WILPINJONG COAL PROJECT

MAIN REPORT

Section Three
Existing Environment

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3 EXISTING ENVIRONMENT

The following sub-sections provide a description of the background environment relevant to the Project.

3.1 LAND RESOURCES

3.1.1 Landforms and Landuse

Landforms in the general Project area are characterised by the narrow flood plains associated with the tributaries of the Goulburn River, the undulating foothills, ridges and escarpments of the Great Dividing Range and the dissected landforms of the Goulburn River National Park.

Local elevations range from approximately 350 m AHD (Australian Height Datum) on Wilpinjong Creek just to the east of the confluence with Cumbo Creek, to approximately 745 m AHD at a series of peaks to the south of the Project along the Great Dividing Range. Elevations in the Goulburn River National Park to the north of the Project are generally less than 600 m AHD (Figure 3-1).

Within MLA 1, elevations generally range from approximately 350 to 440 m AHD, while escarpment areas and narrow ridges adjoining the Munghorn Gap Nature Reserve rise to above 510 m AHD in places (Figure 3-1).

Goulburn River National Park

The Goulburn River National Park adjoins the Project to the north and covers an area of approximately 71,000 ha. As the National Park covers part of the Great Dividing Range, it extends into both the Hunter and Cudgegong River Catchments. Some 90 km of the Goulburn River lies within the National Park (Hill, 1999 and 2000). The flora and fauna values of the Goulburn River National Park are described in Sections 3.6.3 and 3.7.1.

Munghorn Gap Nature Reserve

The Munghorn Gap Nature Reserve covers an area of some 5,900 ha and straddles the Great Dividing Range. Wilpinjong and Cumbo Creeks drain parts of the northern and eastern sides of the Munghorn Gap Nature Reserve, respectively, before flowing through the Project area. The flora and fauna values of the Munghorn Gap Nature Reserve are described in Sections 3.6.2 and 3.7.1.

Landuse

Landuse in the vicinity of the Project is characterised by a combination of coal mining operations (Ulan Coal Mines), agricultural landuses (primarily grazing) and rural residential development (evident in the local villages of Wollar, Ulan and the localities of Cumbo, Slate Gully and Araluen) (Figure 3-1). WCPL controlled lands (Figure 1-5) are currently utilised for the agistment of livestock.

As described in Sections 1.3.1 and 1.3.5, the Project DA is situated wholly within land zoned Zone 1(a) (General Rural) by the Mudgee LEP (Figure 1-3).

3.1.2 Meteorology

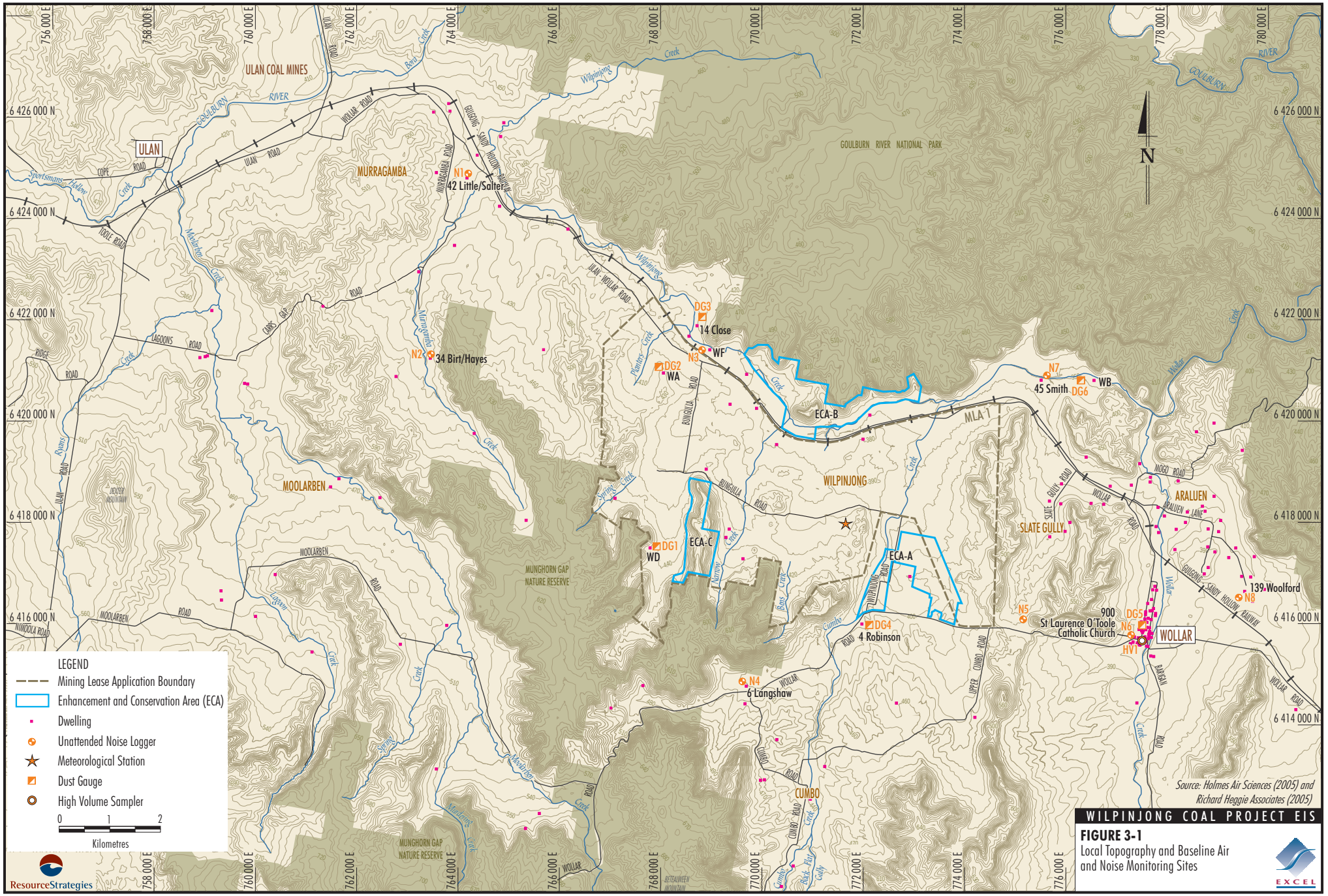
For the Surface Water Assessment (Appendix A), meteorological data was collected from a number of regional monitoring stations (Gulgong Post Office, Mudgee [George Street] and Jerrys Plains Post Office) and local monitoring stations (Wollar, Maree, Budgee Budgee, Ulan [Mittaville] and Ulan Post Office).

Climate monitoring stations at Gulgong Post Office and Mudgee and rainfall monitoring stations at Wollar (Barrigan Street and Maree) provide indicative climatic data for the Project area. The locations and recording periods for these stations are provided in Table 3-1.

Table 3-1
Bureau of Meteorology Station Locations and Recording Periods

Station Name	Station Number	Location	Latitude	Longitude	Elevation (m) AHD	Period of Record
Mudgee (George Street)	062021	Approximately 40 km south-west of the Project	32.5956	149.5956	454	1870-2004
Gulgong Post Office	062013	Approximately 30 km west of the Project	32.3634	149.5329	475	1881-2004
Wollar (Barrigan Street)	062032	Approximately 7 km east of the Project	32.3592	149.9484	366	1901-2004
Wollar (Maree)	062056	Approximately 14 km south-east of the Project	32.4261	149.9535	410	1962-2004

Source: Bureau of Meteorology (2005)



Source: Holmes Air Sciences (2005) and Richard Heggie Associates (2005)

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FIGURE 3-1
Local Topography and Baseline Air and Noise Monitoring Sites

EXCEL

In addition to the Bureau of Meteorology stations, a meteorological station which continuously records wind speed and direction, temperature, relative humidity, net solar radiation, rainfall, and sigma theta (the rate of change of wind direction) was installed at the Project site in May 2004 (Figure 3-1).

Meteorological data collected from various stations is summarised in Table 3-2 and discussed below.

Rainfall

Rainfall records are available from a number of locations in close proximity to the Project site, including a gauge in the village of Wollar (Barrigan Street - 062032) which has 104 years of record and a gauge approximately 6.5 km south of Wollar (Maree - 062056) which has 43 years of data.

The annual average rainfall for these two stations is approximately 591 mm (Station 062032) and 696 mm (Station 062056), while the annual average for Mudgee (George Street) and Gulgong Post Office is 675 mm and 649 mm, respectively (Table 3-2).

Generally the rainfall records indicate moderate seasonality, with the higher rainfall totals being recorded in the summer months and lower rainfall in the winter months (Table 3-2). A long-term annual average rainfall of approximately 650 mm at the Project site is inferred.

Temperature

The data presented in Table 3-2 indicate that regional temperatures are warmest from November through March and coolest from May through September. Average daily maximum temperatures peak in January (31.0^{o}C and 30.8^{o}C for Mudgee [George Street] and Gulgong Post Office, respectively), while average daily minimum temperatures are lowest in July (1.3^{o}C at Mudgee [George Street] and 2.5^{o}C at Gulgong Post Office).

Relative Humidity

Relative humidity records from all sites indicate a seasonal difference with higher humidity in winter and lower humidity in summer (Table 3-2). Average morning (9 am) relative humidity recorded at the Mudgee (George Street) and Gulgong Post Office meteorological stations was lowest in December (60% and 61%, respectively). The highest recorded average morning (9 am) relative humidity at the stations was in June (80% and 84%, respectively). Average afternoon (3 pm) monthly relative humidity ranged from 37 to 56% for Mudgee (George Street) and from 36 to 57% for Gulgong Post Office.

Wind Speed and Direction

Figure 3-2 provides wind roses for the Wilpinjong area (Appendix E) that have been compiled from nine months of data from the meteorological station and three months of data produced by a CSIRO model (The Air Pollution Model [TAPM]). The wind roses indicate that relatively strong winds from the west are dominant during winter and while they are also common during spring, spring exhibits an almost equal distribution of easterly and westerly winds. The wind roses also indicate that winds from the east and east south-east are more common during summer and autumn, respectively. Comparison of measured on-site wind data with TAPM indicates seasonal wind direction compares favourably, with measured on-site wind speeds generally lower than the wind speeds generated by TAPM.

Evapotranspiration

The average annual evapotranspiration at the Project is estimated to be approximately 1,730 mm, with monthly evapotranspiration highest in December (235 mm) and January (220 mm) and lowest in June (65 mm) and July (70 mm). Table 3-2 shows that evapotranspiration rates differ markedly between summer and winter.

3.1.3 Geology

Regional Geology

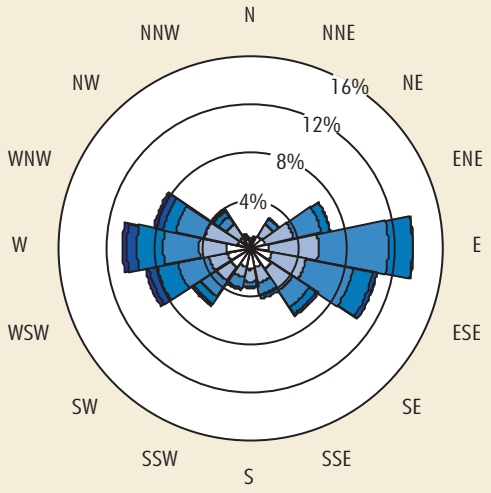
The Project is located in the Western Coalfield near the margin of the Sydney-Gunnedah Basin. The Western Coalfield covers an area of approximately 17,000 km^2 and is a subdivision of the Sydney Basin in NSW (Figure 1-1). The Wilpinjong resource is contained in the Ulan Seam which occurs in the lower part of the Late Permian Illawarra Coal Measures (Figure 2-1). The coal measures are overlain by the Triassic Narrabeen Group (locally known as the Wollar Sandstone) comprising mainly conglomerate and sandstone.

The Narrabeen Group sandstones, conglomerates and siltstones are the dominant geology of the Goulburn River National Park and Munghorn Gap Nature Reserve to the north and south of the Project respectively, and overlie the Permian coal measures.

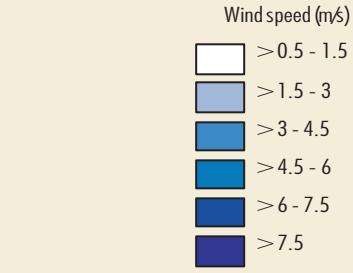
Table 3-2
Meteorological Data Summary

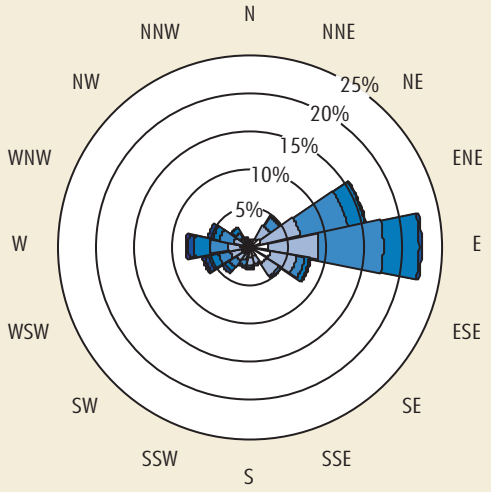
Month	Relative Humidity Monthly Average (% mean)				Average Daily Air Temperature (°C)				Average Rainfall (mm)				Average Evapotranspiration (mm)
	Mudgee		Gulgong		Mudgee		Gulgong						
	9 am	3 pm	9 am	3 pm	Max.	Min.	Max.	Min.	Mudgee	Gulgong	Wollar (062032)	Wollar (062056)	
January	63	39	65	38	31.0	15.5	30.8	16.5	68.6	71.2	68.2	84.8	220
February	65	44	70	42	30.2	15.4	29.8	16.3	63.7	60.7	63.0	65.9	175
March	66	43	69	43	27.8	13.0	27.3	13.6	50.7	54.8	51.7	60.2	170
April	71	45	71	46	23.3	8.5	23.3	9.8	44.9	45.2	39.7	46.0	120
May	77	52	80	52	18.8	5.0	18.9	6.5	50.5	45.9	39.0	46.1	85
June	80	56	84	57	15.2	2.6	15.4	3.4	54.3	50.0	43.1	40.9	65
July	79	53	83	53	14.4	1.3	14.6	2.5	53.3	48.5	41.3	50.3	70
August	74	49	77	48	16.0	2.3	16.3	3.4	54.0	47.2	42.4	53.5	100
September	68	46	70	46	19.6	4.4	19.3	6.1	51.7	46.3	39.5	54.4	120
October	64	44	63	42	23.4	7.6	23.2	9.1	60.5	57.0	54.2	67.2	168
November	61	39	63	39	26.9	10.8	26.3	11.9	59.3	57.9	52.2	58.8	200
December	60	37	61	36	29.8	13.7	29.7	14.9	63.2	63.9	56.6	66.4	235
Annual Average	**69**	**46**	**72**	**45**	**23.0**	**8.3**	**22.8**	**9.4**	-	-	-	-	-
								Annual Average Total	**674.6**	**648.6**	**590.7**	**696.2**	**1,728**

Source: Bureau of Meteorology (2005)

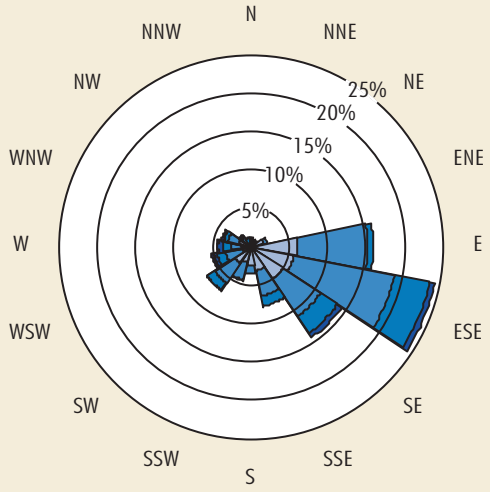


*Annual
Calms = 7.3%

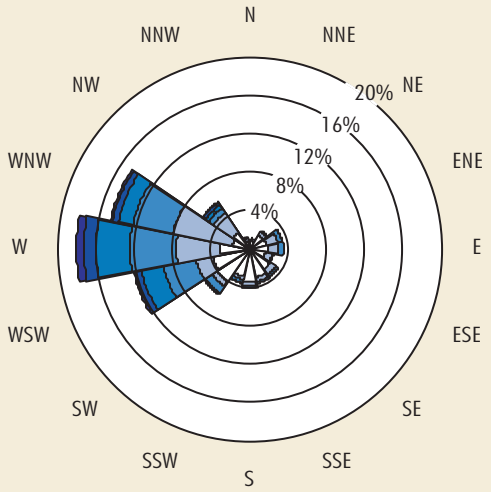




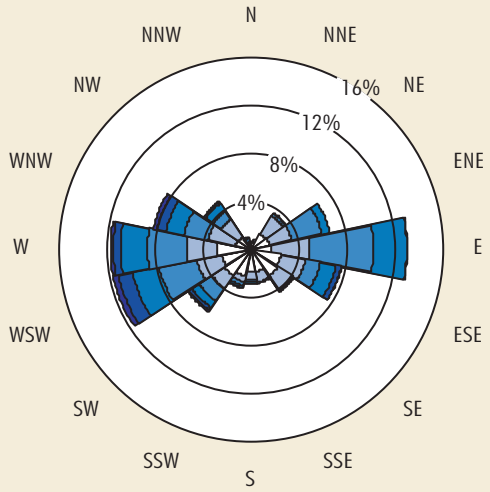
Summer
Calms = 5.7%



*Autumn
Calms = 0.5%



Winter
Calms = 13.09%



Spring
Calms = 9.9%

Source: Holmes Air Sciences (2005)
**Autumn data provided by TAPM*

WILPINJONG COAL PROJECT EIS

FIGURE 3-2
Wind Roses

ResourceStrategies

EXCEL

Local Geology

A summary of the stratigraphy in the Project area is shown on Figure 2-1. A summary of the lithology and occurrence within the Project area is provided below. Figure 3-3 illustrates the geology of the Project area.

Rylstone Volcanics

The Rylstone volcanics are amongst the oldest rocks in the area and small outcrops occur along Cumbo Creek consisting of rhyolitic to dacitic pyroclastic rocks including tuffaceous sandstone, tuff and lavas.

Shoalhaven Group

The Shoalhaven Group occupies the lower slopes and depressions of the secondary drainage lines including Cumbo Creek. The dominant lithologies are conglomerate, pebbly sandstone, and sandstone.

Illawarra Coal Measures

The Illawarra Coal Measures occupy the midslopes of the gently undulating landforms that border the drainage lines. The dominant lithologies include mudstone, laminated siltstone, medium grained quartz-lithic sandstone, lenses of polymictic conglomerate, coal, carbonaceous mudstone, rhyolitic tuff and sporadic torbanite. It contains the Ulan Seam, which would be mined by the Project. Underneath the Ulan Seam is a distinct sandstone unit called the Marrangaroo Sandstone.

Within the valley floor in the Project area, the upper section of the coal measures has been eroded away and the lower section containing the Ulan Seam is present under a thin weathered cover. In the Project area, the Ulan Seam dips to the north-east at around two degrees and subcrops along parts of the southern boundary of MLA 1. Seam structure is very uniform and no faulting has been recognised to date (WCPL, 2003).

Narrabeen Group

The Narrabeen Group overlies the Illawarra Coal Measures. The rugged upland areas of Goulburn River National Park and Munghorn Gap Nature Reserve are areas where the Narrabeen Group Formation is exposed. They form cliffs, ridges and hilltops of mesa-like plateaus and pagodas.

The typical lithologies include pebbly to medium grained quartz sandstone, red-brown and green mudstone and lenses of quartz conglomerate. The Wollar Sandstone is the only named unit of the Narrabeen Group that occurs in the vicinity of the Project.

Tertiary Basalts

The tertiary basalts are thickest further to the north of Wollar forming part of an extensive lava field, which extends from northern Queensland to Victoria. Only small outcrops of basaltic intrusions are present in the general vicinity of the Project area.

Quaternary Alluvium

Quaternary alluvium is found along perennial and intermittent watercourses and the lithology generally consists of silt, clay, sand and gravel with variable humic content. Quaternary alluvium is associated with Wilpinjong Creek and lower Cumbo Creek and localised sediments on Spring, Planters, Bens and Narrow Creeks.

Colluvium is also present at the base of the escarpment slopes (e.g. between Wilpinjong Creek and the Goulburn River National Park).

3.1.4 Soils, Rural Land Capability and Agricultural Suitability

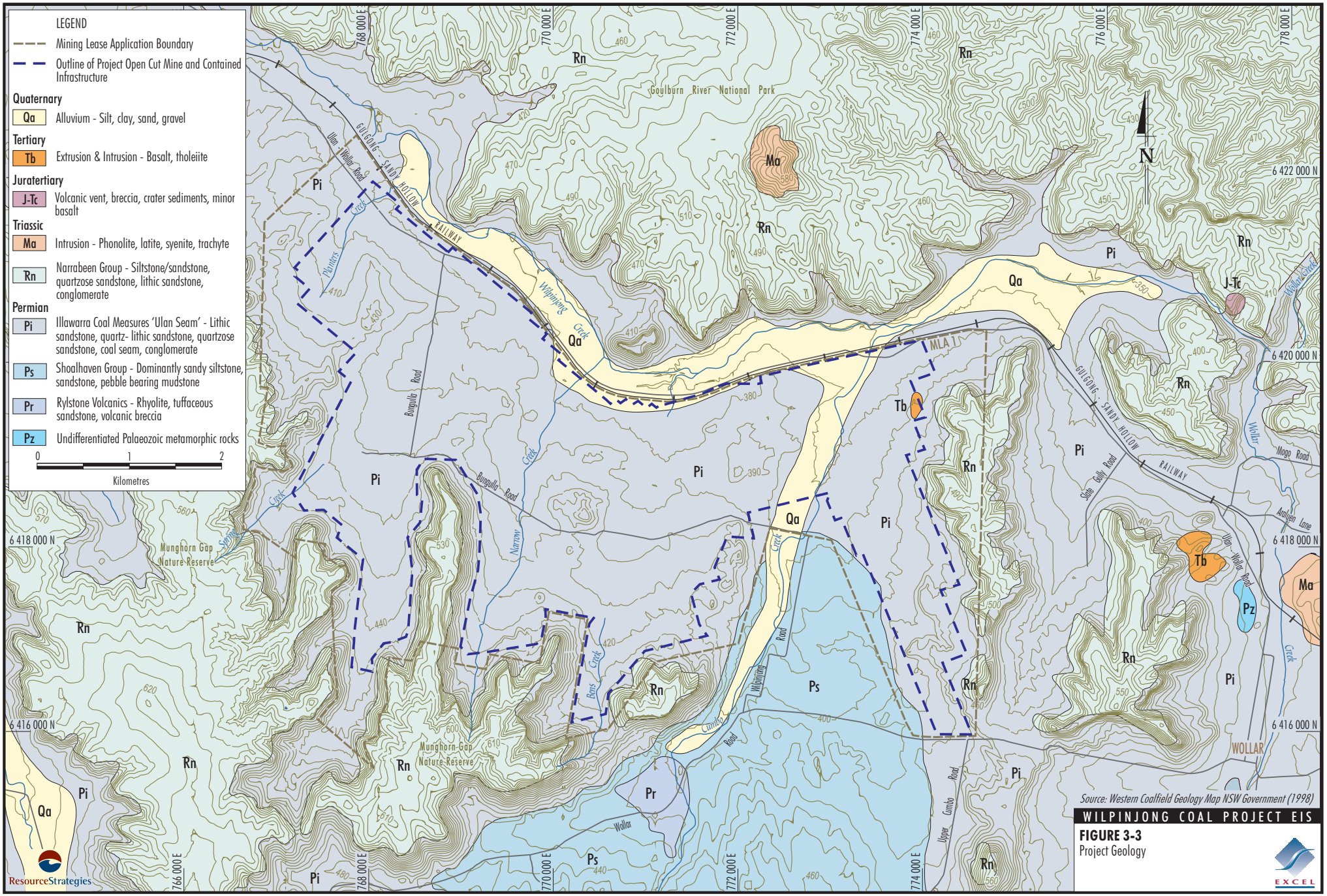
A Soils, Rural Land Capability and Agricultural Suitability Assessment was conducted for the Project and is presented in Appendix M. The assessment utilised information from DLWC Soil Conservation Services of NSW and NSW Agriculture mapping, aerial photography and field surveys.

Soil landscapes, soil type, rural land capability and agricultural suitability mapping for the Project is provided in Appendix M.

Soils

Soil landscapes were classified and mapped in accordance with descriptions in the Soil Landscapes of the Dubbo 1:250,000 Sheet (DLWC, 1998) and Project field surveys.

Three soil landscapes, *viz.* Ulan, Barigan Creek and Lees Pinch (DLWC, 1998) were identified in the vicinity of the Project. Appendix M provides a description of the landform characteristics, lithology and typical soils of each soil landscape.



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Major soil types identified include red podzolic soils which occur over the majority of MLA 1 on lower to mid slopes, yellow podzolic soils which occur on lower slopes and minor drainage lines, and earthy sands which occur along Bens Creek (Figure 3-1) and at the bases of sandstone escarpments. Brown earths occur in small patches on the eastern bank of Cumbo Creek and yellow solodic soils occur as a thin band in the south-east of MLA 1. Lithosols occur on the higher plateaus and escarpments adjoining the Munghorn Gap Nature Reserve and the steeper slopes in the east of MLA 1. Alluvial soils occur along drainage lines.

Rural Land Capability

A rural land capability assessment was conducted in accordance with the standard NSW eight class system (Cunningham *et al.*, undated) which assesses biophysical soil properties and categorises land according to limitations such as erosion hazard, climate and slope. Three broad types of landuse are recognised across the eight classes:

- 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, VIII).

Five of the eight classes were identified in the vicinity of the Project (Appendix M) utilising the DLWC 1:100,000 Land Capability Mapping (Soil Conservation Service of NSW, 1982) and field survey. The five rural land capability classes identified are described below in accordance with Cunningham *et al.* (undated).

Class IV capability is defined (*ibid*.) as:

> *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 in MLA 1 is considered to be Class IV capability.

Class V capability is defined (*ibid*.) as:

> *Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation and structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV.*

Class V capability land is generally associated with mid slopes of the MLA 1 area which typically range from 1 to 15%.

Class VI capability is defined (*ibid*.) as:

> *Land not capable of being regularly cultivated but suitable for grazing with soil 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 land is generally associated with the mid slopes within MLA 1 and areas of gully and sheet erosion. Class VI land is also characterised by seepages within Class IV land. Areas of saline Class VI land were identified including a seep into Cumbo Creek in the south-east, and four isolated seepages along the northern boundary of MLA 1.

Class VII capability is defined (*ibid*.) as:

> *Land best protected by green timber.*

Class VII land is predominantly associated with lithosols occurring on steeper slopes along the eastern and western boundaries of MLA 1.

Class VIII capability is defined (*ibid*.) as:

> *Cliffs, lakes or swamps and other lands incapable of sustaining agricultural or pastoral production.*

Class VIII capability land is restricted to the steep slopes that border the Munghorn Gap Nature Reserve and the Goulburn River National Park (Figure 3-1). Stony and gravelly soils (lithosols) predominantly occur along these steeper slopes.

Agricultural Suitability

An agricultural suitability assessment was conducted in accordance with the five class system (Riddler, 1996), which classifies land according to its potential agricultural productivity. A summary of the agricultural suitability assessment presented in Appendix M is provided below.

Based on the NSW Agriculture (undated) Agricultural Land Classification for the Mudgee LGA and field survey, Class 3, 4 and 5 agricultural lands were identified within MLA 1 (Appendix M). These classes are discussed below (Cunningham *et al.*, undated).

Class 3 agricultural suitability is defined (*ibid.*) as:

> *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 lands occupy the majority of the valley floor and lower slopes within MLA 1. Erosion hazard, soil structural breakdown and climatic factors limit the capacity for cultivation.

Class 4 agricultural suitability is defined (*ibid.*) as:

> *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 lands are located on the lower slopes in the south-east of MLA 1 and are generally characterised by solodic soils and low fertility land.

Class 5 agricultural suitability is defined (*ibid.*) as:

> *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 lands are generally characterised by steeper slopes and lower fertility land associated with escarpments and lower hills in the MLA 1 area.

3.1.5 Land Contamination Assessment

As described in Section 1.3.5, a Land Contamination Assessment has been undertaken for the Project (Appendix O). Land in the area was cleared during the late 1800s and early 1900s and primarily used for grazing sheep and cattle. At no time did the area support intensive irrigation or market gardens (*ibid*.).

No cattle dips were reported to have been constructed in the area (Appendix O). MWRC advised that they hold no records or reports of environmental incidents associated with any of the properties within the Project area (*ibid*.). Three concrete lined sheep dips were identified during the site inspection carried out for the assessment. The dips had not been used since the 1970s and have been filled with general waste and soil to ground level. A disused airstrip superphosphate dump was also identified.

Soil samples were collected from two of the dips and the superphosphate dump and analysed for organochlorine and organophosphorus pesticides and metals. Laboratory analyses indicated that the concentrations of metals in the soil samples were within background levels and that pesticides were not detected (Appendix O).

Only relatively small amounts of diesel fuel and oils have been historically stored on properties in the Project area and only minor surface staining was noted at several sites. No evidence of illegal dumping was evident during the site inspection or in recent aerial photographs (Appendix O).

3.1.6 Visual Character

The Project locality comprises a number of distinct landscape units of varying levels of landscape quality. These have been defined as follows (Appendix N):

- Goulburn River National Park;
- Munghorn Gap Nature Reserve;
- wooded ridgelines;
- pastoral valley areas;
- enclosed spur gullies; and
- the village of Wollar.

These units are described below in the context of regional, sub-regional and local settings. These settings are defined by distance from the Project, as follows:

- *Regional Setting* – greater than 5 km from the Project;
- *Sub-Regional Setting* – 1 to 5 km from the Project; and
- *Local Setting* – up to 1 km from the Project.

Regional Setting (>5 km)

The contrast between cleared agricultural valley floor areas and the rugged and heavily vegetated ridgelines of the Goulburn River National Park, Munghorn Gap Nature Reserve and wooded ridgeline landscape units combine with similar landscapes to the west and east of the MLA 1 area to define the visual character of the regional setting. This visual character has been modified by the development of the Ulan Coal Mines which are located approximately 11 km to the north-west of the Project and the associated Gulgong-Sandy Hollow railway which runs to the north of MLA 1 area (Figure 3-1).

Sub-Regional Setting (1 to 5 km)

The Goulburn River National Park and Munghorn Gap Nature Reserve incorporate elevated sandstone plateau areas with steep sandstone escarpments forming sharp boundaries with cleared lowland areas (Figure 3-1). Wooded ridgelines provide effective visual separation of sections of the valley floor, particularly to the south and east of the MLA 1 area (Figure 1-4). The Goulburn River National Park is considered to be of high scenic quality and the Munghorn Gap Nature Reserve and wooded ridgelines of moderate to high scenic quality (Appendix N).

The village of Wollar is located in a valley to the east of the Project in an area with moderate scenic quality (Appendix N) (Figure 3-1). Views of the MLA 1 area from the village of Wollar are not available as there is significant intervening vegetation and topography.

Local Setting (<1 km)

The visual character of the local setting is defined by the largely cleared and gently sloping lands of the pastoral valley landscape unit comprising the Wilpinjong Creek and Cumbo Creek floodplains.

Sparsely scattered trees are present across the MLA 1 area, which is surrounded by the rising and well-vegetated backdrop of the Goulburn River National Park, Munghorn Gap Nature Reserve and wooded ridgelines (Figure 1-4). The pastoral valley areas are considered to be of moderate scenic quality (Appendix N).

The contrast of the vegetation and topographic form between the wooded ridgelines and pastoral valley areas creates visual interest within the enclosed spur gullies (Figure 1-4) (i.e. views over cleared agricultural land with a backdrop of wooded ridges). These enclosed spur gullies are considered to be of moderate to high scenic quality (Appendix N).

Other features of the local setting include power supply infrastructure associated with the 11 kV electricity transmission line (Figure 1-3), the Ulan-Wollar Road and the railway embankment and train movements associated with the Gulgong-Sandy Hollow railway (Figure 3-1).

Sensitive Visual Settings

The most sensitive visual settings in the vicinity of the Project are rural residences. The views from rural residences in the Project area and surrounds vary according to location, but they are generally situated on cleared flats or slopes and have views across cleared agricultural lands towards the vegetated ridgelines and escarpments which form the backdrop to most views in the area. Residences with views of the Project at distances of 2.5 km or less have a high level of sensitivity (Appendix N).

Views of the MLA 1 area are potentially available from elevated positions on the Ulan-Wollar Road and the Gulgong-Sandy Hollow railway which is located immediately to the north of the MLA 1 area (Figure 3-1). The visual sensitivity of these vantage points is considered to be low (Appendix N). Wollar Road is also considered to have a low to moderate level of sensitivity (*ibid*.).

Night Lighting

The Project area is generally isolated from the effects of night lighting apart from lighting associated with farm residences, sheds and work areas and vehicles on rural roads. Night lighting at the Ulan Coal Mines (Figure 3-1) has however modified the levels of lighting in the regional setting by adding light glow above operational areas such as the CHPP and train loading infrastructure.

3.1.7 Bushfire Regime

The Project is located within the jurisdiction of the Cudgegong Bush Fire Management Committee. The fire season is predominantly from September to December, although it may extend until May depending on weather conditions and fuel loads. Hot, dry weather with strong north-west winds are the conditions typically associated with bushfires within the Goulburn River National Park (DEC, 2004).

The *Goulburn River National Park and Munghorn Gap Nature Reserve Fire Management Plan* (*ibid.*) is of relevance to the Project, given its location between the Munghorn Gap Nature Reserve and the Goulburn River National Park. The vegetation of the Goulburn River National Park and Munghorn Gap Nature Reserve present an increased bushfire risk due to the higher level of vegetative cover and fuel load present in these areas.

Fires within the reserves are predominantly caused by lightning (*ibid.*). The *Goulburn River National Park and Munghorn Gap Nature Reserve Fire Management Plan* (*ibid.*) indicates that significant wildfires causing extensive damage have occurred in the Goulburn River National Park at approximately 40 year intervals. No significant fires have been recorded in the Munghorn Gap Nature Reserve in the period of NPWS records.

3.2 SURFACE WATER

A Surface Water Assessment undertaken by Gilbert and Associates Pty Ltd (2005) is presented in Appendix A and includes characterisation of existing surface water resources.

3.2.1 Regional Hydrology

The Project is located at the headwaters of the Goulburn River catchment which is a major tributary of the Hunter River. The Goulburn River joins the Hunter River at Denman (refer inset on Figure 3-4). The Hunter River catchment drains some 22,000 km^2 of central-eastern NSW to the Pacific Ocean at Newcastle (Figure 1-1).

The Hunter River is one of six river basins that have been regulated by the NSW Government (i.e. where the flow is controlled by a major government-owned dam and managed by DIPNR to meet the needs of licensed downstream water users, whilst ensuring environmental flows are maintained) however the Goulburn River and other major tributaries of the Hunter River remain unregulated (DUAP, 1997). There are no public water supply dams in the Project area or on the Goulburn River.

DIPNR maintains gauging stations on the Goulburn River. A summary of the streamflow statistics obtained from DIPNR gauging stations of relevance to the Project are provided in Table 3-3. Approximate locations are shown on Figure 3-4 and include streamflow gauges at the localities of Sandy Hollow, Kerrabee, Coggan and Ulan (refer inset on Figure 3-4).

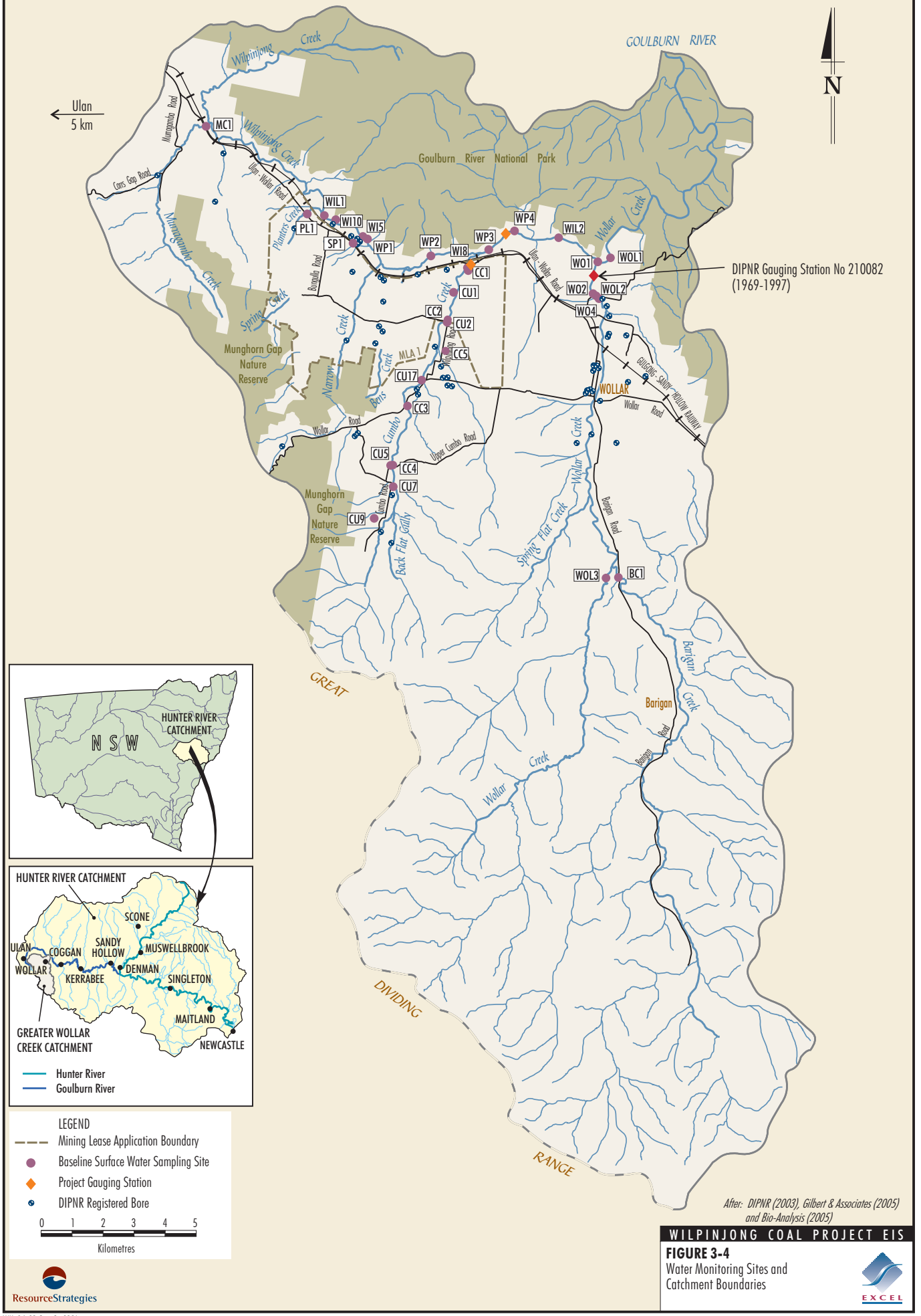
The Project is located in the greater Wollar Creek catchment which drains to the Goulburn River approximately 12 km to the north-east of the Project area. The greater Wollar Creek catchment consists of a number of tributaries including Wilpinjong Creek, Spring Flat Creek and Barigan Creek (Figure 3-4). A gauging station was maintained by DIPNR from 1969 to 1997 on Wollar Creek near Wollar (Figure 3-4). Streamflow statistics from this DIPNR gauging station are provided in Table 3-3.

Table 3-3
Summary of Streamflow Statistics for the Goulburn River and Wollar Creek

Gauging Station	Catchment Area (km^2)	Full Record Length	Period of Reliable Data (complete years)	Mean Daily Flow (ML/day)*
Goulburn River at Sandy Hollow (GS210031)	6,810	1972-2004	18	480
Goulburn River at Kerrabee (GS210016)	4,950	1969-2004	9	242
Goulburn River at Coggan (GS210006)	3,340	1913-2004	76	192
Goulburn River at Ulan (GS210046)	159	1956-1982	22	10.6
Wollar Creek at Wollar (GS210082)	258	1969-1997	21	9.9

Source: DIPNR Pinneena Database (2004)
* In those years with complete data.

GREATER WOLLAR CREEK CATCHMENT



After: DIPNR (2003), Gilbert & Associates (2005) and Bio-Analysis (2005)

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FIGURE 3-4
Water Monitoring Sites and Catchment Boundaries

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3.2.2 Local Hydrology

At a local level, the Project lies in the Wilpinjong Creek catchment and is drained by a number of local tributary watercourses of Wilpinjong Creek including Cumbo Creek, Planters Creek, Spring Creek, Narrow Creek and Bens Creek. Wilpinjong Creek flows into Wollar Creek approximately 4 km downstream of the confluence of Cumbo and Wilpinjong Creeks (Figure 3-4). Cumbo Creek drains an area of some 69 km^2 including some of the eastern parts of the Project area (Figure 3-4).

The upland tributaries of Wilpinjong Creek rise in the densely vegetated sandstone escarpments of the Munghorn Gap Nature Reserve and Goulburn River National Park. The upland tributaries of Wollar Creek rise in the densely vegetated Great Dividing Range. Some of these tributaries are, in places, fed by fresh water springs. Following periods of high rainfall, valley flats along Wilpinjong and Wollar Creeks are often left water logged for extended periods (DIPNR, 2003).

Wilpinjong Creek is incised into the valley floor and forms a series of semi-permanent soaks fed primarily from drainage from the surrounding alluvial plain and colluvium which is recharged by runoff from the adjacent elevated sandstone plateau.

Spring Creek, Narrow Creek and Bens Creek are natural drainage lines which range from small ephemeral and semi-perennial spring fed streams in the upper reaches near the Munghorn Gap Nature Reserve to wide ill-defined ephemeral creeks in the lower reaches near Wilpinjong Creek (Appendix A).

A summary of the stream reach characteristics of the local watercourses is presented in Appendix HD (Aquatic Ecosystem Assessment) and Appendix A.

Table 3-4 provides a brief description of these characteristics.

A search of records held by DIPNR indicates that there are currently no licences issued for extraction of water from Wilpinjong Creek (Appendix A). Riparian landowners are, however, entitled to extract water for livestock and domestic purposes under section 52 of the *Water Management Act, 2000.* The primary commercial use of local creeks is livestock watering.

Gauging stations have been installed on Cumbo and Wilpinjong Creeks by WCPL (Figure 3-4) and would continue to be maintained during development of the Project. No streamflow records for the local catchments were available for reporting in the EIS.

Baseline surface water quality monitoring has been undertaken for the Project since June 2004 (generally on a monthly basis and following rainfall events, where possible). Surface water quality monitoring results reported in the *Greater Wollar Creek Catchment Dryland Salinity Groundwater Investigation* (DIPNR, 2003) and surface water monitoring conducted as part of the Aquatic Ecosystem Assessment (Appendix HD) have also been incorporated. Baseline surface water quality monitoring results are presented in Appendix A and summarised below for specific reaches of local watercourses.

Table 3-5 presents a summary of surface water quality results including minimum, maximum and mean (or median) values for pH, electrical conductivity, total dissolved solids (TDS) and total suspended solids (TSS). Metal results are included in Appendix A. The surface water quality sampling locations are shown on Figure 3-4.

Table 3-4
Stream Reach Characteristics of Local Watercourses

Watercourse	Reach Characteristics
Wilpinjong Creek	Well incised channel (3-4 m deep). Varies significantly including dry areas, semi-permanent soaks, pool and riffle sequences and swampy areas with extensive areas of reed growth along the creek bed. Severely impacted by grazing of livestock and kangaroos. Vegetation on the banks and overbank areas is predominantly grass with occasional trees and little riparian vegetation.
Cumbo Creek	Upper parts of the creek drain through low-lying marshes with stream bank and stream bed erosion. Heavily modified by land clearing and grazing. Little riparian vegetation.
Planters, Spring, Narrow and Bens Creeks	Poorly defined drainage channels, especially in the middle reaches. Significantly altered by small farm dams and grazing.
Wollar Creek	Heavily modified upstream of its confluence with Wilpinjong Creek. Significant erosion and creek banks heavily infested with weeds, including Willows.

Source: after Appendices A and HD

Table 3-5
Surface Water Quality Ranges – Local Watercourses

Reach/Position on Local Watercourse	Site	Source[1]	Sampling Period/Date	pH			Electrical Conductivity (µS/cm)			Total Dissolved Solids (mg/L)			Total Suspended Solids (mg/L)		
				Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Median
Wilpinjong Creek															
Upstream of Cumbo Creek confluence and downstream of Planters Creek.	WIL1 WP1 WP2 WI5 WI10	Project Sample Bio-Analysis Bio-Analysis DIPNR DIPNR	Jul 2004 – Mar 2005 May 2004 May 2004 April 2001 May 2001	5.8	9.1	7.0	681	2,990	1,520	430	2,000	1,005	<2	362	4
Downstream of Cumbo Creek and upstream of the confluence with Wollar Creek.	WIL2 WP3 WP4	Project Sample Bio-Analysis Bio-Analysis	Jun 2004 – Mar 2005 May 2004 May 2004	7.6	8.0	7.8	1,700	5,300	3,921	1,065	3,560	2,651	<2	7	<2
Wollar Creek															
Immediately downstream of Wilpinjong Creek confluence.	WOL1 WO1	Project Sample Bio-Analysis	Jul 2004 – Mar 2005 May 2004	7.6	8.4	8.1	1,690	3,500	2,347	1,140	2,480	1,588	<2	10	<2
Downstream of the village of Wollar and upstream of Wilpinjong Creek confluence.	WOL2 WO2 WO4	Project Sample Bio-Analysis DIPNR	Jun 2004 – Mar 2005 May 2004 April 2001	7.6	8.7	8.1	1,145	2,990	1,878	955	2,445	1,348	<2	6	<2
Upstream of the village of Wollar, immediately upstream of Barigan Creek confluence.	WOL3	Project Sample	Jul 2004 – Mar 2005	6.8	7.8	7.2	185	310	221	112	184	138	<2	6	<2
Cumbo Creek															
Immediately upstream of the confluence with Wilpinjong Creek.	CC1[2] W18	Project Sample DIPNR	Jun 2004 – Mar 2005 April 2001	7.9	8.4	8.2	4,432	8,800	7,223	3,510	5,930	4,814	2	22	11
Wilpinjong Road causeway, upstream of CC1 and downstream of site CC5.	CC2[2] CU1 CU2	Project Sample Bio-Analysis Bio-Analysis	Jun 2004 – Mar 2005 May 2004 May 2004	7.5	8.2	7.9	5,000	7,700	6,435	410	5,390	4,399	<2	12	3
Wollar Road causeway, upstream of site CC5.	CC3[2] CU17	Project Sample DIPNR	Jun 2004 – Dec 2004 April 2001	7.9	8.4	8.2	3,132	6,300	4,933	2,510	4,340	3,493	<2	5	3.5

Table 3-5 (Continued)
Surface Water Quality Ranges – Local Watercourses

Reach/Position on Local Watercourse	Site	Source[1]	Sampling Period/Date	pH			Electrical Conductivity (µS/cm)			Total Dissolved Solids (mg/L)			Total Suspended Solids (mg/L)		
				Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Median
Cumbo Creek (Continued)															
Upper Cumbo Road crossing, upstream of site CC3.	CC4	Project Sample	Jun 2004 – Dec 2004	7.1	8.1	7.7	558	7,500	4,323	1,820	4,020	3,274	<2	73	4
	CU5	DIPNR	April 1971 and April 2001												
	CU7	DIPNR	April 2001												
	CU9	DIPNR	April 2001												
Groundwater seep immediately east of Wilpinjong Road, upstream of site CC2.	CC5	Project Sample	Jun 2004 – Nov 2004	7.1	7.1	I.D.	11,000	12,000	I.D.	6,980	8,040	I.D.	8	12	I.D.
Murragamba Creek															
Immediately upstream of the confluence with Wilpinjong Creek.	MC1	Project Sample	Jul 2004 – Dec 2004	5.4	7.0	6.3	330	690	549	210	540	380	7	294	28
Barigan Creek															
Upstream of the confluence with Wollar Creek.	BC1	Project Sample	Jun 2004 – Mar 2005	7.2	8.2	7.5	569	2,540	1,954	1,190	1,850	1,434	4	216	7
	BA5	DIPNR	April 2001												

[1] Project Sample – Baseline surface water quality sample sites established for the Project (Appendix A).

Bio-Analysis – Surface water quality sample sites in the Aquatic Ecosystem Assessment (Appendix HD).

DIPNR – Historic surface water quality sample sites in the *Greater Wollar Creek Catchment Dryland Salinity Groundwater Investigation* (DIPNR, 2003).

[2] Water quality samples collected at Project sample sites CC1, CC2 and CC3 in January 2005 were taken in pools of fresh rainwater as the creek bed had dried out and rain had recently fallen. The fresh rainwater was found to have significantly different water quality results to previously recorded data and was excluded from the dataset presented in Table 3-5 accordingly.

I.D. Insufficient Data.

3.2.3 Surface Water Quality

A summary of the Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Guidelines) water quality trigger values is provided below.

ANZECC (2000) Guidelines

The ANZECC (2000) Guidelines provide a comprehensive framework for water quality assessment and management. The approach adopted in the Guidelines focuses on site-based risk assessment with a focus on integrated assessment (chemical, physical and biological indicators). The Guidelines recognise that adequate site specific data will often not be available and provide default trigger values for a range of physical and chemical stressors (e.g. salinity, pH, nutrients, dissolved oxygen, turbidity, etc.) and toxicants (e.g. heavy metals). Water quality trigger values are also provided in the Guidelines for livestock drinking water quality.

In the absence of agreed water quality objectives for local streams, the Guideline trigger values provide a quantitative frame of reference for interpreting the results of baseline water quality monitoring.

Physical and Chemical Stressors

The Guideline surface water quality default trigger values for physical and chemical stressors for the protection of aquatic ecosystems are summarised in Table 3-6.

Toxicants

The Guidelines recognise three ecosystem conditions as follows:

- high conservation/ecological value systems;
- slightly to moderately disturbed systems; and
- highly disturbed systems.

Each ecosystem condition in the Guidelines is ascribed with a level of protection applicable to toxicants in aquatic ecosystems and is summarised below:

1. High conservation status or highly valued ecosystems are afforded a protection level based on protection of 99% of species.
2. Slightly to moderately disturbed systems are afforded a 95% protection level in most cases although a higher protection level could be applied to slightly disturbed ecosystems.
3. Highly disturbed systems can be afforded a 95% protection level, however depending on the state of the ecosystem, it can be appropriate to apply a less stringent trigger value (i.e. 90% or 80%) as an intermediate target for water quality improvement.

The Guideline surface water quality default trigger values for toxicants (i.e. metals) for the protection of aquatic ecosystems are summarised in Table 3-7.

Livestock Drinking Water Quality

Water quality trigger values are provided in the Guidelines for livestock drinking water quality (Table 3-8).

Table 3-6
ANZECC (2000) Surface Water Quality Default Trigger Values for the Protection of Aquatic Ecosystems (Physical and Chemical Stressors)

Physical/Chemical Stressor	NSW Upland Rivers[a]
pH	6.5 - 8.0
Total Phosphorus (µg/L - P)	20
Total Nitrogen (µg/L - N)	250
Dissolved Oxygen (% saturation)	90 - 110
Specific Electrical Conductivity (EC) (µS/cm)	350 (NSW rivers)
Turbidity (NTU)	2 - 25 (High values may be observed during high flow events)

Source: ANZECC (2000)
[a] Values for NSW upland rivers (>150 m altitude) in south-east Australia.

Table 3-7
ANZECC (2000) Surface Water Quality Default Trigger Values for the Protection of Aquatic Ecosystems (Toxicants)

Toxicant	Default Trigger Values			
	Protection Levels for Aquatic Ecosystems			
	99%	95%	90%	80%
Arsenic (As) (µg/L)	1	24	94	360
Cadmium (Cd) (µg/L)	0.06	0.2	0.4	0.8
Copper (Cu) (µg/L)	1.0	1.4	1.8	2.5
Lead (Pb) (µg/L)	1.0	3.4	5.6	9.4
Mercury (Hg) – inorganic (µg/L)	0.06	0.6	1.9	5.5
Selenium (Se) – total (µg/L)	5	11	18	34
Zinc (Zn) (µg/L)	2.4	8	15	31

Source: ANZECC (2000)

Table 3-8
ANZECC (2000) Livestock Drinking Water Quality Trigger Values

Livestock Drinking Water Quality	Water Quality Trigger Values
pH	6.0 – 9.0[a]
Specific Electrical Conductivity (EC) (µS/cm)	Beef Cattle, Horses, Pigs: < 6,000[b] Dairy Cattle: < 3,750[b] Sheep: < 7,500[b]
Total Dissolved Solids (TDS) (mg/L)	Beef Cattle, Horses, Pigs: < 4,000 Dairy Cattle: < 2,500 Sheep: < 5,000
Arsenic (As) (µg/L)	500[c] – 5,000[d]
Cadmium (Cd) (µg/L)	10[c]
Copper (Cu) (µg/L)	400 (sheep), 1000 (cattle)[c]
Lead (Pb) (µg/L)	100[c]
Mercury (Hg) - inorganic (µg/L)	2[c]
Selenium (Se) – total (µg/L)	20[c]
Zinc (Zn) (µg/L)	20,000[c]

Source: ANZECC (2000)

[a] Values for livestock watering (surface water) systems.

[b] Calculated by approximate conversion from TDS to EC (ANZECC, 2000).

[c] Concentrations below which there is a minimal risk of toxic effects.

[d] Higher value may be tolerated if not provided as a food additive and natural levels in the diet are low.

Comparisons of water quality results for local creeks with the water quality trigger values provided in the ANZECC (2000) Guidelines are provided below.

Wilpinjong Creek

Surface water quality samples have been taken along Wilpinjong Creek at numerous locations both upstream and downstream of the confluence with Cumbo Creek (Figure 3-4 and Table 3-5).

Sampling results upstream of the confluence with Cumbo Creek indicate an average pH of 7.0 and EC range of 681 to 2,990 microsiemens per centimetre (µS/cm). Downstream of the confluence with Cumbo Creek, sampling results indicate an average pH of 7.8 and an average EC of 3,921 µS/cm. The recorded EC values were higher than the Guideline trigger values for the protection of aquatic ecosystems (i.e. 350 µS/cm) however all recorded EC levels were below the Guideline trigger values for livestock watering (beef cattle). Measured pH levels were generally within the Guideline trigger value ranges with the exception of some occasions when samples were taken during periods of low flow.

Metal concentrations (i.e. As, Cd, Cu, Pb, Hg, Se and Zn) were generally low and below detection limits. Exceptions where metals concentrations have been measured above the toxicant trigger values for the 80% protection level for aquatic ecosystems were copper (3.3 micrograms per litre [µg/L]), and zinc (61 µg/L).

Wollar Creek

Surface water quality monitoring has been undertaken in three stretches of Wollar Creek *viz.* upstream of the confluence of Barigan Creek, immediately downstream of the village of Wollar, and immediately downstream of the confluence with Wilpinjong Creek (Figure 3-4 and Table 3-5).

Sampling results for Wollar Creek upstream of the confluence with Barigan Creek indicate an average pH of 7.2 and EC range of 185 to 310 µS/cm. Measured concentrations of metals were generally low and either below detection limits or below the toxicant trigger values for the 95% protection level for aquatic ecosystems (Table 3-7). The only exception was a single copper concentration of 3 µg/L, which was greater than the toxicant trigger value for the 80% protection level for aquatic ecosystems.

Immediately downstream of the village of Wollar, sampling results indicate an average pH of 8.1 and an average EC of 1,878 µS/cm. Downstream of the confluence with Wilpinjong Creek, sampling results in Wollar Creek indicate an average pH of 8.1 and EC range of 1,690 to 3,500 µS/cm.

Cumbo Creek

Surface water quality samples have been taken at several locations along Cumbo Creek (Figure 3-4 and Table 3-5).

The average EC levels range from 4,323 to 4,933 µS/cm in the mid to upper reaches, upstream of the Project area. A highly saline groundwater seep (EC of 11,000 to 12,000 µS/cm) enters Cumbo Creek immediately east of Wilpinjong Road (CC5) immediately upstream of the Project area. The water quality of the groundwater seep is consistent with the poorer quality groundwater associated with the Nile Subgroup which surfaces (subcrops) in the area (Appendix B). Sampling results at site CC1 (located immediately upstream of the confluence with Wilpinjong Creek) and site CC2 (downstream of the groundwater seep) indicate that average EC levels are 7,223 and 6,435 µS/cm respectively.

Measured EC levels were consistently greater than the Guideline trigger values for the protection of aquatic ecosystems and, on occasions, above the Guideline trigger value for livestock watering (beef cattle). Sampling results indicate pH levels in Cumbo Creek range from 7.1 to 8.4 which were within the Guideline trigger value range for livestock watering.

Concentrations of other key surface water quality indicators were generally low at all sites along Cumbo Creek, with no measured concentrations above the Guideline trigger values for livestock watering. Measured copper and mercury concentrations at sites CC1 to CC5 were above the toxicant trigger values for the protection of aquatic ecosystems (99% level of protection). One sample taken at CC5 also indicated a zinc concentration (19 µg/L) above the toxicant trigger value for the protection of aquatic ecosystems (90% level of protection – Table 3-7).

Murragamba Creek

Surface water quality sampling results for Murragamba Creek (site MC1 located immediately upstream of the confluence with Wilpinjong Creek – Figure 3-4) indicate an average pH of 6.3 and EC of 549 µS/cm.

Whilst the average pH and EC values were outside of the Guideline trigger value range for the protection of aquatic ecosystems, the results were within the trigger value ranges for livestock drinking water quality (Tables 3-6 and 3-8). Concentrations of other key surface water quality indicators were generally low at site MC1 with no measured levels above the Guideline trigger values for livestock watering. Concentrations for copper (6 µg/L) and zinc (120 µg/L) were above the toxicant trigger values for the 80% protection level for aquatic ecosystems.

Barigan Creek

Surface water quality sampling results for Barigan Creek (site BC1 located upstream of the confluence with Wollar Creek – Figure 3-4) indicate an average pH of 7.5 and EC of 1,954 µS/cm.

Concentrations of metals were generally low at this site with no measured concentrations above the Guideline trigger values for livestock watering. However, one sample for copper (2.3 µg/L) was above the toxicant trigger value for the 90% level of protection for aquatic ecosystems.

Other Local Creeks

Water quality samples were collected from the lower reaches of Planters and Spring Creeks during the Aquatic Ecosystem Assessment in May 2004 (Sites PL1 and SP1 – Figure 3-4). Sample results indicate pH values of 7.1 and 9.1 and, and EC levels of 1,781 and 6,000 µS/cm in Spring Creek and Planters Creek, respectively.

3.3 GROUNDWATER

A Groundwater Impact Assessment for the Project was conducted by Australasian Groundwater and Environmental Consultants (AGE) and is presented in Appendix B. The assessment included a review of field hydrogeological investigations by Geoterra (2004) and DIPNR (2003), as well as the results of groundwater level and groundwater quality monitoring conducted by WCPL during a bore census in February 2005.

3.3.1 Previous Studies and Site Testwork

DIPNR (2003) conducted field surveys and groundwater assessments in the greater Wollar Creek catchment (including Wilpinjong, Cumbo and Barigan Creeks) as part of a dryland salinity groundwater investigation funded by the Natural Heritage Trust. The field survey components were primarily conducted in 2001 and methodology included field measurements of groundwater levels and salinities in private bores, wells, dams and sections of creeks in the greater Wollar Creek catchment. The assessment found that surface water flows from the Wilpinjong valley towards Wollar resulted in increased salinity levels. This increase was attributed to evapo-concentration effects and saline groundwater input from deeper groundwater aquifers into the shallower systems and alluvium (DIPNR, 2003).

A hydrogeological study and drilling and sampling programme was undertaken for the Project by Geoterra (2004). The groundwater testwork programme included 24 hour pumping tests and falling/rising head tests. The pumping tests involved pumping a bore for a period of time and observing the response/change in the aquifer. The falling/rising head tests (i.e. slug tests) involved the addition, or removal, of a known volume of water to or from a bore/well and measurement of the subsequent water level recovery.

Extensive exploration drilling has also been conducted within and around the MLA 1 area by a number of parties including the DPI-MR and WCPL. These geological investigations, while not specifically designed to collect data on groundwater, have facilitated description of the geology of the area, including mapping the extent of the Ulan Seam and Marrangaroo Sandstone, which are the main groundwater aquifer systems of interest in the Project area.

3.3.2 Local Hydrogeology

Five aquifer systems have been recognised in the Project area including (Appendix B):

- alluvial and colluvial deposits;
- sandstones and siltstones of the Narrabeen Group;

- Illawarra Coal Measures overlying the Ulan Seam;
- Ulan Seam; and
- Marrangaroo Sandstone.

A description of these aquifer systems in the vicinity of the Project is presented below. A description of the geology across the Project site is described in Section 3.1.3 and shown on Figure 3-3. A conceptual hydrogeological cross section of the aquifers in the Project area is shown on Figure 3-5.

Alluvial and Colluvial Deposits

The alluvial deposits in the Project area are typically shallow and in the order of 5 m thick (Appendix B). Most of the alluvium, particularly the basal component, contains a significant proportion of clay. The standing water level in the Wilpinjong Creek alluvium is about 3 m below ground level (*ibid*.). In topographically elevated areas above the standing groundwater table, the alluvium is often unsaturated, except following significant rainfall (*ibid*.).

Colluvial deposits (i.e. sediments transported by gravity) are present below escarpment areas, particularly in the north of the Project area between Wilpinjong Creek and the Goulburn River National Park (Appendix B).

Narrabeen Group

The siltstones and sandstones of the Narrabeen Group form elevated, mesa-like and deeply incised plateaus to the north and south of the Project area. The sandstones of the Narrabeen Group are elevated high above the valley floors with discharge occurring as lateral drainage to the valleys below and as limited seepage to deeper aquifers. Thin layers of mudstone and siltstone in the Narrabeen Group are likely to restrict the vertical movement of groundwater to such a degree that perched, or semi-perched aquifers are developed within the Group (Appendix B).

Illawarra Coal Measures - Overlying the Ulan Seam

The Illawarra Coal Measures overlying the Ulan Seam are predominantly fine grained deposits however sections with over 50% sandstone are present at various locations. Standing water levels vary between approximately 0.1 to 7.5 m below the ground surface.

Hydraulic conductivities in these coal measures are moderate to low ranging between 0.009 m/day and 0.047 m/day (Appendix B). Generally the upper sections of the Illawarra Coal Measures (above the Ulan Seam) are low yielding and are not a prospective source for groundwater supplies (*ibid*).

Illawarra Coal Measures - Ulan Seam

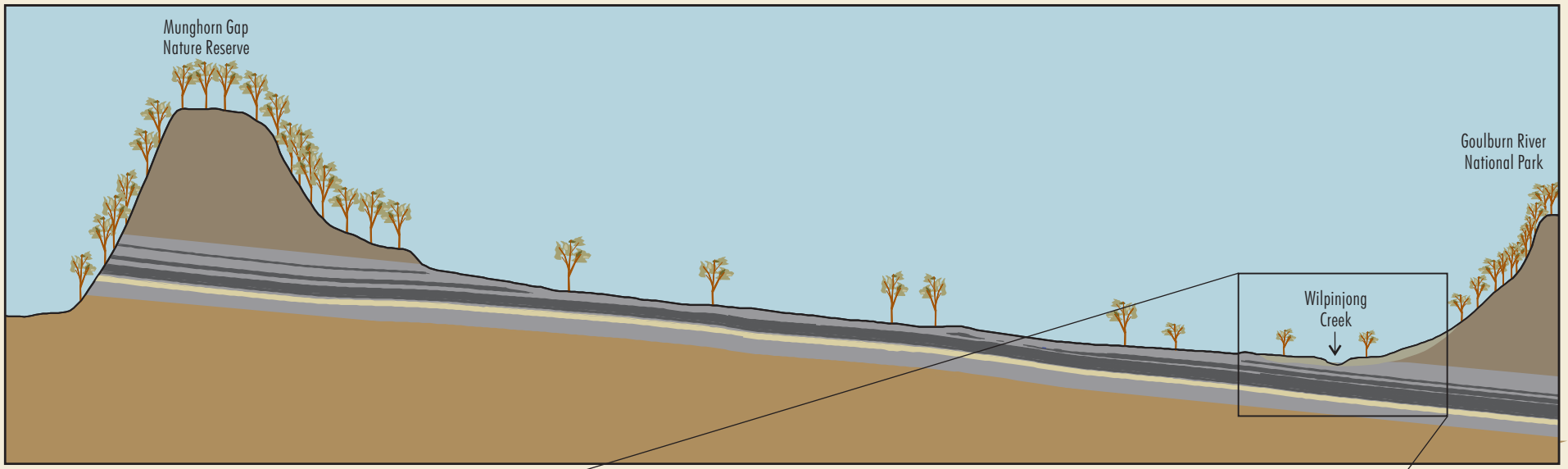
The Ulan Seam is one of the two main aquifer systems in the Project area. The Ulan Seam is generally confined, with standing water levels in the MLA 1 area ranging from approximately 2.7 m above ground to 10 m below ground level. In some areas groundwater is expressed at the surface in the form of artesian seeps. Analysis of the groundwater levels indicates that along parts of the southern extent of the Project area the Ulan Seam may be dry due to its elevation being above regional groundwater levels (Appendix B).

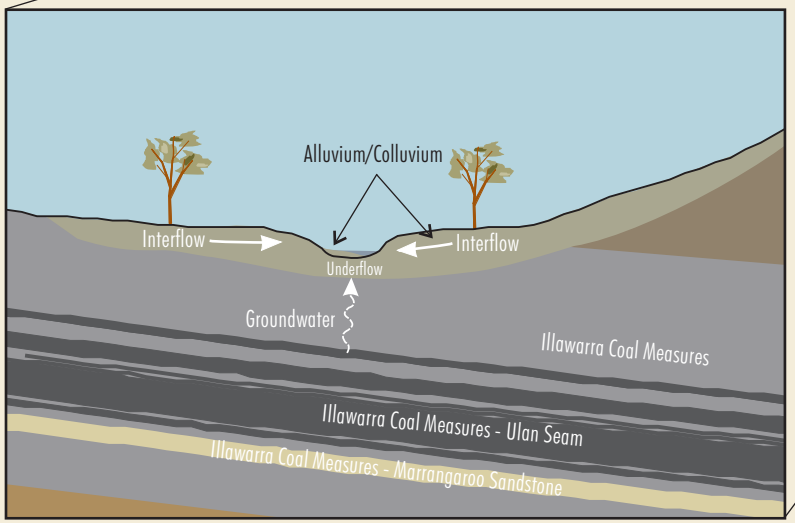
The average hydraulic conductivity obtained from 24 hour pumping tests conducted in the Ulan Seam was 6.43 m/day with results ranging from 1.8 m/day to 11.5 m/day (Appendix B).

Illawarra Coal Measures - Marrangaroo Sandstone

The Marrangaroo Sandstone is the second of the two main aquifer systems in the Project area. The Marrangaroo Sandstone is typically separated from the overlying Ulan Seam by a relatively thin siltstone layer, but often both aquifers are in direct contact with each other. Standing water levels in the Marrangaroo Sandstone range from approximately 11 m below ground level to areas where groundwater is expressed to the surface in the form of artesian seeps (as described above for the Ulan Seam).

Pumping test results reported by Geoterra (2004) indicate that the Ulan Seam and the Marrangaroo Sandstone aquifers are hydraulically connected. The hydraulic conductivity of the Marrangaroo Sandstone aquifer indicates similar hydraulic conductivity to the Ulan Seam (Appendix B).





LEGEND
- Narrabeen Group
- Illawarra Coal Measures
- Illawarra Coal Measures - Ulan Seam
- Illawarra Coal Measures - Marrangaroo Sandstone
- Alluvium/Colluvium
- Shoalhaven Group (Including Nile Subgroup)

Not to Scale

After: Gilbert & Associates (2005) and Australasian Groundwater and Environmental Consultants (2005)

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FIGURE 3-5
Conceptual Hydrogeological South-North Cross Section

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3.3.3 Groundwater Levels and Gradient

Based on measured groundwater levels reported in Geoterra (2004) and DIPNR (2003), results of the bore census conducted in February 2005 and development of the groundwater model for the Project (Appendix B), the existing groundwater table in the Ulan Seam/Marrangaroo Sandstone ranges from approximately 395 m AHD across the southern and central parts of the MLA 1 area to approximately 365 m AHD near the confluence of Cumbo and Wilpinjong Creeks. The general groundwater gradient ranges from approximately 0.006 to 0.01 m/m from the west-southwest to the north-northeast (Appendix B).

3.3.4 Local Groundwater Quality

Groundwater quality varies in the Project area according to the depth and age of the strata in which it occurs. The better quality groundwater is likely to be encountered in the alluvial deposits (Appendix B).

Groundwater quality monitoring records in the Ulan Seam indicate EC ranges from 1,020 to 3,390 µS/cm (Table 3-9). The highest EC recorded in the Illawarra Coal Measures below the Ulan Seam in the Project area was measured at 4,200 µS/cm (Table 3-9).

Groundwater in the underlying Nile Subgroup is generally more saline with EC measurements of 3,600 and 3,700 µS/cm (Appendix B). In addition, Cumbo Creek surface water samples taken from a Nile Subgroup groundwater discharge area recorded EC values of 11,000 and 12,000 µS/cm (Appendix A). The difference in EC between the groundwater in the Nile Subgroup and the overlying formations indicates hydraulic separation of the Nile Subgroup (Appendix B).

Comparison of the measured groundwater salinity levels to the ANZECC Guideline trigger levels for livestock drinking water quality (Table 3-8) indicates that most groundwater sources sampled in the Project area (besides the Nile Subgroup) are suitable for beef cattle, dairy cattle, pigs, horses and sheep.

3.3.5 Other Groundwater Users

AGE (2005) conducted a DIPNR database search of registered bores and wells which indicates there are 68 registered bores and wells within an approximate 10 km radius of the Project area.

Of these, the majority of the registered bores and wells are concentrated in the Project area (on WCPL-owned land), at Wollar village (Figure 3-4) and at Ulan Coal Mines to the west of the Project.

The majority of the registered bores are installed in the Illawarra Coal Measures (37 bores), with less being installed in the Nile Subgroup (7 bores), Wilpinjong Creek alluvium (5 bores), Cumbo Creek alluvium (one bore), and in a volcanic intrusion north of Wollar village (3 bores) (Appendix B). A number of wells are also located in the Wollar Creek and Cumbo Creek alluvium (6 wells each), Murragamba Creek alluvium (one well), and one well in the Illawarra Coal Measures.

In consultation with landowners, a bore census was conducted by WCPL in February 2005 to collect additional data on local registered and known bores/wells. The information collected was used to supplement the data collated for the groundwater assessment (Appendix B).

3.4 NOISE AND BLASTING

An assessment of the existing noise environment has been undertaken by Richard Heggie Associates and is provided in Appendix D.

Recorded and assessed noise levels presented in Appendix D and summarised below are expressed in A-weighted decibels (dBA). The dBA system simulates the response of the human ear, which is more sensitive to high frequency sounds and de-emphasises lower frequency sounds. Table 3-10 provides information on common noise sources in dBA for comparative reference.

Hearing "nuisance" for most people begins at noise levels of about 70 dBA, while sustained (i.e. eight hours) noise levels of 85 dBA can cause hearing damage.

Measured and predicted noise levels are expressed as the equivalent continuous sound pressure level (L_{Aeq}), which is a constant sound level that is equal in energy to the fluctuating levels recorded during the sampling period.

Table 3-9
Summary of Groundwater Quality in the Project Area

Monitoring Site	Aquifer System	Field pH	Field EC µS/cm	TDS mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	HCO_3 mg/L	SO_4 mg/L	Cl mg/L
GW080404	Alluvium (Cumbo Creek)	-	2,100	-	-	-	-	-	-	-	-
GW080408	Alluvium (Wilpinjong Creek)	-	2,600	-	-	-	-	-	-	-	-
GW080410	Alluvium (Wilpinjong Creek)	-	1,000	-	-	-	-	-	-	-	-
GW080413	Mesozoic Laccolith Intrusion	-	1,300	-	-	-	-	-	-	-	-
ERUL27	Ulan Seam	8.0	1,020	665	39.1	30	177.9	10.2	463.7	139.8	40.1
ERUL59	Ulan Seam	7.5	1,550	1,021	43.9	27.5	307.6	15.6	781	32.2	209.9
ERUL67	Ulan Seam	7.4	2,330	1,516	72.5	85.3	350.1	27	449.7	419.8	340
ERUL72	Ulan Seam	6.6	1,380	897	28.6	56.5	219.8	15.6	295.3	249.8	181.9
ERUL77	Ulan Seam	7.6	2,630	1,712	53.3	35.5	560	23.1	1,246.6	264.6	162
DMCM12	Ulan Seam	6.6	3,390	2,200	100	70	565	31	825	685	330
GW080411	Illawarra Coal Measures	-	3,400	-	-	-	-	-	-	-	-
GW080405	Illawarra Coal Measures (below Ulan Seam)	-	4,200	-	-	-	-	-	-	-	-
GW080401	Nile Subgroup	-	3,700	-	-	-	-	-	-	-	-
GW080403	Nile Subgroup	-	3,600	-	-	-	-	-	-	-	-

Source: after Appendix B

Table 3-10
Relative Scale of Various Noise Sources

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110-130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Inside subway train	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
80	Loud	Garbage disposal at 1 m, shouting at 1 m	Urban daytime noise
70	Loud	Vacuum cleaner at 3 m, normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	-
50	Moderate to quiet	Dishwasher next room, wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	-
0-10	Silent	Threshold of hearing	-

Source: after US Dept. Interior, Robinson Project EA (1994) and Richard Heggie Associates (1995)

3.4.1 Project Background Noise Monitoring

Ambient noise surveys to characterise and quantify the existing acoustic environment in the vicinity of the Project were conducted in August, 2004. Eight unattended noise loggers were positioned at representative locations (N1 to N8) (Figure 3-1) between 5 August and 4 September 2004. A ninth unattended logger was also utilised to measure traffic noise on Wollar Road at site N4.

Operator-attended daytime, evening and night-time surveys were also conducted at all eight noise logging locations to supplement the unattended logger measurements and to assist in identifying the character and duration of ambient noise sources.

Distant noise emissions from the existing Ulan Coal Mines were detected by the operator during operator-attended surveys at Site N1. No other industrial noise (excluding road traffic noise) was detected during the surveys (Appendix D).

Rating Background Level

Noise data from the 2004 surveys was processed in accordance with the requirements of the NSW Industrial Noise Policy (INP) (EPA, 2000) to determine background noise levels for the Project acoustic assessment (Table 3-11).

These rating background levels (RBLs) are typical of a rural environment where there is minimal industrial noise and relatively low use transport corridors.

The RBL is a calculated median background level representing each assessment period (day/evening/night) over the whole monitoring period. The RBL measurement methodology and analytical procedures are described in further detail in Appendix D. The locations of noise sensitive receptors (e.g. dwellings, churches, etc.) are provided in Appendix D.

3.4.2 Road Transport Noise

Traffic noise measurements were undertaken on Wollar Road to the west of the proposed Mine Access Road at an offset distance of approximately 25 m from Wollar Road (Site N4 – Figure 3-1). Data recorded at the site was then processed in accordance with the requirements of the *Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999), which indicated that existing traffic noise levels complied with the applicable daytime and night-time criteria at distances of 25 m or more from Wollar Road (Appendix D).

3.4.3 Rail Traffic Noise

The Australian Rail Track Corporation Ltd (ARTC) operates the Gulgong-Sandy Hollow and Main Northern railways and noise emissions from the railways are regulated via ARTC's Environment Protection Licence (EPL).

Table 3-11
Noise Environment for Project Assessment Purposes

General Locality	Project Noise Monitoring Site	Rating Background Level (dBA)		
		7.00 am to 6.00 pm	6.00 pm to 10.00 pm	10.00 pm to 7.00 am
Murragamba	N1, N2	30	30	30
Wilpinjong	N3	30	30	30
Cumbo	N4	30	30	30
Slate Gully	N5	30	30	30
Wollar	N6	31	30	30
Wilpinjong (north-east of the Project area)	N7	30	30	30
Araluen	N8	30	30	30

Source: Appendix D

A prediction of rail traffic noise levels resulting from existing and consented (i.e. approved but not currently utilised) rail movements was undertaken for the Gulgong-Sandy Hollow railway. In addition, a prediction of existing rail traffic noise levels was carried out on the Main Northern railway. Rail traffic noise levels were assessed at offset distances of 30 m, 60 m and 90 m using a computer model (Appendix D).

The results of the above were then compared to the ARTC's EPL guideline noise assessment criteria, which states that L_{Aeq} (equivalent continuous noise level) traffic noise goals are 65 dBA ($L_{Aeq(15hour)}$) during the daytime and 60 dBA ($L_{Aeq(9hour)}$) during the night-time. The maximum (L_{Amax}) passby rail noise goal is 85 dBA.

On the Gulgong-Sandy Hollow railway, the results of the modelling indicate that existing and consented rail noise levels comply with the daytime goal at distances of 30 m or more, and with the night-time goal at distances of 60 m or more from the railway. Compliance with the maximum passby goal would occur at distances of 30 m or more from the railway.

On the Main Northern railway, the results of the modelling indicate that existing rail noise levels comply with the daytime goal at distances of 30 m or more from the railway, the night-time goal at distances of 90 m or more from the railway and compliance with the maximum passby goal occurs at a distance of 60 m or more.

Existing and consented rail movements on the Gulgong-Sandy Hollow railway and the Main Northern railway are discussed in Section 3.11.4.

3.4.4 Blasting and Vibration Levels

Overpressure (or airblast) is reported in linear decibels (dBL) and is the measurable effect of a blast on air pressure, including generated energy that is below the limit of human hearing. Ground vibration is the measurable movement of the ground surface caused by a blast and is measured in millimetres per second (mm/s) as Peak Vector Sum (PVS) vibration velocity.

Discernible blast emission effects can be divided into three main categories:

1. Occupants of a building are inconvenienced or disturbed.
2. Contents of a building are affected.
3. Integrity of a building structure may be compromised.

An individual's response to blasting vibration and overpressure is highly dependent on previous experience and expectations. Vibration and overpressure emissions associated with the Ulan Coal Mines were not detected in the Project area during operator-attended noise surveys. The Ulan Coal Mines are located some 11 km from the Project (Figure 3-1).

3.5 AIR QUALITY

An assessment of air quality in the vicinity of the Project has been undertaken by Holmes Air Sciences (2005) and is presented in Appendix E.

As a component of this assessment, background air quality data was collated and reviewed. The following section provides an overview of background dust deposition and total suspended particulates (TSP), including concentrations of particulate matter less than ten microns in size (PM_{10}).

3.5.1 Dust Deposition

The dust monitoring network at Wilpinjong was installed in May 2004 and includes six dust gauges located in the vicinity of the Project (Figure 3-1).

Average dust deposition results for these six sites are presented in Table 3-12 for the period of on-site records. The EPA has established amenity criteria for dust deposition that seek to limit the maximum increase in dust deposition from a new development to 2 g/m^2/month and total dust deposition from all sources to 4 g/m^2/month.

The mean dust deposition rates over the period of record averaged across all sites was 1.5 g/m^2/month and all sites were below the EPA goal of 4 g/m^2/month (Appendix E). Based on this data, it has been assumed that the annual average background dust deposition rate is 1.5 g/m^3/month.

3.5.2 Suspended Particulates

The DEC has established an amenity based criterion of 90 micrograms per cubic metre ($\mu g/m^3$) for maximum annual average TSP concentrations. The DEC has also established 24 hour average and annual average PM_{10} goals of 50 $\mu g/m^3$ and 30 $\mu g/m^3$ respectively that should be generally met within the region.

Further, the National Environment Protection Measure (NEPM) 24 hour average standard of 50 $\mu g/m^3$ has been interpreted as a PM_{10} goal that should generally be met for the region.

Particulate Matter Less than Ten Microns in Size

A PM_{10} high volume sampler was installed at Wollar (Figure 3-1) in June 2004 to assess local suspended particulate levels.

Measured 24 hour average PM_{10} concentrations at the Wollar monitoring site HV1 were between 0.5 $\mu g/m^3$and 45.2 $\mu g/m^3$ for the period June 2004 to February 2005 (Appendix E). This variability is likely to be associated with local factors such as landuse adjacent to the monitoring site and use of local unsealed roads. The 24 hour average PM_{10} concentration from the monitoring site in Wollar over the period of record was found to be 11 $\mu g/m^3$ (Appendix E). Based on this data, it has been assumed that the annual average PM_{10} background concentration is 11 $\mu g/m^3$.

Total Suspended Particulates

TSP levels can be inferred from the PM_{10} monitoring data (Appendix E). The average inferred TSP concentration (24 hour average) at Wollar for the period June 2004 to February 2005 was 28 $\mu g/m^3$. Based on this data, it has been assumed that the annual average TSP background concentration is 28 $\mu g/m^3$.

Table 3-12
Average Dust Deposition Rates (g/m^2/month)

Month	Dust Monitoring Site					
	DG1	DG2	DG3	DG4	DG5	DG6
May	2.1	1.8	2.0	1.7	-	2.4
June	1.0	1.1	1.2	0.8	2.9	0.8
July	0.6	0.6	0.7	0.4	0.4	1.7
August	1.5	1.0	3.9	0.5	0.7	2.4
September	0.5	0.7	0.2	0.2	0.5	3.6
October	0.1	0.3	5.4	0.1	0.2	1.8
November	2.3	5.5	0.7	0.3	0.3	1.2
December	1.7	1.8	3.6	1.2	1.4	2.9
January	1.0	1.4	1.5	1.1	1.2	1.7
February	1.7	2.5	3.7	2.9	1.1	1.9
Average	**1.2**	**1.7**	**2.3**	**0.9**	**1.0**	**1.9**

Source: Appendix E

3.5.3 Observations

The measured dust deposition and suspended particulate levels in the Project area are considered typical of a rural area remote from industrial emission sources. Air quality in the area is largely determined by emissions from natural sources, road traffic, community and other agricultural activities (Appendix E). From time to time, particulate matter levels would be expected to be affected by smoke from bushfires and dust from regional dust storms.

3.6 FLORA

3.6.1 Regional Setting

The Project is situated in the north-east of the Central Western Slopes Botanical Division (Anderson, 1968; Harden, 2002) and the far north-west corner of the Sydney Basin Interim Biogeographic Regionalisation of Australia (IBRA) Bioregion (Thackway and Cresswell, 1995; Cummings and Hardy, 2000). The Project is also close to both the Brigalow Belt South and NSW South Western Slopes Bioregions (*ibid.*).

3.6.2 Local Setting

The condition of native vegetation in the Project area and surrounds varies, with the most disturbed areas generally occurring along watercourses and on flat and undulating areas which have been cleared for agriculture. Most natural vegetation is restricted to the steep hills and slopes outside of Project disturbance areas, with the exception of the remnant vegetation in Pit 3 (Figure 1-4). There are some small uncleared areas of remnant vegetation scattered throughout the Project area and surrounds and these are mainly associated with stony outcrops.

Goulburn River National Park and Munghorn Gap Nature Reserve, situated to the north and south of the Project, respectively (Figure 3-1), are listed on the Register of the National Estate (DEH, 2005). The statements of significance for the listing of the two areas include recognition of their inherent flora values. A study of vegetation in Goulburn River National Park and Munghorn Gap Nature Reserve was recently conducted by Hill (1999, 2000). A large number of earlier surveys were also conducted by Bell (1995a, 1995b, 1997a, 1997b and 1997c) and McRae and Cooper (1985). Hill (1999, 2000) utilised and built on the earlier studies and identified 27 plant communities in Goulburn River National Park and Munghorn Gap Nature Reserve.

3.6.3 Flora Survey

Survey Timing and Methodology

A flora survey and assessment was conducted for the Project by FloraSearch (2005) in autumn, winter and spring 2004 and is presented in Appendix HA. Areas of remnant vegetation were systematically surveyed using quadrats and spot sampling sites (Figure 3-6) to compile a comprehensive species list and to detect threatened flora species which may have been present.

As outlined in Appendix HA, threatened flora species considered to possibly occur in the Project area or surrounds were specifically targeted (e.g. across a range of seasons). Notwithstanding, where a threatened species was not recorded, the potential for the threatened species to occur in the Project area or surrounds was assessed (e.g. through the occurrence of potential habitat for the species) and, where appropriate, these species were subsequently considered in Eight Part Tests of Significance (Appendix HE).

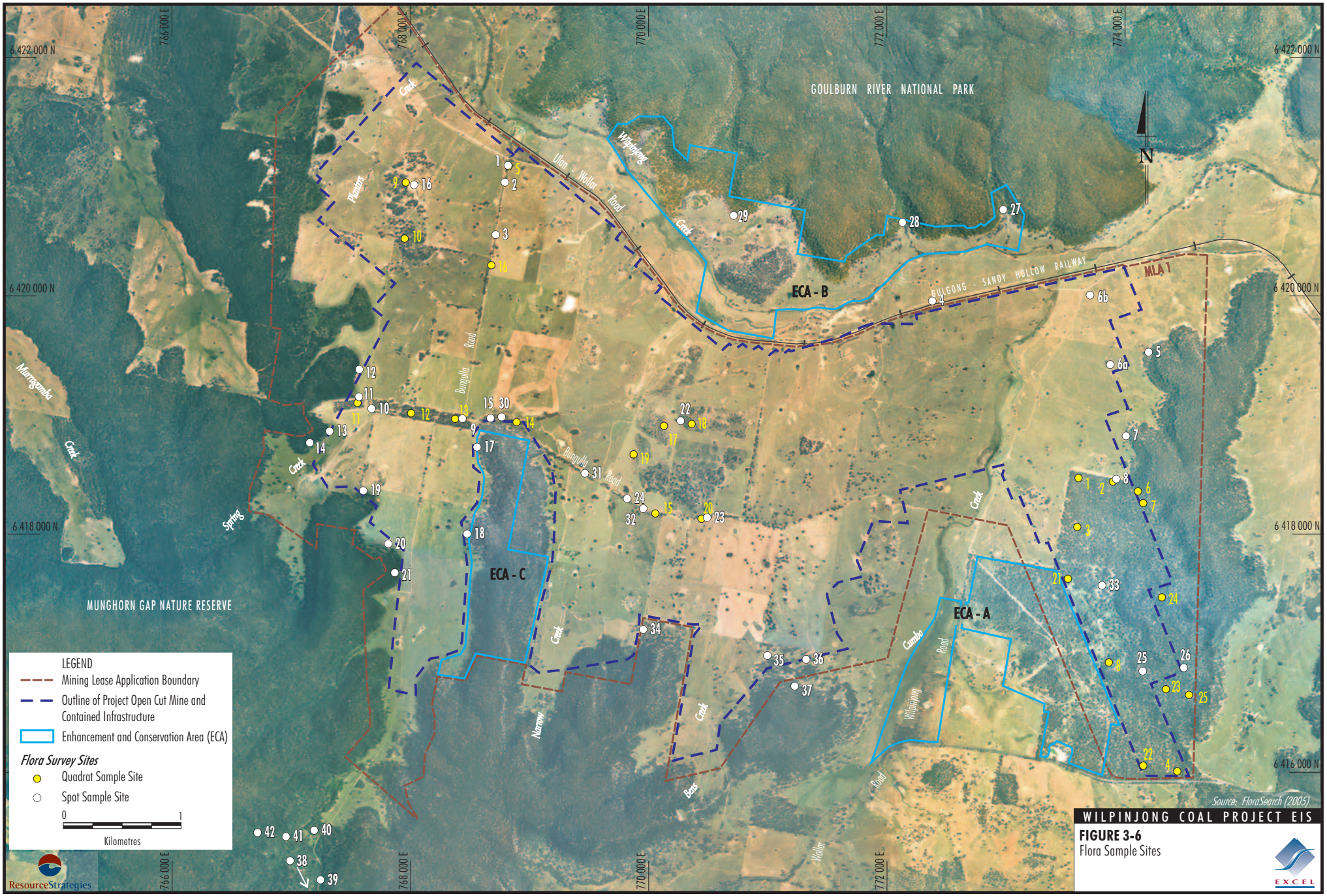
Mapping of the vegetation was conducted at two levels, comprising general vegetation mapping and detailed mapping of threatened vegetation communities in the Project disturbance area and immediate surrounds.

Vegetation Communities

The Project area and surrounds support a diversity of flora species and communities. Remnant vegetation is dominated by eucalypt woodland and forests. A number of tree species including Narrow-leaved Ironbark (*Eucalyptus crebra*), Coast Grey Box (*E. moluccana*), Black Cypress Pine (*Callitris endlicheri*), and Rough-barked Apple (*Angophora floribunda*) are widespread and common and associate with many other species. Other dominant tree species include Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*), White Box (*E. albens*) and Grey Gum (*E. punctata*).
Table 3-13 and Figure 3-7 provide a summary of the vegetation communities identified within the Project area and surrounds (Appendix HA).

Flora Species Composition

A total of 403 plant taxa were recorded by the flora surveys. Of these, 298 taxa are native to the natural vegetation communities surveyed and 105 taxa are introduced (Appendix HA).



WIL-04-01 Sect 3_008H

WIL-04-01 Sect 3_009G

Table 3-13
Vegetation Communities Identified within the Project Area and Surrounds

Vegetation Community		Dominant Species		Landscape Position
		Scientific Names	Common Names	
1	Yellow Box and Blakely's Red Gum Woodlands	*Eucalyptus melliodora/E. blakelyi/Angophora floribunda ± E. moluccana*	Yellow Box/Blakely's Red Gum/Rough-barked Apple ± Coast Grey Box	Permian or volcanic soils of the valley floor, lower south-facing slopes of sandstone ranges north of Wilpinjong Creek, drainage lines.
2	Coast Grey Box Woodlands	*E. moluccana ± E. crebra ± A. floribunda ± Callitris endlicheri*	Coast Grey Box ± Narrow-leaved Ironbark ± Rough-barked Apple ± Black Cypress Pine	Upslope of vegetation community 1, drainage lines and gentle slopes of valleys.
3	Rough-barked Apple Woodlands	*A. floribunda ± E. crebra ± C. endlicheri*	Rough-barked Apple ± Narrow-leaved Ironbark ± Black Cypress Pine	Slopes, rises and low hills on the valley floor on shallow stony soil, sheltered slopes and gullies of sandstone ranges.
4	Narrow-leaved Ironbark Forest	*E. crebra/C. endlicheri ± E. macrorhyncha ± A. floribunda ± E. caleyi*	Narrow-leaved Ironbark/Black Cypress Pine ± Red Stringybark ± Rough-barked Apple ± Caleys Ironbark	Gravelly soils of cleared lands, lower hill slopes, stony rises.
5a	Grassy White Box Woodlands	*E. albens ± E. moluccana ± C. endlicheri*	White Box ± Coast Grey Box ± Black Cypress Pine	Permian clay hills, north-facing colluvial footslopes of sandstone ranges.
5b	Shrubby White Box Woodlands	*E. albens/C. endlicheri ± A. floribunda ± E. moluccana ± E. crebra*	White Box/Black Cypress Pine ± Rough-barked Apple ± Coast Grey Box ± Narrow-leaved Ironbark	East, south and west facing lower and mid slopes of sandstone ranges, dry elevated flats on sandstone ranges.
6	Sandstone Range Shrubby Woodlands	*E. punctata/E. sparsifolia/C. endlicheri ± E. agglomerata ± E. fibrosa ± E. crebra ± A. floribunda ± E. dawsonii*	Grey Gum/Narrow-leaved Stringybark/Black Cypress Pine ± Blue-leaved Stringybark ± Broad-leaved Ironbark ± Narrow-leaved Ironbark ± Rough-barked Apple ± Slaty Gum	Upper slopes and ridges of sandstone ranges, steep stony hills.
7	Cleared Agricultural Land	N/A	N/A	Permian soils of the valley floor.
8	Secondary Shrubland	*Acacia ixiophylla/Bursaria spinosa/Cassinia quinquefaria/Acacia implexa/Acacia linearifolia*	Sticky Wattle/Kangaroo Thorn/Sticky Cassinia/Hickory Wattle/Narrow-leaved Wattle	Recently cleared areas of sandstone range footslopes.

Source: Appendix HA

Plant families with the highest number of species were the Grasses (Poaceae), the Daisy family (Asteraceae), the Pea Flowers (Faboideae), the Eucalypts and related genera in the family Myrtaceae and the Wattles (sub-family Mimosoideae).

Introduced Flora Species and Noxious Weeds

The highest proportion of introduced species and weeds occurred on the cleared agricultural lands and the lowest proportion in the relatively undisturbed vegetation communities on the steeper slopes and ridge tops. Semi-cleared, grazed natural communities and disturbed sites in bushland areas contained intermediate weed levels.

A number of weeds recorded by the flora surveys are regarded as noxious in the MWRLGA including African Boxthorn (*Lycium ferocissimum*), Bathurst Burr (*Xanthium spinosum*), Blackberry (*Rubus fruticosus* [agg. spp.]), Johnson Grass (*Sorghum halepense*), Lacy Ragweed (*Ambrosia tenuifolia*), Prickly Pear (*Opuntia stricta*), St. John's Wort (*Hypericum perforatum*), Sweet Briar (*Rosa rubiginosa*) and Tree of Heaven (*Ailanthus altissima*). None of these species were abundant, with most being recorded only once or twice during the surveys.

Threatened Flora Species

Eight Part Tests of Significance have been undertaken for 15 threatened flora species under Section 5A of the EP&A Act considered to possibly occur in the Project area or surrounds in order to ascertain the likely impacts of the Project on these species and/or their habitats. The findings of the assessment are discussed in Section 4.7.

One threatened flora species listed as Vulnerable under both the TSC Act and EPBC Act was recorded by the surveys, *viz.* Cannon's Stringybark (*Eucalyptus cannonii*). One population of *E. cannonii* was recorded on the midslopes of the sandstone range to the west of the Project (Figure 3-7). This population is not located within the Project disturbance area (Figure 3-7).

E. cannonii is known from the Rylstone, Mudgee, Sunny Corner and Wolgan Valley areas (Hunter, 1998; Hill, 2000) and has not previously been recorded from the Project area or surrounds, Munghorn Gap Nature Reserve or Goulburn River National Park (Hill, 2000; DEC, 2005).

The Atlas of NSW Wildlife (DEC, 2005) indicates *E. cannonii* has been previously recorded approximately 24 km to the south-east of the Project. The specimens of *E. cannonii* recorded to the west of the Project represent an extension of the known range for this species. Although *E. cannonii* has a restricted distribution of about 100 km x 60 km in Central Western NSW, it is relatively widespread and common within this range.

Endangered Ecological Communities

The White Box, Yellow Box, Blakely's Red Gum Woodland EEC listed under the TSC Act and the Grassy White Box Woodlands EEC listed under the EPBC Act were also recorded in the Project area and surrounds by the flora surveys. In addition to the listing of the Grassy White Box Woodlands EEC under the EPBC Act, there is currently a nomination to list Yellow Box/Red Gum Grassy Woodland as an EEC under the EPBC Act (DEH, 2004). The Yellow Box/Red Gum Grassy Woodland nomination, together with the Grassy White Box Woodlands EEC listing represent the community listed as the White Box, Yellow Box, Blakely's Red Gum Woodland EEC under the TSC Act (*ibid.*). Herein, the White Box, Yellow Box, Blakely's Red Gum Woodland EEC and the Grassy White Box Woodlands EEC will collectively be referred to as the WBYBBRG EEC.

In NSW, the WBYBBRG EEC occurs in the New England Tableland, Nandewar, Brigalow Belt South, NSW North Coast, Sydney Basin, NSW South Western Slopes and South Eastern Highlands Bioregions (NSW Scientific Committee, 2002). The WBYBBRG EEC is widespread on the tablelands and western slopes of NSW, generally occurring on higher fertility soils and, as such, has been subjected to extensive clearing over its entire range (NPWS, 2002a and undated; NSW Scientific Committee, 2002; Dobbie, 2004; DEH, 2004). This community includes woodlands characterised by one or more of the following species in varying proportions and combinations: White Box (*E. albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*) (*ibid*.). Grass and herbaceous species generally dominate the ground layer, and shrubs are usually sparse or absent, though they may be locally common (i.e. shrubs may be dominant over parts of an EEC site) (*ibid*.).

Within the Project area and surrounds, the WBYBBRG EEC is represented by two spatially distinct communities (i.e. Yellow Box and Blakely's Red Gum Woodlands [vegetation community 1] and Grassy White Box Woodlands [vegetation community 5a]), which are generally separated by the Coast Grey Box Woodlands (vegetation community 2) (Figure 3-7). The Grassy White Box Woodlands (vegetation community 5a) within the Project area and surrounds are situated mainly on the lower slopes of the sandstone ranges. During the Project flora surveys, this community was characterised by low levels of grasses and herbs and had been subject to heavy grazing by livestock. Were livestock to be excluded, this vegetation community could potentially develop a grassier understorey or, alternatively, could become more characteristic of the Shrubby White Box Woodlands (vegetation community 5b). Vegetation community 5a is considered to represent the WBYBBRG EEC to avoid under-estimating the occurrence of the EEC.

Regionally Significant Flora

Two regionally significant species were recorded by the surveys, *viz., Boronia angustisepala* and *Gonocarpus longifolius*. Both are listed as rare nationally in *Rare or Threatened Australian Plants* (ROTAP)[1] (Briggs and Leigh, 1996). Neither species was recorded within the Project disturbance area. Both were recorded within vegetation community 6 on the upper slopes of the sandstone ranges to the south-west of the Project (Figure 3-7).

In addition, one potential new species of Yellow Buttons (*Chrysocephalum* sp.) was recorded in vegetation community 6 about half way up the slope of a sandstone range to the south-west of the Project and south of spot sample 20 which is shown on Figure 3-6. The Sydney Royal Botanic Gardens has confirmed that the specimens collected appear to represent a new species. The *Chrysocephalum* sp. population is located outside the Project disturbance area.

3.7 FAUNA

3.7.1 Fauna of Goulburn River National Park and Munghorn Gap Nature Reserve

Goulburn River National Park and Munghorn Gap Nature Reserve are listed on the Register of the National Estate (DEH, 2005). The statements of significance for the listing of the areas include recognition of their inherent fauna values.

Systematic fauna surveys of Goulburn River National Park and Munghorn Gap Nature Reserve have been undertaken by NPWS (NPWS, 2001; NPWS, 2002b). Species recorded by the systematic surveys have been included in the DEC Atlas of NSW Wildlife online database. The online database indicates that 282 fauna species have been recorded in Goulburn River National Park and Munghorn Gap Nature Reserve including 14 amphibians, 40 reptiles, 183 birds and 45 mammals. The online database indicates that 25 of the 282 species are listed as threatened under the TSC Act, including 21 Vulnerable and four Endangered species.

Threatened species listed under the TSC Act and EPBC Act that have been recorded in the Goulburn River National Park or Munghorn Gap Nature Reserve include the Malleefowl (TSC-E, EPBC-V)[2], Regent Honeyeater (TSC-E, EPBC-E), Swift Parrot (TSC-E, EPBC-E), Brush-tailed Rock-Wallaby (TSC-E, EPBC-V), Pink-tailed Legless Lizard (TSC-V) and Squirrel Glider (TSC-V). Additional threatened woodland birds listed as Vulnerable under the TSC Act that have been recorded in the Goulburn River National Park or Munghorn Gap Nature Reserve include the Turquoise Parrot, Brown Treecreeper, Speckled Warbler, Black-chinned Honeyeater, Hooded Robin, Grey-crowned Babbler and Diamond Firetail.

The online database also indicates that a number of introduced species have been recorded in the Goulburn River National Park or Munghorn Gap Nature Reserve including, the Common Starling, Black Rat, House Mouse, European Cattle, Fox, Feral Goat, Feral Pig, Feral Cat, Brown Hare and Rabbit.

3.7.2 Terrestrial Fauna Surveys

Birds, mammals, reptiles and amphibians were surveyed in autumn (mid to late April and mid to late May) and spring (late November) 2004 by Mount King Ecological Surveys (2005) as part of the Project Terrestrial Fauna Assessment (Appendix HB). Bat fauna were surveyed separately in autumn (late March to early April) and spring (late November) 2004 by Greg Richards and Associates (2005) as part of the Project Bat Fauna Assessment (Appendix HC).

[1] *B. angustisepala* is listed in ROTAP as *Boronia rubiginosa* (Duretto, 1999).

[2] TSC-E and TSC-V indicate species listed as Endangered and Vulnerable, respectively, under the TSC Act. EPBC-E and EPBC-V indicate species listed as Endangered and Vulnerable, respectively, under the EPBC Act.

A number of reference sources containing the results of regional fauna surveys (i.e. NPWS, 2001 and 2002b; Mount King Ecological Surveys, 1998 and 2003) and database records (e.g. DEC Atlas of NSW Wildlife, Birds Australia, Australian Museum and Hunter Bird Observers Club) were also reviewed and, where appropriate, included in these assessments.

As outlined in Appendices HB and HC, survey timing and techniques were designed to target threatened fauna species considered possible occurrences in the Project area or surrounds. Notwithstanding, where a threatened species was not recorded, the potential for the threatened species to occur in the Project area or surrounds was assessed (e.g. through the occurrence of potential habitat for the species) and where appropriate, these species were subsequently considered in Eight Part Tests of Significance (Appendix HE).

Survey Methodology

A total of 29 fauna sampling sites (12 terrestrial fauna sites and 17 bat fauna sites) were surveyed in autumn and 34 fauna sampling sites (23 terrestrial fauna sites and 11 bat fauna sites) in spring (Figure 3-8). The fauna surveys employed a variety of methods including Elliott traps, pit fall traps, cage traps, spotlighting, hair tubes, herpetofauna searches, call playback, echolocation call detector systems, harp trapping and general observations. Targeted surveys were conducted for threatened fauna species considered to possibly occur in the Project area and surrounds. Details of the survey methodologies utilised are provided in Appendices HB and HC.

Habitat Resources

The natural vegetation cover within the Project area and surrounds includes an overstorey dominated by eucalypts (e.g. Yellow Box, Blakely's Red Gum, Grey Box, Narrow-leaved Ironbark, White Box and Grey Gum) and Rough-barked Apple. In terms of terrestrial fauna habitats, the Project area and surrounds comprise the following (Figure 3-7):

- Woodland on undulating and level land – dominant canopy species in these areas include Yellow Box, Blakely's Red Gum, Rough-barked Apple and Grey Box.
- Woodland on slopes and steep hills – dominant canopy species in these areas include Narrow-leaved Ironbark, Grey Box, Grey Gum and White Box.
- Rocky hills and escarpment (for example in the Crown land to the east of the Project).
- Watercourses – for example Wilpinjong Creek, Cumbo Creek and farm dams – the riparian margins of creeks have predominantly been cleared. There is some low-growing littoral vegetation (e.g. rushes) associated with watercourses and farm dams, however, these habitats have been subject to disturbance by livestock.
- Cleared agricultural land with scattered trees – this habitat type is predominant in the Project disturbance area. Scattered trees within the cleared agricultural land predominantly comprise Eucalypt species (such as Yellow Box, Blakely's Red Gum, and Grey Box) and Rough-barked Apple.

Habitat complexity was assessed for terrestrial fauna by the Project surveys (Appendices HB and HC). The assessments indicated that habitat complexity was highly variable between sites. From a broader perspective, larger remnants situated in the surrounding area (e.g. within Goulburn River National Park and Munghorn Gap Nature Reserve) would be expected to have a greater habitat complexity than those situated within the Project disturbance areas and those immediately proximal to the Project disturbance areas.

Remnant vegetation in the Project area and surrounds provides habitat for a number of woodland birds, including those listed as threatened under the TSC Act and/or EPBC Act. Habitat resources for threatened woodland birds are described in the Eight Part Tests of Significance for these species in Appendix HE. The characteristics of the vegetation/habitats for woodland birds in the Project area and surrounds are also described in Appendices HA (Flora Assessment) and HB (Terrestrial Fauna Assessment).

Species Composition

The number of native fauna species identified during the surveys is provided per fauna type in Table 3-14.

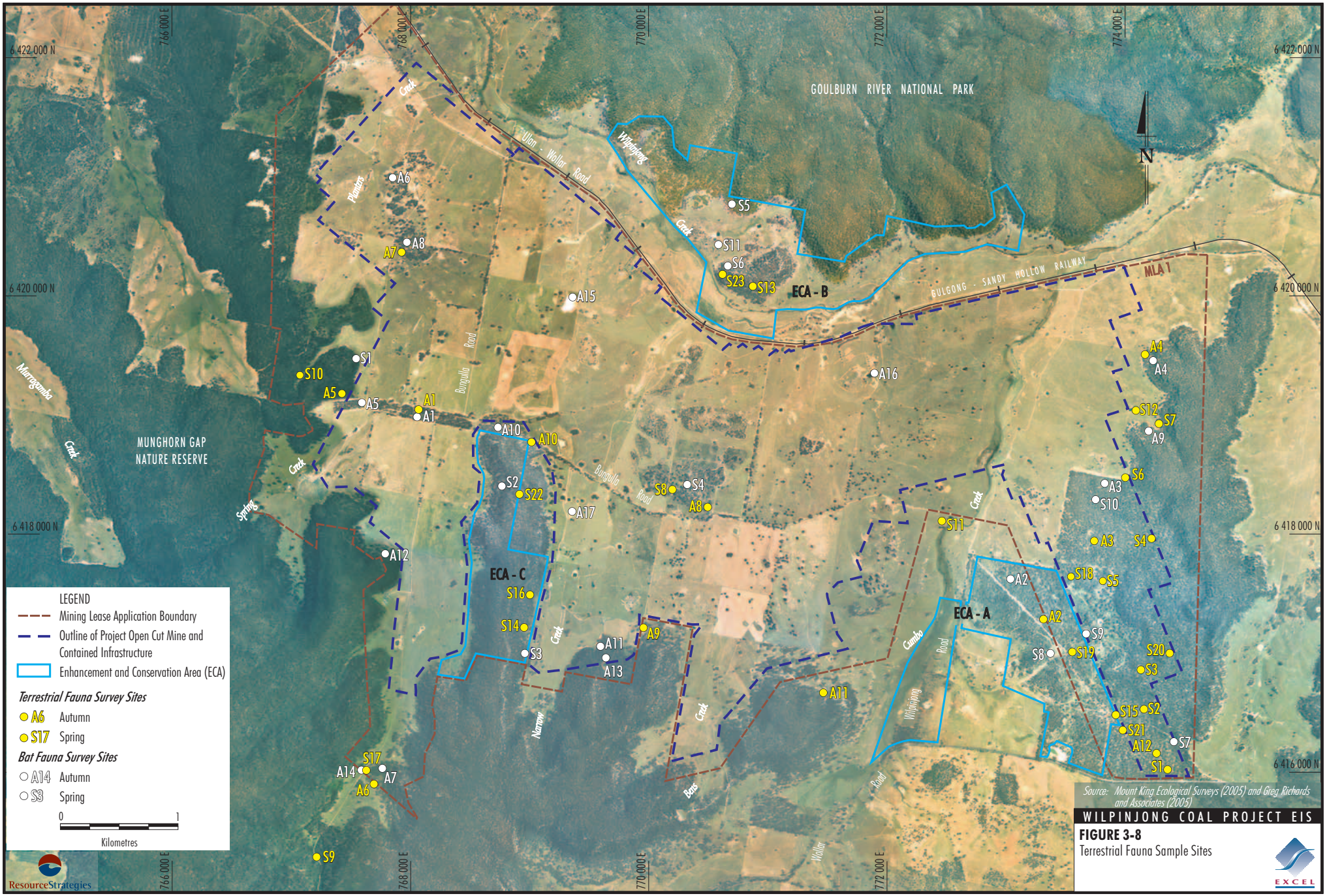


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Table 3-14
Number of Native Fauna Species Identified

Fauna Type	Number of Species Identified
Amphibians	6
Reptiles	17
Birds	122
Mammals	29
Total	**174**

Source: Appendices HB and HC

Six species of frogs were recorded, namely, the Long-thumbed Frog (*Limnodynastes fletcheri*), Striped Marsh Frog (*Limnodynastes peronii*), Common Eastern Froglet (*Crinia signifera*), Peron's Tree Frog (*Litoria peronii*), Rocket Frog (*Litoria nasuta*) and Broad-palmed Frog (*Litoria latopalmata*) (Appendix HB). The amphibians recorded by the surveys were associated with waterbodies, namely, Wilpinjong Creek, Cumbo Creek and some farm dams.

Seventeen reptile species were recorded by the surveys. The diversity and number of reptiles recorded was low with only single individuals of most species recorded. Three burrowing reptile species were recorded including the Prong-snouted Blind Snake (*Ramphotyphlops bituberculata*), Blackish Blind Snake (*Ramphotyphlops nigrescens*) and Two-clawed Worm-skink (*Anomalopus leuckartii*).

A total of 122 native bird species were recorded by the surveys. The richness of bird species was low compared with records from the surrounding region (namely, the Goulburn River National Park, Munghorn Gap Nature Reserve, and at the Ulan Coal Mines). Factors that may have contributed to the lower bird species richness include the lower diversity of habitats in the Project area and surrounds, the disturbed nature of the Project area and surrounds, and the drier than average conditions experienced in the region at the time of the autumn survey period. The assemblage of bird species recorded can be considered as typical of that found within the western slopes of NSW. Woodland birds dominated the assemblage of birds recorded, with all survey sites sampling woodland remnants disturbed to varying degrees.

Twenty-nine native mammals were recorded including the Short-beaked Echidna (*Tachyglossus aculeatus*), Yellow-footed Antechinus (*Antechinus flavipes*), Common Wombat (*Vombatus ursinus*), Squirrel Glider (*Petaurus norfolcensis*), Sugar Glider (*Petaurus breviceps*), Common Brushtail Possum (*Trichosurus vulpecula*), Common Ringtail Possum (*Pseudocheirus peregrinus*), Southern Bush Rat (*Rattus fuscipes*), four macropods (kangaroos and wallabies) and 17 bat species. The assemblage of terrestrial mammals was considered to be typical of the region. Four of the 17 bat species identified by the surveys (i.e. Large-eared Pied Bat, Little Bentwing Bat, Large Bentwing Bat and Eastern Horseshoe Bat) are known to roost in caves or their substitutes (examples of cave substitutes include mine adits and road culverts). No cave structures are known to occur in the Project disturbance area. However, there are caves located in the Munghorn Gap Nature Reserve and Goulburn River National Park, as well as rock shelters/caves in sandstone escarpments and rock shelters associated with isolated tors on slopes proximal to the Project disturbance area (including escarpment slopes in ECA-B and ECA-C).

Introduced Fauna Species

Eleven introduced species were recorded by the surveys, namely, the Common Starling (*Sturnus vulgaris*), House Mouse (*Mus musculus*), Black Rat (*Rattus rattus*), Cat (*Felis catus*), Dog (*Canis familiaris*), Red Fox (*Vulpes vulpes*), Brown Hare (*Lepus capensis*), Rabbit (*Oryctolagus cuniculus*), Goat (*Capra hircus*), Feral Pig (*Sus scrofa*) and European Cattle (*Bos taurus*).

Threatened Fauna Species

Threatened fauna species recorded in the Project area and surrounds by the Project fauna surveys are summarised in Table 3-15. Figure 3-9 illustrates the approximate location at which threatened species were recorded.

Eight Part Tests of Significance have been conducted for 36 threatened fauna species (including those listed in Table 3-15) and are presented in Appendix HE. Findings of the Eight Part Tests of Significance are discussed in Section 4.8.

Table 3-15
Threatened Fauna Species Recorded by Project Surveys

Common Name	Scientific Name	Conservation Status	
		TSC Act[1]	EPBC Act[2]
Black-chinned Honeyeater	*Melithreptus gularis gularis*	V	-
Painted Honeyeater	*Grantiella picta*	V	-
Brown Treecreeper	*Climacteris picumnus victoriae*	V	-
Diamond Firetail	*Stagonopleura guttata*	V	-
Glossy Black-cockatoo	*Calyptorhynchus lathami*	V	-
Hooded Robin	*Melanodryas cucullata cucullata*	V	-
Speckled Warbler	*Pyrrholaemus sagittatus*	V	-
Square-tailed Kite	*Lophoictinia isura*	V	-
Masked Owl	*Tyto novaehollandiae*	V	-
Turquoise Parrot	*Neophema pulchella*	V	-
Squirrel Glider	*Petaurus norfolcensis*	V	-
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	V	-
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V
Eastern Falsistrelle	*Falsistrellus tasmaniensis*	V	-
Little Bentwing Bat	*Miniopterus australis*	V	-
Large Bentwing Bat	*Miniopterus schreibersii*	V	CD
East-coast Freetail Bat	*Mormopterus norfolkensis*	V	-

Source: Appendices HB and HC
[1] NSW *Threatened Species Conservation Act, 1995.*
[2] Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*.
V Vulnerable.
CD Conservation Dependent.

The Regent Honeyeater was not recorded by the targeted surveys for this species (Mount King Ecological Surveys, 2005). However, the DEC provided information about the distribution of records for this species in the vicinity of the Project. There are records for the Regent Honeyeater along the southern end of Wilpinjong Road (Figure 3-9), as well as along Wollar Road and Cumbo Road outside of the Project disturbance area. The distribution of potential habitat for the Regent Honeyeater within the Project area and surrounds closely follows vegetation communities containing Box tree species (particularly White Box).

Migratory Species

Table 3-16 presents the migratory species listed under the EPBC Act that have been recorded in the Project area and surrounding area by various sources, including Project surveys (Mount King Ecological Surveys, 2005), Birds Australia (2004) and the Hunter Bird Observers Club (2004).

Marine Protected Species

Table 3-17 presents the marine protected species listed under the EPBC Act that have been recorded in the Project area and surrounding area by various sources, including Project surveys (Mount King Ecological Surveys, 2005), Birds Australia (2004), the Hunter Bird Observers Club (2004) and the Australian Museum (2004).

3.8 AQUATIC ECOSYSTEMS

A description of the local hydrology of the Project area and surrounds is provided in Section 3.2.2.

3.8.1 Aquatic Ecosystem Survey

An aquatic ecosystem survey and assessment was conducted of Planters, Spring, Cumbo, Wilpinjong and Wollar Creeks by Bio-Analysis (2005) in May 2004 and is presented in Appendix HD.

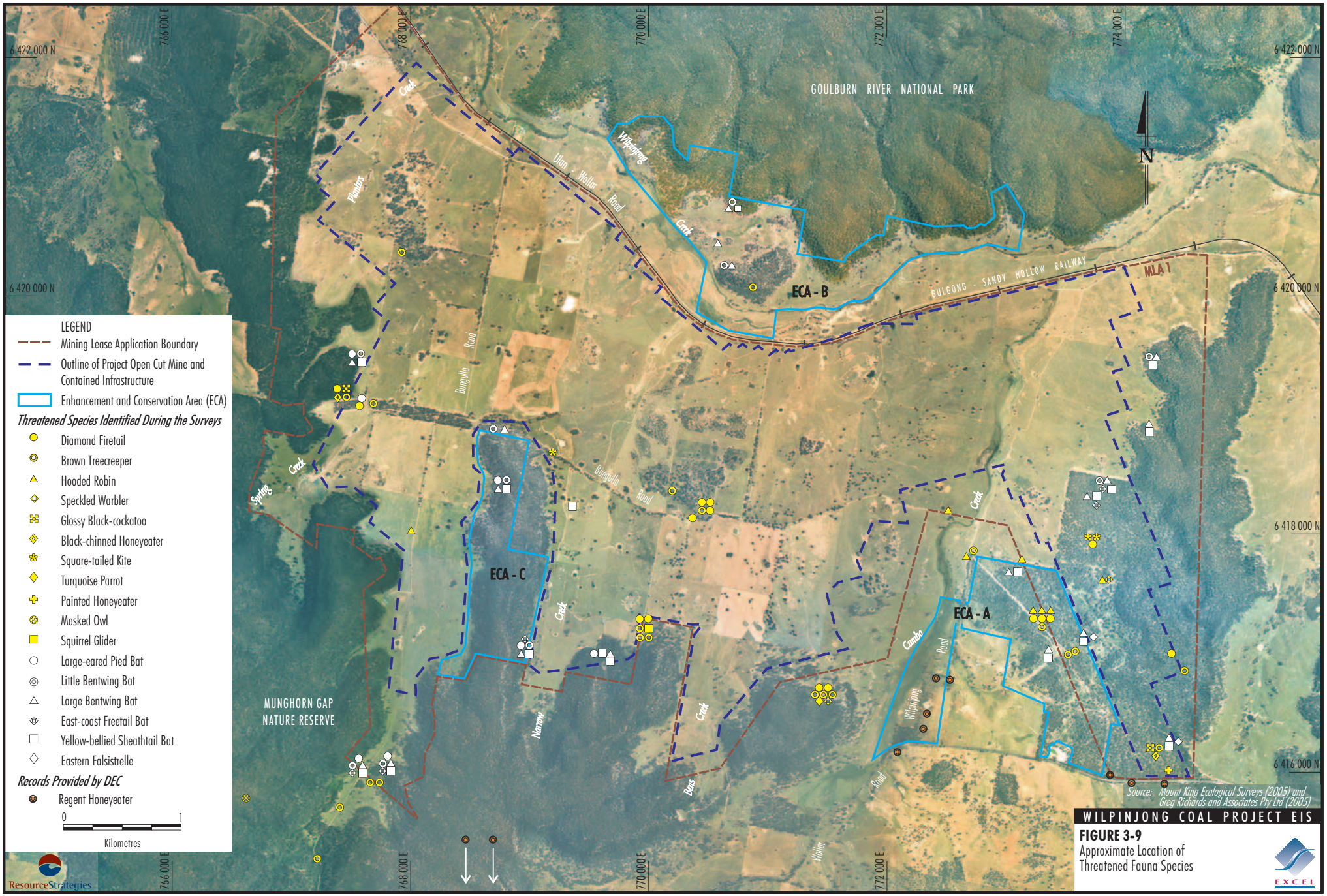

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Table 3-16
Migratory Species Recorded in the Vicinity of the Project

Common Name	Scientific Name	Project Surveys[1]	Birds Australia[2]	Hunter Bird Observers Club[3]
Latham's Snipe	*Gallinago hardwickii*		●	
White-throated Needletail	*Hirundapus caudacutus*		●	●
Rainbow Bee-eater	*Merops ornatus*	●	●	●
Regent Honeyeater	*Xanthomyza phrygia*		●	●
Satin Flycatcher	*Myiagra cyanoleuca*	●		
Rufous Fantail	*Rhipidura rufifrons*	●		
Australian Reed-warbler	*Acrocephalus australis*	●	●	●

1 Mount King Ecological Surveys (2005).
2 Database records for the search area – 149°44' to 150°00'E by 32°15' to 32°28'S (June 2004).
3 Database records for the search area – 149°44' to 150°00'E by 32°15' to 32°28'S (June 2004).

Table 3-17
Marine Protected Species Recorded in the Vicinity of the Project

Common Name	Scientific Name	Project Surveys[1]	Birds Australia[2]	Hunter Bird Observers Club[3]	Australian Museum[4]
Stubble Quail	*Coturnix pectoralis*		●	●	●
Australian Pelican	*Pelecanus conspicillatus*		●		
Little Egret	*Egretta garzetta*			●	
Nankeen Night Heron	*Nycticorax caledonicus*		●		
Australian White Ibis	*Threskiornis molucca*		●	●	
Straw-necked Ibis	*Threskiornis spinicollis*		●	●	
Whistling Kite	*Haliastur sphenurus*	●	●	●	
Swamp Harrier	*Circus approximans*	●			
Brown Goshawk	*Accipiter fasciatus*	●	●	●	●
Nankeen Kestrel	*Falco cenchroides*	●	●	●	●
Purple Swamphen	*Porphyrio porphyrio*		●		
Latham's Snipe	*Gallinago hardwickii*		●		
Black-winged Stilt	*Himantopus himantopus*		●		
Swift Parrot	*Lathamus discolor*			●	
Pallid Cuckoo	*Cuculus pallidus*	●	●	●	
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	●	●	●	●
Black-eared Cuckoo	*Chrysococcyx osculans*		●	●	
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*		●	●	
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		●	●	
Common Koel	*Eudynamys scolopacea*		●		
Channel-billed Cuckoo	*Scythrops novaehollandiae*		●	●	
Southern Boobook	*Ninox novaeseelandiae*	●	●	●	
White-throated Nightjar	*Eurostopodus mystacalis*	●	●	●	
White-throated Needletail	*Hirundapus caudacutus*		●	●	
Sacred Kingfisher	*Todiramphus sanctus*	●	●	●	
Rainbow Bee-eater	*Merops ornatus*	●	●	●	
Dollarbird	*Eurystomus orientalis*		●	●	
Flame Robin	*Petroica phoenicea*		●	●	
Satin Flycatcher	*Myiagra cyanoleuca*	●			
Australian Magpie-lark	*Grallina cyanoleuca*	●	●	●	

Table 3-17 (Continued)
Marine Protected Species Recorded in the Vicinity of the Project

Common Name	Scientific Name	Project Surveys[1]	Birds Australia[2]	Hunter Bird Observers Club[3]	Australian Museum[4]
Rufous Fantail	*Rhipidura rufifrons*	•			
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*	•	•	•	
White-bellied Cuckoo-Shrike	*Coracina papuensis*	•	•	•	
Cicadabird	*Coracina tenuirostris*		•	•	
Little Raven	*Corvus mellori*	•	•		
Richard's Pipit	*Anthus novaeseelandiae*		•	•	
Welcome Swallow	*Hirundo neoxena*	•	•	•	•
Tree Martin	*Hirundo nigrans*		•	•	
Australian Reed-Warbler	*Acrocephalus australis*	•	•	•	
Silvereye	*Zosterops lateralis*		•	•	

1 Mount King Ecological Surveys (2005).
2 Database records for the search area – 149°44' to 150°00'E by 32°15' to 32°28'S (June 2004).
3 Database records for the search area – 149°44' to 150°00'E by 32°15' to 32°28'S (June 2004).
4 Database records for the search area – 149°44' to 150°00'E by 32°15' to 32°28'S (July 2004).

The survey assessed the characteristics and condition of habitats available to aquatic biota and collected data on the assemblages of aquatic macrophytes, macroinvertebrates and fish. A summary of the findings is presented below.

Aquatic Habitats

The banks of the creeks in the Project area and surrounds have been subject to erosion and grazing by cattle and invasion by weeds such as Blackberry (*Rubus fruticosus*) and a Rush (*Juncus acutus*). Generally, the riparian vegetation is sparse and discontinuous. Where riparian vegetation does occur, mainly along part of Wilpinjong Creek, it exists as a range of species including *Imperata cylindrica*, *Eragrostis australasica*, *Cynodon dactylon*, *Bothriochloa* sp., *Lomandra* sp., *Austrostipa* spp., *Angophora* sp., *E. blakelyi*, *E. moluccana* and *Casuarina cunninghamiana*. The riparian vegetation along Wollar Creek has been partially restored by local Landcare groups (DIPNR, 2003).

At the time of the Project aquatic surveys, the creeks had very little permanent water. Planters and Spring Creeks were characterised by a series of small farm dams. Wilpinjong Creek was predominantly dry at the time of the survey with scattered pools, and intermittent running water (principally from groundwater soaks and springs). The upper parts of Cumbo Creek drain through extensive, low-lying marshes.

The aquatic habitat within the Project area and surrounds was given one of three "health" classifications based on the quality of water, sedimentation and erosion, exotic species and diversity and abundance of macrophytes, macroinvertebrates and fish. The classifications were *good*, *moderate* or *poor*. In general, the aquatic habitats in the Project disturbance area were found to be in poor condition, which reflected the degraded nature of their immediate catchments (Appendix HD). Further information on habitat values of the streams is provided in Appendix HD.

Macroinvertebrates

A total of 1,065 macroinvertebrates from 30 macroinvertebrate taxa were collected from the 10 sites sampled (sites PL1, SP1, WP1 to WP4, CU1, CU2, WO1 and WO2 shown on Figure 3-4). Greater numbers of macroinvertebrate taxa were found in Wilpinjong Creek sites WP2 and WP3, Cumbo Creek (sites CU1 and CU2) and Wollar Creek (sites WO1 and WO2), with a lower diversity of taxa found at more degraded sites that were encountered at Spring Creek, Planters Creek and Wilpinjong Creek sites WP1 and WP4 (Figure 3-4). The taxon classification and abundance of macroinvertebrates collected from each site is presented in Appendix HD.

The most abundant taxa collected during the survey were Coleoptera beetles from the family Hydrophilidae (272 individuals). The next most abundant taxa were the freshwater shrimps from the family Atyidae (142 individuals) followed by gastropod snails from the family Physidae (140 individuals) (Appendix HD). Beetles (Hyrdophilidae), snails (Physidae), fly larvae (Chironomidae) and freshwater shrimps (Atyidae) were common at most sites. All of these taxa are highly tolerant to various forms of water pollution and their dominance is indicative of the poor quality of water in the Project area and surrounds.

A SIGNAL biotic index was utilised, with a range of other biological indices, to assess the ecological condition of the sites sampled. Calculation of the SIGNAL biotic index (Chessman, 1995) indicated that the water quality of these creeks falls within the range of severe pollution, an assessment supported by the historical landuse and stream characteristics (Appendix HD). Chessman *et al*. (1997) has also described macroinvertebrate assemblages within a range of creek systems in the Hunter Region, including Wollar Creek, as having poor SIGNAL indices due to the effects of salinity, reduced riparian and in-stream macrophytes and direct impacts associated with grazing cattle.

Fish Fauna Assemblage

The richness and abundance of assemblages of fish within the Project area and surrounds was quite poor with only three native species recorded. The composition and abundance of fish fauna species collected from each site is presented in Appendix HD. Three native fish species were recorded during the survey, *viz.* Long Finned Eel (*Anguila reinhardtii*) (53 individuals), Striped Gudgeon (*Gobiomorphus australis*) (4 individuals), and Australian Smelt (*Retropinna semoni*) (2 individuals). The latter two species were only found in Wilpinjong Creek, whereas the Long Finned Eel was also recorded in Spring Creek and Planters Creek. Native fish species represented less than 6% of the total abundance of fish recorded, with the remainder being the introduced Mosquito Fish (*Gambusia holbrooki*) (1,037 individuals) and Gold Fish (*Carassius auratus*) (21 individuals).

Threatened Aquatic Biota

No threatened aquatic biota listed in the schedules of the TSC Act, *Fisheries Management Act, 1994* or EPBC Act are considered to possibly occur within the Project area or surrounds given the distribution of the listed species, populations or ecological communities and the degraded nature of the habitats available to aquatic biota.

3.9 ABORIGINAL HERITAGE

3.9.1 Background

Aboriginal History

The Project falls within an area which was, at the time of European settlement, inhabited by members of the Wiradjuri linguistic tribal and group. The Wiradjuri is one of the largest language groups within NSW (Tindale, 2000; Ah See, 2003).

The Wiradjuri area extended across Mudgee, Bathurst, Dubbo, Parkes, West Wyalong, Forbes, Orange, Junee, Cowra, Young, Holbrook, Wagga Wagga, Narrandera, Griffith, and Mossgiel (Tindale, 1974) and incorporated the general physiographic regions of the central tablelands in the east, the riverine plains in the west and the transitional western slopes zone in between (White, 1986). The Project is located in the central tablelands physiographic region (Appendix F).

Broad range and regional studies undertaken in the Wiradjuri region of relevance to the Project include Pearson (1981) and Haglund (1985). Further detail from these studies is provided in Appendix F and summarised below.

Haglund (1985) conducted a prehistoric heritage study in the former Mudgee LGA and noted that in the Mudgee area, prior to European settlement, small groups of approximately twenty Aborigines acted independently, but engaged in friendly contact. These groups moved at short intervals, often over a short distance to obtain and use different resources.

Due to a drought on the Bathurst Plains, European settlers arrived in the Mudgee area during the 1820s, despite opposition from the local Aborigines. The gold rush of the 1850s resulted in greater exploitation of the area by settlers (Haglund, 1985).

Early explorers and settlers noted considerable variation in the numbers of Aborigines that would gather for food procurement activities during different seasons of the year. This seasonality was most obvious in the case of gatherings along major rivers, and it has been suggested that during dry periods the water holes remaining in the major rivers would become focal points for the usually scattered groups (*ibid*.).

Pearson (1981) conducted an investigation of Aboriginal and early European settlement patterns within the Upper Macquarie River region of NSW. Pearson excavated three rock shelter sites which provided a regional record of Aboriginal occupation dating back to around 7,000 years before present.

Relevant Previous Archaeological Surveys

Numerous archaeological assessments have been undertaken over the past thirty years within the general areas around Wilpinjong, including Ulan, Gulgong and Mudgee. The majority of these studies relate to the Ulan Coal Mines and include site surveys, salvage excavations, site-specific investigations and rock art conservation and monitoring programmes (Lambert, 1999). Studies have also been conducted within the local area for proposed transmission lines (Cubis, 1981), hard rock and sandstone quarries (Brayshaw, 1987; Smith, 1987; Witter, 1988), a sewerage treatment plant (Griffiths, 1994), vineyards (Maynard, 1999) and roadworks (Benton, 2004). Most of these studies were carried out primarily to identify sites and provide management advice.

Previous research and investigation of the Ulan Coal Mines was summarised by Kuskie (2000). The majority of these studies were undertaken by Haglund (1980; 1981a; 1981b; 1992; 1996a; 1996b; 1996c; 1999a and 1999b). Throughout the surveys and salvage excavations in the Ulan Coal Mines area, Haglund documented the presence of isolated finds, open artefact scatters, shelters with archaeological deposits, rock shelters with art, rock shelters with archaeological deposit and art, grinding grooves and scarred trees, in varying numbers and densities. Haglund further provided a synthesis of historical and ethnographic information for the region. The surveyed areas were generally highly disturbed due to vegetation clearance, erosion and agricultural activities.

Further surveys and research for the Ulan Coal Mines is provided in Kuskie (2000; 2002) and Kuskie and Webster (2001). These studies included examination of grinding groove sites, survey of a basalt quarry and survey of lands above longwall panels 18 to 22. Sites identified or examined included grinding grooves, open artefact scatters, a rock shelter with archaeological deposit and potential archaeological deposits.

Prior to the Project survey, over 180 Aboriginal sites were recorded on the DEC Aboriginal Heritage Information Management System (AHIMS) in a 40 km x 40 km search area around the Project area. Site types listed on the AHIMS register include rock shelters with art and/or deposit and/or grinding grooves, artefact scatters, grinding grooves, scarred trees, a bora ceremonial/carved tree site, a quarry, a waterhole/well and isolated finds. None of these registered sites are located in the Project disturbance area (Appendix F).

3.9.2 Cultural Heritage Assessment

Assessment Programme

An Aboriginal cultural heritage survey and assessment has been carried out over the Project disturbance area as well as the ECAs and some areas of adjoining WCPL-owned land. The assessment was conducted from mid 2004 to second quarter of 2005 and is presented in Appendix F. The assessment included on-going input from the Aboriginal community on cultural heritage values and their participation in the Project site surveys.

Assistance with site surveys and cultural heritage advice was provided by three main groups in the local Aboriginal community:

- Murong Gialinga Aboriginal and Torres Strait Islander Corporation (MGATSIC);
- Mudgee Local Aboriginal Land Council (MLALC); and
- Warrabinga Native Title Claimants Aboriginal Corporation (WBNTCAC).

Table 3-18 summarises the stages of the consultation/survey programme.

Table 3-18
Summary of the Project Aboriginal Heritage Consultation/Survey Programme

Date	Consultation/Survey Conducted
June/July 2004	**Identification** of local Aboriginal community groups with an interest and expertise in cultural heritage matters with the assistance of DEC, MWRC and in consultation with local groups.
5 August 2004	**Initial Meeting** with local groups to discuss the survey and cultural heritage assessment strategy, any cultural heritage restraints or requirements, study timing and participant parties.
10-15 August 2004	**Cultural Heritage Survey Stage 1** – survey of approximately half of the Project disturbance area and on-going consultation with and input from the Aboriginal survey participants.
19-25 August 2004	**Cultural Heritage Survey Stage 2** – survey of the second half of the Project disturbance area and on-going consultation with and input from the Aboriginal survey participants.
August 2004	**Stage 1 Report** issued to the Aboriginal groups describing findings of the first survey stage.
September 2004	**Stage 2 Report** issued to the Aboriginal groups describing findings of the second survey stage and seeking feedback from the community.
October-December 2004	**Written Feedback and Advice** received from Aboriginal groups following their consideration of the first two reports and discussion within the community.
11-14 January 2005	**Cultural Heritage Survey Stage 3** – survey of areas adjoining the Project disturbance area including ECA areas and on-going consultation with and input from the Aboriginal survey participants.
14/15 January 2005	**Community/Elder Site Visits** – site tours, discussion on cultural heritage values and management workshops held at the Project site.
January 2005	**Report** – issued to groups providing survey results and management measures from the on-site workshops and previous consultation for review by groups.
February-April 2005	**Further Consultation** – Meetings and consultation with Aboriginal groups at their request, including attendance at publicly advertised meetings to discuss management measures and future Project involvement.
	Written Feedback and Advice – additional written feedback received from groups, including endorsement of the survey, assessment and consultation methodology by the MLALC and WBNTCAC.

As shown in Table 3-18, consultation with the Aboriginal community was extensive.

Survey of the Project area was conducted in August 2004 and January 2005. During these surveys, discussions were held and input from the Aboriginal community was provided on cultural heritage issues and survey methodology as the surveys progressed. Detail on survey coverage and methodology is provided in Appendix F.

Archaeological Survey Findings

A total of 235 Aboriginal cultural heritage sites (including debated origin sites) were identified during the surveys, including:

- isolated finds and artefact scatters in open contexts;
- rock shelters with surface artefacts (may also contain potential or confirmed archaeological deposits);
- rock shelters with potential or confirmed archaeological deposits;
- rock shelters with rock art;
- possible and probable Aboriginal scar trees;
- potential archaeological deposits in an open context; and
- reported places of Aboriginal cultural significance (reported by some Aboriginal people but disputed by others).

In addition, three non-Aboriginal surveyors scarred trees were recorded.

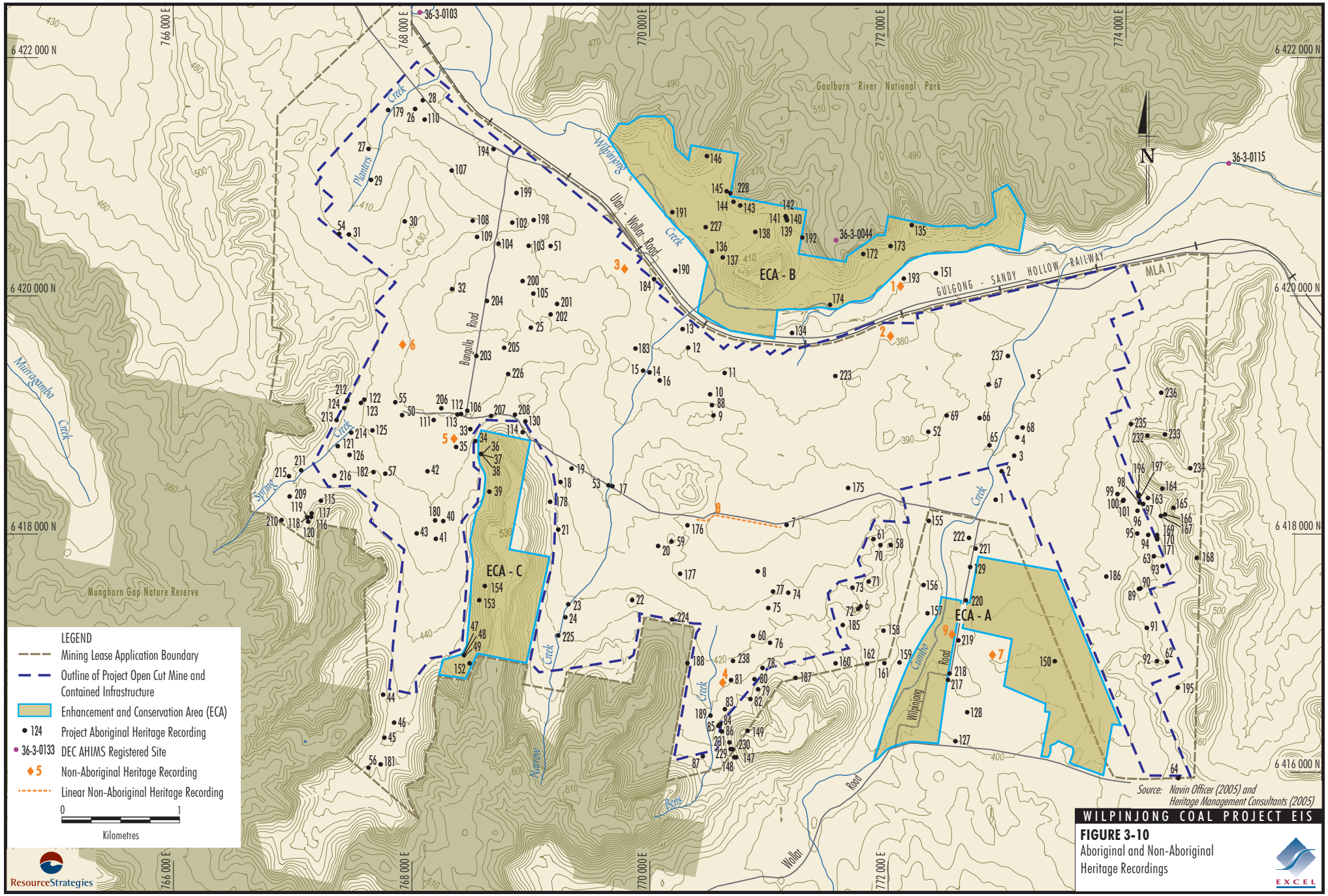
The Aboriginal cultural heritage sites are described in detail in Appendix F and summarised in Table 3-19. The locations of sites are illustrated on Figure 3-10.

The majority of the Project disturbance area was identified as having limited sub-surface archaeological potential. However, some areas were considered to have more archaeological potential for *in-situ* or stratified deposits that may provide chronologically useful information about Aboriginal use of an area over time.

Table 3-19
Aboriginal Cultural Heritage Survey Results

Site Number (Figure 3-10)	Summary Description
134, 174	open artefact scatters with 500+ estimated surface artefacts
136, 216, 227	open artefact scatter with up to 500 estimated surface artefacts
1, 3, 33	open artefact scatters with up to 100 estimated surface artefacts
12, 57, 81, 87,123, 126, 158-59, 162, 198, 208, 213, 214, 220, 224	open artefact scatters with up to 50 estimated surface artefacts
2, 11, 29, 128, 138-39, 151, 156-57, 176, 179, 184, 190, 209, 219	open artefact scatters with up to 20 estimated surface artefacts
4, 13, 15, 22, 25-6, 31, 35, 42, 66-7, 78, 83, 105-06, 108, 121, 125, 189, 202, 211, 217, 226	open artefact scatters with up to 5 estimated surface artefacts
34, 86, 127, 185, 188, 191, 193, 195, 222	open artefact scatters with up to 5 estimated surface artefacts
88	open artefact scatter and procurement site
9, 92	potential archaeological deposit (open context)
6, 53, 55, 69, 89, 91, 93-97, 100-01, 111-12, 114, 122, 129-130, 149, 160, 196-97, 207	possible Aboriginal scarred tree
64, 75, 90, 98, 99, 150, 161, 163, 166-67, 169-71, 234, 236	probable Aboriginal scarred tree
7, 77	probable surveyors scarred tree (debated origin)
52, 113, 124	scarred tree (debated origin)
63	indeterminate tree feature
85	rock shelter with potential archaeological deposit
72, 152, 153	rock shelter with art
36-9, 45, 48-9, 115-16, 118-20, 178	rock shelter with surface artefacts and confirmed or potential archaeological deposit
44, 47, 82, 117, 229-31	rock shelter with potential archaeological deposit
58, 59	reported place of cultural significance
61, 62, 79	reported 'spring' or waterhole
5, 8, 10, 14, 16-21, 23-4, 25, 27-8, 30, 32, 40-1, 43, 46, 50-1, 54, 56, 65, 70-71, 73, 74, 76, 80, 84, 102-04, 107, 109-10, 135, 155, 175, 177, 180-83, 186-87, 199-201, 203-06, 210, 215, 218, 221, 223, 225, 235, 237-38	isolated find
60, 212	isolated find (debated origin)
194	probable modern scatter of crushed rock (debated origin)

Source: after Appendix F


6 422 000 N
6 420 000 N
6 418 000 N
6 416 000 N
766 000 E
768 000 E
770 000 E
772 000 E
774 000 E
36-3-0103
36-3-0115
36-3-0044
Goulburn River National Park
Munghorn Gap Nature Reserve
ECA - A
ECA - B
ECA - C
MLA 1
GULGONG - SANDY HOLLOW RAILWAY
Ulan - Wollar Road
Bungulla Road
Wilpinjong Creek
Planers Creek
Munghumba Creek
Spring Creek
Cumbo Creek
Narrow Creek
Bens Creek
Wollar Road
N
LEGEND
Mining Lease Application Boundary
Outline of Project Open Cut Mine and Contained Infrastructure
Enhancement and Conservation Area (ECA)
124 Project Aboriginal Heritage Recording
36-3-0133 DEC AHIMS Registered Site
5 Non-Aboriginal Heritage Recording
Linear Non-Aboriginal Heritage Recording
0
1
Kilometres
ResourceStrategies
Source: Navin Officer (2005) and Heritage Management Consultants (2005)
WILPINJONG COAL PROJECT EIS
FIGURE 3-10
Aboriginal and Non-Aboriginal Heritage Recordings
EXCEL

These include (Appendix F):

- alluvium associated with substantial drainage lines (e.g. Wilpinjong Creek to the north of the Project and the Cumbo Creek riparian corridor in the Project disturbance area and in ECA-A);
- alluvial terraces, colluvium and alluvial fan deposits (located both within and outside the Project disturbance area) in the heads of narrow valleys;
- three localised sand and gravel deposits associated with *in-situ* weathering of sandstone and conglomerate; and
- rock shelters located on escarpment and debris slopes, and in some places extending onto the edges of the valley floor.

The management of the potential archaeological resources in these areas is described in Section 4.10.4.

Cultural Heritage Values

In addition to the archaeological evidence of previous Aboriginal habitation of the Project area, cultural heritage values of the Project area were provided by contemporary Aboriginal people and incorporated in the assessment. Some Aboriginal people advised that the relocation of the majority of Aboriginal people from the Mudgee area away from their traditional lands in the early 1800s had resulted in significant loss of cultural knowledge and connection to the land, including lands in the Project area. However, reference was made to (Appendix F):

- custodial obligations to the land through descent from original tribal and clan occupants;
- the valley's traditional function as an access route and corridor;
- the patterns of traditional occupation in the open valley, in contrast to those on the escarpment and plateau;
- the occurrence of massacres in unspecified locations across the broader Mudgee district during the early period of contact with European settlers;
- oral tradition that a bora ground was situated somewhere in the greater Ulan-Wilpinjong Valley; and
- the association of the local district with the story of the Governor brothers.

Members from each of the three local Aboriginal community organisations also referred variously to their belief that all evidence of the past occupation of the Project area and surrounds by Aboriginal people was of some cultural value (Appendix F). Both the MLALC and the WBNTCAC have reinforced this with statements regarding their obligation to conserve this evidence.

Members of all three Aboriginal groups were in agreement that three rock art sites that were identified during the Project were of high cultural value, with the larger rock art site (72) generally having more significance (Figure 3-10). All rock art sites identified are located outside the Project disturbance area.

Two sites were also identified during the surveys on the basis of their cultural values to some Aboriginal people in the MLALC and MGATSIC groups. These two sites were topographic features that were identified as men's (59) and women's (58) sites (Figure 3-10) by some of the Aboriginal people who participated in site surveys and visits. This was disputed by other Aboriginal participants. A brief description of these opinions is provided below:

- Site 58 - Following the initial identification of a prominent ridgeline knoll as a women's site by two younger Aboriginal survey participants, some older women, of both the MLALC and MGATSIC developed a strong belief that the location was correctly identified and that its significance extended southward along the ridgeline to the large rock art site. Other Aboriginal people from these same organisations were less committal in expressing their views and some subsequently expressed reservations about the validity of the identification of the site. Members of the WBNTCAC who visited the same area, including older women, felt the knoll and the ridgeline did not have any particular or special cultural significance and contested its identification as such. They advised their belief that such identification should be the jurisdiction of descendants of the local Wiradjuri people, and in particular, subject to the views of older women descendants.

- Site 59 - Following the identification of Site 58, Site 59 was identified by a young male MGATSIC survey participant as a men's site (consisting of a low knoll). Following subsequent inspection of the site, other members of the MGATSIC/MLALC noted that the location provided a commanding view of the surrounding valley and that it would have been used in hunting, scouting for game and keeping watch over the area. Members of the WBNTCAC did not consider this topographic feature to have any particular or special cultural significance and contested its identification as such.

Site 59 is located within while Site 58 is located outside of the Project disturbance area (Figure 3-10).

The NPWS AHIMS database indicates a bora ground is located in the Goulburn River National Park to the north of the Project (Site 36-3-0044 – Figure 3-10).

3.10 NON-ABORIGINAL HERITAGE

The following section summarises the results of the Non-Aboriginal Heritage Impact Assessment presented in Appendix G.

3.10.1 Background

William Lawson explored the upper Goulburn River in November 1822. In the late 1820s or 1830s William Lee occupied land at Bylong to the south-east of Wollar, and by the 1840s, graziers had pushed into the Wollar area from both the west and east. Settlement of the valley was facilitated by small-holdings taken up under the *Crown Lands Alienation Act, 1861*. This legislation and its subsequent amendments opened up significant areas of land in the colony for free selection before survey, and resulted in the settlement of large numbers of farmers and pastoralists who would otherwise have been unable to purchase rural property (Appendix G).

A large number of purchases of small blocks were made in the Project area in the 1870s to 1890s, the most notable residences from that period being *Keylah* (built 1896) and Loy's cottage (built circa 1894). Several more substantial buildings were constructed in the early twentieth centuries, particularly by the Marskell family, as they became established pastoralists.

The Marskell family built stone buildings at *Cumbo Creek* (built 1912) and *Keylah* (built 1922) were the most substantial buildings constructed in the Wilpinjong Valley (Appendix G).

The initial landuse in the Wilpinjong Valley was the grazing of cattle, with sheep being introduced as settlement developed. Dairying income was significant for the local small farmers later in the nineteenth century (Appendix G).

A provisional school operated at Wilpinjong from January 1881, however the number of local children fell below 20 in 1893 and the school was downgraded. It became a public school in 1907, and remained so until it became a subsidised school which operated until about 1931. Wollar school also operated as a provisional school from 1873 to 1881, then as a public school to the present day. When the subsidised school at Wilpinjong closed about 1931, the building was purchased by William Marskell, who used the material to build a shearing shed.

The early transport routes into the Wollar area came both from the upper Hunter and Merriwa directions. A track to Ulan (through the Project area) led on to Mudgee, and another ran via Barrigan, Dry Creek and Bara to Mudgee. A road also led to Rylstone via Bylong and Dabee. Later in the century, a track was constructed in the location of the current road through Munghorn Gap (Wollar Road).

3.10.2 Site Survey

The Project and surrounds was surveyed on foot and by vehicle, following discussions with local residents and examination of early maps. Some 41 structures and sites were identified, of which 21 were of some historical interest. Nine were considered of local heritage significance (Table 3-20 and Figure 3-10). No sites of higher heritage significance (regional or state) were identified.

Two of the local heritage sites identified during the survey (Site 1 - *Cumbo Creek* and Site 3 - *Keylah*) are to be demolished in accordance with a pre-existing development approval from the MWRC. The buildings have been photographically recorded in accordance with Heritage Office guidelines and materials from the buildings will be salvaged by local landowners for re-use. The detailed documentation of the other seven local heritage sites listed in Table 3-20 is provided in Appendix G.

Table 3-20
Sites of Local Heritage Significance Identified in the Project Survey

Site No.	Place Name	History and Description
1.	*Cumbo Creek*	Built 1912, stone cottage with later additions, now in poor condition.
2.	*Hillside*	First building possibly built 1866, and added to over time. Key early slab buildings intact, but in poor condition.
3.	*Keylah*	Slab building built 1896, stone section 1922. Intact and in good condition.
4.	*Warrawong*	Slab cottage, originally built near the junction of Wilpinjong and Cumbo Creek, moved to present site 1912.
5.	Atcheson's cottage, Wyangle Portion 19 Wilpinjong	Concrete structure, probably built 1930s now in poor condition.
6.	Loy's cottage	Slab cottage, built circa 1894, and possibly used for a time as a school room. Now in ruin.
7.	*Pine Park* woolshed	Slab woolshed built in 1930s. In good condition.
8.	Post and rail fence, Portion 106 Cumbo	Long section of post and rail fence, unknown date and in poor condition.
9.	Wilpinjong Road stone embankment, Portion 26 Cumbo	43 m long stone road embankment, possibly from 19th century. Intact.

Source: Appendix G

3.11 TRANSPORT

The existing road system and traffic flows in the vicinity of the Project are described in detail in Appendix K and are summarised below.

3.11.1 Road Hierarchy

State Highways

The Mudgee region is served principally by the Castlereagh Highway (State Highway 18) which has a general north-south alignment and extends from Lithgow in the south, to the Golden Highway (State Road 27) to the north (Figures 1-1 and 3-11). The Castlereagh Highway passes through Mudgee and Gulgong. The Golden Highway has a general east-west alignment and extends from the Hunter Valley (Singleton) to Dubbo to the west. The Golden Highway is located approximately 25 km north of the Project area (Figure 3-11).

The Castlereagh Highway and the Golden Highway are State Roads and are under the management and control of the RTA. Other roads within the Project area are under the care and control of local councils (predominantly the MWRC) (Appendix K).

Main Roads

Wollar Road is located to the south of the Project and forms part of Main Road 208, which extends from the Castlereagh Highway at Mudgee to the Golden Highway at Sandy Hollow (Figure 3-11).

At Bylong, east of the Project, Main Road 208 is intersected by Main Road 215 which extends to the south towards Ilford.

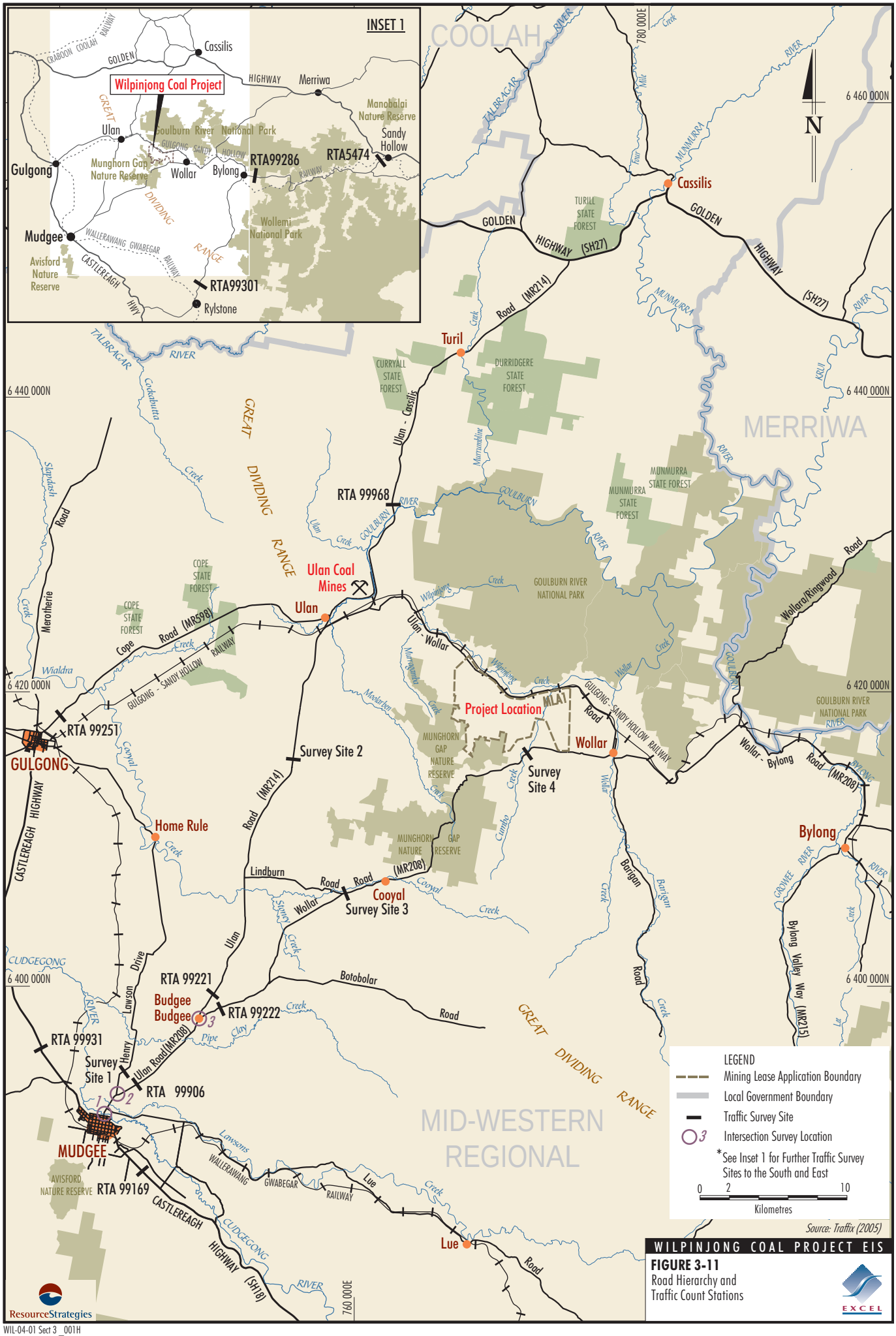
To the west of the Project, Main Road 214 (Ulan-Cassilis Road) runs generally north-south and extends between Main Road 208 (Wollar Road) at Budgee Budgee and the Golden Highway to the west of the township of Cassilis via Ulan (Figure 3-11). Main Road 598 (Cope Road) links Ulan to Gulgong.

These various main roads are regional roads which are under the care and control of the various local councils, with funding assistance provided by the RTA.

A local (unsealed) route (Wollara/Ringwood Road) is also available between Wollar Road (Main Road 208) and the Golden Highway near the township of Merriwa (Figure 3-11).

Local Roads

In the Project area local roads provide access for landowners and local traffic. The main local road of relevance to the Project is the Ulan-Wollar Road which is located between the northern boundary of the Project and Wilpinjong Creek (Figure 3-11) and crosses the Gulgong-Sandy Hollow railway twice in the Project area. Ulan-Wollar Road continues to the east of the Project before swinging south to meet Wollar Road (Main Road 208) at Wollar (Figure 3-11). To the west of the Project Ulan-Wollar Road continues to Ulan (Figure 3-11).



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Minor local roads located in the Project area include Wilpinjong Road and Bungulla Road which are within the Project disturbance area (Figure 3-1). These minor roads are generally only used by local landowners to access their properties and would be closed as a component of the Project (Sections 2.10.2 and 4.12).

3.11.2 Existing Road and Traffic Conditions

The following sub-sections summarise existing road and traffic flow conditions in the Project area and surrounds.

Existing Road Conditions

Main Road 208 (Wollar Road) - Budgee Budgee to Wollar

Wollar Road (Main Road 208) between Budgee Budgee and Wollar (Figure 3-11) is a two lane rural road which has a bitumen seal of variable width ranging from 6 to 7.5 m, with unsealed road shoulders of average width about 2 m (Appendix K). There are two sections (totalling approximately 2.3 km) which are less than 6 m in width (*ibid*.). Wollar Road is constructed on a generally level grade with some sections in rolling terrain and with extensive overtaking opportunities (*ibid.*).

Main Road 208/Main Road 214 (Henry Lawson Drive, Ulan Road, Ulan-Cassilis Road)

Henry Lawson Drive, Ulan Road and Ulan-Cassilis Road (Main Road 208/214) north of Mudgee (Figure 3-11) is constructed as a two lane rural road which has a bitumen seal of variable width ranging from 7 to 7.5 m, with unsealed road shoulders of width ranging from 2 to 3 m (Appendix K). It is constructed on a generally level grade with extensive overtaking opportunities (*ibid*.)

Main Road 598 (Cope Road) - East of Gulgong

Cope Road east of Gulgong (Main Road 598) (Figure 3-11) is a two lane rural road which has a bitumen seal of variable width ranging from 6 to 7.5 m, with unsealed road shoulders of average width 2 m (Appendix K). It is constructed on a generally level grade with some sections within rolling terrain and with extensive overtaking opportunities (*ibid*).

Main Road 215 (Bylong Valley Way/Bylong Road) – South of Bylong

Bylong Valley Way/Bylong Road (Main Road 215) links Bylong and Rylstone (Figures 3-11 and K-1) and is a two lane rural road which has a bitumen seal of variable width ranging from 6 to 7.5 m, with unsealed road shoulders of average width 2 m (Appendix K). It is constructed on a generally level grade with some sections within rolling terrain and with extensive overtaking opportunities (*ibid.*).

Wollara/Ringwood Road

Wollara/Ringwood Road is an unsealed local rural road which provides access between Wollar Road and the Golden Highway near Merriwa (Figure 3-11). It is constructed with a carriageway width that varies between 5 m and 6 m and is in satisfactory condition, with a generally level grade (Appendix K).

Ulan-Wollar Road

The Ulan-Wollar Road is a local rural road which is unsealed for the majority of its length and provides direct access between Ulan and Wollar, via the northern part of the Project site (Figure 3-11). The road is sealed on the approaches to Ulan and Wollar and it is constructed with a carriageway width that is generally 6 m wide with additional shoulders and is in good condition, within generally gently rolling terrain (Appendix K).

Existing Traffic Volumes

Table 3-21 summarises existing traffic flows on the above listed roads. The locations of traffic flow counters are shown on Figure 3-11.

3.11.3 Traffic Safety

A review of accident data has been undertaken for the above roads of interest. The data does not indicate any safety issues associated with the local road network that are of particular relevance to the Project (Appendix K). As would be expected, crash rates are higher for Ulan Road (Main Road 208/ 214) which carries higher traffic volumes (*ibid*.).

Table 3-21
Annual Average Daily Traffic Flows[1]

Road	Station Number	Road Name/Location	Year			
			Other	2001	2002	2004
Main Road 208	RTA 05474	West of Golden Highway	290 (1992)	-	-	-
	RTA 99286	East of Bylong	141 (1999)	-	-	-
	Survey Site 4	Wollar Road - West of Wollar (near Wilpinjong Road)	-	-	-	166
	Survey Site 3	Wollar Road - West of Cooyal	-	-	-	352
	RTA 99222	Wollar Road - East of Ulan Road	-	743	613	-
	RTA 99906	Ulan Road - North of Mudgee	2,969 (1999)	-	3,482	-
	RTA 92268	Ulan-Cassilis Road - North of Ulan	-	597	-	-
Main Road 214	Survey Site 2	Ulan Road - South of Ulan	-	-	-	790
	RTA 99221	Ulan Road - North of Wollar Road/Budgee Budgee	1,490 (1999)	-	1,321	-
Main Road 598	RTA 99510	Cope Road - East of Gulgong Centre	1,119 (1999)	-	-	-
Henry Lawson Drive	Survey Site 1	North of Main Road 208	-	-	-	953
Main Road 215	RTA 99301	Bylong Road - North of Rylstone	359 (1999)	-	-	-
Wollara/Ringwood Road	-	North of Wollar Road	-	-	-	100*
Ulan-Wollar Road	-	East of Main Road 214	-	-	-	175*

Source: Appendix K

[1] Average Annual Daily Traffic is two way traffic (flow in both directions) - seven day count.

* Traffic Flow Estimate.

3.11.4 Rail System and Capacity

The Gulgong-Sandy Hollow railway located on the northern boundary of MLA 1 carries a range of existing train movements associated with the shipping of grain, product coal from Ulan Coal Mines and movements associated with mines in Cobar and at Northparkes.

Existing and consented rail movements on the section of line between Ulan and Bylong are 16 passbys per day (Appendix D).

East of Bylong, the rail network extends to Sandy Hollow where it joins the Merriwa railway which joins the Main Northern railway at Muswellbrook. South of Muswellbrook the Main Northern railway extends to the Port of Newcastle. The Bayswater and Liddell Power Stations (which are to utilise a large proportion of Project product coal) are located south of Muswellbrook, adjacent to the Main Northern railway.

Existing train movements on the Main Northern railway between Muswellbrook and the Bayswater/Liddell rail unloader are significantly higher than the existing number of movements on the Gulgong-Sandy Hollow railway. It is understood that passenger and freight movements on this section of line equate to some 46 passbys per day (Appendix D). In comparison, there are some 16 existing and consented passbys per day on the Gulgong-Sandy Hollow railway (*ibid.*).

The *Hunter Valley Capacity Improvement Strategy* (ARTC, 2005) outlines ARTC's five year plan for the Hunter Valley rail corridor. The strategy ARTC is adopting is to address existing capacity bottlenecks in the short-term and to then ensure that Hunter Valley capacity is delivered ahead of likely demand (ARTC, 2005). The strategy has identified a number of improvements to the rail line between Ulan and Muswellbrook that would be undertaken to improve rail capacity on this route to meet future demands.

3.12 COMMUNITY INFRASTRUCTURE

A Community Infrastructure Assessment was prepared by Martin and Associates Pty Ltd (2005) and is presented in Appendix J. A summary of the study in relation to background demographics, employment and community infrastructure is provided below.

As described in Section 1, the MWRLGA incorporates parts of the former LGAs of Merriwa and Rylstone and the entire former LGA of Mudgee. These former LGAs correlate to the Statistical Local Areas (SLAs) historically used to compile Australian Bureau of Statistics census information. For the purposes of the community infrastructure assessment, these three SLAs were used as the local region that comprised the community infrastructure assessment primary study area.

Given the likely travelling times from the Project and the range of community services available, it is anticipated that Mudgee would be the main area where any in-coming work force associated with the Project would choose to reside (Appendix J). The following discussion therefore focuses on Mudgee and the MWRLGA and relevant services, however relevant census data for all three SLAs in the local region is presented where applicable.

3.12.1 Population Profile

Table 3-22 compares population growth experienced in the three SLAs in the local region and provides estimates of the population growth for the period to 2021 on the basis of historical growth rates.

As shown in Table 3-22 the total population of the local region increased from 17,827 in 1976 to 23,695 in 2001. Using the trends recorded over the past six Census periods, it is predicted that natural population growth in the local region would result in a population of 29,060 by 2021, with the majority of this growth occurring in the Mudgee SLA (Table 3-22 and Appendix J).

Demographics

Table 3-23 provides a summary of the age distribution of the population in the SLAs and the whole local region.

Table 3-23 indicates that the Mudgee SLA has a slightly younger population with a higher percentage of the population under the age of 15 and less people over the age of 45 that the Merriwa and Rylstone SLAs. Rylstone has a lower percentage of people in the 15 to 24 year age bracket than the other two SLAs.

Household Indicators

Table 3-24 provides an indicative comparison of the income and household indicators between the three SLAs that make up the local region and the State of NSW.

Table 3-24 indicates that the Mudgee SLA has a considerably younger population and a slightly larger household size than both Rylstone and Merriwa SLAs. Mudgee also has higher median personal and family income, and residents in Mudgee are paying more for mortgage payments than residents in the other two SLAs. These higher mortgage repayments reflect higher housing and land values in Mudgee.

Comparison of the local SLAs to the State of NSW indicates that the Mudgee SLA more closely approximates the average NSW indicators, while Rylstone and Merriwa have significantly higher median age, lower income, lower house repayments and smaller household sizes.

3.12.2 Employment Profile

A summary of the employment structure of the three SLAs by industry type in the local region is presented in Table 3-25.

Table 3-25 indicates employment in the local region increased from 8,628 to 9,224 between 1996 and 2001, however, there was little change in the relative share of industries providing employment. One employment industry which increased significantly (particularly in the Mudgee SLA) was Agriculture, Forestry and Fishing. This shift is possibly indicative of an increase in smaller rural properties using more intensive cropping methods such as wine and olive production to support commercial and lifestyle objectives (Appendix J). It is noteworthy that mining employment levels have declined in all three SLAs between the 1996 and 2001 censuses.

The Mudgee SLA is larger and more diverse in most sectors while Merriwa was very stable in all categories between 1996 and 2001. The dominance of agriculture in the Rylstone and Merriwa SLAs and the sub-regional service role of Mudgee are also indicated by the levels of employment in retail, wholesale trade, business and property services, government, education and health (Table 3-25).

Table 3-22
Population of the Local Region 1976 to 2001 and Projections to 2021

SLA	Based on Actual Census Figures from 1976 to 2001						Projections to:			
	1976	1981	1986	1991	1996	2001	2006	2011	2016	2021
Mudgee SLA	11,451	13,118	14,122	16,685	17,074	17,682	19,581	20,883	22,186	23,488
Rylstone SLA	4,124	4,068	3,653	3,674	3,734	3,674	3,498	3,406	3,313	3,221
Merriwa SLA	2,252	2,330	2,248	2,339	2,257	2,339	2,325	2,334	2,342	2,351
Total Local Region	**17,827**	**19,516**	**20,023**	**22,698**	**23,065**	**23,695**	**25,404**	**26,622**	**27,841**	**29,060**

Source: after Appendix J

Table 3-23
Age of the Population

Age Category	Mudgee SLA %	Rylstone SLA %	Merriwa SLA %	Total Local Region %
<15 years	23.5	20.2	21.1	22.8
15-24 years	10.9	9.4	11.1	10.7
25-44 years	26.7	23.7	24.1	26.0
45-64 years	25.0	29.4	27.9	26.0
65 and over	13.7	17.0	15.7	14.4

Source: after Appendix J

Table 3-24
Comparative Population Income and Household Indicators
Local Region and NSW – 2001

Indicator	Mudgee SLA	Rylstone SLA	Merriwa SLA	NSW SLA
Median age	37	42	40	35
Median monthly housing loan repayments	$800-$999	$600-$799	$600-$799	$1,000-$1,199
Median weekly rent	$100-$149	$100-$149	$50-$99	$150-$199
Median weekly individual income	$300-$399	$200-$299	$200-$299	$300-$399
Median weekly family income	$700-$799	$600-$699	$600-$699	$800-$999
Median weekly household income	$600-$699	$400-$499	$600-$699	$800-$999
Mean household size	2.6	2.4	2.5	2.6

Source: after Appendix J

Table 3-25
Employment Distribution by Industry Local Region – 1996 and 2001

Industry	Mudgee SLA		Rylstone SLA		Merriwa SLA		Total Local Region	
	1996	2001	1996	2001	1996	2001	1996	2001
Agriculture, Forestry and Fishing	870	1,034	272	319	373	383	1,515	1,736
Mining	470	315	136	81	20	11	626	407
Manufacturing	639	808	237	182	32	47	908	1,037
Electricity, Gas and Water Supply	62	58	10	7	6	0	78	65
Construction	288	380	43	71	35	61	366	512
Wholesale Trade	224	461	25	39	21	33	270	533
Retail Trade	1,017	1,086	98	112	67	85	1,182	1,283
Accommodation, Cafes and Restaurants	374	432	71	46	43	49	488	527
Transport and Storage	205	208	44	30	36	27	285	265
Communication Services	97	63	27	17	13	6	137	86
Finance and Insurance	117	91	18	11	19	6	154	108
Property and Business Services	329	394	52	50	20	26	401	470
Government Administration and Defence	224	199	76	40	62	47	362	286
Education	424	483	99	100	61	57	584	640
Health and Community Services	557	544	86	93	49	45	692	682
Cultural and Recreational Services	77	120	3	18	6	6	86	144
Personal and Other Services	152	172	18	26	10	18	180	216
Non-classifiable economic units	66	16	29	6	17	12	112	34
Not stated	140	136	32	32	30	25	202	193
Total	**6,332**	**7,000**	**1,376**	**1,280**	**920**	**944**	**8,628**	**9,224**

Source: after Appendix J

Unemployment Characteristics and Trends

Unemployment in the local region has been generally above the NSW level over the year to December 2003 as illustrated in Table 3-26.

Table 3-26
Rate of Unemployment (%) in the Mudgee, Rylstone and Merriwa SLAs and Whole of NSW

SLA	Dec-02	Mar-03	June-03	Sept-03	Dec-03
Mudgee	6.2	6.7	6.4	6.5	6.4
Rylstone	8.7	9.8	9.7	9.6	8.9
Merriwa	6.9	6.0	5.6	4.9	5.4
NSW	6.0	5.9	5.9	5.9	5.8

Source: after Appendix J

There were approximately 1,100 people registered as unemployed with the four Mudgee employment agencies when a survey was conducted in mid 2004 and of these people registered, 30 to 40% were described as being long-term unemployed (Appendix J). An unemployment rate of 4.5% would be approaching a full employment situation when very persistent long-term unemployed groups are taken into account and there is substantial numbers of appropriate labour that could potentially be available for the Project (Appendix J).

3.12.3 Housing and Short-term Accommodation

Housing

An investigation of local housing and short-term accommodation in the local region indicated that a very high proportion of the dwelling structures in the local area are separate houses.

Presently in Mudgee, there are five distinct residential areas comprising the original town (Mudgee Central) and four other areas known as Mudgee North, Mudgee South, Mudgee South-West and Mudgee North-West. There is approximately 120 hectares of land zoned Zone 2(c) urban release in the Mudgee area which is potentially available for future residential development (Appendix J).

In October 2003 it was concluded in the Mudgee Shire Residential Land Strategy that (Appendix J):

> *There is substantial scope within the recommended urban footprint for consolidation and infill development in addition to new residential release area and large lot residential development and it is likely that the recommended urban structure could accommodate housing needs for at least twenty years.*

Discussions with local real estate agents in June 2004 indicated that Mudgee has been experiencing a similar boom to most residential property markets throughout country NSW. However, there was a general consensus that there was still adequate residential land to service the Project within Mudgee. A follow-up survey in January 2005, indicated there had been a considerable softening of the residential property market and there was a higher availability of established houses and land for sale (Appendix J).

In Gulgong, there is also considerable land available for residential use and prices are currently approximately half those in Mudgee. The smaller villages also have some land available which is suitably zoned and could be used for housing, but these towns are severely restricted in growth potential because of their relative isolation and lack of services (Appendix J).

Short-term Accommodation

Table 3-27 indicates that short-term accommodation (Hotels, Motels and Serviced Apartments) in Mudgee numbered 333 rooms in the December quarter of 2003 and room vacancy rates were low.

The importance of tourist related industries in Mudgee means that short-term accommodation can be difficult to find at certain times of the year, particularly when special tourist and wine promotional activities are being conducted (e.g. in September) (Appendix J). Consultation with the MWRC indicates that approximately 410 hotel and motel rooms are currently available within 30 km of Mudgee and Gulgong and additional short-term accommodation development is proposed, including serviced apartments and resort developments (Appendix J).

3.12.4 Community Facilities

Education

The MWRLGA is well equipped with education facilities including a range of kindergartens, pre-schools, and primary and secondary schools.

Pre-school and day care centres in Mudgee and Gulgong have waiting lists and the community has identified the need for another day care centre (Appendix J).

The MWRLGA includes a range of local village and larger primary schools, including two small primary schools at the villages of Wollar and Ulan in the vicinity of the Project (Figure 3-1). Mudgee High School (approximately 1,000 students) and Gulgong High School (approximately 300 students) have experienced a recent drop in enrolments caused by the closure of the Mudgee Abattoir (Appendix J).

Table 3-27
Available Short-term Accommodation in Mudgee – December Quarter 2003
Hotels, Motels and Serviced Apartments

Bed Spaces	Guest Rooms	Month	Room Occupancy Rate (%)	Bed Occupancy Rate (%)	Average Length of Stay (Days)
1,029	333	October	72.4	42.2	1.8
		November	55.4	29.6	1.6
		December	51	28.4	1.7
		Total	59.6	33.4	1.7

Source: after Appendix J

Tertiary education opportunities are available at Technical and Further Education (TAFE) facilities in Mudgee, and training and employment services are available at the Central West Community College. University courses are available at the regional centres of Bathurst, Dubbo and Orange.

Community services

Mudgee is the major sub-regional centre for the local area and surrounding districts offering a wide range of recreational and retail facilities such as art galleries, library, swimming pool, golf course, shopping centres and restaurants.

Services available within the local area include Rotary and Lions Clubs, aged care facilities and recreational sporting clubs. Community services are also provided by organisations such as Meals on Wheels, Community Transport, and Mudgee Accommodation Support Service. Family Support Services are provided by the Department and Community Services and a number of non-government organisations.

Health

The Area Health Service offers a wide range of medical, child and family services in Mudgee and surrounding communities such as Gulgong. Family and community health services have waiting lists for most non-urgent services.

The Mudgee District Hospital and Gulgong Hospital provide services such as emergency, medical specialists, surgical, maternal and child health and neonatal as well as integrated community and hospital services and community health services. There are no hospitals in the immediate vicinity of the Project.

There is a recognised shortage of general practitioners in the MWRLGA and the community is actively recruiting doctors to address the shortage. A feasibility study for a new medical centre is being conducted with funding assistance from the MWRC.

There are a variety of allied health service providers including chiropractors, physiotherapists, dentists, optometrists and natural therapies available in the local region.

3.13 OVERVIEW OF THE REGIONAL ECONOMY

A benefit cost analysis and regional economic assessment was prepared for the Project by Gillespie Economics and is presented in Appendix I. The assessment was conducted at two different scales to assess the local impact of the Project and the impacts at NSW state level. As for the Community Infrastructure Assessment, the regional economy chosen for the study was the former SLAs of Mudgee, Merriwa and Rylstone. A summary of the results of the assessment with regard to the existing regional and NSW state economy is provided below.

The regional economic assessment is based on a 2001 input-output analysis for the regional and NSW economies. The local region comprises the former SLAs of Mudgee, Rylstone and Merriwa.

Gross regional product (GRP) for the NSW economy (household income and other value added contributions) is estimated at $225,151M and $131,185M in other value added contributions (includes gross operating surplus, depreciation and net indirect taxes and subsidies).

The GRP for the local regional economy is estimated at $696M, comprising $293M in wages and salaries and $676M in other value added contributions.

The comparative distribution of various industry sectors to the GRP, employment and output earnings for the local region and for the state of NSW are presented in Table 3-28.

Comparison with the state economy reveals that the agriculture, forestry and fishing sector, the mining sector and manufacturing sector are of greater relative importance to the regional economy. The coal mining sector is also the major sector responsible for exports from the region, followed by the manufacturing sectors of wine and spirits, meat and meat products and concrete (Appendix I). Imports are more evenly spread across sectors. The coal mining sector is the most productive sector of the economy (as measured through GRP per employee) and has the highest average wage of all the economy sectors (*ibid*.).

Table 3-28
Contributions to Gross Regional Product, Employment and Output by Industry Sector – Local Region 2001

Sector	Total Employment (%)		Contribution to GRP (%)		Contribution to Output (%)	
	Local Region	NSW	Local Region	NSW	Local Region	NSW
Agriculture/Forestry and Fishing	19	4	12	2	11	2
Mining	5	1	15	2	14	2
Manufacturing	12	12	16	13	32	29
Utilities	1	1	3	2	3	2
Building	5	7	3	4	3	4
Services	59	76	43	67	38	61

Source: after Appendix I

Agricultural and Wine Production

Agriculture is an important contributor to the local economy employing in the order of 1,700 people and producing approximately $75M of agricultural exports during 2001 (Appendix I). Agricultural activities in the region include sheep, beef cattle, dairy cattle, viticulture, irrigation cropping and vegetables. The wine industry has a significant presence in the Mudgee area.

Mining

The coal mining sector is the most productive sector of the regional economy when measured in terms of GRP per employee and has the highest average wage of all the sectors of the economy (Appendix I). The coal mining sector is also responsible for a major component of exports from the region.

Service Industries

The services sector is the most significant sector in terms of employment numbers (Table 3-28 and total wages to employees in the regional economy. Mudgee has a moderate range of recreational, retail and community support facilities and is regarded as a sub-regional service centre for surrounding districts.