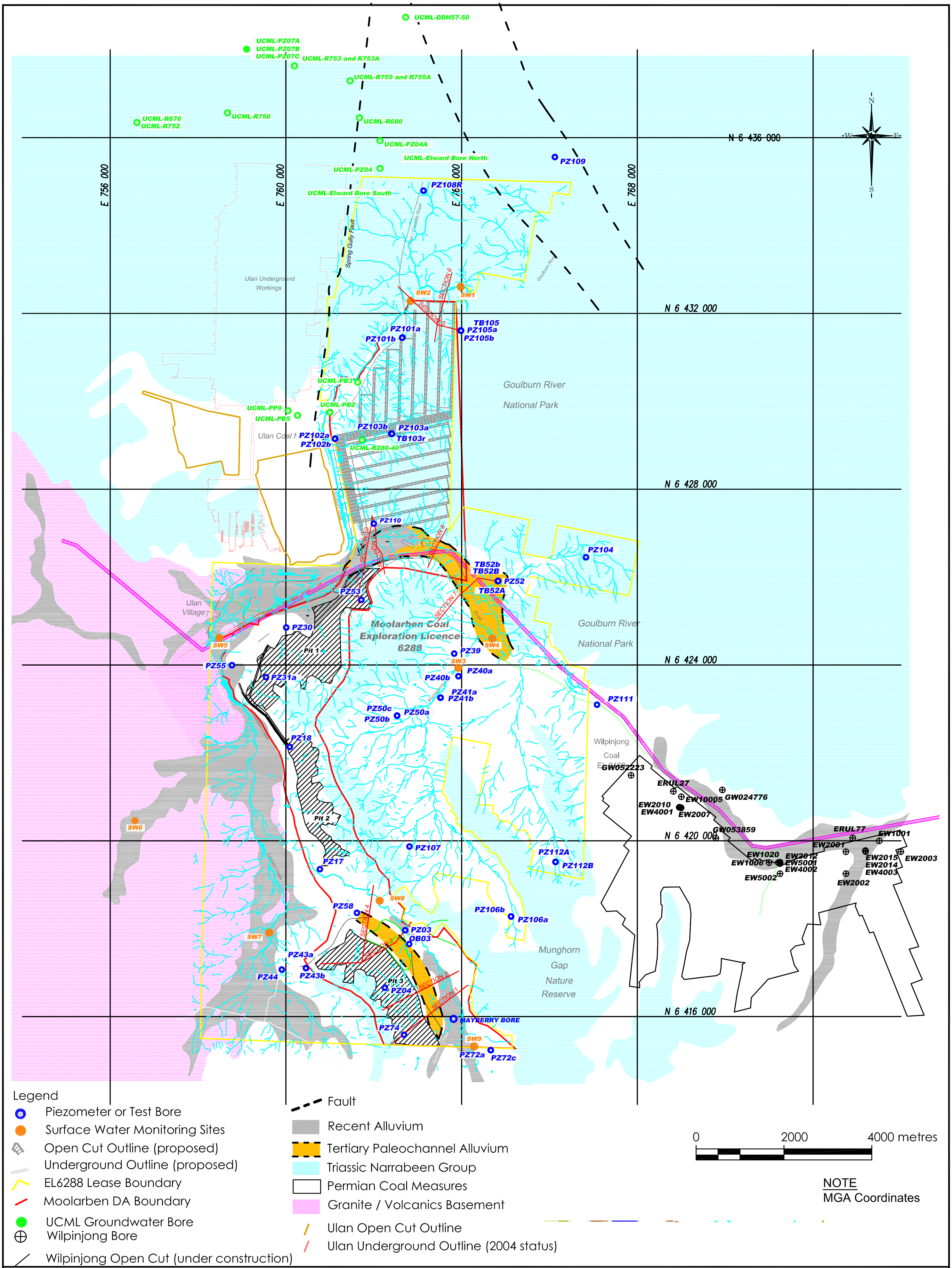
5.6.2 Hydrogeological Units

Groundwater occurs within most lithologies represented in the area. The principal aquifer is the Ulan seam and other parts of the Permian coal measures sequence, with mainly secondary permeability due to fracturing, jointing and cleat within the coal. Other useful aquifers include the Triassic Narrabeen Group and weathered granite basement. Minor groundwater potential also exists in the Quaternary and Tertiary alluvium.

Six regional hydrogeological units (as illustrated in Figure 5.11 and Plan 23 in Volume 2) have been identified, these being:

- Quaternary alluvium;
- Tertiary alluvium;
- Triassic Narrabeen Group;
- Permian Coal Measures, including the Ulan Seam;
- Permian Shoalhaven Group; and
- Basement granite and volcanics.

Additionally, there are a large number of natural springs and seepages throughout the area, some of which have been developed for water supplies with modest yields. A number of farm dams are also believed to be at least partly groundwater fed. The springs, seepages and groundwater-fed dams are believed to be part of a surficial (near surface) groundwater system, which is quite shallow and blankets the hard rock units.



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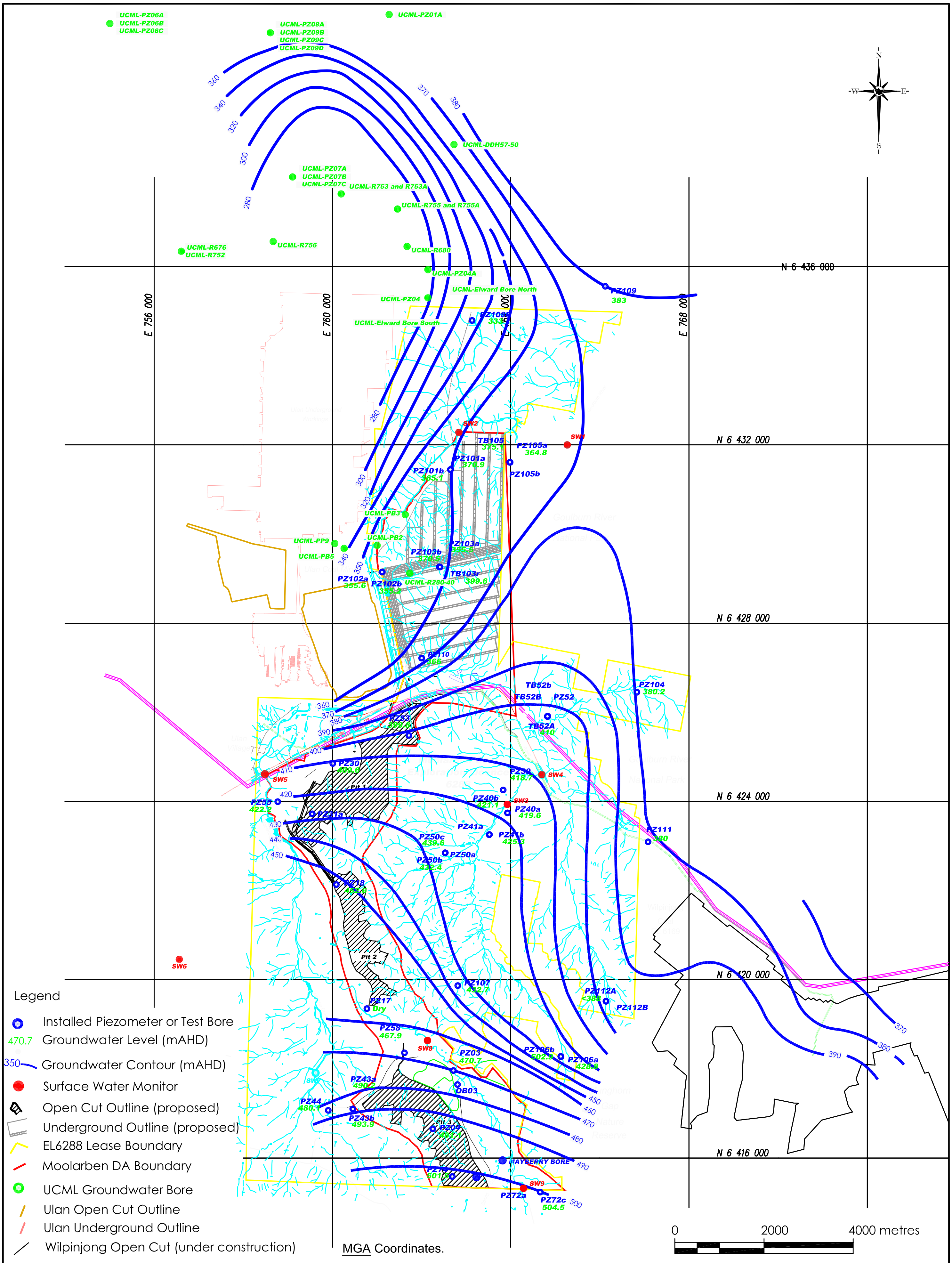
Moolarben Coal Project
Regional Hydrological Units
PETER DUNDON AND ASSOCIATES PTY LTD

Figure 5.11



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Moolarben Coal Project

Existing Groundwater Levels within the Ulan Seam - Permian Coal Measures

PETER DUNDON AND ASSOCIATES PTY LTD

Figure 5.12

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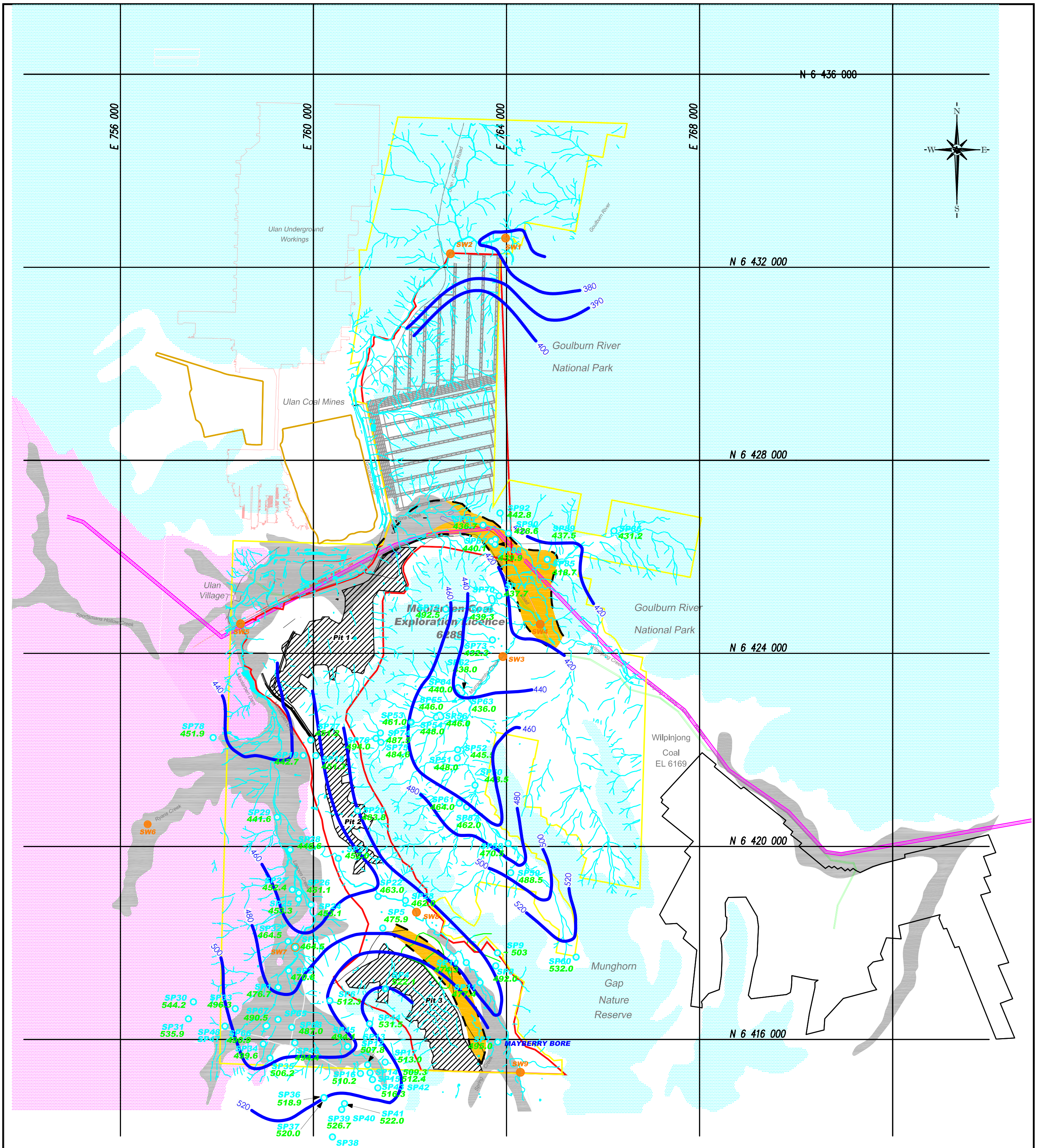

Legend

- SP78 Census - Existing Spring/Soak/Bore
- 451.9 Groundwater Level (mAHD)
- 350 Groundwater Contour (mAHD)
- Open Cut Outline (proposed)
- Underground Outline (proposed)
- EL6288 Lease Boundary
- Moolarben DA Boundary
- Wilpinjong Open Cut (under construction)
- Ulan Open Cut Outline
- Ulan Underground Outline (2004 Status)
- Recent Alluvium
- Tertiary Paleochannel Alluvium
- Triassic Narrabeen Group
- Permian Coal Measures
- Granite / Volcanics Basement

0 2000 4000 metres

NOTE
MGA Coordinates

Pegasus Technical

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Moolarben Coal Project

Moolarben Groundwater Investigation - Surficial Groundwater Contours

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Figure 5.13

5.6.3 Groundwater Levels and Flow

5.6.3.1 Permian Groundwaters

Within the main Permian coal measures aquifer, groundwater flows generally to the north-east, although the flow pattern has been disturbed by an extensive depression in groundwater levels around the Ulan Coal Mine (refer Figure 5.12 and Plan 24 in Volume 2). Historical water levels shown in Ulan Coal Mine bore hydrographs suggest that prior to mine dewatering, groundwater levels in the Permian Coal Measures in the northern part of EL 6288 were probably around 400m to 420m AHD. It is interpreted that the drawdown effect (i.e. the lowering of groundwater levels from water extraction, compared to a previous groundwater level) in groundwater levels in the Ulan Seam and the overlying Permian sediments along the western margin of Underground No. 4 would currently be between about 40m at the southern end and 50m at the northern end compared to original pre-Ulan Coal Mine groundwater levels.

Groundwater levels range from 500m AHD in the south-west to 380m AHD at the northern end of EL 6288.

5.6.3.2 Surficial Groundwaters

The surficial (near-surface) groundwater flow pattern is closely related to the surface topography (refer Figure 5.13 and Plan 25 in Volume 2). This groundwater is believed to be derived by local infiltration of rainfall into the near-surface alluvium, colluvium and highly weathered bedrock zone, and flow is largely confined within this shallow layer, with local discharge to the surface stream system, often emerging mid-slope in springs or seepage zones. The shallow groundwater is believed to be largely unrelated to the flow system in the deeper Permian sediments.

5.6.4 Groundwater Recharge and Discharge

Groundwater recharge occurs by infiltration of rainfall and locally-collected runoff, hence the Permian and Triassic aquifers are primarily recharged in the elevated areas of rock outcrop. Where the hard rock aquifers underlie the Tertiary or Quaternary alluvium, recharge may also occur to the hard rock aquifers by downward percolation from the overlying alluvium, supplementing the primary recharge derived from direct infiltration of rainfall into the rock in areas of outcrop up-gradient.

Local discharges take place wherever an aquifer unit within the Permian sediments outcrops, such as on hillsides or the flanks of creeks and gullies. The ultimate discharge point for groundwater flow within the Permian is likely to be some considerable distance down gradient to the north east, in any locality where the topography falls below the level of the main zones of permeability within the Permian.

The groundwater levels in the Permian coal measures measured in bores close to Goulburn River are below the riverbed level. The Permian is thus not contributing to baseflow in the Goulburn River itself, although there are small contributions to baseflow of relatively saline Permian groundwater in the upper reaches of Moolarben and Lagoon Creeks. Goulburn River is believed to be more closely related to groundwater in the Triassic sediments that outcrop beneath and adjacent to the river. Water discharging at The Drip and similar seepages nearby is derived from perched groundwater in the Triassic sediments.

Groundwater flow within the alluvium is believed to generally follow the surface topography, with a similar flow direction and flow pattern to surface runoff. Groundwater discharge occurs generally locally, as springs or streambed baseflow contributions.

Groundwater flow direction in the east-west Tertiary paleochannel beneath the Bora Creek valley south of Underground No.4 is believed to be to the west, but at some depth below the Quaternary alluvium, and hydraulically separated from it.

5.6.5 Groundwater – Surface Water Interaction

There is abundant evidence in the large number of springs and seeps that the groundwater discharges to the surface throughout the area. However, with few exceptions, the volumes of individual spring and seep discharges are very small. However, the accumulation of groundwater discharges is sufficient to maintain semi-perennial flow in the major tributaries and virtually permanent flow in the Goulburn River (either visible flow or flow within the sandy stream bed).

Groundwater baseflow comprised a significant component of total streamflow during the period of baseline monitoring. This is reflected by a close relationship in the water salinity and major ion chemistry between the groundwater and the surface water during periods of lower rainfall. Thus, in the Moolarben Creek – Lagoon Creek catchment, the surface water quality is generally saline like the typical groundwater from that area. The water quality in the Goulburn River is much less saline than that in the Moolarben Creek – Lagoon Creek system, indicating that the river derives most of its baseflow from other tributaries in which the groundwater is presumably of better quality.

5.6.6 Existing Ground Water Quality

Groundwater quality is variable within the project area. Generally groundwater quality within the lower portion of EL6288 in the Moolarben valley is of poorer quality then groundwater within the northern portion of EL6288 within and north of the Underground No. 4 area.

5.6.6.1 pH

The pH of the groundwater is variable, with recorded pH values ranging from 3.4 to 7.9. Low pH groundwater was all reported from the southern part of EL 6288, with pH generally between 3 and 6 in the Moolarben Creek – Lagoon Creek catchment. Groundwater in the Murragamba Valley catchment is slightly acidic, with pH generally between 5.5 and 6.5. In the northern half of E L6288, pH is close to neutral, generally in the range 6.5 to 7.5.

5.6.6.2 Salinity

The salinity of the groundwater is variable, with total dissolved solids (TDS) ranging from less than 200 mg/L to more than 7000 mg/L. In the northern part of EL 6288, salinities are less than 600 mg/L TDS. However, salinity is more variable in the southern half of EL 6288, with pockets of higher salinity occurring within the Murragamba Valley catchment and in the southern part of the Moolarben Creek – Lagoon Creek catchment.

5.6.6.3 Metals and Nutrients

Moderately elevated dissolved metal concentrations across EL 6288 have been identified. Metal concentrations were in some cases significantly higher then the ANZECC (2000) guideline trigger values for freshwater ecosystem protection.

Nutrient concentrations across EL 6288 were generally lower then the ANZECC (2000) guideline trigger values for freshwater ecosystem protection. Localised minor exceedences observed were identified within EL 6288 and probably reflect local contamination from either fertilisers or animal wastes.

5.6.7 Ground Water Use

Details of the registered bores are presented in Appendix 5. The census of local groundwater usage on properties around EL 6288 conducted between May 2005 and February 2006 identified a small number of bores or wells, a few springs and soaks, and a large number of dams believed by the landowners to be spring-fed. These water sources are currently used for a combination of potable drinking water and stock watering purposes. The water sources identified are shown on Figure 5.13 and Plan 25, and summary details are provided in Appendix 5.

A search of the DNR database was undertaken to identify registered bores and wells in the project locality. The records indicate that there are 72 registered bores and wells within approximately 10km of the project area. These bores are likely to be used for a combination of stock watering, industrial, irrigation and potable water supplies. Summary details of the registered bores are presented in Appendix 5.

Around 10ML/d of groundwater is extracted for dewatering of the Ulan Coal Mine operations (UCML, 2006). Approximately 5ML/d of water excess to mine requirements is disposed of by means of irrigation on the Bobadeen property to the north of Ulan Coal mine and north-west of EL 6288 (UCML, 2005). A further 0.24ML/d is extracted from a water supply bore PC1C, which according to Ulan Coal Mines Limited (2006) is located close to Millers Dam on the eastern side of the Ulan-Cassilis Road, to provide potable water, fire water and other mining requirements.

It is recognised that the natural environment is a legitimate groundwater user; as such groundwater dependant ecosystems have been addressed in Section 5.13 Ecology.

5.6.8 Groundwater Impacts

5.6.8.1 Assessment Methodology

A numerical groundwater model of the groundwater system was set up, using MODFLOW software. The model was first calibrated against the present distribution of groundwater levels, and was then used to simulate the proposed mining operation to enable prediction of potential impacts of the project on the groundwater, surface water, existing users and groundwater dependent ecosystems.

The model was set up to simulate groundwater conditions over a 1600km^2 area, to encompass the area of potential impact of both the Moolarben project and the adjoining Ulan and Wilpinjong Coal mining projects. The 1600km^2 model domain is bounded in the south western corner by Cooyal Creek and the north eastern corner bounded by the Goulburn River near Comiala Flat.

A model simulation of the mining operation was run for the proposed 15 year project life, and for a period of 45 years after project completion to predict the post-project recovery of groundwater levels.

Ongoing independent review and final endorsement of the groundwater modelling was provided by Dr Noel Merrick, Director of the National Centre for Groundwater Management.

The model was calibrated by initially running the model in a steady state, however given the effects of dewatering from Ulan Coal Mine underground a transient state model was also run in an attempt to simulate Ulan Coal Mine's past dewatering pumping and resultant impacts on groundwater levels. The presently observed groundwater levels do not represent an equilibrium condition and as such the steady state calibration can only be approximate.

5.6.8.2 Groundwater Inflows

Using the groundwater model, it was predicted that groundwater inflows to the Underground No. 4 mine may range from 0.3 megalitres per day (ML/d) in Year 1 to 6.5ML/d in the final year of mining. Groundwater inflow rates to the open cuts are predicted to be much lower, ranging up to 0.4ML/d in Open Cut 1 less then 0.1ML/d in Open Cut 3 and negligible inflows to Open Cut 2 (see **Table 5.22)**. The water inflows from open cut and underground mining are detailed within *Section 4 – Water Management.*

Table 5.22: Predicted Moolarben Coal Mine groundwater inflows

Mine Year	Period	Moolarben Mine Water Inflows (ML/a)				Moolarben Pumping Bores
		Open Cut 1	Open Cut 2	Open Cut 3	Underground No. 4	
0	2006-07	-	-	-	113	95
1	2007-08	0	-	-	83	917
2	2008-09	0	-	-	1472	-
3	2009-10	0	-	-	1282	228
4	2010-11	4	-	-	1035	1252
5	2011-12	116	-	-	821	1563
6	2012-13	139	0	-	639	1722
7	2013-14	-	0	-	527	1973
8	2014-15	-	0	0	733	1767
9	2015-16	-	-	0	371	2129
10	2016-17	-	-	0	679	1821
11	2017-18	-	-	-	902	1598
12	2018-19	-	-	-	1479	-
13	2019-20	-	-	-	1925	-
14	2020-21	-	-	-	2255	-
15	2021-22	-	-	-	2402	-
16	2022-23	-	-	-	-	-

The predicted total inflows are sufficient to meet the project's water demand in Years 2 and 12 to 16. In other years there will be a shortfall, which reaches a maximum of 5.8ML/d in Year 9, which will be met by sourcing water from adjacent mines if available, or otherwise by pumping from up to 16 dewatering/water supply bores located along the eastern boundary of

Underground No. 4. Testing has indicated that individual bore yields of 0.3 to 0.4ML/d are sustainable, and that a borefield could sustain a total production rate of at least 7ML/d.

5.6.8.3 Groundwater Levels

The dewatering required for the MCP will have an impact on regional groundwater levels.

Permian Coal Measures

The model-predicted groundwater level impacts include extensive lowering of groundwater levels in the Ulan seam, and to a lesser extent in the overlying coal measures. Drawdown impacts due to the Moolarben project are predicted to extend a distance of approximately 20 km by the completion of mining, with drawdown of about 5 m in the Ulan Seam 10 km east of Underground No. 4, and about 0.5 m in the upper section of the Permian coal measures at this same distance.

Predicted Ulan Seam water levels at the end of the MCP are shown on **Figure 5.14** and **Plan 26** in **Volume 2**.

Triassic Narrabeen Group

Minimal impact on the overlying Triassic aquifer system is predicted, with a maximum drawdown of between 0.4m and 0.5m in a region to the east of Underground No. 4 at the conclusion of underground mining. These results are consistent with observations at Ulan, which reportedly have shown no or minimal drawdown impacts of Ulan Seam dewatering on groundwater levels in the Triassic.

Tertiary and Quaternary Alluvium

No drawdown impact is predicted to occur in the Quaternary or Tertiary alluvium.

Groundwater Level Recovery Post-Mining

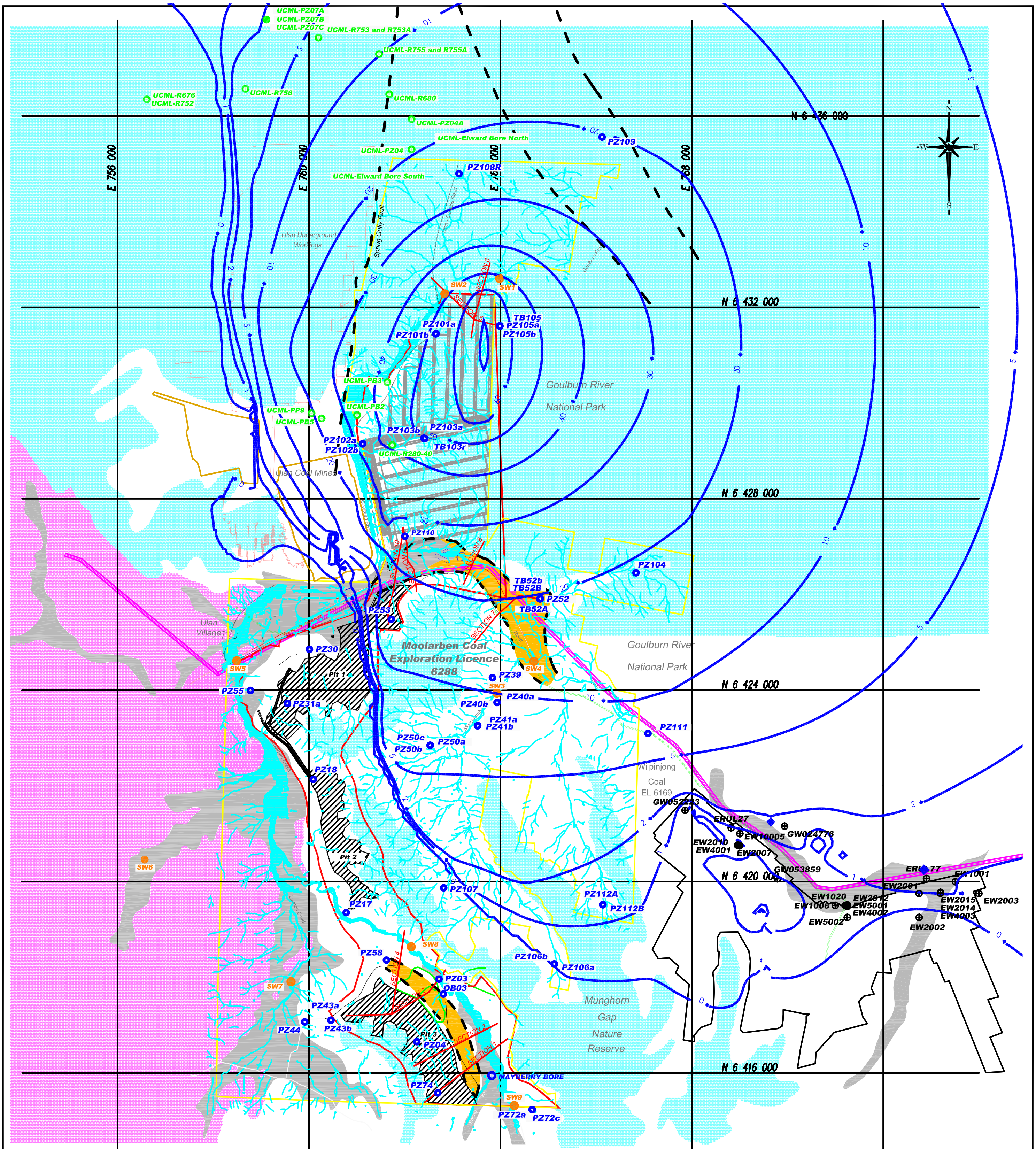
Based on post-project recovery modelling, groundwater levels in the Permian coal measures are predicted to have fully recovered within 10-20 years after project completion. A small residual drawdown of up to about 3m is predicted to remain within the Triassic Narrabeen Group aquifer system at 45 years after completion. This drawdown increases from the 0.4 to 0.5m drawdown at the completion of mining due to the slow percolation of water down into the underlying Permian groundwater.

5.6.8.4 Groundwater – Surface Water Quality

The initial average groundwater quality of mine inflows (and pumped extractions) for each of the four proposed mining areas is expected to be approximately as shown in **Table 5.23**.

It is expected that there will be some variation of water quality from year to within each area, and the Open Cuts in particular may see annual fluctuations above and below the above averages due to the spatial variability in water quality.

Dewatering for Underground No. 4 is likely to generate a slight increase in salinity and a similar accompanying change in some of the other water quality parameters, as more saline water is drawn in from the south. The increase over time may see an increase in salinity in the order of 25% above the initial average salinity.



Legend

- Piezometer or Test Bore
- UCML Groundwater Bore
- Surface Water Monitoring Sites
- Wilpinjong Bore
- Open Cut Outline (proposed)
- Underground Outline (proposed)
- EL6288 Lease Boundary
- Wilpinjong Open Cut (under construction)
- Ulan Open Cut Outline
- Ulan Underground Outline (2004 Status)
- Fault Line
- Recent Alluvium
- Tertiary Paleochannel Alluvium
- Triassic Narabeen Group
- Permian Coal Measures
- Granite / Volcanics Basement
- Moolarben DA Boundary
- 310 Predicted Drawdown Contours(2022-2023)

NOTE
MGA Coordinates

0 2000 4000 metres

Pegasus Technical

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Moolarben Coal Project

Predicted Drawdowns - Ulan Seam at Completion of Mining (2022-2023)

PETER DUNDON AND ASSOCIATES PTY LTD

Figure 5.14

Table 5.23: Average mine water inflow quality

Parameter	Average Concentration (as mg/L unless otherwise specified)			
	Open Cut 1	Open Cut 2	Open Cut 3	Underground No.4
pH	6.45	4.24	6.52	7.41
Total Dissolved Solids	415	532	2047	420
Total Suspended Solids	180	69	581	228
Electrical Conductivity (µS/cm)	643	578	3157	717
Calcium	40	0.4	106	46
Magnesium	16	8.1	123	16
Sodium	49	81	320	60
Potassium	15	2.5	27	16
Bicarbonate as $CaCO_3$	167	18	477	208
Sulphate	82	129	601	95
Chloride	35	50	440	27
Cyanide	<0.01	<0.01	<0.01	<0.01
Aluminium	0.05	1.54	18.02	0.03
Arsenic	0.002	0.007	0.004	0.008
Boron	0.02	0.06	0.04	0.03
Cadmium	0.00015	0.00027	0.00111	0.00015
Chromium	0.002	0.002	0.007	0.00
Cobalt	0.0124	0.0131	0.0865	0.0043
Copper	0.0008	0.0027	0.0450	0.0011
Iron	3.22	2.08	2.49	0.89
Lead	0.0025	0.0070	0.0604	0.0050
Manganese	0.726	0.009	0.352	0.289
Mercury	<0.0001	0.0002	<0.0001	<0.0001
Nickel	0.024	0.024	0.135	0.018
Selenium	<0.001	<0.001	0.003	0.002
Silver	<0.001	<0.001	0.006	<0.001
Zinc	0.058	0.150	0.662	0.085
Ammonia	0.18	0.39	1.64	0.18
Nitrate	0.02	0.05	1.17	0.08
Reactive Phosphorus	0.02	0.03	0.09	0.04
Total Phosphorus	0.27	0.17	0.30	0.32

The dewatering is not expected to have an adverse impact on water quality in the surface water system. In the case of Open Cut 2 and especially Open Cut 3, the dewatering is likely to reduce the volume of the groundwater baseflow component as a percentage of total flow in the surface water as a result of the loss of seeps or soaks would contribute to the base flow. This will result in a corresponding improvement in the average water quality of Moolarben Creek and Lagoon Creek, which should also have a flow on effect to the water quality in Goulburn River.

5.6.8.5 Potential Impacts on Alluvium in the Moolarben Creek – Lagoon Creek Catchment

Open Cut 1

Based on the relative pit floor levels and the alluvium groundwater level, together with the separation between the pit and the edge of the alluvium, it is predicted that Open Cut 1 will have no direct impact on surface water flow or quality in Moolarben Creek, or on groundwater levels or quality in the Moolarben Creek alluvium.

Open Cut 2

Based on the relatively shallow depth of coal in Open Cut 2, the low water table level, the lateral separation of at least 200m between the proposed pit and the edge of the alluvium, and the occurrence of granite outcrop between the pit and the alluvium, it is predicted that Open Cut 2 will have no direct impact on surface water flow or quality in Moolarben Creek and Lagoon Creek, or on groundwater levels or quality in the alluvium associated with those creeks.

Open Cut 3

Open Cut 3 is located well away from Moolarben Creek and in most areas the lowest floor elevation of the open cut will be at or above the creek-bed level. However, the southern end of the open cut is approximately 5m below the current Permian groundwater levels. Mining in the south eastern corner of Open Cut 3 comes close to the ephemeral tributary of Spring Creek. Given existing groundwater levels are 10m below Spring Creek, a drawdown of 5m is not expected to have a material impact on flows in Spring Creek or associated alluvium.

Open Cut 3 is predicted to have no direct impact on surface flow in Moolarben Creek or on groundwater levels or quality in the alluvium associated with Moolarben Creek.

Open Cut 3 is also more than 750m from the edge of the Lagoon Creek alluvium at its closest point, and the pit floor level will be more than 20m above the creek-bed level. Open Cut 3 will have no direct impact on flows or quality in Lagoon Creek.

5.6.8.6 Potential Impacts on Goulburn River Alluvium

As the groundwater levels are already well below the base level of the Goulburn River, it is predicted that the mining in Open Cut 1 and in Underground No. 4 will have no impact on flow or quality in Goulburn River. There is apparently no groundwater present in the Quaternary alluvium, and groundwater levels in the Tertiary alluvium, if present at all, are also well below both the Goulburn River bed level and the base of the associated Quaternary alluvium. Groundwater levels in the Permian coal measures at the southern end of Underground No. 4 are already lower than the base of the Tertiary paleochannel alluvium.

5.6.8.7 Groundwater Users

Five seeps and/or groundwater-fed dams within or close to the open cut footprints will be lost as a result of the project. A further 19 groundwater-fed dams or soaks, located within Murragamba Valley, are within an area where the Permian coal measures aquifer is predicted to become dry during the mining operation, but is expected to recover fully after project completion. They may dry up temporarily as a result, although it is believed that they are more likely to be fed by the surficial aquifer system, which is believed to be unconnected with the underlying deeper Permian aquifer, and may therefore remain unaffected.

The licensed potable/fire water supply bore used by Ulan Coal Mine, which is believed to be located above the Underground No. 4 mine area, is expected to be significantly impacted by the Moolarben dewatering. An additional drawdown of 24m is predicted. A number of Ulan Coal Mine monitoring bores located west of Underground No. 4 are also predicted to experience additional drawdowns of between 11m and 45m.

Two licensed domestic bores which are drawing water from the Triassic Narrabeen Group aquifer system could be minimally affected by the drawdown impacts from the mining project.

Additional drawdowns of up to 0.2m and 1.8m are predicted at the Elward and Mullins-Imrie bores respectively. Strata Engineering have predicted that subsurface cracking from the goaf zone may extend up to about 50m to 75m above the longwall panels, with a 5% chance that continuous cracking might extend as high as 75m to 90m, i.e. to close to the base of the Triassic sediments in the northern part of Underground No. 4. Subsurface cracking is not expected to extend fully to the surface or to connect with surface cracking, except possibly at the very southern end of Underground No. 4.

There is expected to be no impact by the MCP on groundwater users of all bores, wells and soaks situated west of the subcrop line of the Permian sediments or those water sources located with the quaternary alluvium. This includes all the properties in the small lots around Ridge Road on the western side of the Mudgee-Cassilis Road, as well as those properties situated on granite or volcanics on the eastern side of the road.

"The Drip" and similar seepage zones along the Goulburn River are the only known vegetation nearby that is uniquely sourcing water from groundwater. These seepages are totally supported by rainfall infiltrating into the natural ground surface above and up gradient from the discharge points. There is no possibility that these high level seepages such as the Drip are derived from groundwater under pressure rising from depth. As such these seepages will not be affected by either subsidence or mine dewatering associated with the MCP. Groundwater dependant ecosystems have been addressed in further detail within Section 5.13 Ecology.

5.6.9 Groundwater and the Final Pit Voids

Small final pit voids proposed for Open Cut 1 and Open Cut 3 will extend below the current water table level of the Permian Coal Measures groundwater. The final void in Open Cut 2 is expected to be above the water table, as the Ulan Seam and overlying coal measures are largely unsaturated in that area.

5.6.9.1 Open Cut 1 Final Void

Open Cut 1 has two proposed voids. One void is located east of the infrastructure area and will potentially be used for future access to other coal resources east of the current application area. The main final void is located in the northern end of Open Cut 1 with a floor elevation of approximately 355m AHD. Modelling has indicated that 10 to 20 years after the completion of mining subject to their being no further mining in the vicinity that water levels could recover to 400m AHD, although without pre-Ulan Coal Mine groundwater levels the accuracy of this prediction is uncertain.

It is proposed to use this void for the disposal of tailings and reject associated with this application and also for other coal reserves within EL 6288. This void may also be used as a water storage area for years when mine inflows exceed water demand. If the void was to remain unfilled it is likely that it would remain as a local groundwater sink, due to the evaporation of groundwater inflow.

To mitigate this void creating a local groundwater sink it would be necessary to backfill the void to a level above the predicted post mining recovery level. Other measures such as minimising the surface area of the void could also lessen the predicted impacts.

5.6.9.2 Open Cut 3 Final Void

In Open Cut 3, a small final void is proposed for the southern end of the pit. The base level of this proposed pit void will be up to 5m below the anticipated recovery water level. This void is expected to constitute a local groundwater sink, due to evaporation from the open water surface in the pit. With a maximum water depth of only 5m, the evaporation effect is likely to prevent a permanent water body from developing in this void.

To mitigate this void creating a local groundwater sink it would be necessary to backfill the void to a level above the predicted post mining recovery level. Other measures such as minimising the surface area of the void could also lessen the predicted impacts.

5.6.10 Groundwater Impact Mitigation and Management

5.6.10.1 Groundwater Monitoring

It is recommended that the groundwater discharges be monitored closely through the project life. This would include volumes and quality of water discharged from the mine and/or pumped from dewatering and water supply bores, and groundwater levels measured in all pumping bores. It is also recommended that the baseline monitoring program be continued.

Thus the project monitoring program would include the following elements:

- Groundwater extraction volumes – weekly totals from all pumping bores, and weekly totals from each underground pumping station;
- Groundwater discharge quality – weekly measurements on site of the EC and pH of each groundwater extraction, both bores and underground pumping stations;
- Quarterly sampling from all pumping bores and underground pumping stations for comprehensive laboratory analysis, to include:
    - Physical parameters – EC, TDS, TSS and pH;
    - Major cations (calcium, magnesium, sodium and potassium) and anions (carbonate, bicarbonate, sulphate and chloride);
    - Dissolved metals (aluminium, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, selenium, zinc);
    - Nutrients (ammonia, nitrate, phosphorus, reactive phosphorus); and
    - Fluoride, cyanide;
- Monthly water level measurements from the existing network of monitoring bores, together with additional monitoring bores to be installed within the Triassic sediments above and to the north of Underground No. 4; and
- Annual sampling of monitoring bores for laboratory analysis of the above comprehensive suite of analytes.

5.6.10.2 Review and Reporting

The above monitoring data should be subjected to an annual review by a competent hydrogeologist to assess the impacts of that the project has had on the groundwater resources and comparison with the groundwater flow model predictions. It is also recommended that two years after commencement of coal production, a modelling post-audit should be carried out, in accordance with industry best-practice (MDBC, 2001), and if necessary the model should be re-calibrated and further forward predictions made at that time. Further post-audits should be carried out five-yearly through the remainder of the project.

Should any review or post-audit indicate a significant variance from the model predictions with respect to either water quality or groundwater levels, then the implications of such variance should be assessed, and appropriate response actions should be implemented in consultation with DNR, DPI and DEC as appropriate.

It is strongly recommended that the monitoring program be closely integrated as much as possible with the ongoing monitoring programs on the adjoining Ulan and Wilpinjong projects.

5.6.10.3 Groundwater Management Plan

A Groundwater Management Plan will be developed to manage groundwater across the MCP. A component of the management plan will include groundwater emergency response plans for implementation in the event of unforeseen adverse impacts on either groundwater or surface water from the MCP.

The plan, in addition to outlining necessary monitoring, review and reporting requirements, will outline the operational changes necessary and investigations required should water levels fluctuate by 20% from those predicted by the model or if groundwater quality worsens with a salinity change of 50% from that stated within Table 5.22.

5.7 Surface Water

Patterson Britton & Partners Pty Ltd was commissioned to undertake a surface water assessment of the project area. The complete report is appended as **Appendix 6**.

5.7.1 Existing Site Hydrology

The site for the proposed Moolarben coal mine is located primarily within the upper Goulburn River catchment. The upper Goulburn River, above the Ulan-Cassilis Road bridge, drains a catchment area of approximately 24,550 hectares. Moolarben Creek is one of many watercourses that drain to the headwaters of the Goulburn River at Ulan. The creek rises at an elevation of 670m AHD and flows in a northerly direction where it joins the Goulburn River at Ulan at an elevation of about 420m AHD.

Two major watercourses run through the MCP. These are the Goulburn River and the Moolarben Creek. The Goulburn River is a major tributary of the Hunter River, joining it downstream of Denman.

Moolarben Creek drains the area south of the Open Cut 3 mine. Spring Creek, a tributary of Moolarben Creek, also drains through the southern corner of Open Cut 3. Part of the Open Cut 3 area drains in a north and north-westerly direction towards Lagoon Creek, which is also a tributary of Moolarben Creek. Bora Creek, which is a tributary of the Goulburn River, drains through the proposed location for the main infrastructure area. The Bora Creek catchment extends across part of Open Cut 1 and the Underground No. 4 mine areas.

Runoff on the steep upper slopes above the three proposed open cut mine areas quickly becomes concentrated in numerous small ephemeral watercourses. These watercourses typically peter out at the boundary of the open cut areas where the steep forested slopes meet the lower pastured slopes within the Moolarben Creek/Goulburn River valley. Runoff continues across these pastured areas either as sheet flow or in ill-defined watercourses towards Moolarben Creek and the Goulburn River.

5.7.2 Existing Surface Water Quality

5.7.2.1 Baseline Monitoring

Nine (9) surface water monitoring sites were identified late 2004 (refer Figure 5.1) and have been sampled and analysed on a monthly basis for the following (pH, uS/cm, dissolved oxygen, oil and grease, alkalinity (bicarbonate-carbonate), Cl, SO_4, turbidity, TDS, Ca, Mg, K, Na, N, pH, anion sum and cation sum) by a National Association Testing Authority registered laboratory. A summary of the results for selected analytes is contained within **Table 5.24**.

As shown in Figure 5.1, the sampling sites include the following, which are located within the catchment of Moolarben Creek and the Goulburn River:

- SW1, which is located along the Goulburn River downstream of the "The Drip". This sampling site is located outside of EL 6288;
- SW2, which is located along the Goulburn River at "The Drip'". This sampling site is located within EL 6288;
- SW3, which is located along Murragamba Creek near Murragamba Road. This sampling site is located within EL 6288;
- SW4, which is located along the lower reaches of Murragamba Creek near Wilpinjong Creek. This sampling site is located within EL 6288;
- SW5, which is located at the Ulan- Cassilis Road crossing of Moolarben Creek/Goulburn River, near Ulan Village. This sampling site is located within EL 6288;
- SW6, which is located along Ryans Creek near Ulan Road This sampling site is located outside of EL 6288;
- SW7, which is located within the “swampy section” of Lagoon Creek. This sampling site is located within EL 6288;
- SW8, which is located along Moolarben Creek approximately midway between it’s junction with Spring Creek and Lagoon Creek. This sampling site is located within EL 6288; and
- SW9, which is along Moolarben Creek near the southern boundary of the EL. The sampling site is located within EL 6288.

5.7.2.2 Salinity

Salinity has been measured as conductivity with units in µS/cm. The data shows that average conductivity ranges from 260µS/cm at site SW6 (located along Ryans Creek) to over 4600 µS/cm at site SW8 (located along Moolarben Creek upstream of Lagoon Creek).

The monitoring data indicates that elevated conductivity is evident in streamflows in the upper sections of the catchment, and particularly along Lagoon Creek and Moolarben Creek upstream from its confluence with Lagoon Creek. In contrast, the results show low salinity concentrations along Ryans Creek, which drains the western section of the catchment. This is due to the presence of highly saline soils in the upper sections of the Moolarben Creek catchment. Soils in the western section of the catchment, including the Ryans Creek subcatchment, are significantly less saline (refer Appendix 9).

Table 5.24: Water quality results ending July 2006 for the Moolarben Coal Project

Monitoring Site	Description of Site	Sampling Dates	Value	pH - field	Electrical Conductivity µS/cm - field	Dissolved Oxygen mg/L	Turbidity (NTU)	Total Dissolved Solids@ 180 (mg/L)	Total Suspended Solids@105C (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Chloride (mg/L)	Sulfates (mg/L)	Alkalinity – Bicarbonate mg CaCO3/L	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
ANZECC 2000_A				6.5--8.0	30--350	7.7--9.4	2--25	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.25	0.02
ANZECC 2000_B				6.0-9.0	<7500			<5000										
SW1	Goulburn River	Monthly between Feb 2005-Jul 2006	Min Value	6.2	495	7.6	0.8	310	2.0	13.0	11.0	60.0	5.6	68.0	56.0	54.0	0.17	0.01
			Max Value	8.1	880	13.9	48	430	8.0	22.0	18.0	88.0	7.4	110.0	120.0	100.0	0.48	0.05
			Av Value	7.1	**695.5**	**9.8**	6.9	360	4.67	17.8	14.3	71.2	6.59	85.9	83.9	69.6	**0.30**	0.02
SW2	Goulburn River, The Drip Picnic Area	Monthly between Feb 2005-Jul 2006	Min Value	6.6	465	2.2	2.3	300	4.0	14.0	12.0	64.0	5.9	69.0	12.0	57.0	0.25	0.01
			Max Value	7.6	1200	11.2	59	470	12.0	25.0	20.0	94.0	7.9	120.0	140.0	127.0	0.52	0.05
			Av Value	7.09	**770.5**	**7.1**	13.3	401	6.71	19.8	16.1	81.2	6.83	98.4	79.8	96.7	**0.37**	0.02
SW3	Murragamba Ck, Road crossing	Monthly between Feb 2005-Jul 2006	Min Value	5.9	210	1.5	6	190	5.0	3.5	4.0	19.0	4.2	36.0	3.0	8.0	0.14	0.02
			Max Value	7.4	1080	9.25	750	580	400	24.0	23.0	93.0	8.6	240.0	48.0	82.0	1.50	0.46
			Av Value	6.53	**595.3**	**6.3**	**125.1**	326.25	68.69	13.9	13.11	48.81	6.41	111.63	15.94	41.56	**0.72**	**0.11**
SW4	Wilpinjong Ck, Wollar Road	Monthly between Feb 2005-Jul 2006	Min Value	5.1	150	0.5	8.4	220	5.0	2.3	3.8	15.0	4.8	22.0	2.0	20.0	0.14	0.03
			Max Value	7.4	1420	9.55	830	730	440	18.0	29.0	140.0	11.0	320.0	35.0	97.0	1.40	0.51
			Av Value	**6.49**	**564.7**	**5.2**	**263.2**	386.9	122.75	8.86	11.39	55.19	7.08	100.88	13.83	53.88	**0.98**	**0.17**
SW5	Goulbourn River, Ulan Village	Monthly between Feb 2005-Jul 2006	Min Value	6.0	370	3.9	2.8	330	2.0	12.0	9.0	41.0	3.0	68.0	1.6	24.0	0.09	0.02
			Max Value	7.6	1350	9.9	160	660	130	56.0	32.0	120.0	7.4	220.0	200.0	140.0	1.20	0.16
			Av Value	6.83	**818.1**	**6.98**	**25.5**	436.25	17.06	22.0	16.44	85.13	5.03	145.69	42.12	86.69	**0.73**	**0.04**

Monitoring Site	Description of Site	Sampling Dates	Value	pH - field	Electrical Conductivity µS/cm - field	Dissolved Oxygen mg/L	Turbidity (NTU)	Total Dissolved Solids@ 180 (mg/L)	Total Suspended Solids@105C (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Chloride (mg/L)	Sulfates (mg/L)	Alkalinity – Bicarbonate mg CaCO3/L	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
SW6	Ryan's Creek, Ulan Road	Monthly between Feb 2005 - Jul 2006	Min Value	6.10	200	7.9	6	160	3.0	1.0	2.20	24.0	1.1	21.0	9.30	24.0	0.20	0.01
			Max Value	7.70	400	11.3	150	450	240.0	1.4	3.30	36.0	2.4	35.0	20.0	37.0	2.80	0.11
			Av Value	6.94	261.5	**9.6**	**26.6**	186.9	35.8	1.22	2.71	31.4	1.67	27.69	13.64	31.69	**2.08**	**0.04**
SW7	Head water Lagoon Ck	Monthly between Feb 2005 - Jul 2006	Min Value	6.70	2490	2.00	1.2	1500	2.0	90	81.0	240	3.90	460	250	145	0.22	0.01
			Max Value	8.00	5800	13.5	44	4100	64.0	360	240	670	25.0	1300	830	435	4.90	0.33
			Av Value	7.28	**4477**	8.4	7.3	2894.1	14.9	240.2	164.8	429.4	13.1	1001.7	567.1	269.9	**1.56**	**0.07**
SW8	Moolarben Creek	Monthly between Feb 2005 - Jul 2006	Min Value	5.30	3250	0.2	1.5	1800	6.0	45	100	330	12.0	730	200	8.0	0.10	0.02
			Max Value	7.30	6990	10.5	240	6400	310	230	470	1200	28.0	2600	980	140	2.00	0.46
			Av Value	**6.07**	**4602.5**	**6.6**	**85.4**	2818.75	53.25	68.63	190.6	540	17.1	1233.1	357.5	66.25	**0.87**	**0.10**
SW9	Moolarben Creek, Moolarben Road	Monthly between Feb 2005 - Jul 2006	Min Value	0.80	3180	3.0	2	1800	2.0	65	110	310	13.0	730	200	133	0.22	0.01
			Max Value	7.90	4550	11.5	99	2900	38.0		170	530	21.0	1100	370	295	0.73	0.07
			Av Value	6.59	**3973.8**	**7.5**	15.45	2256.3	11.06	76.5	132.5	461.9	16.3	915.3	271.25	244.4	**0.46**	**0.03**

Note: Yellow and bold represents average values that are below lower limits for the ANZECC 2000 trigger values for the Protection of Aquatic Ecosystems. Blue and bold represents average values that are above the upper limits for the ANZECC 2000 trigger values for the Protection of Aquatic Ecosystems.

ANZECC A – represents the Aquatic Ecosystem Guidelines

ANZECC B – represents the Livestock drinking water guidelines

Notably, the average conductivity recorded at site SW5 (Moolarben Creek upstream of Ulan) is less than 20% of the average recorded in the upstream section of Moolarben Creek (SW8). This site is downstream of the Ryans Creek confluence and the results suggest that the lower conductivity at this location may be attributed to dilution due to increased stream flows.

Further reductions in conductivity are observed for SW1 and SW2. Both the sites are downstream. As a consequence, background conductivity levels in the Goulburn River below Bora Creek, are in the order of 700µS/cm.

5.7.2.3 pH

Data collection for pH provides a measure of how balanced the acid/alkali ratio is within the waterways. As discussed above, the presence of acid soils is significant in the upper Moolarben Creek. All sites monitored are within the ANZECC guidelines of between 6.0 and 9.0, with the exception of SW8, which is located immediately downstream of the acid soils area.

5.7.2.4 Nutrients

Nutrients (i.e. nitrogen and phosphorus), are a key indicator of water quality. Excessive nutrient quantities can lead to degradation of water quality by promoting excessive growth, accumulation, and subsequent decay of plants, especially algae. Some nutrients can also be toxic to animals at high concentrations.

The nutrient results documented in Table 5.24 indicate that phosphorus and nitrogen concentrations at all sampling site are generally in excess of ANZECC guidelines for aquatic ecosystems. In particular Ryans Creek exhibits total nitrogen levels that are around ten times greater than ANZECC guidelines. Wilpinjong Creek also exhibits total phosphorus levels that are approximately fifteen times greater than ANZECC guidelines.

The elevated nutrient levels at these locations could be primarily attributed to land use in the area. For example, it is likely that fertilizers may be used across as\adjoining farmland, which can lead to elevated nutrient levels.

5.7.3 ANZECC 2000 Guidelines

The main objective of the ANZECC (Australia New Zealand Environment and Conservation Council) 2000 guidelines is "*to provide an authoritative guide for setting water quality objectives required to sustain current or likely future environmental values for natural and semi-natural water resources in Australia and New Zealand."*

The ANZECC 2000 guidelines are intended to provide government, industry, consultants and community groups with the ability to assess and manage ambient water quality. The ANZECC 2000 guidelines specify the recommended limits for acceptable change in water quality that would continue to protect existing environmental values. The guidelines have no legal status and do not signify threshold levels of pollution, since there is no certainty that significant impacts will occur above these recommended limits. The guidelines provide certainty that there will be no significant impact on water resource values if the guidelines are achieved (ANZECC 2000).

5.7.4 Potential Surface Water Impacts

Potential impacts to surface water as a result of the MCP are outlined in the following sections.

5.7.4.1 Infrastructure Areas

- Contaminated runoff from road and hardstand areas;
- Contaminated runoff from the mine facilities area (e.g., workshop buildings and vehicle re-fuelling hardstands);
- Effluent overflows from domestic sewerage;
- Contaminated runoff from tailings disposal areas; and,
- Potentially contaminated runoff and seepage from the ROM and product stockpiles.

These activities could adversely impact on the water quality of runoff carried by Bora Creek and subsequently on the water quality of flows carried by the upper reaches of the Goulburn River. Contamination of the surface water could include hydrocarbons, acids, salts and sediment, which may or may not have collected other pollutants.

5.7.4.2 Open Cut Areas

The impacts on stream hydrology associated with all three open cut mines are considered to be similar due to their location relative to the creeks that the land surface currently drains to. The potential impacts of the open cut mines on stream hydrology and water quality include:

- Re-allocation/recomposition of catchment areas and subsequent impact on surface flows due to earthworks to construct open cut areas and associated infrastructure;
- Export of contaminated runoff (e.g., incorporating increased sediment and salinity) from disturbed mine areas into Moolarben Creek
- Alteration of runoff and groundwater seepage from active and partially rehabilitated mine waste areas;
- Changes to ground water flows and salt flux due to water table drawdown effects from dewatering of the open cut areas;
- Potentially contaminated mine water from dewatering of the active open cut; and,
- Alterations to surface water runoff and groundwater flows leading to reductions in riparian flows along Moolarben Creek and a reduction in the potential for recharge of the existing Moolarben Creek Dam.

As the open cut operations proceed, the earthworks associated with construction of the open cut areas and associated infrastructure (*e.g., environmental bunds, haul roads*), will alter the catchments both in size and in composition. Contaminated waters may include sediments, salts, acid, and hydrocarbons (oils, fuels and grease) from infrastructure and mining areas.

The composition change of the catchment will be from vegetated land to unvegetated soils, with occasional areas of impervious hardstand. This may increase the rate and volume of surface water runoff. Associated with this is the potential for contamination of surface water runoff as rain falls on open cut areas of coal / spoil. The primary impact of this is a likely increase in salinity.

Dewatering of the active open cut will also have an impact on hydrology and water quality as this is likely to comprise both groundwater inflow and runoff from rainfall over the active mine catchment. Dewatering will effectively lower the groundwater table in the vicinity of the mine areas, thereby reducing the potential for "baseflows" to discharge from the existing groundwater aquifer system into Moolarben Creek. That is, lowering of water levels in the aquifer could have an impact on environmental flows carried by Moolarben Creek and the upper reaches of the Goulburn River, which could in turn affect vegetation along the riparian corridor and aquatic ecosystems. This may also reduce the potential for recharging of the Moolarben Creek Dam.

However, it should be recognised that the section of the Goulburn River that could be affected is already a highly modified system incorporating a dam, culverts and roadway crossings as well as a significant diversion, and is likely to have limited linkage to the aquifer. Moreover, that section of the Moolarben Creek catchment covered by the MCP, comprises only a comparatively small proportion of the total Moolarben Creek catchment. Accordingly, minor alterations to the catchment hydrology across the mine areas is unlikely to have a significant impact on the broader hydrology of Moolarben Creek.

Nevertheless, it is anticipated that the MCP will require the diversion of surface water and the development of a network of swales, channels and storage ponds to manage contaminated surface and groundwater from the mine areas and mitigate any potential adverse impacts on the environment of adjoining areas.

Results of the geochemical assessment of overburden, coal and reject concluded that while the overburden was generally non-saline and not acid forming, the coal and reject have some capacity to generate acid.

5.7.4.3 Underground Area

Subsidence impacts associated with the mining of Underground No.4 (as assessed by Strata Engineering 2006) are likely to impact surface waters as follows:

- Cracks within drainage gullies or creek beds are only likely to impact sections where sandstone outcrops exist. These could result in sub-surface re-routing of surface flows during storm periods (i.e. when the ephemeral drainage gullies are likely to flow);
- The predicted 'upsidence' will probably cause some localised deviation of surface flows along ephemeral creek beds into sub-surface routes above the longwall panels. Surface flows would be expected to re-surface down stream of the damaged area; and
- Some low lying areas in the northern area of Underground No.4 could become poorly drained or boggy after the extraction of Longwalls 12 to 13. In this case, the pattern of drainage may need to be augmented to restore it to pre-mining conditions through surface and sub-surface drainage works.

5.7.5 Surface Water Management

The management of surface water impacts and resulting mitigation will be subject to the development of a Site Water Management Plan (SWMP). Surface water management within the mine infrastructure area will be designed in accordance with the relevant guidelines for erosion and sediment control, including those outlined by the Department of Housing (*1998*) and the Department of Natural Resources (*1999*) and where relevant, to a standard consistent with guidelines outlined in the Landcom document titled, *'Managing Urban Stormwater Soils and Construction'* (*2004*)'. The following sections outline the measures adopted to mitigate surface water impacts.

5.7.5.1 Construction Phase

Erosion and sediment control measures will be implemented during the construction phase of the MCP to control the quality of runoff from the site. These measures will include:

- Construction and regular maintenance of catch drains, silt fences and sedimentation ponds to contain sediment downslope of disturbed areas;
- Construction of the sedimentation ponds within the mine infrastructure area;
- Seeding and, where required, controlled fertilising of all disturbed areas to provide for rapid grass cover;
- Development of an appropriate inspection, maintenance and management system; and
- Placement of oil management systems downslope of high trafficked hardstand areas.

5.7.5.2 Operational Phase

Erosion and sediment control measures that will also be implemented during the mine life. These measures will include:

- Clear identification and delineation of areas that will be disturbed as part of the mining process so that disturbance is limited to those areas;
- Minimising the clearing of vegetation to allow the works to proceed and to minimise machinery disturbance outside of these areas;
- Limiting the number of roads and tracks established;
- Construction of sediment dams to capture, contain and recirculate runoff from disturbed catchment areas;
- Construction of drains upslope of areas to be disturbed to convey clean runoff away from most disturbed areas;
- Constructing access road and earthworks cut and fill batters at slopes (of 1V:3H or less, where possible), to maximise long term stability;
- Reshaping, topsoiling and vegetating road and cut and fill batters as soon as practical;
- Progressively stripping and stockpiling topsoil for later use in rehabilitation;
- Diversion of surface and road runoff away from disturbed areas;
- Regular maintenance of erosion control works and rehabilitated areas;
- Progressive stabilisation and revegetation of disturbed areas;
- Placement of oil management systems downslope of high trafficked hardstand areas; and
- Enhancement and stabilisation of existing lands outside the area of the mine foot print.

5.7.5.3 Water Balance Modelling

Normally, the objective for managing surface water runoff at a coal mine would be to limit the amount of clean water that will run off the catchment and become 'dirty' or contaminated due to it flowing across either open pits or mine infrastructure areas.

However, in the case of the MCP, the amount of clean water runoff that could drain to operational open cut areas is relatively small. This is due to the relatively small catchments extending upstream from the open cut mine areas, and the large areas taken up by either the mine infrastructure or the active pit areas. Therefore, for the purposes of the water balance analysis for this project, it has been assumed that all rainfall that falls on catchments that drain to mine areas should be considered to be 'dirty'.

Accordingly, there is a need to control all runoff that enters the operational areas of the mine so that it does not discharge to the Goulburn River, Moolarben Creek or Bora Creek. The objective of the surface water management strategy for the mine is to direct this water to strategically located sedimentation ponds and to re-use it within open cut operations and for irrigation of rehabilitated areas.

A water balance model was employed to estimate the maximum amount of surface water that will require management around the open cut areas and the mine infrastructure area. The water balance model was created using the Model for Urban Stormwater Improvement Conceptualisation (*MUSIC*) software package which has been developed by the Cooperative Research Centre (*CRC*) for Catchment Hydrology. MUSIC uses meteorological data and user-defined catchment parameters to simulate the quantity and quality of runoff from a catchment over a specified time period (*e.g., a month year*).

The MCP water balance model was constructed with the following principal assumptions:

- The open cut layouts intercept rainfall in the sub-catchments;
- Rehabilitated areas are graded to allow gravity drainage to the collection swales;
- All rain falling on the catchment is considered ‘dirty’; and,
- Seepage losses from sedimentation ponds and swales are assumed to be negligible.

The 6 month and 10 year conceptual stormwater management plans are shown by **Figures 5.15** and **5.16** and **Plans 27** and **28** of **Volume 2** respectively.

The water balance model was used to determine the volume of runoff from each catchment area that will drain to open cut pits or the mine infrastructure area. The analysis was based on wet weather conditions and an assumed volume of mine water that would be re-used for vegetation rehabilitation or dust suppression in the respective catchments.

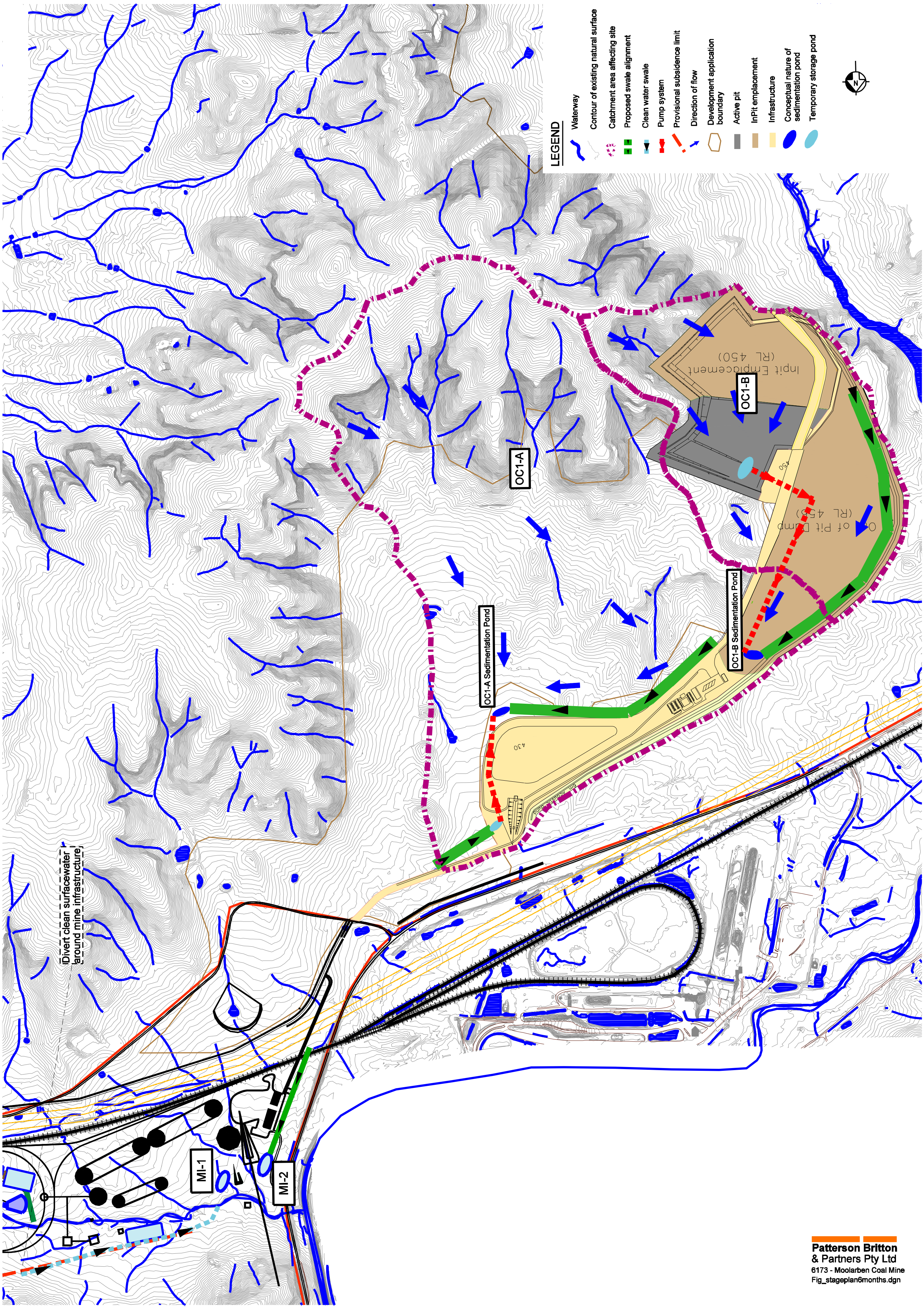
5.7.5.4 Treatment of Dirty Water

Water coming into contact with areas of mining operations needs to be treated prior to re-use. Sedimentation ponds will be the main form of treatment of this ‘dirty’ water.

A series of catch drains will be constructed across the open cut pits and at strategic locations with the mine infrastructure area to convey runoff from the overburden emplacement areas to the proposed sedimentation ponds. The catch drains will be designed to convey peak discharges in the design 20 year ARI storm event. In addition, catch drains will be constructed to limit the potential for erosion at the base of emplacement areas or along the top of the pit wall.

Sedimentation ponds are proposed to be constructed on the north western edge of Open Cuts 1 and 2 and on the eastern edge of Open Cut 3. Rainwater and groundwater that accumulates within the open cut pits will be collected and pumped to the sedimentation basins for treatment. It is assumed that sedimentation ponds can be progressively constructed as open cut mining proceeds. Treated water will be extracted from the sedimentation ponds for use in dust suppression within the open cut pit.

Within the mine infrastructure area a clean water swale located to the north, upslope of the CHPP facilities, will divert clean water coming from the escarpment above Underground No.4 to Bora Creek to prevent contamination. Runoff from the mine infrastructure area will be conveyed to a sedimentation pond MI-2, which is to be located adjacent the transport portal (refer Figure 4.15 and Plan 12a in Volume 2).



Pegasus Technical

Moolarben Coal Project

Conceptual Stormwater Management at 6 months

PATTERSON BRITTON & PARTNERS PTY LTD

Figure 5.15

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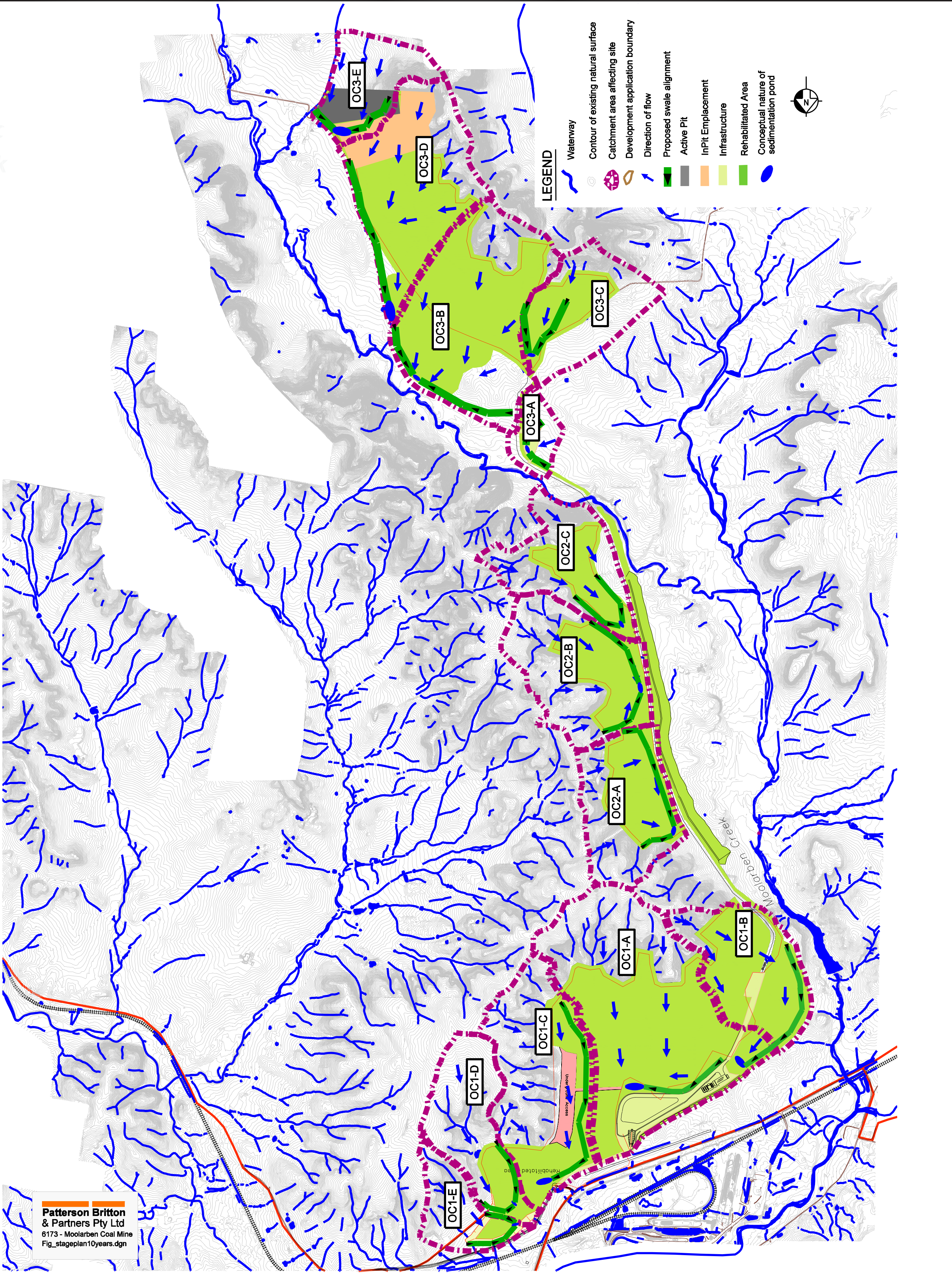

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Moolarben Coal Project

Conceptual Stormwater Management at Year 10

PATTERSON BRITTON & PARTNERS PTY LTD

Figure 5.16

Sedimentation ponds will continue to operate following the completion of mining and during the rehabilitation phase. Runoff from rehabilitated areas will be collected, pumped to the sedimentation ponds for treatment and extracted for use in ongoing irrigation for rehabilitation of the site. The sedimentation ponds will be decommissioned once rehabilitated areas are satisfactorily established.

5.7.5.5 Treatment of Coal Preparation Plant Tailings

A high rate tailings thickener will be used to thicken the fine reject material from the coal preparation plant that is to be located in the mine infrastructure area. The thickener underflow is proposed to be dewatered using belt filter presses and the filter cake will be added to product or to the reject where it will be conveyed to the open cut for disposal in the overburden. The water will be reintroduced into the coal processing circuit.

A tailings dam will be provided to cater for emergency tailings storage should the tailings filters fail or need to be removed from service for maintenance. This dam will also be used to store runoff from contaminated areas of CHPP area. Solids will be removed from the dam periodically after settling and will be trucked to disposal areas in the overburden. Water will be returned to the preparation plant coal processing circuit.

5.7.6 Monitoring

The following recommendations are made for monitoring surface waters and the water management system during the mine life:

- A gauging station should be established on Moolarben for low flows and changes in EC;
- A comprehensive and auditable monitoring and reporting programme should be included in a SWMP. The SWMP should also document management procedures for water pollution control and the operation of the water management system. The SWMP should be updated periodically;
- The baseline water quality monitoring programme should continue on Moolarben Creek, and be extended to Bora Creek to include sampling at points upstream and downstream of the infrastructure area when there is flow in the stream. Water sampling should be conducted during representative flow events. Samples should analysed as for pH, turbidity, salinity and suspended solids as a minimum;
- Operational water quality monitoring should be conducted. Monitoring should target all significant runoff events (i.e., greater than 20 mm in 24 hours). Samples should also be collected from tailings disposal areas initially on a monthly basis and tested for pH and salinity;
- Water levels (reduced to a common datum) should be recorded in all on site water storages and tailings disposal areas on a monthly basis;
- Install and monitor survey lines along ephemeral drainage gullies and along gully crests during and after longwall undermining. Combine with visual inspections to locate damage (cracking, uplift) in drainage lines and ephemeral creeks; and
- The conceptual water balance model should be used to monitor the water balance performance of the Project and to inform planned upgrades or changes to the water management system.

5.7.7 Contingency Measures

There are a range of contingency measures that can be implemented if unforeseen or unacceptable levels of impact are identified during the mine life, these include:

- Provision of flocculation equipment on sedimentation ponds to improve the rate of sedimentation;
- Augmenting the sediment dams to create greater retention volume and residence time to increase the capacity for suspended sediment to settle out;
- Increasing pumping capacity at each of the sedimentation ponds to minimise the potential for sediment laden discharges from the ponds;
- Preferentially discharging treated clean water collected from Underground No.4 off site and the use of groundwater;
- Preferential use of pit-water (which will be the highest salinity water source in Open Cut 3) for dust suppression;
- Utilise the mine infrastructure tailings dam to augment the available wet weather storage afforded in the mine infrastructure area;
- Utilise captured dirty water for watering rehabilitated areas to promote plant growth and to apply additional water to haul roads to increase evaporation losses and reduce the overall volume of dirty water stored on the site;
- In wet periods, distribute surplus water to future mining operations proposed in other parts of EL 6288; and
- If greater than anticipated groundwater inflows occur, seek to enter into an agreement with Wilpinjong Coal Mine for them to take surplus groundwater from the Moolarben Coal Mine Project if they have insufficient water.

5.8 Flooding

Patterson Britton was commissioned to investigate the potential for inundation of the proposed MCP from the Moolarben Creek and Goulburn River for a range of flood designs. A copy of the Patterson Britton report is contained in **Appendix 6**.

Modelling was used to simulate the 5, 20 and 100 year recurrence floods using rainfall intensities for the study area as outlined in the “Australian Rainfall and Runoff – A Guide to Flood Estimation (1987)”. Modelling was undertaken for the Goulburn River, Moolarben, Spring, Lagoons, Bora, Ryan's and numerous unnamed creeks.

Proposed Open Cuts 1, 2 and 3 are located outside the predicted 100 year recurrence flood extent. Open Cuts 1, 2 and 3 will not impact on existing flood behaviour along the lower reaches of Moolarben Creek and sections of the Goulburn River adjacent to EL 6288.

Bora Creek extends across sections of Underground No. 4 and the main infrastructure area. Infrastructure associated with the MCP is above the 100 year recurrence flood event with the exception of a conveyor transfer station.

5.8.1 Impacts and Mitigation

The MCP is generally located outside the predicted 100 year recurrence flood event and will not adversely impact on existing flood behaviour across or outside EL 6288.

5.9 Subsidence

5.9.1 The Nature of Subsidence

"Subsidence" describes ground movement as a result of mining. Subsidence is the vertical distance the ground moves when it is undermined. The ground strains, tilt and curvature are the more important parameters when assessing the impact that subsidence might have on the ground surface and improvements. The natural surface and improvements can tolerate low levels of tilt and strain with no impact. High levels can cause damage. At the same time, many improvements can remain unaffected by subsidence.

Ground strains and curvature associated with substantial subsidence can have significant effects on large or continuous structures. Normal practice is to consider the impact of likely maximum subsidence on each structure separately.

Experience in NSW with rural and the natural environments has shown that the impact of subsidence can be assessed with a high level of certainty. Damage classifications for urban structures are applicable to rural improvements. The level of significance of ground cracking, tilting and related disturbances can be determined from subsidence, strain and tilt predictions, and the location of likely disturbance can be determined by overlaying subsidence predictions on the mine plan.

The design of the Underground No. 4 mine has been strongly influenced by the proximity of "the Drip", Goulburn River National Park, road and rail systems which are located in the area. Surface features within the Underground No. 4 area are shown by **Figure 5.17** and **Plan 29** in **Volume 2**. Wherever practicable, environmental impacts (including subsidence) associated with the MCP are contained within the Major Projects Application boundaries.

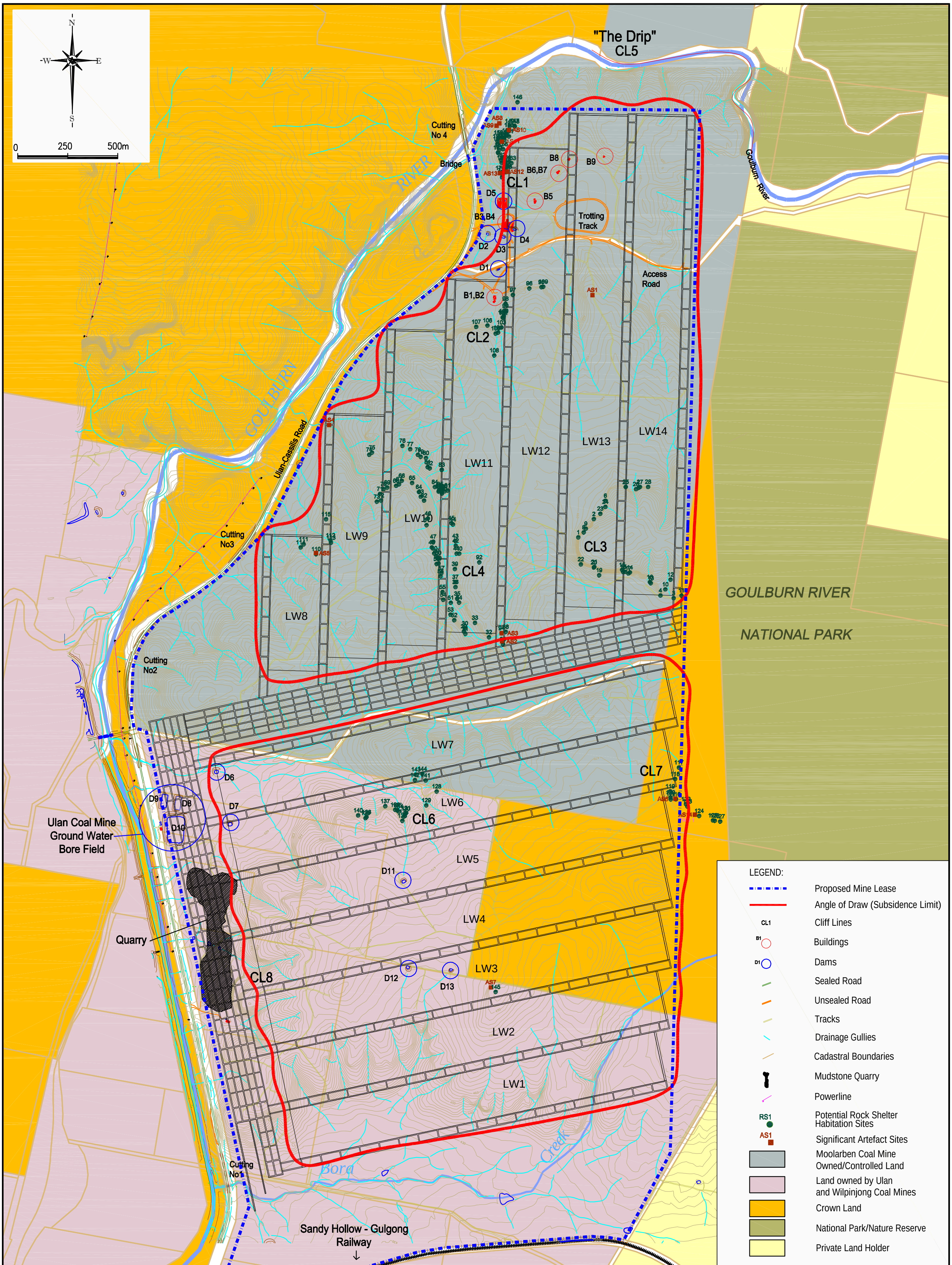
Strata Engineering (Australia) Pty Ltd (Strata Engineering) was commissioned by MCM to undertake a subsidence and impact assessment for the MCP underground mine comprising of fourteen (14) longwall panels. A copy of the report is contained in **Appendix 8**.

5.9.2 Design of Underground Mine and Subsidence Modelling

The MCP underground mine layout is divided into two areas, each containing seven longwall blocks. Longwall panels 1 to 7 will be developed and extracted from south to north and each panel mined in a westerly direction. Longwall panels 8 to 14 will be developed and extracted from west to east and each panel mined in a southerly direction. The main headings will have 6 roadways abreast and will be developed along the western and southern sides of each area.

The longwall panels will have a width of approximately 260m and a chain pillar width of approximately 35m. The average longwall face extraction height will range from 4.2m to 4.5m whilst roadways will be 3.5m. The cover depth over the 14 longwall panels ranges from 85m to 215m.

Subsidence impact parameter predictions have been made using Strata Engineering's empirically based subsidence prediction model, which allows the subsidence reduction potential of the Wollar Sandstone to be assessed. The model was initially developed with ACARP funding in 2003 to address the issue of geology in the context of subsidence prediction methodology. The model links the likely effects of massive strata units and structure in the overburden to the predicted subsidence impact parameter outcomes - summary details of the model are presented in **Appendix 8**.



Pegasus Technical

Moolarben Coal Project

Surface Level Features above Underground No.4

STRATA ENGINEERING (AUSTRALIA) PTY LTD

Figure 5.17

CAD FILE: Figure 5.17

Validation of the model using cross line and centre line data over Ulan Coal Mine’s LWs A, B and 1 to 19, indicates good agreement (i.e. >85% success rate) between the predicted Upper and Lower 95% confidence limits and measured subsidence, tilt and strain values.

5.9.3 Subsidence Impacts

The cover depth over the study area ranges from 85m to 215m with several massive sandstone units present above the Ulan Seam. The units range between 5m and 75m in thickness above the proposed longwalls and are located between 5m and 125m above the longwalls. It is assessed that the Wollar Sandstone will have 'High' Subsidence Reduction Potential above the longwalls that exist below the elevated plateaux areas.

Credible worst-case (i.e. Upper 95% Confidence Limit) subsidence parameter predictions have been determined beneath the key surface features due to the extraction of the proposed Moolarben longwalls in the Ulan Seam. Credible worst-case subsidence (S_{max}) over the longwalls is predicted to range between 1.81m and 2.44m for the range of cover depths. The predictions represent 0.4 and 0.6 times the proposed extraction height of 4.2m.

The proposed chain pillars located between LWs 1 and 14 are 35m wide and 3.5m high, with predicted subsidence values above the pillars ranging between 0.19m and 0.49m for double abutment loading conditions (i.e. after longwalls have extracted coal from both sides of the pillars).

Maximum transverse and longitudinal tilts are estimated to range between 23mm/m and 86mm/m. The measured tilts above the Ulan longwalls ranged between 5mm/m and 55mm/m.

Maximum transverse and longitudinal uniform tensile and compressive strains are expected to range between 8mm/m and 35mm/m with credible worst-case concentrated strains ranging from 14mm/m to 41mm/m predicted. The concentrated strains effectively double the uniform strains and are caused by the effects of cracking and variation of near surface beam thickness. The measured strains above the Ulan Coal Mine longwalls ranged between 3mm/m and 25mm/m, and are comparable to the proposed Underground No. 4 panels.

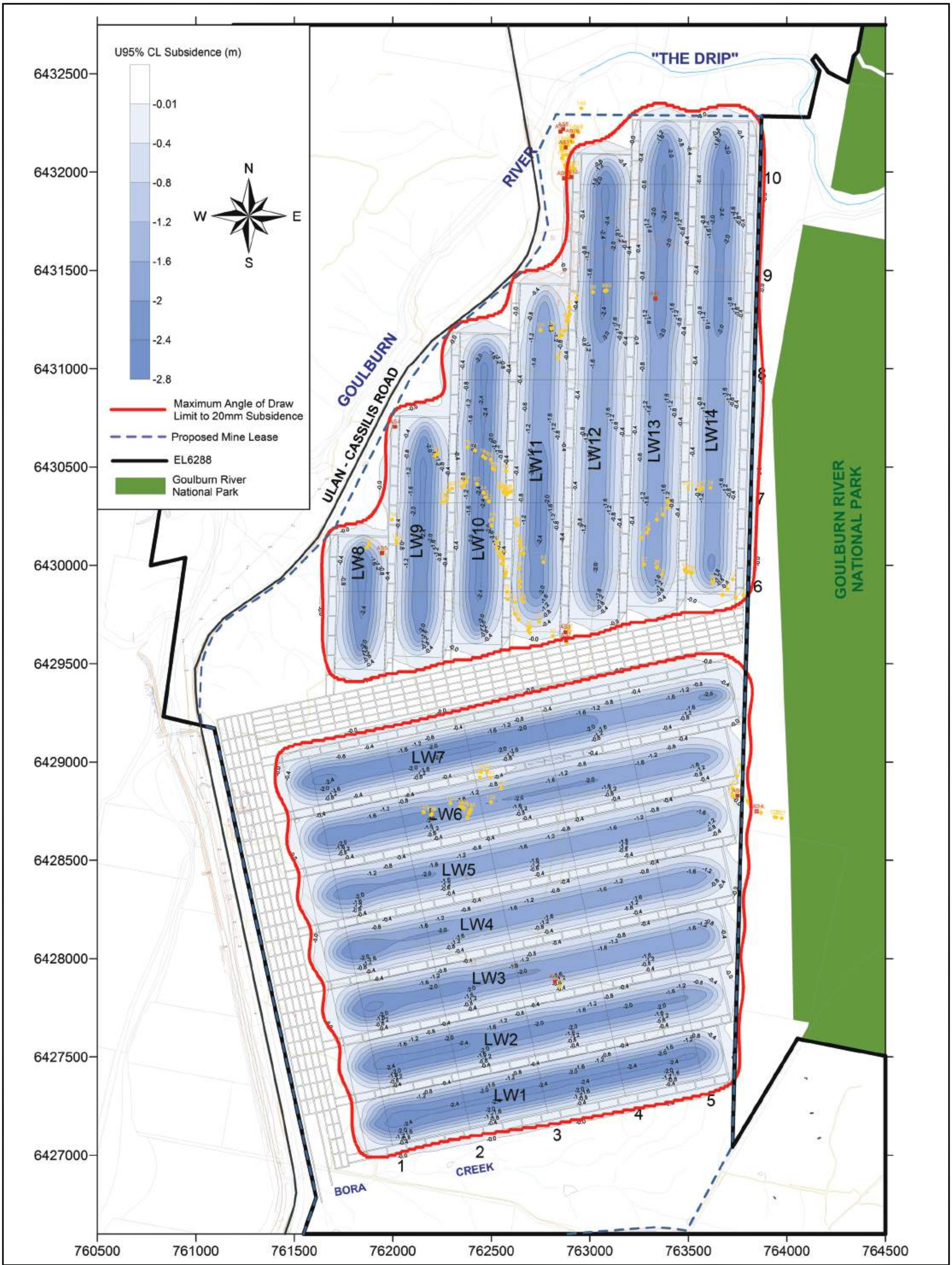
The predicted range of maximum tensile and compressive uniform strains indicate that surface crack widths of between 40mm and 180mm could occur within the limits of extraction (i.e. goaf) after mining is completed. In particular, significant cracks are most likely to occur above areas where surface rock exposures with widely spaced, adversely orientated or absent jointing, coincide with the peak strains.

Predicted subsidence levels and the angle of draw for Underground No. 4 are shown by **Figure 5.18** and **Plan 30** in **Volume 2**.

5.9.3.1 Land Surface

Crack widths are expected to range between 40mm and 90mm above the deeper longwalls with cover depths of > 130m. Crack widths ranging between 70mm and 180mm are estimated above the shallower areas where the cover depths are <130m.

The crack widths have been estimated by multiplying the uniform strain by a distance of 10m (based on the typical bay-length and crack widths observed in the field for the corresponding strains) and assuming that a single crack will occur in the given bay-length. In reality, several smaller cracks may develop or existing joints will open.



Pegasus Technical

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Moolarben Coal Project

Predicted Subsidence Levels for Underground No 4

STRATA ENGINEERING (AUSTRALIA) PTY LTD

Figure 5.18

The cracks will probably be tapered and extend to depths ranging from 3m to 10m and possibly deeper where massive near surface strata units exist.

Buckling or upsidence of between 130mm and 230mm is predicted above the proposed longwalls along the bases of two gullies between cliff lines CL4 and CL6. The combination of buckling and shear cracking of thin to medium bedded, near surface sandstone, is expected to result in localised areas of sub-surface flow paths to develop along the affected watercourses. The surface flows are expected to 'day-light' again down stream of the affected areas.

The impact on the cliffs within the site has been assessed based on: -

- Mining subsidence deformation;
- Public exposure to instability and aesthetics; and
- Instability due to natural weathering conditions presented in ACARP, 2002.

None of the cliffs above Underground No. 4 are visible from public access ways around the site such as Ulan-Cassilis and Ulan-Wollar Roads or the Goulburn River gorge to the north of the site (i.e. "The Drip").

The cliffs outside of the longwall extraction limits have been assigned a 'very low' to 'low' impact rating, with a 'moderate' to 'high' impact rating assessed for the cliff lines above the longwalls. The cliffs above the longwalls will probably be damaged by localised cracking but unlikely to experience large scale collapse.

A rock fall hazard has been identified along the cliff lines. Even though public access will be restricted to the land, further risk analysis and management work will be required to provide appropriate controls to minimise exposure of mine site personnel and visitors to rock falls. Appropriate fencing and/or signage warning bush walkers not to enter mine owned lands will be erected around the boundaries of the Underground No. 4 area.

5.9.3.2 Sub-Surface

Sub-surface cracking above the longwalls may result in direct hydraulic connection developing with all of the coal seams above the workings, but unlikely to extend up into the Wollar Sandstone. It is possible that direct hydraulic connection to the surface could occur above LW1 where the depth of cover is < 100m. Sub-surface monitoring will therefore be necessary to ascertain a suitable finishing point for this panel if direct connection to the surface is not acceptable.

5.9.3.3 Drainage Patterns

In general, the surface drainage patterns are likely to function with minimal changes after subsidence trough development. However, some of the low lying areas in the northern area of the site could become poorly drained or boggy after the extraction of LWs 12 to 13. Drainage restoration works may be necessary. A small area of ponding may also develop up to 1m in depth along a gully located above the northern end of LW 10. The ponding depth will also depend on surface crack and soil percolation rates.

5.9.3.4 Slope Stability and Erosion

The assessment by Strata Engineering states that it is highly unlikely that large scale instability will occur in the long term due to the effects of mining. It is possible that localised instability could occur along cliff lines with overhangs.

The rate of erosion is expected to increase in areas where slopes are greater than 10 degrees. The expected increase in hill, sheet or gully erosion is expected to decrease in the medium to long term after subsidence.

5.9.3.5 Far Field Horizontal Movement

Far-field horizontal displacements have been predicted using an empirical data base of measured movements outside the ends of longwalls in the Newcastle Coalfield with similar geometry to the Moolarben panels. Similar results have been obtained using a simple numerical model of full horizontal stress relief towards the extracted area.

Based on the model, it is assessed that the impact of subsidence and far-field displacements due to LWs 1 to 14 on the cliffs in "The Drip" and along the Goulburn River National Park boundary line to the east of the Underground No. 4 area will be negligible.

5.9.3.6 Aboriginal Heritage Sites

Forty-four aboriginal sites and one potential archaeological deposit have been recorded for the Underground No. 4 area (refer to ARAS, 2006). The types of aboriginal sites recorded include 20 isolated finds, 8 artefact scatters, 15 rock shelters with artefacts and an axe grinding groove site. Two of the rock shelters contain hand paintings. The area also contains approximately 177 rock overhangs / potential rock habitation shelters which have been identified along several of the cliff lines adjacent to the drainage gullies.

Five Aboriginal sites, which include an artefact site, an axe grinding groove site and three rock shelters, are likely to be subject to tensile strains exceeding 0.5mm/m or compressive strains > 3mm/m at some stage during or after mining is complete. It has been assessed that there is a 'moderate' to 'high' likelihood that they will be damaged by cracking and spalling due to mine subsidence. The other sites are located outside the limits of the proposed longwall blocks and are assessed to have a 'low' to 'very low' likelihood of being damaged by mine subsidence. It is considered likely that the remaining rock shelters above the longwalls, that are not significant, will also be damaged by spalling and cracking due to subsidence.

5.9.3.7 Man Made Improvements

The land above the proposed longwalls is largely undeveloped bush with several ephemeral drainage gullies or watercourses and 5m to 30m high sheer to rounded sandstone cliff faces. Surface developments consist of gravel access roads, fire trails, small stock watering dams and residential dwellings on Westwood’s private land holding in the northern area of Underground No. 4. At the time of preparing this report, MCM had secured ownership of Westwood’s land and therefore the residential dwellings will not be occupied during mining.

The Westwood memorial garden and grave of Mr. R. Perry will not be impacted.

5.9.3.8 Dams

Thirteen dams are located throughout the Underground No.4 coal mine area. Dams D4, D6 and D11, D12 and D13 are anticipated to need repair works caused by mining operations.

5.9.3.9 Ulan Coal Mine Water Bore Field

Ulan Coal Mine's groundwater bore field head works are located outside the predicted angle of draw with far-field displacements of < 20mm predicted. Further consultation with representatives of Ulan Coal Mines Pty Ltd will be necessary to establish an appropriate operational agreement with regard to the potential impacts to the bore field.

5.9.3.10 Quarry

The existing Dronvisa Pty Ltd gravel/clay quarry limits are currently outside the angles of draw to LWs 4 and 5 in Underground No. 4 - South. Further consultation with the owners and an operational agreement will be required before the quarry is extended further to the east.

5.9.3.11 Public Utilities

The Ulan-Cassilis Road, associated cuttings and bridge over the Goulburn River are located outside the angle of draw and are therefore not expected to be impacted directly by mine subsidence. However, the bridge and Cutting No 3 are located between 200m and 250m from the north-west corners of LWs 8 and 12 respectively and could therefore be subject to far-field horizontal displacements ranging between 26mm and 57mm. Cutting No's 1 and 2 which are 350m and 600m west of LWs 1 and 8 respectively are expected to experience no more than more than 9mm and 4mm of far-field horizontal displacement.

Consultation with the Mid-Western Regional Council and the Roads and Traffic Authority (RTA) bridge engineers will be required to develop appropriate monitoring and response plans to manage the consequences of this horizontal displacement.

5.9.4 Subsidence Monitoring and Mitigation

5.9.4.1 Surface Monitoring Program

Based on the surface topography, aboriginal heritage sites and surface infrastructure present above the proposed longwalls, the following subsidence and strain monitoring program is suggested for reviewing the predictions and providing adequate information to monitor and implement appropriate subsidence impact management plans in the study area:

- Install a cross line that can be extended as required across both northern and southern area longwalls and monitor cross line panel subsidence (levels) and strain (using standard steel tape);
- Install centre lines at the starts and ends of LWs 1 and 12 to 14 to monitor subsidence, far-field total displacements and strain development from the ends panels and out as far as 250m to provide early warning data for impacts to "The Drip". Establish several reflectors on the crest or equivalent along the northern cliff face of "The Drip" for confirmation of the predicted movements;
- Visual inspection and surveying of surface cracking (width and depth), cliff line instability and significant erosion during longwall extraction. Repair works to cracks should be completed as soon as possible to prevent injury or vehicle damage;
- 3-D (i.e. total station level and horizontal displacement) monitoring of the Cliff Line CL3 using reflectors down the cliff face to check stability during extraction of LW 13 and 14;
- Survey base line data for all buildings and dams for follow up surveys if required to confirm subsidence and strains;
- Low frequency subsidence monitoring of Ulan-Cassilis Road by running corner line out from the NW corners of LWs 8, 10 and 11. Visual inspections of cuttings and pavement, subject to review after the completion of each longwall panel; and
- 2-D or 3-D monitoring of subsidence and strain between pairs of survey pegs adjacent to the significant aboriginal archaeological sites. Two pegs should be installed parallel to and normal to the cliff faces or aligned with the longwall blocks and 10m apart.

Survey pegs should be spaced approximately 10m apart along the cross line and over the longwall panel ends, and a maximum of 20m apart along the centre line sections that are located outside of the end affected areas.

5.9.4.2 Sub-Surface Monitoring Program

It is expected that MCM will be required as a condition of approval to measure the maximum height of continuous and discontinuous fracturing above the sections of LW 1 directly below the alluvium. The data will allow a comparison/validation of measured values between the conceptual model of expected surface and groundwater level impacts and empirical model predictions presented in this report. The monitoring program suggested consists of: -

- Installation of a multi-wire borehole extensometer above the centre of LW 1 at chainage between 260 to 500 from the proposed finishing point on the panel.

  The borehole should be fully cored (preferably HQ wire line) from the surface to the base of the borehole and terminated 10m above the mine roof horizon. The core should be geotechnically logged with fracture logging included. (Note: double packer testing may be conducted at 10m intervals to measure rock mass permeability with Lugeon or constant head/injection tests with a down-the-hole vibrating wire piezometer tool to measure ground water levels. However it is considered that the base-line permeabilty and groundwater level data provided by the hydro-geologist consultant will be adequate at this stage).

  A minimum of 5 spring loaded anchors set at 10m, 30m, 50m, 70m and 90m with an allowance for vertical displacements up to 5m are recommended with readings taken by a real time data-logger.

  Reaming the borehole out to 125mm or 150mm diameter prior to the installation of the extensometer data logger may reduce the risk of losing the hole through shear movements. It is estimated that the hole may be sheared off if dynamic longitudinal tilts exceed 20mm/m to 30mm/m for a 10m thick 'beam' in the overburden with a 100mm and 150mm diameter borehole respectively.

  The empirical model predicts static longitudinal tilts of 25mm/m +/- 12.5mm/m which indicates dynamic tilt of 12.5mm/m +/- 7.5mm/m based on an assumed ratio of dynamic/static tilts of 0.5. Reaming the borehole out to 150mm therefore appears prudent based on the above predictions. The possibility of the borehole shearing during LW retreat is still significant although more data would be obtained prior to shearing. A second borehole would be required after LW1 is extracted would be required after LW 1 is extracted if the first hole is lost prematurely;

- Changes to the hydro-geological environment due to mining will be initially assessed by the measured movements in the borehole extensometer and changes to surface and groundwater levels and in-seam water makes or pump discharge (volume) records; and

- In the event that the results from the borehole extensometer are inconclusive or the extensometer is sheared through before full subsidence development occurs (drilling the extensometer borehole close to the centreline should minimise the risk of this happening), a further cored or open hole borehole may be drilled to measure partial and complete drilling fluid loss locations in the overburden. The monitoring outline above will provide a direct measure of the A and B Zone horizons. The borehole should also be drilled closer to the rib side in the tensile strain zone to ensure the intersection with the overlying fracture sets (drilling near the centre of the LW and in the compression zone in this case, may prove to be inconclusive as the fracture heights may have been closed up after subsidence has fully developed).

Fully coring the borehole will also allow a comparison of fracture logs before and after mining. Repeating the packer testing would also be useful, however sealing of the packer may be difficult in fractured zones.

It is considered that the proposed sub-surface drilling and testing program will probably only be required for the first LW block should measurements confirm the predicted values. Other management tools such as groundwater monitoring wells and underground pumping records would be regarded as sufficient information for assessing the impacts of subsequent longwalls.

5.9.5 Conclusions on Subsidence

The main objective of the study was to assess the credible worst-case magnitudes of surface movement at the above mentioned features due to the extraction of the proposed longwall panels, utilising an empirically based subsidence prediction model.

There are no major structures (dykes or faults) as yet recognised within the Underground No. 4 mine area. Overall, it is considered that each of the long-term impacts due to the proposed MCP longwalls can be managed with the proposed mitigation and management measures presented.

5.10 Soils

A Soils, Rural Land Capability and Agricultural Suitability Assessment was undertaken by Jammel Environmental & Planning Services Pty Ltd (Jammel) for the MCP and is reproduced in **Appendix 9.** Jammel's report is based upon information obtained from the Department of National Resources (soil conservation service of New South Wales), Department of Primary Industries (Agriculture), aerial photography interpretation, field surveys and laboratory analysis of soil samples.

5.10.1 Soil Types and Landscapes of the MCP Area

Soil landscapes of the MCP area are based on those delineated by the Soil Landscapes of the Dubbo 1:250,000 Sheet (DLWC 1998) and field surveys. Four main soil landscapes are found within the MCP area, these being Ulan, Lees Pinch, Bald Hill and Munghorn Plateau.

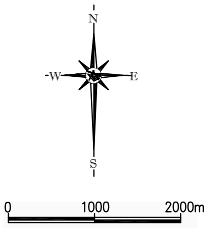
The Ulan Soil Landscape covers the majority of the open cut disturbance areas whilst the infrastructure area is located on the boundary of the Ulan and Munghorn Plateau Soil Landscapes. The Bald Hill Soil Landscape is found in isolated areas within the proposed Underground No. 4 coal mine and adjacent to Open Cut 2.

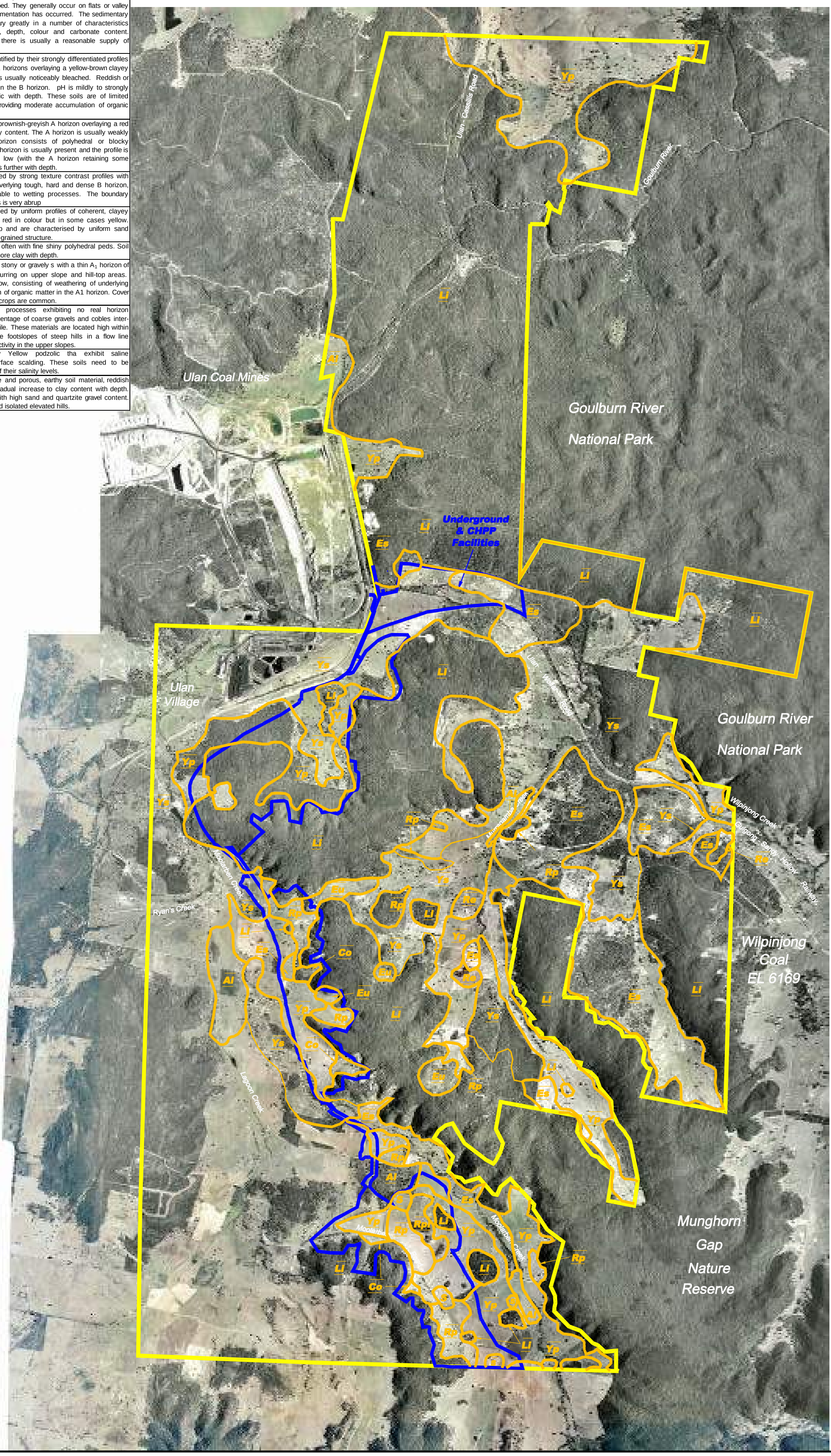
The major soil types found in the MCP area include Yellow Podzolic, Red Podzolic, Earthy Sands, Yellow Solodic, Lithosols and Alluvials as shown by **Figure 5.19** and **Plan 31** in **Volume 2** The Yellow Podzolic soils are dominant throughout the Open Cut 2 and Open Cut 3 disturbance areas, on lower slopes and minor drainage lines. Red Podzolic soils occur predominantly in the disturbance areas of Open Cut Open Cuts 2 and 3 on the upper mid slopes. Earthy Sands soils occur predominantly on the northern side of the Infrastructure Area. These soils are also found along Moolarben Creek in the Open Cut 3 disturbance area. Yellow Solodic soils occur in the low lying areas of Open Cut 1 and the Infrastructure Area. Lithosols occur on the higher plateaus and sandstone escarpments associated with the Underground No. 4 coal mine area. Alluvial soils occur along Moolarben and Lagoon Creeks drainage lines – but outside the MCP disturbance areas.

Soil Type Classification		
Item	Soil Type	Description
Al	Alluvial	Alluvial soils have no true pedological horizons other than an A horizon and are often weakly developed. They generally occur on flats or valley bottoms where bed load sedimentation has occurred. The sedimentary layers of these soils can vary greatly in a number of characteristics including texture, stoniness, depth, colour and carbonate content. Nutrient supply is good as there is usually a reasonable supply of primary rock minerals.
Yp	Yellow Podzolic	Yellow podzolic soils are identified by their strongly differentiated profiles with light, medium textured A horizons overlaying a yellow-brown clayey B horizon. The A_2 Horizon is usually noticeably bleached. Reddish or greyish mottling is common in the B horizon. pH is mildly to strongly acidic, becoming more acidic with depth. These soils are of limited fertility, with the A horizon providing moderate accumulation of organic matter.
Rp	Red Podzolic	Red podzolic soils feature a brownish-greyish A horizon overlaying a red B horizon of much higher clay content. The A horizon is usually weakly structured, whilst the B horizon consists of polyhedral or blocky pedology. A distinct pale A2 horizon is usually present and the profile is acidic. Fertility is generally low (with the A horizon retaining some organic matter) and decreases further with depth.
Ys	Yellow Solodic	Solodic soils are characterised by strong texture contrast profiles with light textured surface soils overlying tough, hard and dense B horizon, which are usually very unstable to wetting processes. The boundary between the A and B horizons is very abrup
Es	Earthy Sand & Sand	Earthy sands are characterised by uniform profiles of coherent, clayey sands which are dominantly red in colour but in some cases yellow. These soils are usually deep and are characterised by uniform sand texture and a massive, single-grained structure.
Eu	Euchrazem	Strongly structured red soils, often with fine shiny polyhedral peds. Soil texture eventually becomes more clay with depth.
Li	Lithosol	Lithosols are shallow skeletal stony or gravely s with a thin A_1 horizon of organic matter generally occurring on upper slope and hill-top areas. Pedological development is low, consisting of weathering of underlying rocks and the gradual addition of organic matter in the A1 horizon. Cover is discontinuous and rock outcrops are common.
Co	Colluvial	Soils derived from colluvial processes exhibiting no real horizon development with a high percentage of coarse gravels and cobles inter-dispersed throughout the profile. These materials are located high within the landscape usually at the footslopes of steep hills in a flow line experiencing high erosional activity in the upper slopes.
S	Saline	These soils are generally Yellow podzolic tha exhibit saline characteristics such as surface scalding. These soils need to be managed separately in view of their salinity levels.
Re	Red Earth	These soil areas are massive and porous, earthy soil material, reddish brown to red colour and a gradual increase to clay content with depth. Textures are sandy loams with high sand and quartzite gravel content. These soils are located around isolated elevated hills.

Legend

- EL 6288
- Disturbance Boundary
- Soil Type Boundaries
- Soil Profile Site





CAD FILE: Figure 5.19

Moolarben Coal Project

Soil Type Boundaries

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Pegasus Technical

Figure 5.19

5.10.2 Rural Land Capability of the MCP Area

Jammel conducted a rural land capability assessment in accordance with the NSW eight class system. The system recognises three types of land use and eight land classes, these being:-

- Land suitable for cultivation (Classes I to III);
- Land suitable for grazing (Classes IV to VI); and
- Land not suitable for rural production (Classes VII and VIII).

Six rural land capability classes are specific to the MCP area as shown by **Figure 5.20** and **Plan 32** in **Volume 2** and are described below in accordance with Cunningham et al; (undated).

Class III is land that can be "regularly cultivated with structural soil conservation works such as diversion banks, graded banks and waterways, together with soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations". Class III land occurs in a small area on the valley floor within Open Cut 2 and on the eastern fringe of Open Cut 3.

Class IV is "land not capable of being regularly cultivated but suitable for grazing with occasional cultivation with soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or re-establishment of permanent pasture". The majority of the valley floor within Open Cut 2 and Open Cut 3 contains class IV lands.

Class V is "land not capable of being regularly cultivated but suitable for grazing with occasional cultivation and structural conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in class IV". Class V lands are located in the Underground No. 4, Open Cut 1, Open Cut 2, Open Cut 3 and infrastructure areas of the MCP.

Class VI is "land not capable of being regularly cultivated but suitable for grazing with conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. This class may require some structural works". Class VI lands are located in Open Cut 1, Open Cut 2, Open Cut 3 and infrastructure areas of the MCP.

Class VII is "land best protected by green timber". Class vii land is predominantly associated with lithosol soils occurring on the steeper slopes and plateaus. Class VII land are located in the underground and fringes of Open Cut 1, Open Cut 2 and Open Cut 3 areas of the MCP.

Class VIII is land comprising of "cliffs, lakes or swamps and other lands incapable of sustaining agricultural or pastoral production". The soil cover comprises of discontinuous lithosol soils with large areas of exposed rock. Class viii lands fringe the west of Open Cut 3.

5.10.3 Agricultural Suitability of the MCP Area

An agricultural suitability assessment was conducted by Jammel in accordance with the five class system (Riddler, 1996) which classifies land according to its productivity for a wide range of agricultural activities. The agricultural suitability assessment is based on mapping and Agricultural Land Classification prepared by the Department of Primary Industries (Agriculture)

LAND CLASSIFICATION AND SOIL CONSERVATION PRACTICES				INTERPRETATIONS AND IMPLICATIONS
SUITABLE FOR REGULAR CULTIVATION		I	No Special soil conservation works or practices.	Land suitable for a wide variety of uses. Where soils are fertile, this is land with the highest potential for agriculture and may be cultivated for vegetable and fruit production, cereal and other grain crops, energy crops, fodder and forage crops and sugar cane in specific areas. Includes "prime agricultural land".
SUITABLE FOR REGULAR CULTIVATION		II	Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation.	Usually gently sloping land suitable for a wide variety of agricultural uses. Has a high potential for production of crops on fertile soils similar to Class I but increasing limitations to production due to site conditions. Includes "prime agricultural land".
SUITABLE FOR REGULAR CULTIVATION		III	Structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage and adequate crop rotation.	Sloping land suitable for cropping on a rotational basis. Generally used for the production of the same type of crops as listed for Class I, although productivity will vary depending upon soil fertility. Individual yield may be the same as for Classes I and II, but increasing restrictions due to the erosion hazard will reduce the total yield over time. Soil erosion problems are often severe. Generally fair to good agricultural land.
SUITABLE GRAZING	Occasional Cultivation	IV	Soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or re-establishment of permanent pasture.	Land not suitable for cultivation on a regular basis owing to limitations of slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Comprises the better classes of grazing land of the State and can be cultivated for an occasional crop, particularly a fodder crop or for pasture renewal. Not suited to the range of agricultural uses listed for Classes I to III. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal and selection of safe building sites and access roads.
SUITABLE GRAZING	Occasional Cultivation	V	Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV.	Land not suitable for cultivation on a regular basis owing to considerable limitations of slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Soil erosion problems are often severe. Production is generally lower than for grazing lands in Class IV. Can be cultivated for an occasional crop, particularly a fodder crop or for pasture renewal. Not suited to the range of agricultural uses listed for Classes I to III. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal and selection of safe building sites and access roads.
SUITABLE GRAZING	No Cultivation	VI	Soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. May include some isolated structural works.	Productivity will vary due to the soil depth and the soil fertility. Comprises the less productive grazing lands. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal and selection of safe building sites and access roads.
OTHER		VII	Land best protected by green timber.	Generally comprises areas of steep slopes, shallow soils and/or rock outcrop. Adequate ground protection must be maintained by limiting grazing and minimising damage by fire. Destruction of trees is not generally recommended, but partial clearing for grazing purposes under strict management controls can be practised on small areas of low erosion hazard. Where clearing of these lands has occurred in the past, unstable soil and terrain sites should be returned to timber cover.
OTHER		VIII	Cliffs, lakes or swamps and other lands unsuitable for agricultural and pastoral production.	Land unusable for agricultural or pastoral uses. Recommended uses are those compatible with the preservation of the natural vegetation, namely: water supply catchments, wildlife refuges, national and state parks and scenic areas.
OTHER		U	Urban areas	
OTHER		M	Mining and quarrying areas.	

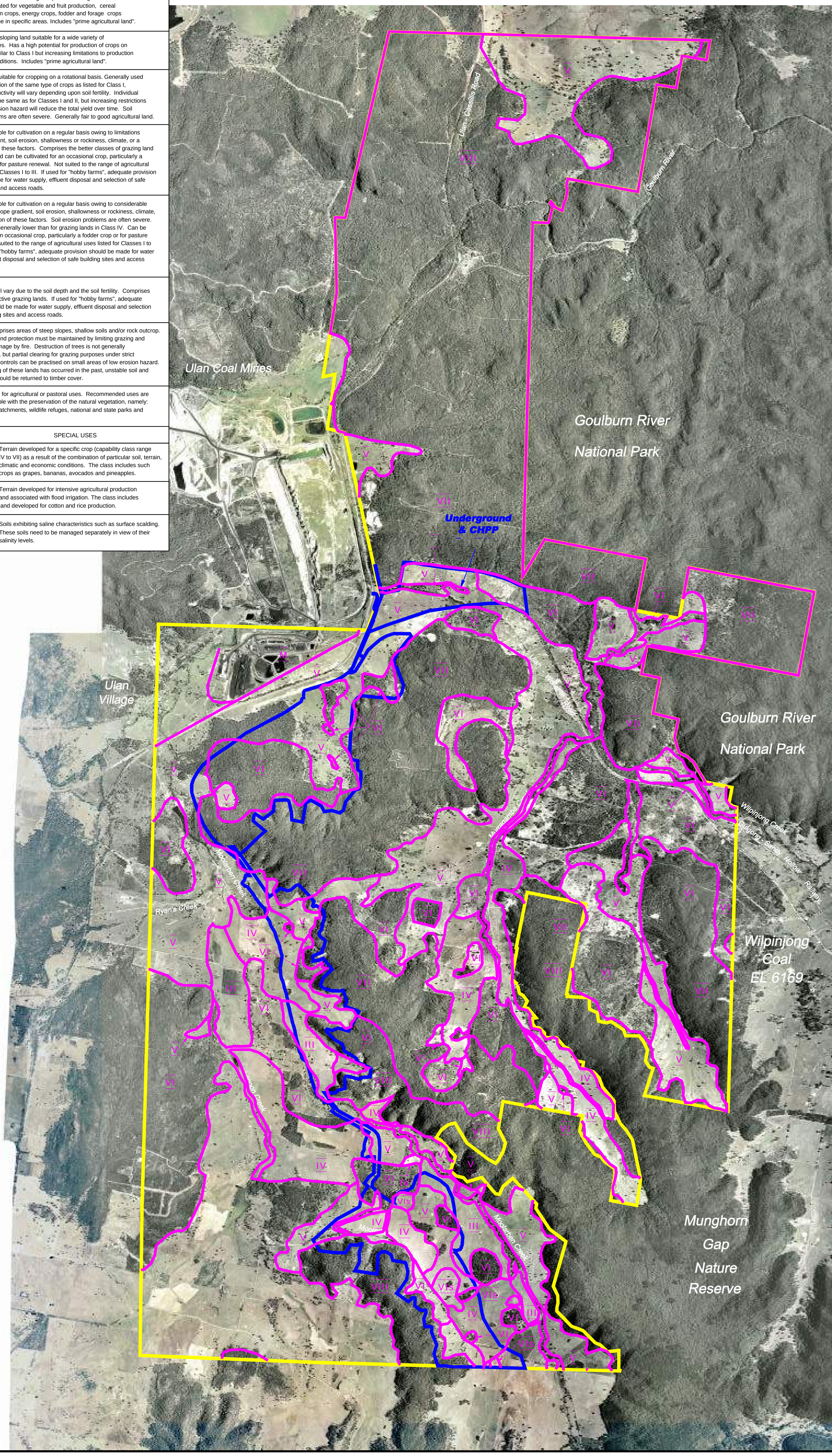
CLASS SUBSCRIPTS	SPECIAL USES
c	Terrain developed for a specific crop (capability class range IV to VII) as a result of the combination of particular soil, terrain, climatic and economic conditions. The class includes such crops as grapes, bananas, avocados and pineapples.
d	Terrain developed for intensive agricultural production and associated with flood irrigation. The class includes land developed for cotton and rice production.
s	Soils exhibiting saline characteristics such as surface scalding. These soils need to be managed separately in view of their salinity levels.

Legend

- EL 6288
- Disturbance Boundary
- III Land Capability Class

N W E S

0 1000 2000m



Pegasus Technical

CAD FILE: Figure 5.20

Moolarben Coal Project

Land Capability

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Figure 5.20

for the former Mudgee Shire in conjunction with field surveys. Three classes of land are found within the MCP as shown by **Figure 5.21** and **Plan 33** in **Volume 2** and are discussed below.

Class 3 is "Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall production level is moderate because of edaphic or environmental constraints. Erosion hazard, soil structural breakdown and other factors including climate may limit the capacity for cultivation, and soil conservation or drainage works may be required".

Class 3 agricultural suitability land is predominant on the valley floor and lower slopes of the MCP area. Small areas of farming for cereal crop production occur, however the dominant land use is primarily cattle and sheep grazing on pastures (improved and native). Erosion hazard, soil structural breakdown and climatic factors limit the capacity for cultivation.

Class 3 areas also include isolated occurrences of surface soil salinity within Open Cut 3 where poor soil drainage is experienced.

Class 4 is "Land suitable for grazing but not for cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high, but the overall production level is low as a result of major environmental constraints".

Class 4 agricultural suitability land occurs in small locations throughout the valley floors and the lower slopes of the MCP area. These areas are represented by either shallow/sandy or dispersible (sodic) soils or land with steep slopes. In conjunction with their edaphic limitation also have moderate to high erosion hazard restricting the agricultural productivity.

Class 5 is "Land unsuitable for agriculture or at best suited to only light grazing. Agricultural production is very low to zero as a result of severe constraints, including economic factors, which preclude land improvement".

Class 5 agricultural suitability land is associated with the escarpments and lower hills within and adjacent to the MCP areas. Class 5 areas are generally characterised by steeper slopes, shallow soils and lower fertility land.

Negligible agricultural production is derived from these lands due to the significant constraints of slope, soil and location.

5.10.4 Impacts to Soils and Agricultural Suitability of the MCP

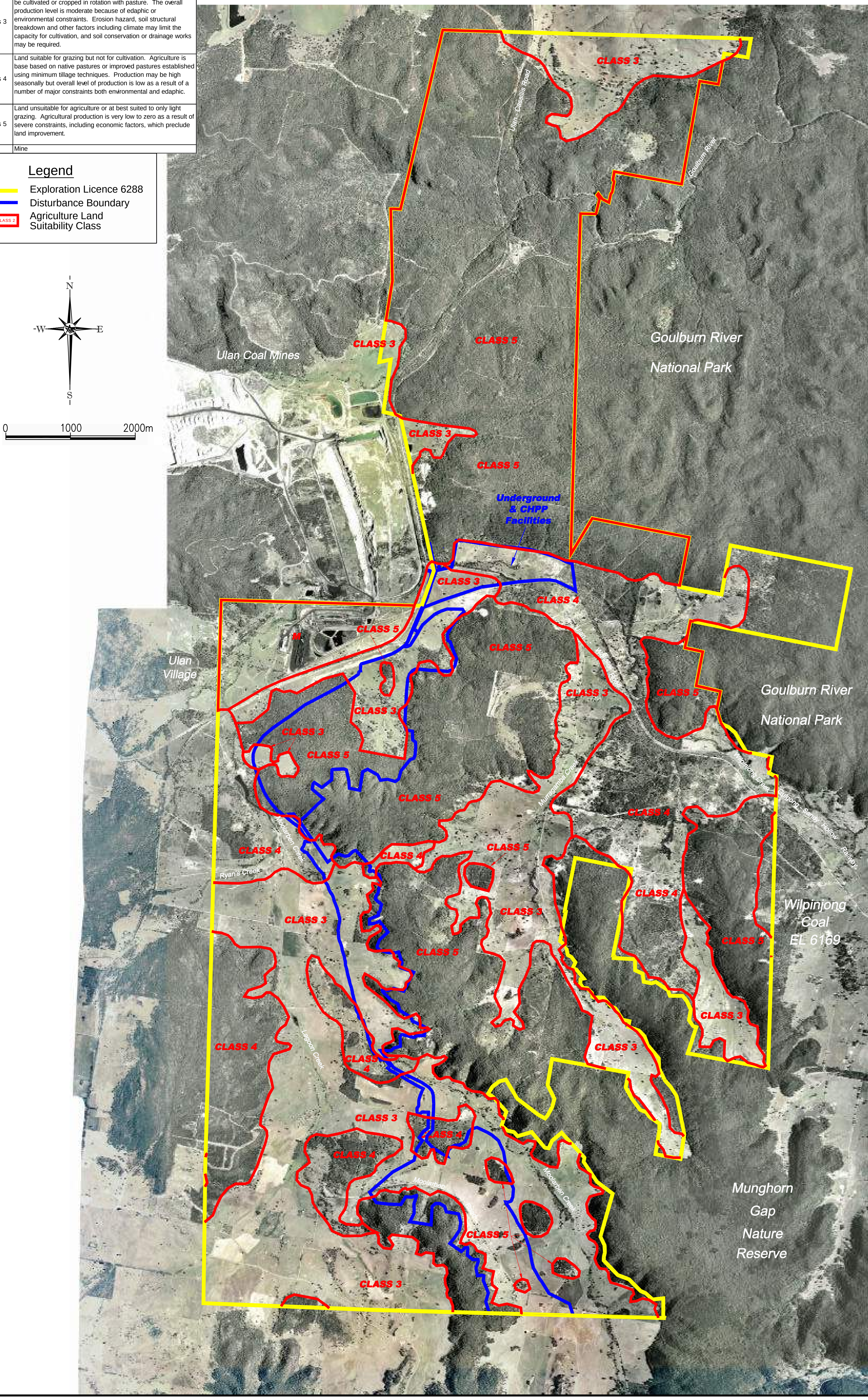
The soil assessment identified the following potential impacts:

- Increased erosion of soils due to erodible soil types within the MCP area;
- Exposure of soils due to vegetation stripping;
- Stripping of soils within mining disturbance areas;
- Soil contamination resulting from spillage of hydrocarbons and other chemicals;
- Alteration of physical and chemical soil properties;
- Erosion of proposed landforms; and

Agricultural Land Suitability	
Land Class	Description
Class 3	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall production level is moderate because of edaphic or environmental constraints. Erosion hazard, soil structural breakdown and other factors including climate may limit the capacity for cultivation, and soil conservation or drainage works may be required.
Class 4	Land suitable for grazing but not for cultivation. Agriculture is base based on native pastures or improved pastures established using minimum tillage techniques. Production may be high seasonally but overall level of production is low as a result of a number of major constraints both environmental and edaphic.
Class 5	Land unsuitable for agriculture or at best suited to only light grazing. Agricultural production is very low to zero as a result of severe constraints, including economic factors, which preclude land improvement.
M	Mine

Legend

- Exploration Licence 6288
- Disturbance Boundary
- Agriculture Land Suitability Class



Pegasus Technical

Moolarben Coal Project

Agricultural Suitability

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Figure 5.21

CAD FILE: Figure 5.21

- Within the Major Projects Application area there are 1181 hectares of Class 3 agricultural land. The MCP will directly impact 640 hectares of this land as a consequence of mining these areas. Those Class 3 agricultural lands associated with Open Cuts 2 and 3 will continue as agricultural lands for livestock grazing after the cessation of mining.

5.10.5 Safeguards, Mitigation and Management of Soils

5.10.5.1 MCP Soil Resource Management Strategies

Preservation and appropriate management of all topsoil material within the surface development areas of the MCP should be a priority to assist in future land rehabilitation activities. The activities of stripping and stockpiling of soil resources prior to any mine-related disturbance will be undertaken in accordance with general soil resource management activities. All disturbance areas will be rehabilitated either progressively or immediately after the completion of mining activities.

The MCP soil resource management strategies are:-

- Identify and quantify the potential soil resource;
- Optimise the recovery of topsoil and subsoil available for rehabilitation;
- Manage topsoil and subsoil reserves so as not to degrade the resource;
- Assist in development of stripping and stockpiling procedures and undertake stripping and stockpiling in accordance with Department of Land and Water Conservation (DLWC) guidelines; and
- Establish effective methods for utilising available soil reserves in future rehabilitation work.

Soil resource management strategies proposed for the MCP disturbance areas are detailed in **Table 5.25**.

Table 5.25: Soil Resource Management Strategies

Prior to Commencement of Stripping Activities	During Stripping and Stockpiling Activities	Prior to and During Rehabilitation Activities
• Quantification of soil resources; • Characterisation of the suitability of material for rehabilitation purposes; and • Formulation of stripping and stockpiling guidelines including the nomination of appropriate depths, scheduling, and location of areas to be stripped and stockpile locations (detailed in the Mining Operations Plan).	• Minimise over-clearing; • Selective stockpiling of soil according to type (i.e. Great soil Group, topsoil, subsoil) and salinity; and • Storage of soil in a manner that does not compromise the long term viability of the resource.	• Implementation of amelioration measures to ensure the long term viability of the soil resources and manage salinity; • Management of soil suitability for rehabilitation; and • Progressive rehabilitation of final landforms as soon as practicable after completion or when areas are no longer required.

Topsoil recovery and management activities will occur in accordance with the progressive development program of MCP on all disturbance areas. The management activities of these soils will be determined by their individual characteristics and limitations.

5.10.5.2 MCP Guiding Principles for the Prevention of Land Degradation

The prevention of land degradation through the adoption of appropriate soil conservation practices will be an integral component of site management over the entire mining operations area.

The identification of land degradation issues in combination with immediate and correct remedial solutions provides good environmental management. The adoption of these principals along with broader land management activities to maintain the land within the MCP will be incorporated into a Land Management Plan.

The following guiding principals should be adhered to for the MCP to prevent or arrest any land degradation:-

- Continual monitoring and reporting on all mining areas for occurrences of soil erosion and landform irregularities;
- Minimise disturbance areas to all essential mining activities and infrastructure developments only;
- An Erosion and Sediment Control Plan be prepared in accordance with the requirements of Managing Urban Stormwater: Soils and Construction (NSW Department of Housing, 1998) for all open cut mining and infrastructure disturbance areas;
- All erosion control and drainage works to be appropriately designed in accordance with Urban and Sediment Control Guidelines (DLWC, 1992);
- Where surface irregularities are identified caused by underground mining activities appropriate soil conservation measures are to be immediately implemented.
- Prevent the diversion of overland flow to areas without adequate stable disposal areas;
- Revegetate all disturbed areas with appropriate revegetation species and techniques which may include hydro mulching and seeding immediately after the mining activity has ceased or erosion has been controlled;
- In relation to Open Cuts 2 and 3, the preferred use of the land following cessation of mining is for the continuation of livestock grazing. In this regard it will be necessary for Farm Management Plans to be prepared and implemented; and
- All access roads and haul roads to be constructed with appropriate pavement surfaces and storm water drainage systems.

All temporary trails to be constructed in accordance with the “Guidelines for the planning, construction and maintenance of tracks” (DLWC 1994)

The soil survey of the disturbance areas identified the dominant soils throughout the project area. From the physical assessment and the chemical analysis of the soils it was determined that the soils are suitable for rehabilitation with the appropriate soil ameliorant and nutrient inputs applied. A small percentage of soils were deemed unsuitable due to having a very high sand and gravel content or having extremely poor chemical features.

5.10.5.3 The Management of Soil Salinity

Salinity levels across the majority of the MCP have been classified as non – saline (EC_{se} < 2 dS/m) however there are soils throughout the Open Cut 3 area which have been identified as saline discharge sites testing low to moderate salinity levels. These sites are relatively localised and easily identified. Use of these soils for rehabilitation purposes is possible by addressing the salinity issue during stockpiling and careful vegetative species selection during rehabilitation.

The key management practices are:

- Where practicable, saline soil types should be stripped and stockpiled separately over an aggregated substrate to allow leaching of salt concentrations (EC_{se}) over time;
- Ensure species selection for rehabilitation purposes are tolerant of saline environments, additionally salinity occurrence is usually associated with water logging so species should also be able to withstand water logged environments; and
- Minimise the application of saline water through irrigation (water use). **Table 5.26** provides guidelines for irrigation water quality.

Table 5.26: Guidelines for irrigation of water based on salinity

Salinity	Comment	EC_{se} (ds/m)
Low	Water can be used with most crops on most soils and with all methods of water application with little likelihood that a salinity problem will develop. Some leaching is required, but this occurs under normal irrigation practices except in soil of extremely low permeability.	0.00 – 0.28
Medium	Water can be used if moderate leaching occurs. Plants with medium salt tolerance can be grown, usually without special measures for salinity control. Sprinkler irrigation with the more saline waters in this class may cause leaf scorch on salt-sensitive crops, especially at high temperatures in the daytime and with low application rates.	0.28 – 0.80
High	Water can not be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required, and the salt tolerance of the plants must be considered.	0.80 – 2.30
Very High	Water is not suitable for irrigation under ordinary conditions. Soils must be permeable, drainage adequate, water must be applied in excess to provide considerable leaching and salt tolerant crops should be selected.	2.30 – 5.50
Extremely High	Water may be used only on permeable, well-drained soils under good management, especially in relation to leaching and for salt tolerant crops, or for occasional emergency use.	> 5.50
(modified after Hart, 1974 in Taylor 1996)		

The final land form and land use, post mining will dictate the composition and structure of species proposed to be established for the rehabilitation phase. Species selection should not only take into consideration climatic and soil nutritional issues but the occurrence of water logging and and salinity levels within the soils. Plant tolerance of soil salinity is measured in terms of root zone soil salinity conditions (where EC_{se}). **Table 5.27** identifies these salinity classes.

Table 5.27: Salinity Soil Classes (EC_{se})

Salinity	EC_{se} (ds/m)
Non Saline	< 2
Slight	2 – 4
Moderate	4 – 8
High	8 – 16
Extreme	> 16
After Marcar & Crawford (2004)	

However with the levels identified in the chemical analysis of the soils throughout the MCP, extreme saline soil conditions do not appear to occur.

5.10.5.4 MCP Strategies for Improving Soil Health as a Plant Growth Medium

All the soils throughout the project area were of an acid pH trend and low in organic matter. These factors reduce the availability of nutrients and create and unfavourable microclimate for germination of plant seeds.

The key management practices to rectify these issues are:

- Application of the appropriate amount of soil ameliorant and fertiliser;
- The establishment of a cover crop for soil protection purposes and improvement in organic matter levels; and
- Potentially the use of imported organic materials such as bio-solids.

An option that is readily becoming accepted as a rehabilitation practice is the application of biosolids. Biosolids products have been used successfully on mine sites and degraded agricultural lands providing organic matter inputs, soil amelioration effect and soil nutrients.

5.10.5.5 Mitigation Measures to ensure the long term viability of Soil Resources

The following soil stockpile management practices will improve the long term viability of the soil resource:

- Soil stockpiles to be located outside of proposed mining areas;
- Keep vehicular traffic to a minimum on the soils to be stripped. Exclude all traffic from soils that are sensitive to structural degradation;
- Use of loaders and trucks rather than scrapers to minimise structural degradation;
- Construction of stockpiles with a “rough” surface condition to reduce erosion hazard, improve drainage and promote revegetation;
- Soil stockpiles will be no more then 60cm high to maintain the soil microflora and macroflora biology. Where site constraints do not allow this, stockpiles will be no deeper then 3m in order to minimise problems with anaerobic conditions;
- Fertilise and seed stockpiles which are to be inactive for extended periods to maintain soil structure, organic matter and microbial activity;
- Installation of silt fences around stockpiles to control potential loss of stockpiled soil through erosion prior to vegetative stabilisation;
- Stockpiles to be deep-ripped to establish aerobic conditions, prior to reapplication of stockpiled soil for rehabilitation;
- The appropriate soil ameliorant be applied at an appropriate rate to dispersive soil stockpiles where necessary; and
- Implement appropriate weed control strategies particularly for any noxious weeds. Immediate revegetation will provide vegetative competition to assist with control of undesirable plant species.

5.11 Geochemical Assessment

MCM commissioned Environmental Geochemistry International Pty Ltd (EGI) to assess the acid rock drainage (ARD), salinity and sodicity hazard potential associated with development of the coal resource. A copy of the report is contained in **Appendix 10**.

Testing was carried out on representative samples of overburden from the proposed underground and open cut developments, and samples of Ulan Seam coal and washability trial rejects.

5.11.1 Overburden and Coal Characteristics

Results of ARD investigations indicate that over 90% of overburden material for open cut and underground operations is likely to be non acid forming (NAF). The remainder is expected to be potentially acid forming low capacity (PAF-LC), with a low ARD potential. No potentially acid forming (PAF) materials were identified for floor samples from the open cut, which suggests that final pit floors will not be a source of ARD. Preliminary results indicate roof and floor materials for the underground project may be PAF-LC.

Most of the coal seam samples tested were PAF-LC, indicating potential acid release from coal stockpiles and underground workings. The coal reject samples were acid forming, with export coal rejects showing the highest ARD potential.

Testing also indicates that overburden, floor and coal reject materials are likely to be non-saline. Coal samples were moderately saline to saline.

Exchangeable sodium percentages and Emerson aggregate test (EAT) results indicate a possible sodicity hazard for topsoil, Quaternary/Tertiary alluvials and weathered Permian. Materials with sodic/dispersion potential may require treatment (with gypsum or lime) if exposed on dump surfaces or used in engineered structures.

No significant enrichment of metals/metaloids was detected in overburden, coal or reject solids.

5.11.2 Conclusions and Mitigation Measures

The findings of these initial investigations have the following implications for materials management:

- Results suggest that normal run-of-mine operational blending of overburden should be sufficient to control ARD, pending confirmation with leach column testing;
- Containment of run off and leachate from coal stockpiles and underground operations may be required to monitor water quality and determine whether treatment is required. Results indicate that these waters may be saline and acidic. The sensitivity of groundwater and surface water to saline and acidic water should be investigated to determine the degree of management required. Provision for acid treatment may be needed, which could include use of a mobile lime dosing plant to treat acid waters and broadcast application of agricultural lime;
- Rejects appear to have a higher ARD risk than other mine materials, and are likely to require specific management to control ARD. Possible approaches include lime treatment, isolation from infiltration (i.e suitable cover), or a combination of these;
- Materials with sodic/dispersion potential may require treatment (with gypsum or lime) if exposed on dump surfaces or used in engineered structures; and
- A routine system of ARD testing should be established during operations to check the ARD potential of mine materials and allow for modification of materials management strategies if required.

5.12 Land Use

5.12.1 Existing Land Use

A description of the existing land use relative to the major components of the MCP is presented below.

The land associated with Underground No. 4 is currently utilised for the grazing of livestock, quarrying, water management and bore field activities associated with the Ulan Coal Mine, housing associated with the Westwood family together with the spelling and training of harness horses (trotters). The northern portion of the Underground No. 4 area also provides legal and practical access to the Mullins-Imrie residence and tourist accommodation known as the Stone Cottages. The area known as "The "Drip" is located immediately north of Underground No. 4 and is used for passive recreation by tourists and local residents.

The lands to be developed as the main Infrastructure area are used for the grazing of livestock. The Gulgong-Sandy Hollow Railway Line forms the land's southern boundary.

Lands associated with Open Cut 1 are currently used for grazing of livestock, whilst the Ulan Coal Mine airstrip and internal access roads traverse the area. Some land within Open Cut 1 forms part of the Ulan Coal Mines' salinity off-set program and is a condition of EPL 394.

Lands associated with Open Cuts 2 and 3 are owned by the Swords, Mayberry and Rayner families who undertake agriculture in the form of livestock grazing and breeding (sheep, cattle and goats), fodder crop production and bee keeping.

The village of Ulan contains 17 dwellings, one school, hotel and tourist accommodation, two churches, one community hall and recreational facilities, water cartage contractor, electrical substation, cemetery, rural fire station, weather station and PM_{10} monitoring site and the Ulan Coal Mine's Flannery Centre. The proposed Open Cut 1Mine is located less than 2km south-east of the village.

Land located west, north and east of the MCP is a mix of ‘broad acre’ agriculture, rabbit farming, hobby farms, boutique tourist accommodation, coal mining and the ICI explosives plant. The Goulburn River National Park and Munghorn Gap Nature Reserve are located immediately east of the EL 6288. The “Drip” picnic area and the Hands on Rock Aboriginal cultural walk are located north of the proposed underground mine.

The existing land use is generally consistent with the provisions of the Mudgee Local Environmental Plan 1998.

5.12.2 Land Use Impacts

The predominant land use impacts associated with the MCP are the loss of agricultural activities associated with the Swords, Mayberry and Rayner properties when mining and rehabilitation occur in respect to Open Cuts 2 and 3. Some of the lands associated with these farms will be lost to mining whilst mining is operational. The remaining non-mined lands will be able to continue to be used for agricultural purposes. A suitable alternate vegetated parcel of land will be sought as a replacement for Ulan Coal Mines' salinity off-set program.

Within the Major Projects Application area there is 1181 hectares of Class 3 agricultural land. The MCP will result in the loss of 640 hectares of this land as a consequence of the MCP proceeding and initiating its preferred rehabilitation and revegetation strategy.

Land use activities which currently occur within the area known as Underground No. 4 will be able to continue subject to negotiated agreements between MCM and the respective land owners in relation to subsidence.

5.12.3 MCP and Future Land Use

Scope exists within the project to firmly establish long term future land use for those lands impacted as a consequence of mining. It is envisaged that land use in the Moolarben Creek valley will be a continuation of "broad acre" farms for those lands associated with Open Cuts 2 and 3.

At the conclusion of mining, Open Cuts 2 and 3 can be rehabilitated with grass and vegetation that permits livestock grazing and embellishment of vegetation that integrates with the adjoining north – south trending ridge lines. Significant improvements to existing remnant stands of vegetation can provide habitat linkages in north – south and east – west directions to increase the area's long term bio-diversity values and attributes.

The area's long term bio-diversity values can be achieved through the preparation and implementation of Farm Management Plans in conjunction with Voluntary Conservation Agreements linked to the title of the lands.

The surface area of the Underground No. 4 mine will be left intact whilst the main headings could be extended in a northerly direction beneath the Goulburn River to access the northern portion of EL 6288.

Infrastructure associated with the CHPP and Open Cut 1 facilities may be utilised for future mining activities associated with the coal reserves of EL 6288.

In any event, the long term land use will be consistent with the land use provisions of the relevant Mid-Western Regional Council planning instrument and state environmental planning policies.

5.13 Ecology

The MCP is located in a transitional zone between the western slopes and coastal areas of New South Wales within the Great Dividing Range. Many plant species and communities representative of these areas intergrade at this locality and are at their range limits.

MCM engaged the services of three specialists – who formed Moolarben Biota – to prepare an ecological assessment for the project. Moolarben Biota undertook a scoping study in late 2004 so as to develop appropriate survey (flora, fauna and aquatic) design and to identify potential ecological and mining constraints for the project.

Ecological surveys were designed and conducted in accordance with the following standards and guidelines:-

- Working Draft Guidelines Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC 2004);

- State Groundwater Dependent Ecosystem policy guidelines (DLWC 2002);
- National River Process and Management Program River Bio-assessment Manual methods (NRPMP 1994) as adapted for the National River Health Program (i.e. AusRivAS method, Turak et al (1999)); and
- NSW DPI Guidelines for the assessment of aquatic habitat (NSW Fisheries 1999).

The study area is characterized six broad vegetation communities and one disturbed landscape, each containing a variety of vegetation associations dominated by various tree and shrub canopy species. Fauna habitats have been defined generally using the broad vegetation community classification scheme, with the resultant units referred to as Terrestrial Stratification Units (TSU's). **Figure 5.22** and **Plan 34** in **Volume 2** illustrates the distribution of these TSU's for the study area, with **Figure 5.23** and **Plan 35** in **Volume 2** illustrating the distribution of vegetation associations for the MCP Development Application area.

5.13.1 Existing Ecology

5.13.1.1 Flora

Survey

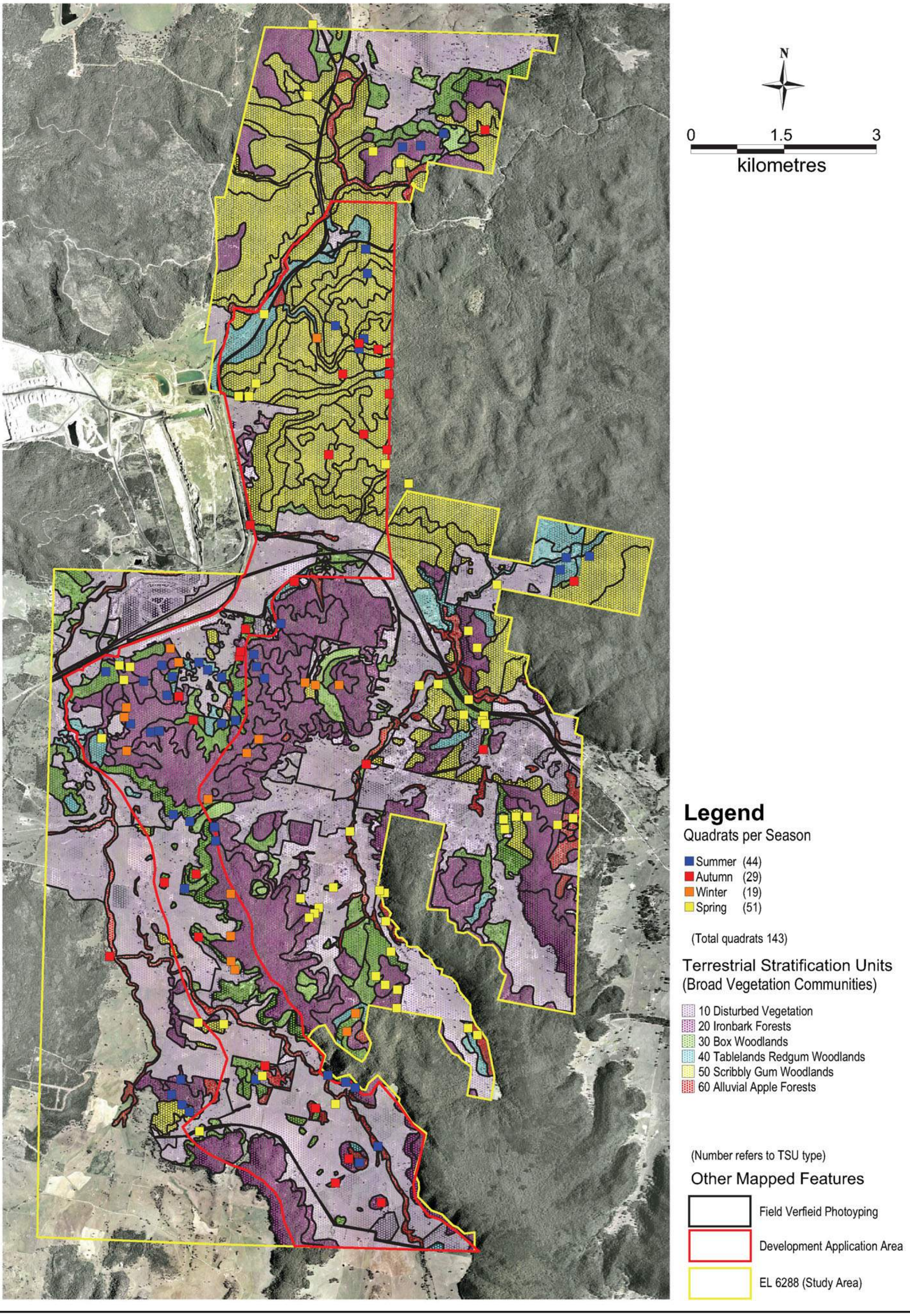
Aerial photography interpretation (API) using 2004 photography at a scale of 1:25,000 was used to identify broad vegetation communities for digitisation into a Geographical Information System (GIS). An orthorectified image of the study area was used to ensure spatial accuracy of the resultant vegetation layer. Geological maps were also imported into the GIS to refine the boundaries of these broad vegetation communities. The resultant broad vegetation mapping delineated six 'Terrestrial Stratification Units' (i.e. TSU's) within the study area, these being shown by **Table 5.28**:

Table 5.28: Terrestrial Stratification Units

No.	Description
10	Disturbed Vegetation (Study Area = 3964 ha; MCP DA Area = 1354 ha).
20	Sedimentary Ironbark Forests (Study Area = 2230 ha; MCP DA Area = 566 ha).
30	Box Woodlands (Study Area = 859 ha; MCP DA Area = 338 ha).
40	Tableland Redgum Woodlands (Study Area = 342 ha; MCP DA Area = 144 ha).
50	Sedimentary Scribbly Gum Woodlands (Study Area = 2159 ha; MCP DA Area = 983 ha).
60	Apple Alluvial Forests (MCP DA Area = 385 ha; MCP DA Area = 93 ha).

The floristic makeup of defined TSUs was investigated in the field using a combination of systematic and opportunistic plant identification and plant cover survey methods; 20 x 20 m quadrats, 50 x 8 m transects and biodiversity searches. Survey effort was greatest in areas of potential direct impact as defined from the mine plans, with reduced replication in areas with limited to no impact. Field data were entered directly into the GIS database via a specialised mobile GIS software loaded onto a personal digital assistant (PDA) linked to a 20 station Geographical Positioning System (GPS).

A total of 143 quadrats were investigated over some 60 days in ten separate field excursions over five seasons (Summer 2004/2005, Autumn, Winter and Spring 2005 and Autumn 2006). Some 502 plants were identified, 428 from the systematic quadrat surveys and 74 from biodiversity surveys.



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Terrestial Stratification Units

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Figure 5.22

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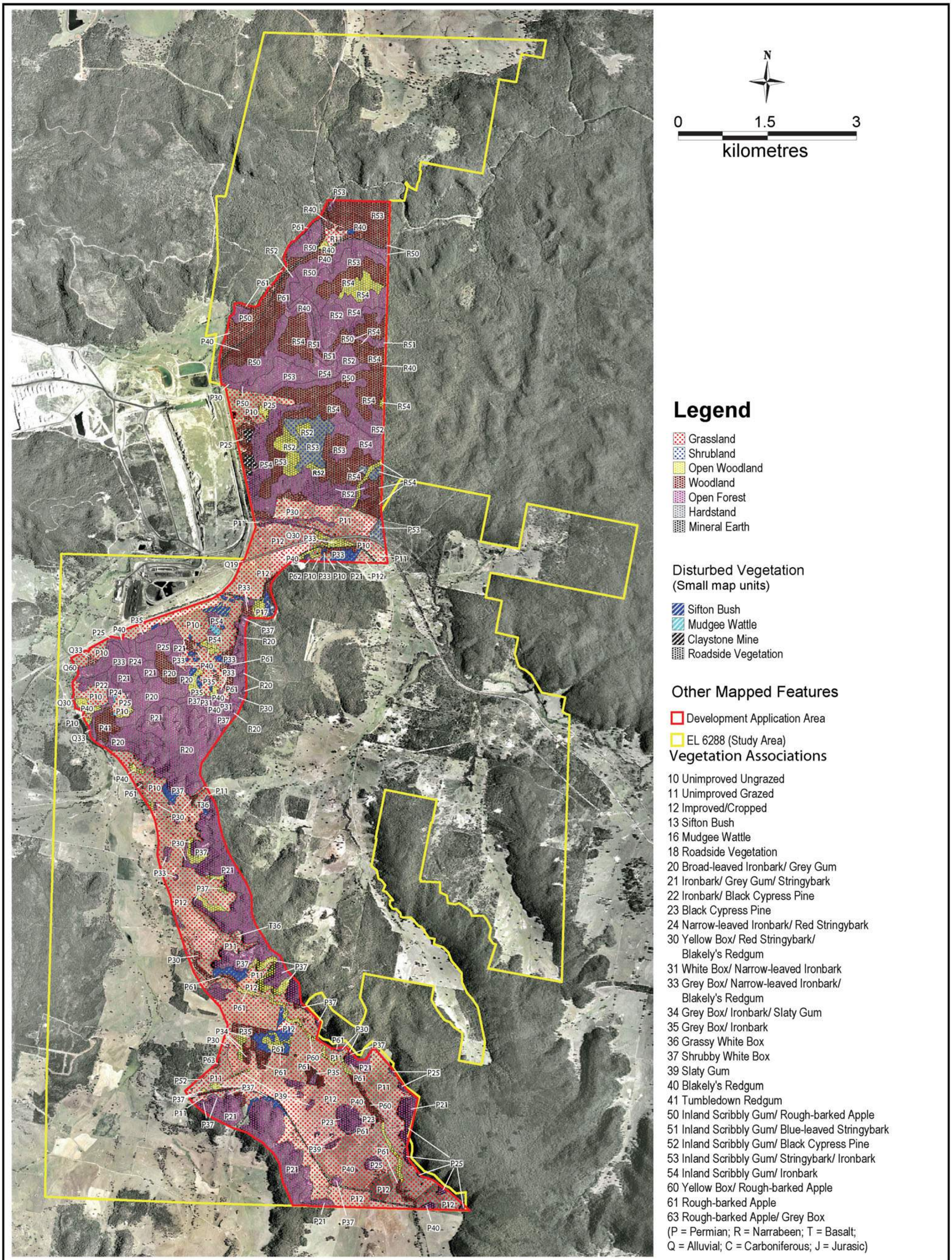

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Vegetation Associations

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Figure 5.23

Quadrat data were analysed using TWINSPAN, a non-parametric statistics package and a modified Braun Blanquet classification scheme to identify the floristic makeup of the defined TSUs. Criteria for categorising areas of high ecological value included presence of EECs, presence or possibility of threatened species, vegetation condition and location.

In general, the valley floor vegetation has been cleared and disturbed, with Alluvial Apple Forest occurring as narrow strips along creek line corridors. Box and Red Gum Woodlands occur as remnant vegetation on the valley floors and adjacent lower slopes. Ironbark Forests occur on ridgelines and upper slopes in the south (south of the Ulan-Wollar Road) and Scribbly Gum Woodlands occur on ridgelines and upper slopes in the north (north of the Ulan-Wollar Road). The total mapped extent of native vegetation within the study area that excludes disturbed landscapes is approximately 5976 ha, with the MCP DA Area containing approximately 2124 ha of the total vegetation cover.

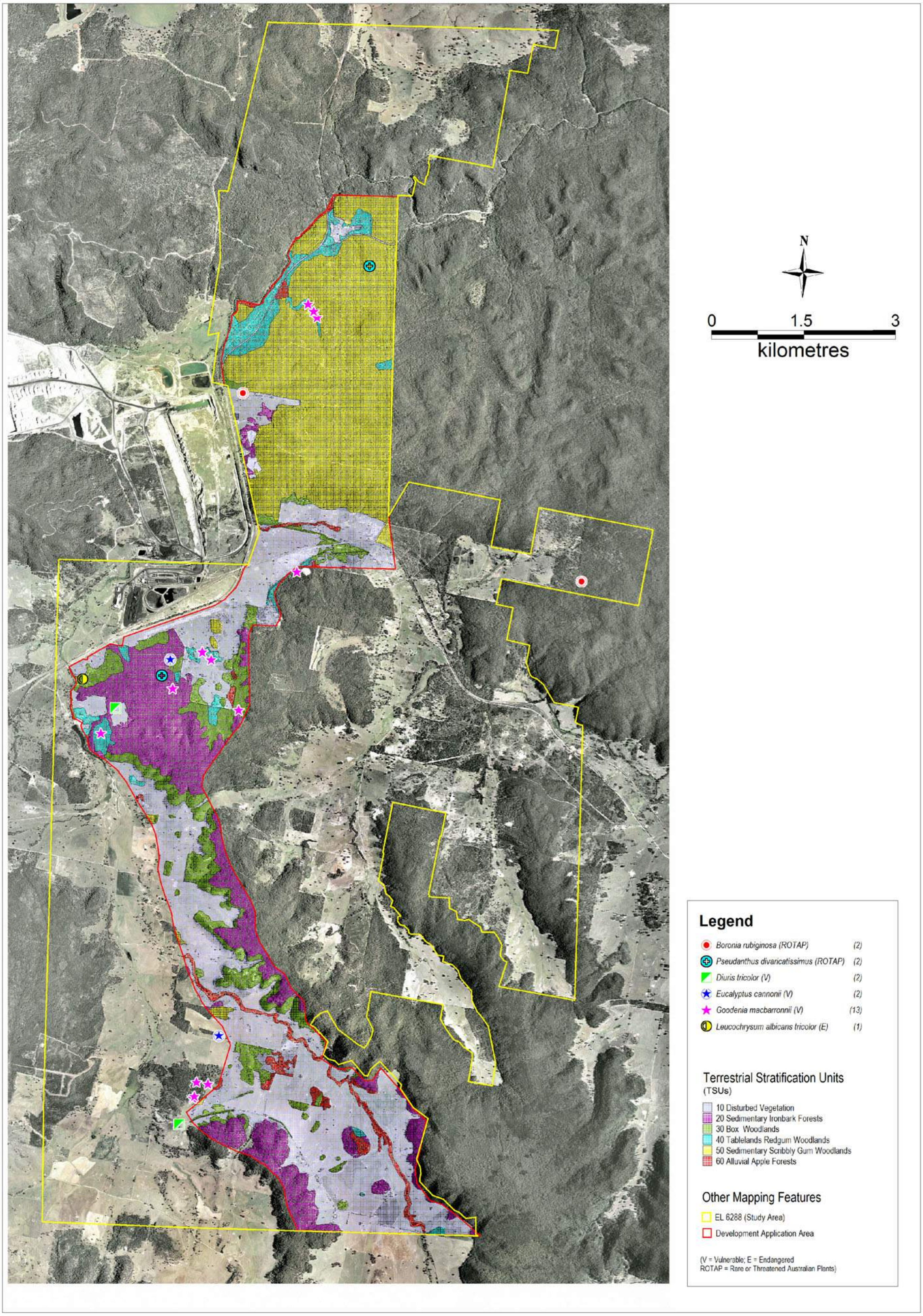
Threatened Flora Species

Four threatened plant species were recorded in the study area. One, the Commonwealth listed Hoary Sunray Leucochrysum albicans var tricolor will not be impacted by the proposed mine. The other three will be impacted by OC1 including a loss of approximately 1000 individuals of Narrow-leaved Goodenia Goodenia macbarronii (or approximately 10% of the known local population), loss of one individual of Double-tailed Donkey Orchid Diuris tricolor and the loss of approximately seven individuals of Capertee Stringybark Eucalyptus cannonii.

Figure 5.23 and Plan 35 in Volume 2 illustrates the distribution of vegetation associations for the MCP Development Area. **Table 5.29** lists threatened flora species of the area whilst **Figure 5.24** and **Plan 36** in **Volume 2** shows their distribution.

Table 5.29: Threatened Flora Species of the Study Area

Species	TSU	Vegetation Association	Details (MCP DA Area)
Goodenia macbarronii V (TSC Act & EPBC Act)	10 Disturbed Vegetation.	11 Unimproved grazed grassland.	Approximately 500 individuals, 1 location.
	20 Sedimentary Ironbark Forests.	20 Broad-leaved Ironbark/ Grey Gum.	200-300 individuals, 1 location.
	20 Sedimentary Ironbark Forests.	23 Black Cypress Pine.	Approximately 500 individuals, 1 location.
	30 Box Woodlands.	30 Yellow Box White Box Blakely's Red Gum.	Undetermined individuals, 1 location.
	40 Tablelands Red Gum Woodlands.	40 Blakely's Red Gum (core habitat).	Approximately 3000 individuals, 7 locations.
	50 Sedimentary Scribbly Gum Woodlands.	52 Inland Scribbly Gum/Rough-barked Apple.	Approximately 1000 individuals, 2 locations.
Diuris tricolor V (TSC Act & EPBC Act)	10 Disturbed Vegetation.	10 Unimproved ungrazed grassland.	2 individuals over 0.25ha, 2 locations.
Leucochrysum albicans var *tricolor* E (EPBC Act)	30 Box Woodlands.	33 Grey Box/Narrow-leaved Ironbark/Blakely's Red Gum Open Forest.	10 individuals over 0.5ha, 1 location.
Eucalyptus cannonii V (TSC & EPBC)	30 Box Woodlands.	33 Grey Box/ Narrow-leaved Ironbark/ Blakely's Redgum.	7 individuals, 1 location.
	60 Alluvial Apple Forest.	62 Rough-barked Apple/Ironbark Open Forest.	1 individual, 1 location.



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Threatened Flora Species

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Figure 5.24

Endangered Ecological Communities

The presence of the TSC Act listed White Box Yellow Box Blakely's Red Gum Woodland was determined using the NPWS (2002) identification guideline. Components of this community are also included within the threatened ecological community – Grassy White Box Woodlands, which is listed separately under the Commonwealth EPBC Act. The presence of this EEC within the study area was also examined using a TWINSPAN statistical analysis with weightings applied to the diagnostic species of this EEC, as listed by the NSW Scientific Committee (2002), to compliment the NPWS (2002) guideline approach. Both methods resulted in comparatively similar results, thereby increasing the confidence of the identification process for EECs within the MCP DA Area.

Six vegetation associations located within the MCP DA Area are consistent with the definition for the TSC Act and EPBC Act listed White Box Yellow Box Blakely's Red Gum Woodland EEC. Mapping identified 786.2ha of White Box Yellow Box Blakely's Red Gum Woodland within in the study area, with approximately 259.6ha contained within the MCP DA Area. Of this, the proposed MCP would result in the removal of 64.68 ha. In addition to the loss of EECs, the MCP will result in the removal of 351 ha non-EEC native vegetation, with the bulk of this vegetation loss assocaited with the Sedimentary Ironbark Forests (TSU 20).

Figure 25 and **Plan 37** in **Volume 2** show the distribution of EEC's for the MCP.

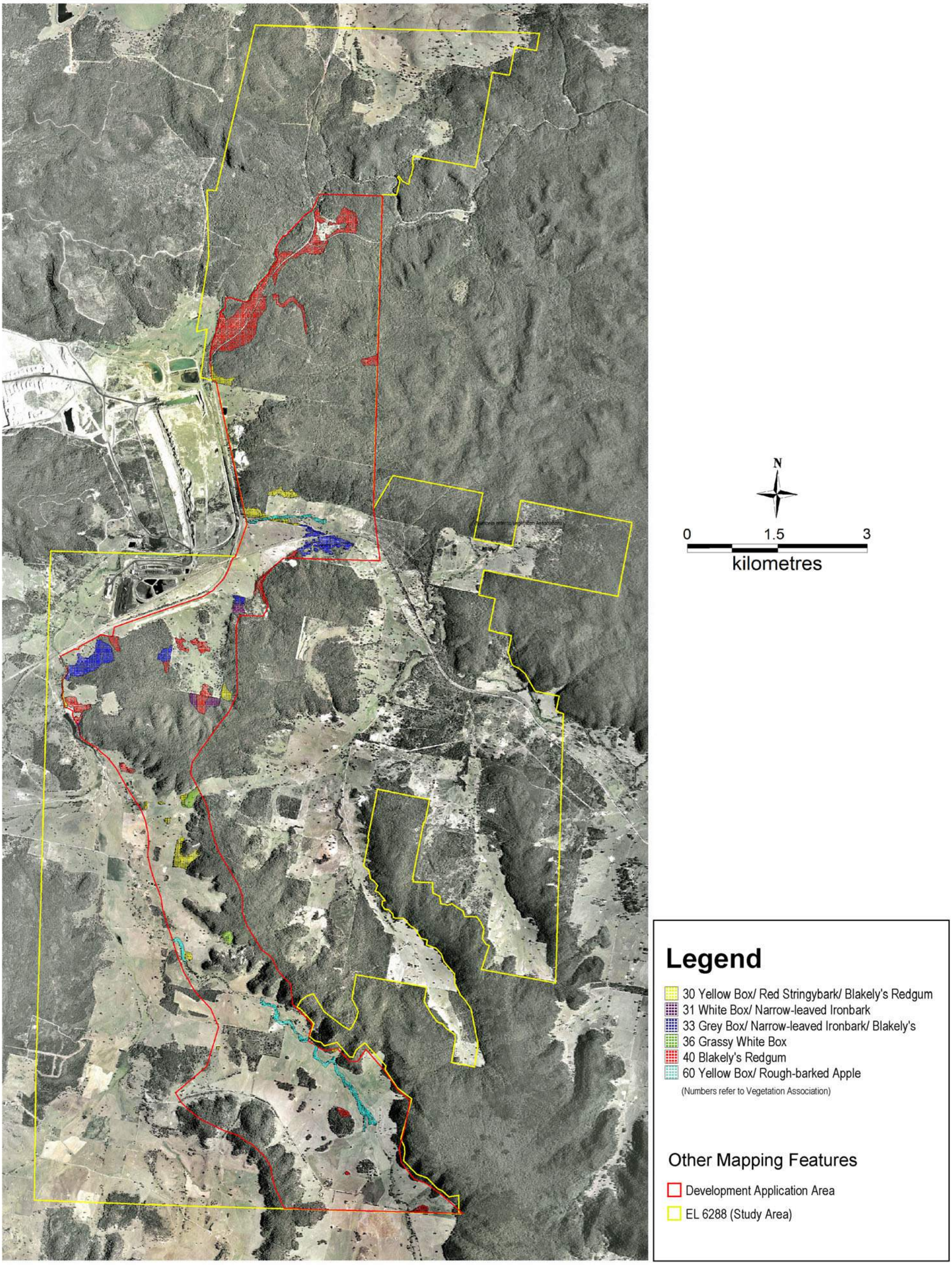
5.13.1.2 Fauna

Threatened fauna species records obtained from agency databases and from literature review were used to compile a list of 28 threatened species plus a list of potential declining woodland birds with either known or potential occurrence within the study area. This list was then used to design a targeted study based around the defined TSUs and including most vegetation associations. Surveys were undertaken at the same time as the flora surveys (described above). Fauna species were identified through trapping (see below), visual and aural detection, and through traces, ie scats, tracks, chew marks etc, nocturnal surveys and targeted means (i.e. harp trapping, pitfall trapping, call playback).

Nineteen fauna survey sites were selected for standardised trapping surveys using Elliot Type A traps. Thirteen additional sites were surveyed using Elliot B tree-mounted traps, Elliot E, Cage Traps and hair tubes. Site selection was based on the combined literature survey and the broad TSU mapping. Fourteen pitfall traplines were set diurnally. Additional hair tube surveys were conducted in conjunction with the aquatic field sampling, to target the native Water Rat *Hydromys chrysogaster*. Other systematic surveys included bird searches (~80 sites), herpetofauna searches (22 sites), Anabat II Bat Detector searches to detect the ultrasonic echolocation calls of microchiropteran bats (40 sites), harp traps to target microchiropteran bats (20 sites), call playback to target threatened owls (33 surveys across ~24 sites) and also the Green & Golden Bell Frog, and spotlighting (31 sites) to target nocturnal fauna – also used in conjunction with call playback. All surveys were supplemented with opportunistic records. A specific targeted survey for the Regent Honeyeater was conducted in August 2005 to coincide with the flowering period of White Box (*E. albens*) and the national survey weekend for the Regent Honeyeater.

Threatened Species

The fauna survey of the study area identified 256 fauna species comprising of 170 birds, 37 mammals, 32 reptiles and 7 amphibians. Of these, there were 29 threatened fauna species and 14 declining woodland birds known or considered likely to occur in the study area and



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Moolarben Coal Project
Endangered Ecological Communites
MOOLARBEN BIOTA

Figure 5.25

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MCP DA Area as illustrated in **Figure 5.26** and **Plan 38** in **Volume 2**. The assessment of fauna occupation within the study area indicated a relationship between local species distribution and TSUs. A higher diversity of fauna species was observed within the Box Woodlands TSU, with the majority of the species composition being woodland birds. Sedimentary Scribbly Gum Woodlands provided habitat for many microchiropteran bat species and reptiles due to the increased abundance of trees with hollows and surface rock. The fauna habitat analysis indicating a requirement for splitting TSUs 10 and 40 into two sub-units, as woodland birds appeared to have a affinity for disturbed landscapes containing predominantly native grasses nearby Box Woodlands (i.e. plant association 10 and 11) and Blakely's Redgum Woodlands (plant association 40).

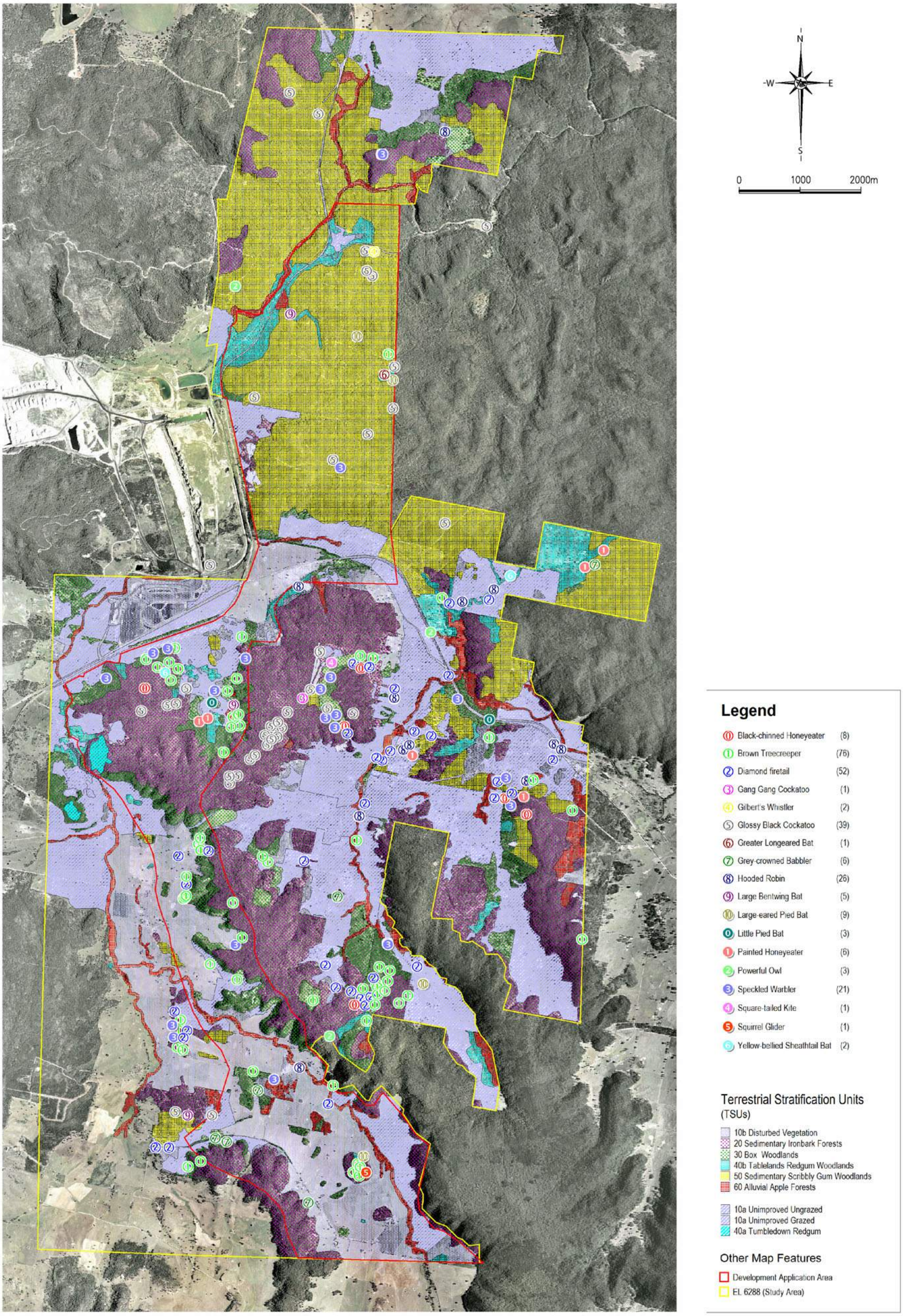
Table 5.30 lists threatened fauna species of the area whilst Figure 5.26 and Plan 38 in Volume 2 shows their distribution.

Table 5.30: Threatened Fauna Species of the Study Area and adjoining locality

Species	Predominant/Likely TSU/Habitat Unit	Vegetation Association/Details
Bush Stone-curlew *Burhinus grallarius*	Not known.	Anecdotal landholder records in the study area.
Square-tailed Kite *Lophoictinia isura*	30 Box Woodlands. 10b Disturbed Vegetation.	1 record in 36 Grassy White Box Woodland.
Gang Gang Cockatoo *Callocephalon fimbriatum*	Most vegetation associations with Callitris sp. 30 Box Woodlands.	1 record in 52 Scribbly Gum/Black Cypress Pine Woodland. Winter visitor.
Glossy Black Cockatoo *Calyptoryhnchus lathami*	Most TSU's.	39 records. Distribution likely to be based around important Allocasuarina feeding sites.
Swift Parrot *Lathamus discolor*	Not known.	May occur in the DA area during mass flowering events. Winter visitor.
Turquoise Parrot *Neophema pulchella*	30 Box Woodlands.	May occur in the DA area occasionally.
Powerful Owl *Ninox strenua*	20 Sedimentary Ironbark Forests. 50 Sedimentary Scribbly Gum Woodlands.	3 records. Recorded in vegetation association with dominance or sub-dominance of Ironbark. Probably uses DA area for foraging, and nests in nearby NP estate.
Masked Owl *Tyto novaehollandiae*	Not known.	Anecdotal landholder records in the study area. Probably only uses DA area for foraging.
Barking Owl *Ninox connivens*	Not known.	Probably uses DA area for foraging, and nests in nearby NP estate.
Gilbert's Whistler *Pachycephala inornata*	10b Disturbed Vegetation. 50 Sedimentary Scribbly Gum Woodlands.	1 record in 10 Ungrazed Unimproved Grasslands and 1 record in 53 Scribbly Gum Stringybark Ironbark Woodland.
Grey-crowned Babbler *Pomatostomus temporalis*	30 Box Woodlands 50 Sedimentary Scribbly Gum Woodlands.	6 records, mainly Box Woodlands – 34, 37, 39. 52 Scribbly Gum Black Cypress Pine Woodland.
Speckled Warbler *Pyrrholaemus sagittatus*	30 Box Woodlands. 20 Sedimentary Ironbark Forests.	Widespread, 21 records across 12 vegetation associations.
Brown Treecreeper *Climacteris picumnus victoriae*	30 – Box Woodlands. 10b Disturbed Vegetation.	Widespread, 76 records across 24 vegetation associations.

Hooded Robin *Melanodryas cucullata cucullata*	10b Disturbed Vegetation (22 out of 26 records)	26 records. Seems to prefer habitats close to creeklines. Also recorded from vegetation associations 36, 40 and 52.
Black-chinned Honeyeater *Melithreptus gularis gularis*	30 Box Woodlands. 10b Disturbed Vegetation. 20 Sedimentary Ironbark Forests.	8 records across 7 vegetation associations. 5 from Box Woodlands. Mainly assocs with dominance or sub-dominance of Ironbarks. Likely to occur only in larger remnants.
Painted Honeyeater *Grantiella picta*	Most TSU's.	6 records across 6 vegetation associations. Distribution likely to focus on areas with concentrations of Mistletoe of Amyema spp.
Regent Honeyeater *Xanthomyza phrygia*	30 Box Woodlands.	May occur in the DA area, particularly during mass flowering events.
Diamond Firetail *Stagonopleura guttata*	10b Disturbed Vegetation. 30 Box Woodlands.	52 records across all TSU's and 18 vegetation associations, 32 records in TSU 10b and 13 in TSU 30.
Giant Barred Frog *Mixophyes iteratus*	Not known.	Not likely to occur in DA area, but some potential to be affected by downstream impacts.
Squirrel Glider *Petaurus norfolcensis*	60 Alluvial Apple Forests. Potentially also 30 Box Woodlands.	1 record in 61 Rough-barked Apple Forest, possibly close to nest site.
Large-eared Pied Bat *Chalinolobus dwyeri*	10b Disturbed Vegetation. 40b Blakelys Red Gum. Woodland	9 records across 4 vegetation associations. 5 records from TSU 10b, 3 records from TSU 40b and 1 record from 54 Scribbly Gum Ironbark Woodland.
Little Pied Bat *Chalinolobus pictatus*	10b Disturbed Vegetation. 40b Blakelys Red Gum Woodland.	3 records across 3 vegetation associations. 1 record from TSU 10b, 1 record from TSU 40b and 1 record from TSU 10a mine site.
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	Not known.	Thought to prefer more extensive and less disturbed remnants.
Eastern Freetail Bat *Mormopterus norfolcensis*	Not known.	No details of preferences known.
Eastern Bent-wing Bat *Miniopterus shreibersi*	40b Blakelys Red Gum Woodland. 50 Sedimentary Scribbly Gum Woodlands.	5 records across 3 vegetation associations. 2 records from TSU 40b, 2 records from 52 Scribbly Gum Black Cypress Pine, 1 record from 61 Rough-barked Apple Forest.
Little Bent-wing Bat *Miniopterus australis*	Not known.	All records from region recorded in conjunction with Eastern Bent-wing Bat.
Greater Long-eared Bat *Nyctophilus timoriensis*	40b Blakelys Red Gum Woodland.	1 record from TSU 40b - Blakely's Red Gum Woodland.
Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris*	40b Blakelys Red Gum Woodland. 30 Box Woodlands.	2 records, 1 from TSU 40b, and the other from 34 Grey Box Ironbark Slaty Gum Woodland.
Eastern Cave Bat *Vespadelus troughtoni*	Not known.	No details of preferences known. Cave roosting.

There are 14 birds recorded in the study area that are considered as 'declining woodland birds' (as defined and listed by Stevens (2001)). The majority of records of declining woodland birds within the study area were obtained from the TSU/habitat units 10, 30, 40 and 50 as described in Table 5.28.



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Moolarben Coal Project

Threatened Fauna Species

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Figure 5.26

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5.13.1.3 Aquatic

Survey

A sampling model, utilising 46 sampling sites was designed to separate out possible mining impacts from other catchment associated impacts, including from adjacent coal mines (Ulan and Wilpinjong). The sites were assessed for overall aquatic habitat condition using a standardised Riparian-Channel-Environment (RCE) ranking scheme. At each site, the main quantitative aquatic habitat study method targets aquatic macroinvertebrates, based on methods adapted for the National River Health Program, now referred to as the AusRivAS method. AusRivAS specifies sampling in Spring and Autumn. The overall condition of the macroinvertebrate communities at each site was analysed by computing Stream Invertebrate Grade Number Average Level (SIGNAL) pollution tolerance scores for each site/sampling period. AusRivAS surveys were supplemented with aquatic plant observations, physical water quality measurements (temperature, conductivity, dissolved oxygen, pH and turbidity) and fish trapping using bait traps. Searches plus habitat assessments were also made for Platypus and Native Water Rat (the latter aided by setting hair tubes at selected sites).

Field surveys were undertaken in Spring 2004, Autumn and Spring 2005 and in Summer 2006 targeting 82 sample sites. Survey intensity varied between 17 and 27 sites visited per season, with only 6 to 11 sites actually having sufficient water available for macroinvertebrate sampling. That is, only 27 sites from the 46 potential sites had sufficient water available for sampling over the sampling period. Aquatic macroinvertebrate seasonal diversity varied from 44 taxa in Autumn 2004 to 60 taxa in Spring 2005 and there were a total of 69 taxa for the study; 51 insect taxa, 6 crustaceans, 4 gastropod molluscs, 2 leeches, and one water mite, springtail, ostracod, worm, bivalve mollusc and flatworm. No aquatic mammals (platypus or native water rat) were found during the study and although they could occur (at least in the lower part of the study area catchment in Goulburn River) none are expected. There were no threatened species found during this study and none are expected.

Based on RCE analysis alone, the best aquatic habitat is located in the Goulburn River sections below the Ulan Creek confluence; including the lower Bobadeen Creek section above the confluence. Of the several sites assessed by RCE analysis as good potential aquatic habitat, only sites in the lower portions of Moolarben Creek and in the middle Ryans Creek section actually had water to sample. The sites in the upper sections of Bora Creek plus the un-named creek north of Bora Creek did not have water over the study period. The remaining sites provide little suitable aquatic habitat by virtue of site disruption by agricultural pursuits plus site instability due to erosion.

Site by season diversities and site SIGNAL values were relatively similar across the study (diversity range 11 to 32 taxa) and site SIGNAL scores ranged from 3.45 to 5.48; 6 sites providing a 'very poor' rating, 19 sites registered 'poor' condition and 3 sites registered 'fair' condition. With regard to seasonal SIGNAL analysis there was very little variation between seasons for the total study with seasonal ranges all in the 'poor' band.

Water quality results confirm that most sampled sites had very little water holding capacity (mean depth around 0.4m). Water conductivity showed a large variation with elevated conductivity readings (3000 to 6500µS/cm occurring in Moolarben Creek sites above the dam with a gradual decrease in conductivity downstream. Creeks feeding to the Goulburn River from the north to Bobadeen Creek contributed water with slightly elevated conductivity (300 to 700µS/cm) whilst Ryans Creek flowing from the west to Moolarben Creek had the lowest conductivity (around 180 to 300µS/cm). The deeper Moolarben Creek sites were generally stratified with depressed dissolved oxygen concentrations in bottom waters. Water acidity was relatively stable, with overall study values between 6.6 and 8.5 pH units. Whilst water turbidity varied widely most readings were between 20 and 200 NTU.

Threatened Species

The initial catchment and scoping study indicated that most of the creeks and drainages in the EL area are ephemeral or intermittent and there are few creeks with permanent (or even semi-permanent) pond or riffle areas. Further, this review (and subsequent reviews of later regional impacts assessments and of Ulan Mine aquatic survey results) indicated that there were no threatened aquatic plants, fish or macroinvertebrate species or populations (as listed under Commonwealth EPBC Act or under the NSW Fisheries Management Act 1994) listed or found in the upper Goulburn River.

5.13.1.4 Groundwater Dependant Ecosystems

Groundwater Dependant Ecosystems (GDEs) are defined as ecosystems that have their species composition and their natural ecological process determined by groundwater (DLWC, 2002).

The possible occurrence of terrestrial, base flow and wetland groundwater dependant ecosystems (GDEs) was determined by examining mapped vegetation associations against their potential relationship with groundwater. The significance of possible GDEs was assessed using the eight-step rapid assessment process contained within the NSW State Groundwater Dependant Ecosystem Policy (DLWC, 2002).

No terrestrial GDEs mappable at the vegetation association level were identified within the MCP DA area or impact zone. 'The Drip', on the Goulburn River north of Underground No. 4, represents the only significant seep/spring GDE within the locality, with native vegetation reliant on this surface expression of groundwater clearly evident within the cliff line of 'The Drip'. No impacts from the mine are expected on this GDE.

Parramatta Redgum (*Eucalyptus parramattensis*) located above Underground No. 4 is associated with high moisture retaining soils (i.e. shale influenced soils) within broad open drainage lines. This vegetation is not considered a GDE as the occurrence of this species is clearly assocaited with localised topographic and soil conditions. Further evidence supporting this claim is the limited extent of the potential groundwater catchment relative to the area containing Parramatta Redgum (*Eucalyptus parramattensis*).

Whilst groundwater is known to provide base-flow to the main creeks and the Goulburn River, assessment of riparian vegetation did not indicate any specific riparian plant communities, which could be considered groundwater dependent. Wetlands identified in the DA area between the confluence of Lagoon and Moolarben Creek and the Moolarben Dam were created as a consequence of constructed surface water constrictions and are not considered groundwater dependent.

Of the possible assessed GDEs considered during the flora and aquatic studies, it is concluded that there are no GDE's within the study area that are likely to be of specific importance to any threatened fauna species. The only threatened fauna species recorded from the general locality with a fairly direct dependence on water is the Giant Barred Frog, which was not recorded from the DA area during the surveys undertaken for this project.

5.13.2 MCP Ecological Impacts

The MCP DA area has been classified in terms of its ecological value (*ie* High, Moderate, Low) using the following matters of significance to define the extent of mining related impacts on local biodiversity values:

- Threatened species, populations, EECs and their habitats;
- Woodland habitats of likely value for declining woodland birds;
- Native vegetation and habitats of importance due to their strategic location, corridor values, and critical or unique resources (i.e. riparian and aquatic zones); and
- The adjoining conservation reserve network.

Areas of high ecological value are generally associated with vegetated lands belonging to the following TSU's:

10 Disturbed Vegetation (unimproved grasslands located close to remnant stands of vegetation).

30 Box Woodlands (vegetation associations classified as EEC).

30 Box Woodlands (non-EECs containing woodland bird habitat).

40 Tableland Redgum Woodlands (vegetation association 40 which is classified as EEC).

60 Apple Alluvial Forests.

Areas of moderate ecological value are generally associated with vegetated lands belonging to the following TSU's:

20 Sedimentary Ironbark Forests.

50 Sedimentary Scribbly Gum Woodlands.

40 Tableland Redgum Woodlands (other than vegetation association 40 which is classified as EEC).

Areas of low ecological value are generally associated with vegetated lands belonging to TSU 10 Disturbed Lands (other than unimproved grasslands located close to remnant stands of vegetation). Low ecological value areas are lands within the MCP DA area supporting disturbed native vegetation and habitats. These areas are generally in poor condition, and of low habitat value. Impacts on the contained biodiversity values within the MCP DA Area are summarised in **Table 5.31**.

Table 5.31: Impacts on Contained Biodiversity Values.

Vegetation Association	Open Cut 1 (ha)	Open Cut 2 (ha)	Open Cut 3 (ha)	Infrastructure (ha)	Total (ha)
TSU 20 (Sub-total)	175.78	0.34	43.02	0	219.14
TSU 30 (Sub-total)	51.31	51.65	29.78	5.83	138.56
TSU 40 (Sub-total)	28.58	0.58	0	0	29.16
TSU 50 (Sub-total)	8.35	0.28	0	6.57	15.19
TSU 60 (Sub-total)	0.1	1.05	8.67	4.9	14.72
Total	264.1	53.9	81.47	16.61	416.77

The final MCP layout, when compared to the initial layout, has reduced the extent of proposed native vegetation clearing from 441.1ha to 416.8ha, representing a reduction of 24.3ha or 5.7%. Most importantly, the reduction of clearing would be most pronounced for vegetation associations classified as White Box Yellow Box Blakely's Red Gum Woodland EEC. The initial mine layout would have resulted in the loss of 83.70ha White Box Yellow Box Blakely's Red Gum Woodland EEC in comparison with the final MCP layout impacting 64.68ha, a reduction of 19.02ha or 22.7%. These statistics clearly demonstrate attempts to avoid vegetated areas of high ecological value (i.e. classified as EEC and providing habitat for threatened and declining woodland bird species). Another major avoidance strategy was implemented within proposed Open Cut 3, with mineable resources contained beneath Moolarben Creek and the adjoining riparian corridor excluded from mining activities. This further reduced the potential impact of mine activities on the adjoining Munghorn Gap Nature Reserve.

The MCP has been structured to avoid and minimise impacts on aquatic ecosystems. Other than several creek crossings for roads and other infrastructure plus the construction of a clean water dam on Bora Creek, there are no direct impacts on aquatic ecosystems. With regard to indirect impacts the potential problems of dust and spillages on aquatic habitats can be minimised to insignificance by proper safe practice. With regard to subsidence impacts on drainage lines above Underground No. 4 there may be some minor ponding but, given the lack of water retention in these drainage lines and creeks some ponding capacity is considered a beneficial impact.

With regard to possible cumulative impacts from combined coal mining in the district, the main consideration relates to total mine water cycle. Practicably there will be times when there are water surpluses. When this occurs, the mine will only discharge water which meets the ANZECC/ARMCANZ (2000) criteria for the protection of aquatic ecosystems and at discharge rates which do not cause a deleterious impact on base-flow. Given the overall low volume of water available for aquatic ecosystems in the upper Goulburn River catchment this discharge is on balance considered a beneficial impact.

Potential impact sources on the adjoining DEC estate (i.e. Goulburn River National Park and Munghorn Gap Nature Reserve) will be restricted to operations associated with Underground No. 4 and Open Cut 3. However, the mining impacts emanating from these sources will be negligible for the following reasons:

- Underground mining has been designed to minimise the occurrence of subsidence along the eastern boundary of Underground No. 4, such that no subsidence impact is expected on Goulburn River National Park;
- The disturbance footprint of Open Cut 3 will range from 200m to 1400m from Munghorn Gap Nature Reserve, with no water drainage capable of entering the reserve; and
- There are no significant impacts on river or creek flow or water quality and there are no significant impacts on off-site groundwater flows. Consequently there are no significant impacts on offsite aquatic ecological attributes or GDEs.

5.13.2.1 MCP Ecology Mitigation Strategy

The preferred mitigation strategy has been developed to deliver a net positive benefit for local biodiversity despite the loss of native vegetation and fauna habitats to the MCP. The key elements of the mitigation strategy are:

- Avoidance of ecologically important values;
- Dedication of significant ecological values to the conservation reserve network;
- Increase the net native vegetation cover within the locality;
- Enhance the contained ecological values within existing native vegetation;

- Conserve important ecological habitats through the salvage of fauna habitats contained within the open cuts and consequential emplacement throughout rehabilitated/ revegetated landscapes; and
- Enter into a Voluntary Conservation Agreement over existing native vegetation and revegetated/ rehabilitated landscapes to provide a secure long term beneficial outcome for local biodiversity.

The mitigation package is summarised in **Table 5.32**.

Table 5.32: MCP Ecology Mitigation Strategy.

Area (ha)	Mitigation Strategy
19	Avoidance of White Box Yellow Box Blakely's Redgum Woodland EEC
130	Dedication of 2:1 White Box Yellow Box Blakely's Redgum Woodland EEC to conservation network
24	Avoidance of non-EEC native vegetation
143	Dedication of non-EEC native vegetation to the conservation reserve network
38	Dedication of potential revegetated lands to conservation reserve network
144	Revegetation Works
370	Rehabilitation Works
1262	Extent of native vegetation excluded from the MCP
1726	Extent of Voluntary Conservation Area

The total extent of mitigation represented by the extent of the dedication to Goulburn River National Park and Voluntary Conservation Agreements is 2037 ha.

The preferred ecological mitigation strategy and final land use for the MCP is shown by **Figure 5.27** and **Plan 39** in **Volume 2**.

5.13.3 MCP Ecology Management

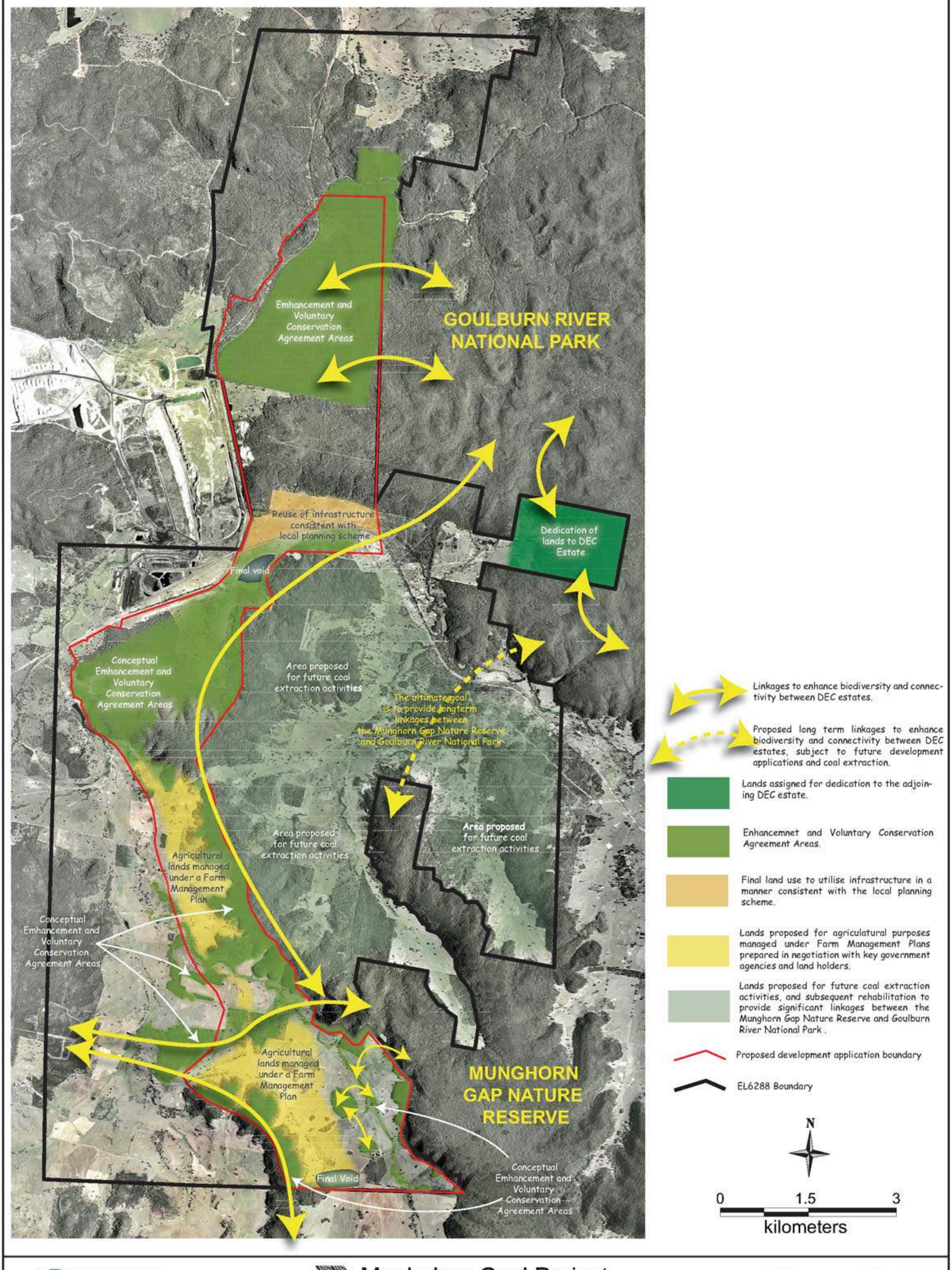
MCM will prepare and implement a Construction Flora, Fauna and Aquatic Management Plan (CFFAMP) and Flora, Fauna and Aquatic Management Plan (FFAMP) for the operational and closure phases of the MCP. The implementation of the management plans will result in the maintenance and improvement of local biodiversity.

5.14 Heritage

MCM engaged Archaeological Risk Assessment Services Pty Ltd (ARAS) to undertake an aboriginal heritage assessment of the exploration area. A copy of the report is contained in **Appendix 12**.

5.14.1 Aboriginal Heritage

The aboriginal heritage assessment process was undertaken inclusive of consultation in accordance with the DEC guidelines and involved the aboriginal community (individuals and groups), comprising the Mudgee Local Aboriginal Land Council, Murong Gialinga Aboriginal



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Moolarben Coal Project

Preferred Final Land Use and Mitigation Strategy

MOOLARBEN BIOTA and WELLS ENVIRONMENTAL SERVICES

Figure 5.27

and Torres Strait Islander Corporation and the Warrabinga Native Title Claimants Aboriginal Corporation.

An archaeological field survey of the MCP footprint and surrounding lands was carried out with members of the three local aboriginal groups, between June 2005 and January 2006.

5.14.1.1 Survey Results

A total of 1,598 aboriginal objects have been recorded as a result of the survey assessment (302 sites). This cultural record is made of: 219 individual stone artefact isolated finds, 63 open stone artefact scatter sites of varying densities, 18 rock shelter sites with artefacts and/or art, a scarred tree site, a grinding groove site and 14 potential archaeological deposits. The distribution of aboriginal objects is shown by **Figure 5.28** and **Plan 40** in **Volume 2**.

The most concentrated occupation areas located within the MCP area are:

- Moolarben Creek near Open Cut 3;
- The northern ridge Lines of Underground No.4; and
- Bora Creek near the main infrastructure area.

Aboriginal objects located within the MCP footprint will be impacted to varying degrees. Objects within the footprints of the open cuts and infrastructure area will be directly impacted, whereas objects within the area of the Underground No. 4 mine will have a range of impacts as a result of subsidence.

Impacts on sandstone shelters, sandstone outcrops (tors, pinnacles, etc) and associated drainage lines may involve cracking, shearing and movement of loose sandstone structures located within or near existing sites.

The main findings of the survey assessment are described in **Table 5.33** below.

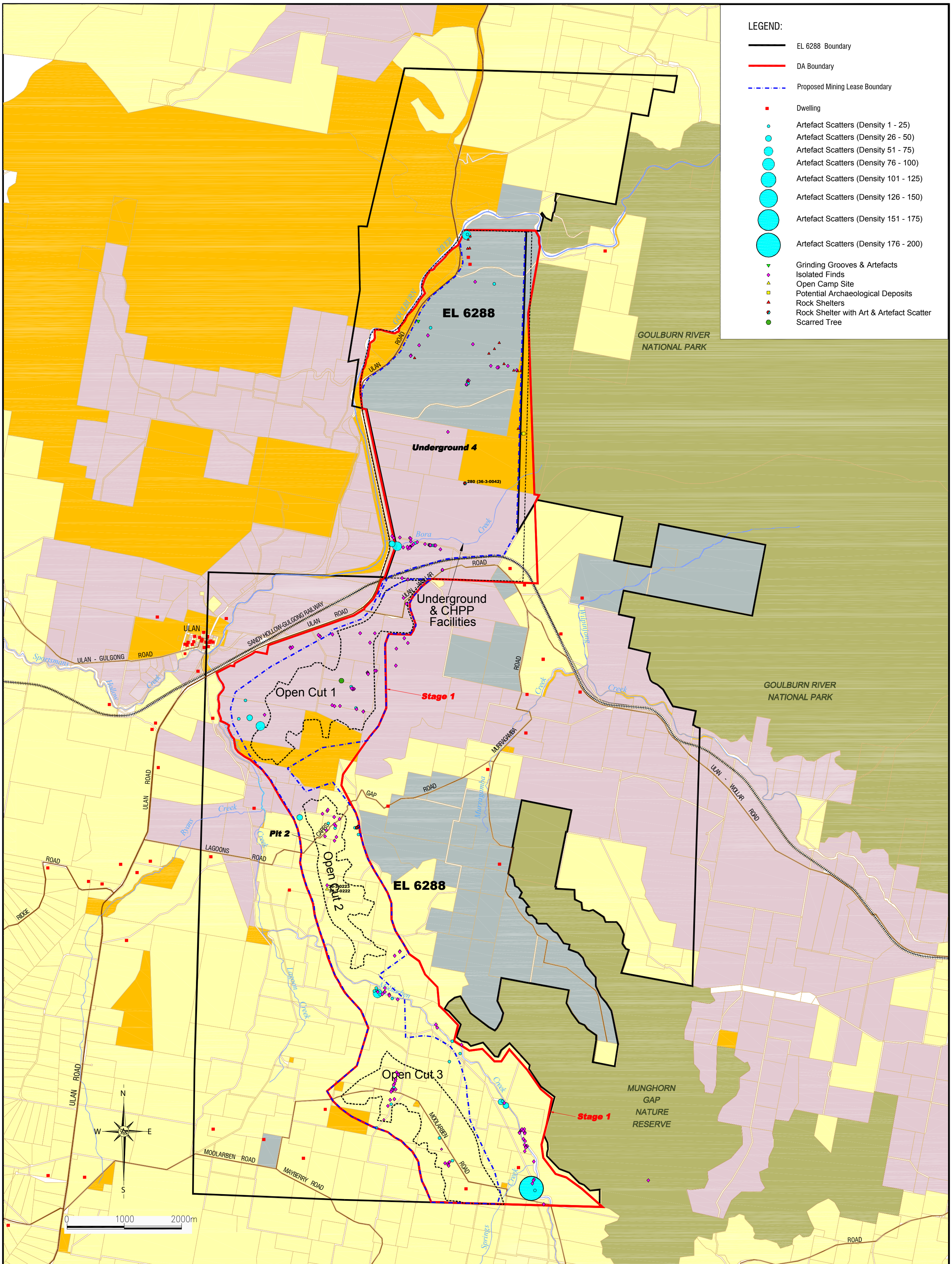
Table 5.33*: Aboriginal Sites and Objects and the risk of subsidence impacts*

High Risk of subsidence impacts: 11 sites	Moderate Risk of subsidence impacts: 1 site	Low Risk of subsidence impacts: 31 sites
S1MC 280 (36-3-0042) S1MC 287-297.	S1MC 264	S1MC 254-263, 265-279, S1MC 281-286.

5.14.1.2 Aboriginal views of sites and cultural landscape value

As part of the assessment process each aboriginal group participating in the survey was asked what cultural landscape values the project area may contain. A number of issues were raised and are summarised below:

- Sites located within the escarpment area (Underground No. 4 area) called “The Drip” have high cultural value because they represent easily identified material remains that can show living aboriginal people about aboriginal land-use, the area is also ceremonially important due to the type of rock art sites present;
- Sites, objects and known places of cultural significance (Hands on the Rock, The Drip) within Wiradjuri country are linked together; and



Pegasus Technical

Moolarben Coal Project
Aboriginal Heritage Locations
ARCHAEOLOGICAL RISK ASSESSMENT SERVICES

Figure 5.28

CAD FILE: Figure 5.28

- Due to the impact of white settlement and government assimilation policies, traditional knowledge of Wiradjuri sites within the development area have not been passed on from generation to generation.

5.14.1.3 Mitigation of Impacts

Site Management Strategies and Conservation Options

Following aboriginal community onsite meetings held on the 10 and 11 of April 2006, a series of management recommendations were developed for specific aboriginal sites and objects likely to be affected by the MCP. The management recommendations include:

- Conservation and preservation from likely mine construction impacts;
- Archaeological salvage and test excavations;
- Surface collection of aboriginal objects;
- Intensive in situ recording;
- On going monitoring and assessment of subsidence impacts; and
- Between Open Cuts 2 and 3 there is a proposed road corridor. This proposed road crosses an existing drainage line and passes a series of recorded open sites to its east. It is recommended that this section of road corridor be tested for potential buried archaeological deposits.

Conservation Management Option

This option will either involve leaving an identified aboriginal site or aboriginal object in place and therefore undisturbed within the landscape. It may also require protection using fencing or appropriate construction barriers to prevent accidental damage.

Aboriginal Cultural Heritage Management Plan

An outcome of the assessment process is that MCM prepare an Aboriginal Cultural Heritage Management Plan in order to assist it in managing likely cultural resources found within the MCP area.

5.14.2 European Heritage

Veritas Archaeology and History Service (Veritas) was engaged to conduct a european heritage assessment for the MCP. The assessment involved conducting a heritage survey to locate remaining heritage items, record, evaluate and advise on the impacts of the MCP. A copy of the report is contained in **Appendix 13**.

5.14.2.1 Background

In 1821 James Blackman and William Lawson led separate exploration parties to the Mudgee area and the first settlers started to arrive the following year. The earliest land taken up in the Ulan area was that of John McDonald and William Robinson along the Goulburn River, Ulan, Moolarben and Lagoons Creek in the early 1850s. Both selected land where there was good water and suitable crossings of the Goulburn River and were the sites of inns and staging posts.

In the Moolarben parish area, the earliest land was taken up by T. Hawkins, T. Wall, N. Barton and in the Wilpinjong area by J. Power and Newell in 1867-68. These early selectors chose places that had good water and reasonable soils.

Land selection was slow except for two periods in 1873-1877 and again in 1889-1892. The first peak may have been a "flow-on" from the gold rush at Gulgong and district. By December 1872 it is estimated that 20,000 people were in the Gulgong area. Disillusioned miners may have taken up land, or others saw opportunities supplying food and timber to the mining areas. From the 1890s many selectors were taking annual leases rather than selecting the poorer country that remained.

Some blocks were only held for a few years and were forfeited, which allowed them to be reselected by other persons, or the selections were sold to more successful land owners. Some of the early selectors who were successful were Swords, Robinson, Roberts and Blackman.

The 1885 survey of land owners shows that all had horses, with a few keeping pigs and sheep. As the land became cleared, sheep played a greater role with some crops on the better country. The exploitation of the cypress pine and iron bark forests played an important part for many early selectors. Railway sleepers, pit props, fence posts and building material were extracted from the surrounding forests.

One important mode of communication was the postal system. A post office was established at "old Ulan" in 1884 and later relocated to Ulan. A telephone service existed at Ulan Post Office as early as 1906 and private telephones became available in the district in 1909.

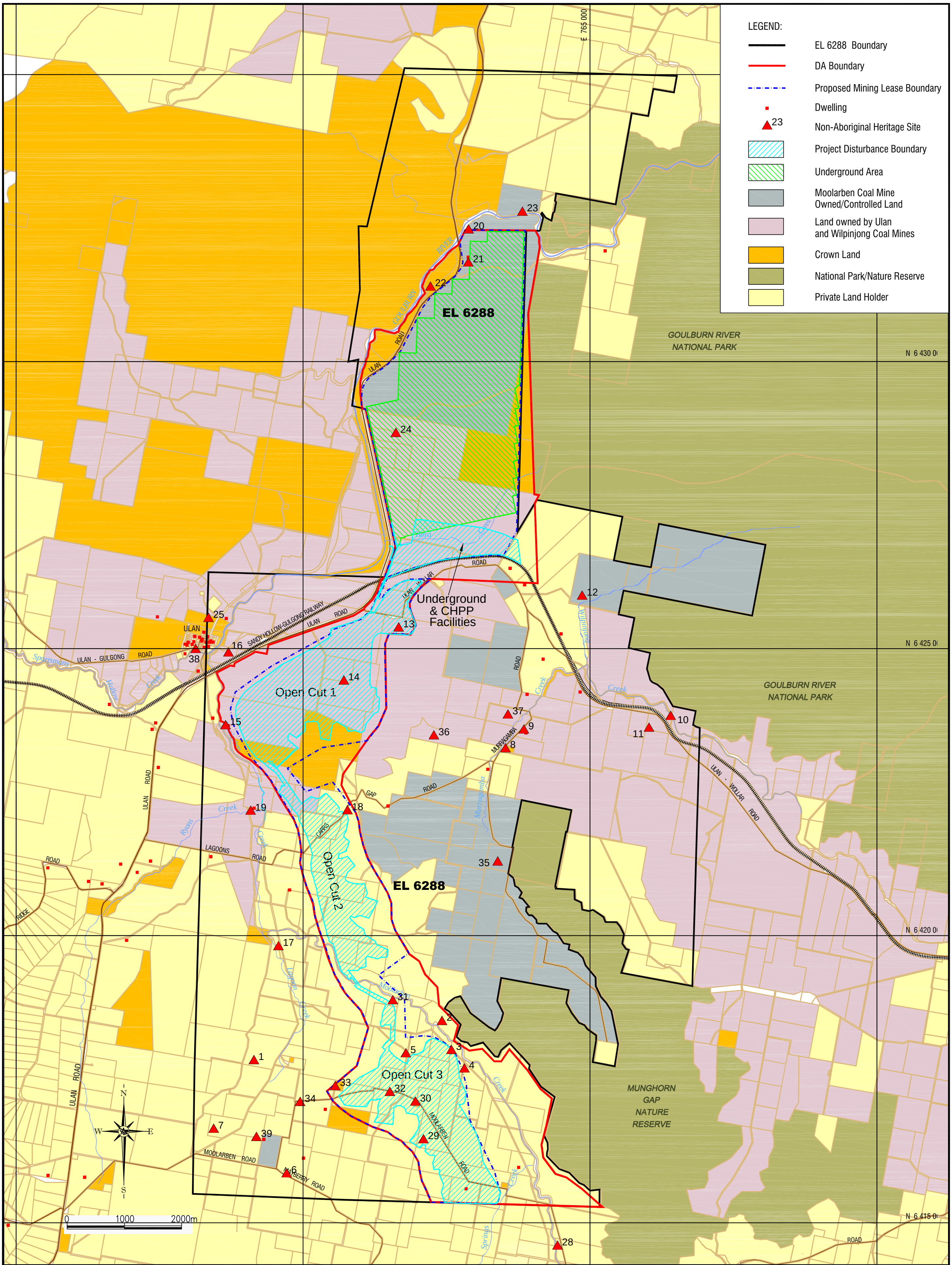
The village of Ulan was proclaimed in 1897. In 1908 the post office was reported serving a district of 35 families with a population of 196 persons. In 1912 it was reported that Ulan had a hotel/store, 2 churches, 1 school, 3 boarding houses, 23 householders, 20 other persons and a cemetery. In 1914 the village had a school, hotel, post office, hall, church and 8 houses. There were some periods of growth such as when the power station and associated coal mine opened, but many of the workers came from surrounding small farms.

It appears that there was an attempt to mine for coal in 1899 as the NSW Department of Mines contacted the Department of Education and asked if they had any objections to a Mr. E. Brissenden mining under the 2 acre school site (Portion 15, Parish Ulan). This appears to have come to nothing, as the next reference to mining is in 1927 when small amounts of coal were mined. At that time the mine was too far from markets to be a success. The mine was reopened in 1942 by the Key family who also purchased the hotel to provide accommodation for the mine employees. The mine remained in operation until sold to Ulan County Council in 1950. They started to build a new power station, but it was taken over by the NSW Electricity Commission and opened in 1957. A new company was formed by Hogan & Gorman to supply coal to the new power station. The power station closed in 1970, but the coal company continued to supply other domestic markets. The mine was taken over by White Industries in 1975.

Other mining activities have been kaolin at Murragamba and deposits of "Mudgee or Ulan stone" at Havelock and Greenbanks. This stone is used as a paver. Leases were also taken out for molybdenite, silica and fireclay.

5.14.2.2 Heritage Assessment Survey

The MCP area and surrounding district was researched by Veritas by reviewing historical records, conducting site inspections and holding interviews and discussions with long term residents. A total of fifty-four (54) heritage sites were located within or in close proximity to EL 6288 as shown by **Figure 5.29** and **Plan 41** in **Volume 2**.



Pegasus Technical

CAD FILE: Figure 5.29

Moolarben Coal Project

European Heritage Locations

ARCHAEOLOGICAL RISK ASSESSMENT SERVICES

Figure 5.29

The heritage survey identified places and relics consistent with the district's past agricultural and pastoral land use and associated social fabric. Numerous house and farm sites were located, together with former school sites, graves, surveyor marks, the old Lagoon Inn and retaining walls associated with the road to Wollar via Carr's Gap Road.

Veritas assessed each of the identified items and assessed their respective level of significance following the guidelines set out by the NSW Heritage office. Each of the sites were assigned a level of significance, together with a recommendation of what further action should be undertaken, having regard to the MCP.

5.14.2.3 MCP Heritage Impact and Mitigation

Heritage items identified by the study and those items which would be impacted by the MCP are listed and described in **Table 5.34** .This table provides the level of significance assigned to each of the items by Veritas, together with a recommendation of further actions on the basis that the MCP receives approval.

Table 5.34: Historic Heritage Sites identified as having exceptional or moderate heritage significance and their impact assessment.

No	Place Name	Impact Status	Significance	Summary Recommendation
1	School site, Portion 85, Ph Moolarben	No impact	Local – high	No further action required In situ conservation.
2	Farm site. Portion 218. Ph Moolarben	No impact	Local – moderate	No further action required In situ conservation.
3	Burial site, Roberts family. Portion 146, Ph Moolarben	Impact by Open Cut 3 development	Local – high	Exhumation. Discussion to be held with related families.
4	House & burial site. Portion 63, Ph Moolarben	Impact by Open Cut 3 development	Local – moderate	Exhumation. Discussion to be held with related families.
7	Farm site. Portion 9 Ph Moolarben	No impact	Local – moderate	Archival recording. In situ conservation.
8	School site. Portion 43 Ph Wilpinjong	No impact	Local – moderate	Archival recording. In situ conservation.
9	Farm site, Portion 77, Ph Wilpinjong	No impact	Local – high	Archival recording. In situ conservation.
10	House site. Portion 30	No impact	Local – moderate	In situ conservation
11	Farm site, Portion 29, Ph Wilpinjong	No impact	Local – moderate	Archival recording. In situ conservation.
12	Farm site, Portion 87, Ph Wilpinjong	No impact	Local – moderate	Archival recording. In situ conservation.
14	House site. Portion 178 Ph Moolarben	Impact by Open Cut 1 development	Local – moderate	Archival recording
15	Moolarben Dam	No impact	Local – moderate	In situ conservation

No	Place Name	Impact Status	Significance	Summary Recommendation
16	Carlisle Graves, Portion 8, Ph Moolarben	No impact	Local – high	Photographed and recorded. Ensure area is maintained with public access.
17	Lagoon Inn. Portion 6, Ph Moolarben	No impact	Local – high	Archival recording. In situ conservation.
18	Carr's Gap Road. Portion 30. Ph Moolarben	Impact by Open Cut 2 development likely	Local – moderate	Archival recording In situ conservation. If impacted recovery works to be recommended
19	Farm site. 'Glen Moor', Portion 203 Ph Moolarben	No impact	Local –exceptional	Archival recording. In situ conservation.
20	Grave & memorial garden. Portion 30 Ph Lennox	No impact	Local - high	Area to be maintained.
22	Stock yards. Portion 34 Ph Lennox	No impact	Local – moderate	Archival recording. In situ conservation.
23	Natural environment. 'The Drip'	No impact	Local – high	Ensure public access is maintained
25	Cemetery. Portion 46, Ph Ulan	No impact	Local - high	Area to be maintained along with public access
26	House site. Portion 21 Ph Moolarben	No impact	Local – moderate	Archival recording
27	Farm site. Portion 104 Ph Moolarben	No impact	Local – moderate	Archival recording.
28	House site. Portion 67 Ph Moolarben	No impact	Local – moderate	Archival recording.
29	House site. Portion 45 Ph Moolarben	Impact by Open Cut 3 development	Local – moderate	Archival recording.
30	School site. Portion 176 Ph Moolarben	Impact by Open Cut 3 development	Local – moderate	Archival recording.
31	House site, Portion 228, Ph Moolarben	No impact	Local – moderate	Archival recording. In situ conservation.
32	House site. Portion 89 Ph Moolarben	Impact by Open Cut 3 development	Local – moderate	Archival recording.
33	Recreation Ground. Portion 204. Ph Moolarben	No impact	Local – moderate	Archival recording. In situ conservation.
34	House site, Portion 139, Ph Moolarben	No impact	Local – moderate	Archival recording. In situ conservation.
36	House site & burial site. Portion 28, Ph Wilpinjong	Impact Status to be advised Stage 2 assessment.	Local – moderate	Management recommendation to be advised upon completion of Stage 2 Assessment.
37	House site. Portion 38 Ph Wilpinjong	No impact	Local – moderate	Management recommendation to be advised upon completion of Stage 2 Assessment.
38	Village of Ulan	No impact	Local – moderate	Archival recording before further deterioration takes place.

No	Place Name	Impact Status	Significance	Summary Recommendation
39	House site, 'Athy', Portion 39, Ph Moolarben	No impact	Local – high	No further action required
53	Goulburn River National Park	No impact	National	No further action required
54	Munghorn Nature Reserve	No impact	National	No further action required

5.14.2.4 Discussion of Impacts

There are a number of positive aspects for heritage within the MCP area. These aspects are: -

- 35 items were assessed as having exceptional, high or moderate local significance, but only seven are in positions that will be impacted by open cut development;
- Site 2, farm site, is on the north side of Moolarben Creek in Open Cut 3 and it may be possible to leave it undisturbed;
- Site 18, dry wall embankment on the road to Carr's Gap, is on the edge of Open Cut 2 and with design modification it may be possible to retain it;
- Sites 26 and 28 are presently outside the lease, but may be impacted if Open Cut 3 is extended south;
- Site 31 is to the north of Open Cut 3 and can be avoided by open cut development:
- Heritage sites within the lease have been identified and basically recorded. Some of these are in very poor condition, and in a few more years evidence of their location would be lost;
- There is the potential to collect further heritage information from more detailed recordings; and
- A considerable amount of background material was collected for the Project. This could be made available to Mudgee & District Historical Society to enhance their record collection.

There are some negative aspects for heritage within the MCP area, these being: -

- Sites that will be impacted are Site 14 within Open Cut 1, Sites 3, 4, 29,30, 32 within Open Cut 3 ;
- There may be a possibility that Site 18 could be impacted by Open Cut 2 development; and
- Other sites within the Project area will continue to deteriorate.

5.14.2.5 Mitigation of Impacts

Since there are sites that will be destroyed, there is the opportunity to increase historical knowledge by further recording and archaeological excavation. Some of the sites would be considered relics, and Section 139 of the NSW Heritage Act 1977 would apply. Some sites are so disturbed, altered or damaged that there is little historic value remaining in the sites. As there are a limited number of sites within the Open Cut areas, there are a number of actions that can be taken to lessen the negative impacts:

- No site should be destroyed unless it will be impacted by mining. All sites should be considered an archaeological resource for the future;
- All sites not to be disturbed by mining are to have in situ conservation. All sites that have this recommendation where applicable must have a physical barrier erected around them to prevent accidental damage during mining development.;

- There are a number of sites within the lease that will not be impacted by mining, but will continue to deteriorate. They require an archival recording made to Heritage Office standards. The sites are 7,8, 9, 11, 12, 17, 19, 22, 27, 29, 31, 33, 34;
- Site 18, a drystone wall embankment on the road to Carr's Gap, is on the edge of Open Cut 2 and it should be retained if possible;
- Sites 3 and 4 may involve exhumation of grave sites – subject to discussions and agreements with relatives of persons interred; and
- Archival works will be recorded in accordance with the heritage Office of New South Wales guidelines with copies being made available to local historical groups and the Mid-Western Regional Council.

5.15 Social and Economic Environment

The Hunter Valley Research Foundation (HVRF) was commissioned to:-

- Prepare an estimate of regional economic impacts resulting from the construction and operation of the MCP; and
- Prepare a socio-economic profile of the area from which it is likely the majority of the mine's operational workforce is likely to reside and be drawn.

A copy of the HVRF is contained in **Appendix 14**.

5.15.1 Background

In March 2004 there was a redistribution of some of the New South Wales local government areas and amalgamation of others. In the MCP area, the newly proclaimed Mid-Western Regional Council now comprises 100% of the former Mudgee Shire, 70% of the former Rylstone Shire and 10% of the former Merriwa Shire. The profile presented within the HVRF report uses a combination of historical data as well as some recently published data for the Mid-Western Regional Council local government area. The "draw area" for the MCP includes the former local government areas of Mudgee, Rylstone and Merriwa.

5.15.2 Existing Demographic Characteristics

Current Australian Bureau of Statistics assessments place the "estimated resident population" of the Mid-Western Regional Council local government area at 22,141 in June 2005. Data from the last three population censuses indicates the following trends:-

- In 2001 the total population of the former Merriwa, Mudgee and Rylstone local government areas was approximately 23,600;
- Since 1991 the population has consistently declined in Rylstone, "see-sawed" in Merriwa and consistently increased in Mudgee, at a higher average rate than the workforce "draw area" in total;
- Employment in the former Merriwa-Mudgee-Rylstone area totalled 9,224 in 2001. The bulk of employment being in the former Mudgee local government area;
- In 2001 the workforce draw area was substantially dependent on the primary sector – despite a decline in the relative importance of mining between 1999 and 2001;
- The three major industry sectors remained agriculture, retail trades and manufacturing;
- During 2005 the Federal Department of Employment and Workplace Relations suggests that on average 10,800 people were employed in the workforce area with an additional 700 seeking work;

- The estimated unemployment rate of 6.6% for 2005 was slightly higher than the state average of 5.2%; and
- Private housing in the workforce draw area is predominantly “low density” with home ownership higher than in the state as a whole.

Table 5.35 provides a summary of the population composition during the period 1991 to 2001 for the Merriwa, Mudgee and Rylstone local government areas.

Table 5.35: Population growth and distribution in former LGAs in the workforce area – summary results

LGA	1991	1996	Av. Annual growth 1991-1996	2001						Av. Annual growth 1996-2001
				Males		Females		Persons		
				No.	% area total	No.	% area total	No.	% area total	
Merriwa	2,356	2,252	-0.9%	1,190	10.0%	1,140	9.7%	2,330	9.9%	0.7%
Mudgee	16,252	17,038	0.9%	8,892	74.4%	8,757	74.9%	17,649	74.6%	0.7%
Rylstone	3,901	3,725	-0.9%	1,865	15.6%	1,799	15.4%	3,664	15.5%	-0.3%
Total area	22,509	23,015	0.4%	11,947	100.0%	11,696	100.0%	23,643	100.0%	0.5%

Source: ABS, *Census of Population and Housing, 1991, 1996 and 2001*

5.15.3 Moolarben Coal Project Employment and Economic Impacts

The development of the MCP will have a strong positive impact upon the economy of the Mid-Western Regional Council local government area, whilst contributing to the state and federal economies directly and indirectly. An overview of the employment and economic benefits is provided below for the construction and operational phases of the MCP.

5.15.3.1 Economic Benefits - Construction

- A total expenditure of $150 million will be spent by the proponent during the construction period, which is estimated to take up to 18 months. This expenditure is expected to stimulate additional production in the region valued at $73 million and additional consumption worth $44 million – an induced benefit of $117 million, providing a total benefit to the region of approximately $267 million;
- The total expenditure of $150 million is expected to generate approximately 220 full-time equivalent jobs during construction. The induced production (108 jobs) and consumption (108 jobs) in the region will generate a further 216 jobs, providing a total employment benefit to the region of 438 jobs; and
- Over the construction period it is estimated that taxation revenue will be approximately $19 million to the federal government and $3 million to the state government, resulting in a public sector benefit of $22 million.

5.15.3.2 Economic Benefits – Operations

- When production revenue is maximised at $356 million per annum in the fourth year of operation, the coal mining activities will stimulate further output in the region valued at approximately $308 million: $162 million of which will result from additional production and $146 million of which will be generated from additional consumption. The total annual output impact from Year 4 inclusive is expected to be valued at more than $664 million;
- Employment at the MCP is expected to be maximised from Year 11 inclusive, with direct annual employment at the mining operations equivalent to around 317 full-time positions. Additional production and consumption in the region will generate a further 280 and 313

jobs respectively, providing an induced employment benefit of 593 jobs. In total, approximately 910 full-time equivalent positions will be created in the region in each financial year of operation; and

- When production revenue is maximised in Year 4, Federal Government taxation receipts are estimated to total approximately $59 million: $37 million from income tax, $13 million from indirect taxes, and $9 million from company tax. Payroll taxation revenue to the State Government is estimated at more than $10 million, yielding a total public sector benefit of more than $69 million in each financial year of operation. It is estimated that a total of $341 million will be paid in production royalties to the State Government over the life of the project.

5.15.4 Workforce Impacts and Mitigation Measures

During the construction and operational phases of the MCP the Mudgee and Gulgong townships, and to a lesser extent Rylstone and Kandos townships, are anticipated to experience an increase in population as a result of experienced mine workers and their respective families taking up residency in the local government area. FRL encourages women to become part of the MCP workforce – similar to other operating mine sites operated and managed by FRL.

FRL, through its experience of operating three coal mining operations in New South Wales and Queensland, estimates that a number of construction workers will temporarily reside in the local government area, whilst up to 160 workers during operations will take up residency.

The following assessment focuses on the major impacts during construction and operations of the MCP.

5.15.4.1 Construction

The MCP will closely follow the construction phase associated with the approved and under construction Wilpinjong Coal Project. Similar to this project, it is believed that a significant proportion of the MCP construction workforce will be sourced from the local region. Approximately 50 workers from outside the region may be employed on the MCP and would be housed in motels, hotels, tourist accommodation, caravan parks and units and other dwellings. Accommodation within the townships of Mudgee, Gulgong, Rylstone and Kandos will record higher than average occupancy rates.

Subject to discussions, scope may also exist to house some of the workers at the construction camp facility developed for the Wilpinjong Coal Mine Project.

5.15.4.2 Operations

It is estimated that 160 experienced mine workers (male and female) and their families will relocate to the Mid-Western Regional Council local government area during the first year of operation. The remainder of the workers will be drawn from the local workforce draw area.

Initially the experienced workers will be needed for the smooth functioning of operations. The experienced workers will provide training to any local trainee workers.

The major impact associated with the operational aspect of the MCP is the housing of the 160 workers and their families relocating to the district. Assuming that each worker has 2 dependents, the population would increase by some 480 persons. A mix of housing types will be needed to accommodate these people. It is anticipated that the majority of the people will seek to reside in the Mudgee or Gulgong townships, given the community infrastructure which exists. The housing construction industry will benefit from the MCP.

The additional people residing in the Mid-Western Regional Council local government area will result in additional demand being placed on existing services, especially those of commercial, education, health care and recreation.

MCM will be seeking to enter into a formal Planning Agreement with the Mid-Western Regional Council and contribute potentially “works in kind” or monetary contributions to off-set the MCP socio-economic impacts. The Minister for Planning would determine the level of contributions if agreement is not achieved between the proponent and the Mid-Western Regional Council.

5.16 Transport

MCM commissioned Sinclair Knight Merz Pty Ltd (SKM) to undertake an assessment of road and rail transport associated with the MCP. A copy of the report is contained in **Appendix 15**.

5.16.1 Roads

5.16.1.1 Existing Road Network

The MCP is located east of the intersection of two designated main roads – Main Road (MR) 214 which connects Mudgee with Cassilis, and MR 598 which links Gulgong to Ulan. The MCP

is located either side of the Ulan – Wollar Road where it meets MR214.

MR214 (Mudgee to Ulan – Ulan to Cassilis) is a 2 lane road with a speed limit of 100km/h. In 2002 MR214 between Mudgee and Ulan the average annual daily traffic (AADT) was 1,300 axle pairs, north of Ulan the figure had decreased to about 600 axle pairs. Growth in traffic is approximately 2.3% per annum.

MR598 (Gulgong to Ulan) is a 2 lane road with a speed limit of 100 km/hour. In 2004 MR598 at the level crossing east of Gulgong the AADT was 1,600 axle pairs with traffic growth approximately 1.5% per annum.

The Ulan – Wollar Road generally follows the Gulgong to Sandy Hollow Railway Line. The Ulan – Wollar Road (east of MR214) is sealed for only the first 4 kilometres.

Both the NSW Roads and Traffic Authority (RTA) and Mid Western Regional Council specified to the Director General of the Department of Planning that a road safety assessment of the key routes that would be used by staff to access the proposed mine should be undertaken.

Road Safety Audits were undertaken by SKM on two roads, these being:

- MR214 between Mudgee (corner Church Street and Short Street) and Ulan (MR214 bridge over railway line); and
- MR598 between Gulgong (corner Station Street and Nandoura Street) and MR214 at Ulan.

The Road Safety Audits identified two areas of concern associated with both routes, these being delineation and road edge formation and shoulder provision. A general addressing of the issues of delineation and edge treatments is likely to improve safety along both routes.

5.16.1.2 Local Public Transport Network

School bus services operate along several routes to, from and within Mudgee, Ulan and Gulgong, including along MR214 and MR598. These buses are on the road generally between 07:30 and 09:00, and 15:00 and 17:00.

5.16.1.3 MCP and the Local Road Network

Access to the MCP underground mine and infrastructure area is proposed off MR214, approximately 400m north of the railway bridge. This access point was approved in 1985 as part of the consent for the Underground No. 4 mine. The access will be designed and constructed in accordance with the RTA's Road Design Guide standards.

It is proposed to realign the Ulan – Wollar Road north from its existing alignment about 200m east of its intersection with MR214. At this point a new intersection will be constructed to provide access to Open Cut 1, 2 and 3 mines. The realigned Ulan – Wollar Road will have a 60 km/h design speed.

The development of Open Cut 2 will require the partial or permanent closure of Carr's Gap Road whilst the development of Open Cut 3 mine will require the partial relocation of the Moolarben Road.

5.16.1.4 MCP Traffic Generation

The MCP will employ 317 people during operations.

The peak number of vehicle movements would occur on a weekday between 06:00 and 07:00, when 118 people would arrive at the site for the day shifts. In the following hour, there would be 73 staff leaving after night shift. The maximum hourly load could be as high as 190 vehicles, although this is likely to be spread over close to 2 hours. Due to the staggered finishing times of the day shifts, the evening peak hour would be between 19:00 and 20:00, when 47 people would leave the site. The preceding hour would see 42 staff arrive for night shift.

On weekends, the peak traffic generation would be 54 vehicles arriving and 54 vehicles leaving between 06:00 and 08:00, and the same number between 18:00 and 20:00.

SKM in assessing traffic impacts assumed that the staff of the Wilpinjong Coal Mine project would utilize the Ulan – Wollar Road for both its construction and operational phases and that the MCP employees would primarily reside in Mudgee and Gulgong and use MR214 and MR598.

5.16.1.5 Road Traffic Impact Assessment and Mitigation

MCP Construction Phase

There would be up to 220 workers employed per day at the peak of construction activities. Hours of construction would be 07:00 to 18:00. This would be a noticeable increase on the base load, but would not adversely impact on road or intersection capacity, due to the low traffic volumes currently on these roads.

Aside from the wide loads, the truck movements to and from the site are not expected to have a significant impact on traffic flow and intersection operation in the area.

There would be some short-term disruptions to traffic associated with the construction of intersections. During the road work construction periods, the following general principles will apply in regard to traffic management:

- Access along all public roads will be maintained at all times;
- Where temporary road closures are required, detours will be constructed around the worksite. Where it is not possible to provide a 2-way detour, portable traffic signals will be used to regulate traffic flow in each direction. This approach has been used where road works have been in place along MR214 between Mudgee and Ulan;
- The movement of heavy vehicles, and in particular over-size loads, would be arranged so as to minimise disruption to traffic during the period immediately before and after school; and
- Separate traffic management plans would be in place for the movement of over-size vehicles.

MCP Operations Phase

SKM have concluded that in 2016 when both MR214 and MR598 reach peak hour volumes of 200 and 170 vehicles respectively, the traffic volumes are well within the capacity of the roads.

Intersection capacities will not be exceeded as a consequence of the MCP. Despite the MR214 and Ulan – Wollar Road intersection having sufficient capacity, some modifications are required to enhance safety. The modifications include line marking and the removal of some trees south-west of the intersection so as to provide good sight distances for motorists.

As the open cut areas are progressively mined, it will be necessary to divert Carrs Gap Road (for Open Cut 2) and Moolarben Road (for Open Cut 3). Access along these roads would be maintained, but details of the diversions will be considered in the future in consultation with Mid-Western Regional Council and other stakeholders.

Public Transport

The proposal would have no impact on the operation of public transport services. School bus services would pass by the mine site between 07:30 and 09:00, and between 15:00 and 17:00.

5.16.2 Rail

5.16.2.1 Existing Rail Network

There are several rail lines in the region, although they are currently not in regular use. These include the Wallerawang to Gwabegar Railway which passes through Mudgee and Gulgong, and the Gulgong to Sandy Hollow Railway Line which connects with the Main Northern Railway. This latter railway is used currently for the transport of coal from the Ulan Coal Mine, adjacent to the MCP. There are no regular passenger services in operation.

As part of the assessment process for the MCP, a report on the condition and operation of all public road level crossings on the lines between Ulan and Muswellbrook and Ulan and Wallerawang was undertaken.

5.16.2.2 Railway Level Crossing Assessment

The physical condition of the crossings inspected as part of this study appeared to be within ARTC maintenance standards.

The additional volume of rail traffic generated by the MCP is considered to be minor and as such the existing protection arrangements are adequate and will remain, even taking into consideration the likely increase in coal haulage.

In terms of potential delays likely to be caused by the increase in the number of trains it is assessed that the calculated level crossing waiting times are within industry accepted tolerances.

Level Crossing Condition

The majority of the public road crossings surfaced with bitumen were fitted with automatic warning lights and bells.

The crossings encountered that had unsealed approach roads had various forms of protection from "Give Way" signs to automatic warning lights and bells.

The crossings are generally in fair condition although some minor surfacing repairs and road marking are required. A number of the crossings have suffered damage to warning signs and posts. In some cases the warning signs are missing.

5.16.2.3 Rail Conclusions

The physical condition of the crossings inspected as part of this study appeared to be within ARTC maintenance standards. With regard to the protection arrangements for crossings, the additional volume of rail traffic generated by the MCP is considered to be minor and as such the existing protection arrangements are adequate and should remain, even taking into consideration the likely increase in coal haulage by rail.

In terms of potential delays likely to be caused by the increase in the number of trains on the Ulan – Muswellbrook railway line it is judged that the additional trains per day will not cause significant delays although increased disruption will occur once other mines (i.e. Wilpinjong) become fully productive.

In relation to the Ulan to Wallerawang railway line, the number of coal trains running on the operational section between Kandos and Wallerawang is very low. The relevant mines are Charbon, Baal Bone and Airley. The increase from 12 train movements to 14 is unlikely to cause any major delays to road users.

5.17 Utility Services

Utility services such as power and telecommunications that prevail in the locality will be impacted by the MCP in some locations. A description of the impacts and proposed mitigation measures is detailed within *Section 4 – Project Description*.

5.18 Hazard and Risks

A detailed hazard analysis was conducted for the MCP by Sinclair Knight Merz (SKM), and incidents with the potential to result in off-site impact were identified. A copy of the hazard analysis for the project is contained in **Appendix 16**. Those incidents identified and carried forward for detailed consequence analysis were:

- Mix truck roll over, fuel leak and fire;

- Explosion on the shotfirers vehicle;
- Premature explosion of the ANFO mix on the mix truck;
- Diesel fuel storage fire;
- Lubricating oil storage fire; and
- Magazine explosion.

5.18.1 Conclusions of Hazard and Consequence Analysis

The hazard and consequence analysis concluded the following:

- All hazardous incidents underground (e.g. fires, explosions, etc.) would be confined within the underground workings and would not result in an offsite impact; and
- The impact of the consequences of all identified hazards in the surface mine and pit top facilities do not have the potential to impact offsite due to the application of buffer zones around the open cut workings, and the location of the site explosives magazine well clear of the site boundary.

5.18.2 Risk Reduction Management and Mitigation Measures

Notwithstanding the majority of analysis results indicating no off-site impact, a number of risk reduction management and hazard mitigation strategies and site emergency responses have been prepared for the MCP. These are detailed below:

- That the potential incidents listed in the Hazard Analysis, be included in the site Emergency Response Plan, along with other incidents identified to have onsite impact to mine equipment and personnel;
- That during the regular emergency response drills, conducted as part of the Mine Rescue Team (MRT) exercises, the hazards be included in the drill exercises to ensure MRT readiness; and
- That fire in vehicles would be a potential hazard on site, and that fire growth has the potential to result in serious damage to occupants and, that all vehicles on site be fitted with at least one dry powder type extinguisher. Larger vehicles should carry at least one 9kg dry powder extinguisher and smaller vehicles at least one 4.5kg dry powder extinguisher.

All staff, contractors and visitors will be required to comply with relevant legislation to ensure that the MCP is a safe place to work and visit.

5.19 Bushfire

5.19.1 Existing Bush Fire Setting

The native vegetation of the locality is largely restricted to the adjoining conservation reserves (Goulburn River National Park and Munghorn Nature Reserve) and elevated ridgelines of low agricultural suitability. Vegetation is mostly of open forest structure with a woody herbaceous/ shrubby understorey which is classified as Group 1 vegetation under the Planning for Bush Fire Guidelines (RFS, 2001). This vegetation cover represents the highest bush fire prone land category prescribed within the guidelines.

Weather conditions during the winter period are typically cold and dry, which contributes to the onset of an early fire season (i.e. September), particularly given the reduced fuel moisture levels (i.e. low rainfall) and fuel accumulation (i.e dry dead material from sub-zero temperatures). Westerly winds during the winter-spring period also contribute to an increased likelihood of fire events. Average monthly relative humidity and temperature data for the September to January period are also conducive to increased fire intensity, with the weather conditions during the months of November and December being particularly suited to fire activity.

The adjoining conservation reserves are principally managed for the conservation of biodiversity, meaning that the use of fire within these areas is generally governed by biological thresholds rather than asset protection. Few man made assets exist along the boundary of this reserve thereby minimising the risk of bush fire impacts on life and property. Many off-park assets are located within extensively cleared lands throughout the valleys, thereby increasing the separation of bush fire prone lands from areas of human habitation. Further, the limited extent of ignition sources (i.e. mostly lightening strikes) significantly reduces the local incidence of bush fires hence of the risk of damage from these events.

Local fire suppression resources include the Cooks Gap, Ulan and Wollar Rural Fire Brigades, which form part of a wider resource base contained within the Mid Western Regional Council local government area. The local National Parks and Wildlife Service at Mudgee also maintain fire management resources for use in local conservation reserves. The National Parks and Wildlife Service often implement prescribed hazard management activities in accordance with specific management plans for each conservation reserve, including both Munghorn Gap Nature Reserve and Goulburn River National Park. Both the Rural Fire Service and National Parks and Wildlife Service have a defined working relationship that allows co-operative operations to suppress bush fires throughout the locality.

5.19.2 Potential Bushfire Impacts

The presence of bush fire prone lands within the locality represents potential risk to the operation of the MCP in following areas:

- The safety of personnel and residents of the area (i.e. contact with smoke and flame);
- Damage to plant and buildings (i.e. vehicles, machinery, administration centre);
- Damage to non-mine owned dwellings;
- Ignition of coal stockpiles and flammable materials such as fuel and lube storages;
- Interruption of mining and agricultural operations; and
- Loss of rehabilitation/ revegetation works.

Also of importance is the potential increase of ignition sources during the undertaking of routine construction and operational activities such as the use of machinery in vegetated lands or the undertaking of hot works under inappropriate conditions. The incidence of accidental/ deliberate human related ignition sources may also rise due to increased human activity in close proximity to native vegetation in remote areas.

Finally, these matters must also be considered in the context of the local biological values contained within the adjoining conservation reserves and freehold lands. Many of the contained ecological assets of Goulburn River National Park and Munghorn Gap Nature Reserve are sensitive to frequent fires, which if occurring may significantly reduce the biodiversity values of these areas. Therefore the management of vegetation for bush fire purposes requires an integrated solution that adequately considers the protection of life, property and biodiversity.

5.19.3 Bushfire Mitigation

The MCP is divided into construction and operational phases, with both phases requiring prescribed management strategies to minimise bush fire risk to activities, processes, infrastructure and other assets located in close proximity to bush fire prone lands. Accordingly, two separate management plans will be prepared to fully describe the methods used to address the identified risks relative to these project phases. These plans will be referred to as:

- Construction Bush Fire Management Plan; and
- Operations Bush Fire Management Plan.

Both these management plans will consider the management regimes prescribed for Goulburn River National Park and Munghorn Gap Nature Reserve to ensure maximum consistency with the conservation objectives for these areas.

MCM will consider the use of perimeter roads, management tracks, management zones in the development of an integrated bush fire management strategy. The availability of fire suppression assets such as water carts, dozers, static water storages etc will be defined in relation to the needs of local fire management organisations (i.e. National Parks and Wildlife Service and Rural Fire Service) to maximise the control of unplanned bush fire events.

5.20 Visual Impact Assessment

MCM commissioned O'Hanlon Design Pty Ltd to undertake an analysis of the area's visual character and to assess the MCP impacts and provide recommendations for the mitigation of those impacts. A copy of the report is contained in **Appendix 17**.

5.20.1 Existing Visual Character of the Area

The visual impact assessment study area stretches from Cooks Gap north to the ranges beyond Ulan and is bounded by the Cope State Forest to the west, the Munghorn Gap Nature Reserve to the south-east and the Goulburn River National Park to the north-east.

Within the study area there are five distinctive landscape units of varying levels of quality. The landscape units are listed below: -

- Ridgelines and upper wooded slopes. This landscape unit forms a visually prominent backdrop to the southern and eastern boundaries of the MCP DA area. The landscape has a maximum height of approximately 745m AHD at the Munghorn and 640m AHD at Dexter Mountain;
- Undulating ridgelines, vegetated and cleared. The extensive areas of remnant woodland provide a contrast to cleared pasture lands that run through the study area;
- Valleys and floodplain areas. This unit is located through the central and southern portion of the study area. The landscape unit encompasses the catchments of Moolarben, Lagoon and Spring Creeks;
- Water bodies. The main water body of the study area is the Goulburn River. Moolarben Dam located south of the village of Ulan on Moolarben Creek also forms part of this landscape unit; and
- Other cultural elements. Those elements which comprise this landscape unit include Ulan village, Ulan Coal Mine and associated infrastructure, the Ulan to Cassilis road bridge over the Gulgong – Sandy Hollow Railway Line and the Wilpinjong Coal Mine.

The nightscape of the area is perceived as being rural in character, with small concentrations of light at the Ulan Village. The lighting of the existing Ulan Coal Mine stands out in the existing nightscape.

Based on the landscape units, O'Hanlon Design Pty Ltd was able to assess the scenic quality of the area, which is shown by **Table 5.36**.

Eleven (11) viewpoints specific to the MCP were chosen to assess the project's visual impact upon the locality. The assessment of the degree of visual impact of the MCP is based on the perceived severity of the works and facilities within the landscape from selected viewpoints and the number of viewers expected to experience the visual changes.

Table 5.36: Scenic Quality Assessment

Landscape Rating Unit	SCENIC QUALITY CRITERIA				Proportional Prominence of Scenic Quality Classes
	Diversity of Landscape Elements	Landform	Vegetation	Water	
Ridgeline & upper wooded slopes	Moderate	High	High	-	High
Undulating foothills and elevated outcroppings	Moderate	Moderate/High	Moderate	-	Moderate
Valleys & flood plains	Moderate/High	Moderate	Low	Low	Low to Moderate
Impact of Cultural modifications	Moderate	Low	Moderate	-	Low to Moderate

5.20.2 MCP Visual Impact

The sequential nature of mining, emplacement, rehabilitation and the location of infrastructure was assessed over the life of the MCP. Visual impact ratings were ranked in decreasing severity on a scale of between 8 and 0 as follows: very high, high, moderate, low and nil, from each of the eleven viewpoints for the life of the MCP. **Figure 5.30** provides a summary of the daytime visual impact and **Figure 5.31** provides a summary of the night time visual impact of the MCP. **Figure 5.32** and **Plan 42** in **Volume 2** shows a cross section from the Ulan village looking in a south-easterly direction to the Open Cut 1 mine.

5.20.3 MCP Visual Impact Mitigation Measures

The following measures if implemented will reduce the overall daytime impacts of the open cut mining areas, the overburden emplacement works and the infrastructural elements from various viewpoints as shown above:

- Create a 6m high bund along the north and northwest edge of Open Cut 1 adjacent to the final void as part of initial works and landscape in the first 6 months;

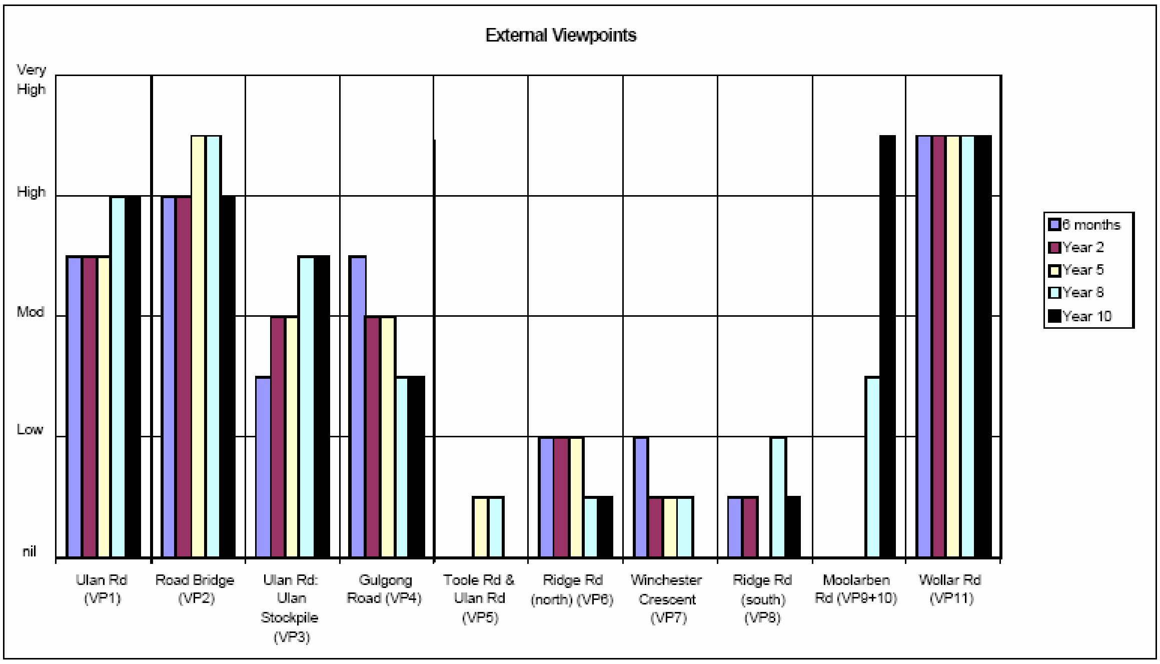


Figure 5.30: Provides a summary of the daytime visual impact of the MCP.

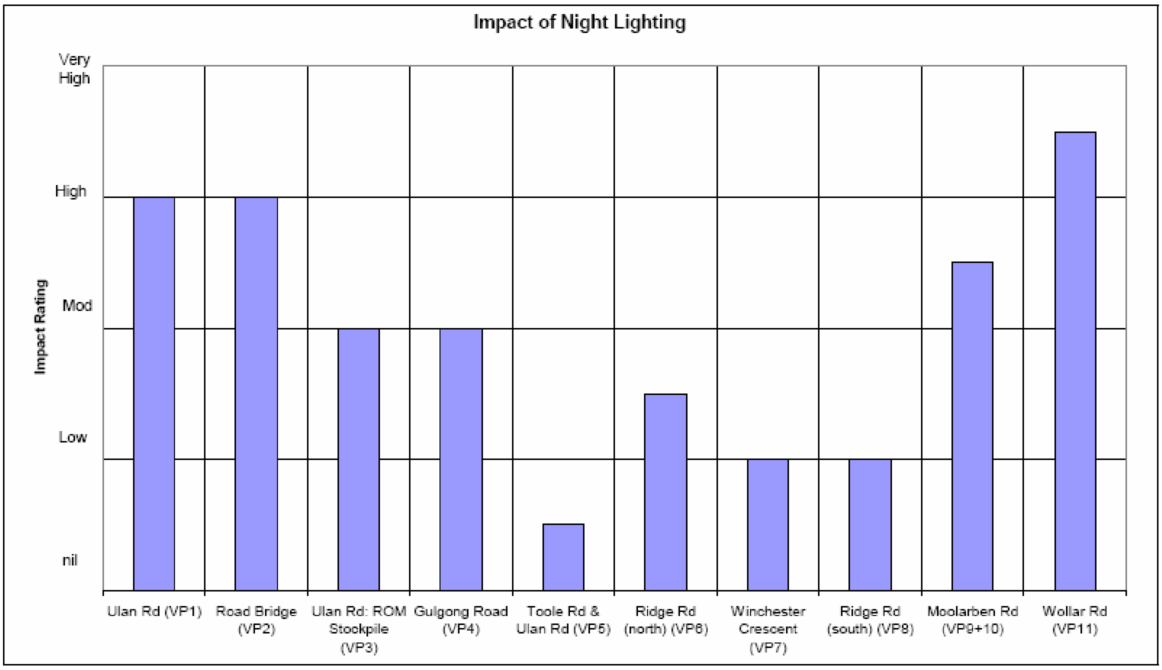
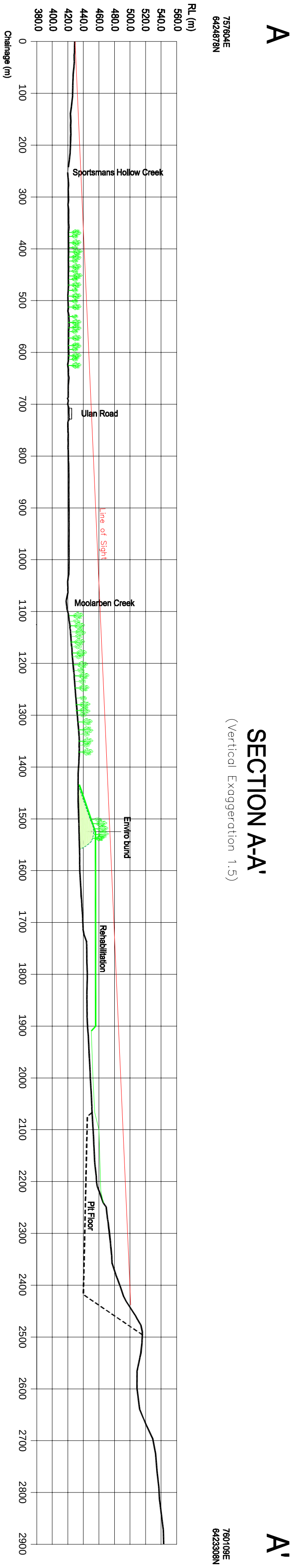
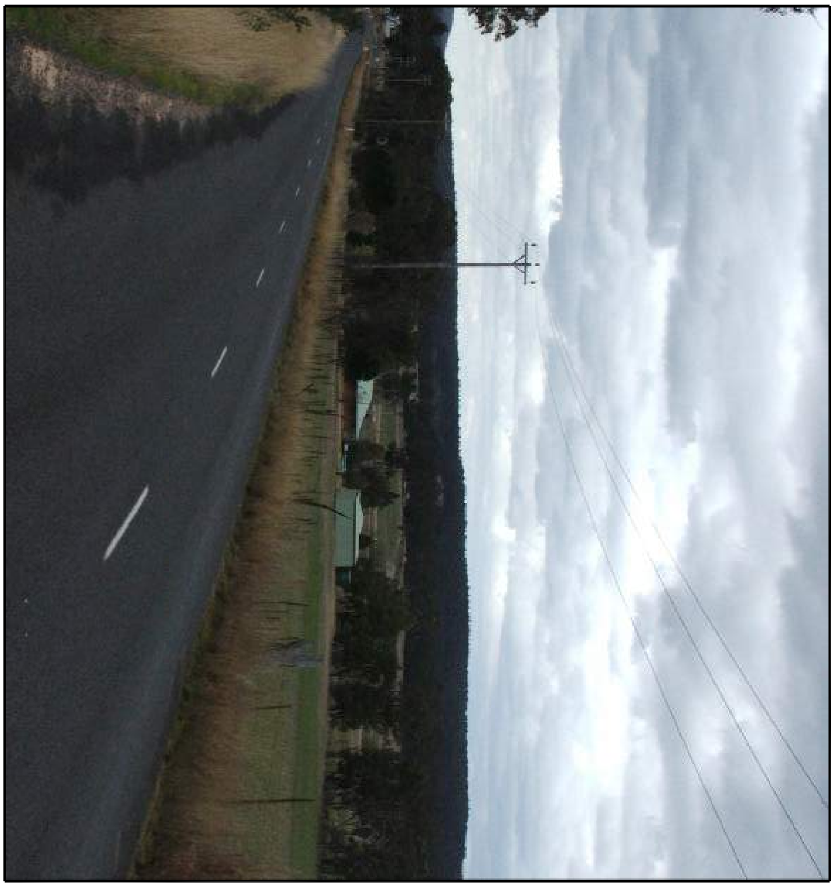
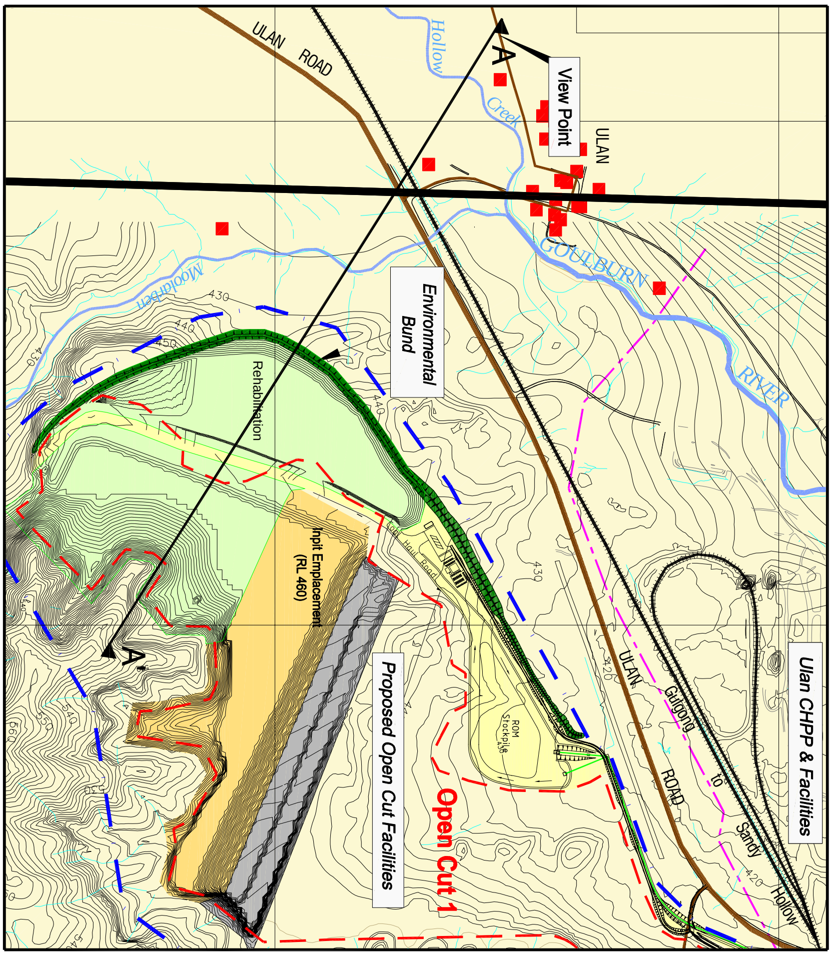


Figure 5.31: Provides a summary of the night time impact of the MCP.







Pegasus Technical

Moolarben Coal Project

Visual Impact from Ulan Village

Figure 5.32

CAD FILE: Figure 5.32

- Create a mixed vegetative screen 4 rows (10 metres) of quick growing acacia species and eucalypts along the north edge of the realignment of Wollar Road as close as reasonable to the road alignment. This will reduce the impacts of the infrastructure area to moderate within 5 years. Plants to be selected relative to final road levels and adjacent topography to screen at eye level between 1m and 2.5m above road level;
- Where the Open Cut 1 acoustic bund is not screened by trees, modify the face of the bund by creating a deep gulley or an extended toe to create a more natural landscape element;
- Modify the tree removal and emplacement strategy along the mid slopes of the east-southeast ridgeline to prevent the removed tree line from forming a horizontal line when viewed from similar elevations. This is relevant along the east edge of Open Cut 1, the east edge of Open Cut 2 and the west edge of Open Cut 3;
- Along the bund edge of Open Cut 1 and Open Cut 2 modify the junction to existing topography to moderate the edge and reduce the straightness on the bund. This can be achieved by filling to match the existing contours and creating a more natural transition from existing ground levels where saddles and ridges exist;
- When a land access agreement is reached with the land owner plant an advanced tree screen (5-6 rows deep) around the proposed facilities area for Open Cut 3. This will form a screen to viewers in the east and along Moolarben Road when operations commence in this area;
- Consider re-contouring or increasing density of vegetation of rehabilitated bench areas in Open Cuts 1, 2 and 3 to reduce the apparent flatness of the benches long term. This reduces potential long term impacts when viewed from elevated locations. This is particularly relevant for Open Cut 3 where long term development or users in Munghorn Gap Nature Reserve may overlook the final rehabilitation from viewing locations around RL 500 to RL 600; and
- Implement a revegetation strategy for each rehabilitation area to mirror the existing vegetation removed from the rehabilitated areas.

The following measures if implemented will reduce the overall night time impacts of the open cut mining areas, the overburden emplacement works and the infrastructural elements from the eleven (11) viewpoints:

The measures that could be taken by MCM to mitigate adverse night lighting impacts are as follows:

- Within the infrastructure areas use approximately 15m high light columns and low brightness floodlights with the floodlight body horizontal and the floodlight reflector designed to provide sharp cut-off and restrict stray light.;
- Use wall mounted lights with horizontal bodies and low brightness design to light areas around the workshop and CHPP to 50 lux and adjacent portions of the hard stand area to 10 lux;
- Shield all floodlights in the open cut area to the maximum extent practicable;
- Face workshop doors east to reduce light spill;
- Where safe to do so, trucks on access roads would make use of portable visual edge markers to increase drivers' visibility of road edges when driving with dipped headlamps; and
- Lighting should be screened to viewers were possible but lighting must always be selected to meet safe working practices.