BLACK RANGE
MINERALS

SYERSTON NICKEL COBALT PROJECT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 3 – APPENDICES G TO JD

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ResourceStrategies

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 3

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BLACK RANGE MINERALS LTD
COMMUNITY INFRASTRUCTURE ASSESSMENT FOR THE PROPOSED SYERSTON NICKEL & COBALT MINING PROJECT

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1 INTRODUCTION

Black Range Minerals Ltd (Black Range) is proposing to mine an average of 2 million tonnes per annum (tpa) of nickel laterite ore and establish a nickel and cobalt extraction plant at Syerston, 45 km northeast of Condobolin and 80 km north-west of Parkes in the Central West of New South Wales. Smaller towns in the immediate vicinity of the Project site include Fifield, Trundle and Tullamore (Figure 1).

An average of approximately 20,000 tpa of metal or up to 42,000 tpa of mixed nickel-cobalt sulphide precipitate products would be produced for sale to international markets. Annual metals production would peak at approximately 20,000 tonnes of nickel and 5,000 tonnes of cobalt.

In addition to the proposed mine site, Black Range propose a number of components which when combined make up the Syerston Nickel Cobalt Project (the Project). In summary, the Project would involve:

- the mine site including ore processing, gas, acid and electricity plants, open pit mining areas and mine waste disposal facilities (eg. waste emplacements, tailings dams and evaporation ponds);
- a raw water supply borefield some 65 km to the south south-east of the mine site;
- a water supply pipeline from the borefield to the mine site;
- a natural gas pipeline from the existing Sydney-Moomba gas-line approximately 90 km south south-west of the mine site
- quarrying, crushing and transport of limestone from a quarry approximately 20 km south-east of the mine site;
- a rail siding on the Bogan Gate-Tottenham Railway approximately 25 km to the south-east of the mine site; and
- road and access upgrades and construction of a road bypass.

An Environmental Impact Statement (EIS) for the proposed Project is required under the NSW *Environmental Planning and Assessment Act (1979)* (EP&A Act). The Project has mineral resources adequate for a mine life of over thirty years. In accordance with regulatory requirements, the EIS assesses the potential environmental impacts of the Project for a term of 21 years.

This report is an assessment of the potential socio-economic impacts of the above Project components for the EIS term and has been prepared as EIS supporting information, in accordance with the Director General Requirements for the EIS.

1.1 Study Requirements

The study was commissioned by Resource Strategies P/L, the environmental consultant responsible for the preparation of the Environmental Impact Statement (EIS) for the proposed Syerston Project. It has been prepared to assess the potential social impact of the proposal and to address the following requirement which was outlined by the director of the NSW Department of Urban Affairs and Planning (DUAP) Assessments Branch, in the DUAP Director Generals Requirements (DUAP, 1998).

> *Social Impact Assessment of the proposal. This is to include details of the proposed workforce and its impacts on the amenities, services and infrastructure … of the nearby population centres during both the construction and operation phases.*

The focus of the study brief was to assess the local towns with regard to facilities, services and housing and their ability to support a Project employing approximately 400 people for an operational period of 20+ years and up to 1,000 people during the 24 month construction period.

Consequently the objectives of this report are to:

- characterise the existing socio-economic environment
- analyse the likely distribution of the non-local component of the workforce among the study area towns

- assess the socioeconomic impacts of the Project on the housing and social infrastructure of these communities.

1.2 Methodology and Structure of the Document

The basic methodology for carrying out the study was to analyse the existing socio-economic environment and then consider how the local region might change without the influence of the proposed Project. The spatial allocation of the non-local component of the work force was calculated using a spatial allocation (gravity) model. Impact analysis of the proposed development was then completed.

Two geographic levels of analysis are referred to in the text. One covered an area within 60 minutes travelling time (approximately 100 km) of the site which is referred to as the primary study area (local workforce catchment area). This area includes the centres of Parkes, Condobolin, Forbes and a number of smaller towns closer to the mine site such as Fifield, Trundle, Tullamore and Bogan Gate. The second refers to the wider Central Western region which includes other significant mining centres such as Orange.

The report contains analysis and discussion of:

- a review of the existing socio-economic environment;
- estimated spatial allocation of the work force in each phase (ie. construction and operation)
- the potential impacts of the Project on population, employment, housing, social and physical infrastructure; and
- conclusions and recommendations.

1.3 Sources of Information and Consultation with Relevant Agencies

The following Government and private bodies were consulted as part of the work programme:

- Parkes Shire
- Lachlan Shire
- Forbes Shire
- NSW Department of Urban Affairs and Planning
- NSW Department of Education and Training
- NSW Department of Health
- NSW Department of Community Services
- Local Court Officers
- Parkes Neighborhood Service Centre
- Local real estate agents
- Local motel and hotel operators.

1.4 Terminology

Terminology used in the subsequent chapters has been defined below:

- *Local Component of the Workforce*

  Existing residents of the primary study area who do not relocate to work on the Project.

- *Non-local Component*

  Those persons who move into and live permanently in the primary study area as a result of the Project.

- *Commuters and Work Week Commuters*

Those persons who live outside the primary study area but commute on a daily or weekly basis to the site.

- *Economic Base*

  A regions economic base consists of those economic activities which involve sales to individuals or firms located outside the region, thus giving rise to inflow of money from non-local sources. An industry which is part of this economic base activity is considered a "basic" or "export" industry.

  All other industries make up the "service" or "local" activity since their output is consumed within the local region. This dichotomy of the entire economy can be contrasted with the input-output approach to regional analysis which uses a three-way division of individual industries. This division is known as the direct, indirect (production induced) and induced components (consumption induced) of an industry.

2 POPULATION AND EMPLOYMENT

2.1 Introduction

This section discusses the employment and population estimates which are used as the basis for impact assessment. It reviews the existing environment, dealing with characteristics of the regional population, projected population increases without the Project and various components of employment including structure and employment.

2.2 Definition of the Study Area

Over the past 15 years it has been observed in a wide range of similar projects, both in Australia and overseas, that the most significant variable affecting the degree of socio-economic impact on a region is the size of the introduced non-local workforce (Brealey & Newton, 1981). Consequently, the definition of the local impact area or study area is of fundamental importance to the following analysis.

The study area was determined by considering the likely commuting patterns of the construction and operational workforce. A trip-table (Table 1) was developed which shows distance and travelling time to the surrounding population centres. This table was then considered in relation to the ability of the Project to attract workers. After research into commuter behaviour for the existing North Parkes Mine, 100 km or 60 minutes travelling time was considered to be the primary employment catchment area.

Table 1
Trip Time Table from the Project Area to Neighbouring Centres

Mine Site to:	Distance (km)(approx.)	Travel Time (mins (approx.)
Condobolin	45	30
Parkes	85	50
Forbes	105	70
Trundle	25	20
Tullamore	30	20
Bogan Gate	60	40

Figure 1 shows the location of the neighboring centres (outlined in Table 1) which define the study area.

The towns and associated areas within this boundary have been considered for employment potential in this study. The majority of the Project components are located in Lachlan Shire which has an economic base comprised of mainly grazing and extensive farming properties (wheat, cotton). Parkes Shire includes the second largest population centre (ie. Parkes, 10,500 population) in the study area and is approximately 85 km from the Project area.

Parkes industrial base has been stimulated by the North Parkes Mine which has been in operation since 1996. The local economy of the Parkes Shire has been diversifying significantly in the past five years to become a transportation hub based on a completed wool scouring operation and proposed development in both air and rail infrastructure. The Parkes airport is proposing to develop an international air freight facility and the rail network is being re-established as the hub of the NSW network with significant new investment particularly by the private sector.

Forbes Shire is the other local government area affected by the Project, however, as Forbes (population 10,600) is over 100 km from the Project site it is anticipated that the population impacts of the Project on this Shire will be limited. However, due to the presence of the Red Bend Catholic College near Forbes, the education facilities of the Shire will be utilised.

2.3 Population

2.3.1 Regional Trends

The total population of the immediate sub-region of the larger NSW Central Western region in June 1996 was 32,627 which includes Lachlan, Parkes and Forbes Shires. Growth in the sub-region over the past 20 years has been variable with Parkes Shire experiencing considerable growth in the 1990's, while growth was steady in other urban areas. The surrounding rural areas have experienced periods of decline over the same period (see Table 2).

Table 2
Estimated Resident Population Primary Study Area 1986 – 1996
and Projections to 2001, 2006 and 2011

Population	Area km^2	1986	1991	1996	2001	2006	2011
Parkes Shire	5,919	14,047	13,936	15,064	15,366	15,875	16,383
Lachlan Shire	14,965	8,040	7,687	7,425	7,102	6,795	6,487
Forbes Shire	4,717	10,500	10,351	10,138	9,925	9,712	9,499
Total Study Area	25,601	32,587	31,974	32,627	32,393	32,381	32,369

Source: Australian Bureau of Statistics (ABS) Census Data 1986; 1996 (Primary Study Area)

2.3.2 Primary Study Area Growth Rates

The focus of the present study is Lachlan, Parkes & Forbes Shires. The total population of the primary study area in 1991 was 31,974 and 32,627 in 1996. Using the trends shown over the past three Census periods from Table 2, baseline population projections were carried out for the years 2001, 2006 and 2011. As shown in Chart 1 the population in the primary study area without the Project would continue to decrease slightly to 32,393 by 2001 and be virtually stable after this point to 2011.

Contrary to this overall trend is Parkes Shire, which has shown buoyant growth since the early 1990's due to mining and a general diversification of its economy into agricultural processing and transport and mining services. This growth has offset the gradual declines of the other two local government areas which are more typical of rural shires in NSW. Official projections carried out by the NSW Department of Urban Affairs and Planning following the 1991 Census suggested that the population would gradually decline over the 1990's. If other growth prospects for Parkes Shire materialise then the baseline projections will tend to be on the low side. The average annual growth rate of the shire was calculated at 1.5 % per year for the period 1991-1996 and in both of the other Shire areas the population growth rate was slightly negative. Substantial growth in the diversification of the Parkes economy could offset declines in the other two local government areas leading to an overall net increase.

2.3.3 Age and Other Characteristics of the Population

The age and family type distribution in the primary study area, are reported in Chart 2 and Tables 3 and 4. The general similarity in the population of the three local government areas of the study area is apparent. The only noteworthy difference is the larger proportion of young adults and teenagers in Forbes. This could be explained by the presence of the Red Bend Catholic College which has a substantial boarding school population. Parkes also has a significantly higher median household income, indicating a higher proportion of families with two incomes.

Table 3
Family Type, Study Area 1996

Type of Family	Lachlan Shire No.	Parkes Shire No.	Lachlan Shire %	Parkes Shire %
Lone Households	587	1,363	12.59%	14.41%
Group Households	57	125	1.22%	1.32%
Other Households	2,038	4,055	43.72%	42.88%
One Parent Families	253	540	5.43%	5.71%
Couple Only Families	716	1,329	15.36%	14.05%
Two Parent Families	961	1,970	20.62%	20.83%
Other Families	49	74	1.05%	0.78%
Total	4,661	9,456	100.00%	100.00%

Source: ABS Census 1996

Table 4
Comparative Population Income & Household Indicators

Comparative Indicators	Parkes	Lachlan	Forbes
Median age	34	35	34
Median individual income $	251	240	244
Median household income $	523	475	487
Average household size	2.6	2.7	2.6

Source: ABS Census Income in $A per week

2.4 Employment

2.4.1 Employment Structure

The economic structure of the study area in 1996 showed considerable differences between the two local government areas that will experience the majority of the social and economic changes associated with the Project. Table 5 shows the comparison with Parkes Shire being considerably more diverse in most sectors. The dominance of agriculture in Lachlan Shire and the sub regional service role of Parkes are both apparent.

The manufacturing sector in Parkes also shows the diversification that has occurred in the Parkes economy since the development of the North Parkes Mine and development of the wool scouring operations. Agriculture itself is also still very significant in Parkes with 13.9 % (831 jobs) of the workforce. The broad range of services available in Parkes is illustrated by the combined retail and wholesale trades and cafes and restaurants sectors, together representing 24.14% (1,443 jobs). Education in Lachlan Shire had a comparatively higher share of employment compared to Parkes Shire but is probably due to the vast area of the Shire supporting many schools in smaller centres.

Table 5
Comparative Economic Structure
Parkes & Lachlan Shires 1996

Industry	Parkes Shire		Lachlan Shire	
	1996 No.	%	1996 No.	%
Agriculture Forestry Fishing	831	13.90%	1098	38.20%
Mining	492	8.23%	22	0.77%
Manufacturing	334	5.59%	81	2.82%
Electricity Gas Water	63	1.05%	34	1.18%
Construction	308	5.15%	80	2.78%
Wholesale Trade	285	4.77%	128	4.45%
Retail trade	825	13.80%	249	8.66%
Accommodation cafes & restaurants	333	5.57%	130	4.52%
Transport & Storage	355	5.94%	114	3.97%

Table 5 (Continued)
Comparative Economic Structure
Parkes & Lachlan Shires 1996

Industry	**Parkes Shire**		**Lachlan Shire**	
	1996 No.	**%**	**1996 No.**	**%**
Communication Services	86	1.44%	41	1.43%
Finance & Insurance	125	2.09%	39	1.36%
Property & Business Services	319	5.34%	79	2.75%
Govt Administration & Defence	301	5.04%	119	4.14%
Education	395	6.61%	228	7.93%
Health & Community Services	550	9.20%	249	8.66%
Cultural & Recreational Services	38	0.64%	15	0.52%
Personal & Other Services	180	3.01%	58	2.02%
Non Classifiable	41	0.69%	30	1.04%
Not Stated	117	1.96%	80	2.78%
Total Workforce	**5,978**	**100.00%**	**2,874**	**100.00%**

Source: 1996 ABS Census

2.4.2 Unemployment Characteristics and Trends

Unemployment in the region had been approximately the same as the NSW level up until 1996 but since then the level has consistently been below the State level. The regional labour market unemployment data calculated from ABS monthly employment surveys and workforce data are shown in Tables 6, 7 and 8.

This data and consultation with local employment agencies and the Commonwealth Department of Employment in Orange, suggest that there is sufficient employed people with adequate skills and a pool of unemployment in the primary study area appropriate for the unskilled and semi-skilled jobs required in both phases of the Project. However the employment data also suggests that the local labour market is becoming tight for semi-skilled and skilled workers. The Commonwealth Department of Employment suggested that in rural NSW, an unemployment rate of 4.5% was approaching a full employment situation when very persistent long-term unemployed groups are taken into account. The figures in Table 7 suggest that at least in two quarters the local market was virtually fully employed.

An important factor to consider is the level of underemployment that also may be available in the surrounding agricultural industries. There will be a component of labour on the smaller more marginal family operated farms which will choose to seek employment within the mining industry whilst still operating the family farm. As the average size of many properties is large, this effect may not be as pronounced as in other areas of the State where mining industry projects have been established.

Competition for the unskilled workers and semi skilled workers is coming from the agricultural processing sector, particularly from the diversification of the economy in Parkes. In areas just outside the sub-region, there were also anecdotal reports of orchardists being unable to recruit labour for seasonal picking and have resorted to the use of out of area project contracting in order to maintain wages at award levels.

Table 6
Number of Unemployed by Local Government Area and Total Study Area

Shire	Mar-97	Jun-97	Sep-97	Dec-97	Mar-98	Jun-98	Sep-98	Dec-98	Mar-99	Jun-99	Sep-99	Dec-99	Mar-00
Forbes	301	257	196	278	276	275	315	297	288	226	270	216	239
Lachlan	277	230	152	203	215	207	253	202	227	178	208	157	183
Parkes	549	507	360	503	541	488	578	431	530	395	468	385	428
Total	**1,127**	**994**	**708**	**984**	**1,032**	**970**	**1,146**	**930**	**1,045**	**799**	**946**	**758**	**850**

Source: ABS

Table 7
Rate of Unemployment (%) by Local Government Area & Total Study Area

Shire	Mar-97	Jun-97	Sep-97	Dec-97	Mar-98	Jun-98	Sep-98	Dec-98	Mar-99	Jun-99	Sep-99	Dec-99	Mar-00
Forbes	6.2	5.3	4.1	5.7	5.8	5.7	6.2	6.1	6.2	4.8	5.6	4.7	5.1
Lachlan	7.1	5.9	4.3	5.7	6.1	5.9	6.8	5.7	6.6	5.1	5.8	4.6	5.3
Parkes	8.4	7.8	4.9	6.8	7.5	6.7	7.5	5.9	7.5	5.5	6.4	5.5	6.1
Study Area	7.2	6.3	4.4	6.1	6.5	6.1	6.8	5.9	6.8	5.1	5.9	4.9	5.5

Source: ABS

Table 8
Total Workforce Study Area December 1996 to March 2000

Shire	Dec-96	Jun-97	Dec-97	Mar-98	Jun-98	Mar-99	Jun-99	Sep-99	Dec-99	Mar-00
Forbes	4,880	4,875	4,845	4,768	4,792	4,682	4,737	4,828	4,625	4,645
Lachlan	3,880	3,876	3,573	3,517	3,534	3,453	3,494	3,561	3,411	3,426
Parkes	6,510	6,504	7,350	7,234	7,269	7,103	7,186	7,324	7,017	7,047
Total Workforce	**15,270**	**15,255**	**15,768**	**15,519**	**15,595**	**15,238**	**15,417**	**15,713**	**15,053**	**15,118**

Source: Dept of Employment, Workplace & Small Business Local Labour Market Estimates 1996-2000

3 HOUSING AND COMMUNITY INFRASTRUCTURE

3.1 Housing

Dwelling structures in the primary study area are shown in Table 9. Permanent housing and residential construction in the township of Parkes Shire experienced a short term boom associated with the construction stage of the North Parkes mine which lasted for around 18 months in 1993/94. North Parkes Mine developed some housing stock to cater for some of their incoming staff. Since 1993/94 when there were over 130 residential building applications, the number of applications have gradually returned to the pre-mining level of activity with between 70-100 building applications being received per year.

In Parkes there is also a substantial amount of older housing available in the established areas of the town with up to 500 houses now being considered to be available for sale or rent. Average prices for housing and land packages were around $125,000 and these have now dropped to around $100,000. Blocks of land which were available for an average price of $33,000 have now dropped to around $25,000. Rural residential blocks are limited in the Shire and are only presently available to the south of the town (and have been in more demand than housing in the town).

In Condobolin, the housing stock available is significantly lower than in Parkes with approximately 50 houses available for rent or sale. Building applications for residential construction are currently running at around 20-25 per year so the construction industry for building houses is somewhat limited.

Trundle and Tullamore in Parkes Shire, have some land available in the villages that is zoned and could be used for housing but both towns are severely restricted in growth potential because of the lack of a reliable water supply. There is a reticulated supply operating but severe restrictions are required during summer. The Parkes Shire Planning study dated 1996 anticipates that the population of these towns will remain stable. Comparison of the 1,994 population estimate with the 1996 Census data and visual inspection of the town suggest that there may be very slight growth in both of these towns (of the order of 50-100 people). Neither town has a reticulated sewerage system but individual septic systems were reported to be giving an acceptable level of service.

In areas outside the villages, development of housing is not encouraged and there are requirements in the Local Environmental Plan (LEP) for a minimum sized roof tank of 45,000 Litres if there is no access to reticulated supply. There is no zoned rural residential land in the vicinity of the villages.

Fifield village has a very small population (less than 20 people) but there is zoned land that could be used for housing. This village is severely restricted in growth potential due to its relative isolation and the high cost of the provision of services. Lachlan Shire sometimes trucks in water to supply the existing residents. Lachlan Shire does not want to encourage any development in this village.

Table 9
Housing Stock in the Primary Study Area (1996)

Type	Parkes Shire		Lachlan Shire		Forbes Shire	
	Occupied Dwellings	Unoccupied Dwellings	Occupied Dwellings	Unoccupied Dwellings	Occupied Dwellings	Unoccupied Dwellings
House	4,831	406	2,439	603	3,539	355
Townhouse	81	7	13	3	84	9
Flat	383	41	119	39	232	35
Caravan	110	3	37	4	70	0
Other	325	11	154	67	280	49
Total	**5,730**	**468**	**2,762**	**716**	**4,205**	**448**

Source: ABS Census Data 1996

3.2 Short Term Accommodation

The short term accommodation available in the primary study area is shown in Table 10. This data is the last available which published actual supply.

Table 10
Available Short Term Accommodation Study Area December Quarter 1997

Shire	Establishments	Guest rooms	Bed Spaces	Employment				
Forbes	7	160	430	45				
Lachlan	5	69	185	19				
Parkes	14	285	845	113				
	Room Nights Occupied				Room Occupancy Rates			
Shire	Oct	Nov	Dec	Dec Quarter	Oct	Nov	Dec	Dec quarter
Forbes	2,639	1,874	1,624	6,137	53.2	39	32.7	41.7
Lachlan	1,254	1,166	852	3,272	58.6	56.3	39.8	51.5
Parkes	5,775	4,058	3,343	13,176	65.4	47.5	37.8	50.3

Source : ABS : Tourist Statistics (1997).

Consultation with real estate agents found that there was a mini-boom in demand for accommodation during the North Parkes Mine construction period, particularly for rental houses and serviced apartments in Parkes. The data for 1993 suggest that construction workers did not rely on the use of motels and hotels, as occupancy rates during this period did not go higher than 57.1% in this period. During the peak construction period rental accommodation was very tight and dropped below a vacancy rate of 2%. Since the end of the construction period, the vacancy rates have returned to normal levels with considerable excess capacity for sale and rent.

3.3 Community Infrastructure

3.3.1 Health Services

Parkes

The Parkes health service incorporates the Parkes District hospital and a Community Health Centre. The hospital has 63 beds and provides a broad range of district hospital services supported by visiting medical services. The Lachlan Health Services Plan indicates that there is an oversupply of acute hospital beds. The town has 9 doctors, 3 pharmacies, 3 dentists, a home care service and meals on wheels. From a health care perspective Parkes has a satisfactory level of service compared to the other towns in the subregion.

Condobolin

Condobolin has a district hospital which was reported by the hospital manager to have an excess of acute hospital beds. The hospital is supported by visiting services from Parkes, Forbes & Orange with urgent or higher risk patients generally evacuated to either Parkes or Orange, and occasionally Sydney. There are 2 doctors in the town which support a community medical health centre at the hospital. There is a separate Aboriginal Health Centre in the main street of the town which provides women’s nursing, aboriginal mental health workers and an alcohol worker.

3.3.2 Education

Education facilities in the Study Area are reported in Table 11. The Red Bend Catholic College in Forbes provides the main private secondary school in the study area.

Table 11
Schools in Study Area

Location	School	Attendance 1996
Parkes	Parkes High School	782
Parkes	Parkes Primary	425
Parkes	Middleton Primary	285
Parkes	East Parkes Primary	410
Parkes	Parkes Central West Christian School	140
Parkes	Holy Family Primary	270
Bogan Gate	Bogan Gate Primary	29
Trundle	Trundle Central	150
Trundle	St Patricks	59
Tullamore	Tullamore Central	145
Forbes	Red Bend Catholic College	719 (169 Parkes) (11 Condo)
Condobolin	Condobolin Primary	703* includes all Lachlan Shire
Condobolin	St Joseph's Primary	153
Condobolin	Condobolin High School	499

According to current information, all schools are operating at acceptable levels of service and there are no current demand problems.

3.3.3 Other Community Facilities and Services

Other community facilities and services in Parkes are extensive and include childcare facilities (including long day care, kindergarten and family day care), family services, youth services, aged and disabled services, public libraries and theatres. Non-government organisations and the private sector provide many of the services. The level and standard of facilities varies significantly throughout the Shire. The smaller settlements do not have the range of services that are provided in Parkes but the informal sector is more active in the villages in supporting needy social groups. There is a wide range of recreation available including active and passive opportunities in Parkes.

Condobolin is a much smaller centre than Parkes but still provides a reasonable range of facilities and services for a town of this size. Child care services include a pre-school kindergarten and there is a family day care scheme operating. There is a library and aged care services. There is also family support, alcohol and drug services and women's services including crisis accommodation and domestic violence services. Active recreation is very well catered for with many sporting clubs.

4 POTENTIAL IMPACTS OF THE PROPOSAL

4.1 Employment

4.1.1 Employment Multipliers

The following excerpt from the regional economics report (Gillespie Economics, 2000) describes multipliers.

Multipliers indicate the total impact of changes in demand for the output of any one industry on all industries in an economy (ABS 1995). Conventional output, employment, value added and income multipliers show the output, employment, value added and income responses to an initial output stimulus (Jensen and West 1986).

Components of the conventional output multiplier are as follows:

Initial Effect - which is the initial output stimulus, usually a $1 change in output from a particular industry (Powell and Chalmers 1995; ABS 1995).

First round effects - the amount of output from all intermediate sectors of the economy required to produce the initial $1 change in output from the particular industry (Powell and Chalmers 1995; ABS 1995).

Industrial support effects - the subsequent or induced extra output from intermediate sectors arising from the first round effects (Powell and Chalmers 1995; ABS 1995).

Production induced effects - the sum of the first round effects and industrial support effects i.e. the total amount of output from all industries in the economy required to produce the initial $1 change in output (Powell and Chalmers 1995; ABS 1995).

Consumption induced effects - the spending by households of the extra income they derive from the production of the extra $1 of output and production induced effects. This spending in turn generates further production by industries (Powell and Chalmers 1995; ABS 1995).

The total multiplier is the sum of the initial effect plus the production-induced effect and consumption induced effect.

For employment, value added and income it is also possible to derive relationships between the initial or own sector effect and flow-on effects. For example, the flow-on income effects from an initial income effect or the flow-on employment effects from an initial employment effect etc. These own sector relationships are referred to as ratio multipliers.

Employment multipliers provide a method of calculating the flow-on employment effects of the Project. The estimated Type 11A ratio employment multipliers calculated by Gillespie Economics (2000) for the construction and operational phase of the mining proposal are provided in Table 12.

Table 12
Employment Multipliers for the Syerston Project

EMPLOYMENT. (No.)	Initial Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL
Construction Phase	1.000	0.129	0.226	0.354	1.354
Operation Phase	1.000	0.507	0.923	1.430	2.430

Source: Gillespie Economics, 2000

4.1.2 Construction Employment

Construction employment effects are normally short term with abrupt peaks and very rapid declines in the workforce. A construction workforce is highly transient and although total numbers of the workforce may appear stable, this may result from equal numbers of incoming and outgoing workers. This highlights the need for flexible accommodation arrangements. Due to the size of the proposed workforce and the relative geographical isolation, a construction camp will be built on-site. It will take approximately three months to have the camp ready for occupation.

There will be a pre-construction period of approximately 12 months for planning which will require very limited on-site personnel. The actual construction period will be approximately 24 months in duration. The construction workforce will peak at 962 persons in month 14 and average 611 persons over the peak year of the construction period.

The construction camp and essential on-site infrastructure will be completed in month 3 and any workforce mobilised prior to this will need to be accommodated off-site. The size of the workforce at month 3 will be approximately 180, so up to this point there will be a gradual buildup averaging 60 persons/month.

From a review of the employment data provided by the proponent, approximately 21% of the jobs are expected to be filled by residents from the primary study area (within 100 km of the mine). The majority of skilled labour and the balance of the other skill categories will be drawn from outside the region.

It is anticipated that the construction workforce will adopt a 12 hour shift roster system which will allow extended periods of work, followed by up to four day breaks to allow workers to return home.

4.1.3 Operation Employment

The operational workforce for the proposed Project is expected to peak at approximately 371 full time jobs in year 4 over the predicted life of the Project of more than 30 years.

The North Parkes Mine is an existing mine located near Parkes and can provide an indication of the pattern of employment that can be expected from a mine in the region. The North Parkes Mine source of recruitment has varied over the years with up to 50% of the workforce originally recruited from local sources. New recruitment for highly skilled jobs has been predominately from non-local sources but general operators have been sourced locally.

The Syerston Project would have a higher proportion of skilled work force focused on processing and refining rather than general mining (as for North Parkes), and consequently can not be directly compared with North Parkes.

The direct operational workforce was allocated to its local and non-local components based on the likely workforce skills requirement, and the skills makeup of the workforce in surrounding centres. The allocation of the workforce resulted in 73% of the workforce being designated as non-local and 27% as being capable of being available in the designated study area.

The implication for the Syerston Project is that there will be an increasing need to import labour for many of the processing and some of the mining jobs. More competition for labour will also lead to less stability in the local labour market, as workers are attracted to other sectors by above award wages.

4.2 Population and Housing

4.2.1 Construction Phase

Initial Construction Period

As the construction camp will not be completed until after month 3, the impacts of the Projects on the surrounding communities will vary up until camp completion. The impacts on total population and accommodation arising from the direct and flow-on workforce during the initial construction period are set out in Table 13.

Table 13
Population and Accommodation Requirements of the Initial Construction Phase (Month 3)

Month 3 Prior to Commencement of Construction Camp	Workers	Spouses	Children	Total Population Increase	Accommodation Requirements	
					Family	Single
Construction Workforce						
Local	38	-	-	-	-	-
Non-local	142	14	9	165	14	128
Flow-on Employment						
Local (Consumption Induced)	41	-	-	-	-	-
Non-local (Production Induced)	23	16	11	50	16	7
Total	**244**	**30**	**20**	**215**	**30**	**135**
Spatial Distribution of Incoming Population by Gravity Model						
Construction Camp	0	-	-	0	-	-
Parkes	30	5	3	38	5	25
Condobolin	95	20	16	131	20	75
Trundle/ Tullamore	40	5	1	46	5	35
Total	**165**	**30**	**20**	**215**	**30**	**135**

If the Syerston construction camp is built according to schedule, there will be adequate accommodation in the area for the first three months provided Parkes is considered close enough to the site for daily commuting. Condobolin should experience an increase in demand for accommodation in this period, as it is the closest centre with significant facilities. Population was assigned to Condobolin based on the amount of temporary accommodation available after an allowance for normal requirements reported in the ABS 1997 accommodation survey (Table 10). Trundle has limited accommodation available, but some sub-contractors may choose to use caravan facilities and the one hotel. Tullamore is also a potential location that some sub-contractors could use but due to its smaller size and distance to both Condobolin and Parkes for retail facilities and other entertainment, it is considered that Trundle would be a more favourable location.

For the initial construction period, short term impacts (such as increased traffic, increased local retail business and significant increases in the use of hotels) associated with the presence of a construction work force can be anticipated. This will be particularly so in Condobolin which will be the closest large town to both the site and the components of infrastructure (gas and water pipelines), which will be built from the southern section of the study area to the site. Once the construction camp is completed, the use of local facilities will reduce due to facilities provided in the camp. Even though the total amount of local activity may reduce, businesses are likely to continue to be affected positively throughout the period of construction particularly for normal retail services and activities.

Average Construction Period

The peak construction period will be relatively short, of the order of several months. For planning purposes the average work force figure of 611 for the peak year of construction is a better indicator of impact after camp completion than the peak workforce of 962.

Assuming 10% of the direct workforce are accompanied married transient workers (who will not locate at the construction camp), there will be a population increase in the primary study area of 757 on average over the construction period.

Flow-on employment of 217 equivalent jobs will be created for short periods in the primary study area during the construction period. The production induced component of these jobs will create up to 79 jobs which are assumed to require non-local labour (for planning purposes all of these workers were assumed to be accompanied marrieds). The balance of 138 consumption induced jobs were considered to be capable of being absorbed by local residents.

As can be seen in Table 14 the average impacts of the construction period on accommodation remain modest.

Table 14
Population and Accommodation Requirements of the Average Construction Phase

Average Construction Period	Workers	Spouses	Children	Total Population Increase	Accommodation Requirements	
					Family	Single
Construction Workforce						
Local	128	-	-	-	-	-
Non-local	483	48	32	563	48	435
Flow-on Employment						
Local (Consumption Induced)	138	-	-	-	-	-
Non-local (Production Induced)	79	79	36	194	79	-
Total	**828**	**127**	**68**	**757**	**127**	**435**
Spatial Distribution of Incoming Population by Gravity Model						
Construction Camp	435	-	-	435	-	435
Parkes	16	16	2	34	16	0
Condobolin	95	95	64	254	95	0
Trundle/ Tullamore	16	16	2	34	16	0
Total	**562**	**127**	**68**	**757**	**127**	**435**

Table 13 and 14 show the likely distribution of potential housing requirements among the communities in the study area during the initial and average (peak year) construction periods. This spatial distribution was based on the existing reported levels of short term accommodation available in the study area towns. It should be emphasised that during the construction period for North Parkes Mine, there was more demand for extended rental accommodation in Parkes than for conventional hotel and motel accommodation.

4.2.2 Operation Phase

The projected increases in population and housing requirements of the operational phase are shown in Table 15 (based on the projected direct workforce and flow–on multipliers in Table 12) (Gillespie Economics, 2000).

Table 15
Operational Phase Projected Population and Housing Requirements

	Workers	Spouses	Children	Total Population Increase	Accommodation Requirements	
					Family	Single
Direct Project Jobs						
Local	100	-	-	-	-	-
Non-Local Component	271	190	127	588	190	81
Flow on Jobs						
Local Component (Consumption Induced)	342	-	-	-	-	-
Non-Local Component (Production Induced)	188	132	88	408	132	56
Total	**901**	**322**	**215**	**996**	**322**	**137**

4.2.2.1 Spatial Allocation of the Operation Workforce

Analysis of the operational workforce at the existing North Parkes Mine shows the strong attraction for Parkes which is within 25 minutes drive of that operation and has a diverse range of urban services and infrastructure (Table 16).

Table 16
Location of Existing Operational Workforce
as at 31 December, 1998 - North Parkes Mine

Location	Number	%
Parkes	150	83.8
Forbes	6	3.35
Peak Hill	12	6.7
Dubbo	2	1.12
Trundle	3	1.68
Bogan Gate	1	0.56
Alectown	2	1.12
Bedgarabong	1	0.56
Goonumbla	2	1.12
	179	

Source: MREMP North Parkes 1998 & personal communication

This indicates the type of lifestyle the operational workforce of the Syerston Project is likely to prefer and the tendency for people relocating to the area to choose the larger well serviced centres over the outlying smaller centres. This was considered in the development of the next step in the impact analysis which was to allocate the non-local work force between the towns which make up the study area. This was done using a gravity model which allocated the direct workforce on the basis of weighted scores on four criteria:

- Population of each centre
- Distance measured as travelling time to the site
- Access to day high schools (non-boarding)
- Access to spouse employment

The flow- on work force was allocated on the basis of two criteria as these jobs are not site dependent:

- Size of local labour force
- Access to all schools

The results of the analysis are shown in the Table 17.

Table 17
Spatial Allocation of Incoming Operational Workforce with Accommodation Requirements

	Population Increase				**Accommodation Requirements**	
	Workers	**Spouses**	**Children**	**Total**	**Family**	**Single**
Spatial Distribution of Incoming Population by Gravity Model						
Parkes	344	241	161	746	241	103
Condobolin	110	78	52	240	78	32
Trundle/ Tullamore	5	3	2	10	3	2
Total	**459**	**322**	**215**	**996**	**322**	**137**

4.2.2.2 Potential Population Impacts on Small Villages in the Site Vicinity

The predicted distribution of population by the gravity model does indicate a strong preference of the incoming direct workforce and flow on employment workforce to choose the larger centres over the smaller towns due to the comparative level of services available and the increased access to spouse employment. This does not discount the possibility that the smaller centres will experience some population growth due to more complex settlement factors not addressed in the gravity model. It should be pointed out however that under the EP&A Act, the Shire Council has the power to withhold consent for housing development if the cumulative impacts of such development are considered to be significant or there is not considered to be adequate infrastructure.

Trundle and Tullamore are located in Parkes Shire and have present populations of 600 and 400 respectively. Fifield (in Lachlan Shire) has a population of less than 20.

Trundle is a buoyant community with a range of social and community facilities including a Central School and small hospital. It plays the role of the local service centre for the surrounding agricultural community and even though the population is aging, appears to be holding its own as a viable community. Trundle has limited ability to provide additional water supply and has no town sewerage facilities. Its ability to cope with increased population is driven more by these physical infrastructure constraints rather than its social infrastructure.

Due to the requirements of the potential incoming non-local workforce, Trundle probably does not have the range of facilities and enough access to alternative employment to attract a significant number of mining employees.

Tullamore is a smaller town than Trundle and is also limited by its physical infrastructure rather than its community facilities, which also boast a Central School and a small hospital. Even though its retail facilities are limited it also appears to be playing a viable role as the local service centre for the surrounding agricultural community.

The Local Environmental Plan (LEP) for Parkes Shire requires a minimum storage requirement of tank water and the development consent of Council is required for dwelling construction in areas without a reticulated water supply. To this extent, Council has the ability to control unplanned population growth outside the village areas.

Fifield is a very small village located some 2 km south-east of the proposed Project and has a number of residences and one hotel. The reason for the continued viability of the town is unclear but the town does not appear to play a significant service role other than those offered by the hotel. Fifield's reasonably isolated location, lack of a service function and the lack of infrastructure facilities (particularly water supply) means it is unlikely that a population from the Project would settle in this village.

4.3 School Facilities and Services

4.3.1 Construction Phase

The potential impact of the Project on school facilities is not expected to be significant for the construction phase of the Project, with only low numbers of accompanied workers expected to migrate into the region. The total number of children that could be generated would be 68 who would be spread between Condobolin, Trundle & Parkes.

4.3.2 Operation Phase

During the operational phase, the anticipated number of children is shown in Table 18. Even though the number of children anticipated to go to Parkes is a relatively large number (161), the size of the existing school population (the total school enrolment in 1997 was 2,800) in Parkes itself and the presence of a large private college in Forbes should mean that significant capacity problems in any one school would not be anticipated. The number of children attending Condobolin schools would increase by 52 and again the number of schools and childcare facilities are considered adequate to cater to the increased need. This conclusion is still subject to a review being conducted by the area office of the Department of Education and Training.

Table 18
Total Number of Non-Local Children
Generated by Operational Phase at Parkes & Condobolin

Age	Condobolin	Parkes
0-4 Years	14	42
5-9 Years	14	44
10-14 Years	14	44
15-19 Years	10	31
Total Children	52	161

4.4 Community Services and Facilities

4.4.1 Construction Phase

Parkes has a large district hospital and a community health centre which has a range of services which can address the needs of the construction workforce.

At this stage consultation with Condobolin Hospital has found that no significant impact on the delivery of acute hospital care is anticipated, as there is currently some excess capacity in the system. Community health services may experience some increase in demand during the construction phase, due to the presence of a large construction work force in the relatively remote location at Syerston.

As the construction workforce may have different health and welfare needs to the existing population, on-going liaison with the NSW Department of Health and Community Services is recommended to ensure that existing services are rationalised to the extent possible, to offer appropriate services to the incoming population. The Department has in the past committed to monitor trends in notification rates for family support services.

4.4.2 Operation Phase

No significant potential impacts are anticipated upon hospital services or community health services during the operational phase as there will be adequate time for normal planning procedures to occur.

- It is anticipated that the Project may lead to a gradual additional demand being placed on community support services and facilities, particularly in the Condobolin area as the level and range of services is not as broad as what is offered in Parkes.

- Areas of community support that should be reviewed further are:
  - women's counselling and support services
  - social and counselling services, particularly “crisis intervention” within family groups.

5 CONCLUSIONS AND RECOMMENDATIONS

The relatively isolated location of this Project, its relatively large construction work force and high skill level required for the operational phase makes it somewhat different to other mining projects in the immediate region. For the first 3 months of the construction phase there will be high short term demand for accommodation in the area. Once the construction camp is completed, accommodation demand will moderate considerably. Some sub-contractors may prefer to accommodate their workers off-site during the construction period. The proponent should specify in tender documents that accommodation will be provided at the on-site camp and keep the number of workers accommodated off-site to a minimum.

For the operational phase, allocation of potential incoming population to local towns was carried out using a gravity model. The results of the modeling suggest that the most significant socioeconomic impact of the Syerston Project will be the effects on the housing sectors of both Parkes and Condobolin.

The likely demand for housing in Parkes associated with the Project workforce and flow on employment would be a total of 344 housing units (241 units suited for married couples and families and 103 single units). As Parkes has an estimated 500 housing units available for sale or rent, and the normal annual rate of residential building activity in Parkes in recent years has been in the vicinity of 70-100 building applications, the increase in demand could be accommodated.

For Condobolin, the estimated demand in housing units associated with the Project would be 110 units in a town which normally processes around 20 building applications per year. Approximate housing stock available in the town is currently around 50 housing units. In this case the housing sector will take time to gear up to accommodate this increase in activity and some delays in the construction of housing can be anticipated while the industry gears up. This issue has the potential to lead to more non-local workers choosing Parkes rather than Condobolin as it was not included in the gravity model as a factor.

The results of the modeling also suggest that extended socio-economic impacts on the smaller villages in the vicinity of the site will be of only moderate significance. There is potential for short term increases in housing demand in the early part of the construction period and some contract flow on effects will continue throughout the construction period. The transient nature of construction workers can lead to occasional social impacts of a nuisance nature such as noise and traffic associated with local hotels. If construction workers are accompanied by family, there can also be social impacts arising from family conflicts at a higher rate than would normally be the case. Such issues can be monitored and managed effectively by ongoing consultation between the proponent and local and State government service providers (eg. NSW Department of Health and Community Services). During the operational phase of the Project, no significant inflow of non-local personnel is anticipated into these smaller villages.

In the larger towns of Parkes and Condobolin the other elements of community infrastructure such as education, health other community services and recreational services, appear to have sufficient excess capacity to accommodate the increase in population and housing that will accompany the proposed Project. The ability of the building industry in Condobolin to accommodate the potential growth will be a critical issue for planning liaison between the local government and the private sector.

The review undertaken in this study of the existing social and economic structure in the primary study area found that the socio-economic benefits of the existing North Parkes Mine and a smaller operation known as Mineral Hill (65 km from Condobolin) have been significant for local employment and income, but there was no evidence of any negative marginal social costs to community infrastructure in the surrounding region.

The recruitment of the operational workforce of the North Parkes Mine was completed with approximately half of the personnel being drawn from the local area. In comparison, the Syerston Project would have considerably more personnel working in processing rather than mining, with consequent increases in the level of skill required for its workforce. This would result in a requirement to import more skilled labour and affect the spatial distribution of the workforce. The Syerston workforce is likely to locate to a town of sufficient size for the spouses of employees to also have a reasonable chance of gaining employment.

While the Syerston Project would require a larger percentage of operational employees from outside the region, the general level of effects on social infrastructure associated with the Project would be comparable with the impacts of the operational North Parkes Mine. However, there is potential for more sustained impact in the housing sector.

With the size of the incoming Project workforce, the present excess capacity in housing in Parkes should be reduced considerably. During the construction period of the North Parkes Mine, a considerable volume of speculative housing was built in Parkes, leading to a considerable drop in prices in recent years due to oversupply. Providing there is not a second wave of speculative construction, the sustained effects of the Syerston Project would last into the operational period.

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FIGURE AND CHARTS

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 1

Project Location

BLACK RANGE MINERALS

BRM-98-01-Social_004E

Chart 1

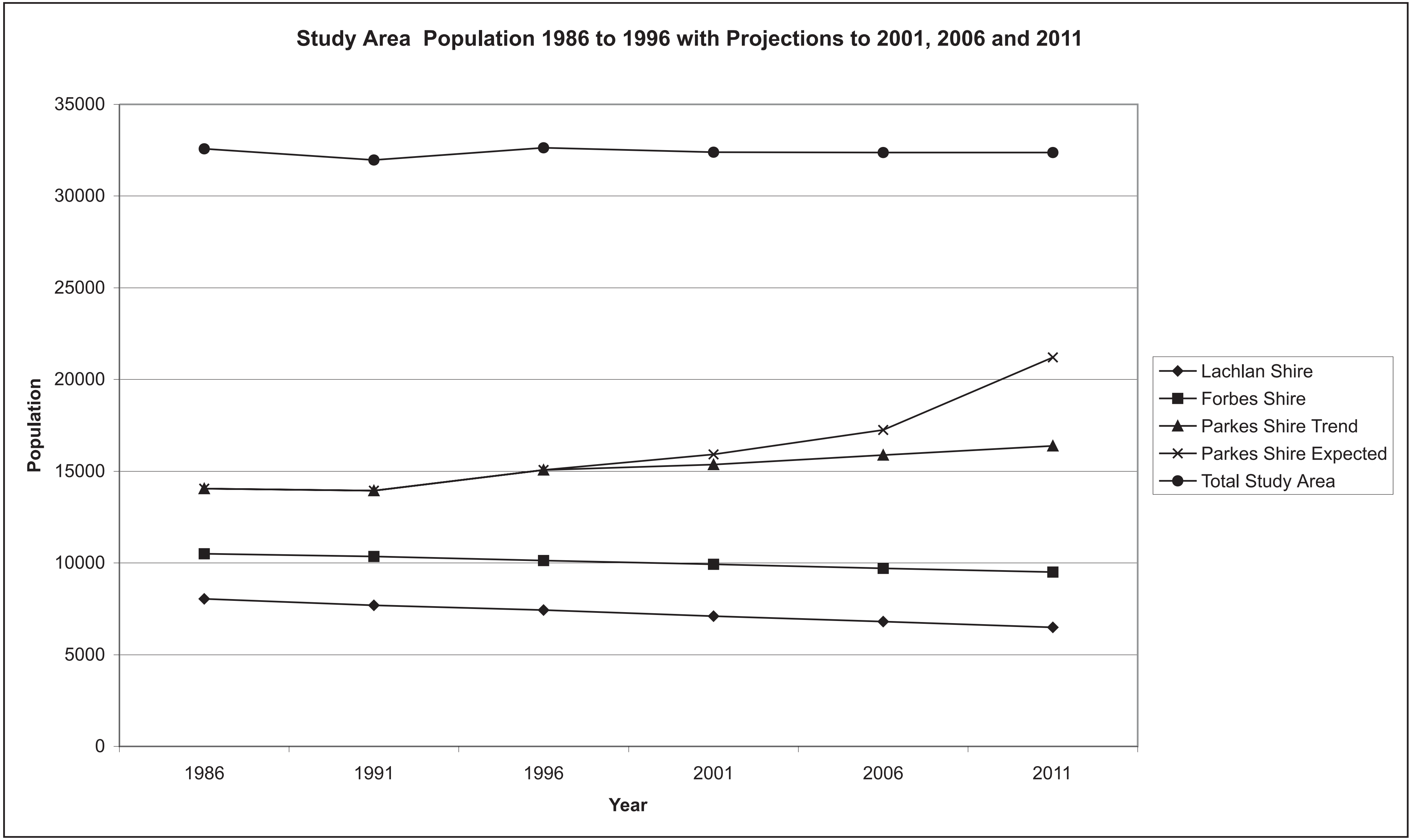

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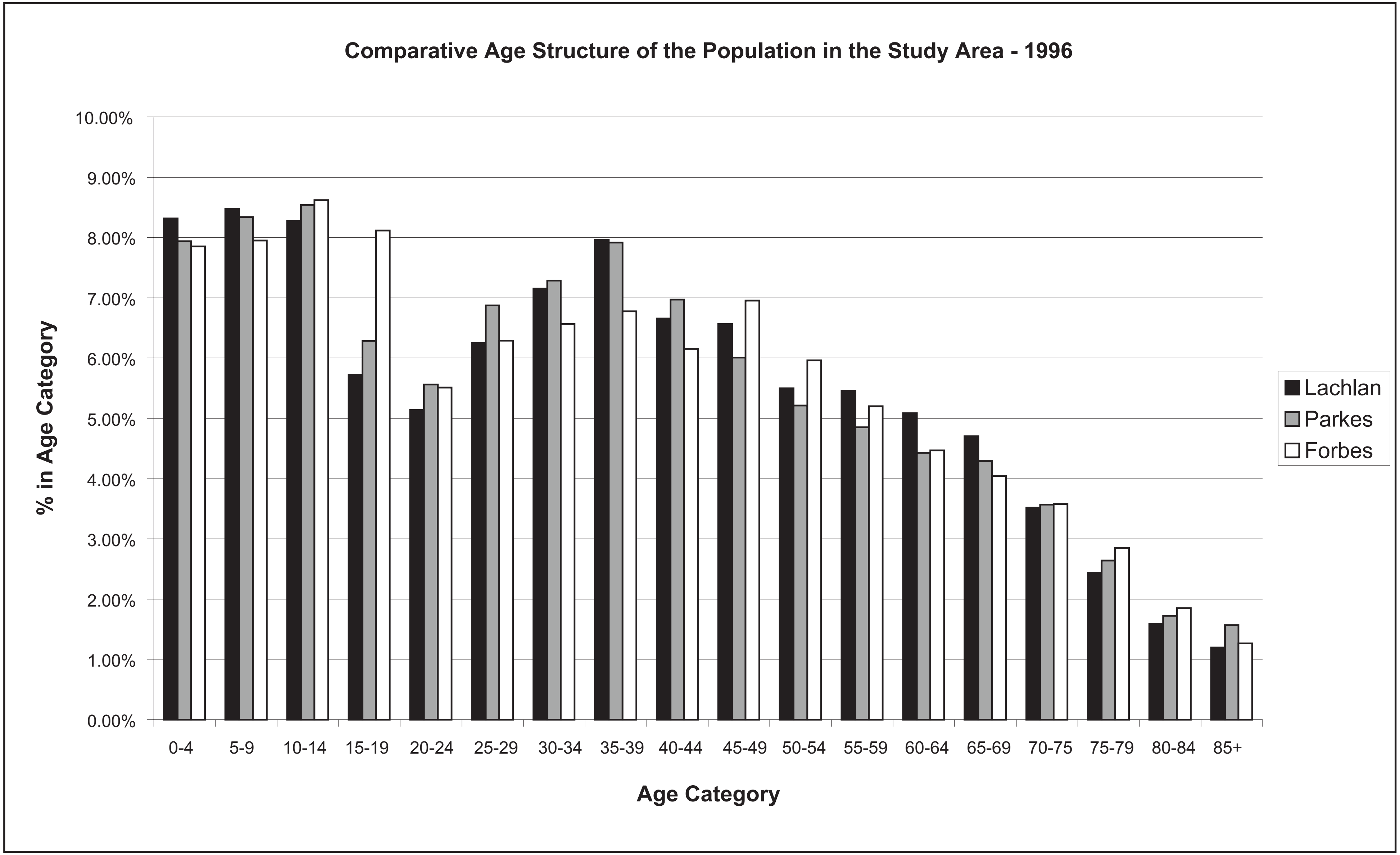
Chart 2



BRM-98-01-Social_001B

APPENDIX H

Benefit Cost Analysis

and

Regional Economic Impact Assessment

of the

Proposed Syerston Nickel-Cobalt Project

A REPORT PREPARED

FOR

Black Range Minerals Ltd

BY

GILLESPIE ECONOMICS

August 2000

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Black Range Minerals Ltd, the proponent for the Syerston Nickel-Cobalt Project, is proposing to:

- mine a nickel and cobalt deposit approximately 80km north west of Parkes and some 45km north east of Condobolin;
- construct and operate a nickel and cobalt processing facility onsite;
- transport processed nickel and cobalt to Port Botany for transportation and sale overseas.

Ancillary works include:

- construction and operation of a natural gas pipeline to meet energy supply requirements;
- construction and operation of a borefield and water pipeline to meet water supply requirements;
- construction and operation of a limestone quarry 20km south-east of the mine site with extracted limestone trucked to the mine site for use in the processing of the ore;
- construction and operation of a rail siding together with a road upgrade from the rail siding to the Project site to facilitate efficient transportation of inputs to the production process and transportation of the final product.

The deposit comprises significant quantities of nickel and cobalt and potentially significant by-products of platinum and scandium. It is estimated that the Syerston Project will be one of the largest cobalt producers in the world and a medium sized nickel producer on a world scale.

Such mining and processing activity requires development consent under the NSW Environmental Planning and Assessment Act 1979. The proposed mining and mineral processing activities are also designated development and hence require the preparation of an environmental impact statement to accompany the development application. The contents of an environmental impact statement are specified in Schedule 2 and clause 54A of the Environmental Planning and Assessment Regulation 1994 and must include an assessment of the likely impact of the proposal on the environment including the economic impact of the development.

The Syerston Project can be considered within two economic frameworks:

- regional economic impact analysis which considers the likely regional economic contribution of the Project to direct and indirect output, value-added, income and employment. For this study, the region was defined as the Central West Statistical Division of NSW. This comprises the Statistical Sub Division of Bathurst-Orange, Central Tablelands (excluding Bathurst-Orange) and the Lachlan. Statistical Local Areas included in this region are Blayney, Cabonne, Evans, Orange, Greater Lithgow, Oberon, Rylstone, Bland, Cowra, Forbes, Lachlan, Parkes and Weddin.

Some consideration was also given to the potential impacts on towns in the immediate vicinity of the proposal such as Tullamore, Fifield, Trundle, Ootha and Condobolin.
- benefit cost analysis which considers the net community welfare (economic efficiency) impacts of the proposal.

A regional economic impact analysis using input-output analysis, estimated that in total the peak year of construction of the Syerston Project may contribute up to $67M in annual direct and indirect regional output or business turnover, $35M in direct and indirect regional value added including $25M in household income. The direct and indirect annual employment impact may be up to 828 jobs (although it is noted that in the peak month of construction direct employment alone may reach 962). These total impacts are based on estimates of average annual direct effects in the peak year of construction (i.e. $46M in output, $20M in income, $24M in value added and 611 jobs) and type 11A ratio multipliers estimated at 1.441 for output, 1.441 for value added, 1.227 for income and 1.354 for employment. These particular impacts on the regional economy are only likely to be felt for a period in the order of 1 year with lesser impacts felt in year 1 and year 3 of construction.

The operation of the Syerston Project is likely to contribute in the order of $351M in annual direct and indirect regional output or business turnover, $190M in direct and indirect regional value added including $41M in household income. The direct and indirect employment impact is likely to be in the order of 901. These total annual regional impacts are based on estimates of average annual direct effects in the operation phase of the project (i.e. $290M in output, $26M in income, $156M in value added and 371 jobs) and type 11A ratio multipliers of 1.211 for output, 1.215 for value added, 1.600 for income and 2.430 for employment.

The establishment and operation of the Project will stimulate demand in the local and regional economy leading to increased business turnover in a range of sectors and increased employment opportunities. Towns that can provide the inputs to the production process required by Black Range Minerals Ltd and/or the products and services required by employees will benefit from the proposal by way of an increase in economic activity. Towns in the immediate vicinity of the proposal such as Tullamore, Fifield, Trundle, Ootha, Condobolin will be able to benefit through the provision of key requirements for prospective employees such as accommodation and retail services.

Cessation of the Project in 45 years or so will, however, lead to a reduction in economic activity. The significance of these Project cessation impacts will depend on:

- the degree to which displaced workers and their families remain within the region, even if they remain unemployed. This is because continued expenditure by these people in the regional economy (even at reduced levels) contributes to final demand; and
- the economic structure and trends in the regional economy at the time. For example, if Project cessation takes place in a declining economy the impacts might be felt more greatly than if it takes place in a growing diversified economy.

Given the long term nature of the Project it is not possible to foresee the likely circumstances within which Project cessation will occur. It is therefore important for regional authorities and leaders to take every advantage from the stimulation to regional economic activity and skills and expertise that the Project will bring to the region, to strengthen and broaden the regions economic base.

A benefit cost analysis of the Syerston Project identified a range of potential economic costs and benefits of the proposal and placed values on most of the production costs and benefits. Possible environmental externalities of the proposal were identified but remained unquantified. The analysis indicated that the total net quantified production benefits of the Project are likely to have a net present value in the order of $1,176M, with $762M of these benefits accruing to Australia. This figure of $762M represents the minimum opportunity cost to Australian society of not proceeding with the proposal. This is a minimum opportunity cost as some of the potential production benefits of the proposal remained unquantified, namely benefits associated with utilising labour that would otherwise remain unemployed.

Put another way, any environmental externalities from the Syerston Project, after mitigation by Black Range Minerals Ltd, would need to be valued at greater than $762M to make the proposal questionable from an economic efficiency perspective.

To put this threshold value in some context, every household in the region of Forbes, Lachlan and Parkes would need to be willing to pay in order of $71,969 to avoid the identified potential environmental impacts of the Syerston Project, to make the proposal undesirable from an Australian economic efficiency perspective. Alternatively each household in the Central West Statistical Division would need to be willing to pay in the order of $11,929 to avoid the identified potential environmental impacts of the Project, to make the proposal undesirable from an Australian economic efficiency perspective. The equivalent figure for NSW households is $337.

1.0 INTRODUCTION

Black Range Minerals Ltd, the proponent for the Syerston Nickel-Cobalt Project, is proposing to:

- mine a nickel and cobalt deposit approximately 80km north west of Parkes and some 45km north east of Condobolin;
- construct and operate a nickel and cobalt processing facilities onsite;
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Such mining and processing activity requires development consent under the NSW Environmental Planning and Assessment Act 1979. The proposed mining and mineral processing activities are also designated development and hence require the preparation of an environmental impact statement to accompany the development application. The contents of an environmental impact statement are specified in Schedule 2 and clause 54A of the Environmental Planning and Assessment Regulation 1994 and must include an assessment of the likely impact of the proposal on the environment including the economic impact of the development.

2.0 ECONOMICS

Economics is primarily concerned with the allocation of scarce resources to maximise community welfare i.e. economic efficiency. The main technique that is used to evaluate proposals with respect to economic efficiency is benefit cost analysis. The Department of Urban Affairs and Planning Draft EIS guidelines, titled *Economic Effects and Evaluation in Environmental Impact Assessment*, (James and Gillespie 1997) strongly advocates the preparation of benefit cost analysis in environmental impact statements. This is consistent with NSW Treasury guidelines (NSW Treasury 1997) on economic appraisal.

The guidelines also recognise that information on the regional economic impact of development proposals may be a useful adjunct to a benefit cost analysis.

This study reports on:

- a benefit cost analysis of the Syerston Nickel-Cobalt Project; and
- a regional economic impact assessment of the construction and operation phases of the Project based on the estimated direct impact and calculated multipliers.

Consideration is also given to the regional economic impacts of the ultimate cessation of the Project.

3.0 BENEFIT COST ANALYSIS OF THE SYERSTON NICKEL-COBALT PROJECT

One of the primary focuses of economics is the allocation of scarce resources to maximise community welfare. This is referred to as economic efficiency or allocative efficiency.

Efficiency in resource allocation is achieved when the so-called Pareto criterion is met, namely that "no re-allocation of resources can make anybody better off without making another worse off" (James and Gillespie 1997, p. 10). However, in reality it is highly likely that a change in resource allocation, such as the establishment and operation of a new mine, would adversely affect some individuals or social groups. Therefore in practice the criterion for economic efficiency that is used is the potential Pareto improvement. This criterion states that a change in resource allocation is desirable on economic grounds if, in principle, the gainers are able to compensate the losers (i.e. benefits exceed costs), although compensation need not be actually made in practice (James and Gillespie 1997).

The main technique that economists used to assess the efficiency of alternative resource allocation options is benefit cost analysis.

In benefit cost analysis, a resource is anything that is capable of affecting the utility of individuals and the community (through direct use of the resource as well as non use) and includes man-made as well as natural resources.

Benefit cost analysis is therefore essentially concerned with how a change in the allocation of such resources affects the net benefits (benefits minus costs) to consumers and producers as a result of resource changes, referred to as consumers' surplus and producers' surplus, respectively. Consumers' surplus is the difference between what a person would be willing to pay for a good or service (the total benefit to the consumers) and what they have to pay (the cost to the consumer). It is measured as the area between a demand curve and the price line. Producers' surplus is the difference between the costs of the inputs used in the production process (economic cost to producers) and the price received for the finished product (total benefit to producers). It is measured as the area between a supply curve and a given price for a specified quantity supplied. In practical terms it is the net revenue that is earned by producers (James and Gillespie 1997). For commercial activities the appropriate measure of economic value is the producers surplus or net returns on an operation.

Where competitive markets exist, prices would reflect willingness to pay for goods and the opportunity costs of resources. However, where benefits and costs relate to goods and services that are either not traded in conventional markets or are traded in markets that are subject to distortions, economists derive imputed economic values (referred to as shadow prices). Shadow prices are an estimate of what the value would be if a competitive market existed.

To identify and measure the changes in benefits and costs or consumer' and producers' surplus that may result from a proposal it is essential to collaborate with other experts contributing information on physical, ecological, cultural and social impacts. This information is then interpreted in terms of economic efficiency.

What follows in a benefit cost analysis of the proposed Syerston Nickel-Cobalt Project based on technical and environmental advice provided by Resource Strategies Pty Ltd and Black Range Minerals Ltd.

3.1 Scope and Objectives of the Analysis

The objective of this benefit cost analysis is to, as far as possible, consider the net impacts of the Syerston Nickel-Cobalt Project on community welfare. A 22-year time frame has been used for the analysis to reflect the period of time for which detailed projections have been made, although the mine life is in excess of 30 years.

3.2 Identification of Constraints

There are numerous environmental constraints on the proposed mining and processing operations that have been or will be set by regulatory authorities such as the NSW Environment Protection Authority, the Department of Mineral Resources and the Department of Urban Affairs and Planning. Should the application be successful, the Project will be designed to meet all regulatory requirements and minimise external impacts.

3.3 Identification of the Base Case and Alternatives

Identification of the "base case" or "without" project option is required in order to facilitate the identification of the marginal economic costs and benefits of alternatives. The base case is not necessarily equivalent to the continuation of the status quo, as even without implementation of an alternative resource allocation, changes to the status quo may occur over time. However, in this case, the "without" project case does not involve changes to the status quo over time. That is:

- the private land the subject of the Project would continue in its current use for grazing and cropping;
- the regrowth State forest land impacted by the proposal would continue in its current use for forestry; and
- the small area of previously mined Crown land would continue to remain vacant.

Alternatives to the proponent for the mining and processing of nickel and cobalt are limited. Black Range Minerals Ltd undertook exploratory drilling and located the subject resource. It has acquired the land subject of the MLA because of the significant reserves of nickel and cobalt known to occur and to internalise impacts from the mining operation. The Company has not at this stage located, at sufficient levels of certainty, any alternate nickel and cobalt resources and hence at this stage there are no alternative sites considered. However, mining and processing of nickel and cobalt reserves from the subject land may take many forms. This may include different scales, designs, technologies, processes, modes of transport, timing, impact mitigation measures etc (Gillespie 1995). Therefore a number of alternatives for mining and processing may be possible.

However, these alternatives could be considered to be variants of the preferred proposal rather than distinct alternatives. Consequently, this benefit cost analysis focuses on Black Range Minerals Ltd preferred proposal, compared to the base case identified above.

The project is based on a maximum throughput rate of 2Mt per annum of mined ore, being the capacity of the autoclave in the pressure leach circuit. With an economic ore resource of over 90Mt, the project life will be over 35 years subject to renewal of the mining lease after 21 years. However, the benefit cost analysis will assume a life of 22-years to reflect:

- that detailed projections of the operation of the project have only been made for 20 years of operation; and
- Treasury guidelines that point out that costs and benefits out past 20 to30 years have only minimal impacts on the results of the analysis (NSW Treasury 1997).

3.4 Identification of Costs and Benefits

It is necessary to identify the marginal costs and benefits of the mine and processing proposal over time, to producers and consumers.

Table 3.1 below summarises the main potential economic benefits and costs of the mining and processing proposal.

It should be noted that the potential external environmental impacts, listed in the table, are only economic costs to the extent that they affect individual and community wellbeing through direct use of resources by individuals or non-use. If the potential impacts are mitigated to the extent where community wellbeing is insignificantly affected then no external economic costs arise.

Table 3.1 – Economic Costs and Benefits of the Proposed Syerston Nickel-Cobalt Project

Stakeholder	Costs	Benefits
Black Range Minerals	Opportunity cost of MLA land (farm land, State forests and Crown land)	Sale value of processed nickel and cobalt
	Opportunity cost of capital equipment	Residual value of land at cessation of the Project
	Capital costs of Project establishment and construction including ancillary works.	Residual value of capital at the cessation of the Project
	Operating costs of Project, including ancillary works.	
	Rehabilitation costs at cessation of Project.	
External	Impacts on air quality	Consumer surplus price effect of decrease in market price
	Impacts on water quality and quantity of surface, riverine and groundwater resources	
	Impacts of noise and vibration	
	Impacts of transportation	
	Visual impacts on the existing view catchment	
	Risk of accidents and death to mine employees	
	Impacts on flora & fauna	

3.5 Quantification/Valuation of Cost and Benefits

In accordance with Treasury Guidelines (1997), where market prices are available, they have generally been used as an indicator of economic values.

3.5.1 Black Range Minerals Ltd

<u>*Economic Costs*</u>

Opportunity cost of land

Black Range Minerals Ltd has purchased or will purchase the private land which is the subject of the mining and processing proposal as well as the land for the limestone quarry and rail siding. It has a compensation agreement with State Forests regarding the affected forest and has the option to obtain easements for the water and gas supply pipeline and the road upgrade. It is not required to purchase the vacant Crown land.

There is an opportunity cost associated with using this land for mining, ore processing and associated activities, instead of using it in its next best use permissible under the existing land use regulations. An indication of the opportunity cost of the land can be gained from its current market value. The analysis includes an allowance for land purchases, easements and compensation payments within the Owner's Cost category in Table 3.2.

Nevertheless, it should be noted that the value included is likely to overestimate the opportunity cost of the land, since the purchase price is often greater than the true market value.

Opportunity Cost of Plant

Where the mining and processing activity would utilise plant and machinery already owned by the Company there is an opportunity cost associated with utilising this plant rather than selling it or using it elsewhere. However, for the purpose of this analysis it is assumed that all plant and machinery would be newly purchased with the opportunity cost of this plant and machinery captured by its market value (see capital costs below).

Capital Cost of Mine Establishment, Construction of the Processing Facility and Associated Infrastructure Establishment

The capital cost of the mine establishment, construction of the processing facility and associated infrastructure is estimated to be approximately $629M expended over a three year period i.e. $119.4M in year 1, $319.5M in year 2 and $190.1M in year 3.

A breakdown of capital costs is given below.

Table 3.2 – Total Capital Costs of the Syerston Nickel-Cobalt Project

CAPITAL COSTS	
Direct Costs	
Mining	$3,037,000
Site Preparation	$6,377,058
Leach Plant	$157,954,389
Processing facilities	$62,824,081
Utilities	$61,231,676
Services	$78,878,808
Infrastructure	$35,374,833
Sub-Total Directs	$405,677,845
EPC Indirect Costs	
Indirects	$35,711,590
EPCM	$62,961,200
Sub-Total Indirects	$98,672,791
Owner's Costs	
Owner's Costs, including management and land	$77,938,696
Contingency	$46,805,468
Sub-Total Owners Cost	$124,744,164
TOTAL Development Capital	$629,094,800

Annual Operating Costs of the Mine

The annual operating costs of the Project include those associated with:

- mining of the site;
- ore leaching;
- the processing facilities;
- utilities;
- services;
- infrastructure;
- administration and
- transportation to Port Botany.

Total operating costs vary from year to year but are in the range of $115M to $143M pa (excluding royalty payments), including $25.5M in payments to labour.

It should be noted that while royalties are a cost to Black Range Minerals Ltd they are part of the overall producer surplus benefit of the mining activity that is redistributed by government. They are therefore not included in the calculation of the resource costs of operating the Syerston Nickel-Cobalt Project. Nevertheless, it should be noted that the proposal will generate royalties of between $50,000 and $120,000 per annum, at an average of $94,000 once the proposal is fully operational.

Where inputs to the production process would otherwise be employed elsewhere in the economy, the opportunity cost of their use is the price paid for them. For labour, that price is the wage rate and it is this wage rate that has been included in the estimates of operating costs above. However, if an input into a production process, such as labour, would otherwise be unemployed, its opportunity cost is less than the wage rate for labour and hence for an economic analysis the financial cost to the company of employing labour should be reduced. The opportunity cost of employing a worker who would otherwise be unemployed can be considered to be the wage rate less income tax paid on that wage and any foregone social security payments (Bennett 1991).

For this analysis the estimated operating wages bill has not been adjusted downward to take account of the opportunity cost of that part of the labour force that would otherwise be unemployed. Consequently, the net production benefits identified could be considered a minimum figure.

Rehabilitation Costs

Operating costs referred to above include an allowance for ongoing rehabilitation related to the progressive rehabilitation of disturbance areas during mining operations and decommissioning infrastructure and final rehabilitation at the cessation of mining activities. The rehabilitation objectives of the Project are to provide a landform which is stable and compatible with sustainable end land use objectives. This includes a landform that contains mining and processing wastes in the long term and achieves an acceptable standard of surface and groundwater quality both on and off the Project sites.

Economic Benefits

Sale Value of Nickel and Cobalt

The provisional mining and processing schedule for the project is provided below. Production is estimated to commence in year 3, after 32 months of construction and preparation (the last 24 months of which is on site construction works).

Table 3.3 – Estimated Annual Production Rates

Year	Mined Ore (t)	Mined Waste (t)	Mined Total (t)	Total Metal Produced (t)	
				Nickel	Cobalt
1	0	0	0	0	0
2	0	1,185,000	1,185,000	0	0
3	866,000	4,125,256	4,991,256	4,339	1,739
4	1,657,000	4,438,078	6,095,078	15,810	4,352
5	1,999,999	3,782,276	5,782,275	20,574	4,638
6	2,000,000	6,594,940	8,594,940	18,460	4,647
7	1,999,999	7,035,462	9,035,461	16,368	4,259
8	2,102,460	5,229,895	7,332,355	17,550	3,776
9	2,071,659	5,160,624	7,232,283	16,690	3,652
10	2,144,458	5,146,554	7,291,012	18,061	3,161
11	2,133,445	4,975,046	7,108,491	21,553	2,485
12	2,172,645	4,677,363	6,850,008	18,042	2,868
13	2,078,460	4,947,054	7,025,514	15,872	3,644
14	2,098,250	5,020,205	7,118,455	17,559	3,348
15	2,049,485	4,960,584	7,010,069	13,208	3,693
16	2,149,074	8,309,680	10,458,754	14,184	3,129
17	2,067,918	8,432,092	10,500,010	15,117	2,799
18	2,155,716	8,230,202	10,385,918	16,638	2,680
19	2,113,759	8,142,285	10,256,044	12,843	3,177
20	2,236,445	8,263,560	10,500,005	16,762	2,124
21	2,223,975	8,276,028	10,500,003	13,453	1,895
22	2,004,820	8,476,790	10,481,610	12,569	1,314
Total	**40,325,567**	**125,408,974**	**165,734,541**	**315,652**	**63,380**
Average	**2,016,278**	**5,971,856**	**7,892,121**	**15,783**	**3,169**

65% of primary nickel consumption is in the manufacturing of stainless steel with other uses being non-ferrous alloys (12%), plating (7%), foundry (5%), alloy steels (5%), batteries (4%) and other uses (2%) (BRM, 2000).

The world price of nickel has fluctuated between US$4,000/tonne (A$2.78/lb[1]) and US$10,000/tonne (A$6.98/lb) over the last 8 years. For the purpose of the economic analysis a conservative price of A$5.15/lb has been used for nickel (BRM, 2000).

World production of cobalt is predominantly used in the manufacturing of chemicals with other uses including super alloys, magnets, carbide and diamond tools, hard facing and HS steel (BRM, 2000).

[1] An exchange rate of 0.65 has been used to convert US$ to A$.

World price of cobalt has fluctuated between US$11/lb (A$16.90/lb) and US$33/lb (A$50.70/lb) over the last 8 years. Given that cobalt production from the Syerston Project will substantially increase world production and therefore is likely to reduce the world price, a very conservative cobalt price of A$13.08/lb has been used in the analysis (BRM, 2000).

Residual Value at End of the Evaluation Period

At the end of the Project, capital equipment and land may have some residual value. This is essentially equivalent to their sale value. Cessation of the Project would also have some decommissioning costs that would need to be considered.

However, because the Project is likely to have a life in excess of the 22 year evaluation period with continued annual net production benefits after this time period, no residual values (or decommissioning costs) are included in the analysis. However, the consequence of a 22-year time frame for the analysis is that the results are likely to underestimate the net production benefits of the proposal.

3.5.2 Externalities

Positive Externalities

One of the positive external impacts of the mining and processing of cobalt and nickel would be the consumers' surplus associated with any reduction in price compared to those that would prevail under the base case. The magnitude of gains in consumers' surplus from an increase in supply of nickel and cobalt would depend on the magnitude of the change in supply relative to the market supply as well as supply and demand elasticity's of the products involved (Bennett 1991).

If market demand for nickel and cobalt is perfectly elastic there will be no net gain (consumers' surplus) for consumers from the increased supply of nickel and cobalt. This is likely to be the case if the nickel and cobalt produced in plentiful supply and have close substitutes and/or if the increase in supply is minor as a proportion of total world supply.

This is likely to be the case for nickel since the estimated production of 20,000 tonnes per annum from the Syerston Project will only be a small proportion of the 1M tonnes per annum produced worldwide.

However, with respect to cobalt the 5,000 tonnes per annum production from the Syerston Project will be approximately a sixth of the current world production levels of 30,000 tonnes per annum and hence is expected to result in reductions in the world price.

The size of the gains in consumers' surplus from a price reduction depends on the level of price reduction, the elasticities of supply and demand and the increased production levels.

The calculation of consumers' surplus benefits were based on the following assumptions:

- that world price for cobalt reduces from A$24/lb (a moderate price for cobalt over the last 8 years to A$13.08 (the conservative price for cobalt assumed in this economic analysis);
- the increase in world production of cobalt is as identified in the production schedule in Table 3.3; and
- that the slopes of the demand and supply curves are equal.

This gives a net present value of consumer's surplus benefit from price reduction in the order of A$375M. Refer to Attachment 1 for an explanation of this consumers' surplus benefit.

Potential Negative Externalities

Black Range Minerals Ltd has considered a range of potential environmental impacts from the mining proposal and potential means of mitigation. Each is briefly considered here from an economic perspective.

Air quality – potential air quality impacts include dust generation and gaseous emissions from the processing plant and mine area to the surrounding environment. However, any potential externality costs will be largely internalised. Dust suppression methods such as hoods, shrouds, dust suppressants and road watering will be used where appropriate. Where air quality impacts do eventuate, these would impact consumer surpluses of individuals and could potentially be measured through property price effects, costs of illness or the contingent valuation method, depending on the nature of the impacts.

Hydrological impacts – Black Range Minerals Ltd propose to supply water to the project by pipeline from the Lachlan River paleochannel to a water storage dam on site. To the extent that this water abstraction results in some decline in aquatic and riverine ecosystems there would be an impact on the consumer surplus associated with visits to the affected area as well as non use values. To the extent that abstraction of water from the paleochannel results in a loss of water to other users there may be a loss in consumer or producer surplus, depending on the alternative water use. However, use of water from the paleochannel groundwater is not expected to impact riverine flows.

Any potential externalities associated with erosion and sedimentation associated with overland flow will be largely internalised by management and mitigation of potential impacts through implementation of an integrated erosion and sedimentation plan.

Noise impacts – the Syerston Project area is characterised by low ambient background noise levels in keeping with its predominantly rural setting. There could potentially be increased noise impacts at surrounding properties due primarily to the operation of the mine and processing facilities. However, modelling indicates that noise levels at most surrounding properties will not exceed the relevant noise emission criteria. Any surplus noise impacts would impact the consumers' surplus associated with adjoining properties and would be reflected in changes in property values.

Transportation Impacts – there is potential for increased road pavement damage and increased risk of accidents associated with transportation of mine and processing facilities inputs and product between the mine site and the railway siding. In order to mitigate these effects and internalise the potential impacts from transportation, Black Range Minerals Ltd is proposing to upgrade the existing rural road between the two locations to a two way, sealed roadway. This would have the effect of substantially increasing the safety and carrying capacity of the roadway for not only the Syerston Project but also for the local community.

Visual impacts – the visual character of the Syerston Project area is predominantly influenced by historic and existing land use practices such as clearing for grazing and cropping. The existing landscape is characterised by freehold, cleared lands with a small area of Crown land to the north east of the Project area that has previously been subjected to mining and a small area of State forest that has been subject to timber harvesting. Views of the Syerston mine and processing facilities will be limited to a few properties. To minimise visual impacts, infrastructure will be coloured to blend in where appropriated and appropriate bunding and planting will be undertaken. Visual intrusion can potentially impact the consumer surplus of surrounding households (reflected in changes in property values of affected lands) and visitors to surrounding areas (which can be measured via the contingent valuation method).

Flora and Fauna – the small area of regrowth State forest, disturbed vacant Crown land and vegetated areas within the natural gas and water pipeline corridors are the main areas of vegetation that will be impacted by the Syerston Project. However, ecological studies indicate that these lands have limited flora and fauna values and Project impacts would not be significant. Should there be any significant impacts on aquatic and terrestrial species or communities, these impacts would likely affect the non use economic values (consumers' surplus) of individuals and may be interpreted in an economic context via surveys to elicit the community's willingness to pay to avoid any potential impacts.

Risk of accidents and death to mine employees – there is some risk to mine employees associated with mining. This is an economic cost to the extent that individuals are willing to pay to avoid risk or willing to accept compensation to be exposed to risk of death. To the extent that higher wages for mine employees already includes a wage risk premium the economic costs of increased risk of accidents and death have already be internalised into the capital and operating costs of Black Range Minerals Ltd.

Heritage impacts – the Project may potentially disturb European and Aboriginal heritage sites. Mitigation measures are proposed to either protect or appropriately register and record sites to be disturbed in accordance with relevant regulatory requirements. Any impacts on heritage may impact the consumer surplus of visitors to the sites as well as people's non use values. These could potentially be measured through the contingent valuation method.

Non-quantified Potential Negative Externalities

Non-quantified potential negative externalities were assessed by couching the estimated production welfare benefits of the mining and processing facilities proposal as a minimum threshold value for assessing any potential negative environmental or social costs. The threshold value or net quantified production benefits of the Syerston Project comprise the minimum opportunity costs that the community would be obliged to incur if it did not wish the proposal to proceed.

3.6 Consolidation of Value Estimates

To determine the threshold value, a 7% discount rate was used to consolidate the streams of quantified economic production costs and benefits over time into a present value. Sensitivity testing of this present value using a 4% and 10% discount rate was also undertaken. The results of this discounting process are provided in Table 3.4.

Table 3.4 – Total Net Present Value of Quantified Net Production Benefits

	NPV @ 4%	NPV @ 7%	NPV @ 10%
Net Production Benefits	$1,231M	$802M	$514M
Consumers' Surplus from Price Effect for Cobalt	$498M	$375M	$290M
Total Production Benefits	$1,729M	$1,176M	$804M

Thus at a 7% discount rate, the quantified net production benefits of the Syerston Project would be a minimum of $1,176M.

However, it is traditional and continuing practice in benefit cost analysis to take a nationalistic definition of society and hence only consider the net benefits that accrue within, in this case, the Australian borders (Sinden and Thampapillai 1995). Consequently, some adjustment needs to be made to these net production benefits from the proposal to take into account that some of these benefits accrue overseas.

Producers' surplus benefits accrue to Black Range Minerals Ltd (and the general community through royalty payments to government) whereas consumers' surplus benefits from the price effect on cobalt will accrue to consumers' of cobalt.

Black Range Minerals Ltd advises that shareholdings in Black Range Minerals Ltd are predominantly held by Australians i.e. in the order of 95% of shares are held by Australians. Consequently, 95% of the net production benefits identified i.e. Table 3.4 are assumed to accrue to Australia i.e. $762M.

Black Range Minerals Ltd advises that there is negligible consumption of cobalt in Australia and hence it is assumed that none of the price effect benefits of cobalt production will accrue in Australia. Consequently, the net production benefit that accrues to Australia is estimated at $762M.

3.7 Application of Decision Criteria

NSW Treasury guidelines (1997) identify four decision criteria that can be used to determine the economic desirability (potential Pareto improvement) of a proposal, choose between mutually exclusive proposals or rank alternative proposals. However, the main decision criterion is usually the net present value (NPV). The NPV is the sum of the discounted benefits less the discounted costs. A positive NPV indicates that it would be desirable from an economic perspective for society to allocate resources to the project. If projects are mutually exclusive the alternative with the highest net present value is the most desirable in terms of economic efficiency. In this instance, because only some of the production costs and benefits have been able to be identified and valued, these discounted values represent a minimum threshold value.

What this indicates is that, on the basis of the assumptions made, there are likely to be net economic production benefits to Australia associated with the Syerston Project. If the external economic costs to Australia were likely to exceed $762M then from an Australian economic efficiency perspective the Syerston Project may not be desirable. However, to the extent that the potential external economic costs of the proposal may be able to be substantially ameliorated or are considered to be valued at less than $762M, the Syerston Project would be desirable from an Australian economic efficiency perspective.

3.8 Risk and Uncertainty

Risk is where the probability of occurrence of a variable is known, whereas uncertainty is characterised by the absence of information on probabilities. Risk can be incorporated into benefit cost analysis through attaching probabilities to benefits and costs and deriving an expected net present value. In most applications of benefit cost analysis, including this application, probability information is limited and instead there is uncertainty arising from the predictive ability of specialists giving estimates of the physical, social and ecological impacts of the Syerston Project, as well as the predictive ability of economists in estimating the economic effects of these impacts. Uncertainty can be dealt with through changing the values of critical variables in the analysis (James and Gillespie 1997). In this threshold value analysis, the net quantifiable production benefit to Australia (threshold value) was tested for changes to the following variables by plus and minus 20%:

- capital costs;
- operating costs;
- real prices of nickel and cobalt; and
- reduction in world cobalt price.

The results of the sensitivity testing indicated that under all changes in key assumptions the present value of the total net production benefits to Australia was strongly positive i.e. between $276M and $1,248M (at a discount rate of 7%). The level of the present value of total net production benefits varied as assumptions varied with the result being most sensitive to the change in world price of cobalt and nickel.

Thus from a threshold value perspective, under 20% changes in individual assumptions there is always an opportunity cost associated with not permitting the Syerston Project to proceed. Whether this opportunity cost would always exceed the external benefits of not proceeding would depend on the extent to which any environmental externalities of the proposal could be mitigated and the community's willingness to pay to avoid any identified environmental externalities.

One factor potentially reducing the identified threshold value relates to the differential growth rate of the value over time between nickel and cobalt and environmental goods and services. It has been postulated by Fisher, Krutilla and Cicchetti (1972) that environmental protection values may increase over time relative to those for producible goods. The more mutually exclusive the Project and the environmental benefits from the area, the greater the influence of differential growth rates on the identified threshold value i.e. the lower the threshold value. However, to the extent that the potential environmental externalities of the Syerston project are likely to be minimal the identified threshold value would not be significantly impacted.

3.9 Interpretation of the Threshold Value

To assist the decision-makers in interpreting the threshold value it is often useful to examine economic valuation studies of similar policy issues to get an indication of people's willingness to pay to avoid similar sorts of potential impacts. However, perusal of the economic valuation literature revealed no valuation studies of similar proposals with similar potential environmental impacts that could be utilised in this manner.

An alternative is therefore to interpret the threshold value in terms of how much each household in various geographic regions would need to be willing to pay to avoid the potential environmental impacts. If the decision-maker considered that households would be willing to pay these amounts, then this would make the economic costs of the proposal exceed the economic benefits and thus the proposal would be undesirable from an economic efficiency perspective (Table 3.5).

Table 3.5 - Interpretation of the threshold value in terms of WTP per household to avoid potential externalities of the proposal

Region	No. of Households	Threshold Value Per Household
Lachlan, Forbes and Parkes LGA	10,584	$71,969
Central West Statistical Division	63,853	$11,929
NSW	2,261,684	$337

The above table indicates every household in the region of Forbes, Lachlan and Parkes would need to be willing to pay in order of $71,969 to avoid the identified potential environmental impacts of the Syerston Project, to make the proposal undesirable from an Australian economic efficiency perspective. Alternatively each household in the Central West Statistical Division would need to be willing to pay in the order of $11,929 to avoid the identified potential environmental impacts of the Project, to make the proposal undesirable from an Australian economic efficiency perspective. The equivalent figure for NSW households is $337.

3.10 Conclusion

The Project is calculated to result in quantified net production benefits of $1,176M, with $762M of these benefits accruing to Australia. This figure represents the minimum opportunity cost to Australian society of not proceeding with the Project. Interpreted another way, any negative environmental externalities from the Project, after mitigation by Black Range Minerals Ltd, would need to be costed at greater than $726M to make the proposal questionable from an Australian economic efficiency perspective.

4.0 REGIONAL ECONOMIC IMPACT ASSESSMENT

4.1 Introduction

Economic impact assessment is primarily concerned with the effect of an impacting agent on an economy in terms of a number of specific indicators, such as employment, income, value added and output. An impacting agent may be a change to a local economy or may be an existing activity within an economy (Powell *et al*. 1985; Jensen and West 1986). This assessment is concerned with the likely impact of an additional activity (the Syerston Nickel-Cobalt Project) to a regional economy.

The assessment commences by examining the nature of the regional economy and then the likely regional economic impacts of both the construction phase and operational phase of the proposed Syerston Project. Consideration is then given to the likely regional economic impacts of cessation of the Project.

The economy on which the impact is measured can range from a township to the entire nation (Powell *et al*. 1985). In selecting the appropriate economy regard needs to be had to capturing the local expenditure associated with the mine proposal but not making the economy so large that the impact of the proposal becomes trivial (Powell and Chalmers 1995). Regard also needs to be had to available economic information.

For this study, it was decided to consider the impact of the proposed Syerston Project on the Central West Statistical Division of NSW. This comprises the Statistical Sub Division of Bathurst-Orange, Central Tablelands (excluding Bathurst-Orange) and the Lachlan. Statistical Local Areas included in this region are Blayney, Cabonne, Evans, Orange, Greater Lithgow, Oberon, Rylstone, Bland, Cowra, Forbes, Lachlan, Parkes and Weddin. Some consideration is also given to the potential impacts on small towns in the immediate vicinity of the proposal such as Tullamore, Fifield, Trundle, Ootha and Condobolin.

Powell *et al*. (1985) identify a range of methods that can be used to examine the economic impact of a shock on an economy. This includes economic base theory, Keynesian multipliers, econometric models, mathematical programming models and input-output models. This study uses regional input-output analysis.

4.2 Methodology

Input-output analysis essentially involves two steps:

- construction of an appropriate input-output table (regional transaction table);
- identification of the initial impact or stimulus in a form which is compatible with the input-output equations so that the input-output multipliers and flow-on effects can then be estimated (West 1993, p 2-1).

4.2.1 Transaction Table

The transaction table indicates the purchase and sale of goods and services between sectors in an economy over a period of time, usually 1 year, and therefore provides a detailed picture of the inter-sectoral linkages of the economy (West 1993). The table is in the form of a matrix with the rows indicating the sales from a sector to all other sectors and conversely the columns indicating the purchases of a sector from all the other sectors (Powell and Chalmers 1995).

The transaction table comprises four quadrants: the intermediate quadrant; the final demand quadrant; the primary inputs quadrant; and the primary input to final demand quadrant.

The intermediate quadrant, or interindustry quadrant as it is sometimes called, represents the interdependence or linkages among the producing sectors in the economy (Jensen and West 1986; West 1993).

The final demand quadrant identifies the disposal of output of each sector to final use of goods and services such as for household consumption, exports from the region, capital formation, government expenditure, net increases in stocks etc., rather than as inputs to other processing sectors in the economy (Jensen and West 1986; West 1993).

The primary inputs quadrant lists the inputs into each intermediate sector which are not purchased from firms within the local economy but originate outside the production system. These include salaries and wages, payments to government, gross operating surplus and imports by each sector (Jensen and West 1986; West 1993).

The primary inputs to final demand quadrant "shows those transactions which directly link the primary inputs to final demand without transmission through the local production system or intermediate quadrant" (Jensen and West 1986, p 16).

There are essentially three means of deriving input-output or transaction tables for an economy:

1. collection of detailed data from all firms in the economy through direct survey methods
2. using statistical and estimation methods involving no survey work; and
3. a combination or 'hybrid' of 1. and 2. above.

For this study, the Centre for Agricultural and Regional Economics (CARE) Pty Ltd provided a 1995/96 input-output table for the Central West Statistical Division. This was the most recent available model of the Central West economy. CARE utilised the 'hybrid', Generation of Regional Input-output Tables (GRIT) procedure, developed by the University of Queensland and recognised internationally, to develop the table. Refer to Attachment 2 for an overview of the GRIT system.

A 107 sector input-output table of the Central West economy was aggregated to 30 sectors and 6 sectors for the purpose of describing the economy. However, the full 107 sector input-output table was used in the impact assessment.

4.2.2 Identification of Initial Impact or Stimulus

For the purposes of this study, two impacts or stimulus were examined i.e.

- the expenditure by Black Ranges Minerals Ltd and the estimated direct employment levels during the construction phase of the Syerston Project; and
- the revenue and expenditure of Black Range Minerals Ltd and direct employment levels during the operation phase of the Syerston Project.

The estimated regional economic impact of two different aspects of the Syerston Project (construction and operation) were undertaken because expenditure, revenue and employment patterns may be quite different between these two phases and hence the regional economic impacts associated with them may also vary.

The impacts of operation of the Syerston Project are then used to infer the likely regional economic impacts of cessation of the Project.

4.3 Economic Structure of Regional Economy

4.3.1 Overview of the Central West Region Economy

A highly aggregated input-output table for the 1995/96 Central West economy is provided in Table 4.1. The rows of the table indicate how the output of an industry is allocated as sales to other industries, to households, to exports and other final demands (OFD, which includes stock changes, capital expenditure and government expenditure). The corresponding column shows the sources of inputs to produce that output. These include purchases of intermediate inputs from other industries, the use of labour (household income), the returns to capital or Other Value Added (OVA which includes gross operating surplus, depreciation and net indirect taxes and subsidies) and goods and services imported from outside the region. The number of people (from the region) employed in each industry is also indicated in the final row.

TABLE 4.1 - AGGREGATED TRANSACTIONS TABLE: CENTRAL WEST 1995-96, $'000

	Ag/Forest/Fish	Mining	Manufacturing	Utilities	Building	Services	TOTAL	H-hold Exp	O.F.D	Exports	Total
Ag/Forest/Fish	57431	261	167636	7	257	5139	230731	24626	21022	477579	753958
Mining	823	34442	33668	26683	2042	4292	101951	0	-4319	402518	500150
Manufacturing	10378	5275	181023	2122	52005	77098	327901	270813	51277	861592	1511583
Utilities	7810	8893	21743	15947	740	54273	109405	46777	1298	129377	286857
Building	2933	1401	275	208	155	75443	80415	0	227115	151	307681
Services	95790	37120	171349	13266	34312	391841	743677	1508226	750815	104459	3107177
TOTAL	175164	87392	575694	58233	89512	608085	1594079	1850442	1047208	1975676	6467406
H-hold Income	246527	129066	233838	45987	110771	1117307	1883495	0	0		1883495
O.V.A.	169415	185982	243745	161993	35145	768651	1564931	193371	46203		1804505
Imports	162852	97710	458307	20645	72253	613133	1424900	661990	388792		2475682
TOTAL	753958	500150	1511583	286857	307681	3107177	6467406	2705803	1482204	1975676	12631089
Employment	10142	2153	8391	1131	3640	43556	69013				

From this table it can be seen that the Gross Value of Output for the Central West economy was $6,467M. However, it is generally considered that Gross Regional Product is a better measure of economic activity as it avoids double counting associated with purchases of intermediate products.

Gross Regional Product for Central West economy was $3,448M that included $1,883M paid to households as wages and salaries (including imputed payments to self-employed and employers) and $1,565M in Other Value Added.

The employment total for the Central West economy was 69,013 with average wage and salary earned being $27,000 per person.

Figure 4.1 – Summary of Aggregated Sectors: Central West (1995-96)

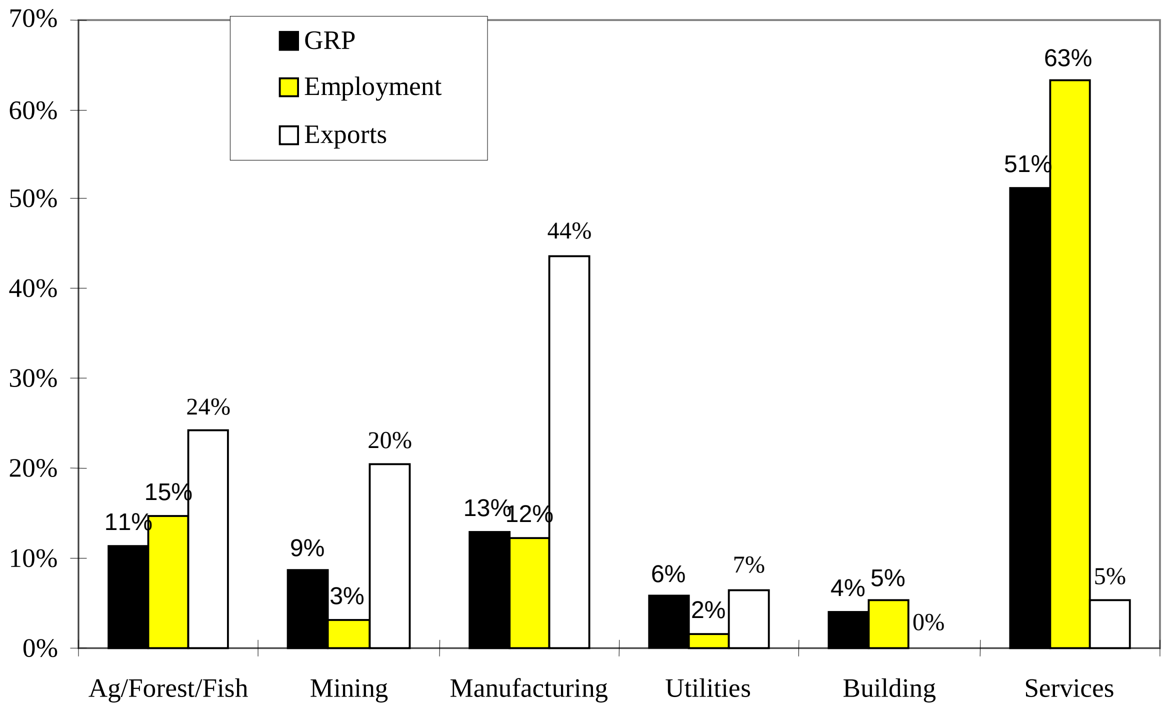
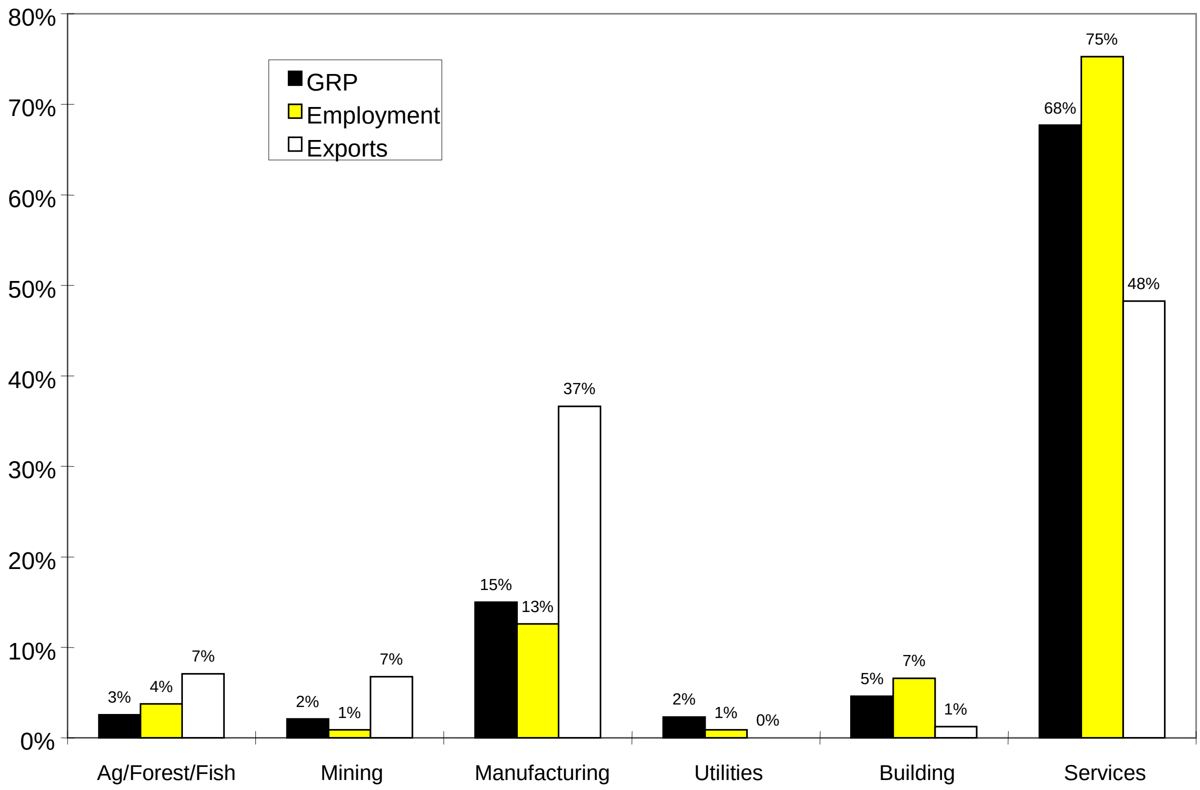


Figure 4.2 – Summary of Aggregated Sectors: NSW (1995-96)

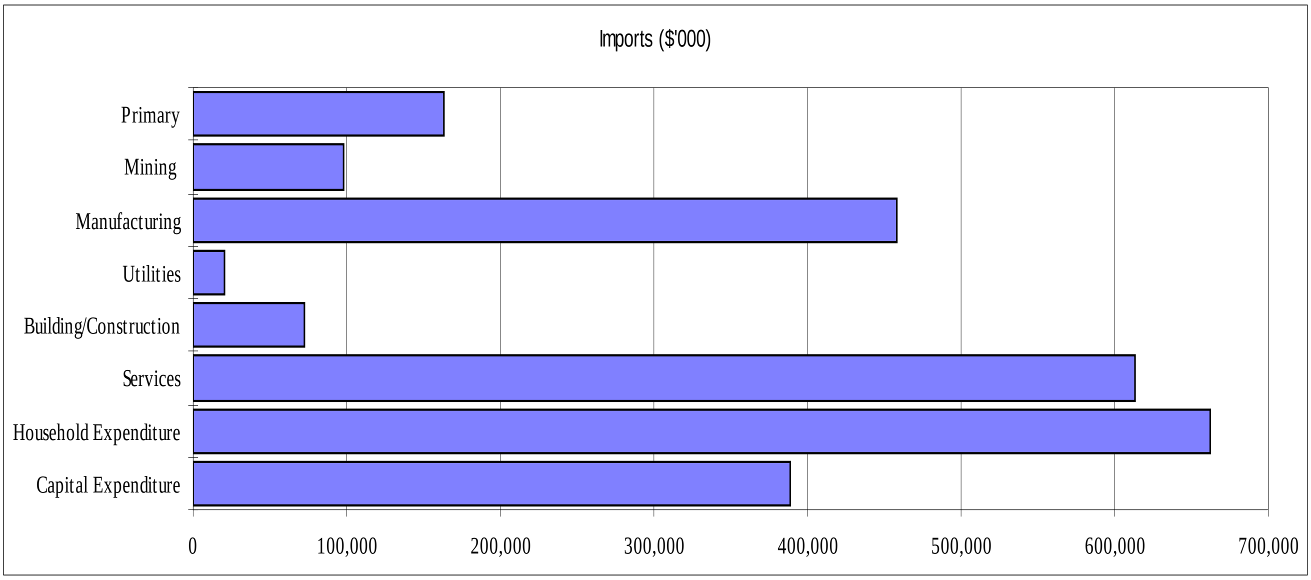


Reference: Powell *et al*. 1999.

The economic structure of the Central West region may be compared with that for NSW through a comparison of Figure 4.1 and Figure 4.2. This reveals that in the Central West economy, agriculture/forestry/fishing, mining, utilities are of greater relative importance than they are to the NSW economy, while services are of less relative importance. The relative importance of manufacturing and building are similar in the Central West to NSW.

The Central West region imports ($2,476M) a slightly greater value of goods and services than it exports ($1,976M). 84% of exports relate to the manufacturing, mining and agriculture/forest/fishing sector with the contribution of each of these sectors to exports being 44%, 20% and 24% respectively. The destination of imports in the local region from all sources (overseas, inter regional and interstate) are shown in aggregate in Figure 4.3 and in detail by industry in Figure 4.9. As is the case with most regions, the largest import items are goods for consumption by local households i.e. 27% of all imports. However, there are also significant imports to the services and manufacturing sectors. Expenditure on capital items represented 15.7 % of imports.

Figure 4.3 – Distribution of Imports by Destination Sector



Household expenditure was $2,706M. This is 78% of the GRP of $3,448M and more than the payments to households as wages and salaries. A number of factors potentially contribute to this including a high proportion of non-working dependents (such as retirees), a high level of social welfare recipients, the earnings from investments and a likely significant "informal" economy. These factors enable regional households to spend much more on consumption expenditure than they earn from wage and salary employment (Powell *et al*. 1999).

Figures 4.4 to 4.11 provide a more expansive sectoral distribution of gross output, employment, household income, value added, exports and can be used to provide some more detail in the description of the economic structure of the economy.

In terms of output, food manufacturing is the most significant industry sector in the regional economy, followed by retail trade and property services. The greatest sectoral contribution to regional value added are from coal mining, food manufacturing, utilities, retail trade transport, property services, education and health. In terms of employment the tertiary sectors contribute the greatest level reflecting their labour intensive nature. In terms of wages to households the tertiary sectors again are substantial contributors. The majority of exports from the region are in the agriculture, mining and manufacturing sectors while imports are more evenly spread across sectors.

As indicated in Figure 4.10 the mining sectors are also one of the most productive sectors of the Central West economy (as measured through Gross Regional Product per employee) and has the highest average wage of all the economy sectors. Refer to Figure 4.11.

Figure 4.4 – Sectoral Distribution of Output ($,000)

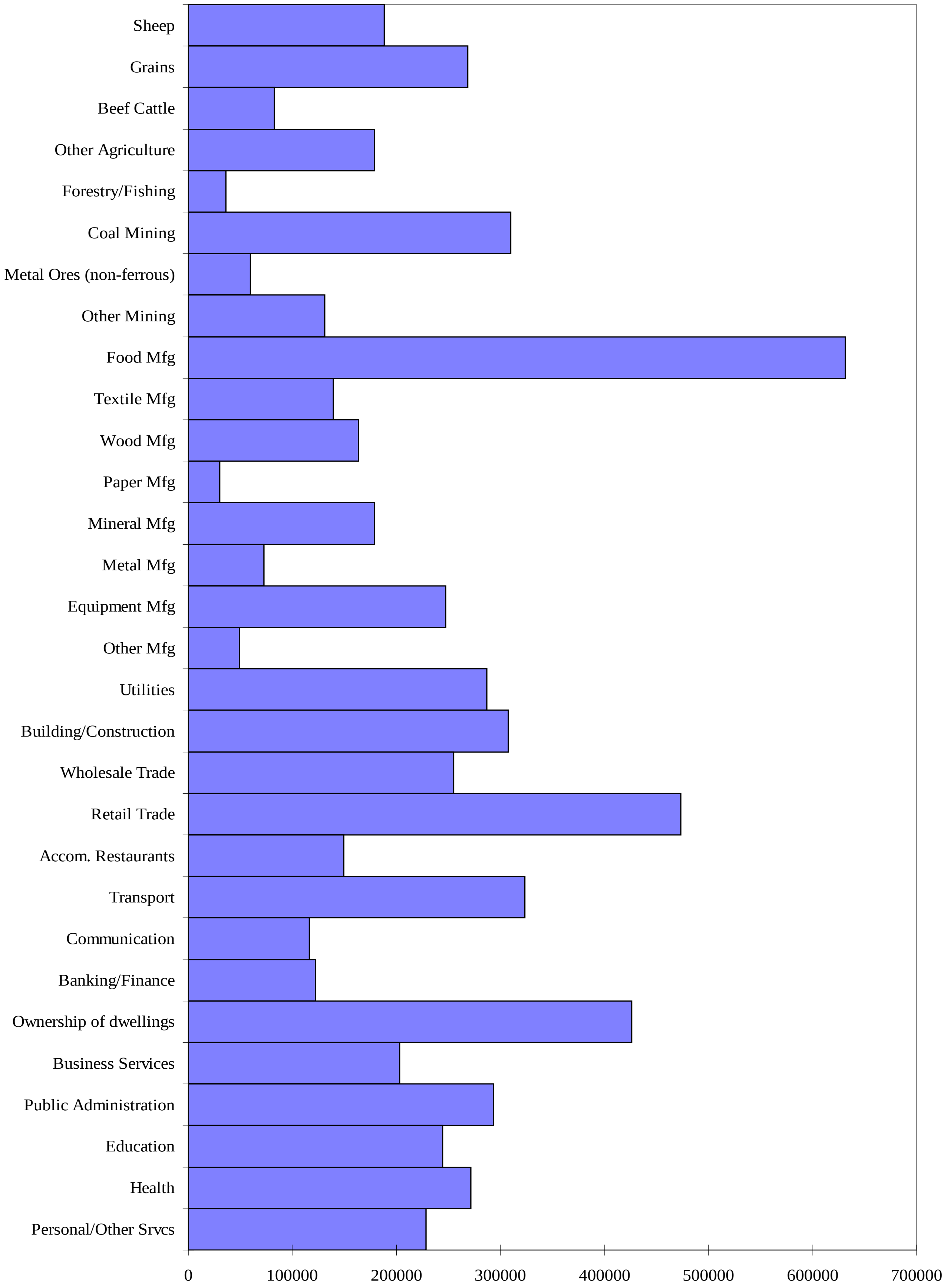


Figure 4.5 - Sectoral Distribution of Gross Regional Product ($,000)

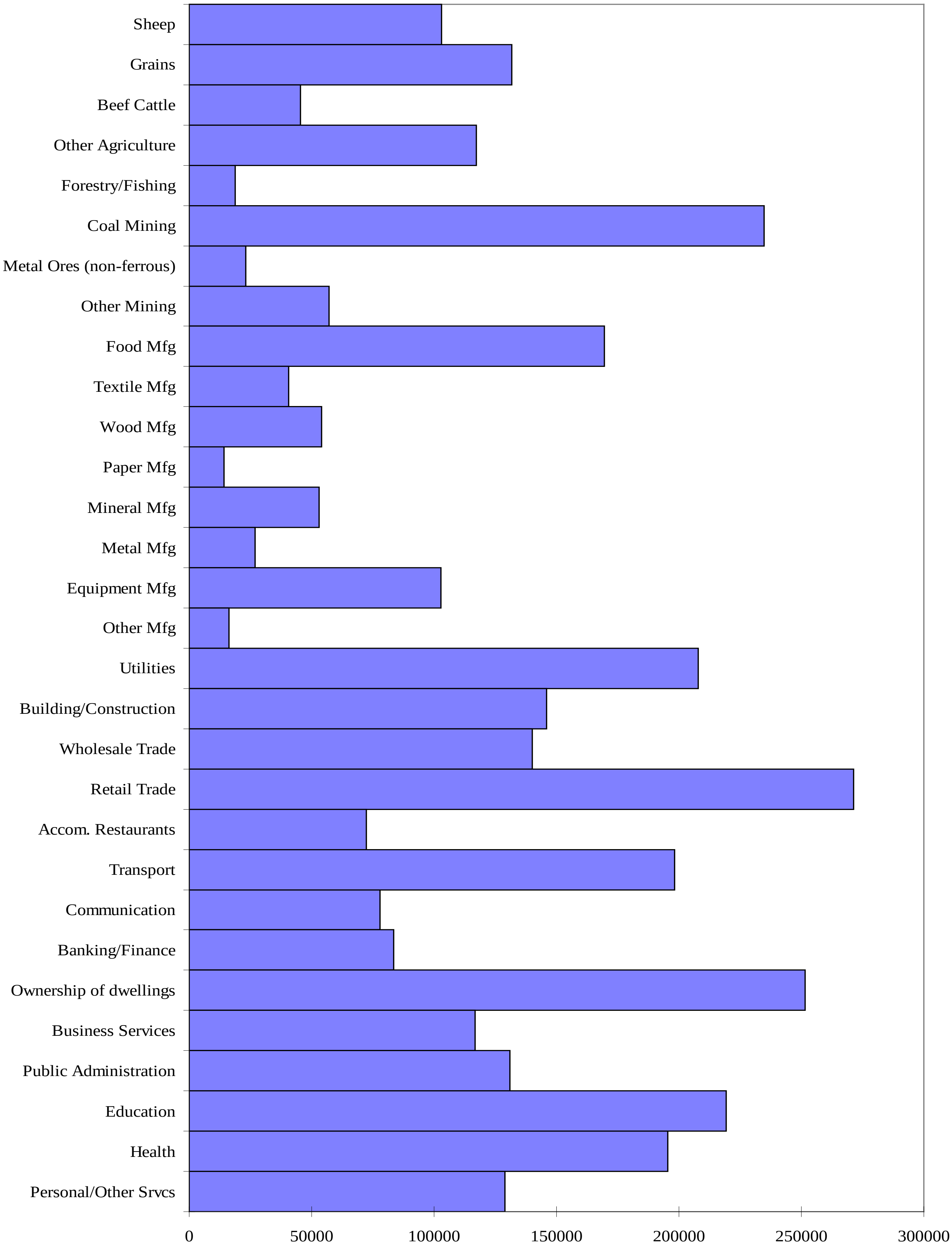


Figure 4.6 – Sectoral Distribution of Income ($,000)

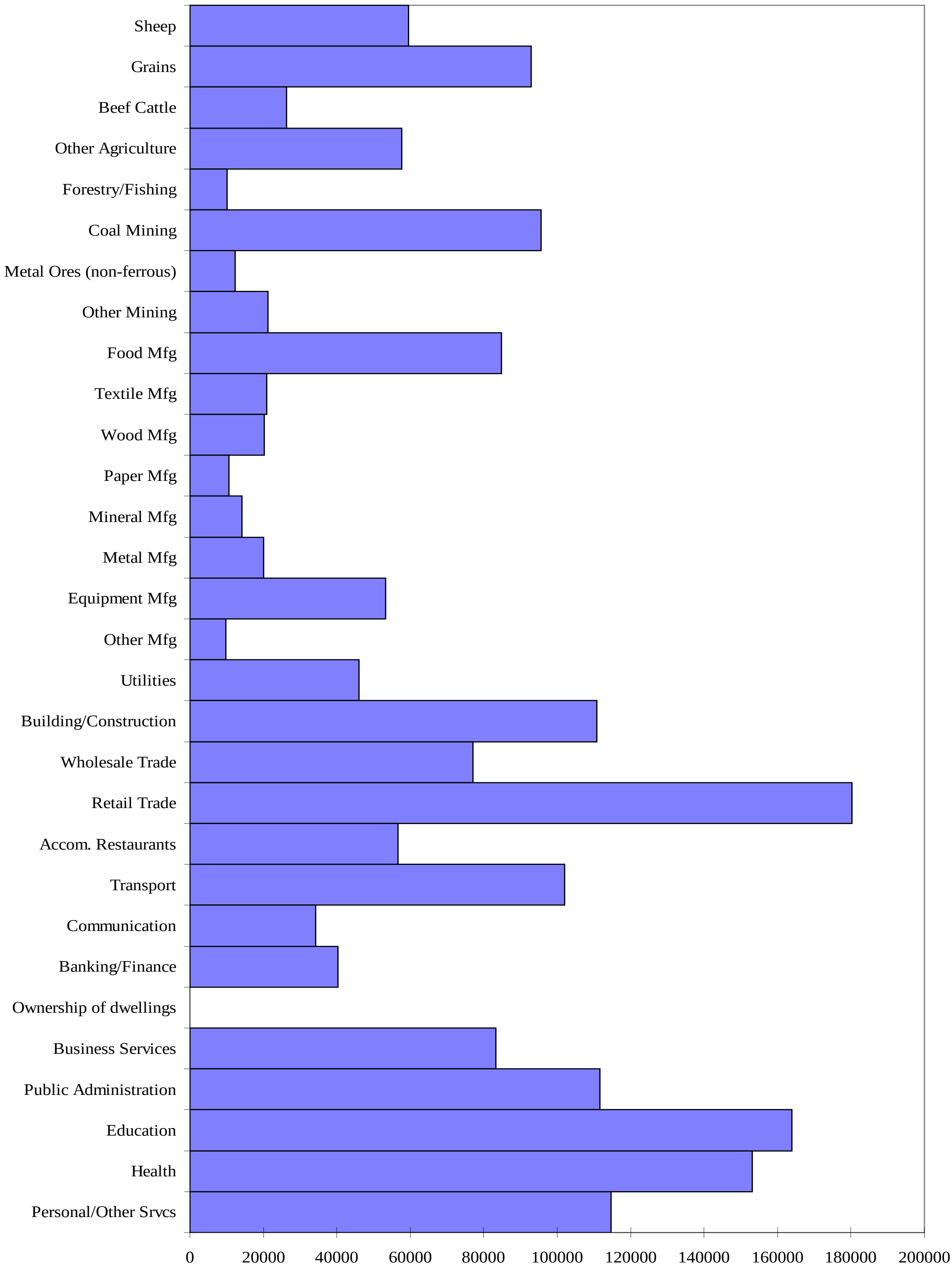


Figure 4.7 – Sectoral Distribution of Employment (No's)

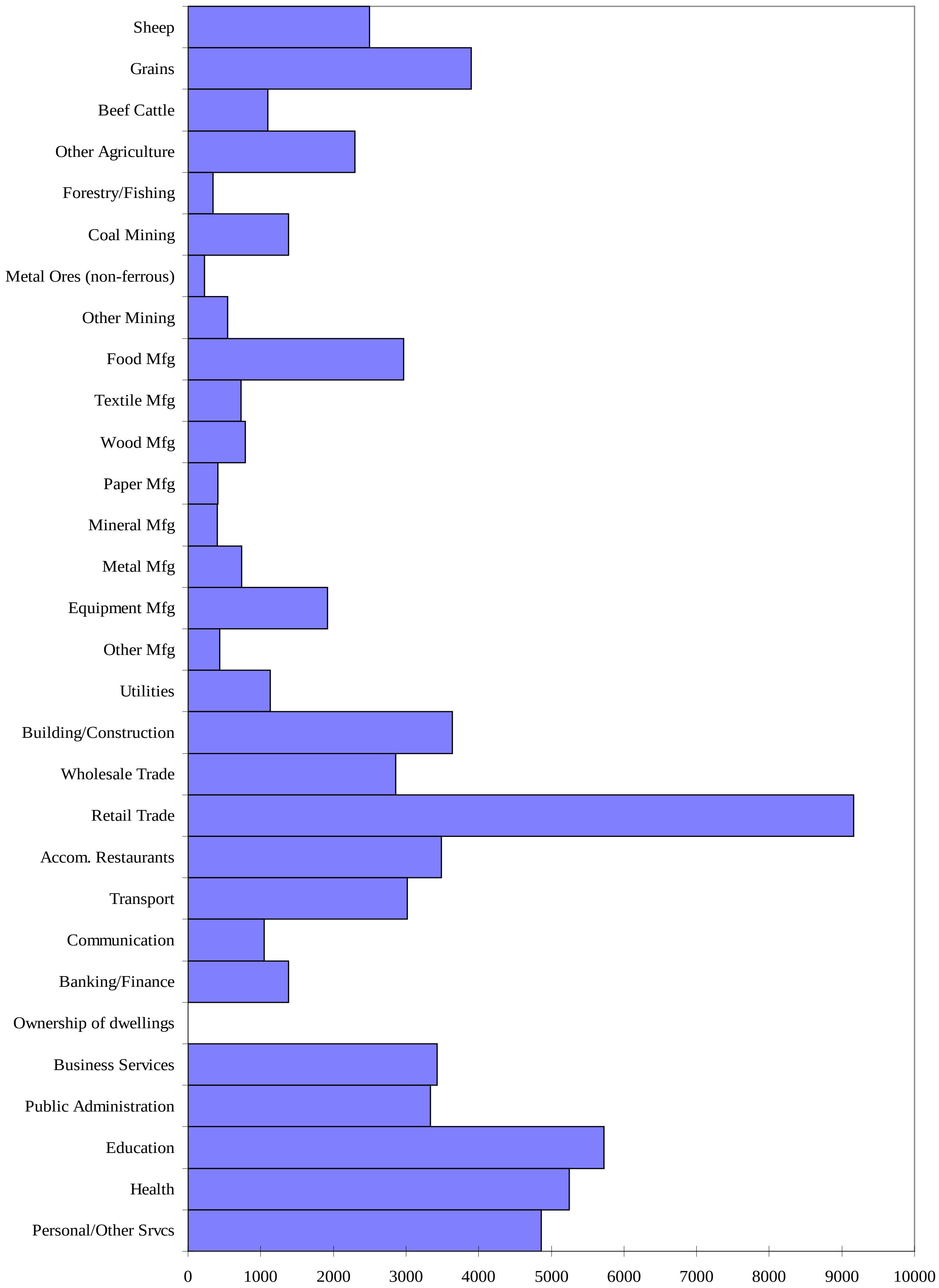


Figure 4.8 – Sectoral Distribution of Exports ($,000)

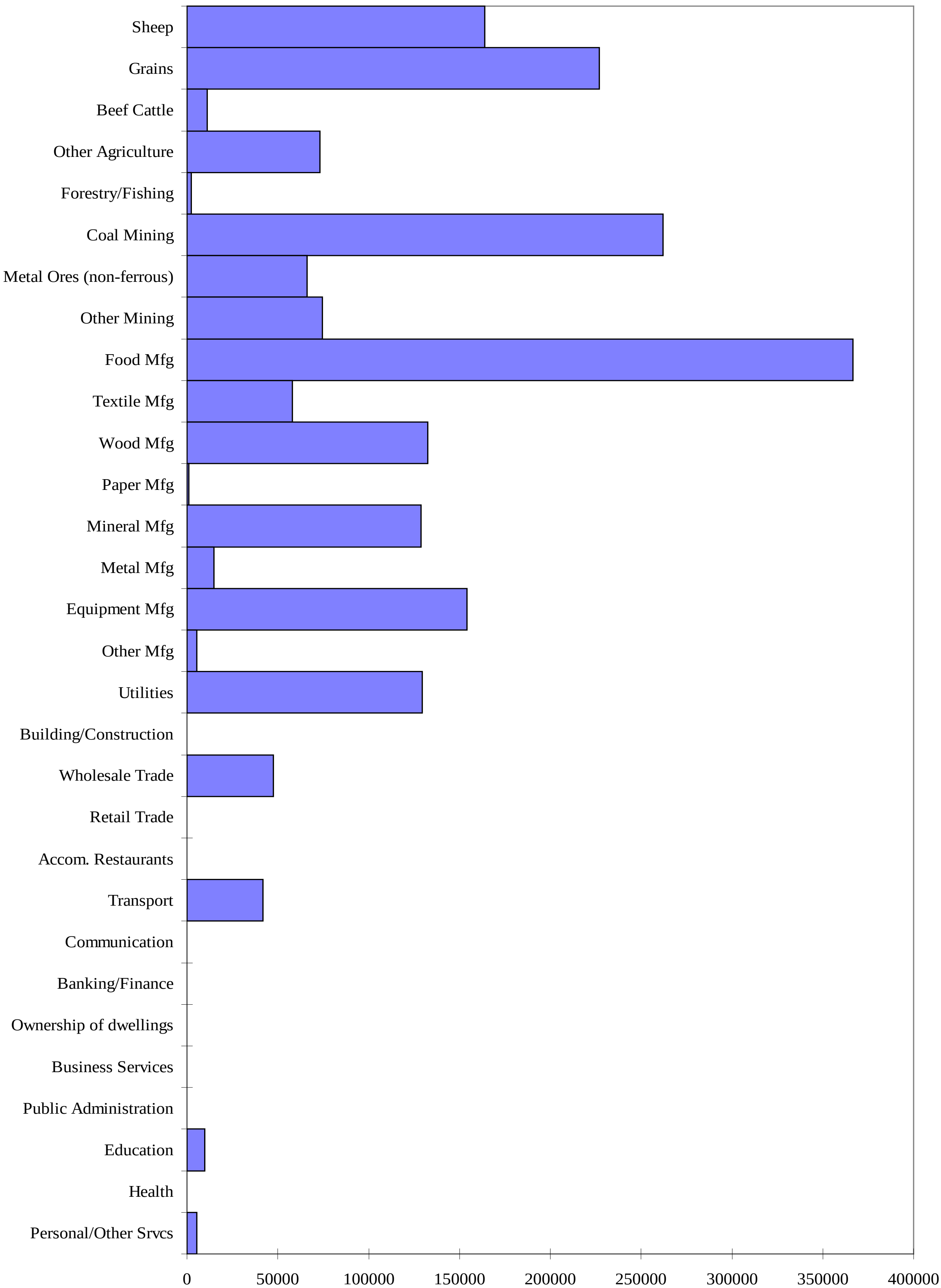


Figure 4.9 – Sectoral Distribution of Imports ($,000)

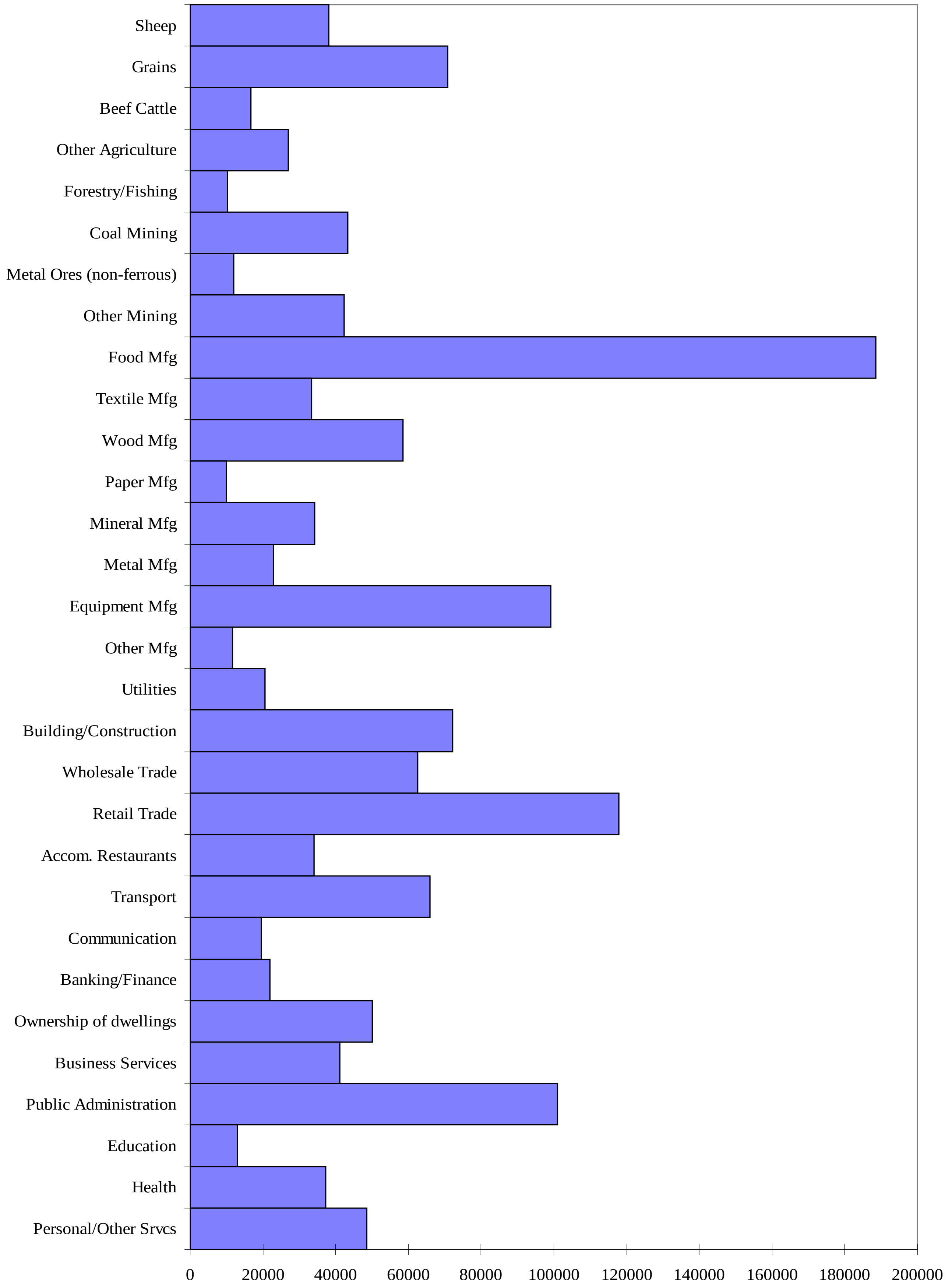


Figure 4.10 – Sectoral Distribution of Productivity (GRP ($,000)/person)

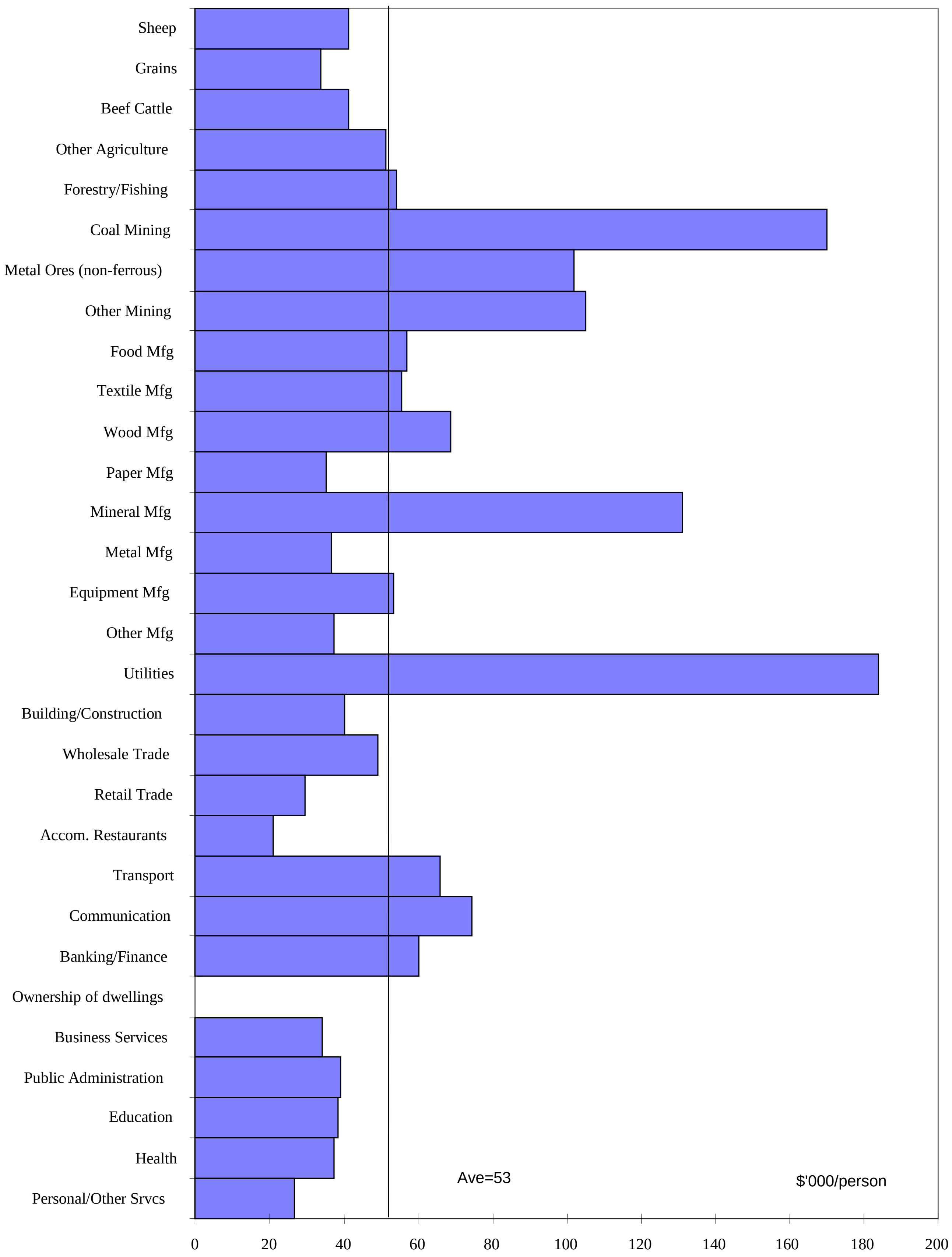
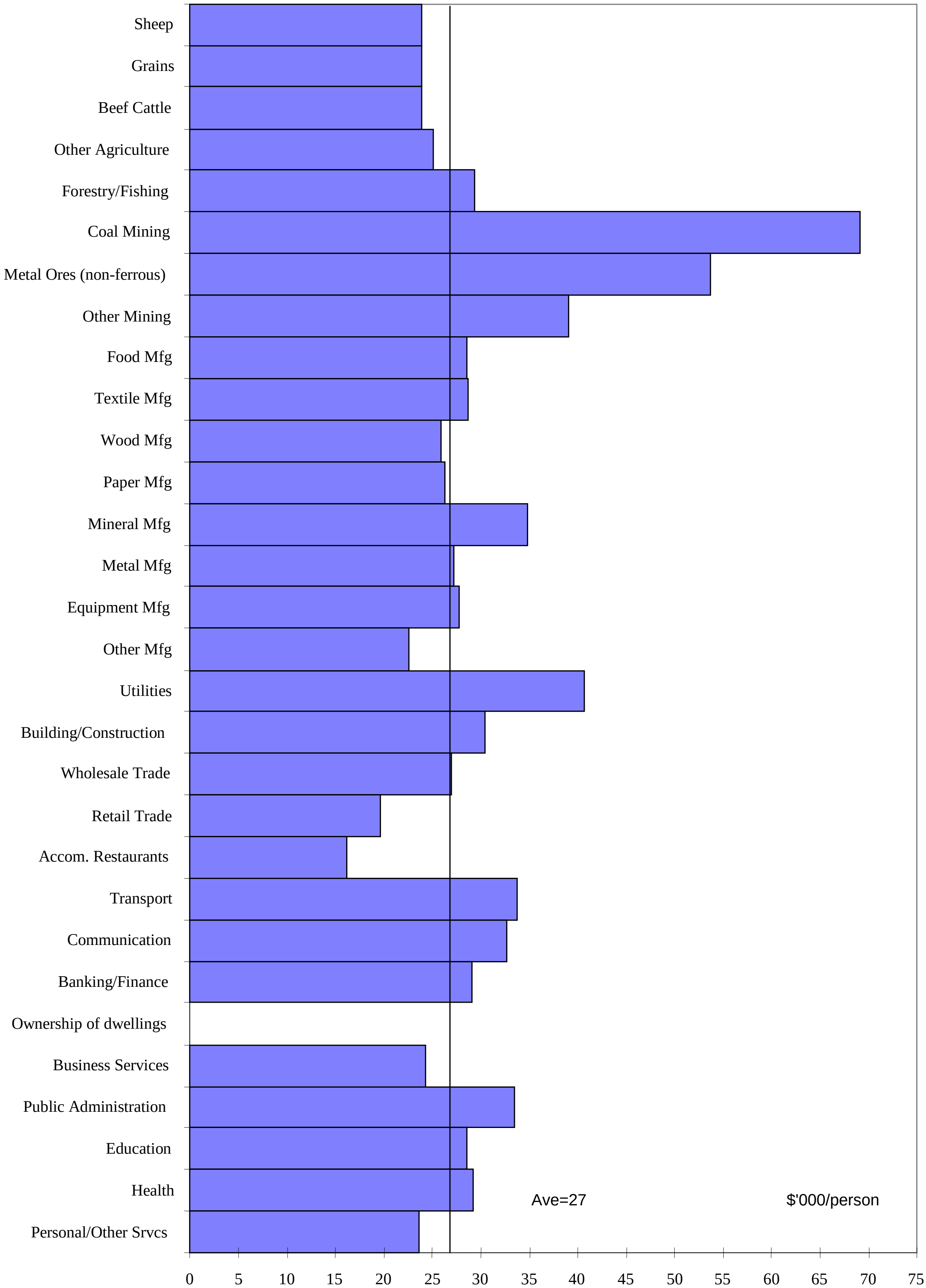


Figure 4.11 – Sectoral Distribution of Average Wages and Salaries



4.3.2 Multipliers

The multipliers for each sector of the economy can also be derived from the input-output table for the Central West economy.

The calculation of multipliers from the input-output table is based on the following underlying assumptions:

- “there is a fixed input structure in each industry, described by fixed technological coefficients....;
- all products of an industry are identical or are made in fixed proportions to each other;
- each industry exhibits constant returns to scale in production;
- unlimited labour and capital are available at fixed prices.....; and
- there are no other constraints, such as the balance of payments or the actions of government, on the response of each industry to a stimulus.” (ABS 1995, p 24).

Multipliers therefore do not take account of economies of scale, unused capacity or technological change since they describe average effects rather than marginal effects (ABS 1995).

Multipliers indicate the total impact of changes in demand for the output of any one industry on all industries in an economy (ABS 1995). Conventional output, employment, value added and income multipliers show the output, employment, value added and income responses to an initial output stimulus (Jensen and West 1986).

Components of the conventional output multiplier are as follows:

Initial Effect - which is the initial output stimulus, usually a $1 change in output from a particular industry (Powell and Chalmers 1995; ABS 1995).

First round effects - the amount of output from all intermediate sectors of the economy required to produce the initial $1 change in output from the particular industry (Powell and Chalmers 1995; ABS 1995).

Industrial support effects - the subsequent or induced extra output from intermediate sectors arising from the first round effects(Powell and Chalmers 1995; ABS 1995).

Production induced effects - the sum of the first round effects and industrial support effects i.e. the total amount of output from all industries in the economy required to produce the initial $1 change in output (Powell and Chalmers 1995; ABS 1995).

Consumption induced effects - the spending by households of the extra income they derive from the production of the extra $1 of output and production induced effects. This spending in turn generates further production by industries (Powell and Chalmers 1995; ABS 1995).

The *simple multiplier* is the initial effect plus the production induced effects.

The *total multiplier* is the sum of the initial effect plus the production-induced effect and consumption induced effect.

Conventional employment, value added and income multipliers have similar components to the output multiplier, however, through conversion using the respective coefficients show the employment, value added and income responses to an initial output stimulus (Jensen and West 1986).

For employment, value added and income it is also possible to derive relationships between the initial or own sector effect and flow-on effects. For example, the flow-on income effects from an initial income effect or the flow-on employment effects from an initial employment effect etc. These own sector relationships are referred to as ratio multipliers, although they are not technically multipliers because there is no direct line of causation between the elements of the multiplier. For instance, it is not the initial change in income that leads to income flow-on effects, both are the result of an output stimulus (Jensen and West 1986).

A description of the different ratio multipliers is given below.

$$\text{Type 1A Ratio Multiplier} = \frac{\text{Initial + First Round Effects}}{\text{Initial Effects}}$$

$$\text{Type 1B Ratio Multiplier} = \frac{\text{Initial + Production Induced Effects}}{\text{Initial Effects}}$$

$$\text{Type 11A Ratio Multiplier} = \frac{\text{Initial + Production Induced + Consumption Induced Effects}}{\text{Initial Effects}}$$

$$\text{Type 11B Ratio Multiplier} = \frac{\text{Flow-on Effects}}{\text{Initial Effects}}$$

(Centre for Farm Planning and Land Management 1989, p.207)

Multipliers for the 107 sector Central West economy are provided in Attachment 3.

4.5 Economic Impact of the Syerston Project

4.5.1 Construction Phase

Economic activity associated with the Syerston construction phase could essentially occur in two sectors of the economy i.e:

- the building and construction sectors; and
- the metal/machinery/equipment/other manufacturing sectors.

The former sector includes economic activity in the preparation of mine sites as well as the construction of non residential buildings, such as the processing plant. The latter sector refers to that part of the economy engaged in the manufacturing of machinery, equipment and plant that may be used in mining and ore processing facilities. For the purposes of this report, the construction phase is adopted as 36 months (ie 3 years) which includes a 12 month period of off-site activity and capital cost expenditure followed by 24 months of on-site construction activity.

In total, the capital costs of mine preparation and construction of the ore processing facilities and water and natural gas pipelines is estimated to be in the order of $629M, spread over 3 years i.e. $119.4M in year 1, $319.5M in year 2 and $190.1M in year 3. Of this, in the order of $300M is projected to be plant and equipment costs, leaving $329M as building and construction expenditure i.e. approximately 52% of capital expenditure relates to building and construction.

Given the largely specialist nature of capital equipment, for the purpose of this analysis it is assumed that all such purchases are made from outside the region. Thus regional economic activity from the mine establishment phase primarily relates to the building and construction sector.

The peak of building and construction expenditure is estimated to be $167M in year 2 (i.e. 52% of the total $319.5M capital expenditure in year 2). Black Range Minerals Ltd identify that the building and construction expenditure is predominantly for the construction of the ore processing facilities and is highly specialised. Consequently, much of the skill base needed to undertake this work would be brought into the region.

Data obtained from Black Range Minerals Ltd indicates that in the peak construction year the project will have an estimated average workforce over the year of 611 (ranging on a month by month basis from zero in January of year 2 to a maximum of 962 in September of year 2). In the order of 21% of this construction workforce is likely to be sourced from the Central West region i.e. 200 during the peak month and 128 on average for the peak year of construction.

A starting point for consideration of the indicative magnitude of regional economic impacts associated with this construction activity can be obtained by assuming that:

- the new building and construction sector enterprises that temporarily establish in the region will have the same input output coefficients and hence regional linkages as the existing building and construction sector in the Central West Statistical Division; and
- the 611 yearly average direct workforce in the peak year of construction will have the same pattern of regional expenditure as a normal workforce within the region.

Under these assumption 28% of the $167M building and construction expenditure would need to be spent within the region to result in a direct workforce of 611 people. The direct and indirect regional economic impacts of this level of expenditure in the region in the peak year for the construction phase of the Syerston Project is provided below.

Impacts

On the basis of the above assumptions, Table 4.2 indicates what the total and disaggregated regional economic impacts of the peak year of the construction phase of the Syerston Project on the Central West economy in terms of output, value added, income and employment would be. These unadjusted impacts are based on the estimated average annual direct effects in the peak year of construction and the multipliers in Table 4.5.

Table 4.2 – Unadjusted Regional Economic Impacts of the Construction Phase of the Syerston Project

	Direct Effect	Production Induced	Consumpt. Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	46,590	17,418	29,525	46,943	93,533
INCOME ($'000)	19,852	4,392	8,363	12,755	32,607
VALUE ADDED ($'000)	24,303	8,555	16,296	24,851	49,154
EMPL. (No.)	611	157	350	507	1,118

The total regional impacts referred to above, separate out the flow-on effects that are associated with firms buying goods and services from each other (production-induced effects) and the flow-on effects that are associated with employing people who subsequently buy goods and services as households (consumption-induced effects). It is important to separate these two effects as they operate in different ways and have different spatial impacts.

Production-induced effects occur in a near-proportional way, whereas the consumption-induced flow-on effects will only occur in a proportional way if workers and their families enter or leave the region. The implicit assumption in the impact summary provided in Table 4.2, is that all employment generated by the construction phase is sourced from workers outside the region who subsequently migrated into the region. Advice from Black Range Minerals Ltd about the specialist nature of the construction workforce suggests that in the order of 21 % of construction workforce will be sourced from the Central West region.

Thus a conservative estimate of the consumption induced flow-on effects is to take 79% of those identified in Table 4.2. This is conservative since it assumes that the 21% of construction workforce who already reside in the Central West region are employed and earn a similar salary to what they will receive working on the Syerston Project construction. To the extent that this overestimates the existing spending power of future employees who already reside in the region the consumption induced effects will be underestimated.

Adjusted estimates of regional economic impacts of the construction phase of the Syerston Project, having regard to the estimated sourcing of labour, are provided in Table 4.3. The associated multipliers are provided in Table 4.6.

Table 4.3 – Adjusted Annual Regional Economic Impacts of the Construction Phase of the Syerston Project

	Direct Effect	Production Induced	Consump. Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	46,590	17,418	23,325	40,743	87,333
INCOME ($'000)	19,852	4,392	6,607	10,999	30,851
VALUE ADDED ($'000)	24,303	8,555	12,874	21,429	45,732
EMPL. (No.)	611	157	277	434	1,045

However, there are good reasons to suspect that the impacts summarised in Table 4.3 may overestimate the regional economic impacts of the construction phase of the Project.

Firstly, given the very specialised nature of construction activity, particularly that related to construction of the ore processing facilities, it is highly likely that contractors associated with the building and construction phase may exhibit purchasing patterns that have a greater reliance on imports rather than local production.

Secondly, given the manner in which labour will be accommodated i.e. in an onsite camp, it is highly likely individual expenditure pattern will differ and be less than the remainder of the workforce in the region.

It is difficult to predict the likely regional expenditure patterns. However to take some account of the abovementioned likely eventualities, production induced effects and consumption induced effects have been halved. The results are reported in Table 4.4. The associated multipliers are provided in the Table 4.7.

Table 4.4 – Final Estimated Regional Economic Impacts of the Construction Phase of the Syerston Project

	Direct Effect	Production Induced	Consumpt. Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	46,590	8,709	11,662	20,371	66,961
INCOME ($'000)	19,852	2,196	3,303	5,499	25,351
VALUE ADDED ($'000)	24,303	4,278	6,437	10,714	35,017
EMPL. (No.)	611	79	138	217	828

In total, the peak year of construction of the Syerston Project may contribute up to $67M in annual direct and indirect regional output or business turnover, $35M in direct and indirect regional value added including $25M in household income. The direct and indirect employment impact may be up to 828. These total impacts are based on estimates of average annual direct effects in the peak year of construction and type 11A ratio multipliers estimated between 1.227 for income and 1.441 for output. These particular average annual total impacts on the regional economy are only likely to be felt for a period of in the order of 1 year with lesser construction impacts felt in year 1 and year 3 of construction.

Multipliers

The unadjusted type 11A ratio multipliers for the peak year of the construction phase of the Syerston Project are provided in Table 4.5.

Table 4.5–Unadjusted Multipliers for the Construction Phase of the Syerston Project

	Initial Effect	Productn. Induced	Consum. Induced	Total Flow-on	TOTAL
OUTPUT					
Type 11A Ratio	1.000	0.374	0.634	1.008	2.008
INCOME					
Type 11A Ratio	1.000	0.221	0.421	0.643	1.643
VALUE ADDED					
Type 11A Ratio	1.000	0.352	0.671	1.022	2.023
EMPL. (No.)					
Type 11A Ratio	1.000	0.257	0.572	0.829	1.829

Any anomaly between the total and the addition of the components of the total are due to rounding

The adjusted type 11A ratio multipliers for the peak year of construction, to take account of assumptions regarding the use of local labour, are provided in Table 4.6.

Table 4.6– Adjusted Multipliers for the Construction Phase of the Syerston Project

	Initial Effect	Productn. Induced	Consum. Induced	Total Flow-on	TOTAL
OUTPUT					
Type 11A Ratio	1.000	0.374	0.501	0.875	1.875
INCOME					
Type 11A Ratio	1.000	0.221	0.333	0.554	1.554
VALUE ADDED					
Type 11A Ratio	1.000	0.352	0.530	0.882	1.882
EMPL. (No.)					
Type 11A Ratio	1.000	0.257	0.452	0.709	1.709

Any anomaly between the total and the addition of the components of the total are due to rounding

However, taking account of the likely different expenditure pattern within the region by both the proponent and the employees the effective type 11A ratio multipliers used to calculated the final estimated average annual regional economic impacts of the peak year of the construction phase of the Syerston Project are given in Table 4.7.

Table 4.7– Final Multipliers Used for the Construction Phase of the Syerston Project

	Initial Effect	Productn. Induced	Consum. Induced	Total Flow-on	TOTAL
OUTPUT					
Type 11A Ratio	1.000	0.187	0.250	0.437	1.437
INCOME					
Type 11A Ratio	1.000	0.111	0.166	0.277	1.277
VALUE ADDED					
Type 11A Ratio	1.000	0.176	0.265	0.441	1.441
EMPL. (No.)					
Type 11A Ratio	1.000	0.129	0.226	0.354	1.354

Any anomaly between the total and the addition of the components of the total are due to rounding

The final Type 11A ratio multipliers for the construction phase of the mining proposal range from 1.277 for income up to 1.441 for value added.

4.5.2 Operation Phase

For the analysis of the operation phase of the Syerston Project, a new Syerston sector was inserted into the input-output table. For this new sector, the estimated average annual gross revenue, average annual operating expenditure, average employment numbers and average wages bill were determined from Black Range Minerals Ltd’s financial spreadsheets.

Estimated average annual gross revenue was allocated to the *total output value* row of the new Syerston sector. The difference between average annual gross revenue and average annual operating costs was allocated to the *other value-added sector.* Payments to labour were allocated to the *household sector*.

This left average annual operating costs (net of payments to labour) to be allocated across *intermediate sectors* and *imports* to the region. Advice from Black Range Minerals Ltd was that annual operating costs included in the order of $65M of reagents such as sulphur, natural gas, limestone, magnesium oxide and sodium hydroxide. Natural gas inputs to the production process were estimated to be in the order of $9M per annum. This amount was allocated to the *gas supply sector* (after making adjustments to basic values and allowing for imports based on the location quotient for the natural gas sector). $6.5M of purchases of limestone were estimated to come from the Black Range Minerals Ltd’s own limestone quarry and hence can be considered to be an internal purchase.

The remaining $49.5M of reagents was allocated to *imports* in accordance with advice from Black Ranges Minerals Ltd regarding the likely source of these purchases. This left in the order of $81M of production costs to be allocated between *intermediate* sectors within the Central West regional economy or to *imports*. Consistent with advice from Black Range Minerals Ltd that the bulk of purchases would be from outside the region, 80% of the remaining production costs were allocated to imports. For the 20% of remaining production costs assumed to be expended within the Central West region:

- 12% was considered to be spent on mining relating aspects of the project (generally in proportion to the expenditure profile in the region for the *non ferrous metal ores* sector i.e. the parent sector within which activities such as nickel and cobalt mining are generally located); and
- 88% was considered to be spent on ore processing facilities related aspects (generally in accordance with the expenditure profile in the region for the basic *non-ferrous metal and products* sector i.e. the parent sector within which activities such as refining of nickel and cobalt are located).

In total this resulted in an assumption that 17% of non labour operating costs or 30% of total operating costs would be expended in the Central West regional economy.

On this basis the estimated regional economic impacts of the operation phase of the Syerston Project were determined.

Impacts

The total and disaggregated annual impacts of the operational phase of the Syerston Project on the Central West Statistical Division in terms of output, value added, income and employment (in 1999/2000 dollars) are shown in Table 4.8. The associated multipliers are provided in Table 4.10.

Table 4.8 – Unadjusted Annual Regional Economic Impacts of the Operation Phase of the Syerston Project

	Direct Effect	Production Induced	Consump. Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	290,000	32,211	39,628	71,839	361,839
INCOME ($'000)	25,454	7,086	11,224	18,310	43,764
VALUE ADDED ($'000)	156,410	17,713	21,872	39,585	195,995
EMPL. (No.)	371	188	469	657	1,028

The implicit assumption in the impact summary provided in Table 4.8 is that all employment generated by the proposal is sourced from workers outside the region who subsequently migrate into the region. While the specialist nature of the mining and processing facilities operation means that the majority of the operational workforce will be sourced from outside the region, Black Range Minerals Ltd has indicated that in the order of 100 jobs i.e. 27%, may be able to be filled from local labour.

Thus a conservative estimate of the consumption induced flow-on effects is to take 73% of those identified in Table 4.8. This is conservative since it assumes that the 27% of employees who already reside in the Central West region are employed and earn a similar salary to what they will receive working on the Syerston Project. To the extent that this overestimates the existing spending power of future employees who already reside in the region the consumption induced effects will be underestimated.

Adjusted estimates of regional economic impacts of the operation phase of the Syerston Project, having regard to the estimated sourcing of labour, are provided in Table 4.9. The associated multipliers are provided in Table 4.11.

Table 4.9 – Adjusted Annual Regional Economic Impacts of the Operation Phase of the Syerston Project

	Direct Effect	Production Induced	Consump. Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($'000)	290,000	32,211	28,928	61,139	351,139
INCOME ($'000)	25,454	7,086	8,194	15,280	40,734
VALUE ADDED ($'000)	156,410	17,713	15,967	33,680	190,090
EMPL. (No.)	371	188	342	530	901

In total, the operation of the Syerston Project is likely to contribute in the order of $351M in annual direct and indirect regional output or business turnover, $190M in direct and indirect regional value added including $41M in household income. The direct and indirect employment impact is likely to be in the order of 901. These total regional impacts are based on the estimates of average annual direct effects in the operation phase of the project and type 11A ratio multipliers estimated between 1.211 for output and 2.430 for employment.

Multipliers

The unadjusted and adjusted type 11A ratio multipliers for the operational phase of the Syerston Project are provided in Table 4.10 and Table 4.11 below.

Table 4.10 – Unadjusted Multipliers for the Operation Phase of the Syerston Project

	Initial Effect	Productn. Induced	Consum. Induced	Total Flow-on	TOTAL
OUTPUT					
Type 11A Ratio	1.000	0.111	0.137	0.248	1.248
INCOME					
Type 11A Ratio	1.000	0.278	0.441	0.719	1.719
VALUE ADDED					
Type 11A Ratio	1.000	0.113	0.14	0.253	1.253
EMPL. (No.)					
Type 11A Ratio	1.000	0.507	1.265	1.772	2.772

Any errors between the total and the addition of the components of the total are due to rounding

Table 4.11 – Adjusted Multipliers for the Operation Phase of the Syerston Project

	Initial Effect	Productn. Induced	Consum. Induced	Total Flow-on	TOTAL
OUTPUT					
Type 11A Ratio	1.000	0.111	0.100	0.211	1.211
INCOME					
Type 11A Ratio	1.000	0.278	0.322	0.600	1.600
VALUE ADDED					
Type 11A Ratio	1.000	0.113	0.102	0.215	1.215
EMPL. (No.)					
Type 11A Ratio	1.000	0.507	0.923	1.430	2.430

Any errors between the total and the addition of the components of the total are due to rounding

The adjusted Type 11A ratio multipliers for the operational phase of the mining proposal range from 1.211 for output up to 2.43 for employment.

The higher ratio multipliers for employment and income reflect the capital-intensive nature of operation of the Syerston Project. Capital intensive industries tend to have a high level of linkages with other sectors in an economy thus contributing substantial flow-on employment while at the same time only having a lower level of direct employment (relative to output levels). This tends to lead to high ratio multipliers for employment. The lesser ratio multiplier for income (compared to employment) probably largely reflects comparatively higher wage levels in the mining and ore processing sectors compared to incomes in the sectors that will experience flow-on effects from the Project. The low ratio multipliers for output and value-added largely reflect the high direct output and value-added generated by the project compared to the sectors that experience flow-on effects from the project.

4.6 Main Sectors/Towns Affected

The disaggregated impact of the operation of the proposed Syerston Project in different sectors in the Central West regional economy is shown in Attachment 4.

From the tables in Attachment 4, it can be seen that the impacts of the operation of the Project are likely to be distributed across many of the sectors in the economy with the major regional output flow-on impacts being in the gas supply sector (17.1%), retail trade sector (8%), non-ferrous mining sector (6.1%) and ownership and leasing of residential and commercial properties (10.3%).

Towns that can provide the inputs to the production process required by Black Range Minerals Ltd and/or the products and services required by employees will benefit from the proposal by way of an increase in economic activity. Towns in the immediate vicinity of the proposal such as Tullamore, Fifield, Trundle, Ootha, Condobolin will be able to benefit through the provision of key requirements for prospective employees such as accommodation and retail.

4.7 Cessation of the Syerston Project

The establishment and operation of the Syerston Project will stimulate demand in the local and regional economy leading to increased business turnover in a range of sectors and increased employment opportunities. While the mining lease is for a period of 21 years, the size of the nickel and cobalt resource is such that at an extraction rate of 2Mt per annum the Project may have a life of in the order of 45 years. Nevertheless, whenever it occurs in the future, cessation of Project will lead to a sudden reduction in economic activity.

The magnitude of the regional economic impacts of cessation of the Project will largely depend on whether the workers and their families affected by Project cessation will leave the region. If it is assumed that some of the workers remain in the region, for example the 27% estimated to be originally sourced from the region, then the impacts of mine cessation will not be as severe compared to a greater level leaving the region. This is because the consumption-induced flow-ons of the decline will be reduced through the continued consumption expenditure of those who stay (Economic and Planning Impact Consultants 1989). Under this assumption the regional economic impacts of mine closure will approximate those identified in Table 4.9. However, if additional displaced workers and there families leave the region then impacts may begin to approximate those identified in Table 4.8. Alternatively, a greater retention of displaced workers in the region will minimise the regional economic impacts of cessation.

The decision by workers, on cessation of the Project, to move or stay will be affected by a number of factors including the prospects of gaining employment in the local region compared to other regions, the likely loss or gain from homeowners selling, and the extent of "attachment" to the local region (Economic and Planning Impact Consultants 1989).

There is some evidence to suggest that on closure of major employment activities in regional economies, such as abattoirs etc., that many displaced workers and their families remain in the area. The greater number of families that remain in the region the less will be the economic impact of Project cessation.

The regional economic impetus of Syerston Project may also stimulate a ‘virtuous cycle’ of growth. This theory of regional economic growth suggests that places that are able to attract population immigration (e.g. associated with mining and manufacturing proposals) create increased demand for goods and services and thus more jobs. This growth leads to increasing local multiplier effects, scale economies and an increase in the rate of innovation and capital availability (Sorensen 1990). Local authorities should endeavour to capitalise on the prosperity of the region during the establishment and operation phase of the Project to strengthen and broaden the regions economic base. This could be achieved through some regional development analysis and planning to assess the regions competitive advantages and facilitate the targeting and attraction of complimentary and other business activities and ventures for the region.

Ultimately, the significance of the economic impacts of cessation of the Project will depend on the economic structure and trends in the regional economy at the time. For example, if the impact of Project cessation take place in a declining economy the impacts might be significant. Alternatively, if Project cessation takes place in a growing diversified economy where there are other development opportunities, the ultimate cessation of the Project may not be a cause for concern.

To the extent that alternative development opportunities arise in the regional economy, the regional economic impacts associated with mining closure that arise through reduced production and employment expenditure can be substantially ameliorated and absorbed by the growth of the region. One key factor in the growth potential of regions is a regions capacity to expand its factors of productions by attracting investment and labour from outside the region (BIE 1994). This in turn can depend on a region’s natural endowments. The region is highly prospective with a number of mining companies having interests in the area. It is therefore likely that over time new mining developments will occur, offering potential to strengthen and broaden the economic base and hence buffer against impacts of the cessation of individual activities.

Nevertheless, given the long term nature of the Project it is not possible to foresee the likely circumstances within which Project cessation will occur. It is therefore important for regional authorities and leaders to take every advantage from the stimulation to regional economic activity and skills and expertise that the Project will bring to the region.

5.0 CONCLUSION

The Syerston Project can be considered within two economic frameworks:

- regional economic impact analysis which considers the likely regional economic contribution of the Project to direct and indirect output, value-added, income and employment. For this study, the region was defined as the Central West Statistical Division of NSW. This comprises the Statistical Sub Division of Bathurst-Orange, Central Tablelands (excluding Bathurst-Orange) and the Lachlan. Statistical Local Areas included in this region are Blayney, Cabonne, Evans, Orange, Greater Lithgow, Oberon, Rylstone, Bland, Cowra, Forbes, Lachlan, Parkes and Weddin. Some consideration was also given to the potential impacts on towns in the immediate vicinity of the proposal such as Tullamore, Fifield, Trundle, Ootha and Condobolin.
- benefit cost analysis which considers the net community welfare (economic efficiency) impacts of the proposal.

A regional economic impact analysis using input-output analysis, estimated that in total the peak year of construction of the Syerston Project may contribute up to $67M in annual direct and indirect regional output or business turnover, $35M in direct and indirect regional value added including $25M in household income. The direct and indirect annual employment impact may be up to 828 jobs (although it is noted that in the peak month of construction direct employment alone may reach 962). These total impacts are based on estimates of average annual direct effects in the peak year of construction (i.e. $46M in output, $20M in income, $24M in value added and 611 jobs) and type 11A ratio multipliers estimated at 1.441 for output, 1.441 for value added, 1.227 for income and 1.354 for employment. These particular impacts on the regional economy are only likely to be felt for a period in the order of 1 year with lesser impacts felt in year 1 and year 3 of construction.

The operation of the Syerston Project is likely to contribute in the order of $351M in annual direct and indirect regional output or business turnover, $190M in direct and indirect regional value added including $41M in household income. The direct and indirect employment impact is likely to be in the order of 901. These total annual regional impacts are based on estimates of average annual direct effects in the operation phase of the project (i.e. $290M in output, $26M in income, $156M in value added and 371 jobs) and type 11A ratio multipliers of 1.211 for output, 1.215 for value added, 1.600 for income and 2.430 for employment.

The establishment and operation of the Project will stimulate demand in the local and regional economy leading to increased business turnover in a range of sectors and increased employment opportunities. Towns that can provide the inputs to the production process required by Black Range Minerals Ltd and/or the products and services required by employees will benefit from the proposal by way of an increase in economic activity. Towns in the immediate vicinity of the proposal such as Tullamore, Fifield, Trundle, Ootha, Condobolin will be able to benefit through the provision of key requirements for prospective employees such as accommodation and retail services.

Cessation of the Project in 45 years or so will, however, lead to a reduction in economic activity. The significance of these Project cessation impacts will depend on:

- the degree to which displaced workers and their families remain within the region, even if they remain unemployed. This is because continued expenditure by these people in the regional economy (even at reduced levels) contributes to final demand; and
- the economic structure and trends in the regional economy at the time. For example, if Project cessation takes place in a declining economy the impacts might be felt more greatly than if it takes place in a growing diversified economy.

Given the long term nature of the Project it is not possible to foresee the likely circumstances within which Project cessation will occur. It is therefore important for regional authorities and leaders to take every advantage from the stimulation to regional economic activity and skills and expertise that the Project will bring to the region, to strengthen and broaden the regions economic base.

A benefit cost analysis of the Syerston Project identified a range of potential economic costs and benefits of the proposal and placed values on most of the production costs and benefits. Possible environmental externalities of the proposal were identified but remained unquantified. The analysis indicated that the total net quantified production benefits of the Project are likely to have a net present value in the order of $1,176M, with $762M of these benefits accruing to Australia. This figure of $762M represents the minimum opportunity cost to Australian society of not proceeding with the proposal. This is a minimum opportunity cost as some of the potential production benefits of the proposal remained unquantified, namely benefits associated with utilising labour that would otherwise remain unemployed.

Put another way, any environmental externalities from the Syerston Project, after mitigation by Black Range Minerals Ltd, would need to be valued at greater than $762M to make the proposal questionable from an economic efficiency perspective.

To put this threshold value in some context, every household in the region of Forbes, Lachlan and Parkes would need to be willing to pay in order of $71,969 to avoid the identified potential environmental impacts of the Syerston Project, to make the proposal undesirable from an Australian economic efficiency perspective. Alternatively each household in the Central West Statistical Division would need to be willing to pay in the order of $11,929 to avoid the identified potential environmental impacts of the Project, to make the proposal undesirable from an Australian economic efficiency perspective. The equivalent figure for NSW households is $337.

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ATTACHMENTS

Attachment 1 - Explanation of Consumers' Surplus Benefit from a Price Reduction in Cobalt

The benefits associated with the production of cobalt and nickel can be estimated with reference to market data. To facilitate the estimation process, it is useful to make reference to a model of the market for the metal ore. A generalised model of the market for nickel and cobalt is used. This model and the associated explanation is directly sourced from Bennett (1991, p. 94-98).

The Syerston Project involves the production of two main commodities: cobalt and nickel. Each of these ores is sold through separate markets and so in theory, there are two separate demand curves rather than one. However, the two minerals are joint products and hence share a common supply curve. For the purpose of constructing a generalised model of the market for these ores a single supply and single demand curve, representing both ores, is used.

The market model for cobalt and nickel is depicted in Figure A1. By defining the potential output from the Syerston Project as XY, the supply curve of nickel and cobalt without the Syerston Project is SALS. Permitting production from the Syerston Project causes the supply curve to become SS'. By incorporating a demand curve for the composite good, nickel and cobalt ore, DD, it is possible to conclude that as a result of allowing mining and processing, more nickel and cobalt are marketed (OQ' instead of OQ), and the price of the ores is lower (OP' instead of OP). Note that advice from Black Range Minerals Ltd is that only the price of cobalt will decrease.

The first benefit to be noted is the increase in producers' surplus enjoyed by the proponent of the Syerston Project. This benefit is equivalent to the area FGBA.

Another benefit accrues to the consumers of cobalt and nickel. They find that with the increased production, prices fall and they are able to purchase greater quantities. Their consumers' surplus increase by the area PMNP'.

There is an offsetting loss and it is felt by the other producers of nickel and cobalt. They find that their producers' surplus is reduced by the area PMTP'. Because of the lower price being received for their output. This loss is made up of losses to the producers of OX equal to PJFP' and the losses to those who formerly produced XQ but now produce YQ' equal to KRNG, which in turn is equal to JMTF.

It is apparent that the loss to other producers is more than offset by the gains to consumers. There is a net benefit equal to the area MNT.

The total amount of benefit from the Syerston Project is therefore equal to the area FGBA and where prices are expected to decrease (i.e. for cobalt) the area MNT.

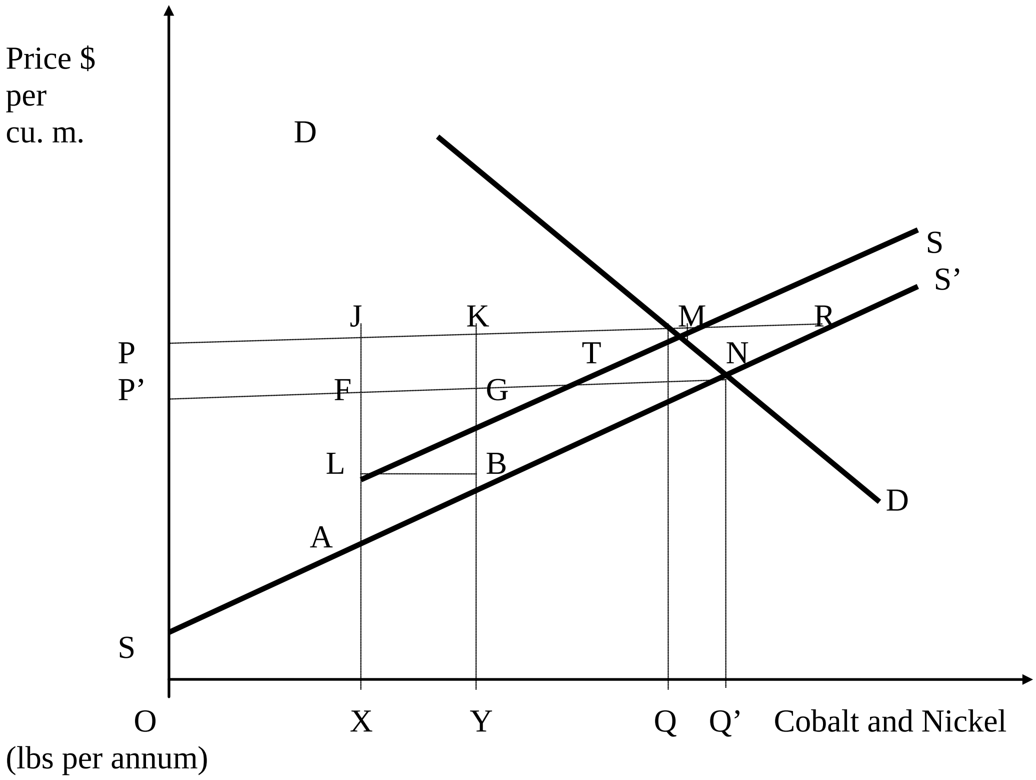

Figure A1: Conceptual Model of the Nickel and Cobalt Market
Reference: Bennett (1991, p. 97).

To estimate the price effect component of the overall benefit from a drop in cobalt price (the area MNT), it is necessary to know the increase in production (TN) each year and the change in price that would be caused by the supply change (PP'). If the slope of the demand and supply curve are assumed to be equal then the area of the triangle MNT can be estimate by the formula 0.5*PP'*TM.

Attachment 2 – the GRIT System for Generating Input-Output Tables

"The GRIT system was designed to:

- combine the benefits of survey based tables (accuracy and understanding of the economic structure) with those of non-survey tables (speed and low cost);
- enable the tables to be compiled from other recently compiled tables;
- allow tables to be constructed for any region for which certain minimum amounts of data were available;
- develop regional tables from national tables using available region-specific data;
- produce tables consistent with the national tables in terms of sector classification and accounting conventions;
- proceed in a number of clearly defined stages; and
- provide for the possibility of ready updates of the tables.

The resultant GRIT procedure has a number of well-defined steps. Of particular significance are those that involve the analyst incorporating region-specific data and information specific to the objectives of the study. The analyst has to be satisfied about the accuracy of the information used for the important sectors; in this case the non-ferrous metals and building and construction sectors. The method allows the analyst to allocate available research resources to improving the data for those sectors of the economy that are most important for the study. It also means that the method should be used by an analyst who is familiar with the economy being modelled, or at least someone with that familiarity should be consulted.

An important characteristic of GRIT-produced tables relates to their accuracy. In the past, survey-based tables involved gathering data for every cell in the table, thereby building up a table with considerable accuracy. A fundamental principle of the GRIT method is that not all cells in the table are equally important. Some are not important because they are of very small value and, therefore, have no possibility of having a significant effect on the estimates of multipliers and economic impacts. Others are not important because of the lack of linkages that relate to the particular sectors that are being studied. Therefore, the GRIT procedure involves determining those sectors and, in some cases, cells that are of particular significance for the analysis. These represent the main targets for the allocation of research resources in data gathering. For the remainder of the table, the aim is for it to be 'holistically' accurate (Jensen 1980). That means a generally accurate representation of the economy is provided by the table, but does not guarantee the accuracy of any particular cell. A summary of the steps involved in the GRIT process is shown in Table A1.1" (Powell and Chalmers 1995, p13-14)

Table A1.1 - The GRIT Method

Phase	Step	Action
PHASE 1		ADJUSTMENTS TO NATIONAL TABLE
	1	Selection of national input-output table. (109-sector table with direct allocation of all imports, in basic values)
	2	Adjustment of national table for updating.
	3	Adjustment for international trade.
PHASE II		ADJUSTMENTS FOR REGIONAL IMPORTS
		(*Steps 4-14 apply to each region for which input-output tables are required*)
	4	Calculation of ‘non-existent’ sectors.
	5	Calculation of remaining imports.
PHASE III		DEFINITION OF REGIONAL SECTORS
	6	Insertion of disaggregated superior data.
	7	Aggregation of sectors.
	8	Insertion of aggregated superior data.
PHASE IV		DERIVATION OF PROTOTYPE TRANSACTIONS TABLES
	9	Derivation of transactions values.
	10	Adjustments to complete the prototype tables.
	11	Derivation of inverses and multipliers for prototype tables.
PHASE V		DERIVATION OF FINAL TRANSACTIONS TABLES
	12	Final superior data insertions and other adjustments.
	13	Derivation of final transactions tables.
	14	Derivation of inverses and multipliers for final tables.

Source: Table 2 in Bayne and West (1988)

Attachment 3 – Multipliers for the Central West SD 1995-96

TOTAL OUTPUT MULTIPLIERS

Central-West NSW SD 1995-96

SECTOR	INITIAL	FIRST	INDUST	TOTAL	CONS'M	TOTAL	TYPE I	TYPE II
Sheep	1.00	0.25	0.05	1.30	0.51	1.81	1.30	1.81
Grains	1.00	0.25	0.06	1.31	0.54	1.85	1.31	1.85
Beef cattl	1.00	0.25	0.06	1.31	0.51	1.82	1.31	1.82
Dairy catt	1.00	0.40	0.11	1.51	0.54	2.05	1.51	2.05
Pigs	1.00	0.43	0.13	1.56	0.45	2.01	1.56	2.01
Poultry	1.00	0.49	0.24	1.72	1.28	3.00	1.72	3.00
Agricultur	1.00	0.16	0.03	1.20	0.45	1.65	1.20	1.65
Services t	1.00	0.08	0.02	1.10	0.52	1.62	1.10	1.62
Forestry a	1.00	0.18	0.04	1.22	0.43	1.65	1.22	1.65
Commercial	1.00	0.38	0.16	1.54	0.39	1.93	1.54	1.93
Coal; oil	1.00	0.10	0.03	1.13	0.42	1.55	1.13	1.55
Iron ores	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Non-ferrou	1.00	0.41	0.15	1.55	0.42	1.97	1.55	1.97
Other mini	1.00	0.16	0.05	1.20	0.21	1.41	1.20	1.41
Services t	1.00	0.31	0.10	1.41	0.41	1.82	1.41	1.82
Meat & mea	1.00	0.64	0.22	1.87	0.50	2.37	1.87	2.37
Dairy prod	1.00	0.52	0.24	1.76	0.31	2.07	1.76	2.07
Fruit & ve	1.00	0.27	0.09	1.36	0.27	1.63	1.36	1.63
Oils & fat	1.00	0.53	0.25	1.78	0.38	2.16	1.78	2.16
Flour mill	1.00	0.52	0.20	1.72	0.37	2.08	1.72	2.08
Bakery pro	1.00	0.31	0.13	1.44	0.46	1.90	1.44	1.90
Confection	1.00	0.22	0.07	1.29	0.38	1.67	1.29	1.67
Food produ	1.00	0.33	0.12	1.44	0.29	1.73	1.44	1.73
Soft drink	1.00	0.49	0.17	1.66	0.35	2.01	1.66	2.01
Beer & mal	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Wine & spi	1.00	0.40	0.11	1.51	0.35	1.86	1.51	1.86
Tobacco pr	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Textile fi	1.00	0.51	0.22	1.72	0.43	2.16	1.72	2.16
Textile pr	1.00	0.44	0.25	1.69	0.39	2.08	1.69	2.08
Knitting m	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Clothing	1.00	0.38	0.24	1.61	0.36	1.97	1.61	1.97
Footwear	1.00	0.44	0.33	1.77	0.50	2.27	1.77	2.27
Leather &	1.00	0.60	0.45	2.05	0.41	2.46	2.05	2.46
Sawmill pr	1.00	0.28	0.07	1.35	0.27	1.62	1.35	1.62
Other wood	1.00	0.33	0.09	1.42	0.30	1.72	1.42	1.72
Pulp, pape	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
P'board co	1.00	0.24	0.10	1.34	0.27	1.61	1.34	1.61
Printing &	1.00	0.14	0.04	1.18	0.60	1.78	1.18	1.78
Publishing	1.00	0.23	0.06	1.29	0.53	1.81	1.29	1.81
Petroleum	1.00	0.66	0.12	1.78	0.32	2.10	1.78	2.10
Basic chem	1.00	0.46	0.21	1.67	0.32	1.98	1.67	1.98
Paints	1.00	0.38	0.21	1.59	0.40	1.99	1.59	1.99
Medicinal	1.00	0.40	0.17	1.57	0.39	1.96	1.57	1.96
Soap & oth	1.00	0.41	0.20	1.60	0.34	1.94	1.60	1.94
Cosmetic &	1.00	0.32	0.14	1.46	0.39	1.85	1.46	1.85
Other chem	1.00	0.39	0.16	1.55	0.43	1.98	1.55	1.98
Rubber pro	1.00	0.36	0.14	1.51	0.49	2.00	1.51	2.00
Plastic &	1.00	0.38	0.18	1.55	0.48	2.03	1.55	2.03
Glass & gl	1.00	0.37	0.13	1.50	0.32	1.82	1.50	1.82

Ceramic pr	1.00	0.35	0.11	1.46	0.32	1.78	1.46	1.78
Cement, li	1.00	0.54	0.18	1.72	0.27	1.98	1.72	1.98
Plaster &	1.00	0.48	0.21	1.69	0.33	2.01	1.69	2.01
Non-metall	1.00	0.39	0.13	1.53	0.31	1.84	1.53	1.84
Iron & ste	1.00	0.42	0.21	1.63	0.54	2.16	1.63	2.16
Basic non-	1.00	0.55	0.29	1.83	0.36	2.20	1.83	2.20
Strucutura	1.00	0.38	0.16	1.54	0.49	2.03	1.54	2.03
Sheet meta	1.00	0.21	0.09	1.29	0.43	1.72	1.29	1.72
Fabricated	1.00	0.26	0.10	1.36	0.50	1.86	1.36	1.86
Motor vehi	1.00	0.39	0.19	1.58	0.46	2.04	1.58	2.04
Ships and	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Railway eq	1.00	0.28	0.11	1.39	0.38	1.77	1.39	1.77
Aircraft	1.00	0.34	0.12	1.46	0.62	2.07	1.46	2.07
Photograph	1.00	0.28	0.09	1.37	0.44	1.81	1.37	1.81
Electronic	1.00	0.28	0.11	1.39	0.31	1.70	1.39	1.70
Household	1.00	0.15	0.04	1.19	0.32	1.51	1.19	1.51
Other elec	1.00	0.37	0.19	1.56	0.40	1.96	1.56	1.96
Ag, mine &	1.00	0.22	0.08	1.29	0.37	1.67	1.29	1.67
Other mach	1.00	0.24	0.10	1.33	0.44	1.77	1.33	1.77
Prefabrica	1.00	0.29	0.11	1.39	0.33	1.72	1.39	1.72
Furniture	1.00	0.41	0.16	1.57	0.53	2.09	1.57	2.09
Other manu	1.00	0.38	0.14	1.51	0.51	2.02	1.51	2.02
Electricit	1.00	0.21	0.04	1.25	0.28	1.53	1.25	1.53
Gas supply	1.00	0.14	0.03	1.17	0.31	1.48	1.17	1.48
Water supp	1.00	0.16	0.05	1.21	0.37	1.58	1.21	1.58
Residentia	1.00	0.31	0.12	1.42	0.50	1.92	1.42	1.92
Other cons	1.00	0.27	0.10	1.37	0.63	2.01	1.37	2.01
Wholesale	1.00	0.21	0.06	1.26	0.47	1.73	1.26	1.73
Retail tra	1.00	0.20	0.05	1.26	0.58	1.84	1.26	1.84
Mechanical	1.00	0.08	0.02	1.11	0.46	1.56	1.11	1.56
Other repa	1.00	0.22	0.07	1.29	0.67	1.95	1.29	1.95
Accommodat	1.00	0.29	0.11	1.40	0.60	2.00	1.40	2.00
Road trans	1.00	0.20	0.05	1.25	0.41	1.66	1.25	1.66
Rail, pipe	1.00	0.18	0.06	1.24	0.90	2.14	1.24	2.14
Water tran	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Air & spac	1.00	0.19	0.06	1.25	0.34	1.59	1.25	1.59
Services t	1.00	0.11	0.03	1.13	0.38	1.51	1.13	1.51
Communicat	1.00	0.16	0.04	1.20	0.43	1.63	1.20	1.63
Banking	1.00	0.15	0.03	1.17	0.45	1.62	1.17	1.62
Non-bank f	1.00	0.26	0.05	1.31	0.42	1.73	1.31	1.73
Financial	1.00	0.07	0.02	1.09	0.69	1.78	1.09	1.78
Insurance	1.00	0.05	0.00	1.05	0.64	1.69	1.05	1.69
Serv to fi	1.00	0.01	0.00	1.01	0.53	1.53	1.01	1.53
Ownership	1.00	0.29	0.10	1.40	0.14	1.53	1.40	1.53
Other prop	1.00	0.22	0.06	1.28	0.57	1.84	1.28	1.84
Scientific	1.00	0.23	0.06	1.29	0.57	1.85	1.29	1.85
Legal, acc	1.00	0.22	0.06	1.28	0.62	1.90	1.28	1.90
Other busi	1.00	0.22	0.06	1.28	0.71	1.99	1.28	1.99
Government	1.00	0.21	0.05	1.26	0.57	1.82	1.26	1.82
Defence	1.00	0.34	0.12	1.47	0.46	1.93	1.47	1.93
Education	1.00	0.05	0.01	1.06	0.84	1.90	1.06	1.90
Health ser	1.00	0.14	0.04	1.18	0.76	1.94	1.18	1.94
Community	1.00	0.25	0.07	1.32	0.75	2.07	1.32	2.07
Motion pic	1.00	0.30	0.08	1.38	0.66	2.04	1.38	2.04
Libraries,	1.00	0.14	0.04	1.18	0.62	1.80	1.18	1.80

Sport, gam	1.00	0.27	0.07	1.34	0.44	1.79	1.34	1.79
Personal s	1.00	0.26	0.08	1.34	0.66	2.00	1.34	2.00
Other serv	1.00	0.17	0.05	1.22	0.85	2.07	1.22	2.07

TOTAL INCOME MULTIPLIERS
Central-West NSW SD 1995-96

SECTOR	INITIAL	FIRST	INDUST	TOTAL	CONS'M	TOTAL	TYPE I	TYPE II
Sheep	0.32	0.09	0.02	0.42	0.14	0.56	1.32	1.78
Grains	0.35	0.08	0.02	0.45	0.15	0.60	1.29	1.74
Beef cattl	0.32	0.08	0.02	0.42	0.14	0.56	1.31	1.77
Dairy catt	0.30	0.11	0.03	0.44	0.15	0.60	1.47	1.98
Pigs	0.22	0.12	0.04	0.37	0.13	0.50	1.70	2.29
Poultry	0.89	0.10	0.07	1.05	0.36	1.41	1.19	1.60
Agricultur	0.31	0.05	0.01	0.37	0.13	0.50	1.20	1.61
Services t	0.40	0.02	0.01	0.43	0.15	0.58	1.08	1.45
Forestry a	0.29	0.05	0.01	0.35	0.12	0.48	1.23	1.65
Commercial	0.19	0.09	0.04	0.32	0.11	0.44	1.68	2.27
Coal; oil	0.31	0.03	0.01	0.35	0.12	0.47	1.12	1.51
Iron ores	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-ferrou	0.21	0.09	0.04	0.34	0.12	0.46	1.67	2.24
Other mini	0.11	0.04	0.01	0.17	0.06	0.23	1.48	2.00
Services t	0.20	0.10	0.03	0.33	0.12	0.45	1.63	2.19
Meat & mea	0.15	0.20	0.07	0.41	0.14	0.56	2.81	3.78
Dairy prod	0.04	0.15	0.07	0.26	0.09	0.35	7.14	9.61
Fruit & ve	0.13	0.07	0.03	0.22	0.08	0.30	1.72	2.31
Oils & fat	0.11	0.13	0.07	0.31	0.11	0.42	2.89	3.89
Flour mill	0.10	0.15	0.06	0.30	0.10	0.41	3.17	4.26
Bakery pro	0.27	0.07	0.04	0.38	0.13	0.51	1.39	1.87
Confection	0.23	0.06	0.02	0.31	0.11	0.42	1.35	1.82
Food produ	0.12	0.08	0.04	0.24	0.08	0.32	2.00	2.69
Soft drink	0.12	0.12	0.05	0.28	0.10	0.38	2.46	3.32
Beer & mal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wine & spi	0.14	0.11	0.03	0.29	0.10	0.38	2.02	2.71
Tobacco pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textile fi	0.16	0.14	0.06	0.36	0.12	0.48	2.27	3.05
Textile pr	0.16	0.09	0.07	0.32	0.11	0.43	2.04	2.75
Knitting m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clothing	0.15	0.07	0.07	0.29	0.10	0.39	1.92	2.58
Footwear	0.24	0.09	0.08	0.41	0.14	0.55	1.68	2.26
Leather &	0.11	0.11	0.12	0.34	0.12	0.46	3.02	4.06
Sawmill pr	0.12	0.08	0.02	0.22	0.08	0.30	1.91	2.57
Other wood	0.13	0.09	0.03	0.25	0.09	0.33	1.90	2.55
Pulp, pape	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P'board co	0.14	0.06	0.03	0.23	0.08	0.30	1.64	2.21
Printing &	0.44	0.04	0.01	0.49	0.17	0.66	1.13	1.52
Publishing	0.33	0.09	0.02	0.43	0.15	0.58	1.31	1.77
Petroleum	0.04	0.19	0.03	0.26	0.09	0.35	6.84	9.20
Basic chem	0.12	0.09	0.05	0.26	0.09	0.35	2.15	2.89
Paints	0.21	0.07	0.05	0.33	0.11	0.44	1.59	2.14
Medicinal	0.16	0.11	0.05	0.32	0.11	0.43	1.96	2.64
Soap & oth	0.14	0.09	0.05	0.28	0.10	0.38	2.04	2.74
Cosmetic &	0.21	0.08	0.04	0.32	0.11	0.43	1.56	2.10

Other chem	0.21	0.10	0.04	0.35	0.12	0.48	1.70	2.29
Rubber pro	0.26	0.11	0.04	0.40	0.14	0.54	1.56	2.10
Plastic &	0.26	0.09	0.04	0.39	0.13	0.52	1.52	2.04
Glass & gl	0.16	0.08	0.04	0.27	0.09	0.36	1.70	2.29
Ceramic pr	0.15	0.08	0.03	0.27	0.09	0.36	1.74	2.34
Cement, li	0.06	0.11	0.05	0.22	0.08	0.29	3.54	4.76
Plaster &	0.12	0.09	0.05	0.27	0.09	0.36	2.15	2.89
Non-metall	0.14	0.08	0.04	0.26	0.09	0.34	1.84	2.47
Iron & ste	0.28	0.11	0.05	0.44	0.15	0.59	1.59	2.14
Basic non-	0.12	0.11	0.07	0.30	0.10	0.40	2.53	3.40
Strucutura	0.25	0.11	0.05	0.40	0.14	0.54	1.60	2.15
Sheet meta	0.27	0.06	0.02	0.35	0.12	0.47	1.31	1.77
Fabricated	0.30	0.08	0.03	0.41	0.14	0.55	1.35	1.82
Motor vehi	0.22	0.10	0.05	0.38	0.13	0.51	1.69	2.28
Ships and	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Railway eq	0.22	0.07	0.03	0.31	0.11	0.42	1.42	1.91
Aircraft	0.37	0.11	0.04	0.51	0.17	0.68	1.39	1.86
Photograph	0.27	0.07	0.03	0.36	0.12	0.48	1.33	1.79
Electronic	0.15	0.07	0.03	0.25	0.09	0.34	1.67	2.25
Household	0.21	0.04	0.01	0.26	0.09	0.36	1.25	1.68
Other elec	0.20	0.08	0.05	0.33	0.11	0.45	1.63	2.20
Ag, mine &	0.22	0.06	0.02	0.31	0.11	0.41	1.38	1.86
Other mach	0.27	0.07	0.03	0.36	0.12	0.48	1.36	1.83
Prefabrica	0.17	0.07	0.03	0.27	0.09	0.36	1.61	2.16
Furniture	0.30	0.09	0.05	0.43	0.15	0.58	1.44	1.93
Other manu	0.30	0.08	0.04	0.42	0.15	0.56	1.39	1.87
Electricit	0.15	0.06	0.01	0.23	0.08	0.30	1.49	2.01
Gas supply	0.17	0.07	0.01	0.26	0.09	0.34	1.49	2.01
Water supp	0.25	0.04	0.02	0.30	0.10	0.41	1.22	1.63
Residentia	0.31	0.07	0.03	0.41	0.14	0.55	1.31	1.77
Other cons	0.43	0.07	0.03	0.52	0.18	0.70	1.22	1.64
Wholesale	0.30	0.07	0.02	0.39	0.13	0.52	1.28	1.72
Retail tra	0.39	0.07	0.02	0.48	0.17	0.64	1.23	1.66
Mechanical	0.34	0.02	0.01	0.38	0.13	0.50	1.09	1.47
Other repa	0.47	0.06	0.02	0.55	0.19	0.74	1.17	1.57
Accommodat	0.38	0.08	0.03	0.49	0.17	0.66	1.30	1.75
Road trans	0.26	0.07	0.02	0.34	0.12	0.45	1.31	1.77
Rail, pipe	0.68	0.05	0.02	0.74	0.26	1.00	1.10	1.48
Water tran	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Air & spac	0.21	0.05	0.02	0.28	0.10	0.38	1.35	1.81
Services t	0.27	0.03	0.01	0.31	0.11	0.42	1.15	1.55
Communicat	0.30	0.05	0.01	0.35	0.12	0.48	1.20	1.61
Banking	0.31	0.05	0.01	0.37	0.13	0.50	1.21	1.62
Non-bank f	0.24	0.10	0.02	0.35	0.12	0.47	1.48	1.98
Financial	0.54	0.02	0.01	0.57	0.20	0.76	1.06	1.42
Insurance	0.50	0.02	0.00	0.52	0.18	0.70	1.04	1.40
Serv to fi	0.43	0.00	0.00	0.43	0.15	0.58	1.01	1.35
Ownership	0.00	0.09	0.03	0.11	0.04	0.15	0.00	0.00
Other prop	0.37	0.08	0.02	0.46	0.16	0.62	1.25	1.69
Scientific	0.37	0.08	0.02	0.47	0.16	0.63	1.26	1.69
Legal, acc	0.41	0.08	0.02	0.51	0.18	0.68	1.24	1.66
Other busi	0.49	0.08	0.02	0.58	0.20	0.79	1.19	1.60
Government	0.39	0.07	0.02	0.47	0.16	0.63	1.21	1.63
Defence	0.24	0.10	0.04	0.38	0.13	0.51	1.58	2.13
Education	0.67	0.02	0.00	0.69	0.24	0.93	1.03	1.38

Health ser	0.56	0.05	0.01	0.62	0.22	0.84	1.11	1.49
Community	0.51	0.08	0.02	0.62	0.21	0.83	1.21	1.62
Motion pic	0.42	0.10	0.03	0.54	0.19	0.73	1.29	1.74
Libraries,	0.45	0.05	0.01	0.51	0.18	0.69	1.13	1.52
Sport, gam	0.26	0.09	0.02	0.37	0.13	0.49	1.43	1.92
Personal s	0.44	0.08	0.02	0.54	0.19	0.73	1.22	1.65
Other serv	0.63	0.06	0.02	0.70	0.24	0.94	1.11	1.50

TOTAL EMPLOYMENT MULTIPLIERS
Central-West NSW SD 1995-96

SECTOR	INITIAL	FIRST	INDUST	TOTAL	CONS'M	TOTAL	TYPE I	TYPE II
Sheep	0.01	0.00	0.00	0.02	0.01	0.02	1.28	1.73
Grains	0.02	0.00	0.00	0.02	0.01	0.03	1.26	1.70
Beef cattl	0.01	0.00	0.00	0.02	0.01	0.02	1.27	1.72
Dairy catt	0.01	0.00	0.00	0.02	0.01	0.02	1.41	1.92
Pigs	0.01	0.00	0.00	0.02	0.01	0.02	1.61	2.19
Poultry	0.04	0.00	0.00	0.04	0.02	0.06	1.16	1.57
Agricultur	0.01	0.00	0.00	0.02	0.01	0.02	1.17	1.58
Services t	0.01	0.00	0.00	0.02	0.01	0.02	1.08	1.54
Forestry a	0.01	0.00	0.00	0.01	0.01	0.02	1.24	1.76
Commercial	0.01	0.00	0.00	0.01	0.01	0.02	1.71	2.41
Coal; oil	0.00	0.00	0.00	0.01	0.01	0.01	1.26	2.38
Iron ores	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-ferrou	0.00	0.00	0.00	0.01	0.01	0.01	2.10	3.39
Other mini	0.00	0.00	0.00	0.01	0.00	0.01	1.61	2.41
Services t	0.01	0.00	0.00	0.01	0.01	0.01	1.87	2.81
Meat & mea	0.01	0.01	0.00	0.02	0.01	0.02	2.77	3.78
Dairy prod	0.00	0.01	0.00	0.01	0.00	0.01	8.31	11.44
Fruit & ve	0.00	0.00	0.00	0.01	0.00	0.01	1.78	2.56
Oils & fat	0.00	0.01	0.00	0.01	0.00	0.02	3.41	4.84
Flour mill	0.00	0.01	0.00	0.01	0.00	0.01	3.99	5.70
Bakery pro	0.01	0.00	0.00	0.01	0.01	0.02	1.42	2.02
Confection	0.01	0.00	0.00	0.01	0.00	0.02	1.38	1.96
Food produ	0.00	0.00	0.00	0.01	0.00	0.01	2.11	2.98
Soft drink	0.00	0.00	0.00	0.01	0.00	0.01	2.92	4.22
Beer & mal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wine & spi	0.01	0.00	0.00	0.01	0.00	0.01	2.13	2.98
Tobacco pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textile fi	0.01	0.01	0.00	0.01	0.01	0.02	2.53	3.62
Textile pr	0.01	0.00	0.00	0.01	0.01	0.02	2.04	2.88
Knitting m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clothing	0.01	0.00	0.00	0.01	0.00	0.02	1.80	2.50
Footwear	0.01	0.00	0.00	0.02	0.01	0.02	1.65	2.29
Leather &	0.00	0.00	0.01	0.01	0.01	0.02	3.34	4.68
Sawmill pr	0.01	0.00	0.00	0.01	0.00	0.01	1.78	2.46
Other wood	0.01	0.00	0.00	0.01	0.00	0.01	1.84	2.56
Pulp, pape	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P'board co	0.00	0.00	0.00	0.01	0.00	0.01	1.91	2.82
Printing &	0.02	0.00	0.00	0.02	0.01	0.03	1.11	1.51
Publishing	0.01	0.00	0.00	0.02	0.01	0.02	1.33	1.85
Petroleum	0.00	0.00	0.00	0.01	0.00	0.01	4.40	7.67
Basic chem	0.00	0.00	0.00	0.01	0.00	0.01	2.22	3.27

Paints	0.01	0.00	0.00	0.01	0.01	0.02	1.59	2.30
Medicinal	0.01	0.00	0.00	0.01	0.01	0.02	2.03	2.88
Soap & oth	0.01	0.00	0.00	0.01	0.00	0.01	2.06	2.89
Cosmetic &	0.01	0.00	0.00	0.01	0.01	0.02	1.61	2.29
Other chem	0.01	0.00	0.00	0.01	0.01	0.02	1.79	2.57
Rubber pro	0.01	0.00	0.00	0.02	0.01	0.02	1.45	1.93
Plastic &	0.01	0.00	0.00	0.02	0.01	0.02	1.39	1.87
Glass & gl	0.00	0.00	0.00	0.01	0.00	0.01	1.85	2.81
Ceramic pr	0.00	0.00	0.00	0.01	0.00	0.01	1.78	2.65
Cement, li	0.00	0.00	0.00	0.01	0.00	0.01	3.63	5.39
Plaster &	0.00	0.00	0.00	0.01	0.00	0.01	2.21	3.20
Non-metall	0.00	0.00	0.00	0.01	0.00	0.01	1.99	2.96
Iron & ste	0.01	0.00	0.00	0.01	0.01	0.02	1.72	2.70
Basic non-	0.00	0.00	0.00	0.01	0.00	0.01	2.27	3.45
Strucutura	0.01	0.00	0.00	0.02	0.01	0.02	1.54	2.10
Sheet meta	0.01	0.00	0.00	0.01	0.01	0.02	1.28	1.79
Fabricated	0.01	0.00	0.00	0.02	0.01	0.02	1.34	1.86
Motor vehi	0.01	0.00	0.00	0.01	0.01	0.02	1.63	2.28
Ships and	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Railway eq	0.01	0.00	0.00	0.01	0.01	0.02	1.42	1.99
Aircraft	0.01	0.00	0.00	0.02	0.01	0.02	1.49	2.19
Photograph	0.01	0.00	0.00	0.01	0.01	0.02	1.29	1.76
Electronic	0.01	0.00	0.00	0.01	0.00	0.01	1.68	2.34
Household	0.01	0.00	0.00	0.01	0.00	0.01	1.26	1.77
Other elec	0.01	0.00	0.00	0.01	0.01	0.02	1.60	2.25
Ag, mine &	0.01	0.00	0.00	0.01	0.00	0.02	1.35	1.87
Other mach	0.01	0.00	0.00	0.01	0.01	0.02	1.33	1.84
Prefabrica	0.01	0.00	0.00	0.01	0.00	0.02	1.55	2.11
Furniture	0.02	0.00	0.00	0.02	0.01	0.03	1.31	1.72
Other manu	0.02	0.00	0.00	0.02	0.01	0.03	1.26	1.66
Electricit	0.00	0.00	0.00	0.01	0.00	0.01	1.45	2.33
Gas supply	0.01	0.00	0.00	0.01	0.00	0.01	1.53	2.35
Water supp	0.01	0.00	0.00	0.01	0.00	0.01	1.30	2.00
Residentia	0.01	0.00	0.00	0.01	0.01	0.02	1.32	1.87
Other cons	0.01	0.00	0.00	0.02	0.01	0.02	1.26	1.83
Wholesale	0.01	0.00	0.00	0.01	0.01	0.02	1.28	1.78
Retail tra	0.02	0.00	0.00	0.03	0.01	0.03	1.16	1.48
Mechanical	0.01	0.00	0.00	0.01	0.01	0.02	1.09	1.52
Other repa	0.02	0.00	0.00	0.02	0.01	0.03	1.13	1.50
Accommodat	0.02	0.00	0.00	0.03	0.01	0.04	1.19	1.49
Road trans	0.01	0.00	0.00	0.01	0.01	0.02	1.34	1.91
Rail, pipe	0.02	0.00	0.00	0.02	0.01	0.03	1.14	1.78
Water tran	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Air & spac	0.00	0.00	0.00	0.01	0.00	0.01	1.59	2.50
Services t	0.01	0.00	0.00	0.01	0.00	0.02	1.17	1.68
Communicat	0.01	0.00	0.00	0.01	0.01	0.02	1.22	1.79
Banking	0.01	0.00	0.00	0.01	0.01	0.02	1.21	1.72
Non-bank f	0.01	0.00	0.00	0.01	0.01	0.02	1.44	2.00
Financial	0.02	0.00	0.00	0.02	0.01	0.02	1.07	1.61
Insurance	0.02	0.00	0.00	0.02	0.01	0.03	1.04	1.49
Serv to fi	0.01	0.00	0.00	0.01	0.01	0.02	1.01	1.45
Ownership	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Other prop	0.01	0.00	0.00	0.02	0.01	0.02	1.24	1.71
Scientific	0.01	0.00	0.00	0.02	0.01	0.02	1.28	1.81
Legal, acc	0.01	0.00	0.00	0.02	0.01	0.03	1.25	1.76

Other busi	0.03	0.00	0.00	0.03	0.01	0.04	1.12	1.42
Government	0.01	0.00	0.00	0.01	0.01	0.02	1.24	1.83
Defence	0.01	0.00	0.00	0.01	0.01	0.02	1.60	2.25
Education	0.02	0.00	0.00	0.02	0.01	0.03	1.03	1.45
Health ser	0.02	0.00	0.00	0.02	0.01	0.03	1.12	1.58
Community	0.03	0.00	0.00	0.03	0.01	0.04	1.14	1.47
Motion pic	0.01	0.00	0.00	0.02	0.01	0.03	1.36	1.98
Libraries,	0.02	0.00	0.00	0.02	0.01	0.03	1.13	1.57
Sport, gam	0.02	0.00	0.00	0.02	0.01	0.03	1.26	1.58
Personal s	0.03	0.00	0.00	0.03	0.01	0.04	1.14	1.46
Other serv	0.02	0.00	0.00	0.02	0.01	0.03	1.15	1.70

TOTAL VALUE ADDED MULTIPLIERS
Central-West NSW SD 1995-96

SECTOR	INITIAL	FIRST	INDUST	TOTAL	CONS'M	TOTAL	TYPE I	TYPE II
Sheep	0.55	0.17	0.03	0.75	0.28	1.03	1.37	1.88
Grains	0.49	0.15	0.04	0.67	0.30	0.97	1.37	1.99
Beef cattl	0.55	0.15	0.04	0.74	0.28	1.02	1.34	1.85
Dairy catt	0.44	0.22	0.06	0.73	0.30	1.02	1.65	2.32
Pigs	0.28	0.24	0.07	0.59	0.25	0.84	2.10	3.00
Poultry	0.38	0.19	0.13	0.70	0.71	1.40	1.83	3.69
Agricultur	0.69	0.11	0.02	0.81	0.25	1.06	1.19	1.55
Services t	0.85	0.04	0.01	0.90	0.29	1.19	1.07	1.41
Forestry a	0.53	0.11	0.02	0.66	0.24	0.90	1.25	1.70
Commercial	0.41	0.17	0.09	0.66	0.22	0.88	1.62	2.16
Coal; oil	0.76	0.05	0.02	0.83	0.23	1.06	1.09	1.40
Iron ores	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Non-ferrou	0.39	0.17	0.08	0.63	0.23	0.86	1.62	2.21
Other mini	0.67	0.08	0.03	0.78	0.11	0.89	1.16	1.33
Services t	0.23	0.15	0.06	0.43	0.22	0.66	1.88	2.85
Meat & mea	0.21	0.34	0.13	0.68	0.28	0.96	3.21	4.52
Dairy prod	0.23	0.24	0.13	0.61	0.17	0.78	2.63	3.38
Fruit & ve	0.24	0.13	0.05	0.42	0.15	0.57	1.71	2.32
Oils & fat	0.24	0.23	0.13	0.60	0.21	0.81	2.50	3.37
Flour mill	0.30	0.25	0.11	0.65	0.20	0.86	2.20	2.89
Bakery pro	0.39	0.14	0.07	0.60	0.25	0.85	1.53	2.18
Confection	0.44	0.11	0.04	0.59	0.21	0.80	1.34	1.81
Food produ	0.30	0.15	0.06	0.51	0.16	0.67	1.73	2.27
Soft drink	0.19	0.24	0.09	0.51	0.19	0.70	2.70	3.71
Beer & mal	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Wine & spi	0.34	0.24	0.07	0.65	0.19	0.84	1.88	2.43
Tobacco pr	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Textile fi	0.30	0.25	0.12	0.67	0.24	0.91	2.24	3.04
Textile pr	0.32	0.17	0.13	0.62	0.21	0.83	1.93	2.59
Knitting m	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Clothing	0.34	0.14	0.12	0.59	0.20	0.79	1.76	2.35
Footwear	0.34	0.14	0.13	0.62	0.27	0.89	1.80	2.59
Leather &	0.18	0.18	0.21	0.57	0.23	0.80	3.20	4.49
Sawmill pr	0.35	0.16	0.04	0.55	0.15	0.69	1.57	2.00
Other wood	0.32	0.17	0.05	0.54	0.17	0.71	1.70	2.22
Pulp, pape	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
P'board co	0.41	0.12	0.05	0.58	0.15	0.73	1.40	1.76
Printing &	0.45	0.07	0.02	0.55	0.33	0.88	1.22	1.95

Publishing	0.49	0.14	0.03	0.66	0.29	0.95	1.34	1.94
Petroleum	0.23	0.47	0.07	0.77	0.18	0.94	3.32	4.09
Basic chem	0.31	0.21	0.11	0.62	0.17	0.80	2.03	2.61
Paints	0.37	0.15	0.10	0.62	0.22	0.84	1.69	2.30
Medicinal	0.29	0.18	0.08	0.56	0.22	0.77	1.92	2.67
Soap & oth	0.23	0.17	0.10	0.50	0.19	0.69	2.17	2.99
Cosmetic &	0.40	0.14	0.07	0.61	0.22	0.83	1.52	2.06
Other chem	0.33	0.17	0.08	0.57	0.24	0.81	1.75	2.48
Rubber pro	0.34	0.17	0.08	0.59	0.27	0.86	1.73	2.52
Plastic &	0.38	0.17	0.09	0.63	0.26	0.89	1.67	2.36
Glass & gl	0.48	0.20	0.07	0.75	0.18	0.93	1.56	1.94
Ceramic pr	0.46	0.20	0.06	0.73	0.18	0.90	1.57	1.96
Cement, li	0.27	0.31	0.10	0.67	0.15	0.82	2.54	3.09
Plaster &	0.42	0.23	0.11	0.76	0.18	0.94	1.81	2.23
Non-metall	0.36	0.21	0.07	0.65	0.17	0.82	1.80	2.28
Iron & ste	0.28	0.17	0.10	0.55	0.30	0.85	1.97	3.04
Basic non-	0.32	0.25	0.14	0.71	0.20	0.91	2.20	2.83
Strucutura	0.36	0.16	0.08	0.59	0.27	0.86	1.65	2.42
Sheet meta	0.50	0.09	0.04	0.64	0.24	0.87	1.27	1.74
Fabricated	0.38	0.12	0.05	0.55	0.28	0.82	1.45	2.18
Motor vehi	0.32	0.16	0.09	0.56	0.25	0.82	1.77	2.56
Ships and	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Railway eq	0.37	0.11	0.05	0.53	0.21	0.74	1.43	2.00
Aircraft	0.41	0.16	0.06	0.63	0.34	0.97	1.52	2.34
Photograph	0.47	0.15	0.05	0.66	0.24	0.91	1.42	1.94
Electronic	0.36	0.13	0.05	0.55	0.17	0.72	1.51	1.97
Household	0.42	0.08	0.02	0.52	0.18	0.70	1.23	1.65
Other elec	0.42	0.15	0.09	0.66	0.22	0.89	1.58	2.11
Ag, mine &	0.39	0.10	0.04	0.53	0.21	0.74	1.35	1.87
Other mach	0.46	0.11	0.05	0.61	0.24	0.86	1.33	1.85
Prefabrica	0.36	0.12	0.06	0.54	0.18	0.72	1.49	1.99
Furniture	0.36	0.17	0.08	0.61	0.29	0.90	1.69	2.49
Other manu	0.42	0.20	0.07	0.68	0.28	0.97	1.62	2.29
Electricit	0.72	0.15	0.02	0.90	0.15	1.05	1.24	1.45
Gas supply	0.79	0.09	0.02	0.90	0.17	1.07	1.14	1.35
Water supp	0.73	0.09	0.03	0.84	0.20	1.04	1.16	1.44
Residentia	0.44	0.13	0.06	0.64	0.27	0.91	1.45	2.08
Other cons	0.52	0.13	0.06	0.71	0.35	1.06	1.35	2.02
Wholesale	0.55	0.12	0.03	0.70	0.26	0.96	1.27	1.75
Retail tra	0.55	0.12	0.03	0.70	0.32	1.02	1.28	1.87
Mechanical	0.68	0.05	0.01	0.74	0.25	0.99	1.09	1.46
Other repa	0.56	0.12	0.04	0.71	0.37	1.08	1.27	1.93
Accommodat	0.48	0.15	0.06	0.69	0.33	1.03	1.43	2.12
Road trans	0.56	0.12	0.03	0.71	0.23	0.94	1.26	1.67
Rail, pipe	0.68	0.09	0.03	0.80	0.50	1.30	1.18	1.91
Water tran	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00
Air & spac	0.53	0.11	0.04	0.68	0.19	0.86	1.27	1.63
Services t	0.81	0.07	0.02	0.89	0.21	1.10	1.10	1.36
Communicat	0.67	0.10	0.02	0.79	0.24	1.03	1.18	1.53
Banking	0.66	0.10	0.02	0.78	0.25	1.03	1.18	1.55
Non-bank f	0.42	0.18	0.03	0.64	0.23	0.87	1.50	2.05
Financial	0.86	0.04	0.01	0.91	0.38	1.30	1.06	1.51
Insurance	0.86	0.05	0.00	0.91	0.35	1.26	1.06	1.46
Serv to fi	0.98	0.01	0.00	0.99	0.29	1.28	1.01	1.30
Ownership	0.59	0.15	0.05	0.79	0.08	0.87	1.34	1.47

Other prop	0.58	0.13	0.03	0.74	0.31	1.05	1.29	1.83
Scientific	0.58	0.13	0.04	0.75	0.31	1.06	1.29	1.83
Legal, acc	0.57	0.14	0.03	0.74	0.34	1.08	1.30	1.90
Other busi	0.58	0.13	0.03	0.74	0.39	1.14	1.29	1.97
Government	0.45	0.13	0.03	0.61	0.31	0.92	1.35	2.05
Defence	0.28	0.17	0.06	0.51	0.25	0.77	1.85	2.76
Education	0.90	0.03	0.01	0.93	0.46	1.40	1.04	1.56
Health ser	0.72	0.09	0.02	0.83	0.42	1.25	1.15	1.74
Community	0.52	0.15	0.04	0.71	0.41	1.12	1.36	2.15
Motion pic	0.42	0.17	0.05	0.64	0.36	1.00	1.52	2.39
Libraries,	0.71	0.08	0.02	0.81	0.34	1.15	1.15	1.63
Sport, gam	0.48	0.15	0.04	0.67	0.25	0.92	1.41	1.93
Personal s	0.44	0.14	0.05	0.63	0.36	1.00	1.43	2.25
Other serv	0.68	0.10	0.03	0.81	0.47	1.28	1.18	1.87

Attachment 4 – Disaggregated Regional Economic Impacts of the Operation Phase of the Syerston Project

ESTIMATED OUTPUT EFFECTS $000
CENTRAL WEST NSW SD 1995/96

SECTOR	F.DEMAND	INDUST	CONS'M	TOTAL	(%)	FLOW-ON	(%)
Sheep	0.0	4.1	91.0	95.1	0.0	95.1	0.1
Grains	0.0	2.0	137.8	139.9	0.0	139.9	0.2
Beef cattl	0.0	5.8	333.9	339.7	0.1	339.7	0.5
Dairy catt	0.0	1.3	75.9	77.2	0.0	77.2	0.1
Pigs	0.0	0.9	50.9	51.8	0.0	51.8	0.1
Poultry	0.0	0.1	8.9	9.0	0.0	9.0	0.0
Agricultur	0.0	7.4	497.0	504.5	0.1	504.5	0.7
Services t	0.0	2.2	60.5	62.7	0.0	62.7	0.1
Forestry a	0.0	52.3	32.6	84.9	0.0	84.9	0.1
Commercial	0.0	0.2	15.7	15.9	0.0	15.9	0.0
Coal; oil	0.0	1783.8	214.2	1998.0	0.6	1998.0	2.8
Iron ores	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-ferrou	0.0	6158.1	4.9	6163.0	1.7	6163.0	8.6
Other mini	0.0	133.2	37.1	170.3	0.0	170.3	0.2
Services t	0.0	2413.1	9.7	2422.8	0.7	2422.8	3.4
Meat & mea	0.0	13.0	882.9	895.9	0.2	895.9	1.2
Dairy prod	0.0	3.2	180.7	183.9	0.1	183.9	0.3
Fruit & ve	0.0	1.3	441.8	443.1	0.1	443.1	0.6
Oils & fat	0.0	2.1	19.5	21.5	0.0	21.5	0.0
Flour mill	0.0	4.5	211.1	215.6	0.1	215.6	0.3
Bakery pro	0.0	10.8	447.9	458.7	0.1	458.7	0.6
Confection	0.0	0.2	144.5	144.7	0.0	144.7	0.2
Food produ	0.0	5.9	916.4	922.3	0.3	922.3	1.3
Soft drink	0.0	1.4	104.9	106.3	0.0	106.3	0.1
Beer & mal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wine & spi	0.0	1.9	76.5	78.4	0.0	78.4	0.1
Tobacco pr	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textile fi	0.0	19.1	261.5	280.6	0.1	280.6	0.4
Textile pr	0.0	17.2	46.0	63.3	0.0	63.3	0.1
Knitting m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clothing	0.0	6.8	464.5	471.3	0.1	471.3	0.7
Footwear	0.0	3.7	92.0	95.8	0.0	95.8	0.1
Leather &	0.0	1.8	104.4	106.2	0.0	106.2	0.1
Sawmill pr	0.0	8.7	67.9	76.6	0.0	76.6	0.1
Other wood	0.0	16.0	151.6	167.7	0.0	167.7	0.2
Pulp, pape	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P'board co	0.0	5.2	14.0	19.2	0.0	19.2	0.0
Printing &	0.0	28.3	97.4	125.7	0.0	125.7	0.2
Publishing	0.0	30.5	210.5	241.0	0.1	241.0	0.3
Petroleum	0.0	348.6	66.7	415.3	0.1	415.3	0.6
Basic chem	0.0	525.8	29.2	555.0	0.2	555.0	0.8
Paints	0.0	4.2	3.6	7.8	0.0	7.8	0.0
Medicinal	0.0	5.8	29.1	34.9	0.0	34.9	0.0
Soap & oth	0.0	2.9	15.7	18.6	0.0	18.6	0.0
Cosmetic &	0.0	0.3	12.2	12.5	0.0	12.5	0.0
Other chem	0.0	48.5	11.1	59.6	0.0	59.6	0.1

Rubber pro	0.0	3.5	3.5	7.0	0.0	7.0	0.0
Plastic &	0.0	46.5	34.6	81.1	0.0	81.1	0.1
Glass & gl	0.0	4.9	25.0	29.8	0.0	29.8	0.0
Ceramic pr	0.0	44.7	31.8	76.6	0.0	76.6	0.1
Cement, li	0.0	70.1	76.0	146.1	0.0	146.1	0.2
Plaster &	0.0	12.1	16.0	28.0	0.0	28.0	0.0
Non-metall	0.0	39.0	36.2	75.2	0.0	75.2	0.1
Iron & ste	0.0	193.4	24.1	217.4	0.1	217.4	0.3
Syerston	290000.0	0.0	0.0	290000.0	80.1	0.0	0.0
Basic non-	0.0	3712.5	6.9	3719.4	1.0	3719.4	5.2
Strucutura	0.0	102.5	68.3	170.8	0.0	170.8	0.2
Sheet meta	0.0	19.9	60.8	80.7	0.0	80.7	0.1
Fabricated	0.0	179.4	176.5	355.9	0.1	355.9	0.5
Motor vehi	0.0	5.6	32.8	38.5	0.0	38.5	0.1
Ships and	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Railway eq	0.0	86.3	41.0	127.3	0.0	127.3	0.2
Aircraft	0.0	3.5	5.7	9.2	0.0	9.2	0.0
Photograph	0.0	1.5	10.9	12.5	0.0	12.5	0.0
Electronic	0.0	2.1	10.0	12.1	0.0	12.1	0.0
Household	0.0	5.5	383.5	389.0	0.1	389.0	0.5
Other elec	0.0	10.6	9.3	19.8	0.0	19.8	0.0
Ag, mine &	0.0	107.8	15.4	123.3	0.0	123.3	0.2
Other mach	0.0	59.6	14.3	73.9	0.0	73.9	0.1
Prefabrica	0.0	34.4	1.5	36.0	0.0	36.0	0.1
Furniture	0.0	2.3	139.8	142.1	0.0	142.1	0.2
Other manu	0.0	25.6	36.7	62.3	0.0	62.3	0.1
Electricit	0.0	1921.1	1110.9	3032.0	0.8	3032.0	4.2
Gas supply	0.0	8500.0	78.2	8578.2	2.4	8578.2	11.9
Water supp	0.0	71.2	252.8	324.0	0.1	324.0	0.5
Residentia	0.0	7.9	1171.9	1179.8	0.3	1179.8	1.6
Other cons	0.0	121.5	33.8	155.3	0.0	155.3	0.2
Wholesale	0.0	777.3	1396.6	2173.9	0.6	2173.9	3.0
Retail tra	0.0	15.9	5799.1	5815.0	1.6	5815.0	8.1
Mechanical	0.0	108.3	1174.1	1282.4	0.4	1282.4	1.8
Other repa	0.0	25.9	79.9	105.8	0.0	105.8	0.1
Accommodat	0.0	104.8	2165.0	2269.8	0.6	2269.8	3.2
Road trans	0.0	565.6	1128.1	1693.6	0.5	1693.6	2.4
Rail, pipe	0.0	1047.5	568.3	1615.8	0.4	1615.8	2.2
Water tran	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Air & spac	0.0	107.6	377.3	484.9	0.1	484.9	0.7
Services t	0.0	74.2	137.4	211.5	0.1	211.5	0.3
Communicat	0.0	400.4	1231.1	1631.5	0.5	1631.5	2.3
Banking	0.0	259.3	871.3	1130.7	0.3	1130.7	1.6
Non-bank f	0.0	88.0	164.5	252.5	0.1	252.5	0.4
Financial	0.0	34.2	9.1	43.3	0.0	43.3	0.1
Insurance	0.0	25.6	137.3	162.9	0.0	162.9	0.2
Serv to fi	0.0	58.2	66.7	124.9	0.0	124.9	0.2
Ownership	0.0	0.0	6896.2	6896.2	1.9	6896.2	9.6
Other prop	0.0	370.4	267.8	638.2	0.2	638.2	0.9
Scientific	0.0	454.7	187.9	642.6	0.2	642.6	0.9
Legal, acc	0.0	302.4	686.9	989.2	0.3	989.2	1.4
Other busi	0.0	147.3	376.3	523.7	0.1	523.7	0.7
Government	0.0	3.1	9.7	12.7	0.0	12.7	0.0
Defence	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Education	0.0	44.1	810.1	854.2	0.2	854.2	1.2

Health ser	0.0	4.7	2396.2	2400.9	0.7	2400.9	3.3
Community	0.0	2.8	638.2	641.0	0.2	641.0	0.9
Motion pic	0.0	24.0	95.7	119.8	0.0	119.8	0.2
Libraries,	0.0	5.7	173.4	179.1	0.0	179.1	0.2
Sport, gam	0.0	1.1	300.5	301.7	0.1	301.7	0.4
Personal s	0.0	8.6	597.4	606.0	0.2	606.0	0.8
Other serv	0.0	72.1	304.3	376.4	0.1	376.4	0.5
TOTAL	290,000	32,211	39,628	361,839	100	71,839	100
MULTIPLIER	1.0	0.1	0.1	1.2		0.2	

ESTIMATED INCOME EFFECTS $000
CENTRAL WEST NSW SD 1995/96

SECTOR	F.DEMAND	INDUST	CONS'M	TOTAL	(%)	FLOW-ON	(%)
Sheep	0.0	1.3	28.8	30.1	0.1	30.1	0.2
Grains	0.0	0.7	47.7	48.4	0.1	48.4	0.3
Beef cattl	0.0	1.8	106.0	107.8	0.2	107.8	0.6
Dairy catt	0.0	0.4	22.9	23.3	0.1	23.3	0.1
Pigs	0.0	0.2	11.1	11.3	0.0	11.3	0.1
Poultry	0.0	0.1	7.9	7.9	0.0	7.9	0.0
Agricultur	0.0	2.3	154.0	156.3	0.4	156.3	0.9
Services t	0.0	0.9	24.2	25.1	0.1	25.1	0.1
Forestry a	0.0	15.1	9.4	24.4	0.1	24.4	0.1
Commercial	0.0	0.0	3.0	3.1	0.0	3.1	0.0
Coal; oil	0.0	550.2	66.1	616.3	1.4	616.3	3.4
Iron ores	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-ferrou	0.0	1270.3	1.0	1271.3	2.9	1271.3	6.9
Other mini	0.0	15.1	4.2	19.3	0.0	19.3	0.1
Services t	0.0	493.1	2.0	495.1	1.1	495.1	2.7
Meat & mea	0.0	1.9	130.0	131.9	0.3	131.9	0.7
Dairy prod	0.0	0.1	6.5	6.6	0.0	6.6	0.0
Fruit & ve	0.0	0.2	57.3	57.5	0.1	57.5	0.3
Oils & fat	0.0	0.2	2.1	2.3	0.0	2.3	0.0
Flour mill	0.0	0.4	20.1	20.6	0.0	20.6	0.1
Bakery pro	0.0	2.9	122.0	125.0	0.3	125.0	0.7
Confection	0.0	0.1	33.1	33.1	0.1	33.1	0.2
Food produ	0.0	0.7	108.8	109.5	0.3	109.5	0.6
Soft drink	0.0	0.2	12.1	12.2	0.0	12.2	0.1
Beer & mal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wine & spi	0.0	0.3	10.9	11.1	0.0	11.1	0.1
Tobacco pr	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textile fi	0.0	3.0	41.1	44.1	0.1	44.1	0.2
Textile pr	0.0	2.7	7.1	9.8	0.0	9.8	0.1
Knitting m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clothing	0.0	1.0	70.7	71.8	0.2	71.8	0.4
Footwear	0.0	0.9	22.3	23.2	0.1	23.2	0.1
Leather &	0.0	0.2	11.8	12.0	0.0	12.0	0.1

Sawmill pr	0.0	1.0	7.8	8.8	0.0	8.8	0.0
Other wood	0.0	2.1	19.8	21.9	0.0	21.9	0.1
Pulp, pape	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P'board co	0.0	0.7	1.9	2.6	0.0	2.6	0.0
Printing &	0.0	12.3	42.4	54.7	0.1	54.7	0.3
Publishing	0.0	10.1	69.6	79.7	0.2	79.7	0.4
Petroleum	0.0	13.4	2.6	16.0	0.0	16.0	0.1
Basic chem	0.0	63.6	3.5	67.1	0.2	67.1	0.4
Paints	0.0	0.9	0.7	1.6	0.0	1.6	0.0
Medicinal	0.0	0.9	4.8	5.7	0.0	5.7	0.0
Soap & oth	0.0	0.4	2.2	2.6	0.0	2.6	0.0
Cosmetic &	0.0	0.1	2.5	2.6	0.0	2.6	0.0
Other chem	0.0	10.1	2.3	12.4	0.0	12.4	0.1
Rubber pro	0.0	0.9	0.9	1.8	0.0	1.8	0.0
Plastic &	0.0	11.9	8.9	20.8	0.0	20.8	0.1
Glass & gl	0.0	0.8	3.9	4.7	0.0	4.7	0.0
Ceramic pr	0.0	6.8	4.8	11.7	0.0	11.7	0.1
Cement, li	0.0	4.3	4.7	9.0	0.0	9.0	0.0
Plaster &	0.0	1.5	2.0	3.5	0.0	3.5	0.0
Non-metall	0.0	5.4	5.0	10.5	0.0	10.5	0.1
Iron & ste	0.0	53.5	6.7	60.2	0.1	60.2	0.3
Syerston	25454.3	0.0	0.0	25454.3	58.2	0.0	0.0
Basic non-	0.0	439.1	0.8	439.9	1.0	439.9	2.4
Strucutura	0.0	25.9	17.2	43.1	0.1	43.1	0.2
Sheet meta	0.0	5.3	16.2	21.5	0.0	21.5	0.1
Fabricated	0.0	54.2	53.3	107.6	0.2	107.6	0.6
Motor vehi	0.0	1.3	7.3	8.6	0.0	8.6	0.0
Ships and	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Railway eq	0.0	19.0	9.0	28.0	0.1	28.0	0.2
Aircraft	0.0	1.3	2.1	3.4	0.0	3.4	0.0
Photograph	0.0	0.4	3.0	3.4	0.0	3.4	0.0
Electronic	0.0	0.3	1.5	1.8	0.0	1.8	0.0
Household	0.0	1.2	80.8	81.9	0.2	81.9	0.4
Other elec	0.0	2.1	1.9	4.0	0.0	4.0	0.0
Ag, mine &	0.0	23.9	3.4	27.3	0.1	27.3	0.1
Other mach	0.0	15.8	3.8	19.6	0.0	19.6	0.1
Prefabrica	0.0	5.8	0.3	6.1	0.0	6.1	0.0
Furniture	0.0	0.7	42.1	42.7	0.1	42.7	0.2
Other manu	0.0	7.7	11.1	18.8	0.0	18.8	0.1
Electricit	0.0	291.1	168.4	459.5	1.0	459.5	2.5
Gas supply	0.0	1452.1	13.4	1465.5	3.3	1465.5	8.0
Water supp	0.0	17.7	62.9	80.6	0.2	80.6	0.4
Residentia	0.0	2.5	363.0	365.5	0.8	365.5	2.0
Other cons	0.0	51.8	14.4	66.2	0.2	66.2	0.4
Wholesale	0.0	234.8	421.9	656.7	1.5	656.7	3.6
Retail tra	0.0	6.2	2256.6	2262.8	5.2	2262.8	12.4
Mechanical	0.0	37.2	402.9	440.0	1.0	440.0	2.4
Other repa	0.0	12.2	37.5	49.7	0.1	49.7	0.3
Accommodat	0.0	39.7	820.0	859.7	2.0	859.7	4.7
Road trans	0.0	144.9	289.1	434.0	1.0	434.0	2.4
Rail, pipe	0.0	709.2	384.8	1094.0	2.5	1094.0	6.0
Water tran	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Air & spac	0.0	22.5	78.8	101.2	0.2	101.2	0.6
Services t	0.0	20.0	37.1	57.1	0.1	57.1	0.3
Communicat	0.0	118.2	363.3	481.5	1.1	481.5	2.6

Banking	0.0	79.4	266.9	346.3	0.8	346.3	1.9
Non-bank f	0.0	20.7	38.6	59.3	0.1	59.3	0.3
Financial	0.0	18.4	4.9	23.3	0.1	23.3	0.1
Insurance	0.0	12.9	68.9	81.8	0.2	81.8	0.4
Serv to fi	0.0	24.9	28.5	53.5	0.1	53.5	0.3
Ownership	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other prop	0.0	137.1	99.1	236.2	0.5	236.2	1.3
Scientific	0.0	168.5	69.6	238.1	0.5	238.1	1.3
Legal, acc	0.0	124.1	281.8	405.8	0.9	405.8	2.2
Other busi	0.0	72.1	184.2	256.3	0.6	256.3	1.4
Government	0.0	1.2	3.7	4.9	0.0	4.9	0.0
Defence	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Education	0.0	29.6	543.7	573.2	1.3	573.2	3.1
Health ser	0.0	2.7	1350.9	1353.5	3.1	1353.5	7.4
Community	0.0	1.4	324.9	326.4	0.7	326.4	1.8
Motion pic	0.0	10.1	40.1	50.1	0.1	50.1	0.3
Libraries,	0.0	2.6	78.3	80.9	0.2	80.9	0.4
Sport, gam	0.0	0.3	76.7	77.0	0.2	77.0	0.4
Personal s	0.0	3.8	264.4	268.2	0.6	268.2	1.5
Other serv	0.0	45.2	190.6	235.7	0.5	235.7	1.3
TOTAL	25,454	7,086	11,224	43,764	100	18,310	100
MULTIPLIER	1.0	0.3	0.4	1.7		0.7	

ESTIMATED EMPLOYMENT EFFECTS No.
CENTRAL WEST NSW SD 1995/96

SECTOR	F.DEMAND	INDUST	CONS'M	TOTAL	(%)	FLOW-ON	(%)
Sheep	0.0	0.1	1.2	1.3	0.1	1.3	0.2
Grains	0.0	0.0	2.0	2.0	0.2	2.0	0.3
Beef cattl	0.0	0.1	4.5	4.5	0.4	4.5	0.7
Dairy catt	0.0	0.0	1.0	1.0	0.1	1.0	0.1
Pigs	0.0	0.0	0.5	0.5	0.0	0.5	0.1
Poultry	0.0	0.0	0.3	0.3	0.0	0.3	0.1
Agricultur	0.0	0.1	6.4	6.5	0.6	6.5	1.0
Services t	0.0	0.0	0.8	0.9	0.1	0.9	0.1
Forestry a	0.0	0.5	0.3	0.8	0.1	0.8	0.1
Commercial	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Coal; oil	0.0	8.0	1.0	8.9	0.9	8.9	1.4
Iron ores	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-ferrou	0.0	23.7	0.0	23.7	2.3	23.7	3.6
Other mini	0.0	0.4	0.1	0.5	0.1	0.5	0.1
Services t	0.0	12.3	0.1	12.4	1.2	12.4	1.9
Meat & mea	0.0	0.1	5.2	5.3	0.5	5.3	0.8
Dairy prod	0.0	0.0	0.2	0.2	0.0	0.2	0.0
Fruit & ve	0.0	0.0	1.8	1.8	0.2	1.8	0.3
Oils & fat	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Flour mill	0.0	0.0	0.5	0.6	0.1	0.6	0.1

Bakery pro	0.0	0.1	4.1	4.2	0.4	4.2	0.6
Confection	0.0	0.0	1.1	1.1	0.1	1.1	0.2
Food produ	0.0	0.0	3.6	3.6	0.4	3.6	0.5
Soft drink	0.0	0.0	0.3	0.3	0.0	0.3	0.1
Beer & mal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wine & spi	0.0	0.0	0.4	0.4	0.0	0.4	0.1
Tobacco pr	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textile fi	0.0	0.1	1.2	1.3	0.1	1.3	0.2
Textile pr	0.0	0.1	0.3	0.3	0.0	0.3	0.1
Knitting m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clothing	0.0	0.0	2.8	2.8	0.3	2.8	0.4
Footwear	0.0	0.0	0.8	0.9	0.1	0.9	0.1
Leather &	0.0	0.0	0.4	0.4	0.0	0.4	0.1
Sawmill pr	0.0	0.0	0.3	0.4	0.0	0.4	0.1
Other wood	0.0	0.1	0.8	0.8	0.1	0.8	0.1
Pulp, pape	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P'board co	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Printing &	0.0	0.5	1.7	2.2	0.2	2.2	0.3
Publishing	0.0	0.4	2.6	2.9	0.3	2.9	0.4
Petroleum	0.0	0.4	0.1	0.5	0.0	0.5	0.1
Basic chem	0.0	1.9	0.1	2.0	0.2	2.0	0.3
Paints	0.0	0.0	0.0	0.1	0.0	0.1	0.0
Medicinal	0.0	0.0	0.2	0.2	0.0	0.2	0.0
Soap & oth	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Cosmetic &	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Other chem	0.0	0.3	0.1	0.4	0.0	0.4	0.1
Rubber pro	0.0	0.0	0.0	0.1	0.0	0.1	0.0
Plastic &	0.0	0.5	0.4	1.0	0.1	1.0	0.1
Glass & gl	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Ceramic pr	0.0	0.2	0.1	0.3	0.0	0.3	0.1
Cement, li	0.0	0.1	0.1	0.3	0.0	0.3	0.0
Plaster &	0.0	0.1	0.1	0.1	0.0	0.1	0.0
Non-metall	0.0	0.2	0.1	0.3	0.0	0.3	0.0
Iron & ste	0.0	1.3	0.2	1.4	0.1	1.4	0.2
Syerston	371.0	0.0	0.0	371.0	36.1	0.0	0.0
Basic non-	0.0	13.6	0.0	13.6	1.3	13.6	2.1
Strucutura	0.0	1.1	0.7	1.8	0.2	1.8	0.3
Sheet meta	0.0	0.2	0.6	0.8	0.1	0.8	0.1
Fabricated	0.0	2.1	2.0	4.1	0.4	4.1	0.6
Motor vehi	0.0	0.1	0.3	0.3	0.0	0.3	0.0
Ships and	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Railway eq	0.0	0.7	0.3	1.0	0.1	1.0	0.2
Aircraft	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Photograph	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Electronic	0.0	0.0	0.1	0.1	0.0	0.1	0.0
Household	0.0	0.0	2.9	2.9	0.3	2.9	0.4
Other elec	0.0	0.1	0.1	0.1	0.0	0.1	0.0
Ag, mine &	0.0	0.9	0.1	1.0	0.1	1.0	0.2
Other mach	0.0	0.6	0.1	0.8	0.1	0.8	0.1
Prefabrica	0.0	0.2	0.0	0.3	0.0	0.3	0.0
Furniture	0.0	0.0	2.1	2.2	0.2	2.2	0.3
Other manu	0.0	0.4	0.6	0.9	0.1	0.9	0.1
Electricit	0.0	7.1	4.1	11.2	1.1	11.2	1.7
Gas supply	0.0	38.5	0.4	38.8	3.8	38.8	5.9
Water supp	0.0	0.4	1.6	2.0	0.2	2.0	0.3

Residentia	0.0	0.1	12.7	12.8	1.2	12.8	1.9
Other cons	0.0	1.6	0.4	2.0	0.2	2.0	0.3
Wholesale	0.0	8.7	15.7	24.4	2.4	24.4	3.7
Retail tra	0.0	0.3	123.1	123.4	12.0	123.4	18.8
Mechanical	0.0	1.4	14.7	16.0	1.6	16.0	2.4
Other repa	0.0	0.6	1.7	2.3	0.2	2.3	0.3
Accommodat	0.0	2.4	50.5	52.9	5.1	52.9	8.1
Road trans	0.0	4.8	9.6	14.4	1.4	14.4	2.2
Rail, pipe	0.0	17.6	9.5	27.1	2.6	27.1	4.1
Water tran	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Air & spac	0.0	0.5	1.7	2.2	0.2	2.2	0.3
Services t	0.0	0.7	1.2	1.9	0.2	1.9	0.3
Communicat	0.0	3.6	11.1	14.8	1.4	14.8	2.2
Banking	0.0	2.7	9.2	11.9	1.2	11.9	1.8
Non-bank f	0.0	0.8	1.5	2.3	0.2	2.3	0.3
Financial	0.0	0.5	0.1	0.7	0.1	0.7	0.1
Insurance	0.0	0.4	2.3	2.7	0.3	2.7	0.4
Serv to fi	0.0	0.8	0.9	1.7	0.2	1.7	0.3
Ownership	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other prop	0.0	5.3	3.8	9.1	0.9	9.1	1.4
Scientific	0.0	5.8	2.4	8.1	0.8	8.1	1.2
Legal, acc	0.0	4.4	9.9	14.2	1.4	14.2	2.2
Other busi	0.0	4.1	10.6	14.7	1.4	14.7	2.2
Government	0.0	0.0	0.1	0.2	0.0	0.2	0.0
Defence	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Education	0.0	1.0	19.0	20.0	1.9	20.0	3.0
Health ser	0.0	0.1	46.3	46.3	4.5	46.3	7.1
Community	0.0	0.1	17.6	17.6	1.7	17.6	2.7
Motion pic	0.0	0.3	1.2	1.5	0.1	1.5	0.2
Libraries,	0.0	0.1	2.9	3.0	0.3	3.0	0.5
Sport, gam	0.0	0.0	4.9	4.9	0.5	4.9	0.7
Personal s	0.0	0.2	14.9	15.1	1.5	15.1	2.3
Other serv	0.0	1.3	5.5	6.8	0.7	6.8	1.0
TOTAL	371	188	469	1,028	100	657	100
MULTIPLIER	1.0	0.5	1.3	2.8		1.8	

ESTIMATED VALUE ADDED EFFECTS $000
CENTRAL WEST NSW 1995/96

SECTOR	F.DEMAND	INDUST	CONS'M	TOTAL	(%)	FLOW-ON	(%)
Sheep	0.0	2.3	49.8	52.0	0.0	52.0	0.1
Grains	0.0	1.0	67.6	68.6	0.0	68.6	0.2
Beef cattl	0.0	3.2	183.1	186.3	0.1	186.3	0.5
Dairy catt	0.0	0.6	33.4	34.0	0.0	34.0	0.1
Pigs	0.0	0.3	14.3	14.5	0.0	14.5	0.0
Poultry	0.0	0.0	3.4	3.4	0.0	3.4	0.0
Agricultur	0.0	5.1	341.2	346.3	0.2	346.3	0.9
Services t	0.0	1.9	51.1	53.0	0.0	53.0	0.1
Forestry a	0.0	27.7	17.2	44.9	0.0	44.9	0.1
Commercial	0.0	0.1	6.4	6.5	0.0	6.5	0.0

Coal; oil	0.0	1351.5	162.3	1513.7	0.8	1513.7	3.8
Iron ores	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-ferrou	0.0	2406.7	1.9	2408.6	1.2	2408.6	6.1
Other mini	0.0	89.5	25.0	114.5	0.1	114.5	0.3
Services t	0.0	556.7	2.2	558.9	0.3	558.9	1.4
Meat & mea	0.0	2.7	186.7	189.4	0.1	189.4	0.5
Dairy prod	0.0	0.7	41.7	42.4	0.0	42.4	0.1
Fruit & ve	0.0	0.3	108.0	108.3	0.1	108.3	0.3
Oils & fat	0.0	0.5	4.7	5.1	0.0	5.1	0.0
Flour mill	0.0	1.3	62.6	63.9	0.0	63.9	0.2
Bakery pro	0.0	4.2	175.9	180.1	0.1	180.1	0.5
Confection	0.0	0.1	64.2	64.3	0.0	64.3	0.2
Food produ	0.0	1.8	271.5	273.2	0.1	273.2	0.7
Soft drink	0.0	0.3	19.8	20.1	0.0	20.1	0.1
Beer & mal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wine & spi	0.0	0.6	26.3	27.0	0.0	27.0	0.1
Tobacco pr	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textile fi	0.0	5.7	77.9	83.6	0.0	83.6	0.2
Textile pr	0.0	5.6	14.8	20.4	0.0	20.4	0.1
Knitting m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clothing	0.0	2.3	156.0	158.3	0.1	158.3	0.4
Footwear	0.0	1.3	31.7	32.9	0.0	32.9	0.1
Leather &	0.0	0.3	18.5	18.8	0.0	18.8	0.0
Sawmill pr	0.0	3.0	23.6	26.6	0.0	26.6	0.1
Other wood	0.0	5.1	48.5	53.6	0.0	53.6	0.1
Pulp, pape	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P'board co	0.0	2.2	5.8	8.0	0.0	8.0	0.0
Printing &	0.0	12.8	44.0	56.8	0.0	56.8	0.1
Publishing	0.0	14.9	102.5	117.4	0.1	117.4	0.3
Petroleum	0.0	80.5	15.4	95.9	0.0	95.9	0.2
Basic chem	0.0	160.4	8.9	169.3	0.1	169.3	0.4
Paints	0.0	1.6	1.3	2.9	0.0	2.9	0.0
Medicinal	0.0	1.7	8.4	10.1	0.0	10.1	0.0
Soap & oth	0.0	0.7	3.6	4.3	0.0	4.3	0.0
Cosmetic &	0.0	0.1	4.9	5.0	0.0	5.0	0.0
Other chem	0.0	15.8	3.6	19.4	0.0	19.4	0.0
Rubber pro	0.0	1.2	1.2	2.4	0.0	2.4	0.0
Plastic &	0.0	17.6	13.1	30.7	0.0	30.7	0.1
Glass & gl	0.0	2.3	12.0	14.3	0.0	14.3	0.0
Ceramic pr	0.0	20.6	14.7	35.3	0.0	35.3	0.1
Cement, li	0.0	18.6	20.1	38.7	0.0	38.7	0.1
Plaster &	0.0	5.1	6.7	11.8	0.0	11.8	0.0
Non-metall	0.0	14.0	13.0	27.0	0.0	27.0	0.1
Iron & ste	0.0	53.8	6.7	60.5	0.0	60.5	0.2
Syerston	156409.6	0.0	0.0	156409.6	79.8	0.0	0.0
Basic non-	0.0	1195.5	2.2	1197.8	0.6	1197.8	3.0
Strucutura	0.0	36.4	24.2	60.6	0.0	60.6	0.2
Sheet meta	0.0	10.0	30.5	40.5	0.0	40.5	0.1
Fabricated	0.0	67.5	66.4	133.9	0.1	133.9	0.3
Motor vehi	0.0	1.8	10.5	12.2	0.0	12.2	0.0
Ships and	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Railway eq	0.0	31.7	15.1	46.8	0.0	46.8	0.1
Aircraft	0.0	1.4	2.4	3.8	0.0	3.8	0.0
Photograph	0.0	0.7	5.1	5.8	0.0	5.8	0.0
Electronic	0.0	0.8	3.6	4.4	0.0	4.4	0.0

Household	0.0	2.3	162.4	164.7	0.1	164.7	0.4
Other elec	0.0	4.4	3.9	8.3	0.0	8.3	0.0
Ag, mine &	0.0	42.5	6.1	48.5	0.0	48.5	0.1
Other mach	0.0	27.5	6.6	34.1	0.0	34.1	0.1
Prefabrica	0.0	12.5	0.6	13.0	0.0	13.0	0.0
Furniture	0.0	0.8	50.8	51.6	0.0	51.6	0.1
Other manu	0.0	10.8	15.5	26.3	0.0	26.3	0.1
Electricit	0.0	1385.1	801.0	2186.1	1.1	2186.1	5.5
Gas supply	0.0	6703.7	61.7	6765.4	3.5	6765.4	17.1
Water supp	0.0	51.6	183.1	234.7	0.1	234.7	0.6
Residentia	0.0	3.5	513.5	517.0	0.3	517.0	1.3
Other cons	0.0	63.4	17.6	81.0	0.0	81.0	0.2
Wholesale	0.0	427.0	767.2	1194.2	0.6	1194.2	3.0
Retail tra	0.0	8.7	3159.1	3167.8	1.6	3167.8	8.0
Mechanical	0.0	73.1	792.3	865.4	0.4	865.4	2.2
Other repa	0.0	14.5	44.7	59.2	0.0	59.2	0.1
Accommodat	0.0	50.7	1047.6	1098.3	0.6	1098.3	2.8
Road trans	0.0	319.0	636.3	955.3	0.5	955.3	2.4
Rail, pipe	0.0	709.2	384.8	1094.0	0.6	1094.0	2.8
Water tran	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Air & spac	0.0	57.1	200.0	257.1	0.1	257.1	0.6
Services t	0.0	60.0	111.2	171.2	0.1	171.2	0.4
Communicat	0.0	268.7	826.1	1094.9	0.6	1094.9	2.8
Banking	0.0	171.8	577.2	749.0	0.4	749.0	1.9
Non-bank f	0.0	37.3	69.8	107.2	0.1	107.2	0.3
Financial	0.0	29.5	7.8	37.3	0.0	37.3	0.1
Insurance	0.0	22.1	118.3	140.4	0.1	140.4	0.4
Serv to fi	0.0	57.1	65.4	122.5	0.1	122.5	0.3
Ownership	0.0	0.0	4066.4	4066.4	2.1	4066.4	10.3
Other prop	0.0	213.5	154.3	367.8	0.2	367.8	0.9
Scientific	0.0	262.8	108.6	371.5	0.2	371.5	0.9
Legal, acc	0.0	172.7	392.2	564.9	0.3	564.9	1.4
Other busi	0.0	85.1	217.4	302.5	0.2	302.5	0.8
Government	0.0	1.4	4.4	5.7	0.0	5.7	0.0
Defence	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Education	0.0	39.6	727.2	766.8	0.4	766.8	1.9
Health ser	0.0	3.4	1722.4	1725.8	0.9	1725.8	4.4
Community	0.0	1.5	333.2	334.7	0.2	334.7	0.8
Motion pic	0.0	10.1	40.1	50.1	0.0	50.1	0.1
Libraries,	0.0	4.1	122.6	126.7	0.1	126.7	0.3
Sport, gam	0.0	0.5	142.8	143.3	0.1	143.3	0.4
Personal s	0.0	3.8	264.4	268.2	0.1	268.2	0.7
Other serv	0.0	49.3	208.3	257.6	0.1	257.6	0.7
TOTAL	156,410	17,713	21,872	195,995	100	39,585	100
MULTIPLIER	1.0	0.1	0.1	1.3		0.3	

APPENDIX I

SYERSTON NICKEL-COBALT PROJECT FLORA REPORT

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JULY 2000

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I1 INTRODUCTION

This report presents the results of a flora survey conducted for the Syerston Nickel-Cobalt Project. The proposed nickel laterite mine is situated approximately 2 km north-west of Fifield and 45 km north-east of Condobolin in central New South Wales (Figure I-1). The mine site comprises mainly freehold farmland, but also includes a small area of State Forest (Fifield State Forest), Crown Reserve and Crown land (Figure I-2). Infrastructure associated with the Project includes (Figure I-1):

- Mine site (including MLA 141,140, 132, 113 and 139);
- a gas pipeline from the existing Sydney to Moomba pipeline (south of Condobolin) to the mine site (approximately 90 km);
- a water supply pipeline from two borefields located in the Lachlan Valley palaeochannel (west of Forbes) to the mine site (approximately 65 km), and an associated water spurline (approximately 12 km) to the proposed limestone quarry;
- upgrade of Route 64 (approximately 17 km);
- construction of the Fifield Bypass (approximately 12 km);
- a limestone quarry situated approximately 10 km to the north-west of Trundle; and
- a rail siding and associated access road, north of Trundle.

A detailed description of the Project is provided in Section 2 of the Environmental Impact Statement (EIS).

I1.1 SURVEY OBJECTIVES

The aims of this study were to:

1. determine the vegetation communities present within the Project area;
2. develop a comprehensive species list for each vegetation community;
3. develop a list of threatened plant species that could potentially occur in the plant communities represented in the disturbance areas;
4. conduct targeted searches for the nominated threatened plant species; and
5. conduct Eight Part Tests of Significance on the nominated threatened plant species.

I1.2 REGIONAL SETTING

The Project area is located at the western edge of the Central Western Slopes botanical region (Harden, 1990-93) or, alternatively, the NSW South Western Slopes biogeographical region (Thackway and Cresswell, 1995). The boundaries with the South West Plains and North West Plains botanical regions lie only some 20 km to the west and 90 km to the north of the mine site, respectively. Similarly, the mine site is close to the edge of the Cobar Peneplain biogeographical region. It is to be expected that the flora on the Project area would contain significant elements of plains communities as well as plants typical of the western slopes.

The nearest conservation reserves to the mine site are the Woggoon and Tollingo Nature Reserves about 50 km to the west. These primarily conserve mallee habitats. Goobang National Park is located some 85 km to the east and conserves a variety of communities including White Cypress Pine / Bulloak (*Callitris glaucophylla / Allocasuarina luehmannii*), Yellow Box (*Eucalyptus melliodora*) and White Box (*E. albens*) woodlands, Ironbark communities (*E. fibrosa* and *E. sideroxylon*) and hill communities (*E. rossii* / *E. macrorhyncha* / *Callitris endlicheri*) typical of the eastern parts of the Central West Slopes. The nearest reserve to the north is the Macquarie Marshes Nature Reserve, about 170 km away, conserving wetland communities. To the south are two small Nature Reserves, (Buddigower and Charcoal Tank), conserving Grey Box / Mugga Ironbark (*Eucalyptus microcarpa / E. sideroxylon*) and mallee, each about 125 km away, while Conapaira Nature Reserve and Cocopara National Park are about 190 km to the south west (mainly inland hill communities with some Poplar Box / White Cypress Pine (*Eucalyptus populnea* subsp. *bimbil* / *Callitris glaucophylla*) and Weddin Mountains National Park (similar communities to Goobang National Park) is 130 km to the south-southeast. There are no conservation reserves in close proximity to the mine site.

Several small State Forests occur within 50 km of the mine site. These include Fifield State Forest, situated within MLA 140 and 132. Others include Bulbodney, Albert, Taratta, Mt. Nobby, Mount Tilga, Murda, East Cookeys Plains, West Cookeys Plains, Trundle, Blowclear, Coradgery, Curra, Euchabil, Strahorn and Coradgery State Forests. These are primarily managed for the production of White Cypress Pine (*Callitris glaucophylla*) timber and are important reservoirs of biodiversity as they contain a different mix of plant communities from those in the National Parks and Nature Reserves of the region. They usually contain areas of better quality soils similar to those on nearby agricultural lands and support similar plant communities.

The conservation status of plant communities in the Project area and surrounds is regarded as poor. Thackway and Cresswell (1995) indicate that less than one percent of the area of the NSW South Western Slopes biogeographical region is set aside in conservation reserves and there is a high degree of bias in the communities reserved.

I1.3 GENERAL DESCRIPTION OF THE PROJECT AREA

I1.3.1 Mine Site

The mine site occurs on gently undulating country at the top of the divide between the Lachlan and Macquarie Valleys ranging from about 270 to 320m in altitude. The site is situated in the upper headwaters of Bullock Creek, within the Darling River catchment. The mine site is drained generally to the northeast by unnamed ephemeral drainage lines. Several of these drainage lines lose definition to the northeast of the site due to the flat open terrain or are excised by the old mine workings. Several areas of low gravelly hills occur across the site with broad shallow valleys between.

According to Cunningham (1997) the geology of the mine site comprises mainly Quarternary sedimentary sands, silts and gravels with some older Tertiary sediments. Outcrops of Girilambone Group rocks occur in the south of the site and of the Tout Intrusive Complex in the north west. The latter comprise slates, schists, phyllites, quartz greywacke, quartzite and altered volcanics.

The soils are mainly non-calcic brown soils on the flatter areas and mid-slopes with shallower lithosols on the upper slopes (Cunningham, 1997). The drainage lines have red earthic soils and recent alluvium.

I1.3.2 Associated Infrastructure

The gas and water pipeline routes originate near or on the floodplain of the Lachlan River, respectively, before ascending the northern side of the shallow valley to the mine site. These routes cross a much wider range of soil types and habitats than are found on the mine site.

South of the Lachlan River the gas pipeline initially traverses mainly stagnant alluvial plain (Euglo and Selems Road soil landscapes) and gilgai (Myall Park soil landscape) before encountering the active alluvial soil landscape (Mulgutherie) of the Lachlan River floodplain (King 1998). The landscapes feature many seasonally wet areas in gilgai depressions, billabongs and creeks. North of Condobolin the route alternates between stagnant alluvial (Derriwong) and erosional soil landscapes (Ootha) that are underlain by Ordovician and Devonian metasediments. The stagnant alluvial landscapes are flat to gently undulating while the erosional landscapes are more undulating with low rises and occasional rocky hills.

The water pipeline originates on the active alluvial floodplain of the Lachlan River and tributary creeks (Corinella and Mulgutherie Soil Landscapes); the first 20 km or so dominated by seasonally wet habitats. North of Bumbuggan Creek it traverses areas of the Ootha erosional soil landscape and the Derriwong stagnant alluvial soil landscape (King 1998). Similarly, Route 64 traverses mainly erosional and stagnant alluvial soil landscapes. Although existing soil landscape mapping does not extend to the remaining associated infrastructure areas, the similarity of topography and climate would indicate that similar soil types to those outlined above could be expected. The exception is the occurrence of terra rossa soils on an isolated outcrop of upper Devonian limestone at the site of the proposed limestone quarry.

I1.4 LAND USE

I1.4.1 Mine Site

Historically, the lands of the mine site have been used for cropping, grazing, forestry and mining. The flatter terrain with deeper soils has mostly been cleared of its native vegetation cover and is used for cropping, principally wheat growing. The wheat paddocks have only scattered remnant native trees occurring singly or as small clusters. The hillier sites on the mine site retain a greater cover of native vegetation, but have generally been significantly thinned in the past to promote growth of grasses for grazing. Dense regeneration of White Cypress Pine (*Callitris glaucophylla*) has occurred on some of these areas. Strips of natural vegetation have been left along the drainage lines in the farmed areas to prevent soil erosion.

The north-eastern portions of the mine site have been heavily disturbed by previous mining activities for magnesite, including parts of Fifield State Forest, the Crown reserve and the Crown land. The mined areas have been stabilised and are revegetating.

Few old growth trees remain in Fifield State Forest due to past logging for White Cypress Pine (*Callitris glaucophylla*) and thinning out of competing eucalypts, so that the forest is now dominated by regenerating *C. glaucophylla*.

I1.4.2 Associated Infrastructure

Service corridors for the water and gas supply pipelines will be established in existing easements beside public roads for the majority of their length (Figure I-1). The density of native vegetation currently remaining in the easements varies considerably from site to site along the corridors and depends on the width of the easement and degree of past disturbance. The wider corridors are Travelling Stock Routes subject to periodic grazing during droughts. These generally retain more or less intact samples of the original vegetation.

Route 64 is a narrow easement over most of its length and consists of thin strips of remnant native vegetation within the road corridor. The limestone quarry and water supply borefield are both characterised by cleared grazing and cropping paddocks. The Fifield bypass traverses a mixture of thinned remnant box-pine and ironbark woodlands, cleared farmland and roadside, while the rail siding has been cleared of its native tree cover and is characterised by a diverse grassland.

I1.5 PREVIOUS STUDIES AND VEGETATION CLASSIFICATION

There have been several published studies of the regional flora of the proposed Project area. Beadle (1948) provided a coarse vegetation map of the western areas of New South Wales that showed three major natural vegetation communities (referred to as associations) occur in the Fifield area. These are:

1. *Eucalyptus microcarpa* (Grey Box) alliance (recorded as *Eucalyptus woollsiana* association in Beadle (1948)).

2. *Eucalyptus populnea* ssp. *Bimbil* / *Callitris glaucophylla* (Bimble Box / White Cypress Pine) association (recorded in Beadle (1948) as *E. populifolia* / *C. glauca*).

3. *Eucalyptus dealbata* / *Eucalyptus sideroxylon* (Tumbledown Gum / Mugga Ironbark) association.

In the vicinity of the gas and water pipeline routes, Beadle (1948) identified two additional communities:

4. *Eucalyptus populnea* ssp. *Bimbil* (recorded as *E. populifolia* in Beadle (1948)) (Poplar Box) association.

5. *Eucalyptus largiflorens* (recorded as *E. bicolor* by Beadle (1948)) (Black Box) association.

Cunningham (1997) is the only previous specific study of the mine site. This study identified nine plant communities and 94 species. The plant communities included agricultural systems and different successional stages of regenerating natural communities. If agricultural systems and degree of disturbance are discounted, Cunningham (1997) identified four distinct natural plant communities on the mine site with dominant overstorey species as follows:

1. Box – Pine Woodland (*Eucalyptus microcarpa* / *E. populnea* ssp. *Bimbil* / *Callitris glaucophylla*)

2. Wilga – Belah Woodland (*Geijera parviflora* / *Casuarina cristata*)

3. Mugga Ironbark – Tumbledown Gum Woodland (*Eucalyptus sideroxylon* / *E. dealbata*)

4. Watercourse Woodland (*Eucalyptus melliodora*)

Several other vegetation studies are useful in interpreting the plant communities of the Project area. Each classifies the vegetation alliances and associations of central NSW somewhat differently.

Specht *et al*. (1974) presented a classification of Australian vegetation alliances based on both plant species composition and structural formation. Alliances were divided according to the height of the tallest stratum and the percentage of the ground surface it covered. Alliances recognised by Specht *et al*. (1974) in central NSW are shown in Table I-1 in comparison with the schemes of other workers.

Beadle (1981) presented an expanded classification of the Australian vegetation. He used a hierarchy of alliances, sub-alliances and associations, recognising a greater number of alliances/sub-alliances than Specht *et al*. (1974) (Table I-1).

A third general classification of the Australian vegetation was presented by Specht *et al.* (1995). This scheme was based partly on an analysis of the data in 650 vegetation surveys by the computer classification program TWINSPAN. The computer output defined some 343 ‘major communities’ in Australia. A comprehensive literature search led to the definition of an additional 578 ‘minor communities’. The communities recognised by Specht *et al.* (1995) for Central NSW are shown in Table I-1.

Schrader (1988) provided a brief non-technical description of the plant communities of the Parkes Shire and a checklist of all species identified in a survey of the shire by the Parkes Naturalist Group. Some 442 species were recorded. The mine site lies at the eastern edge of Lachlan Shire about 12 km west of the boundary with Parkes Shire. Many plants would occur across the common boundary.

Table I-1. Vegetation Alliances, Associations and 'Communities' in Central New South Wales

Syerston Mine Site 'communities' Cunningham (1997)	**Wheat-belt Communities Sivertson and Metcalf (1995)**	**Formal Classifications**				
		Alliances			**Major or Minor Communities**	**Associations**
		Beadle (1948)	**Beadle (1981)**	**Specht *et al.* (1974)**	**Specht *et al.* (1995)**	**Benson (1989)**
	E. camaldulensis		*E. camaldulensis*	*E. camaldulensis*	*E. camaldulensis*	*E. camaldulensis*
	E. largiflorens	*E. largiflorens*	*E. largiflorens*	*E. largiflorens*	*E. largiflorens*	*E. largiflorens*
			E. sideroxylon		*E. sideroxylon*	*E. sideroxylon*
E. sideroxylon / *E. dealbata*	*E. dwyeri* / *E. sideroxylon*	*E. dealbata* / *E. sideroxylon*	*E. dealbata* / *E. sideroxylon* (sub-alliance)	*E. dealbata* / *E. sideroxylon*	*E. dealbata* / *E. sideroxylon*	*E. sideroxylon* / *E. dealbata*
					E. dwyeri	
					Callitris endlicheri	*Acacia doratoxylon*
E. microcarpa / *E. populnea* / *Callitris glaucophylla*	*E .microcarpa* / *E .populnea*	*E. microcarpa*	*E. microcarpa*	*E. microcarpa*	*E. microcarpa*	*E. populnea* / *E. microcarpa*
					E. microcarpa / E. sideroxylon	*E. microcarpa* / *Callitris glaucophylla*
			E .populnea	*E. populnea*		
	Callitris glaucophylla / *E. populnea* / *E. microcarpa*	*E. populnea* / *Callitris glaucophylla*	*E. populnea* / *Callitris glaucophylla* (sub-alliance)	*E. populnea* / *Callitris glaucophylla*	*E. populnea* ± *Callitris glaucophylla*	
					Callitris glaucophylla	
			E. populnea / Eremophila mitchellii sub-alliance			*E. populnea* (grassy understorey)
			E. populnea / *Casuarina cristata* (sub-alliance)			*E .populnea* / *Casuarina cristata*
	Allocasuarina luehmannii / *Casuarina cristata*				*Allocasuarina luehmannii*	*Allocasuarina luehmannii* (± various)

Table I-1. Vegetation Alliances, Associations and 'Communities' in Central New South Wales (Continued)

Syerston Mine Site 'communities' Cunningham (1997)	Wheat-belt Communities Sivertson and Metcalf (1995)	Formal Classifications				
		Alliances			Major or Minor Communities	Associations
		Beadle (1948)	Beadle (1981)	Specht *et al.* (1974)	Specht *et al.* (1995)	Benson (1989)
						E. populnea / *E. melliodora*
E. melliodora						*E. melliodora* / *Callitris glaucophylla*
Geijera parviflora / *Casuarina cristata*		*Casuarina* / *Alectryon*				*Casuarina cristata* / *Alectryon oleifolius*
			E. populnea / *Geijera parviflora* (sub-alliance)			*Geijera parviflora* / *Alectryon oleifolius*
			Acacia pendula	*Acacia pendula* / *Atriplex nummularia*	*Acacia pendula* / *Atriplex nummularia*	*A. pendula* ± *Alectryon oleifolius*
		E. socialis / *E. dumosa*	*E. socialis* / *E. dumosa*	*E. socialis* / *E. dumosa*	*E. socialis* / *E. dumosa*	*E. socialis* / *E. dumosa*
			E .viridis		*E. viridis*	*E. viridis*
			Stipa aristiglumis	*Stipa aristiglumis*	*Stipa aristiglumis*	*Stipa aristiglumis*
			Eragrostis australasica	*Eragrostis australasica*	*Eragrostis australasica*	*Eragrostis australasica*
			Phragmites australis sub-alliance			*Phragmites australis*
						Cynodon dactylon
			Typha domingensis		*Eleocharis acuta* / *Potamogeton crispus* / *Typha* spp.	*Typha* spp.
			Marsilea drummondii			*Marsilea drummondii*
			Muehlenbeckia cunninghamii			*Muehlenbeckia cunninghamii*
			Eleocharis pallens			*Eleocharis pallens*
					Melaleuca uncinata	*Melaleuca uncinata*

Sivertson and Metcalfe (1995) sampled and mapped the larger areas of remnant vegetation in the wheat belt on the Forbes and Lake Cargelligo 1:250,000 map sheets. The northern edge of the Forbes map is about 23 km south of the mine site and covers significant portions of the gas and water pipeline routes. However, the map does not show roadside vegetation and does not attempt to reconstruct the original distribution of natural plant communities in the area. The mapping of Sivertson and Metcalfe (1995) was based mainly on air photo interpretation and vegetation pattern analysis from a large number of sample sites, which together were used to define 20 vegetation types ('map units') for mapping. Geology, soil types and landform were also taken into account. This procedure resulted in the subdivision of some disturbed plant communities according to the density of the overstorey.

The map units of Sivertson and Metcalfe (1995) differ from the alliances of Specht *et al*. (1974) and Beadle (1981) in that the former did not distinguish communities with different dominant *Eucalyptus* species if they had similar physical structures and densities that could not be reliably distinguished in aerial photo interpretation. This has resulted in the amalgamation of some of the alliances of Specht *et al*. (1974) and Beadle (1981) into the same map unit, primarily the Box Woodlands dominated by *Eucalyptus populnea* ssp. *Bimbil* and *E. microcarpa.* It has also resulted in the creation of a map unit for Bulloak (*Allocasuarina luehmanii*) and Belah (*Casuarina cristata*) woodlands which are easily recognised in aerial photos, but were not separated by Specht *et al*. (1974) who instead included them as part of alliances dominated by eucalypts. By contrast, Beadle (1981) recognises separate alliances for both *A. luehmannii* and *C. cristata*, while Specht *et al.* (1995) only recognise a 'major community' for *A. luehmannii*. Similarly, Specht *et al*. (1974) did not recognise an alliance dominated solely by *Callitris glaucophylla* as Sivertson and Metcalfe (1995) have. By contrast, Specht *et al.* (1995) also recognised a 'major community' for *C. glaucophylla*. These differences in interpretation and others are shown in Table I-1.

Benson (1989) presented a list of 432 plant associations for New South Wales along with estimates of their conservation status. Plant associations are named by the one or two dominant upper stratum species of the community and describe more localised vegetation groupings than an alliance. Alliances are region-wide groupings of species and consist of mosaics of associations which are each adapted to particular sets of localised site characteristics within the broader landscape. It can be argued that the association is the fundamental ecological plant grouping. The vegetation of the Syerston Project area potentially comprises 26 of Benson's (1989) associations (Table I-1).

Table I-1 also compares the vegetation classifications of Beadle (1948, 1981), Specht *et al*. (1974, 1995), Sivertson and Metcalfe (1995) and Cunningham (1997) for the alliances or major communities found in the Parkes – Condobolin area. All classifications treat the floodplain communities dominated by *E. camaldulensis* and *E. largiflorens* in a similar manner. The hill vegetation dominated by *E. sideroxylon* and *E. dealbata* is also treated similarly by most authors, except that Specht *et al.* (1995) recognise two additional communities, *E. dwyeri* and *Callitris endlicheri*. By contrast, there are significant differences in the treatment of the alliances dominated by *E. microcarpa, E. populnea* and *C. glaucophylla* on the stagnant alluvial and erosional soil landscapes on flat to undulating terrain. While the vegetation associations on these landscapes may be relatively uniform over large areas they may also form complex blending mosaics. The interpretation of alliances for these communities in the literature has been somewhat arbitrary and may be difficult to apply to particular situations. The complexity of the vegetation of Central NSW is amply illustrated by the pattern analysis of Sivertson and Metcalfe (1995).

I2 METHODS

I2.1 TARGETED SEARCHES FOR THREATENED SPECIES

A list of threatened plant species (Table I-2) classified as vulnerable, endangered or extinct, which could possibly occur within the Project area, was compiled from *Rare or Threatened Australian Plants* (Briggs and Leigh 1996), the schedules of the *New South Wales Threatened Species Conservation Act, 1995*, the Commonwealth *Protection of the Environment Biodiversity Conservation Act, 1999* and from consultations with the NSW National Parks and Wildlife Service (NPWS). Species were selected from the listings in Briggs and Leigh (1996) for the Central Western Slopes (Region 51), and the Western Plains (Region 49) since the study area lies near the boundary of these biogeographical zones. The choice was further narrowed by considering the known distribution and habitats of the threatened species (Cunningham *et al*., 1981; Harden, 1990-93; Ayers *et al*., 1996; Cunningham, 1997) and eliminating from further consideration those that occurred more than 200 km from the Project area or in habitats very different from those on the Project area. The NPWS provided a list of threatened species predicted by bioclimatic modelling to potentially occur in the Project area and a list of threatened species recorded within 50 km of the mine site. In addition, the Austral Pillwort, *Pilularia novae-hollandiae*, was included because it had been found within the Project area in recent surveys associated with the Cowal Gold Project (Clements and Rodd, 1995; Bower, 1998), and represented an extension of the species known range in New South Wales. Eighteen threatened species were selected for targeted surveys and Eight Part Tests of Significance (Table I-2).

I2.2 FIELD SURVEY

I2.2.1 Mine Site

Field surveys of the mine site were conducted from 26 to 29 December 1998, with four additional sites sampled on 17 October 1999. The surveys focussed on areas of remnant native vegetation identified in Cunningham (1997). Cropped areas were not examined since ploughing is known to eliminate all vegetation except for some weeds. Areas of remnant vegetation within MLAs 141, 140, 132, 113 and 139 were systematically searched to compile a comprehensive flora list and to detect any threatened species that may be present. In all, 14 sites were surveyed, two in the State Forest, three in the Crown land and nine within MLAs 113, 139 and 141. Opportunistic observations of other species were made when moving around the mine site. Details of the locations of the 14 intensive sample sites are given in Attachment I-A and shown in Figure I-3.

Table I-2. Endangered or Vulnerable Plant Species for Targeted Survey

Species	Endangered	Vulnerable	Likelihood of Former Occurrence
Acacia curranii		NRE	low
Bothriochloa biloba		NRE	medium
Dichanthium setosum		NE	medium
Dodonaea sinuolata subsp. *acrodentata*	N		low
Eleocharis obicis		NRE	medium
Eriostemon ericifolius		N	medium
Eucalyptus pulverulenta		NRE	medium
Goodenia macbarronii		NRE	medium
Indigofera efoliata	NRE		low
Lepidium monoplocoides	NRE		low
Monotaxis macrophylla	N		medium
Pilularia novae-hollandiae	N		high
Pterostylis cobarensis		NRE	low
Rulingia procumbens		NRE	medium

Table I-2. Endangered or Vulnerable Plant Species for Targeted Survey (Continued)

Species	Endangered	Vulnerable	Likelihood of Former Occurrence
Stipa wakoolica	NRE		medium
Swainsona murrayana		NRE	low
Tylophora linearis	NRE		medium
Zieria ingramii	NE	R	low

N Listed under the NSW *Threatened Species Conservation Act 1995.*
R Listed under *Rare or Threatened Australian Plants* (Briggs and Leigh, 1996).
E Listed under the *Environment Protection and Biodiversity Conservation Act, 1999*

Ratings of likelihood of former occurrence on the Project area: high = recorded for the same botanical region (Central West Slopes) and habitats; medium = recorded for same botanical region (Central West Slopes; low = recorded for adjacent botanical regions (North West Slopes and North and South West Plains)

I2.2.2 Associated Infrastructure

Associated infrastructure sites were surveyed on 17 to 20 October 1999 (60 sites), 27 to 29 January 2000 (20 sites) and 9 and 10 June 2000 (7 sites). Not all surveyed sites are reported here since some were on alternatives that have not been adopted. The gas and water pipelines, Route 64 and the Fifield bypass were surveyed by systematic 15 minute searches along a 25 m length of roadside at each site extending to the fenceline on both sides. Where the gas pipeline crosses farmland the searches covered the width of the service corridor (100m). Sample sites were spaced at 4 km intervals in uniform terrain with additional sites between these if different habitats were encountered, such as creeks or rocky hilltops. In this way a conscious effort was made to sample all habitats.

The entire site of the proposed rail siding was surveyed on foot. Two of the easternmost cultivation paddocks of the limestone quarry site were traversed by vehicle with frequent stops to examine plants of interest, while the cleared limestone outcrop was examined on foot. The water supply borefield was covered by vehicle with three naturally vegetated sites sampled in detail. Details of location and vegetation association are given for each site in Attachment I-A and locations are shown in Figure I-3.

I2.3 SAMPLING PROCEDURES

With the exception of commoner trees and shrubs, which were recorded in a field notebook, specimens of all species encountered were collected and preserved for later confirmation of their identity. All specimens were keyed to species using a stereomicroscope and the *Flora of New South Wales* (Harden, 1990-93) as the principal reference. Any specimens whose identities were in doubt were forwarded to the National Herbarium at the Royal Botanic Gardens, Sydney. The plant specimen collection has been preserved and retained by the senior author.

I2.4 DEFINITION OF VEGETATION ASSOCIATIONS AND ALLIANCES

In this report associations are defined by the one, two or three most common tree or other overstorey plant species at each sample site. If one species comprised 90 percent or more of the canopy the association was named for that species alone. If two species were prominent (ratios from approximately 1:5 to 1:1), the association was named for the pair. Similarly, if three species were well represented, the association was named after all three.

Alliances are groups of associations that tend to occur together in similar environments and geographical regions. Like associations, alliances are named for the one or two most dominant or characteristic upper storey species. Alliances define the vegetation on a regional scale while associations relate to more specific local ecological conditions. Alliance names used in this study are those formally defined by Specht *et al.* (1974) and Beadle (1981) and the major communities (equivalent to alliances) are those of Specht *et al.* (1995) (Table I-1).

I3 RESULTS

I3.1 PLANT ALLIANCES / ASSOCIATIONS

For the purposes of this study some 11 vegetation alliances or major communities comprising 24 associations are recognised within the Project area (Table I-3 and Figure I-4). The vegetation falls into four major groupings:

1. Floodplain communities of the Lachlan River and associated creeks.
   - *Eucalyptus camaldulensis* alliance
   - *E. largiflorens* alliance
   - *Stipa aristiglumis* alliance
   - *Marsilea drummondii* alliance

2. Seasonally wet low lying and gilgai communities.
   - *Acacia pendula* alliance
   - *Allocasuarina luehmanii* major community
   - *Eucalyptus socialis/E. dumosa* alliance

3. Alliances on undulating stagnant alluvial and erosional soil landscapes.
   - *Eucalyptus populnea* alliance
   - *Eucalyptus microcarpa* alliance

4. Hill communities on shallow rocky soils.
   - *Eucalyptus sideroxylon/E. dealbata* alliance
   - *Eucalyptus viridis* alliance

I3.1.1 Mine Site

The mine site comprises mainly erosional soil landscapes with small areas of alluvial fan. The natural vegetation is dominated by associations in the *Eucalyptus populnea* (Popular Box), *E. microcarpa* (Grey Box) and *E. sideroxylon* (Mugga Ironbark) */ E. dealbata* (Tumbledown Red Gum) alliances (Figure I-4, Attachment I-A). The *E. populnea* and *E. microcarpa* alliances intergrade to form complex mosaics including several associations with White Cypress Pine (*Callitris glaucophylla*). Other prominent tree species include Belah (*Casuarina cristata*), Wilga (*Geijera parviflora*), Kurrajong (*Brachychiton populneus*) and Rosewood (*Alectryon oleifolius*) (Attachments I-A and I-B1).

C. glaucophylla is common throughout most of the mine site, but tends to be less abundant on alluvial fans in the Fifield State Forest and on the drier ridges. The species of accompanying eucalypts vary according to site characteristics along environmental gradients, particularly soil moisture and slope. Yellow box (*E. melliodora*) occurs mainly in deeper alluvial soils along major drainage lines where it may form almost pure stands, but scattered trees also occur on some of the low ridges (sites S7 and S8, Attachment I-B1). Grey Box (*E. microcarpa*) appears to favour the deeper soils back from watercourses where it occurs with Poplar Box (*E. populnea* subsp. *bimbil*), but may be less common on the low ridges than Poplar Box. Mugga Ironbark (*E. sideroxylon*) and Tumbledown Red Gum (*E. dealbata*) are dominant mainly on gravelly and rocky ridgetops, often grading into *E .microcarpa* on the lower slopes. However, *E. sideroxylon* is also scattered through the area on other sites.

The four natural communities recognised by Cunningham (1997) for the mine site contain 8 associations identified in this study. The increase in the number of recognised communities is due to the subdivision of Cunningham's (1997) 'box – pine woodland' community into four associations. Cunningham's (1997) designation of this community recognises the complex intergradation of associations involving *E. populnea*, *E. microcarpa* and *Callitris glaucophylla* in the study area.

Prominent plant species found in the shrub and herb layers in each association are given in Table I-3. In general the remnant natural habitats of the mine site are open grassy woodlands with scattered shrubs. The exceptions are areas of dense regenerating White Cypress Pine within MLA 113 and in Fifield State Forest.

Figure 1-5 shows the eight vegetation associations recorded at the mine site. Brief descriptions of the main vegetation communities on the mine site follow.

I3.1.1.1 Yellow Box Woodland (E. melliodora /C. glaucophylla)

This quite distinctive community predominates along the drainage lines within the mine site (Figure I-5). It occurs in the south western parts of Fifield State Forest on a broad alluvial fan where a drainage line runs out into flat country. Here there are very large specimens of *E melliodora* and few *C. glaucophylla* in an open eucalypt woodland formation. Elsewhere, it tends to form relatively narrow strips along the drainage lines and some *E. microcarpa* and *E. populnea* subsp. *bimbil* may also be present.

I3.1.1.2 Other Box - Pine Woodland Associations (Mosaics of associations in the Eucalyptus populnea and E. microcarpa alliances)

Four associations within the box-pine woodland alliances are the dominant communities of the mine site (Figure I-5). They are well represented in near natural condition in Fifield State Forest, except that thinning of the eucalypts has changed the ratio of trees in favour of White Cypress Pine. These communities would formerly have dominated most of the flatter farmland areas now used for cropping. It also occupies the lower slopes and low ridges where the main remnants now persist on the farmland.

A small area of pure *E. populnea* open woodland with a grassy understorey persists within MLA 113. This community type was not seen elsewhere in the study area and may represent an isolated occurrence.

I3.1.1.3 Mugga Ironbark (E. sideroxylon) and Mugga Ironbark/Grey Box (E. sideroxylon/ E. microcarpa)

These communities are a relatively minor component of the native vegetation of the mine site. They occur on stony rises in the north of MLA 141 and in the south of MLA 139 (Figure I-5). The northern occurrence is small (and therefore not presented on Figure I-5) and semi-cleared. It contains *E. sideroxylon*, *E. microcarpa*, and *E. populnea* subsp. *bimbil*, but not *E. dealbata*. However, the latter occurs nearby in the absence of *E. sideroxylon*. The tree species present suggest the northern occurrence is a marginal or ecotonal example of this community.

The southern occurrence is more significant and more typical of the *E. sideroxylon* / *E. dealbata* alliance. It contains *E. microcarpa* on the lower slopes grading into *E. sideroxylon* and *E. dwyeri* on the upper slopes. *Acacia doratoxylon* and *Callitris endlicheri* occur on the ridgetops.

I3.1.1.4 Wilga - Rosewood Woodland (Geijera parviflora /Alectryon oleifolius)

This community occurs in the south-eastern parts of the area on a gilgai landscape and has been substantially thinned for cropping and grazing. Belah (*Casuarina cristata*) is a common associate, with smaller numbers of White Cypress Pine (*Callitris glaucophylla*), Grey Box (*E. microcarpa*) and Poplar Box (*E. populnea* subsp. *bimbil*).

I3.1.2 Associated Infrastructure

The service corridors traverse a much wider variety of habitat types and a greater number of vegetation associations than are found on the mine site. This is due to the long length of the water and gas pipeline routes, their origin at the bottom of the Lachlan Valley and the much greater array of soil types and environmental conditions traversed. The vegetation associations recorded at each sample site are shown in Table I-3 and Attachment I-A.

Table I-3. Vegetation Associations Identified Within the Syerston Project Area

Vegetation Alliance	Vegetation Association	Sample Sites[1]	Other Prominent Native Species
Eucalyptus camaldulensis	*E. camaldulensis*	2, 2A, 3, 4A, 5, 26, 67, 68	*Calotis scapigera, Goodenia fascicularis, Rumex brownii, Ranunculus sessiliflorus, Eleocharis plana*
E. largiflorens	*E. largiflorens*	22A, 23, 25	*Calotis scabiosifolia, Centipeda cunninghamii, Pycnosorus chrysanthus, Atriplex spinibractea, Sclerolaena muricata, Chenopodium nitrariaceum*
E. sideroxylon/E. dealbata	*E. sideroxylon*	S2, S9, 39b	*Bracteantha viscosa, Acacia doratoxylon, Goodenia hederacea, Leptospermum divaricatum, Dampiera lanceolata*
	E. sideroxylon/E. microcarpa	64	*Acacia doratoxylon, Acacia deaneii, Cassinia uncata, Goodenia hederacea, Bracteantha bracteata, Panicum simile, Austrodanthonia eriantha, Austrostipa densiflora*
	E. sideroxylon/E. dwyeri	11A, 12A	*Bracteantha bracteata, Cassinia laevis, Centipeda cunninghamii, Ozothamus diosmifolius, Vittadinia cuneata, Acacia doratoxylon, Dodonaea heteromorpha*
	E. sideroxylon/E. viridis/E. dwyeri	39a	*Acacia doratoxylon, Phebalium obcordatum, Callitris endlicheri, Platysace lanceolata, Cassinia laevis, Cassinia uncata, Olearia pimelioides, Ozothamnus diosmifolius, Melichrus urceolatus, Phyllanthus hirtellus*
	E. populnea/E. dwyeri	31A	*Cassinia uncata, Bracteantha bracteata, Acacia doratoxylon, Dodonaea heteromorpha, Goodenia hederacea, Gonocarpus elatus, Lomandra effusa*
	E. microcarpa/E. dwyeri	7, 22	*Bracteantha bracteata, Calotis scabiosifolia, Rhagodia spinescens, Phyllanthus hirtellus, Goodenia hederacea, Sida cunninghamii, Dianella longifolia*
Mosaics of *E. populnea* and *E. microcarpa* alliances	*E. populnea*	31, RS	*Acacia deaneii, Calotis lappulacea, Haloragis aspera, Enteropogon acicularis, Austrodanthonia caespitosa, Austrodanthonia richardsonii, Austrostipa blackii,*
	E. microcarpa	56, 65, 66	*Geijera parviflora, Eremophila mitchellii, Enchylaena tomentosa, Solanum ferocissimum, Plantago cunninghamii, Eragrostis lacunaria, Chloris truncata*
	E. populnea/E. microcarpa	11, 13, 16, 30, 35	*Callitris glaucophylla, Senna artemisioides, Acacia deaneii, Calotis cuneifolia, Sclerolaena diacantha,*
	E. populnea/Callitris glaucophylla	S3, S4, R1, 45, 46, 49	*Brachychiton populneus, Myoporum montanum, Daucus glochidiatus, Bracteantha viscosa, Vittadinia dissecta, Chenopodium desertorum, Goodenia cycloptera*
	E. microcarpa/C. glaucophylla	S6, 12, 14, 15, 18, 34, 36, 39, 47	*Geijera parviflora, Dodonaea viscosa* subsp. *mucronata*, *Calotis lappulacea, Maireana microphylla,*
	E. microcarpa/E. populnea/C. glaucophylla	F1, 5A, 9, 10, 28, 29, 32, 44, 48	*Acacia deaneii, Myoporum montanum, Senna artemisioides, Calotis cuneifolia, Sida corrugata*

Table I-3. Vegetation Associations Identified Within the Syerston Project Area (Continued)

Vegetation Alliance	Vegetation Association	Sample Sites[1]	Other Prominent Native Species
	E. melliodora/C. glaucophylla	F2, S1, S7, S8	*Acacia decora, Daucus glochidiatus, Bracteantha bracteata, Centipeda thespidioides*
	C. glaucophylla	R2, R3	*Acacia hakeoides, Senna artemisioides, Dodonaea viscosa, Calotis cuneifolia, Einadia nutans,*
	G. parviflora/Alectryon oleifolius	S5, 33	*Callitris glaucophylla, Myoporum montanum, Maireana enchylaenoides, Senna artemisioides, Daucus glochidiatus, Goodenia pinnatifida,*
Allocasuarina luehmanii	*Allocasuarina luehmanii*	51	*Apophyllum anomalum, Eremophila mitchellii, Pittosporum phylliraeoides, Atriplex spinibractea,*
Acacia pendula	*Acacia pendula*	24, 27	*Marsilea drummondii, Calotis scabiosifolia, Calocephalus sonderi, Pycnosorus chrysanthus, Atriplex spinibractea, Chenopodium desertorum, Sclerolaena stelligera*
	A. pendula/A. oswaldii	21	*Ptilotis polystachys, Brachyscome ciliaris, Hyalosperma semisterile, Minuria leptophylla, Triptilodiscus pygmaeus, Sclerolaena diacantha, Goodenia pinnatifida*
	Acacia oswaldii	20	*Calotis lappulacea, Minuria leptophylla, Pycnosorus chrysanthus, Rhodanthe floribunda, Austrodanthonia caespitosa, Panicum subxerophilum,*
Eucalyptus socialis / E. dumosa	*E. dumosa*	19	*Leptorhynchus panaetoides, Rhodanthe floribunda, Convolvulus remotus, Austrostipa nodosa*
Eucalyptus viridis	*E. viridis*	56a	*Acacia doratoxylon, Acacia lineata, Acacia flexifolia, Cassinia uncata, Olearia decurrens, Austrodanthonia linkii, Austrodanthonia caespitosa, Austrostipa scabra*
Stipa aristiglumis	*Stipa aristiglumis*	1	*Calotis scapigera, Vittadinia gracilis, Chenopodium nitrariaceum, Rumex tenax, Juncus flavidus*
Marsilea drummondii	*Marsilea drummondii*	63	*Calotis scapigera, Goodenia heteromera, Pratia concolor, Cyperus gunnii, Eleocharis plana*

[1] For locations of sample sites see Figure I-3 and Attachment I-A.

I3.1.2.1 Water Pipeline

Twenty one sites were sampled along the proposed water pipeline route (Figure I-3, Attachment I-A). Five vegetation alliances were recognised (Figure I-4). Within these alliances, seven vegetation associations were identified comprising two floodplain communities (the *Stipa aristiglumis* and *Eucalyptus camaldulensis* associations), three box-pine woodland communities (the *Eucalyptus populnea / E. microcarpa / C. glaucophylla, E. microcarpa / C. glaucophylla* and *E. populnea / E. microcarpa* associations) and two hill communities (the *E. sideroxylon / E. dwyeri* and *E. dwyeri / E. microcarpa* associations).

The first 15.5 km of the water pipeline route (Sites 1 to 5) traverses floodplain communities in which the flora is adapted to periodic flooding. The River Red Gum, *Eucalyptus camaldulensis*, is the dominant tree species forming monospecific forest stands along creeks and rivers and across associated floodplains. The Nardoo (*Marsilea drummondii*) association, sampled as part of the borefield survey (see below), occupies swales and depressions that retain water after floods recede, while the Plains Grass (*Stipa aristiglumis*) dominates a grassland association in open areas between stands of River Red Gums.

North of Goobang Creek the water pipeline route traverses mainly box-pine woodlands (*Eucalyptus populnea* and *E. microcarpa* alliances) all the way to the mine site except where it crosses three rises (Sites 7, 11A and 12A) supporting communities of the *E. sideroxylon / E. dealbata* alliance.

I3.1.2.2 Gas Pipeline

Twenty-eight sites were sampled along the proposed gas pipeline route (Figure I-3, Attachment I-A). Of the seven vegetation alliances, some 17 associations were identified comprising two floodplain communities (the *Eucalyptus camaldulensis* and *E. largiflorens* associations), four communities on ephemerally wet sites (the *Acacia pendula, A. oswaldii, A. pendula / A. oswaldii* and *Eucalyptus dumosa* associations), six box-pine woodland communities (the *E. populnea, E. microcarpa, E. populnea / E. microcarpa, E. microcarpa / Callitris glaucophylla, E. populnea / E. microcarpa / C. glaucophylla,* and *Geijera parviflora / Alectryon oleifolius* associations) and five hill communities (the *Eucalyptus sideroxylon, E. sideroxylon / E. viridis / E. dwyeri, E. dwyeri / E. microcarpa*, *E. dwyeri / E. populnea* and *E. viridis* associations).

The first three sites north of the connection point to the Moomba gas pipeline (Sites 16-18) support remnants of box-pine woodland, although site 17 is largely cleared. Site 19 is a small remnant of mallee comprising only one overstorey species, White Mallee (*Eucalyptus dumosa*), in a gilgaied landscape. Sites 20, 21, 24 and 27 are acacia shrublands dominated by Myall (*Acacia pendula*) or Miljee (*A. oswaldii*) on poorly drained stagnant alluvial soils. South of the Lachlan River, the acacia shrublands are interspersed with creeks supporting the *Eucalyptus largiflorens* association (Sites 22A, 23 and 25) or the *E. camaldulensis* association (site 26) on active alluvial soils.

North of the Parkes-Condobolin Road the gas pipeline route is vegetated mainly by remnants of box-pine woodlands along Springvale Road (Figure I-4, Attachment I-A) with two occurrences of hill communities, one of which was sampled (Site 31A). One hill community site (Site 22) supporting the *E. dwyeri / E. microcarpa* association also occurred south of Condobolin. When the pipeline route departs Springvale Road into farmland it initially traverses remnant box-pine woodlands (Sites 35 and 56) before entering an area of poor soils dominated by remnant Ironbark – Mallee associations of Mugga Ironbark (*Eucalyptus sideroxylon*), Green Mallee (*E. viridis*) and Dwyer's Mallee Gum (*E dwyeri*) (Sites 39a, 39b and 56a) with shrubby heath-like understoreys. These associations are interspersed with areas dominated by Grey Box (*E. microcarpa*) (Sites 39 and 56).

I3.1.2.3 Route 64

Six sites were sampled along Route 64 (Figure I-3, Attachment I-A). Three vegetation associations were identified (*Eucalyptus populnea / Callitris glaucophylla, E. microcarpa / C. glaucophylla* and *E. microcarpa / E. populnea / C. glaucophylla*) all of which belong to the box-pine woodland mosaic (*E. populnea* and *E. microcarpa* alliances).

I3.1.2.4 Fifield Bypass

Four sample sites on the Fifield bypass route (Figure I-3, Attachment I-A) comprised three quite distinct vegetation associations. Site 51 at the eastern end includes an isolated occurrence of gilgai dominated by *Allocasuarina luehmanii*. One kilometre west of Route 64 the bypass traverses an area (Site 64) dominated by *Eucalyptus sideroxylon* and *E. microcarpa* at the southern boundary of a semi-cleared bush block. A further 0.7 km along the bypass on the western side of the bush block, the community is dominated by *E. microcarpa* alone (Site 65). *E. microcarpa* also dominates at Site 66 where an unnamed watercourse crosses the Fifield – Wilmatha Road.

I3.1.2.5 Water Supply Borefields

The water supply borefields and associated pipelines are proposed to be established on cleared farmlands supporting some modified remnants of the original native plant communities. The original vegetation of the area was a mosaic of Lachlan River floodplain and box-pine woodland communities. The former box-pine woodlands have mostly been cleared for cropping, while the lower lying floodplain areas still support much of the original flora, except that most of the tree cover has been removed and some floodplain has been converted to cropping land by the erection of levy banks to hold out floods. There is evidence the area also supported some Myall (*Acacia pendula*) shrubland, but nearly all of this has disappeared.

Three floodplain communities are present; River Red Gum (*E. camaldulensis*) woodlands (Sites 67 and 68), Plains Grass (*Stipa aristiglumis*) grasslands (part of Site 67) and Common Nardoo (*Marsilea drummondii*) ephemeral wetlands (Site 63 and part of 67). The western borefield is situated in floodplain remnants. The eastern borefield by contrast is located in cleared cropping paddocks. The pipeline connecting the borefields passes through cultivated land for most of its length and traverses natural floodplain communities at its western end.

I3.1.2.6 Gas Pipeline Connection Point

The proposed connection point of the Syerston gas pipeline to the Moomba-Sydney gas pipeline is in a ploughed wheat paddock. No elements of the original natural community remain. The site supports introduced crop species and weeds. This site was not specifically sampled due to its highly disturbed nature. Instead, the adjacent roadside vegetation at the commencement of the gas pipeline corridor (Site 16) was sampled.

I3.1.2.7 Limestone Quarry

The limestone outcrop at the centre of the proposed limestone quarry lacks almost all its original tree cover and is now a native grassland (Site LQ). It is surrounded by intensively managed farmland paddocks used for cropping and grazing. Clearing and ploughing has removed almost all of the natural vegetation over the entire area except for the limestone outcrop itself. A few paddock trees remain within the ploughed areas and some native herb and grass species persist in the unploughed corners of paddocks. The few remnant trees and the roadside vegetation indicate the area was formerly dominated by box-pine woodlands (*Eucalyptus populnea* and *E. microcarpa* alliances).

I3.1.2.8 Rail Siding

The proposed rail siding (Site RS) at the eastern end of Route 64 has lost nearly all its former native tree cover and is now a native grassland with a wide diversity of native grasses and herbs. The adjoining roadside trees and few remaining paddock trees suggest the area was predominantly a grassy, open Poplar Box (*Eucalyptus populnea*) woodland. It does not appear to have been cultivated in the past.

I3.2 PLANT SPECIES

Attachment I-B tabulates the vascular plant taxa recorded at each sample site including species, subspecies, varieties and forms. A total of 433 taxa was identified on the 78 sites reported here. Of these, 321 (74.1%) taxa are native and 112 (25.9%) introduced. Several plant families have a high diversity of species in the study area. The grasses (Poaceae) are represented by 93 species (65 native and 28 exotic), the daisies (Asteraceae) by 66 species (44 native and 22 introduced), the saltbushes (Chenopodiaceae) by 24 native species , the pea flowers (Faboideae) by 22 species (7 native and 15 exotic, mainly deliberately introduced pasture plants), the wattles (Mimosoideae) by 13 native species, the eucalypts (Myrtaceae) by 10 native species, the sedges (Cyperaceae) by 11 native species and the mat-rushes (Lomandraceae) by 7 native taxa.

The preponderance of grasses and daisies, and the high diversity of other herbaceous species and small shrubs, reflects the former open grassy woodland habitat natural to the study area.

I3.2.1 Mine Site

The plant species found on the mine site are given in Attachment I-B1. Some 252 taxa were recorded, of which 184 are native and 68 introduced.

The most common shrubs in the box-pine woodlands are species of wattle (*Acacia* spp.), cassia (*Senna artemisioides* ssp. *filifolia*), hop bush (*Dodonaea viscosa*) and western boobialla (*Myoporum montanum*), while *Callitris endlicheri*, *Cassinia laevis* and *Leptospermum divaricatum*, characterise the hill communities of the *Eucalyptus sideroxylon / E. dealbata* alliance (Table I-3, Attachment I-A).

The highly diverse ground layer is dominated by grasses and members of the daisy (Asteraceae) and saltbush (Chenopodiaceae) families with the Goodenias (Goodeniaceae) and Sidas (Malvaceae) also prominent. The many daisy family species include Flannel Cudweed (*Actinobole uliginosum*), Golden Everlasting (*Bracteantha bracteata*), Purple Burr-daisy (*Calotis cuneifolia*), Yellow Buttons (*Chrysocephalum apiculatum*), Common White Sunray (*Rhodanthe floribunda*), a Fuzzweed (*Vittadinia dissecta*) and many introduced weedy species. Prominent saltbushes included Desert Goosefoot (*Chenopodium desertorum*), Climbing Saltbush (*Einadia nutans*), Wingless Fissure Weed (*Maireana enchylaenoides*) and Grey Copper Burr (*Sclerolaena diacantha*). The dominant grasses are species of *Austrostipa* and *Austrodanthonia* (Attachment I-B1). Other common herbs include Pink Tongues (*Rostellularia adscendens*), Native Carrot (*Daucus glochidiatus*), Stinking Pennywort (*Hydrocotyle laxiflora*), Sweet Hound's Tongue (*Cynoglossum suaveolens*), Tufted Bluebell, (*Wahlenbergia communis*), Annual Chalkwort (*Gypsophila australis*), Kidney Weed (*Dichondra* species A), Dense Stonecrop, (*Crassula colorata*), Variable Glycine (*Glycine tabacina*), Wood-sorrel (*Oxalis chnoodes*), Plantain (*Plantago hispida*), Swamp Dock (*Rumex brownii*), Native Tobacco (*Nicotiana simulans*), Creamy Candles (*Stackhousia monogyna*), Yellow Rush-lily (*Tricoryne elatior*) and Leek Lily (*Bulbine semibarbata*). The main grasses are Jericho Wiregrass (*Aristida jerichoensis*), White Top (*Austrodanthonia caespitosa*), Hill Wallaby Grass (*Austrodanthonia eriantha*), Rough Speargrass (*Austrostipa scabra*), Pitted Bluegrass (*Bothriochloa decipiens*), Common Wheatgrass (*Elymus scaber*), Yadbila Grass (*Panicum queenslandicum*) and several introduced species.

I3.2.2 Water Pipeline

Twenty one roadside sites surveyed along the proposed water pipeline corridor supported a total of 225 species; 154 native and 71 exotic (Attachment I-B2). The box-pine woodlands (Sites 5A, 9-11, 12, 13-15) featured a similar flora to the same communities present on the mine site and described above. Additional common native herb species included the Yellow Burr Daisy (*Calotis lappulacea*), a Fuzzweed (*Vittadinia cuneata*), Saloop (*Einadia hastata*), Eastern Cotton Bush (*Maireana microphylla*), Black Rolypoly (*Sclerolaena muricata*), Pink Bindweed (*Convolvulus erubescens*), Serrated Goodenia (*Goodenia cycloptera*), Scrambled Eggs (*Goodenia pinnatifida*), a Wood Sorrel (*Oxalis perennans*), Sago Weed (*Plantago cunninghamii*) and Smooth Flax Lily (*Dianella longifolia*). Additional prominent grasses included a Wallaby Grass (*Austrodanthonia linkii*), Small Flowered Wallaby Grass (*Austrodanthonia setacea*), a Speargrass (*Austrostipa nodosa*), Curly Windmill Grass (*Enteropogon acicularis*) and Gilgai Grass (*Panicum subxerophilum*).

The floodplain flora represented by sample Sites 1 to 5 supports many species not found in the drier habitats (Attachment I-B2). Virtually no shrub species were found, the habitats being herbfields, grasslands and grassy woodlands. The exception is Nitre Goosefoot (*Chenopodium nitrariaceum*). Characteristic herb species include Tufted Burr-daisy (*Calotis scapigera*), Silky Goodenia (*Goodenia fascicularis*), Poison Pratia (*Pratia concolor*), Shiny Dock (*Rumex tenax*), and Small-flowered Buttercup (*Ranunculus sessiliflorus*). The damp habitats also support several Spike-rushes (*Eleocharis* spp.), Rushes (*Juncus* spp.) and distinctive grasses including Blown Grass (*Agrostis avenacea*), Brown-back Wallaby Grass (*Austrodanthonia duttoniana*), Plains Grass (*Austrostipa aristiglumis*), Couch Grass (*Cynodon dactylon*), Gilgai Grass (*Panicum subxerophilum*) and Warrego Grass (*Paspilidium jubiflorum*).

The three hill community sample sites on the water corridor (Sites 7, 11A and 12A, Figure I-3) also contained distinctive species not found in the other habitats. In addition to those given above for the mine site are the shrubs *Dodonaea heteromorpha* (a Hop Bush), Sticky Cassinia (*Cassinia uncata*) and Currawang (*Acacia doratoxylon*); the herbs, Forest Goodenia (*Goodenia hederacea*) and Hill Raspwort (*Gonocarpus elatus*) and the grasses, Purple Wiregrass (*Aristida ramosa*) and Hill Wallaby Grass (*Austrodanthonia eriantha*).

I3.2.3 Gas Pipeline

A complete list of the vascular plant species found on the 28 gas pipeline sample sites is given in Attachment I-B3. A total of 279 taxa comprising 214 native and 65 introduced species was found.

As would be expected, there is considerable overlap in the plant species present on the gas pipeline and water pipeline routes given they traverse similar habitats. However, the gas pipeline route encompasses a number of communities not present on the water pipeline route and these include some plant species not prominent elsewhere in the survey. The major difference is in the communities along the West Wyalong – Condobolin Road, particularly the *Acacia pendula* and *Eucalyptus largiflorens* alliances, and those north-east of Springvale Road where the pipeline traverses farmland supporting shrubby Ironbark – Mallee communities dominated by *Eucalyptus sideroxylon*, *E. viridis* and *E. dwyeri* (Figure I-4, Attachment I-A).

The *A. pendula* alliance occupies flat terrain subject to waterlogging in wet winters. It typically has a sparse understorey of grasses and herbs including many daisies (Asteraceae) such as Variable Daisy (*Brachyscome ciliaris*), Smooth Daisy (*B. trachycarpa*), Tufted Burr-daisy (*Calotis scapigera*), Rough Burr-daisy (*C. scabiosifolia*), Orange Sunray (*Hyalosperma semisterile*), Common Sneezeweed (*Centipeda cunninghamii*), Minnie Daisy (*Minuria leptophylla*), Woolly Buttons (*Leptorhynchus panaetoides*) and Golden Billy-buttons (*Pycnosorus chrysanthus*); mulla mullas (Amaranthaceae) including Long Tails (*Ptilotus polystachys*); the Broughton Pea (*Swainsona procumbens*) and the Small Vanilla Lily (*Arthropodium minus*). Prominent grasses included Windmill Grass (*Chloris truncata*) and Curly Windmill Grass (*Enteropogon acicularis*).

The *Eucalyptus largiflorens* sites included Common Nardoo (*Marsilea drummondii*), Rough Burr-daisy (*Calotis scabiosifolia*), Yellow Twin-heads (*Eclipta platyglossa*), Golden Billy-buttons (*Pycnosorus chrysanthus*), Caustic Weed (*Chamaesyce drummondii*), Lignum (*Muehlenbeckia florulenta*) and members of the buttercup family (Ranunculaceae) including Smooth Buttercup (*Ranunculus pentandrus*) and Mousetails (*Myosurus minimus*). Grasses included *Amphibromus nervosus*, a Wallaby Grass (*Austrodanthonia linkii*), Plains Grass (*Austrostipa aristiglumis*), Couch Grass (*Cynodon dactylon*) and Curly Windmill Grass (*Enteropogon acicularis*).

The Ironbark – Mallee communities occur on poor soils and support a heathy understorey comprising a diverse range of shrubs (Attachment I-B3). These include Club-leaved Phebalium (*Phebalium obcordatum*), Shrubby Platysace (*Platysace lanceolata*), Cough-bush (*Cassinia laevis*), Sticky Cassinia (*Cassinia uncata*), Showy Daisy-bush (*Olearia pimelioides*), Clammy Daisy-bush (*Olearia decurrens*), Shiny Daisy-bush (*Olearia tenuifolia*), Pill Flower (*Ozothamnus diosmifolius*), Streaked Wattle (*Acacia lineata*), Bent-leaf Wattle (*Acacia flexifolia*), Coil Pod Wattle (*Acacia pravifolia*), Kangaroo Thorn (*Bursaria spinosa*), Quandong (*Santalum acuminatum*), a Dodonaea (*Dodonaea heteromorpha*), Urn Heath (*Melichrus urceolatus*), Erect Guinea Flower (*Hibbertia riparia*) and Thyme Spurge (*Phyllanthus hirtellus*). Other species found in these habitats include Grooved Dampiera (*Dampiera lanceolata*), a Leek Lily (*Bulbine semibarbata*), Irongrass (*Lomandra patens*), Spreading Flax-lily (*Dianella revoluta*) and Foxtail Speargrass (*Austrostipa densiflora*).

I3.2.4 Route 64, Fifield Bypass, Limestone Quarry, Rail Siding and Water Supply Borefield

The vegetation along Route 64 comprises remnants of associations of the box-pine woodland mosaic. Some 117 plant species were found on the six sites examined; 73 native and 44 exotic (Attachment I-B4). The array of species present is similar to that in the same communities on the mine site, and the relevant parts of the gas and water pipeline routes. Additional prominent species include the shrubs, Warrior Bush (*Apophyllum anomalum*), Wingless Fissure Weed (*Maireana enchylaenoides*), *Maireana humillima*, Budda (*Eremophila mitchellii*), Corrugated Sida (*Sida corrugata*), Ridge Sida (*Sida cunninghamii*) and Quena (*Solanum esuriale*). Prominent herbs include Tufted Bluebell (*Wahlenbergia communis*), a Kidney Weed (*Dichondra* species A), Twining Glycine (*Glycine clandestina*), Twining Woodruff (*Asperula conferta*) and Smooth Flax Lily (*Dianella longifolia*). Conspicuous sedges, rushes and grasses include Knob Sedge (*Carex inversa*), Wattle Mat-rush (*Lomandra filiformis*), Bunch Wiregrass (*Aristida behriana*), a Speargrass (*Austrostipa nodosa*), Rough Speargrass (*Austrostipa scabra*), Common Wheatgrass (*Elymus scaber*) and Knottybutt Grass (*Paspilidium constrictum*).

The four Fifield bypass sample sites yielded 99 species; 78 native and 21 introduced (Appendix I-B4). Site 51 of the Fifield Bypass includes Grey Box (*Eucalyptus microcarpa*) woodland and an area of gilgai supporting a stand of Bulloak (*Allocasuarina luehmanii*) and associated shrubs such as Warrior Bush (*Apophyllum anomalum*), Budda (*Eremophila mitchellii*), Weeping Pittosporum (*Pittosporum phylliraeoides*) and Broad-leaf Hop-bush (*Dodonaea viscosa* subsp. *mucronata*). The gilgai depressions support several semi-aquatic species including Common Nardoo (*Marsilea drummondii*), Knob Sedge (*Carex inversa*) and *Cyperus gracilis*.

Site 64 of the Fifield Bypass supports hill community species typical of the *Eucalyptus sideroxylon / E. dealbata* alliance such as Tumbledown Red Gum (*Eucalyptus dealbata*), Currawang (*Acacia doratoxylon*) Sticky Cassinia (*Cassinia uncata*), Hill Raspwort (*Gonocarpus elatus*) and Forest Goodenia (*Goodenia hederacea*). Other species include Golden Everlasting (*Bracteantha bracteata*), Purple Burr-daisy (*Calotis cuneifolia*), Ruby Saltbush (*Enchylaena tomentosa*), Western Black Wattle (*Acacia hakeoides*), Jericho Wiregrass (*Aristida jerichoensis* subsp. *subspinulifera*) and Foxtail Grass (*Austrostipa densiflora*). Sites 65 and 66 support species typical of Grey Box communities (Table I-3).

The Limestone Quarry site is dominated by introduced weed and pasture species (Attachment I-B4). Of the total of 89 species observed, 39 were native and 50 introduced. A few native species persist in small uncultivated locations in the corners of cropping paddocks, around dams and along fencelines, including Scrambled Eggs (*Goodenia pinnatifida*), Rough Raspwort (*Haloragis aspera*), Corrugated Sida (*Sida corrugata*), Quena (*Solanum esuriale*), and a few grasses and sedges. The limestone outcrop lacks nearly all its original tree cover, but has never been cultivated and therefore retains a native grassland cover dominated by species of Speargrass (*Austrostipa*), particularly *A. trichophylla* and Rough Speargrass (*A. scabra* subsp. *scabra*). The scattered remnant trees include Poplar Box (*E. populnea* subsp. *bimbil*), Weeping Pittosporum (*Pittosporum phylliraeoides*), Rosewood (*Alectryon oleifolius*), Kurrajong (*Brachychiton populneus*) and Yarran (*Acacia melvillei*). There are many weed species present, especially where stock camp under the trees.

The rail siding paddock survey found 75 plant species, 50 native and 25 introduced (Attachment I-B4). It appears never to have been cultivated and retains a diverse cover of native herbs and grasses despite being cleared of most of its original trees. The flora is typical of the box-pine woodlands of the region. Scattered shrubs include Wilga (*Geijera parviflora*), Deanes Wattle (*Acacia deaneii*), Sticky Hopbush (*Dodonaea viscosa* var. *cuneata*) and Eastern Cotton Bush (*Maireana microphylla*). The herbs include Smooth Flax-lily (*Dianella longifolia*), Serrated Goodenia (*Goodenia cycloptera*), a Fuzzweed (*Vittadinia gracilis*), Slender Tick Trefoil (*Desmodium varians*), Rough Raspwort (*Haloragis aspera*) and Native Pennyroyal (*Mentha satureioides*). The diverse grass flora includes Bunch Wiregrass (*Aristida behriana*), Curly Windmill Grass (*Enteropogon acicularis*), Crested Speargrass (*Austrostipa blackii*), a Wallaby Grass (*Austrodanthonia richardsonii*), White Top (*Austrodanthonia caespitosa*), Queensland Bluegrass (*Dichanthium sericeum*) and Two Colour Panic (*Panicum simile*).

Three areas of remnant native vegetation were sampled in the water supply borefield (Attachment I-B2). Some 54 plant species were found, 33 native and 21 introduced. All sample sites were in floodplain associated with the western borefield. The natural communities feature a range of species adapted to periodic flooding and many are not found in other habitats. These species are mainly herbs and grasses including a Buttercup (*Ranunculus undosus*), Tufted Burr-daisy (*Calotis scapigera*), Spreading Goodenia (*Goodenia heteromera*), Poison Pratia (*Pratia concolor*), Lignum (*Muehlenbeckia florulenta*), Shiny Dock (*Rumex tenax*), Spike-rushes (*Eleocharis pallens, E. plana*), Flecked Flat-sedge (*Cyperus gunnii*), Juncus species (*Juncus australis, J. flavidus*), Plains Grass (*Austrostipa aristiglumis*), Brown-back Wallaby Grass (*Austrodanthonia duttoniana*) and Warrego Grass (*Paspilidium jubiflorum*).

I3.3 CONDITION OF THE VEGETATION

I3.3.1 Mine Site

The least disturbed or best preserved natural plant communities in the mine site are located in the Fifield State Forest, due to its management for low intensity production of native timber, primarily White Cypress Pine. Grazing pressure by domestic stock has also been low since the forest is fenced and not leased for grazing, at least in recent times (State Forests, Dubbo, pers. comm.). Principally due to the lack of grazing, the communities present in the forest support diverse native shrub and herb layers (Attachment I-B1).

The forest is an open woodland formation, with fairly wide spacings between the trees and shrubs. In the box-pine woodland areas the ground cover is relatively sparse. By contrast, the drainage lines dominated by Yellow Box / White Cypress Pine woodland are more densely covered with native grasses and herbs. Disturbed, semi-cleared drainage line areas with few trees may be heavily covered with introduced weeds including Paterson's Curse (*Echium plantagineum*), Saffron Thistle (*Carthamus lanatus*), Prickly Lettuce (*Lactuca serriola*) and Maltese Cockspur (*Centaurea melitensis*).

Because of past silvicultural treatments there are few old growth trees in Fifield State Forest. Mature White Cypress Pine trees have been commercially logged, and the eucalypt species significantly thinned to encourage regeneration of dense stands of pines.

Past mining for magnesite has affected parts of the Crown reserve and much of the Crown land. The disturbed areas are being recolonised by native and introduced plant species and tend to have a high proportion of weeds.

The farmed areas of the mine site have been cropped and grazed for a long time. The cropping paddocks contain virtually no native plant species apart from scattered trees retained to shade stock. These include Kurrajong (*Brachychiton populneum*), Wilga (*Geijera parviflora*), Rosewood (*Alectryon oleifolius*) and White Cypress Pine (*Callitris glaucophylla*).

Many areas of remnant native vegetation on the farmland have been heavily thinned in the past and are regenerating, but continue to be heavily grazed. By contrast to Fifield State Forest, patches of native vegetation on the farmland have very few shrubs (Attachment I-B1) and a sparse ground layer. Shrubs found on the farmland included Cough Bush (*Cassinia laevis*) (2 sites), White Dogwood (*Ozothamnus diosmifolius*) (1 site), Western Golden Wattle (*Acacia decora*) (1 site), Currawang (*Acacia doratoxylon*) (4 sites), Coil-pod Wattle (*Acacia pravifolia*) (1 site), Western Boobialla (*Myoporum montanum*) (7 sites), Weeping Pittosporum (*Pittosporum phylliraeoides*) (2 sites), Hooked Needlewood (*Hakea tephrosperma*) (2 sites), Sticky Hop-bush (*Dodonaea viscosa* subsp. *angustissima*) (1 site) and Shrubby Platysace (*Platysace lanceolata*) (1 site). The shrub most able to withstand heavy grazing appears to be Western Boobialla.

I3.3.2 Gas and Water Pipelines

The gas and water pipelines are contained within road easements through farmland over most of their lengths. In general the surrounding country has been heavily cleared of nearly all its natural vegetation cover except where the routes traverse hills and rises supporting the Mugga Ironbark / Tumbledown Red Gum (*Eucalyptus sideroxylon / E. dealbata*) alliance and where the gas pipeline route passes Murda State Forest for 3.2 km on Springvale Road. The gas pipeline route is also within a broad naturally vegetated Travelling Stock Route for some 27 km along the West Wyalong – Condobolin Road.

The condition of the native vegetation remaining along the gas and water pipelines varies considerably from site to site depending on the width of the road easement and the degree of past disturbance. Some areas have been cleared of all native trees and shrubs and may have only a few remnant native herbs and grasses along with high numbers and densities of weeds (Sites 4, 6, 8, 52, 17; Attachments I-B2 and I-B3). A few areas, having a high diversity of native trees, shrubs and understorey species, and few weeds, seem relatively little disturbed. An example is the densely vegetated stretch of the Ootha-Fifield Road from Sites 9 to 11A, a distance of about 11 km. However, most sites are intermediate with significant elements of the original vegetation remaining along with many weeds. Indeed, the roadsides and Travelling Stock Routes of inland New South Wales collectively retain important samples of the original flora in vast areas now largely cleared for wheat cropping and sheep production. This is evidenced by the fact that even though most sites in this study have been highly disturbed, 74 percent of all species found were native and 26 percent introduced.

The Travelling Stock Route along the West Wyalong-Condobolin Road appears to be in a relatively natural condition over much of its length with few weeds in the undisturbed areas away from the road. The habitat is probably more open than the original community due to thinning of the dominant trees and shrubs to encourage grasses for grazing. Heavy grazing during droughts would also have reduced shrub numbers and hindered regeneration. Nevertheless, the integrity of the natural community remains and the understorey seems remarkably intact.

I3.3.3 Route 64, Fifield Bypass, Limestone Quarry, Rail Siding and Water Borefield

Route 64 is a narrow road easement over most of its length and therefore has only thin strips of remnant native vegetation beside it. At least 73 native plant species persist in the corridor, but some 44 weed species (38 percent) are also present indicating a significant degree of disturbance. Due to its narrowness, high degree of disturbance and isolation in a sea of cleared farmland, it has limited value for flora conservation.

Fifield bypass traverses a mixture of thinned remnant box-pine and ironbark woodlands, cleared farmland and roadside. The cleared farmland and roadside (Fifield – Wilmatha Road) lack most of their original tree cover, are highly disturbed and have minimal conservation value. The remnant woodland area at the south-eastern end of the bypass retains much of its biological integrity despite thinning of its tree cover and heavy grazing by sheep evident at the time of the survey. There is also a diversity of plant communities present, a prominent shrub layer and few weeds.

The limestone quarry site comprises entirely cropping and grazing paddocks and has been intensively managed for agricultural pursuits for many years. The degree of disturbance is reflected in the ratio of introduced to native plant species found in the survey. Of 89 species, 50 (56 percent) are introduced, while only 39 native species were found. The limestone outcrop itself is a weedy native grassland with only a few scattered native trees. The site has virtually no value for conservation.

The rail siding paddock has suffered little past disturbance apart from the removal of most of the original trees. The diverse ground cover of native herbs and grasses has some 25 (33 percent) introduced species, but these are scattered and represent only a small part of the total biomass. While the area is a good sample of the box-pine woodland understorey, it is small, bordered by a railway line and road, and has very limited conservation value.

The water borefield and associated connecting pipelines are situated on cropping and grazing lands near the Lachlan River. Due possibly to the fertile floodplain soils the survey found a relatively low number of native plant species, 33, and 21 (39 percent) introduced species. The cropping paddocks have lost all their original vegetation cover except for the occasional shade tree for stock. The floodplain areas used for grazing have retained much of their original herb and grass layer, but most of the original River Red Gum (*Eucalyptus camaldulensis*) tree cover has been removed. Disturbance of this area will have a minimal negative impact on nature conservation, particularly since the proposed works are located some distance from the river.

I3.4 INTRODUCED SPECIES AND WEEDS

The dominant weeds on the Project area are grasses (Poaceae) and herbaceous daisies (Asteraceae) (Attachment I-B). These are present on nearly all sites and often represented the bulk of the ground cover, particularly along roadsides. The most common weedy daisy species included Capeweed (*Arctotheca calendula*), Saffron Thistle (*Carthamus lanatus*), Cretan Weed (*Hedypnois cretica*), Smooth Catsear (*Hypochaeris glabra*), Catsear (*Hypochaeris radicata*), Prickly Lettuce (*Lactuca serriola*) and Common Sowthistle (*Sonchus oleraceus*).

The most prominent grass weeds were species of Wild Oats (*Avena* spp.), Bromes (*Bromus* spp.), Barley Grasses (*Hordeum* spp.), Ryegrasses (*Lolium* spp.) and Vulpias (*Vulpia* spp.). These grasses comprised most of the biomass in the understorey on many roadside sites in spring. However, they tended to die off in summer to be replaced by native species.

Other prominent and widespread weeds included Paterson's Curse (*Echium plantagineum*), Common Peppercress (*Lepidium africanum*), Indian Hedge Mustard (*Sisymbrium orientale*), Velvet Pink (*Petrorhagia velutina*), Wild Sage (*Salvia verbenaca*) and Curled Dock (*Rumex crispus*). Only one introduced weedy shrub was recorded, African Boxthorn (*Lycium ferocissimum*). One or more species of deliberately introduced clovers (*Trifolium* spp.) or medics (*Medicago* spp.) also occurred at most sites.

I3.5 THREATENED SPECIES

No plant species listed as threatened under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Protection of the Environment Biodiversity Conservation Act, 1999* was found within the Project area during this survey. However, one species, the Austral Pillwort (*Pilularia novae-hollandiae*), listed as endangered in Schedule 1, Part 1 of the NSW *Threatened Species Conservation Act 1995*, has been found previously in the vicinity of Site 23 of the gas pipeline route (Bower, unpublished report, 1998). Also, one species, *Phebalium obcordatum*, listed as rare in *Rare or Threatened Australian Plants* (ROTAP) (Briggs and Leigh, 1996), was recorded at Site 39a on the gas pipeline route.

Pilularia novae-hollandiae is a small grass-like perennial fern (family Marsiliaceae) that grows in mud when seasonally dry depressions fill with water in winter. The growth cycle is completed before the depression dries out in summer. The site where *P. novae-hollandiae* had been detected previously was examined during the survey reported here, but was not found. This is most likely due to the relatively dry winter of 1999, such that the gilgai depression did not wet sufficiently to stimulate growth of the fern from sporocarps in the dried mud. The gilgai was quite dry at the time this survey, by contrast to the conditions when the previous sighting was made at the same time of year. It is probable *P. novae-hollandiae* persists at the site in a dormant condition during dry seasons and germinates only in wet years.

Phebalium obcordatum is listed as 3RCa in ROTAP indicating it has a geographic range of over 100 km, is rare, is conserved in dedicated conservation reserves, and that the total population in reserves is known to exceed one thousand plants, i.e. it is regarded as adequately reserved. It occurs in Cocoparra National Park, Cocoparra Nature Reserve and Yathong Nature Reserve in NSW, and four reserves in Victoria. At Site 39a in the Project area, *P. obcordatum* occurs in a heath understorey in a community dominated by Mugga Ironbark (*Eucalyptus sideroxylon, E. viridis* and *E. dwyeri*) in undulating country on poor soils near the top of the divide between the Lachlan and Macquarie River Valleys. Only one population was found, numbering less than ten plants.

I4 DISCUSSION

I4.1 SIGNIFICANT PLANT COMMUNITIES

No plant communities listed under the NSW *Threatened Species Conservation Act 1995* occur within the Project area.

Benson (1989) assessed the conservation status of 432 major plant associations identified as occurring in NSW. Associations identified in this study, and their conservation status according to Benson (1989) are shown in Table I-4.

Eleven of the communities recognised in this study are not listed in Benson (1989) (Table I-4). These may be 'minor' associations, or ecotonal associations that Benson (1989) considered did not warrant specific recognition, or they may represent associations overlooked in previous broad studies. The *E. populnea / E. dwyeri*, *E. sideroxylon / E. microcarpa* and *E. microcarpa / E. dwyeri* associations found on several sites in this study were isolated occurrences of *E. dwyeri* or *E. sideroxylon* on low rises within landscapes dominated by *E. populnea* and *E. microcarpa* woodlands and might therefore be regarded as minor associations. However, these 'minor' hill community associations appear to be quite widespread in the study area and perhaps deserve formal recognition. Indeed, Specht *et al.* (1995) have recognised *E. sideroxylon / E. microcarpa* as a community. The *E. microcarpa / E. populnea / C. glaucophylla* association recognised on many sites in this study does not appear to correspond directly to any of Benson's associations, though it may equate to his *E. microcarpa / E. populnea* association. The *E. microcarpa / E. populnea / C. glaucophylla* association reflects the blending of the *E. microcarpa* and *E. populnea* alliances in central New South Wales as also recognised by Sivertson and Metcalf (1995) and Cunningham (1997). Oddly, the *E. populnea / C. glaucophylla* association is also not listed by Benson (1989) despite its prominence in central and southern inland New South Wales. The *C. glaucophylla* association identified in this study may be artefactual rather than natural, given it was only recorded on two disturbed sites on Crown land at the mine site. The high degree of disturbance may have eliminated the eucalypts that would normally be expected to associate with this species. However, *C. glaucophylla* has been given formal recognition as a major community by Specht *et al.* (1995). Finally, the *Acacia pendula / A. oswaldii*, *A. pendula* and *A. oswaldii* associations, also not listed in Benson (1989), may be 'minor' associations incorporated in his *A. pendula* ± *Alectryon oleifolius* association.

Of the 15 remaining associations recognised in this study and by Benson (1989), five are regarded as endangered and six as vulnerable by Benson (1989), with the other four not considered to be threatened (Table I-4). The endangered and vulnerable associations include the box-pine woodland associations that dominate the mine site and much of the service corridors.

Also significant is the endangered status of the *Acacia pendula / Alectryon oleifolius* association that is well represented on the proposed gas pipeline route in the travelling stock route south of Condobolin.

The *A. pendula / A. oleifolius* association is regarded as endangered and not conserved by Benson (1989). This area may well qualify as 'significant roadside vegetation' a designation now being used by some Shire Councils to protect poorly conserved vegetation types along roadsides.

Another area that could qualify for classification as 'significant roadside vegetation' is the dense box-pine woodland along the Ootha-Fifield Road in the vicinity of Sites 9 to 11A. Sites 9 to 11 support the *E. microcarpa / E. populnea* association with and without *Callitris glaucophylla*. This association is regarded as endangered and not conserved by Benson (1989). The remnant is well developed with good species diversity and has relatively few weeds (Attachment I-B2). The major limitation to this area for conservation purposes is the relatively narrow road easement. Pipeline construction is likely to impact upon this remnant.

None of the 15 associations listed by Benson (1989) and found in areas examined in this study is considered to be adequately conserved (Table I-4). Six were not considered to be conserved at all and the conservation status of the other nine was regarded as inadequate, though more recent reservations may have changed this.

The low representation of these associations in conservation reserves is due to the history of rural development in the wheat belt of New South Wales. When these areas were settled most of the box woodlands and the alluvial floodplains were taken up for farming as they encompassed the better soils. These lands were cleared progressively for cropping and grazing, the process continuing until quite recent times (Sivertson and Metcalfe, 1995).

Table I-4. Conservation Status of Plant Associations Identified Within the Project Area[1]

Association	Risk Category	Conservation Status
Eucalyptus camaldulensis	Vulnerable	Inadequate
E. largiflorens	Not threatened	Inadequate
E. sideroxylon	Vulnerable	Inadequate
E. sideroxylon / *E. dwyeri* (*E. dealbata*)	Not threatened	Inadequate
E. sideroxylon / E. microcarpa	(Not listed)	
E. populnea / E. dwyeri	(Not listed)	
E. microcarpa / E. dwyeri	(Not listed)	
E. microcarpa / E. viridis / E. dwyeri	(Not listed)	
E. populnea (grassy woodland)	Endangered	Not conserved
E. populnea / Callitris glaucophylla	(Not listed)	
E. microcarpa	(Not listed)	
E. populnea / *E. microcarpa*	Endangered	Not conserved
E. microcarpa / *C. glaucophylla*	Vulnerable	Not conserved
E. microcarpa / E. populnea / C. glaucophylla	(Not listed)	
E. melliodora / *C. glaucophylla*	Endangered	Not conserved
C. glaucophylla	(Not listed)	
Allocasuarina luehmanii	Vulnerable	Inadequate
Geijera parviflora / Alectryon oleifolius	Not threatened	Inadequate
Acacia pendula / A. oleifolius (Probably includes *A. pendula*; *A. pendula / A. oswaldii* and *A. oswaldii*)	Endangered	Not conserved
Eucalyptus dumosa	Vulnerable	Inadequate
E. viridis	Vulnerable	Inadequate
Stipa aristiglumis	Endangered	Not conserved
Marsilea drummondii	Not threatened	Inadequate

[1] after Benson (1989)

Conservation Status

Not conserved	Not conserved or is of only miniscule areas located in reserves
Inadequately conserved	Inadequately conserved, either because only relatively small areas are located in reserves or major parts of its geographical range remains unprotected.

Risk Category

Endangered	likely to become extinct within a few decades if action is not taken to rectify the decline of the association and protect and manage areas
Vulnerable	likely to become endangered within a few decades if action is not taken to rectify the decline of the association and protect and manage areas
Not threatened	Not threatened in the foreseeable future, however this could change if landuse changes.

Despite the endangered and vulnerable status assigned by Benson (1989) (Table I-4) to the Popular Box (*E. populnea* subsp. *bimbil*), Grey Box (*E. microcarpa*) and Yellow Box (*E. melliodora*) woodlands, considerable total areas of these habitats remain (Sivertson and Metcalfe, 1995). Some 134,400 hectares of box-pine woodlands occur in the wheat belt areas of the Forbes and Lake Cargelligo 1:250,000 map sheets alone (Sivertson and Metcalfe, 1995). If other parts of the wheat belt have a similar proportion of box-pine woodlands remaining, the total area could exceed 600,000 ha. While this total seems impressive it represents only about 5 to 6 percent of the wheat belt area. The main problems from a conservation point of view are the high degree of fragmentation (Saunders *et al*., 1991) of the remaining woodlands, the lack of wilderness-sized remnants and the all-pervasive effects of grazing (Adamson and Fox, 1982).

There are significant inconsistencies between Benson's (1989) assessment of the conservation status of some box woodland associations (Table I-4) and that of Specht et al (1974) for their *E. microcarpa, E. populnea* and *E. populnea / Callitris glaucophylla* alliances. While Benson (1989) regards all box woodland associations as not conserved, Specht et al. (1974) considered that the *E. microcarpa* alliance was excellently conserved as a woodland formation and reasonably conserved as a low woodland formation; the *E. populnea* alliance was moderately well conserved as both woodland and low woodland formations and that the *E. populnea / C. glaucophylla* alliance was poorly conserved as both woodland and low woodland formations. There has been no decrease in the reserve system between 1974 and 1989 that might explain these discrepancies. It may be that Benson (1989) underestimated the conservation status of at least some of the box woodland associations, that Specht et al. (1974) grossly overestimated it, or that the two were using quite different criteria for conservation status.

The main box woodland remnants occur in a patchwork of relatively small State Forests scattered through the Wheat Belt. As indicated in the introduction, some 15 State Forests are located within a 50 mile radius of the mine site. Management of these forests has been primarily to foster growth of White Cypress Pine. Although management has not focussed on nature conservation it has not been completely inimical to it. Despite harvesting of White Pine, removal of most of the competing eucalypts, and the use of grazing as a fire management tool, most forests seem to retain much of their original biodiversity.

Apart from Fifield State Forest and parts of the adjoining Crown land most of the box woodland remnants on the mine site are very highly disturbed, greatly diminishing their conservation value. The relatively less disturbed parts of Fifield State Forest and the Crown land by contrast have a higher conservation value. However, the area of higher quality habitat is quite small and fragmented by past mining activity. As such it has low suitability for establishment of a conservation reserve.

I4.2 THREATENED SPECIES

In general the habitats on the Project area are not suitable for most of the threatened species listed in Table I-2 (see Eight Part Tests, Attachment I-C). The Project area habitats are widespread in inland NSW, despite being highly fragmented and poorly conserved. Hence the species they support also tend to be widespread and generally common.

No plant species listed as threatened under the NSW *Threatened Species Conservation Act 1995* or in ROTAP (Briggs and Leigh, 1996) were found on the mine site and only one species regarded as threatened, the Austral Pillwort (*Pilularia novae-hollandiae*) is known to occur along any of the service corridors or outlying infrastructure sites (Site 23 on the gas pipeline route). A further species listed as rare in ROTAP (Briggs and Leigh, 1996), the Club-leaved Phebalium, *Phebalium obcordatum*, was found at one site on the gas pipeline route.

Previous surveys for *P. novae-hollandiae* (Bower, unpublished) found the species to be common in the Lake Cowal region in gilgai depressions after a wet winter. It was concluded that *P. novae-hollandiae* is much more common in gilgai landscapes than formerly realised. Plants are small, inconspicuous and appear ephemerally only after wet winters. Dry seasons are spent underground as a dormant sporocarp. For these reasons it has been poorly collected in New South Wales with few specimens in herbarium collections.

Given the widespread distribution of *P. novae-hollandiae* in Central New South Wales, its isolated occurrence in the gilgai at Site 23 is not critical to the survival of the species in the wild. In any event, it is recommended that the gas pipeline be located to avoid this population.

I5 SUMMARY AND CONCLUSIONS

1. A flora survey was conducted on lands proposed to be affected by the Syerston Nickel - Cobalt Project, including the mine site, associated gas, water and transport corridors, limestone quarry and rail siding.

2. The study areas were found to support remnants of vegetation communities belonging to 24 plant associations and 11 alliances typical of the central New South Wales wheat belt. Most of the study area was originally open grassy woodlands.

3. Some 321 native (74%) and 112 introduced (26%) vascular plant taxa (species, subspecies, varieties and forms) were found on the study areas. The main plant families represented were the grasses (Poaceae) (93 species - 65 native, 28 exotic), the daisies (Asteraceae) (66 species - 44 native, 22 introduced) and the saltbushes (Chenopodiaceae) (24 taxa - all native).

4. Eight plant associations belonging to three alliances occur on the mine site. The native vegetation is dominated by mixed 'box-pine woodlands' comprising mosaics of four associations of the Grey Box (*Eucalyptus microcarpa*) and Poplar Box (*E. populnea*) alliances. Smaller occurrences of the Mugga Ironbark (*E. sideroxylon*) / Tumbledown Gum (*E. dealbata*) alliance are found on stony ridges and of the Wilga (*Geijera parviflora*) / Rosewood (*Alectryon oleifolius*) association on gilgai country.

5. MLAs 141, 113 and 139 comprise mainly cropping paddocks from which the original native flora has been eliminated except for isolated shelter trees for stock. Remnants of natural communities, comprising mainly dense regenerating stands of White Cypress Pine (*Callitris glaucophylla*) persist on the ridges, but grazing by stock has severely reduced most of the original native shrubs and ground flora.

6. Fifield State Forest supports areas of box-pine woodland that appear to contain much of their original diversity, but have few old growth trees. Parts of the Crown land have been highly disturbed by recent mining for magnesite and are slowly being recolonised by weeds and some native species.

7. The condition of the native vegetation along the proposed gas pipeline, water pipeline and transport routes (i.e. Route 64 and Fifield bypass) varied from completely cleared to relatively intact. About 10 percent of sample sites were completely cleared and dominated by weeds. Another 10 percent of sites appear to retain a high proportion of the original flora and are relatively weed free. The majority of sites retain some elements of the original flora with varying degrees of disturbance and weed invasion.

8. The gas pipeline corridor passes through a Traveling Stock Route (TSR) on the West Wyalong - Condobolin Road. Although some past disturbance has occurred, the TSR retains a significant sample of the central Lachlan Valley flora, particularly the Myall (*Acacia pendula*) alliance considered to be endangered by Benson (1989).

9. The water pipeline corridor passes through a long (11 km), but narrow, high quality remnant of *Eucalyptus microcarpa / E. populnea* box-pine woodland, considered to be endangered by Benson (1989), but not by Specht *et al.* (1974) on the Ootha -Fifield Road between Sites 9 and 11A.

10. The sites of the proposed limestone quarry and the connection point to the Moomba - Sydney gas pipeline are on highly disturbed sites that retain very little to virtually none of their original flora, respectively.

11. The water borefield supports remnants of a mix of floodplain and box-pine woodland vegetation communities. Only the floodplain communities retain much of their original integrity, but only in the ground cover; most of the original River Red Gum tree layer has been removed. The proposed rail siding at the eastern end of Route 64 has been largely cleared of its native tree cover leaving a diverse herbaceous grassland. The ground cover appears never to have been ploughed and is in relatively good condition, but has little value for conservation.

12. No plant species listed as vulnerable, endangered or extinct under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Protection of the Environment Biodiversity Conservation Act, 1999* or the national Rare or Threatened Australian Plants (Briggs and Leigh, 1996) listing was found on the study areas during the survey reported here. However, the Austral Pillwort (*Pilularia novae-hollandiae*), listed as endangered in Schedule 1, Part 1 of the NSW *Threatened Species Conservation Act 1995*, is known to occur in a gilgai depression at Site 23 on the gas pipeline route. A small population of the Club-leaved Phebalium, *Phebalium obcordatum*, listed as rare in the *Rare or Threatened Australian Plants* (Briggs and Leigh, 1996) listing, was found at Site 39a on the gas pipeline route.

13. No plant communities listed as threatened under the NSW *Threatened Species Conservation Act 1995* were found in the study areas.

14. Ten of the vegetation associations found in the study areas are regarded as endangered or vulnerable by Benson (1989). This reflects the lack of large conservation reserves in the wheat belt of New South Wales. Significant roadside remnants of two of these occur, one each on the gas and water pipeline routes (described in points 8 and 9 above).

15. Despite the fragmentation and poor representation in dedicated conservation reserves of the region's flora, a considerable total area of all communities remains. The Project will not have a significant impact on the total area of these habitat types in the region. Many of the communities, particularly the box-pine woodlands and hill communities are well represented on crown land in many small State Forests and Travelling Stock Reserves and Routes throughout the region.

I6 RECOMMENDATIONS

1. Box woodland remnants of the mine site, which do not need to be disturbed for Project development, should be managed to maintain and enhance the biodiversity of the Mining Lease area and the region. This could involve reducing the levels of grazing, or fencing areas out from grazing to allow them to regenerate.

2. Gilgai areas at Site 23 on the gas pipeline route should be avoided when constructing the pipeline to prevent damage to the local population of the threatened Austral Pillwort (*Pilularia novae-hollandiae*).

3. The population of Club-leaved Phebalium, *Phebalium obcordatum*, at Site 39a on the gas pipeline route should be protected from disturbance if at all practicable.

4. Disturbance to the soil and natural vegetation in the Travelling Stock Route on the West Wyalong - Condobolin Road should be minimised to lessen impacts on valuable Myall (*Acacia pendula*) alliance communities. Construction camps and infrastructure should be located on already disturbed sites and care should be taken with vehicles and earth moving equipment to avoid unnecessary disturbance. Similar precautions should be employed on the water pipeline route between sample sites 9 and 11A on the Ootha - Fifield Road to minimise impacts on significant remnants of *E. microcarpa / E. populnea / C. glaucophylla* box-pine woodland.

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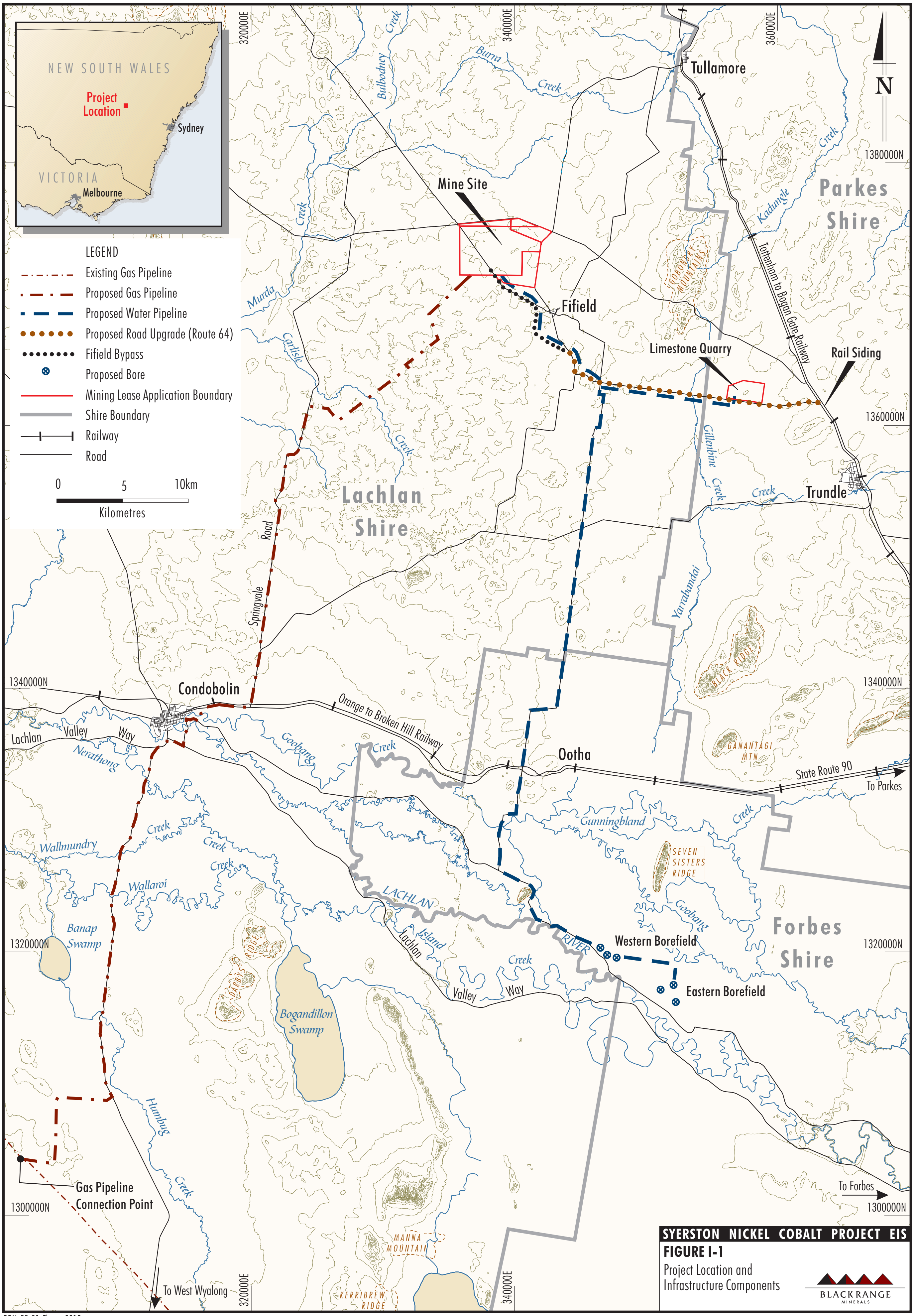
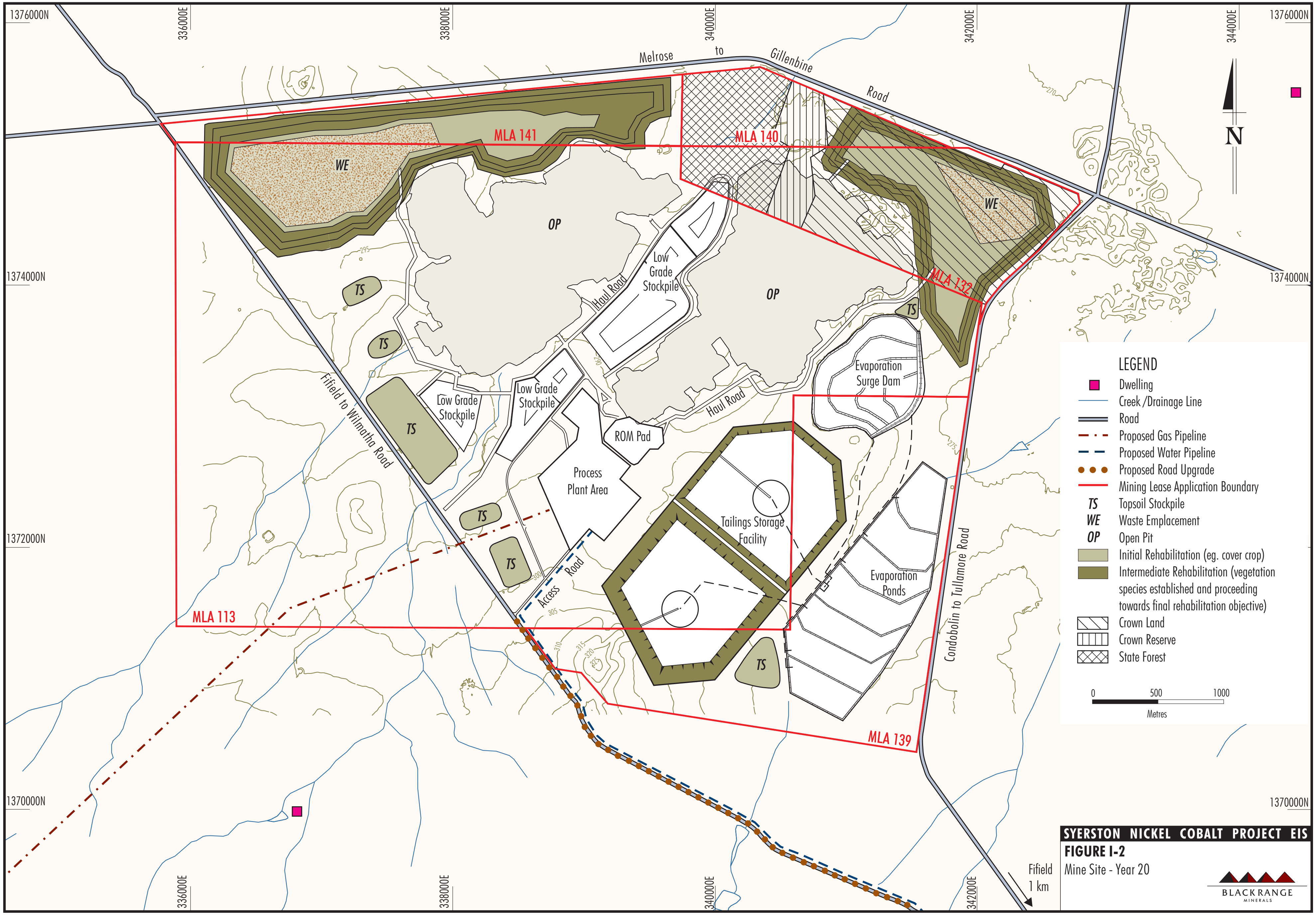
FIGURES



SYERSTON NICKEL COBALT PROJECT EIS
FIGURE I-1
Project Location and Infrastructure Components

BLACK RANGE MINERALS

BRM-98-01-Flora _001E



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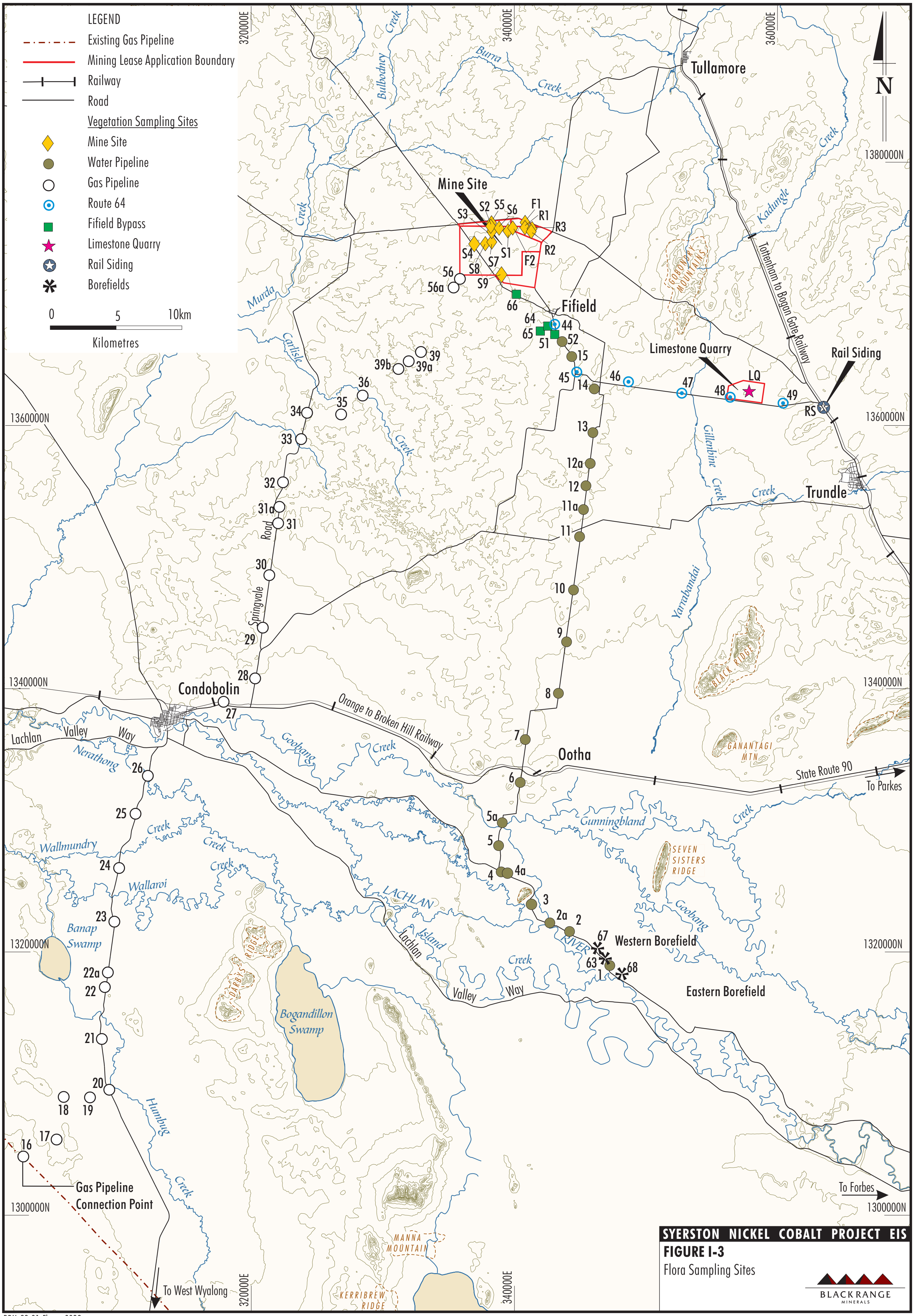


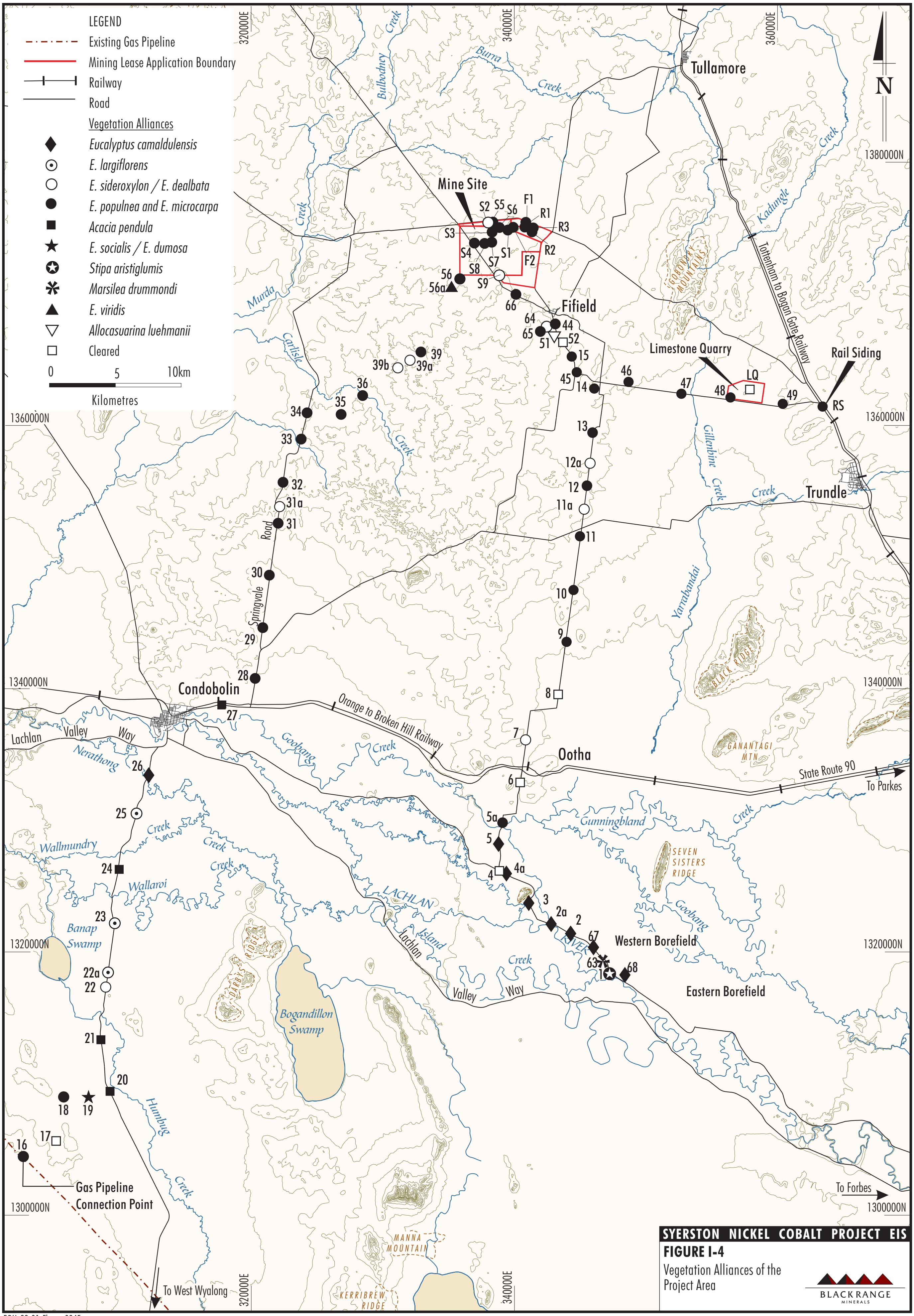
SYERSTON NICKEL COBALT PROJECT EIS

FIGURE I-3

Flora Sampling Sites

BLACKRANGE MINERALS

BRM-98-01-Flora _003G



SYERSTON NICKEL COBALT PROJECT EIS

FIGURE I-4

Vegetation Alliances of the Project Area

BLACKRANGE MINERALS

BRM-98-01-Flora _004F

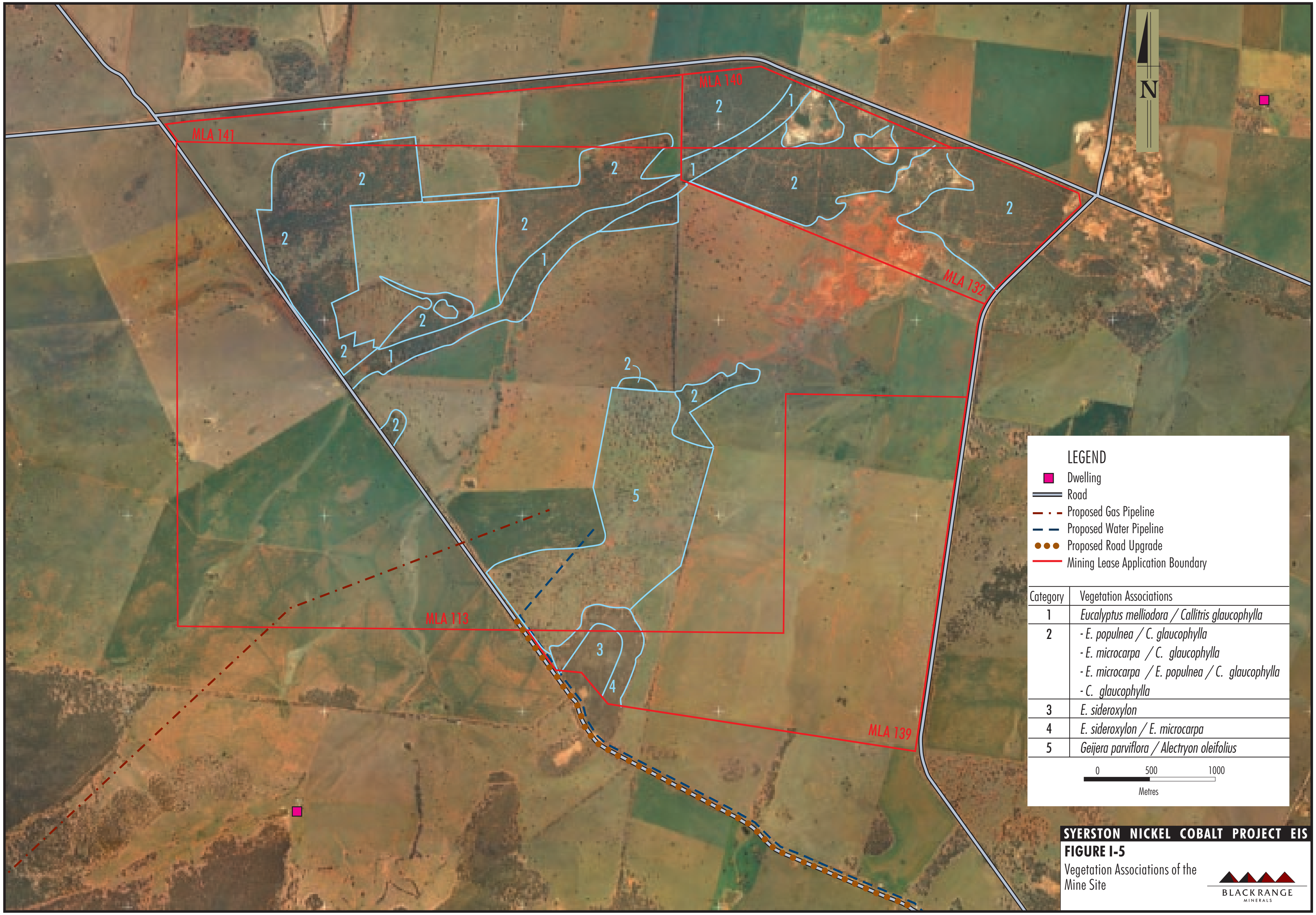


FIGURE I-5

Vegetation Associations of the Mine Site

BRM-98-01-Flora_005D

ATTACHMENT I-A

DETAILS OF VEGETATION SAMPLING SITES

ATTACHMENT I-A
DETAILS OF VEGETATION SAMPLING SITES

Site numbers without letters are systematic samples, taken as per the methods section, those with letters are additional sites representing less common habitats. Except for samples taken on the Project site, which were geocoded from topographic maps, site co-ordinates were read from a hand-held GPS (Garmin 12).

Sample Group	Site Number	Easting	Northing	Site Location	Vegetation Association
Mine Site	F1	0540950	6376660	Fifield State Forest	*Eucalyptus populnea/E. microcarpa/Callitris glaucophylla*
	F2	0540000	6376300	Fifield State Forest	*E. melliodora/C. glaucophylla*
	R1	0541014	6376270	Flora and Fauna Reserve	*E. populnea/C. glaucophylla*
	R2	0541458	6376047	Flora and Fauna Reserve	*C. glaucophylla* (mining regeneration)
	R3	0541510	6376251	Flora and Fauna Reserve	*C. glaucophylla* (mining regeneration)
	S1	0539650	6376050	Syerston Farm	*E. melliodora/C. glaucophylla*
	S2	0538420	6376670	Syerston Farm	*E. sideroxylon*
	S3	0538350	6376030	Syerston Farm	*E. populnea/C. glaucophylla*
	S4	0536910	6375070	Syerston Farm	*E. populnea/C. glaucophylla*
	S5	0538540	6376080	Syerston Farm	*Geijera parviflora/Alectryon oleifolium*
	S6	0539000	6376230	Syerston Farm	*E. microcarpa/C. glaucophylla*
	S7	0538450	6375250	Syerston Farm	*E. melliodora/C. glaucophylla*
	S8	0537900	6375050	Syerston Farm	*E. melliodora/C. glaucophylla*
	S9	0539162	6372712	Syerston Farm	*E. sideroxylon*
Water Pipeline	1	0547205	6320262	North Condobolin Road	*Stipa aristiglumis*
	2	0544309	6322834	North Condobolin Road	*E. camaldulensis* (cleared)
	2A	0542840	6323589	North Condobolin Road	*E. camaldulensis* (cleared)
	3	0541303	6324971	North Condobolin Road	*E. camaldulensis* (cleared)
	4	0539419	6327329	North Condobolin Road	cleared
	4A	0538852	6329355	Bumbuggan Creek, South of Ootha	*E. camaldulensis*
	5	0539089	6331087	Goobang Creek, South of Ootha	*E. camaldulensis*
	5A	0539455	6331880	South of Ootha	*E. populnea/E. microcarpa/C. glaucophylla*
	6	0540524	6334072	South of Ootha	cleared
	7	0540993	6337400	North of Ootha	*E. dwyeri/E. microcarpa*
	8	0543412	6340886	Ootha-Fifield Road	cleared
	9	0544017	6344888	Ootha-Fifield Road	*E. populnea/E. microcarpa/C. glaucophylla*
	10	0544574	6348743	Ootha-Fifield Road	*E. populnea/E. microcarpa/C. glaucophylla*
	11	0545102	6352805	Ootha-Fifield Road	*E. populnea/E. microcarpa*

Sample Group	Site Number	Easting	Northing	Site Location	Vegetation Association
Water Pipeline (Cont.)	11A	0545102	6354847	Ootha-Fifield Road	*E. sideroxylon/E. dwyeri*
	12	0545609	6356753	Ootha-Fifield Road	*E. microcarpa/C. glaucophylla*
	12A	0545655	6358400	Ootha-Fifield Road	*E. sideroxylon/E. dwyeri*
	13	0546087	6360712	Ootha-Fifield Road	*E. populnea/E. microcarpa*
	14	0546570	6363991	Ootha-Fifield Road	*E. microcarpa/C. glaucophylla*
	15	0544481	6366610	Ootha-Fifield Road	*E. microcarpa/C. glaucophylla*
	52	0543422	6368033	Ootha-Fifield Road	cleared
Gas Pipeline	16	0502702	6305751	Start Gas Pipeline	*E. populnea/E. microcarpa*
	17	0505280	6306945	NE start Gas Pipeline	cleared
	18	0505796	6310416	NE start Gas Pipeline	*E. microcarpa/C. glaucophylla*
	19	0507840	6310298	NE start Gas Pipeline	*E. dumosa*
	20	0509381	6310818	West Wyalong-Condobolin Road	*Acacia oswaldii*
	21	0508720	6314669	West Wyalong-Condobolin Road	*A. pendula/A. oswaldii*
	22	0509013	6318555	West Wyalong-Condobolin Road	*E. dwyeri/E. microcarpa*
	22A	0509214	6319696	West Wyalong-Condobolin Road	*E. largiflorens*
	23	0509772	6323595	West Wyalong-Condobolin Road	*E. largiflorens*
	24	0510016	6327548	West Wyalong-Condobolin Road	*A. pendula* (cleared)
	25	0511373	6331744	West Wyalong-Condobolin Road	*E. largiflorens* (cleared)
	26	0512218	6334611	West Wyalong-Condobolin Road	*E. camaldulensis*
	27	0517933	6340190	Condobolin-Parkes Road	*A. pendula*
	28	0520415	6342061	Condobolin-Fifield Road	*E. populnea/E. microcarpa/C. glaucophylla*
	29	0520977	6345928	Springvale Road	*E. populnea/E. microcarpa/C. glaucophylla*
	30	0521504	6349926	Springvale Road	*E. populnea/E. microcarpa*
	31	0522080	6353807	Springvale Road	*E. populnea*
	31A	0522265	6355023	Springvale Road	*E. populnea/E. dwyeri*
	32	0522485	6356903	Springvale Road	*E. populnea/E. microcarpa/C. glaucophylla*
	33	0523873	6360207	Springvale Road	*G. parviflora/A. oleifolium*
	34	0524332	6362218	Springvale Road	*E. microcarpa/C. glaucophylla*
	35	0526582	6349926	Northern End of Gas Pipeline	*E. populnea/E. microcarpa*
	36	0528516	6363477	Northern End of Gas Pipeline	*E.microcarpa/C. glaucophylla*
	39	0532921	6366800	Northern End of Gas Pipeline	*E. microcarpa/C. glaucophylla*
	39A	0532035	6366099	Northern End of Gas Pipeline	*E. sideroxylon/E. viridis/E. dwyeri*
	39B	0530932	6365987	Northern End of Gas Pipeline	*E. sideroxylon*
	56	0535841	6372356		*E. microcarpa*
	56A	0535376	6371731		*E. viridis*

Sample Group	Site Number	Easting	Northing	Site Location	Vegetation Association
Route 64	44	0543165	6368936	Route 64	*E. populnea/E. microcarpa/C. glaucophylla*
	45	0544812	6365328	Route 64	*E. populnea/C. glaucophylla*
	46	0548667	6364438	Route 64	*E. populnea/C. glaucophylla*
	47	0552710	6363840	Route 64	*E. microcarpa/C. glaucophylla*
	48	0556553	6363315	Route 64	*E. populnea/E. microcarpa/C. glaucophylla*
	49	0560606	6362931	Route 64	*E. populnea/C. glaucophylla*
Fifield Bypass	51	0543186	6368160	Eastern End	*Allocasuarina luehmanii* (gilgai)
	64	0542550	6368725		*E. sideroxylon/E. microcarpa*
	65	0542025	6368350		*E. microcarpa*
	66	0540250	6371180		*E. microcarpa*
Limestone Quarry	LQ			Turnoff from R64 to "The Troffs"	cleared
Rail Siding	RS			Across Rail Line from Route 64	*E. populnea*
Water Borefield	63	0547429	6320643	Western borefield	*Marsilea drummondii*
	67	0546260	6321510	Western borefield	*E. camaldulensis*
	68	0548110	6319525	Southern borefield pipeline route	*E. camaldulensis*

ATTACHMENT I-B1

VASCULAR PLANT SPECIES FOUND ON SURVEY SITES ON THE MINE SITE

ATTACHMENT I-B1 Vascular Plant Species Found on Survey Sites on the Syerston Mine Site.

Asterisk denotes introduced species.

Family	Scientific Name	Common Name	Sample Site													
			F1	**F2**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**R1**	**R2**	**R3**
PTERIDOPHYTES		**Ferns**														
Sinopteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	Rock Fern		o	o			o				o	f	o		
CONIFEROPSIDA																
Cupressaceae	*Callitris endlicheri*	Black Pine											c			
	Callitris glaucophylla	White Cypress Pine	a	f	a	c	a	a	c	a	a	a		a	a	c
MAGNOLIOPSIDA		**Flowering Plants**														
MAGNOLIIDAE		**Dicotyledons**														
Acanthaceae	*Brunoniella australis*	Blue Trumpet		o										o		
	Rostellularia adscendens subsp. *adscendens* var. *pogonanthera*	Pink Tongues	c	o	o	f	o	f		o		o			o	
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	o	f	f						f	o				
	**Amaranthus* sp.			o	o											
	Ptilotus obovatus var. *obovatus*	Cotton Bush	o					o								
Apiaceae	**Ciclospermum leptophyllum*	Slender Celery		o	o						o					
`	*Daucus glochidiatus* Form D	Native Carrot	c	c	c	c	c	c	c	c	c	c		o	o	
	Hydrocotyle laxiflora	Stinking Pennywort	c	c	c	f	f	f	o		c				o	
	Platysace lanceolata	Shrubby Platysace											o			
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	o											o		
Asclepiadaceae	*Marsdenia* sp.											o				
	**Tweedia coerulea*	Tweedia				f										
Asparagaceae	**Myrsiphyllum asparagoides*	Bridal Creeper												o		
Asteraceae	*Actinobole uliginosum*	Flannel Cudweed	c			c	c	c	c	c		c				
	Bracteantha bracteata	Golden Everlasting	a	c	c	c	c	c	c	c	c	c			o	
	Bracteantha viscosa	Sticky Everlasting		o		o	f	f			o	f	a	f		
	Calotis cuneifolia	Purple Burr-daisy	o	f		f	f	f	o	o	o	o	c	f	f	
	Calotis lappulacea	Yellow Burr-daisy	o				o				o					
	**Carduus pycnocephalus*	Slender Thistle													o	
	**Carthamus lanatus*	Saffron Thistle	f	f	c	c	c	c	c	c	c	c		o	o	o

Family	Scientific Name	Common Name	Sample Site													
			F1	F2	S1	S2	S3	S4	S5	S6	S7	S8	S9	R1	R2	R3
	Cassinia laevis	Cough Bush	c	c		c	f							o		
	**Centaurea melitensis*	Maltese Cockspur	f	f	c	c		c	c	c		c				o
	Centipeda thespidioides	Desert Sneezeweed		c	c						c					
	**Chondrilla juncea*	Skeleton Weed													o	
	Chrysocephalum apiculatum	Yellow Buttons	f	f		f	f	f						f		
	Chrysocephalum semipapposum	Clustered Everlasting	f			f	f					o		o		
	**Cirsium vulgare*	Spear Thistle		o				o		o		o			o	o
	**Conyza bonariensis*	Flaxleaf Fleabane	o	o		o		o		f	f	o		o		
	Cymbonotus lawsonianus	Bear’s Ear	o									o				
	Gnaphalium sphaericum	A Cudweed	c	c	f	f	f	f		o	c	o				
	**Hedypnois rhagodioloides* subsp. *cretica*	Creton Weed		f	o	f				o	o				o	f
	**Hypochaeris glabra*	Smooth Catsear	c	c		c		c	c	c				o	o	o
	**Hypochaeris radicata*	Catsear	c	c	c	c	c	c			c	c	o			
	**Lactuca serriola*	Prickly Lettuce	o	o	o		o	o			o				o	o
	Leptorhynchos baileyi	Plains Plover Daisy	o				f	o								
	Minuria leptophylla	Minnie Daisy				o										
	Minuria sp.	Minuria					o									
	Olearia pimeleoides	Showy Daisy-bush	o													
	Ozothamnus diosmifolius	White Dogwood	o	f									o			
	Pseudognaphalium luteoalbum	Jersey Cudweed														o
	Rhodanthe floribunda	Common White Sunray	a	f	f	c	c	c			f	c			o	
	Senecio quadridentatus	Cotton Fireweed	c	c	c	f	f	f		o	f	f	o	o	o	
	Solenogyne bellioides										o					
	**Sonchus asper* subsp. *glaucescens*	Prickly Sowthistle														o
	**Sonchus oleraceus*	Common Sowthistle	f		f	f	f	f		o	f	o		o	o	o
	Triptilodiscus pygmaeus	Common Sunray		f			f	f		f	f	f				
	Vittadinia condyloides	A Fuzzweed														o
	Vittadinia cuneata var. *hirsuta*	A Fuzzweed														o
	Vittadinia dissecta var. *hirta*	A Fuzzweed	f	o		f	f	f		o	o	o		o		
	Vittadinia pustulata	A Fuzzweed	o		o	o										
	Vittadinia spp.	Fuzzweeds	o													
Boraginaceae	*Cynoglossum suaveolens*	Sweet Hound’s Tongue	f	o	o					o	o					
	**Echium plantagineum*	Paterson’s Curse	o	c	o											o
	**Echium vulgare*	Viper’s Bugloss	o	a	f											
	Halgania cyanea	Rough Halgania														o
Brassicaceae	**Lepidium africanum*	Common Peppercress	o	o							o					
	**Lepidium bonariense*	Cut-leaf Peppercress		o							o					
	**Rapistrum rugosum*	Turnip Weed													o	

Family	Scientific Name	Common Name	Sample Site													
			F1	F2	S1	S2	S3	S4	S5	S6	S7	S8	S9	R1	R2	R3
	**Sisymbrium irio*	London Rocket	o				o									
	**Sisymbrium officinale*	Hedge Mustard	f			o					o					
	**Sisymbrium orientale*	Indian Hedge Mustard													o	
Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell	c	c	o			f	f	f	f	f		o	f	f
	Wahlenbergia gracilis	Sprawling Aust. Bluebell		c	c		f	f	f			f				
	Wahlenbergia stricta subsp. *alterna*	Tall Bluebell											o			o
	Wahlenbergia stricta subsp. *stricta*	Tall Bluebell				f	f		o				o			o
Capparaceae	*Apophyllum anomalum*	Warrior Bush	o													
Caryophyllaceae	*Gypsophila australis*	Annual Chalkwort	c			o	o			o		o				
	**Petrorhagia velutina*	Velvet Pink	f	f	f	f	f		f	f		f			o	o
	**Polycarpon tetraphylla*	Four-leaved Allseed	o	c	c					c	c					
	**Silene apetala*			o	o							o				
Chenopodiaceae	*Atriplex spinibractea*	Spiny-fruit Saltbush	o													
	Chenopodium carinatum	Green Crumbweed	o							o						
	Chenopodium cristatum	Crested Crumbweed										o				
	Chenopodium desertorum subsp. *microphyllum*	Desert Goosefoot		f		f	f	f		f		f		o		
	Einadia hastata	Saloop											o			
	Einadia nutans	Climbing Saltbush												o	o	o
	Einadia nutans subsp. *oxycarpa*	Climbing Saltbush	o			o	o			o		o				
	Einadia polygonoides															o
	Maireana enchylaenoides	Wingless Fissure Weed	o			o								o		
	Maireana microphylla	Eastern Cotton Bush	o	o												
	Maireana pentagona	Hairy Bluebush												o		
	Salsola kali var. *kali*	Buckbush	o									o				
	Sclerolaena diacantha	Grey Copperburr	o					o							o	
	Sclerolaena spp.		c	c	c	c	c	c		c		c				
Clusiaceae	*Hypericum gramineum*	Small St John’s Wort	o	o												
Convolvulaceae	*Convolvulus erubescens*	Pink Bindweed	o	o	o	o					o				o	o
	Dichondra species A		c	c	c		f			f	f			o		
Crassulaceae	*Crassula colorata* var. *acuminata*	Dense Stonecrop	f		o	o	o	o		o	o					
Cucurbitaceae	**Citrullus lanatus*	Bitter Melon, Camel Melon	o	o												

Family	Scientific Name	Common Name	Sample Site													
			F1	**F2**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**R1**	**R2**	**R3**
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed	o												o	
	Phyllanthus virgatus		f	f							f					
Fabaceae																
Caesalpinioideae Subfamily	*Senna artemisioides* subsp. *filifolia*	Silver Cassia	f			o	o							f	o	o
Faboideae Subfamily	*Glycine clandestina*	Twining Glycine	f		f	f	f	f	f			o		o	o	
	Glycine tabacina	Variable Glycine	f	f	f	f	f				f			o		
	Indigofera australis	Australian Indigo							o							
	**Medicago minima*	Woolly Burr Medic													o	
	**Medicago polymorpha*	Burr Medic														o
	**Medicago truncatula*	Barrel Medic													o	o
	Psoralea tenax	Emu-foot	o	f	o						f					
	Swainsona oroboides	Kneed Darling Pea		o												
	**Trifolium angustifolium*	Narrow-leaved Clover	o	c	c		c				o					
	**Trifolium arvense*	Haresfoot Clover	c	f	c	f	o	o		o	o	o				
	**Trifolium campestre*	Hop Clover	c	a	a	a	a	a	a	a	a	a			f	f
	**Trifolium glomeratum*	Clustered Clover	a													
	**Trifolium tomentosum*	Woolly Clover														o
Mimosoideae Subfamily	*Acacia deanei* subsp. *deanei*	Deanes Wattle	f											f	o	
	Acacia decora	Western Golden Wattle	f		o									f		
	Acacia difformis	Drooping Wattle	o													
	Acacia doratoxylon	Currawang	o	o		o	o		o				o		o	
	Acacia hakeoides	Western Black Wattle	o											o		o
	Acacia pravifolia	Coil-pod Wattle				f						o				
Gentianaceae	**Centaurium erythraea*	Common Centaury	o		o						o	o				
	Centaurium spicatum	Spike Centaury	f	o	o						o					
	**Centaurium tenuifolium*	Branched Centaury	o	o	o			o								
Geraniaceae	**Erodium cicutarium*	Common Storksbill													o	o
	Erodium crinitum	Blue Storksbill										o			o	o
	Geranium solanderi	Native Geranium										o				
Goodeniaceae	*Dampiera lanceolata* var. *lanceolata*	Grooved Dampiera											f			
	Goodenia cycloptera	Serrated Goodenia	c				f	c						f	o	
	Goodenia hederacea var. *hederacea*	Forest Goodenia	f		f	c	f	c		f			o	o		
	Goodenia pinnatifida	Scrambled Eggs	o		f	c	c	c	f	f		f		o	o	f
	Scaevola humilis	Sandplain Fan-flower	o			c		o				f				

Family	Scientific Name	Common Name	Sample Site													
			F1	F2	S1	S2	S3	S4	S5	S6	S7	S8	S9	R1	R2	R3
Haloragaceae	*Gonocarpus elatus*	Hill Raspwort											a			
Lamiaceae	*Ajuga australis*	Austral Bugle	o		o											
	**Marrubium vulgare*	Horehound	o	o						o						o
	Mentha satureioides	Native Pennyroyal		o	o									o		
	**Salvia verbenaca*	Wild Sage	o												o	o
Linaceae	*Linum marginale*	Native Flax	o	o												o
Loranthaceae	*Amyena miquelii*	Box Mistletoe	o													
Lythraceae	*Lythrum hyssopifolia*	Hyssop loosestrife		o												
Malvaceae	*Hibiscus sturtii* var. *sturtii*	Hill Hibiscus				o										
	Sida corrugata	Corrugated Sida	f	f	f	c		o		o		o		o	o	
	Sida cunninghamii	Ridge Sida	f	f	o	c		o			o	o				
Myoporaceae	*Eremophila debilis*	Winter Apple	o			o										
	Eremophila mitchellii	Budda	f													
	Myoporum montanum	Western Boobialla	f	f	o	f	f	f	f	f		f		f	o	
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Gum							c							
	Eucalyptus dwyeri	Dwyer’s Red Gum											o			
	Eucalyptus melliodora	Yellow Box	o	c	c					f	c	o				
	Eucalyptus microcarpa	Grey Box	o		o	f	o	f		f						
	Eucalyptus populnea subsp. *bimbil*	Bimble Box	c		o	c	c		c		c			c		
	Eucalyptus sideroxylon	Ironbark	o		o	f				f			a			
	Leptospermum divaricatum												c			
Nyctaginaceae	*Boerhavia dominii*	Tarvine	o													
Oleaceae	**Ligustrum vulgare*	European Privet							o							
Oxalidaceae	*Oxalis chnoodes*		f	f	o	o	o	o		o	o	o				
	Oxalis perennans														o	
Pittosporaceae	*Pittosporum phylliraeoides*	Weeping Pittosporum	o		o	o										
Plantaginaceae	*Plantago cunninghamii*	Sago Weed	f	f										o	o	o

Family	Scientific Name	Common Name	Sample Site													
			F1	F2	S1	S2	S3	S4	S5	S6	S7	S8	S9	R1	R2	R3
	Plantago debilis	Shade Plantain								f						
	Plantago hispida	Plantain		f	o	f	f	f			f	f				
Polygonaceae	**Polygonum aviculare*	Wireweed	o	o	o						o					
	**Polygonum plebeium*	Small Knotweed	o		o											
	Rumex brownii	Swamp Dock	o	f	o					o	o				o	
	**Rumex crispus*	Curled Dock		o							o					
Primulaceae	**Anagallis arvensis*	Blue & Scarlet Pimpernel	o	o	o										f	f
Proteaceae	*Hakea tephrosperma*	Hooked Needlewood	o			o			o							
Resedaceae	**Reseda luteola*	Wild Mignonette		o							o					
Rubiaceae	*Asperula conferta*	Common Woodruff	o													
	**Galium divaricatum*	Slender Bedstraw	o	o												
	Galium gaudichaudii	Rough Bedstraw					o									
	**Galium murale*	Small Bedstraw													o	
Rutaceae	*Geijera parviflora*	Wilga	f	o		f			f					f	f	
Sapindaceae	*Alectryon oleifolius*	Western Rosewood	o			o	o		o							
	Dodonaea viscosa subsp. *cuneata*	Sticky Hop-bush	o			o										
	Dodonaea viscosa subsp. *mucronata*	Broad-leaf Hop-bush	o												o	f
Scrophulariaceae	*Mimulus prostratus*	Small Monkey Flower		o												
	**Orobanche minor*	Lesser Broomrape	f	o		f					o				o	
	Veronica plebeia	Trailing Speedwell			o		o				o					
Solanaceae	*Nicotiana simulans*	Native Tobacco	o	o		o			o	o						
	Solanum ellipticum	Velvet Potato-bush	o			o										
	Solanum esuriale	Quena													o	
	Solanum ferocissimum	Spiny Potato-bush				o										
	**Solanum nigrum*	Black-berry Nightshade		o						o					o	
Stackhousiaceae	*Stackhousia monogyna*	Creamy Candles	c			c	c	c	f	f		f				
	Stackhousia muricata	Western Stackhousia												o		
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*	Kurrajong	o	o	o	o	o	o		o					o	
	Brachychiton populneus subsp. *trilobus*	Kurrajong							o							

Family	Scientific Name	Common Name	Sample Site													
			F1	F2	S1	S2	S3	S4	S5	S6	S7	S8	S9	R1	R2	R3
Thymelaeaceae	*Pimelea simplex* subsp. *simplex*	Desert Rice-bush					o									o
Verbenaceae	**Verbena officinalis*	Common Verbena	o													
LILIIDAE		**Monocotyledons**														
Anthericaceae	*Dichopogon fimbriatus*	Nodding Chocolate Lily	c	f		c										
	Thysanotus tuberosus subsp. *tuberosus*	Common Fringe-lily	f	f			o									
	Tricoryne elatior	Yellow Rush-lily	f	f	f			o			o	o				
Asphodelaceae	*Bulbine semibarbata*	Leek Lily	f	f	o			o	f							
Cyperaceae	*Carex inversa*	Knob Sedge		o	o						f					
	Cyperus concinnus			o												
	Cyperus fulvus				o											
	Cyperus rigidellus			o												
Juncaceae	**Juncus bufonius*	Toad Rush		o												
	Juncus remotiflorus			o	o						f					
	Juncus subsecundus	Finger Rush		f							o					
Lomandraceae	*Lomandra cylindrica*		o													
	Lomandra filiformis subsp. *coriacea*	Wattle Mat-rush	o													
	Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush												f	f	
	Lomandra multiflora	Many-flowered Mat-rush	o	o					o							
	Lomandra patens	Irongrass					o									
	Lomandra spp.	Mat-rushes			o	o		o			o					
Orchidaceae	*Microtis unifolia*	Common Onion Orchid		o												o
	Pterostylis mutica	Midget Greenhood												o	o	
Phormiaceae	*Dianella longifolia*	Smooth Flax-lily	o	o	o		o							o		
	Dianella revoluta	Spreading Flax-lily	o			o								o		
Poaceae	*Agrostis avenacea* var. *avenacea*		f	f	f											o
	Amphipogon caricinus var. *caricinus*	Long Greybeard Grass				o										
	Aristida behriana	Bunch Wiregrass	f			f					o					
	Aristida jerichoensis var. *subspinulifera*	Jericho Wiregrass	f		f	o			f							
	Aristida leichhardtiana		o	o	o											
	Aristida ramosa var. *scaberula*			o												

Family	Scientific Name	Common Name	Sample Site													
			F1	**F2**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**R1**	**R2**	**R3**
	Aristida vagans	Threeawn speargrass		o	o	o			f							
	Austrodanthonia auriculata	Lobed Wallaby Grass	o													
	Austrodanthonia caespitosa	White Top	c	a				o		f		c		f	f	
	Austrodanthonia eriantha	Hill Wallaby Grass				o			c			o	f	f		
	Austrodanthonia linkii var. *fulva*	Wallaby Grass		f	o		c			o				o		
	Austrodanthonia longifolia	Long-leaved Wallaby Grass	c								o				o	
	Austrodanthonia setacea	Small-flowered Wallaby Grass	o													
	Austrostipa aristiglumis	Plains Grass	f		o	o					o					
	Aistrostipa blackii	Crested Speargrass													f	
	Austrostipa densiflora	Foxtail Speargrass	f		o	o							f			
	Austrostipa nodosa	Speargrass												f		f
	Austrostipa scabra subsp. *scabra*	Rough Speargrass	f			f	c	c	c	c	c	a	f	f	f	
	**Avena barbata*	Bearded Oats													o	
	**Avena fatua*	Wild Oats	o				o									
	Bothriochloa decipiens	Pitted Bluegrass	f	f		o					f				o	
	**Briza minor*	Shivery Grass		o							f					
	**Bromus cartharticus*	Prairie Grass									c					
	**Bromus diandrus*	Great Brome														o
	**Bromus molliformis*	A Soft Brome		o							o					o
	Chloris truncata	Windmill Grass	o			o					f					o
	Cynodon dactylon	Couch Grass	o	o												o
	Dichelachne micrantha	Shorthair Plumegrass	f	f		f	f			f						
	Digitaria hystrichoides	Curly Umbrella Grass	o	o							o					
	Elymus scaber	Common Wheatgrass	f	f	f	f	f		f	f	f					
	Enneapogon gracilis	Slender Nineawn													o	
	Enneapogon intermedius	Tall Bottlewashers														f
	Enteropogon acicularis	Curly Windmill Grass	o			o					o					
	Eragrostis elongata	Clustered Lovegrass	f	f	f											
	Eragrostis lacunaria	Purple Lovegrass		f									f			
	**Hordeum leporinum*	Barley Grass	o	o						c						
	**Lolium loliaceum*	Stiff Ryegrass													f	
	Panicum effusum	Hairy Panic			f											
	Panicum queenslandicum var. *queenslandicum*	Yadbila Grass	o	f	o	f		o	o							
	Panicum subxerophilum	Gilgai Grass														c
	Paspalidium constrictum	Knottybutt Grass		o												
	**Paspalum dilatatum*	Paspalum		o												
	**Pentaschistis airoides*	False Hairgrass	f	f	f	f	f			f	f					
	**Phalaris paradoxa*	Paradoxa Grass	o	o			f									
	Poa sieberiana var. *hirtella*		o	o					f	f				o		
	**Rostraria cristata*	Annual Cat's Tail	f	f	f	f	f	f	f	f	f	f				o

Family	Scientific Name	Common Name	Sample Site													
			F1	**F2**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**R1**	**R2**	**R3**
	Setaria paspalidioides			o												
	Sporobolus caroli	Fairy Grass								o						o
	Themeda australis	Kangaroo Grass	o	o							f					
	Thyridolepis mitchelliana	Mulga Grass	o										o			
	**Vulpia bromoides*	Squirrel-tail Fescue	f													
	**Vulpia muralis*		c	c	c	c	c	c	c	c	c	c				
	**Vulpia myuros*	Rat’s Tail Fescue	f													

Code for abundance: a = abundant; c = common; f = frequent; o = occasional

ATTACHMENT I-B2

VASCULAR PLANT SPECIES FOUND ON SURVEY SITES ON THE WATER PIPELINE ROUTE

ATTACHMENT I-B2 Vascular Plant Species Found at Sample Sites on the Water Pipeline Route.

Asterisk denotes introduced species

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			Pipeline																				
			63	67	68	1	2	2a	3	4	4a	5	5a	6	7	8	9	10	11	11a	12	12a	13	14	15	52
PTERIDOPHYTES		**Ferns**																								
Marsiliaceae	*Marsilea drummondii*	Common Nardoo	x	x	x				x																	
Sinopteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	Rock Fern															x	x	x	x	x	x		x		x
CONIFEROPSIDA																										
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine											x				x	x	x		x	x		x	x	
MAGNOLIOPSIDA		**Flowering Plants**																								
MAGNOLIIDAE		**Dicotyledons**																								
Acanthaceae	*Rostellularia adscendens* subsp. *adscendens* var. *pogonanthera*	Pink Tongues																								x
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	x	x	x						x														x	
	Ptilotus spathulatus	Pussy-tails																	x							
Apiaceae	*Daucus glochidiatus* Form D	Native Carrot										x										x				
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo																x								
Asteraceae	**Arctotheca calendula*	Capeweed				x		x		x	x	x		x	x	x		x					x	x		
	Bracteantha bracteata	Golden Everlasting											x		x	x	x	x		x	x	x		x		x
	Bracteantha viscosa	Sticky Everlasting																	x		x					
	Calotis cuneifolia	Purple Burr-daisy											x		x		x		x	x						x
	Calotis lappulacea	Yellow Burr-daisy											x			x	x	x	x		x		x	x		
	Calotis scabiosifolia var. *scabiosifolia*	Rough Burr-daisy														x										
	Calotis scapigera	Tufted Burr-daisy	x	x		x			x																	
	**Carduus nutans*	Nodding Thistle														x										
	**Carduus pycnocephalus*	Slender Thistle						x															x		x	
	**Carthamus lanatus*	Saffron Thistle		x												x	x	x	x				x	x	x	x
	Cassinia laevis	Cough Bush																				x				
	Cassinia uncata	Sticky Cassinia													x											
	**Centaurea melitensis*	Maltese Cockspur																	x							x
	Centipeda cunninghamii	Common Sneezeweed			x							x									x	x				

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			Pipeline																				
			63	67	68	1	2	2a	3	4	4a	5	5a	6	7	8	9	10	11	11a	12	12a	13	14	15	52
	Centipeda thespidioides	Desert Sneezeweed									x															
	Chrysocephalum apiculatum	Yellow Buttons																	x			x				
	**Cirsium vulgare*	Spear Thistle		x	x			x																		
	**Conyza bonariensis*	Flaxleaf Fleabane																								x
	Cymbonotus sp.	Bear's Ear																			x					
	Gnaphalium sphaericum	A Cudweed	x		x																					
	**Hedypnois rhagodioloides* subsp. *cretica*	Creton Weed						x								x		x								
	Hyalosperma semisterile																		x							
	**Hypochaeris glabra*	Smooth Catsear						x			x	x		x	x	x	x				x	x	x	x		
	**Hypochaeris radicata*	Catsear									x															
	**Lactuca saligna*	Willow-leaved Lettuce		x	x																					
	**Lactuca serriola*	Prickly Lettuce	x		x	x		x	x			x	x										x			X
	Minuria leptophylla	Minnie Daisy											x		x				x							
	**Onopordum acanthium* subsp. *acanthium*	Scotch Thistle				x																				
	Ozothamnus diosmifolius	White Dogwood																			x	x				
	**Podospermum resedifolium*	Scorzonera					x	x		x																
	Pseudognaphalium luteoalbum	Jersey Cudweed									x															
	Rhodanthe floribunda	Common White Sunray				x					x	x			x				x							
	Senecio quadridentatus	Cotton Fireweed		x																						
	**Silybum marianum*	Variegated Thistle			x				x																	
	**Sonchus asper* subsp. *glaucescens*	Prickly Sowthistle			x			x	x	x	x															
	**Sonchus oleraceus*	Common Sowthistle			x	x			x			x					x		x		x	x		x	x	x
	**Taraxacum officinale*	Dandelion														x							x	x		
	Triptilodiscus pygmaeus	Common Sunray														x			x			x				
	Vittadinia cuneata	A Fuzzweed														x	x	x				x				
	Vittadinia cuneata var. *hirsuta*	A Fuzzweed		x						x			x	x						x	x			x		x
	Vittadinia gracilis	A Fuzzweed				x															x					
	Vittadinia pustulata	A Fuzzweed								x																
	**Xanthium occidentale*	Noogoora Burr			x																				x	
	**Xanthium spinosum*	Bathurst Burr		x	x	x	x																			
Boraginaceae	**Echium plantagineum*	Paterson's Curse		x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x	x
Brassicaceae	**Lepidium africanum*	Common Peppercress		x		x				x	x							x						x	x	x
	**Rapistrum rugosum*	Turnip Weed				x	x	x	x	x	x	x														
	**Sisymbrium irio*	London Rocket																						x		
	**Sisymbrium orientale*	Indian Hedge Mustard	x					x		x		x					x	x						x		

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			Pipeline																				
			63	67	68	1	2	2a	3	4	4a	5	5a	6	7	8	9	10	11	11a	12	12a	13	14	15	52
Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell													x		x	x	x				x	x		x
	Wahlenbergia gracilis	Sprawling Aust. Bluebell														x							x			
	Wahlenbergia luteola														x									x		
	Wahlenbergia stricta subsp. *alterna*	Tall Bluebell											x		x											
	Wahlenbergia stricta subsp. *stricta*	Tall Bluebell													x											
Capparaceae	*Apophyllum anomalum*	Warrior Bush							x									x								
Caryophyllaceae	**Petrorhagia velutina*	Velvet Pink														x			x							
Casuarinaceae	*Allocasuarina luehmannii*	Bulloak																					x		x	
	Casuarina cristata	Belah																				x				
Chenopodiaceae	*Atriplex spinibractea*	Spiny-fruit Saltbush											x					x								
	Chenopodium desertorum subsp. *microphyllum*	Desert Goosefoot		x									x		x		x	x		x	x					
	Chenopodium nitrariaceum	Nitre Goosefoot				x				x																
	Einadia hastata	Saloop																	x	x		x		x		
	Einadia nutans	Climbing Saltbush							x						x		x	x		x	x	x	x	x		
	Einadia polygonoides																									x
	Enchylaena tomentosa	Ruby Saltbush																								x
	Maireana humillima													x												
	Salsola kali var. *kali*	Buckbush											x													
	Sclerolaena birchii	Galvanised Burr		x			x																			
	Sclerolaena brachyptera	Short-winged Copperburr												x												
	Sclerolaena diacantha	Grey Copperburr											x				x	x	x							
	Scleolaena muricata var. *villosa*	Black Rolypoly															x	x		x				x		x
Convolvulaceae	*Convolvulus erubescens*	Pink Bindweed													x	x	x						x	x		x
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed			x																					
Fabaceae																										
Caesalpinioideae	*Senna artemisioides* subsp. *filifolia*	Silver Cassia											x				x	x	x		x		x			
Faboideae	*Glycine tabacina*	Variable Glycine																		x						
	**Lupinus angustifolius`*	Narrow-leaved Lupin																					x			
	**Medicago laciniata*	Cut-leaved Medic											x													
	**Medicago minima*	Woolly Burr Medic					x	x				x	x	x			x	x					x	x		

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			Pipeline																				
			63	67	68	1	2	2a	3	4	4a	5	5a	6	7	8	9	10	11	11a	12	12a	13	14	15	52
	**Medicago polymorpha*	Burr Medic	x	x																						
	**Medicago praecox*	Small-leaved Burr Medic				x												x								
	**Medicago truncatula*	Barrel Medic																					x			
	Psoralea tenax	Emu-foot	x																							
	**Trifolium angustifolium*	Narrow-leaved Clover				x					x	x											x			x
	**Trifolium arvense*	Haresfoot Clover								x	x	x				x										x
	**Trifolium campestre*	Hop Clover									x					x							x			x
	**Trifolium glomeratum*	Clustered Clover						x				x						x							x	
	**Trifolium hirtum*	Rose Clover						x		x						x		x					x	x		
	**Trifolium repens*	White Clover				x		x				x														
	**Trifolium tomentosum*	Woolly clover				x		x			x	x														
Mimosoideae	*Acacia deanei* subsp. *deanei*	Deanes Wattle															x		x	x	x		x			
	Acacia decora	Western Golden Wattle																		x						
	Acacia doratoxylon	Currawang													x					x						
	Acacia hakeoides	Western Black Wattle															x							x		
	Acacia pendula	Weeping Myall							x																	
Fumariaceae	**Fumaria bastardii*	Bastard’s Fumitory														x										
Geraniaceae	*Erodium crinitum*	Blue Storksbill														x						x				
	Geranium solanderi	Native Geranium																							x	
Goodeniaceae	*Goodenia cycloptera*	Serrated Goodenia											x		x		x		x	x						
	Goodenia fascicularis	Silky Goodenia					x																			
	Goodenia hederacea var. *hederacea*	Forest Goodenia													x				x	x		x				
	Goodenia heteromera	Spreading Goodenia	x																							
	Goodenia pinnatifida	Scrambled Eggs											x					x			x		x	x		
Haloragaceae	*Gonocarpus elatus*	Hill Raspwort													x							x				
Lamiaceae	**Marrubium vulgare*	Horehound																			x					
	**Salvia verbenaca*	Wild Sage								x				x		x			x					x	x	x
Linaceae	*Linum marginale*	Native Flax														x										x
Lobeliaceae	*Pratia concolor*	Poison Pratia	x		x						x															

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			Pipeline																				
			63	67	68	1	2	2a	3	4	4a	5	5a	6	7	8	9	10	11	11a	12	12a	13	14	15	52
Loranthaceae	*Amyena linophyllum* subsp. *orientale*									x																
Lythraceae	*Lythrum hyssopifolia*	Hyssop Loosestrife									x															x
Malvaceae	*Sida corrugata*	Corrugated Sida											x					x			x					
	Sida cunninghamii	Ridge Sida															x		x	x						
	**Malva parviflora*	Small-flowered Mallow						x															x		x	
Myoporaceae	*Eremophila longifolia*	Berrigan															x									
	Eremophila mitchellii	Budda							x				x					x								
	Myoporum montanum	Western Boobialla																			x					
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum		x	x			x	x		x	x														
	Eucalyptus dealbata	Tumbledown Gum													x											
	Eucalyptus dwyeri	Dwyer's Red Gum															x			x		x				
	Eucalyptus microcarpa	Grey Box							x				x		x		x	x	x		x		x	x	x	
	Eucalyptus populnea subsp. *bimbil*	Bimble Box			x				x				x				x	x	x				x			
	Eucalyptus sideroxylon	Ironbark																		x		x				
	Leptospermum divaricatum																					x				
Oxalidaceae	*Oxalis chnoodes*															x	x									
	Oxalis perennans							x	x						x			x	x	x		x				
	Oxalis spp.																				x					
Plantaginaceae	*Plantago cunninghamii*	Sago-weed																	x		x				x	
	Plantago hispida	Plantain																	x							
Polygonaceae	*Muehlenbeckia florulenta*	Lignum	x	x							x	x														
	Persicaria decipiens	Slender Knotweed									x	x														
	Persicaria prostrata	Creeping Knotweed									x	x														
	**Polygonum aviculare*	Wireweed	x																							
	**Polygonum plebeium*	Small Knotweed									x															
	Rumex brownii	Swamp Dock		x	x			x																		
	**Rumex crispus*	Curled Dock	x	x	x	x		x	x	x													x			x
	Rumex tenax	Shiny Dock				x					x															
Primulaceae	**Anagallis arvensis*	Blue & Scarlet Pimpernel																	x							x

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			**Pipeline**																				
			63	**67**	**68**	**1**	**2**	**2a**	**3**	**4**	**4a**	**5**	**5a**	**6**	**7**	**8**	**9**	**10**	**11**	**11a**	**12**	**12a**	**13**	**14**	**15**	**52**
Ranunculaceae	*Ranunculus sessiliflorus* var. *sessiliflorus*	Small-flowered Buttercup							x	x																
	Ranunculus undosus	A Buttercup		x	x																					
Rubiaceae	**Galium aparine*	Goosegrass						x																		
Rutaceae	*Eriostemon difformis* subsp. *difformis*																x				x					
	Geijera parviflora	Wilga							x				x		x		x	x			x	x	x	x		
Sapindaceae	*Alectryon oleifolius*	Western Rosewood															x									
	Dodonaea heteromorpha														x				x	x		x				
	Dodonaea viscosa subsp. *mucronata*	Broad-leaf Hop-bush													x			x	x		x	x			x	
Scrophulariaceae	**Veronica peregrina*	Wandering Speedwell							x																	
	Veronica plebeia	Trailing Speedwell											x													
Solanaceae	**Lycium ferocissimum*	African Boxthorn		x					x	x																
	Solanum esuriale	Quena		x																						x
	Solanum ferocissimum	Spiny Potato-bush													x											
	**Solanum nigrum*	Black-berry Nightshade			x						x	x														x
Stackhousiaceae	*Stackhousia monogyna*	Creamy Candles																			x					
	Stackhousia muricata	Western Stackhousia																x	x							
Sterculiaceae	*Brachychiton populneus* subsp. *trilobus*	Kurrajong															x	x				x	x			
Verbenaceae	**Phyla nodiflora*	Carpet Weed	x	x	x						x															
	**Verbena bonariensis*	Purpletop			x																					
	**Verbena supina*	Trailing Verbena									x															
LILIIDAE		**Monocotyledons**																								
Colchicaceae	*Wurmbea dioica* subsp. *dioica*	Early Nancy																	x							
Cyperaceae	*Carex inversa*	Knob Sedge																			x		x	x	x	
	Cyperus gunnii subsp. *gunnii*	Flecked Flat-sedge	x																							
	Eleocharis pallens	Pale Spike-rush	x								x															
	Eleocharis plana	Ribbed Spike-rush	x						x																	
	Eleocharis pusilla	Small Spike-rush						x			x															

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			Pipeline																				
			63	67	68	1	2	2a	3	4	4a	5	5a	6	7	8	9	10	11	11a	12	12a	13	14	15	52
Juncaceae	*Juncus aridicola*	Tussock Rush				x				x													x			
	Juncus australis		x																							
	Juncus flavidus		x			x		x	x																	
	Juncus subsecundus	Finger Rush																							x	
Lomandraceae	*Lomandra effusa*	Scented Mat-rush													x	x										
	Lomandra filiformis	Wattle Mat-rush																	x							
Orchidaceae	*Diuris tricolor*	Donkey Orchid																	x							
Phormiaceae	*Dianella longifolia*	Smooth Flax-lily														x		x	x		x					
	Dianella revoluta	Spreading Flax-lily													x						x					
Poaceae	*Agrostis avenacea* var. *avenacea*			x				x	x		x															
	Amphibromus macrorhinus		x																							
	Amphibromus nervosus						x	x															x			
	Aristida behriana	Bunch Wiregrass															x	x								
	Aristida muricata														x											
	Aristida ramosa var. *scaberula*																			x	x	x				
	Austrodanthonia caespitosa	White Top												x	x		x	x			x					
	Austrodanthonia duttoniana	Brown-back Wallaby Grass	x			x		x	x																	
	Austrodanthonia eriantha	Hill Wallaby Grass													x					x		x				
	Austrodanthonia linkii var. *fulva*	Wallaby Grass								x			x					x			x			x		x
	Austrodanthonia linkii var. *linkii*	Wallaby Grass																x								
	Austrodanthonia longifolia	Long- leaved Wallaby Grass					x																			
	Austrodanthonia setacea	Small-flowered Wallaby														x			x		x		x			
	Austrostipa aristiglumis	Plains Grass	x	x	x	x																				
	Austrostipa bigeniculata	Yangabil															x									
	Austrostipa blackii	Crested Speargrass															x	x		x						
	Austrostipa densiflora	Foxtail Speargrass																				x				
	Austrostipa elegantissima	Feather speargrass																x								
	Austrostipa nodosa	Speargrass									x		x	x		x		x						x		x
	Austrostipa scabra subsp. *scabra*	Rough Speargrass													x		x	x	x	x	x	x		x		
	Austrostipa spp.	Speargrasses					x	x	x	x									x							
	**Avena barbata*	Bearded Oats						x					x													x
	**Avena fatua*	Wild Oats					x		x			x				x							x		x	
	**Avena ludoviciana*	Ludo Wild Oats														x										
	**Bromus alopecuros*									x																

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			Pipeline																				
			63	67	68	1	2	2a	3	4	4a	5	5a	6	7	8	9	10	11	11a	12	12a	13	14	15	52
	**Bromus cartharticus*	Prairie Grass																					x		x	
	**Bromus diandrus*	Great Brome				x		x				x		x									x	x	x	
	**Bromus molliformis*	A Soft Brome											x			x							x	x	x	x
	**Bromus sterilis*	Sterile Brome																						x		
	Chloris truncata	Windmill Grass	x	x						x				x												
	Chloris ventricosa	Tall Chloris																								x
	Cynodon dactylon	Couch Grass			x					x	x												x			
	Dichanthium sericeum	Queensland Bluegrass																								x
	Dichelachne micrantha	Shorthair Plumegrass																					x			
	Digitaria brownii	Cotton Panic Grass																								x
	Elymus scaber	Common Wheatgrass													x						x		x	x		
	Enteropogon acicularis	Curly Windmill Grass											x		x		x	x					x	x		
	Eragrostis lacunaria	Purple Lovegrass																				x				
	Eriochloa pseudoacrotricha	Early Spring Grass																								x
	**Hordeum glaucum*	Northern Barley Grass				x	x									x										
	**Hordeum leporinum*	Barley Grass				x								x								x		x		
	**Hordeum marinum*	Sea Barley Grass						x																		
	**Hordeum* spp.	Barley Grasses								x																
	**Lolium loliaceum*	Stiff Ryegrass				x	x															x		x		
	**Lolium multiflorum*	Italian Ryegrass				x		x																		
	**Lolium perenne*	Perennial Ryegrass				x		x			x	x						x			x		x		x	
	**Lolium rigidum*	Wimmera Ryegrass						x		x				x	x	x	x		x							
	**Lolium* spp.	Ryegrasses		x																						
	Panicum laevinode	Pepper Grass	x																							
	Panicum queenslandicum var. *queenslandicum*	Yadbila Grass								x																
	Panicum simile	Two Colour Panic																								x
	Panicum subxerophilum	Gilgai Grass	x							x	x							x			x		x			
	Paspalidium constrictum	Knottybutt Grass																								x
	Paspalidium jubiflorum	Warrego Grass			x			x				x			x											
	**Paspalum dilatatum*	Paspalum					x					x											x		x	
	**Phalaris aquatica*	Canary Grass						x				x														
	**Phalaris minor*	Lesser Canary Grass						x	x		x															
	**Phalaris paradoxa*	Paradoxa Grass				x																				
	Poa fordeana	Sweet Swamp-grass						x																		
	Themeda australis	Kangaroo Grass														x										
	Thyridolepis mitchelliana	Mulga Grass																	x	x						
	**Vulpia bromoides*	Squirrel-tail Fescue														x				x			x			
	**Vulpia muralis*																		x				x			

Family	Scientific Name	Common Name	Sample Site																							
			Borefield			Pipeline																				
			63	67	68	1	2	2a	3	4	4a	5	5a	6	7	8	9	10	11	11a	12	12a	13	14	15	52
	**Vulpia myuros*	Rat's Tail Fescue												x		x							x			
	**Vulpia* spp.				x																					x

ATTACHMENT I-B3

VASCULAR PLANT SPECIES FOUND ON SURVEY SITES ON THE GAS PIPELINE ROUTE

ATTACHMENT I-B3 Vascular Plants Found on Survey Sites on the Gas Pipeline Route

Asterisk denotes introduced species

Family	Scientific Name	Sample Site																											
		16	17	18	19	20	21	22	22a	23	24	25	26	27	28	29	30	31	31a	32	33	34	35	36	39	39a	39b	56	56a
PTERIDOPHYTES																													
Azollaceae	*Azolla* sp.												x																
Marsiliaceae	*Marsilea drummondii*								x		x	x																	
Sinopteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	x						x							x		x	x	x	x		x	x	x	x	x	x		x
CONIFEROPSIDA																													
Cupressaceae	*Callitris endlicheri*																									x	x		
	Callitris glaucophylla	x	x	x			x	x							x	x			x	x		x		x	x				
MAGNOLIOPSIDA																													
MAGNOLIIDAE																													
Acanthaceae	*Rostellularia adscendens* subsp. *adscendens* var. *pogonanthera*																				x								
Amaranthaceae	*Alternanthera denticulata*			x		x				x														x				x	x
	Ptilotus polystachys var. *polystachys*						x																						
	Ptilotus semilanatus														x														
	Ptilotus spathulatus																					x							
Apiaceae	*Daucus glochidiatus* Form D							x								x													
	Hydrocotyle laxiflora															x		x							x		x	x	
	Platysace lanceolata																								x	x			
Apocynaceae	*Parsonsia eucalyptophylla*																				x								
Asclepiadaceae	*Rhyncharrhena linearis*	x																											
Asteraceae	**Arctotheca calendula*	x			x				x	x		x	x	x	x				x				x		x				
	Brachyscome ciliaris var. *ciliaris*						x																						
	Brachyscome trachycarpa											x																	
	Bracteantha bracteata	x						x							x	x	x		x	x		x	x						
	Bracteantha viscosa															x									x	x	x		
	Calocephalus sonderi													x															

Family	Scientific Name	Sample Site																											
		16	**17**	**18**	**19**	**20**	**21**	**22**	**22a**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**31a**	**32**	**33**	**34**	**35**	**36**	**39**	**39a**	**39b**	**56**	**56a**
	Calotis cuneifolia	x		x				x							x	x	x						x	x	x	x	x	x	x
	Calotis lappulacea			x		x	x								x		x					x	x						
	Calotis scabiosifolia var. *scabiosifolia*								x	x	x																		
	Calotis scapigera												x	x															
	**Carduus pycnocephalus*												x																
	**Carthamus lanatus*	x		x											x	x	x	x		x	x	x		x					
	Cassinia laevis																								x	x			
	Cassinia uncata																									x			x
	**Centaurea melitensis*															x		x					x						
	Centipeda cunninghamii								x		x		x																
	Chrysocephalum apiculatum	x						x								x			x	x									
	Chrysocephalum semipapposum																								x				
	**Cirsium vulgare*								x																			x	
	Cotula australis																										x		
	Cymbonotus sp.																								x				
	Eclipta platyglossa								x																				
	**Hedypnois rhagodioloides* subsp. *cretica*	x					x	x	x	x			x			x	x	x			x	x							
	Hyalosperma semisterile						x	x								x													
	**Hypochaeris glabra*	x													x	x	x	x			x	x	x	x			x		
	**Hypochaeris radicata*							x				x											x						
	**Lactuca serriola*												x				x				x								
	Leptorhynchus panaetioides				x					x				x															
	Minuria integerrima													x															
	Minuria leptophylla					x	x													x									
	Olearia decurrens																									x			x
	Olearia pimeleoides															x													
	Olearia tenuifolia																								x				
	**Onopordum acanthium* subsp. *acanthium*										x																		
	Ozothamnus diosmifolius																									x	x		x
	**Podospermum resedifolium*			x	x								x	x															
	Pseudognaphalium luteoalbum												x																
	Pycnosorus chrysanthus				x	x			x	x		x		x															
	Rhodanthe floribunda	x			x	x			x											x		x							
	Senecio quadridentatus																	x			x								
	**Sonchus asper* subsp. *glaucescens*																											x	
	**Sonchus oleraceus*			x	x	x			x		x	x	x	x		x		x			x	x	x					x	
	**Taraxacum officinale*			x													x				x								
	Triptilodiscus pygmaeus						x								x	x	x					x							
	Vittadinia cuneata																x												

Family	Scientific Name	Sample Site																											
		16	17	18	19	20	21	22	22a	23	24	25	26	27	28	29	30	31	31a	32	33	34	35	36	39	39a	39b	56	56a
	Vittadinia cuneata var. *hirsuta*					x	x			x			x	x	x			x		x	x	x						x	
	Vittadinia dissecta var. *hirta*															x													
	Vittadinia gracilis		x																	x			x	x					
	Vittadinia pustulata																						x						
	Vittadinia sulcata														x														
	Vittadinia spp.	x																											
	**Xanthium occidentale*										x	x	x								x								
Boraginaceae	**Echium plantagineum*		x		x		x		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x					
	Halgania cyanea	x																											
Brassicaceae	**Hirschfeldia incana*								x									x											
	**Lepidium africanum*		x		x	x				x		x	x	x		x	x	x		x									
	**Rapistrum rugosum*								x		x																		
	**Rorippa palustris*												x																
	**Sisymbrium irio*					x		x		x						x													
	**Sisymbrium orientale*				x	x									x	x		x		x	x		x						
Campanulaceae	*Wahlenbergia communis*	x	x	x									x		x	x		x	x	x			x	x					
	Wahlenbergia luteola	x					x	x									x						x					x	
	Wahlenbergia stricta subsp. *alterna*															x			x								x	x	
	Wahlenbergia stricta subsp. *stricta*							x	x														x						
Capparaceae	*Apophyllum anomalum*			x	x	x	x			x																			
Caryophyllaceae	**Petrorhagia velutina*							x										x		x	x	x							
	**Spergularia rubra*													x															
Casuarinaceae	*Allocasuarina luehmannii*	x		x																									
	Casuarina cristata	x																											
Chenopodiaceae	*Atriplex spinibractea*					x	x			x		x		x							x	x							
	Chenopodium desertorum subsp. *microphyllum*	x								x				x	x	x	x	x		x				x					
	Chenopodium nitrariaceum				x					x		x																	
	Einadia hastata														x			x								x		x	
	Einadia nutans	x	x	x		x		x						x		x		x		x	x			x					
	Einadia nutans subsp. *nutans*																			x									
	Einadia polygonoides	x		x											x			x											
	Einadia trigonos subsp. *leiocarpa*																			x									

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	Enchylaena tomentosa														x														
	Maireana enchylaenoides	x															x	x			x								
	Maireana humillima																x			x		x		x					
	Maireana microphylla		x				x					x			x						x	x	x					x	
	Rhagodia spinescens							x							x														
	Rhagodia ulicina														x		x												
	Salsola kali var. *kali*						x							x															
	Sclerolaena diacantha	x				x	x							x			x	x											
	Scleolaena muricata var. *villosa*								x			x									x	x	x						
	Sclerolaena stelligera													x															
Convolvulaceae	*Convolvulus erubescens*							x			x				x	x	x	x		x	x	x	x						
	Convolvulus remotus				x																								
	Dichondra species A																x	x			x		x					x	x
Cucurbitaceae	**Citrullus lanatus*											x																	
	**Cucumis myriocarpus*											x											x						
Dilleniaceae	*Hibbertia riparia*																								x				
Epacridaceae	*Melichrus urceolatus*																								x	x			
Euphorbiaceae	*Chamaesyce drummondii*									x							x												
	**Euphorbia peplus*									x			x																
	Phyllanthus hirtellus Forma B							x																		x			
Fabaceae																													
Caesalpinioideae	*Senna artemisioides* subsp. *filifolia*	x		x			x								x	x	x		x		x		x						
Faboideae	*Glycine clandestina*																				x							x	
	Glycine tabacina															x													
	**Medicago laciniata*													x							x								
	**Medicago minima*				x	x			x	x	x		x	x		x	x				x	x	x						
	**Medicago polymorpha*											x		x															
	**Medicago sativa*												x																
	**Medicago truncatula*									x			x							x		x							
	Swainsona procumbens											x																	
	**Trifolium angustifolium*												x																
	**Trifolium campestre*																			x		x	x						

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	**Trifolium glomeratum*								x														x	x					
	**Trifolium hirtum*																x												
	**Trifolium repens*								x					x															
Mimosoideae	*Acacia deanei* subsp. *deanei*	x													x	x					x		x		x				
	Acacia decora							x											x						x				
	Acacia doratoxylon																x		x						x	x			x
	Acacia flexifolia																												x
	Acacia hakeoides	x																							x				x
	Acacia ligulata												x																
	Acacia lineata																									x			x
	Acacia oswaldii				x	x	x											x				x							
	Acacia pendula						x							x															
	Acacia pravifolia																								x	x			
	Acacia stenophylla								x																				
Gentianaceae	*Centaurium* sp.								x																				
Geraniaceae	*Erodium crinitum*									x	x																		
Goodeniaceae	*Dampiera lanceolata* var. *lanceolata*																								x	x			
	Goodenia cycloptera		x												x				x				x	x					
	Goodenia fascicularis													x															
	Goodenia hederacea var. *hederacea*							x								x			x				x	x	x	x			
	Goodenia heteromera																									x			
	Goodenia ovata																							x					
	Goodenia pinnatifida			x	x		x	x		x					x		x			x	x	x							
Haloragaceae	*Gonocarpus elatus*																		x						x	x	x		
Lamiaceae	**Marrubium vulgare*									x	x		x								x								
	**Salvia verbenaca*	x	x		x						x				x	x	x	x		x	x	x							
Linaceae	*Linum marginale*																x	x		x	x								
Loranthaceae	*Amyena miquelii*																						x						x
	Amyena quandang var. *quandang*			x	x	x	x	x																					x
Malvaceae	*Abutilon fraseri*																	x			x								

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	Sida corrugata	x	x			x								x	x	x	x	x			x	x	x	x				x	
	Sida cunninghamii	x						x												x			x	x				x	
	**Malva parviflora*										x																		
Myoporaceae	*Eremophila debilis*									x																			
	Eremophila deserti			x																									
	Eremophila longifolia														x										x				
	Eremophila mitchellii									x					x					x			x	x				x	
	Myoporum montanum	x		x																					x		x		x
Myrtaceae	*Eucalyptus camaldulensis*												x																
	Eucalyptus dumosa				x					x																			
	Eucalyptus dwyeri							x											x						x	x			
	Eucalyptus largiflorens								x	x			x																
	Eucalyptus microcarpa	x		x				x							x	x	x			x		x	x	x	x			x	
	Eucalyptus populnea subsp. *bimbil*	x					x			x					x	x	x	x	x	x	x		x						
	Eucalyptus sideroxylon																								x	x	x		
	Eucalyptus viridis																									x	x		x
	Leptospermum divaricatum																								x	x			
Oleaceae	*Jasminum lineare*							x	x																				
Oxalidaceae	*Oxalis perennans*	x	x		x			x						x	x			x	x		x		x	x	x				
	Oxalis spp.			x								x				x	x			x									
Pittosporaceae	*Bursaria spinosa* var. *obovata*	x																								x			
	Pittosporum phylliraeoides			x																								x	
Plantaginaceae	*Plantago cunninghamii*							x					x		x	x	x							x			x	x	
	Plantago debilis																										x		
Polygonaceae	*Muehlenbeckia florulenta*								x		x																		
	Rumex brownii			x													x				x							x	x
	**Rumex crispus*											x	x																
	Rumex tenax								x																				
Primulaceae	**Anagallis arvensis*																		x	x		x							
Proteaceae	*Hakea tephrosperma*															x													

Family	Scientific Name	Sample Site																											
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Ranunculaceae	*Myosurus minimus* var. *australis*								x																				
	Ranunculus sessiliflorus var. *sessiliflorus*																									x			
	Ranunculus pentandrus var. *platycarpus*								x																				
Rhamnaceae	*Cryptandra amara*																								x				
Rubiaceae	*Asperula conferta*	x									x						x												
	Asperula cunninghamii						x																						
Rutaceae	*Geijera parviflora*	x		x				x							x	x		x		x	x							x	
	Phebalium obcordatum																									x			
Santalaceae	*Santalum acuminatum*															x		x								x			
	Santalum lanceolatum																	x											
Sapindaceae	*Alectryon oleifolius*	x					x			x							x				x				x				
	Dodonaea heteromorpha																		x							x			
	Dodonaea viscosa subsp. *cuneata*																												x
	Dodonaea viscosa subsp. *mucronata*						x								x	x				x		x			x	x		x	
Solanaceae	**Lycium ferocissimum*			x				x							x						x								
	Solanum esuriale							x						x									x						
	Solanum ferocissimum																			x								x	
	**Solanum nigrum*												x					x										x	x
Stackhousiaceae	*Stackhousia muricata*															x			x										
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*	x																		x	x	x							
Verbenaceae	**Verbena officinalis*												x																
Zygophyllaceae	*Zygophyllum glaucum*				x																								
LILIIDAE																													
Anthericaceae	*Arthropodium minus*				x		x	x																					
Asphodelaceae	*Bulbine semibarbata*																x									x	x		

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Cyperaceae	*Carex inversa*			x						x	x	x	x					x							x			x	x
	Cyperus exaltatus												x																
	Cyperus fulvus																												x
	Eleocharis acuta								x																				
	Eleocharis plana								x																				
	Eleocharis pusilla												x																
Juncaceae	*Juncus aridicola*								x												x								
	Juncus flavidus																												x
	Juncus radula																									x			
	Juncus remotiflorus											x															x	x	
	Juncus subsecundus			x							x	x													x				
Lomandraceae	*Lomandra collina*																				x								
	Lomandra filiformis	x		x																									
	Lomandra filiformis subsp. *filiformis*																				x								
	Lomandra patens																								x				
	Lomandra spp.																		x										
Orchidaceae	*Calochilus* sp.																								x				
	Pterostylis mutica																		x										
Phormiaceae	*Dianella longifolia*			x			x	x								x			x	x									
	Dianella revoluta																								x	x			x
Poaceae	*Agrostis avenacea* var. *avenacea*												x												x				
	Amphibromus nervosus								x																				
	Aristida ramosa var. *scaberula*														x	x													
	Asutrodanthonia caespitosa	x	x			x	x								x		x		x	x	x	x	x						x
	Austrodanthonia duttoniana											x																	
	Austrodanthonia eriantha		x					x								x			x						x				
	Austrodanthonia linkii var. *fulva*			x			x		x	x															x		x	x	x
	Austrodanthonia linkii var. *linkii*														x														
	Austrodanthonia longifolia												x																
	Austrodanthonia setacea																								x				
	Austrodanthonia spp.				x																								
	Austrostipa aristiglumis								x		x	x	x																
	Austrostipa blackii	x													x						x								
	Austrostipa densiflora								x																	x			

Family	Scientific Name	Sample Site																											
		16	**17**	**18**	**19**	**20**	**21**	**22**	**22a**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**31a**	**32**	**33**	**34**	**35**	**36**	**39**	**39a**	**39b**	**56**	**56a**
	Austrostipa nodosa		x		x					x			x		x	x		x				x							
	Austrostipa scabra subsp. *scabra*					x	x	x					x		x				x			x		x		x			x
	Austrostipa setacea																										x		
	Austrostipa verticillata														x														
	Austrostipa spp.	x	x	x	x	x	x	x			x	x				x	x		x	x	x	x	x	x	x				
	**Avena barbata*	x											x		x								x						
	**Avena fatua*				x			x		x	x	x		x			x	x		x		x							
	**Avena* spp.															x			x		x								
	**Briza minor*																										x		
	**Bromus alopecuros*															x													
	**Bromus diandrus*				x				x		x	x	x		x		x	x			x								
	**Bromus molliformis*		x		x			x			x		x			x	x			x	x	x							
	**Bromus rubens*							x												x									
	**Bromus sterilis*																	x											
	Chloris truncata			x			x			x														x					
	Cynodon dactylon								x			x	x					x						x					
	Dichanthium sericeum					x																							
	Digitaria hystrichoides			x																									
	Diplachne parviflora								x																				
	Elymus scaber			x																x								x	x
	Enteropogon acicularis			x			x	x		x		x	x	x	x		x	x	x	x	x		x	x				x	
	Eragrostis lacunaria																											x	
	**Eragrostis pilosa*																											x	
	**Hordeum glaucum*								x				x																
	**Hordeum leporinum*									x																			
	**Hordeum* spp.	x	x	x	x			x			x	x		x		x	x	x		x	x		x	x					
	**Lolium loliaceum*								x				x																
	**Lolium perenne*				x	x			x			x						x				x	x						
	**Lolium rigidum*						x			x				x			x	x											
	**Lolium* spp.	x	x	x							x				x	x			x		x			x					
	Monachather paradoxa							x																					
	Panicum effusum																								x		x		
	Panicum simile																											x	
	Panicum subxerophilum	x			x	x		x	x		x					x			x				x		x	x	x		x
	Paspalidium constrictum									x								x					x					x	
	Paspilidium gracile																											x	
	Paspalidium jubiflorum																					x							
	**Paspalum dilatatum*											x																	
	**Pentaschistis airoides*		x																										

Family	**Scientific Name**	**Sample Site**																											
		16	**17**	**18**	**19**	**20**	**21**	**22**	**22a**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**31a**	**32**	**33**	**34**	**35**	**36**	**39**	**39a**	**39b**	**56**	**56a**
	**Phalaris paradoxa*								x		x	x																	
	Poa fordeana								x																				
	**Rostraria cristata*															x													
	Sporobolus caroli									x																			
	Themeda australis							x							x			x	x	x	x	x					x		
	Thyridolepis mitchelliana							x							x	x			x		x								
	**Vulpia bromoides*							x												x									
	**Vulpia muralis*							x																					
	**Vulpia* spp.		x							x			x																
Typhaceae	*Typha* sp.												x																

ATTACHMENT I-B4

VASCULAR PLANTS FOUND ON SURVEY SITES ON ROUTE 64, FIFIELD BYPASS, LIMESTONE QUARRY AND RAIL SIDING

ATTACHMENT I-B4 Vascular Plants Found on Survey Sites on Route 64, Fifield Bypass, the Limestone Quarry and Rail Siding.

Asterisk denotes introduced species

Family	Scientific Name	Common Name	Sample Site											
			Route 64								Bypass			
			44	45	46	47	48	49	LQ	RS	51	64	65	66
PTERIDOPHYTES		**Ferns**												
Marsiliaceae	*Marsilea drummondii*	Common Nardoo									x			
Sinopteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	Rock Fern		x		x				x				
CONIFEROPSIDA														
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	x	x	x	x	x	x	x	x		x		
MAGNOLIOPSIDA		**Flowering Plants**												
MAGNOLIIDAE		**Dicotyledons**												
Acanthaceae	*Rostellularia adscendens* subsp. *adscendens* var.	Pink Tongues					x	x						
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed									x			
Anacardiaceae	**Schinus areira*	Pepper Tree												x
Asteraceae	**Arctotheca calendula*	Capeweed	x		x	x								
	**Bidens subalternans*	Greater Cobbler's Tacks												x
	Bracteantha bracteata	Golden Everlasting			x	x		x	x	x		x		
	Bracteantha viscosa	Sticky Everlasting	x											
	Calotis cuneifolia	Purple Burr-daisy	x		x			x	x	x	x	x		
	Calotis hispidula								x					
	Calotis lappulacea	Yellow Burr-daisy				x	x	x	x	x				
	**Carthamus lanatus*	Saffron Thistle		x	x	x	x	x	x	x				
	Cassinia uncata	Sticky Cassinia										x		
	**Centaurea melitensis*	Maltese Cockspur	x				x		x	x				x
	Centipeda thespidioides	Desert Sneezeweed							x					
	Centipeda sp.	Sneezeweed		x										
	**Chondrilla juncea*	Skeleton Weed					x							
	Chrysocephalum semipapposum	Clustered Everlasting		x										
	**Cirsium vulgare*	Spear Thistle							x	x				
	**Conyza bonariensis*	Flaxleaf Fleabane							x	x				
	Cymbonotus sp.	Bear’s Ear								x				
	Gnaphalium sphaericum	A Cudweed							x					

Family	Scientific Name	Common Name	Sample Site											
			Route 64								Bypass			
			44	45	46	47	48	49	LQ	RS	51	64	65	66
	**Hedypnois rhagodioloides* subsp. *cretica*	Creton Weed	x	x	x		x	x						
	**Hypochaeris glabra*	Smooth Catsear			x				x	x		x	x	
	**Hypochaeris radicata*	Catsear				x			x					
	**Lactuca serriola*	Prickly Lettuce							x	x				
	Minuria leptophylla	Minnie Daisy		x				x		x				
	**Onopordum acanthium* subsp. *acanthium*	Scotch Thistle							x					
	**Podospermum resedifolium*	Scorzonera					x							
	Pseudognaphalium luteoalbum	Jersey Cudweed							x					
	Senecio quadridentatus	Cotton Fireweed			x					x				
	**Silybum marianum*	Variegated Thistle							x					
	Solenogyne bellioides												x	
	**Sonchus asper* subsp. *glaucescens*	Prickly Sowthistle							x	x				x
	**Sonchus oleraceus*	Common Sowthistle	x		x			x	x	x				
	**Taraxacum officinale*	Dandelion							x					
	Triptilodiscus pygmaeus	Common Sunray					x							
	Vittadinia cuneata	A Fuzzweed			x									
	Vittadinia cuneata var. *hirsuta*	A Fuzzweed	x				x		x	x	x			x
	Vittadinia gracilis	A Fuzzweed								x				
	Vittadinia pterochaeta	Rough Fuzzweed					x							
	Vittadinia sulcata	A Fuzzweed				x								
	**Xanthium occidentale*	Noogoora Burr							x	x				
	**Xanthium spinosum*	Bathurst Burr							x	x				x
Boraginaceae	**Echium plantagineum*	Paterson’s Curse		x		x	x	x	x	x			x	x
Brassicaceae	**Capsella bursa-pastoris*	Shepherds Purse							x					
	**Hirschfeldia incana*	Hairy Brassica												x
	**Lepidium africanum*	Common Peppercress			x	x			x	x	x			x
	Lepidium pseudohyssopifolium	Peppercress							x					
	**Rapistrum rugosum*	Turnip Weed												x
	**Sisymbrium irio*	London Rocket							x					
	**Sisymbrium orientale*	Indian Hedge Mustard			x		x		x					
Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell	x	x	x	x	x	x						
	Wahlenbergia luteola										x			
Capparaceae	*Apophyllum anomalum*	Warrior Bush	x								x			

Family	Scientific Name	Common Name	Sample Site											
			Route 64								Bypass			
			44	45	46	47	48	49	LQ	RS	51	64	65	66
Caryophyllaceae	**Petrorhagia velutina*	Velvet Pink			x									
	**Spergularia rubra*	Sandspurrey	x								x			
Casuarinaceae	*Allocasuarina luehmannii*	Bulloak	x								x	x		
Chenopodiaceae	*Atriplex spinibractea*	Spiny-fruit Saltbush	x		x	x				x	x			x
	Chenopodium desertorum subsp. *microphyllum*	Desert Goosefoot				x					x			
	Einadia nutans	Climbing Saltbush			x	x	x	x						
	Einadia nutans subsp. *linifolia*	Climbing Saltbush								x	x		x	
	Einadia nutans subsp. *nutans*	Climbing Saltbush			x							x		
	Einadia polygonoides													x
	Enchylaena tomentosa	Ruby Saltbush									x	x	x	
	Maireana enchylaenoides	Wingless Fissure-weed	x	x		x		x						
	Maireana humillima				x	x				x	x			
	Maireana microphylla	Eastern Cotton Bush			x	x				x	x	x		x
	Salsola kali var. *kali*	Buckbush	x						x	x	x			
	Sclerolaena birchii	Galvanised Burr											x	x
	Sclerolaena diacantha	Grey Copperburr	x				x				x			
Clusiaceae	**Hypericum perforatum*	St John's Wort		x						x				
Convolvulaceae	*Convolvulus erubescens*	Pink Bindweed	x	x		x		x	x	x	x			
	Convolvulus remotus						x							
	Dichondra repens								x	x		x		
	Dichondra species A				x		x	x	x		x			
Cucurbitaceae	**Citrullus lanatus*	Bitter Melon							x	x				x
	**Cucumis myriocarpus*	Paddy Melon							x	x				x
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed	x								x			
Fabaceae														
Caesalpinioideae	*Senna artemisioides* subsp. *filifolia*	Silver Cassia			x	x	x	x		x				
Faboideae	**Astragalus hamosus*	Yellow Milk Vetch					x		x					
	Desmodium varians	Slender Tick Trefoil								x				
	Glycine clandestina	Twining Glycine		x	x									
	Glycine tabacina	Variable Glycine	x	x			x				x			

Family	Scientific Name	Common Name	Sample Site											
			Route 64								Bypass			
			44	45	46	47	48	49	LQ	RS	51	64	65	66
	**Medicago laciniata*	Cut-leaved Medic			x				x					
	**Medicago minima*	Woolly Burr Medic	x	x			x	x						
	**Medicago polymorpha*	Burr Medic			x				x					
	**Medicago praecox*	Small-leaved Burr Medic				x		x						
	**Medicago sativa*	Lucerne							x					
	**Medicago truncatula*	Barrel Medic		x										
	**Trifolium angustifolium*	Narrow-leaved Clover			x			x		x				
	**Trifolium arvense*	Haresfoot Clover			x	x			x					
	**Trifolium campestre*	Hop Clover			x				x					
	**Trifolium glomeratum*	Clustered Clover							x					
	**Trifolium hirtum*	Rose Clover			x	x								
	**Trifolium repens*	White Clover							x					
Mimosoideae	*Acacia deanei* subsp. *deanei*	Deanes Wattle		x	x	x				x		x		
	Acacia decora	Western Golden Wattle		x	x			x		x				
	Acacia doratoxylon	Currawang										x		
	Acacia hakeoides	Western Black Wattle	x							x		x		
	Acacia melvillei	Yarran							x					
Fumariaceae	**Fumaria bastardii*	Bastard’s Fumitory							x					
Geraniaceae	*Erodium crinitum*	Blue Storksbill								x				
Goodeniaceae	*Goodenia cycloptera*	Serrated Goodenia								x				
	Goodenia hederacea var. *hederacea*	Forest Goodenia										x		
	Goodenia pinnatifida	Scrambled Eggs	x	x	x	x	x	x	x		x			
	Velleia paradoxa	Spur Velleia		x							x			
Haloragaceae	*Gonocarpus elatus*	Hill Raspwort										x		
	Haloragis aspera	Rough Raspwort							x	x				
Lamiaceae	**Marrubium vulgare*	Horehound					x	x	x	x				x
	Mentha satureioides	Native Pennyroyal								x				
	**Salvia verbenaca*	Wild Sage	x	x	x	x	x	x	x	x				x
Lobeliaceae	*Pratia concolor*	Poison Pratia								x				
Malvaceae	*Sida corrugata*	Corrugated Sida			x			x	x	x	x			x

Family	Scientific Name	Common Name	Sample Site											
			Route 64								Bypass			
			44	45	46	47	48	49	LQ	RS	51	64	65	66
	Sida cunninghamii	Ridge Sida		x				x		x	x			
	Lavatera plebeia	Australian Hollyhock							x					
	**Malva parviflora*	Small-flowered Mallow							x					x
Myoporaceae	*Eremophila mitchellii*	Budda	x								x		x	
	Myoporum montanum	Western Boobialla								x				
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Gum										x		
	Eucalyptus microcarpa	Grey Box	x			x	x			x	x	x	x	x
	Eucalyptus populnea subsp. *bimbil*	Bimble Box		x	x		x	x	x	x				x
	Eucalyptus sideroxylon	Ironbark										x		
Oxalidaceae	*Oxalis chnoodes*			x		x								
	Oxalis perennans		x				x				x			
Pittosporaceae	*Pittosporum phylliraeoides*	Weeping Pittosporum							x		x			
Plantaginaceae	*Plantago cunninghamii*	Sago-weed	x	x										
	Plantago hispida	Plantain		x										
	**Plantago lanceolata*	Lamb's Tongue												x
Polygonaceae	**Polygonum aviculare*	Wireweed							x					
	Rumex brownii	Swamp Dock												x
	**Rumex crispus*	Curled Dock							x	x				
Primulaceae	**Anagallis arvensis*	Blue & Scarlet Pimpernel		x										
Resedaceae	**Reseda luteola*	Wild Mignonette		x					x					
Rubiaceae	*Asperula cunninghamii*	Twining Woodruff	x	x							x			
	**Galium divaricatum*	Slender Bedstraw								x				
Rutaceae	*Geijera parviflora*	Wilga	x	x	x			x		x		x	x	x
Sapindaceae	*Alectryon oleifolius*	Western Rosewood	x		x		x		x					
	Dodonaea viscosa subsp. *cuneata*	Sticky Hop-bush								x				
	Dodonaea viscosa subsp. *mucronata*	Broad-leaf Hop-bush	x		x						x			x

Family	Scientific Name	Common Name	Sample Site											
			Route 64								Bypass			
			44	45	46	47	48	49	LQ	RS	51	64	65	66
Solanaceae	**Lycium ferocissimum*	African Boxthorn	x			x					x		x	
	Solanum esuriale	Quena		x			x		x	x				
	**Solanum nigrum*	Black-berry Nightshade				x			x					x
Stackhousiaceae	*Stackhousia muricata*	Western Stackhousia					x	x						
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*	Kurrajong							x					
	Brachychiton populneus subsp. *trilobus*	Kurrajong			x			x	x					
Thymelaeaceae	*Pimelea curviflora* var. *sericea*								x					
LILIIDAE		**Monocotyledons**												
Cyperaceae	*Carex inversa*	Knob Sedge			x	x			x	x	x			
	Cyperus gracilis										x			
Juncaceae	*Juncus subsecundus*	Finger Rush							x					
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush		x		x	x							
	Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush		x	x					x				x
	Lomandra patens	Irongrass								x				
Phormiaceae	*Dianella longifolia*	Smooth Flax-lily	x	x	x	x		x	x	x			x	
	Dianella revoluta	Spreading Flax-lily			x									
Poaceae	*Agrostis avenacea* var. *avenacea*								x					
	Aristida behriana	Bunch Wiregrass					x			x		x		
	Aristida jerichoensis var. *subspinulifera*	Jericho Wiregrass								x		x		
	Aristida ramosa var. *scaberula*								x					
	Aristida ramosa var. *speciosa*											x		
	Austrodanthonia auriculata	Lobed Wallaby Grass						x						
	Austrodanthonia caespitosa	White Top		x	x	x	x	x	x	x	x			x
	Austrodanthonia eriantha	Hill Wallaby Grass										x		
	Austrodanthonia linkii var. *fulva*	Wallaby Grass							x	x	x	x	x	
	Austrodanthonia longifolia	Long- leaved Wallaby Grass											x	
	Austrodanthonia richardsonii	Wallaby Grass								x				
	Austrodanthonia setacea	Small-flowered Wallaby	x							x				
	Austrodanthonia spp.	Wallaby Grasses		x										
	Austrostipa blackii	Crested Speargrass								x	x			

Family	Scientific Name	Common Name	Sample Site											
			Route 64								Bypass			
			44	45	46	47	48	49	LQ	RS	51	64	65	66
	Austrostipa densiflora	Foxtail Speargrass										x		
	Austrostipa nodosa	Speargrass		x	x		x		x		x			
	Austrostipa scabra subsp. *scabra*	Rough Speargrass	x			x		x	x	x	x			s
	Austrostipa trichophylla	A Speargrass							x					
	Austrostipa tuckeri	Tucker's Speargrass						x						
	Austrostipa verticillata	Slender Bamboo Grass							x					
	Austrostipa spp.	Speargrasses	x	x	x		x		x					
	**Avena barbata*	Bearded Oats		x		x		x	x					x
	**Avena fatua*	Wild Oats			x	x		x	x					
	**Avena ludoviciana*	Ludo Wild Oats							x	x				
	**Bromus diandrus*	Great Brome		x	x	x	x		x	x				
	**Bromus molliformis*	A Soft Brome			x	x		x	x	x				
	Chloris truncata	Windmill Grass	x						x		x		x	
	Cynodon dactylon	Couch Grass												x
	Dichanthium sericeum	Queensland Bluegrass								x	x			x
	Elymus scaber	Common Wheatgrass				x					x			
	Enteropogon acicularis	Curly Windmill Grass	x		x		x			x	x		x	
	**Eragrostis cilianensis*	Stink Grass							x					
	Eragrostis lacunaria	Purple Lovegrass									x	x	x	
	Eragrostis parviflora	Weeping Lovegrass									x			
	Eriochloa pseudoacrotricha	Early Spring Grass									x			
	**Hordeum glaucum*	Northern Barley Grass					x							
	**Hordeum leporinum*	Barley Grass							x					
	**Hordeum* spp.	Barley Grasses	x		x	x	x		x					
	**Lolium loliaceum*	Stiff Ryegrass	x				x	x	x					
	**Lolium multiflorum*	Italian Ryegrass		x	x									
	**Lolium perenne*	Perennial Ryegrass				x			x	x				
	**Lolium rigidum*	Wimmera Ryegrass							x					
	**Lolium* spp.	Ryegrasses				x			x					
	Monachather paradoxa	Bandicoot Grass									x			
	Panicum effusum	Hairy Panic	x						x		x			x
	Panicum queenslandicum var. *queenslandicum*	Yadbila Grass											x	x
	Panicum simile	Two Colour Panic								x		x		
	Panicum subxerophilum	Gilgai Grass	x	x										
	Paspalidium constrictum	Knottybutt Grass				x	x	x			x			x
	Paspalidium distans													x
	**Paspalum dilatatum*	Paspalum			x				x	x				x
	Poa labillardieri			x										

Family	Scientific Name	Common Name	Sample Site											
			Route 64								Bypass			
			44	45	46	47	48	49	LQ	RS	51	64	65	66
	**Rostraria cristata*	Annual Cat's Tail	x											
	Sporobolus caroli	Fairy Grass	x								x			
	Themeda australis	Kangaroo Grass												x
	**Triticum aestivum*	Wheat							x					
	**Vulpia bromoides*	Squirrel-tail Fescue			x									
	**Vulpia muralis*		x											
	**Vulpia myuros*	Rat's Tail Fescue				x								
	**Vulpia* spp.			x					x					

ATTACHMENT I-C

FLORA THREATENED SPECIES ASSESSMENT
EIGHT PART TESTS OF SIGNIFICANCE

ATTACHMENT I-C

SYERSTON NICKEL-COBALT PROJECT

FLORA - THREATENED SPECIES ASSESSMENT

EIGHT PART TESTS OF SIGNIFICANCE

PREPARED BY

C.C.BOWER

ORCHID RESEARCH

JULY 2000

Document No. FLORA 8PT-R01-J.DOC

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Table I-C1 Endangered or Vulnerable Plant Species

I-C1 INTRODUCTION

This attachment considers the potential impact of the proposed Syerston Nickel-Cobalt Project on threatened plant species in accordance with Section 5A of the NSW *Environmental Planning and Assessment Act, 1979*. It identifies endangered and vulnerable species that may occur on the Project area and applies 'Eight Part Tests of Significance' to each in order to evaluate the potential impact of the Project. The Project area includes the following components:

- the mine site (including MLA 141, 140, 132, 113 and 139),
- a gas pipeline route from the existing Sydney to Moomba pipeline (south of Condobolin) to the mine site (approximately 90 km),
- a water pipeline from two borefields located in the Lachlan Valley palaeochannel (west of Forbes) to the mine site (approximately 75 km), and an associated water spurline (approximately 10km) to the proposed limestone quarry,
- a road upgrade (Route 64),
- construction of the Fifield Bypass (approximately 12 km),
- a limestone quarry situated approximately 10 km to the north-west of Trundle, and
- a rail siding and associated access road, north of Trundle.

I-C2 ENDANGERED POPULATIONS AND COMMUNITIES

The flora survey (Bower and Kenna, 2000) showed that no Endangered Populations or Ecological Communities listed in the New South Wales *Threatened Species Conservation Act 1995* occur on the proposed Project area. All the listed endangered populations or ecological communities are confined to the Sydney region where they are threatened by urban development. The coastal environments in which these populations and communities exist are not found in the Project area or region.

I-C3 THREATENED SPECIES

A list of plant species (Table I-C1) classified as vulnerable, endangered or extinct, which could possibly occur within the Project area, was compiled from:

- Briggs and Leigh (1996) *Rare or Threatened Australian Plants*;
- the schedules of the *New South Wales Threatened Species Conservation Act, 1995;*
- the schedules of the Commonwealth *Protection of the Environment Biodiversity Conservation Act, 1999;* and
- from consultations with the NSW National Parks and Wildlife Service (NPWS).

Species were selected from the listings in Briggs and Leigh (1996) for the Central Western Slopes (Region 51), and the Western Plains (Region 49) since the Project area lies near the boundary of these biogeographical zones. The list was then refined by considering the known distribution and habitats of the threatened species (Cunningham *et al*., 1981; Harden, 1990-93; Ayers *et al*., 1996; Cunningham, 1997) and eliminating from further consideration those that occurred more than 200 km from the Project area or in habitats very different from those on the Project area.

The NPWS provided a list of threatened species predicted by bioclimatic modelling to potentially occur in the Project area and a list of threatened species recorded within 50 km of the mine site. In addition, the Austral Pillwort, *Pilularia novae-hollandiae*, was included because it had been found in the vicinity of and within the Project area in recent surveys (Clements and Rodd, 1995; Bower, 1998) which represented an extension of the species known range in New South Wales. Eighteen threatened species were selected for Eight Part Tests of Significance. These are listed in Table I-C1.

Table I-C1. Endangered or Vulnerable Plant Species

Species	Endangered	Vulnerable	Likelihood of Former Occurrence
Acacia curranii		NRE	low
Bothriochloa biloba		NRE	medium
Dichanthium setosum		NE	medium
Dodonaea sinuolata subsp. *acrodentata*	N		low
Eleocharis obicis		NRE	medium
Eriostemon ericifolius		N	medium
Eucalyptus pulverulenta		NRE	medium
Goodenia macbarronii		NRE	medium
Indigofera efoliata	NRE		medium
Lepidium monoplocoides	NRE		low
Monotaxis macrophylla	N		medium
Pilularia novae-hollandiae	N		high
Pterostylis cobarensis		NRE	low
Rulingia procumbens		NRE	medium
Stipa wakoolica	NRE		medium
Swainsona murrayana		NRE	low
Tylophora linearis	NRE		medium
Zieria ingramii	NE	R	low

N Listed under the NSW *Threatened Species Conservation Act 1995.*
R Listed under *Rare or Threatened Australian Plants* (Briggs and Leigh, 1996).
E Listed under the *Environment Protection and Biodiversity Conservation Act, 1999.*

Ratings of likelihood of former occurrence on the Project area:
high = recorded for the same botanical region (Central West Slopes) and habitats;
medium = recorded for same botanical region (Central West Slopes);
low = recorded for adjacent botanical regions (North West Slopes and South and North West Plains).

I-C3.1 JUSTIFICATION FOR INCLUSION OF SPECIES

The following statements give the reasons for including each of the 18 species in the candidate list for the Syerston Project area.

I-C3.1.1 *Acacia curranii* -- Curly-bark Wattle

Acacia curranii is an erect or spreading shrub to 3m high which sheds its reddish-brown bark in narrow curling strips. The leaves are linear, terete, up to 18 cm long, and the flowers are borne in short ovoid heads in the leaf axils. *A.curranii* is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1). It has been recorded in the North West and South West Plains (Harden, 1990-93) from the Cobar to Hillston and Lake Cargelligo areas, and in Queensland. It occurs on rocky outcrops in mallee and *Acacia* shrublands. It is included for consideration here on the basis of the nearness of known populations to the Project area, about 90 km west of Condobolin (Ayers *et al*., 1996, Cunningham, 1997).

I-C3.1.2 *Bothriochloa biloba* -- a Red Grass

Bothriochloa biloba grows to about 1m high from a basal tuft of leaves. There are 3 to 6 subdigitate racemes in the inflorescence with white or purplish villous hairs. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1). It has been recorded from Queensland, the New South Wales North and Central Coasts, Northern Tablelands, Northern and Central Western Slopes and North West Plains (Harden, 1990-93). *B.biloba* grows in woodland on poorer soils (Harden, 1990-93) and has been recorded from the Cobar area in a Poplar Box community on red earth soils (Cunningham et al. 1981). *B.biloba* also occurs near Duri on the North Western Slopes on a fertile black cracking clay soil (Hosking and James, 1998), which contrasts with the report in Harden (1990-93) that it occurs mainly on poorer soils. It is being considered here because of its wide distribution and the similarity of the Cobar habitat to that of the Project area.

I-C3.1.3 *Dichanthium setosum* -- a Bluegrass

Dichanthium setosum is a Bluegrass growing to less than a metre high with prominent purplish racemes to 8 cm long. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*, but not in ROTAP (Briggs and Leigh, 1996) (Table I-C1). *D.setosum* occurs on the North West Slopes and Plains, Northern Tablelands and Central West Slopes of NSW. It also occurs in Queensland and Western Australia. *D.setosum* is found in woodland and grassland. According to Hosking and James (1998) *D.setosum* is generally common in *Eucalyptus albens* communities in the Tamworth - Manilla area of the North West Slopes and occurs with *Bothriochloa biloba* on black cracking clay soils at Duri. It is included for consideration on the basis of its habitat and a record about 95 km to the north-east of the mine site (Ayers *et al.* 1996).

I-C3.1.4 *Dodonaea sinuolata* subsp. *acrodentata* -- a Hopbush

Dodonaea sinuolata subsp. *acrodentata* is a shrub to 3m high with pinnate leaves to 4cm long and 25mm wide. It has a leathery three-winged capsule to 13 mm long and 15 mm wide. It is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, but is not included in the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* or ROTAP (Briggs and Leigh, 1996) (Table I-C1). It occurs in Queensland and at one locality in New South Wales near Hillston. The habitat is sandy or stony sites in open woodland (Harden, 1990-93). It has been included for consideration because of its woodland habitats and uncertain distribution. The lack of known sites in NSW means that its habitats and former distribution are poorly understood.

I-C3.1.5 *Eleocharis obicis* -- a Spikerush

Eleocharis obicis is a tufted perennial rush to 30 cm high with terete culms, a linear-cylindrical spikelet to 30 mm long and straw coloured glumes with dark red-brown tinges. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1). *E.obicis* is known only from the South West Plains and the Far North West Plains of New South Wales, near Condobolin, Hay and the Barrier Range (Harden, 1990-93). It occurs in ephemerally wet situations such as mitre drains. *E.obicis* has been included for consideration because Condobolin lies within the Project area.

I-C3.1.6 *Eriostemon ericifolius* -- a Waxflower

Eriostemon ericifolius is a spreading shrub to 2 m high with warty stems, needle-like leaves to 8mm long and clusters of 1-6 sessile flowers with pink petals. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995* but is not listed in the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* or ROTAP (Briggs and Leigh, 1996) (Table I-C1). *E.ericifolius* has been recorded only from the Central West and North West Slopes of New South Wales where it is known from the upper Hunter Valley and Peak Hill to Pillaga districts (Harden, 1990-93). Its habitats are damp sandy flats and gullies in dry sclerophyll forests and heaths. It is included for consideration here on the basis of the proximity of known populations to the north-east, east and south-east, the nearest being in Goobang National Park about 95 km east of the mine site (Cunningham, 1997, Porteners, 1997).

I-C3.1.7 *Eucalyptus pulverulenta* - Silver-leaved Gum

Eucalyptus pulverulenta is a small tree or mallee to 10 m high. It is a distinctive understorey tree with smooth bark, shedding in long ribbons and opposite glaucous leaves. It occurs in grassy woodlands on poor or sandy soils in small isolated stands mainly on the Central and Southern Tablelands of NSW from Bathurst to Bombala. It is included in this assessment on the basis of a outlying record at Black Ridge about 8 km north of Yarrabandai and about 55 km SSE of the mine site. According to the herbarium record, *E. pulverulenta* occurs in the *Eucalyptus rossii / E.macrorhyncha* alliance on sandstone at Black Ridge. *E. pulverulenta* is listed as vulnerable in the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1).

I-C3.1.8 *Goodenia macbarronii* -- a Goodenia

Goodenia macbarronii is an annual herb to 30 cm high with basal oblanceolate, toothed leaves to 11 cm long and racemes of bright yellow flowers on erect leafless stems. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1). *G.macbarronii* is a widespread species recorded from the Tablelands of New South Wales south of Guyra and Inverell, the North West and Central West Slopes and the North West and South West Plains (Harden, 1990-93). It also occurs in Victoria. *G.macbarronii* grows in damp sandy soils in a variety of habitats. It has recently been recorded commonly at several damp, disturbed sites in Goobang National Park 95 km to the east of the Project area (Porteners 1997) in Blakely's Red Gum / Yellow Box / Grey Box (*Eucalyptus blakelyi / E.melliodora / E.microcarpa*) habitat. It is included here because of its widespread distribution and apparently suitable habitats in the Project area.

I-C3.1.9 *Indigofera efoliata* -- a native Indigo

Indigofera efoliata is a low broom-like subshrub to 40 cm high having hairy stems and leaves to 3.5 cm long with 5 to 9 pairs of vestigial obcordate leaflets to 4 mm long. The short inflorescence (to 2 cm) has pink pea flowers that produce short round sparsely hairy pods to 25mm long. *I.efoliata* is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1). It is known only from stony ground in the Dubbo area on the Central Western Slopes of New South Wales and is included for consideration because it occurs about 150 km north-east of the Project area (Ayers *et al*, 1996).

I-C3.1.10 *Lepidium monoplocoides* -- Winged Peppercress

Lepidium monoplocoides is an erect, branched, annual herb to 20 cm high with narrow-linear pinnatisect to entire leaves to 7 cm long and inflorescences on an elongating terminal raceme. It is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and in ROTAP (Briggs and Leigh, 1996) (Table I-C1). *L.monoplocoides* was formally widespread in arid areas of New South Wales including the North West and South West Plains and the North and South Far West Plains (Harden, 1990-93). It is also known from Victoria and South Australia. *L.monoplocoides* occurs in mallee habitats (Leigh et al. 1984) and Poplar Box woodlands (Cunningham *et al*. 1981). It is included for consideration here because of its former widespread distribution and records of it from similar habitats to those on the Project area.

I-C3.1.11 *Monotaxis macrophylla*

Monotaxis macrophylla is an erect herb to 25cm high with thick purplish stems, thin dark green, ovate-oblong leaves to 50 cm long and dense clusters of yellow flowers on short stalks. It is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, but is not included in the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* or ROTAP (Briggs and Leigh, 1996) (Table I-C1). *M.macrophylla* is known from Queensland and the North West Slopes and Plains of New South Wales. It occurs only on scattered rocky ridges and hillsides and is known from localities such as Condobolin, Nymagee, Cobar, and Hermitage Plains. *M.macrophylla* has also been recorded from Boona Trigonometrical Station, only 24 km west of the Project area. It has been included for consideration due to the close proximity of the record.

I-C3.1.12 *Pilularia novae-hollandiae* -- Austral Pillwort

Pilularia novae-hollandiae is a small grass-like perennial fern that grows in mud when seasonally dry depressions fill with water. It consists of a slender creeping rhizome just below the soil surface from which the filiform bright green fronds arise in groups of two or three at intervals of about 1 cm. *P.novae-hollandiae* is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, but is not included in the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* or ROTAP (Briggs and Leigh, 1996) (Table I-C1). *P.novae-hollandiae* has been recorded on the Central Coast, Southern Tablelands and South West Slopes of New South Wales (Harden 1990) and in Victoria, South Australia and Tasmania. Flora surveys near Lake Cowal conducted as part of the environmental assessment for the Cowal Gold Project (Clements and Rodd, 1995; Bower 1998) showed *P.novae-hollandiae* may occur in gilgai depressions between Condobolin and West Wyalong. It has been included for consideration here because the proposed gas pipeline and road transport routes pass through areas of gilgai habitat.

I-C3.1.13 *Pterostylis cobarensis* -- a Rufa Greenhood Orchid

Pterostylis cobarensis is a small herb with 7 to 11 prostrate narrow-elliptic leaves (to 2.5 cm long) in a rosette around the single flower stem (to 40 cm high) bearing 3 to 8 transparent rufa greenhood type flowers with green and brown markings. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1). *P.cobarensis* is known from the North West Plains and the North and South Far West Plains of New South Wales mainly from Nyngan to Bourke. It occurs on low hills among rocks and on steep slopes above streams. It is included for consideration because it has been recorded about 175 km to the north west of the Project area (Ayers *et al*. 1996) and possibly suitable habitat (low hills) occurs in the Project area.

I-C3.1.14 *Rulingia procumbens* -- a Rulingia

Rulingia procumbens is a prostrate, stellate hairy shrub with trailing stems to 30 cm long arising from woody stolons and having ovate to lanceolate leaves (to 5 cm long) with irregularly crenate or lobed margins. The inflorescence consists of pink flowers in few flowered cymes. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1). *R.procumbens* is recorded from the Central West Slopes and North and South West Plains of New South Wales in the Dubbo - Mendooran - Gilgandra region and the Pilliga and Nymagee areas (Harden, 1990-93). It grows mainly on sandy sites. It is included for consideration here because populations are known to occur 150 km to the north-east of the mine site (Ayers *et al.* 1996).

I-C3.1.15 *Stipa wakoolica* -- a Speargrass

Stipa wakoolica is a densely tufted perennial grass to 1m high with strongly ribbed leaves, widely gaping spikelets early in development, unequal glumes, and a silky brown lemma with a coma of erect soft hairs. It is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and in ROTAP (Briggs and Leigh, 1996) (Table I-C1). *S.wakoolica* has been recorded from the Central West Slopes and South West Plains of New South Wales where it grows on floodplains of tributaries of the Murray River (Harden, 1990-93). Its preferred habitat is stated to be open woodlands on grey silty clay or sandy loam (Ayers *et al*. 1996). It occurs between Jerilderie and Cunninyeuk in the Murray Valley and in the Lachlan Valley (Ayers *et al*. 1996, Sivertson and Metcalfe, 1995). It is included for consideration here because of the proximity of some of the Lachlan Valley records. However, Sivertson and Metcalfe (1995) recorded *S.wakoolica* from peneplain and hill habitats as well as riverine communities, suggesting some Lachlan Valley records may be misidentifications.

I-C3.1.16 *Swainsona murrayana* -- Slender Darling Pea

Swainsona murrayana is a prostrate to erect subshrub to 25 cm high with densely pubescent stems and pinnate leaves to 10 cm long having 3 to 11 narrow lateral leaflets to 30mm long. Pink or purple pea flowers are borne in racemes of 3 to 9 ten mm long flowers. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and ROTAP (Briggs and Leigh, 1996) (Table I-C1). *S.murrayana* is a formerly widespread species recorded from the North and Central West Slopes, North and South West Plains, and South Far West Plains in New South Wales as well as Queensland, Victoria and South Australia (Harden, 1990-93). It occurs mainly in depressions on heavy soils, often with *Maireana* species. It is included for consideration here because it has been recorded in widely scattered localities in central NSW with records about 130 km to the south-west of the mine site (Ayers *et al.* 1996).

I-C3.1.17 *Tylophora linearis* -- a Tylophora

Tylophora linearis is a slender twiner with linear leaves, a milky latex sap and small purple flowers (3-6 mm wide) in umbels of 3 to 8. It is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and in ROTAP (Briggs and Leigh, 1996) (Table I-C1). *T.linearis* has been recorded from the North and Central West Slopes of New South Wales and Queensland. It is known from the Barraba, Mendooran, West Wyalong and Temora districts (Harden, 1990-93). The habitat is recorded as 'dry scrub'. It has recently been recorded from three locations on dry sedimentary flats in Goobang National Park to the east of the Project area (Porteners, 1997). The sites included communities similar to some found on the Project area; Mugga Ironbark / Black Cypress Pine (*Eucalyptus sideroxylon / Callitris enlicheri*) and White Cypress Pine / Bulloak (*Callitris glaucophylla / Allocasuarina luehmanii*). It is considered here because of its wide distribution to the north, east and south of the Project area and the existence of potentially suitable habitats within the Project area.

I-C3.1.18 *Zieria 'ingramii'* -- a Zieria

Zieria 'ingramii' is not yet formally described and is identified as *Zieria* sp. E in Harden (1990-93). It is a slender spindly shrub to 60 cm high with ridged branches, trifoliate narrow, revolute leaves (to 19 mm long and 3 mm wide) and small white to pale pink flowers with 4 ovate petals to 3 mm long, mostly in 7-flowered inflorescences. It is listed as endangered under the NSW *Threatened Species Conservation Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* and vulnerable in ROTAP (Briggs and Leigh, 1996) (Table I-C1). *Z.'ingramii'* has been recorded only from the Central West Slopes of New South Wales in Goonoo Goonoo State Forest near Dubbo (Harden, 1990-93). It grows in dry sclerophyll forest on light sandy soils. It is included for consideration because it occurs about 150 km to the north-east of the Project area (Ayers *et al*. 1996).

I-C4 EIGHT PART TESTS OF SIGNIFICANCE

Eight Part Tests of Significance are a requirement under Section 5A of the *Environmental Planning and Assessment Act 1979*. The tests are designed to assist decision makers to assess the likely impact of proposed developments on threatened species, populations or ecological communities, or their habitats.

The Eight Part Test is a systematic list of the factors that must be taken into account under the Act in assessing the impact of a proposed development on threatened species, populations and communities. The eight factors are:

a) **in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,**

b) **in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,**

c) **in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,**

d) **whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,**

e) **whether critical habitat will be affected,**

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

These factors are considered below for each of the 18 threatened species identified above as possibly occurring on the study site. The assessment is made in accordance with the guidelines in *Threatened Species Management* (Information Circular No. 2: Threatened Species Assessment under the EP&A Act: The '8 Part Test of Significance', NSW National Parks and Wildlife Service, November 1996).

I-C4.1 EIGHT PART TESTS

I-C4.1.1 *Acacia curranii* (Mimosoideae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area reported here. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats known to support *Acacia curranii* were not found in the Project area surveys, and have not been reported in the immediate region.

Potential habitats for *Acacia curranii* include rocky outcrops, mallee and *Acacia* woodlands (Harden,1990-93), and do not occur on the Project area or nearby. The Project would have no impact on these habitats from a regional perspective.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

The species has not been identified in any conservation reserve.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Acacia curranii* occurred in the area it would be at the eastern limit of its known distribution.

4.1.2 *Bothriochloa biloba* (Poaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species occurred in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Bothriochloa biloba* have not been identified in the surveys of the study areas reported above, and have not been reported in the immediate region.

Potential habitats for *B.biloba*, red earthic soils in Poplar Box woodland (Cunningham *et al*., 1981), occur in the Project area (Cunningham, 1997). However, these habitats are widespread in the region and the Project would have a minimal impact on them.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Bothriochloa biloba is not known to occur in any conservation reserve

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Bothriochloa biloba* occurred in the area it would be at the southern limit of its known distribution.

4.1.3 *Dichanthium setosum* (Poaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the study areas reported above. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Dichanthium setosum* have not been identified in the surveys of the study areas reported above, or in the immediate region.

Potential habitats for *D.setosum* of woodland and grassland (in the broad sense) (Harden, 1990-93), occur on the Project area. However, it seems likely that *D.setosum* occurs mainly in moister White Box (*Eucalyptus albens*) woodlands (Hosking and James, 1998), which are absent from the Project area, and in more northern areas with summer-dominant rainfall. If *D.setosum* were to occur in the habitats on the Project area, the Project would have a minimal regional impact on them as they are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Dichanthium setosum is not known to occur in any secure conservation reserve.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing , the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Dichanthium setosum* occurred on the Project area it would be at the south-western limits of its distribution.

I-C4.1.4 *Dodonaea sinuolata* subsp. *acrodentata* (Sapindaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Dodonaea sinuolata* subsp. *acrodentata* were not found in the surveys of the Project area, and have not been found in the immediate region.

Potential habitats for the subspecies, sandy or stony sites in open woodland (Harden, 1990-93), particularly stony sites, may occur on the Project area. If the subspecies were to occur in the habitats on the Project area, the Project would have a minimal regional impact on them as they are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

It is not known whether *Dodonaea sinuolata* subsp. *acrodentata* occurs in a conservation reserve.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

Only one locality near Hillston is known for *Dodonaea sinuolata* subsp. *acrodentata* in New South Wales. Any occurrence of the subspecies on the Project area would represent a considerable extension of range to the east.

I-C4.1.5 *Eleocharis obicis* (Cyperaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Eleocharis obicis* have not been identified in the surveys of the Project area.

The known distribution of the species suggests it occurs on ephemerally wet sites on the plains rather than in undulating country such as the mine site. Habitat that may be suitable for *E.obicis* occurs on areas of the Lachlan River floodplain traversed by the gas and water pipeline routes. If the species occurred in these areas, the Project would have a minimal regional impact on them as the habitats are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Eleocharis obicis is not known to occur in any conservation reserve (Briggs and Leigh, 1996).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of small areas of remnant native vegetation in potentially suitable habitat for *E.obicis.* Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Eleocharis obicis* occurred on the Project area it would be an extension of its range to the east.

I-C4.1.6 *Eriostemon ericifolius* (Rutaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Eriostemon ericifolius* have not been identified in the surveys of the Project area, or in the immediate region.

Potential habitats for the species, damp sandy flats and gullies in dry sclerophyll forests and heaths (Harden, 1990-93), do not occur on the Project area. However, if *E.ericifolius* were to occur in the habitats on the Project area, the Project would have a minimal regional impact on them as they are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Eriostemon ericifolius is conserved only in Wingen Maid Nature Reserve (Briggs and Leigh, 1996) and Goobang National Park (Porteners, 1997).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Eriostemon ericifolius* occurred on the Project area it would be an extension of its known range to the south-west.

I-C4.1.7 *Eucalyptus pulverulenta* (Myrtaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Eucalyptus pulverulenta is a large, conspicuous and distinctive species. Habitats supporting *E. pulverulenta* were not found in surveys of the Project area. In its closest occurrence to the Project area, *Eucalyptus pulverulenta* grows in a community of the Western Scribbly Gum (*Eucalyptus rossii*) / Red Stringybark (*E. macrorhyncha*) alliance at Black Ridge on sandy soils derived from Devonian sandstones. This plant community and soil type is absent from the Project area. The project is unlikely to have any impact on the habitats of this species.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

Habitats likely to support *E. pulverulenta* do not occur in the Project area. The Project is outside the known range of the species and is therefore unlikely to increase the isolation of any of the existing populations. Potential habitat for *E. pulverulenta* is already very fragmented due to the natural isolation of Devonian sandstone outcrops and the plant communities they support in Central Western NSW.

e) whether critical habitat will be affected,

No areas of critical habitat have been found in the Project area.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

E. pulverulenta is not recorded from any conservation reserve.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *E. pulverulenta* occurred in the Project area it would be at the north-western limits of its distribution

I-C4.1.8 *Goodenia macbarronii* (Goodeniaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Goodenia macbarronii* were not found in the surveys of the Project area, and have not been reported to occur in the immediate region.

Potential habitats for the species, damp sandy soils (Harden, 1990-93), occur on the Project area. However, the vegetation associations in which *G.macbarronii* is known to occur; Blakely's Red Gum / Yellow Box (*E.blakelyi / E.melliodora*) woodland in hilly country (Porteners, 1997) does not occur on the study areas. However, if *G.macbarronii* were to occur in the habitats on the Project area, the Project would have a minimal regional impact on them as they are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Goodenia macbarronii is conserved in Warrumbungle National Park (Briggs and Leigh, 1996) and the recently declared Goobang National Park (Porteners, 1997), but is not known to be present in any reserve close to the Project area.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Goodenia macbarronii* occurred on the Project area it would be near the western extremity of its distribution.

I-C4.1.9 *Indigofera efoliata* (Faboideae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Indigofera efoliata* were not found in the surveys of the Project area, and have not been reported to occur in the immediate region.

Potential habitats for the species, stony ground (Harden, 1990-93), occur on the mine site on hills in the north (MLA 141) and far south (MLA 139). They also occur where the gas and water pipeline routes cross hilltops and ridges. The alienation of these areas would have negligible impact on the total available regional habitat as it is widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Indigofera efoliata is not known to occur in any conservation reserve (Briggs and Leigh, 1996).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Indigofera efoliata* occurred in the Project area it would represent a considerable extension of range from the Dubbo area, its only known location at present (Harden, 1990-93).

I-C4.1.10 *Lepidium monoplocoides* (Brassicaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Lepidium monoplocoides* were not found in the surveys of the Project area, and have not been reported to occur in the immediate region.

Potential habitats for the species, Poplar Box woodlands (Harden, 1990-93), occur on the Project area. However, even if *L.monoplocoides* were to occur in these habitats, the Project would have a minimal impact on them from a regional perspective as these habitats are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Lepidium monoplocoides is not known to be protected in any conservation reserves in New South Wales, but is present in the Hattah-Kulkyne and Wyperfeld National Parks in Victoria (Briggs and Leigh, 1996).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Lepidium monoplocoides* occurred on the Project area it would represent an eastern extension of its known range.

I-C4.1.11 *Monotaxis macrophylla* (Euphorbiaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species occurred in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Monotaxis macrophylla* were not found on the study areas in the surveys reported above. However, a population is known at Boona Trigonometrical Station in the Boona Mountains some 24 km west of the Project area. The Boona Mountains comprise an isolated sandstone range differing in geology and topography from the Project area. It also supports different plant communities with *M.macrophylla* reported to occur in an association of Dwyers Mallee Gum (*Eucalyptus dwyeri*) and Currawang (*Acacia doratoxylon*) (Cunningham, 1997). Potential habitats for the species occur on the gas and water pipeline routes where they cross hilltops and ridges. If *M.macrophylla* occurred in these habitats, the Project would have a minimal impact because only very small proportions of the habitats are proposed to be affected.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

It is not known if *Monotaxis macrophylla* occurs in any conservation reserves, regional or otherwise.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Monotaxis macrophylla* occurred on the Project area it would be at the eastern limit of its known range.

I-C4.1.12 *Pilularia novae-hollandiae* (Marsiliaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Pilularia novae-hollandiae* were not found in the surveys reported above, but have previously been recorded at Site 23 on the gas pipeline route, 12 km south of Condobolin on the West Wyalong – Condobolin Road (Bower 1998). The population occurs in a single gilgai depression. All known populations of *P.novae-hollandiae* in Central Western NSW are found in gilgai habitat (Clements and Rodd, 1995; Bower 1998).

P. novae-hollandiae is very common and widespread in gilgai habitat in the Lake Cowal area (Bower 1998) and is likely to be distributed widely through the Central West. Very little of the known habitat is proposed to be modified by the Project. Previous surveys have shown some 96 gilgai depressions, or 46 percent of those randomly sampled, in the vicinity of Lake Cowal have populations of *P. novae-hollandiae* (Bower 1998).

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

One area supporting a viable population of *P.novae-hollandiae* was found in the vegetation surveys. Due to its small area, less than 10 square metres, the gas pipeline will be positioned to avoid it. Therefore the Project will not impact upon critical habitat of this species.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

P.novae-hollandiae is not known to occur in any conservation reserve (Briggs and Leigh, 1996).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The occurrence of *P.novae-hollandiae* on the gas pipeline route is at the westernmost edge of the known distribution of the species in New South Wales.

I-C4.1.13 *Pterostylis cobarensis* (Orchidaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. If the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Pterostylis cobarensis* have not been identified in the surveys of the study areas reported above, and have not been reported to occur in the immediate region. Potentially suitable habitats occur on small areas of rocky hills in the far north and far south of the Project area, and where the gas and water pipeline routes cross hilltops and ridges. However, from a regional perspective, the impact of the Project on these habitats will be low since they are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Pterostylis cobarensis is not known to occur in any conservation reserve (Briggs and Leigh, 1996).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Pterostylis cobarensis* occurred on the Project area it would represent a considerable extension of its range to the south-east.

I-C4.1.14 *Rulingia procumbens* (Sterculiaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Rulingia procumbens* were not identified in the surveys of the Project area, and have not been found in the immediate region.

Potential habitats for the species, sandy sites (Harden, 1990-93), do not occur on the Project area. However, even if populations of *R.procumbens* occurred in the existing habitats, the Project would have a minimal regional impact on them since they are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Rulingia procumbens is not known to occur in any secure conservation reserve.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Rulingia procumbens* occurred on the Project area it would represent a considerable extension of its known range to the south.

I-C4.1.15 *Stipa wakoolica* (Poaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species occurred, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Stipa wakoolica* were not identified in the surveys of the Project area, but have been reported in the immediate region by Sivertson and Metcalf (1995). However, the habitat records of Sivertson and Metcalf (1995) contrast with those reported by Harden (1990-93) and Ayres *et al*. (1996).

Potential habitats for the species, open woodlands on grey silty clay or sandy loam (Ayers *et al*., 1996), do not appear to occur on the mine site, but are found on the Lachlan River floodplain traversed by the water and gas pipeline routes. Even if populations of *S.wakoolica* did occur in the existing habitats, the Project would have a minimal regional impact on them from a since they are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Stipa wakoolica is not known to occur in any conservation reserve (Briggs and Leigh, 1996).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia’s Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Stipa wakoolica* occurred on the Project area it would represent a significant extension of range to the north east.

I-C4.1.16 *Swainsona murrayana* (Faboideae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species occurred in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Swainsona murrayana* were not found in the surveys of the Project area, and have not been found elsewhere in the immediate region.

Potential habitats for the species, depressions in heavy soils, often with *Maireana* species (Harden, 1990-93), may occur on the Lachlan River floodplains. However, the Project would have a minimal regional impact on these habitats since they are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Swainsona murrayana is not known to occur in any conservation reserve in New South Wales. However, it is present in the Barret Flora and Fauna Reserve in northern central Victoria.

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

If *Swainsona murrayana* occurred on the Project area it would be near the eastern limits of its former wide range.

I-C4.1.17 *Tylophora linearis* (Asclepiadaceae)

b) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

No populations of this species were found in the detailed surveys of the Project area. However, if the species occurred in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Tylophora linearis* were not found in the surveys of the study areas reported above, and there are no other records in the immediate region.

Potential habitats for the species may occur on the Project area. If populations of *T.linearis* were to occur, the Project would have a minimal regional impact on them since the potential habitats are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Viable populations of *Tylophora linearis* are conserved in Goobang National Park (Porteners, 1997).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

Tylophora linearis is known from scattered locations between Barraba, West Wyalong, Peak Hill and Temora on the western slopes. If it occurred on the Project area it would be at about the centre of its known range.

I-C4.1.18 *Zieria 'ingramii'* (Rutaceae)

a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No populations of this species were found in the detailed surveys of the Project area. However, if the species were to occur in the area, local populations could be threatened by mine workings and Project infrastructure development.

b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be compromised,

Not applicable

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Habitats supporting *Zieria ingramii* have not been identified in the current surveys of the study site, and there are no other records for the immediate region.

Potential habitats for the species, light sandy soils in dry sclerophyll forest (Harden, 1990-93), do not occur on the Project area. If populations of *Z.ingramii* were to occur in the existing habitats, the Project would have a minimal regional impact on them since those habitats are widespread.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The nature of the Project is unlikely to isolate habitats of the species. Potential habitat is already highly disturbed and fragmented as a result of current land use practices. There is no evidence this effect will significantly increase as a result of the proposed Project.

e) whether critical habitat will be affected,

No areas of critical habitat have been found on the study sites.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

Zieria ingramii is not known to occur in any conservation reserve (Briggs and Leigh, 1996).

g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development will include clearance of remnant areas of native woodland for open pit mining and for the development of infrastructure associated with ore processing, the disposal of waste rock and tailings, and pipeline construction and roadworks. Vegetation clearance is recognised as a threatening process in the National Strategy for the Conservation of Australia's Biological Diversity and the NSW Biodiversity Strategy.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

Zieria ingramii is so far known only from Goonoo Goonoo State Forest near Dubbo. Any occurrence on the Project area would represent a large extension of its range.

I-C5.0 CONCLUSION

Eighteen threatened species known or considered possible occurrences in the Project area were selected for assessment by Eight Part Tests of Significance. One threatened plant species, the Austral Pillwort, *Pilularia novae-hollandiae* has been identified in the Project area. In most other cases the precise habitat requirements of the species were not met by the Project area habitat resources, or the Project area was well outside the known distribution of the species.

P.novae-hollandiae is known from only one location on areas to be affected by the Project. It occurs on the gas pipeline corridor in a gilgai depression on the travelling stock route along the West Wyalong – Condobolin Road about 12 km south of Condobolin. Searches of other gilgai depressions in the same area failed to find additional populations. *P.novae-hollandiae* is common in the Lake Cowal area where it occupies almost 50 percent of gilgai depressions (Bower 1998). It is likely to be quite widespread and common in suitable gilgai habitat in Central Western NSW.

It is recommended that the gas pipeline be positioned to avoid the *P.novae-hollandiae* population present on the gas pipeline in the gilgai in which it is present.

The proposed works associated with the Project are not considered likely to have a significant affect on threatened plant species, populations, ecological communities or their habitats. As such, a Species Impact Statement (SIS) is not considered necessary.

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APPENDIX JA

SYERSTON NICKEL COBALT PROJECT
TERRESTRIAL FAUNA SURVEY AND ASSESSMENT

PREPARED BY
MOUNT KING ECOLOGICAL SURVEYS
“OORONG”
BATHURST ROAD
OBERON   NSW   2787

JULY 2000
Project No.BRM-01\3.7
Document No. TERR. FAUNA-R01-J.DOC

INSERT LETTER FROM MKES TO RS

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SYERSTON NICKEL-COBALT PROJECT - TERRESTRIAL FAUNA SURVEY AND ASSESSMENT by

MOUNT KING ECOLOGICAL SURVEYS

JA 1.0 INTRODUCTION

Black Range Minerals Ltd propose to mine the Syerston Nickel-Cobalt deposit (Syerston Project) which is located approximately 2 km north-west of Fifield, in the Central West of New South Wales (Figure JA-1). It is proposed to mine the deposit by open pit methods and to process the ore on site. In addition, there will be several areas where associated infrastructure will be located (Figure JA-1). Associated infrastructure includes:

- a limestone quarry situated approximately 10 km to the north-west of Trundle;
- a gas pipeline from the existing Sydney to Moomba pipeline (south of Condobolin) to the mine site (about 90 km);
- a water supply pipeline route from the two borefields located in the Lachlan Valley palaeochannel (west of Forbes) to the mine site (approximately 65 km), and an associated water spurline (approximately 12 km) to the proposed limestone quarry;
- upgrade of Route 64;
- construction of Fifield bypass; and
- a rail siding and associated access road, north of Trundle.

The Syerston Project area (i.e. the mine site and associated infrastructure) is shown in Figure JA-1.

The mine site and majority of the infrastructure areas are located within the Cobar Peneplain Interim Biogeographic Regionalisation for Australia (IBRA) Region, with the borefields and some of the water pipeline being located within the NSW South-western Slopes IBRA Region.

A detailed description of the Project is provided in Section 2 of the Environmental Impact Statement (EIS). The proposed general arrangement of the mine site at Year 20 is shown in Figure JA-2.

This report describes the terrestrial fauna (excluding bats) known and/or likely to occur within the Project area and surrounds, and assesses the potential impacts of the Project on terrestrial fauna.

The NSW National Parks and Wildlife Service (NPWS) define **subject area** as the area that is directly affected by the activity and the **study area** is defined as that area indirectly affected by the activity. In the case of the Syerston Project, these two areas can be considered the same i.e. the Project area. The **locality** is defined as that area of land surrounding the subject area and is considered, in this Project, as an area covering Tullamore, Peak Hill and Condobolin.

The locality is covered by the five 1:100 000 topographic map sheets: Tullamore, Peak Hill, Bogan Gate, Condobolin and Boona Mount. The **region** is considered to be the Cobar Peneplain IBRA Region, although some of the Project area is within the NSW South West Slopes IBRA Region.

JA 2.0 REGIONAL DESCRIPTION

JA 2.1 DESCRIPTION OF THE IBRA REGIONS

The IBRA Region covering most of the Project area is the Cobar Peneplain, with a small amount (i.e. the borefields and part of the water pipeline) being within the NSW South West Slopes IBRA Region.

The Cobar Peneplain IBRA Region is described in Thackway and Cresswell (p.64, 1995[1]) as "Plains and low hills on Palaeozoic rocks; earths, lithosols; *E. populnea* and *E. intertexta* woodlands". Morgan and Terrey (p.109, 1992[2]) characterizes the Cobar Peneplain region as "an undulating to hilly landscape with shallow red earth soils and open woodlands and woodlands of poplar box, white cypress, red box and, in the more arid areas, mulga". Alluvial deposits fringe the peneplain in the east. The mine area is within the Nymagee-Rankins Springs Province that is a complex of igneous, acid volcanic and sedimentary rocks (Morgan and Terrey, 1992).

The NSW South West Slopes IBRA Region is classed as an extensive area of foothills and isolated ranges comprising the lower inland slopes of the Great Dividing Range. Morgan and Terry (1992) divides this region into two sub-regions, of which the Project area is within the Lower Slopes Sub-Region. This unit is described as having undulating plains dominated by grey box woodlands. However, the general landforms and soil types within the Project area are typical of the eastern sections of the Cobar Peneplain IBRA Region.

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[1] R. Thackway and I.D.Cresswell 1995 "An Interim Biogeographic Regionalisation for Australia" Environment Australia, Canberra

[2] G.Morgan and J.Terrey 1992 "Nature Conservation in Western New South Wales" National Parks Association of NSW Inc, Sydney

JA 2.2 LAND SYSTEMS

A land system is defined as "an area or group of areas throughout which there is a recurring pattern of topography, soil and vegetation" (Christian, 1958[3]). The major land system within the eastern margin of the Cobar Peneplain IBRA Region is the Pangee Land System (Walker, 1991[4]) and is representative of the land within the Syerston Project area. Pangee Land System is described as level country with deep calcareous red earths on Quarternary alluvium derived from undulating country with a relief to 3 m. This land systems also contains in-flowing broad non-incised drainage lines and small swamps. The extent of this system in NSW is estimated as 1,940 km^2 (Walker, 1991).

The mine site and sections of the gas and water pipeline routes are located within sandstone, mixed sediments and siltstone. The remainder of the pipeline routes are within soils dominated by alluviums. The limestone quarry and rail siding sites are within soils derived from shales and sandstone.

JA 2.3 LANDSCAPE PROFILES

The draft Mid-Lachlan Vegetation Management Plan[5] divides the Mid-Lachlan region into "Landscape Profiles" that are made up of the physiographic features that dominate the landscape. Attached to each landscape profile are categories that describe soil types, geology, vegetation and extent of land degradation. There are three landscapes that cover the Project area. These are:

- Parkes-Forbes Hills and Rises (including rail siding, limestone quarry and part of Route 64)
- Yarrabandai Plains (covers part of Route 64, mine site, section of the water and gas pipeline routes)
- Lachlan River (including sections of the water pipeline route and borefields).

Parkes-Forbes Hills and Rises include the following landforms: level to gently inclined slopes and footslopes; undulating plains and rises; undulating slopes and low hills. Soils include red and brown earths, lithosols, non-calcic brown soils and red podozolic soils. Underlying geology includes alluvium and colluvium and some Ordovician Volcanics.

Yarrabandai Plains include the following landforms: level plains with poorly drained gilgai depressions that pond water following rainfall; level plains, drainage lines, narrow floodplains and swampy depressions. Soils include grey, brown and red clays at gilgais, red earths, earthy sands and alluvial soils. Underlying geology includes Quarternary alluvium and minor colluvium.

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3 C.S.Christian 1958 The concept of land units and land systems *Proc. Ninth Pacific Sci Congr., 1957 20:* 74-81

4 Walker, P.J. 1991 "Land Systems of Western New South Wales" Soil Conservation Service of NSW Technical Report No.25

5 Department of Land and Water Conservation 1999 *Mid-Lachlan Regional Vegetation Management Plan* Draft Report, March 1999

Lachlan River landscape comprises flat alluvial plains, slightly raised above the surrounding countryside; level alluvial plains with lagoons, sandhills, terraces and backswamps of the Lachlan River; alluvial floodplains and terraces and gilgai. Soils include red brown earths, clays, alluvial soils and podzolic soils. Underlying geology is Quarternary alluvium.

JA 2.4 VEGETATION COMMUNITIES

Plains within the Cobar Peneplain IBRA Region are dominated by bimble box (*Eucalyptus populnea*), white cypress pine (*Callitris glaucophylla*) and yarran (*Acacia homalophylla*), with sparse budda (*Eromophila mitchellii*), warrior bush (*Apophyllum anomalum*), umbrella grasses (*Digitaria* spp.) and windmill grass (*Chloris truncata*). Within the drainage lines there is scattered bimble box, white cypress pine, yarran, budda, turpentine (*Eremophila sturtii*) and broad-leaf hopbush (*Dodonaea viscosa*). Most of the natural vegetation communities within the plains land system have been cleared and are only represented as scattered remnants. The Project area is no exception, with small patches of highly disturbed woodlands surrounded by cleared and cropped land. There are fragments of the original vegetation retained within public corridors, such as roads and stock routes, and some small patches of woodland within some paddocks (e.g. the Sunrise property, south of the mine site).

The vegetation within the Lower Slopes Sub-Region of the NSW South-Western Slopes Region is dominated by grey box woodlands and open woodlands with white cypress. There is yellow box and belah on lower areas. Poplar box and wilga, with the occasional kurrajong and red box, are found in the Project area.

The undulating and gently inclined plains found in the Parkes-Forbes Hills and Rises landscape unit (found near Trundle) support woodlands of bimble box, fuzzy box, grey and white box. Further to the west and south (Yarrabandai Plains landscape unit) the dominant vegetation communities are weeping myall woodlands, belah woodlands and box woodlands. The Lachlan River landscape unit supports river red gum forests, black box forests, as well as myall and box woodlands.

JA 2.5 CLIMATE

The Project area is characterised by a low annual rainfall, high daytime temperature in summer, with low winter minima, and year-round rainfall. Climatological data from the Condobolin Agricultural Research Station shows an annual mean daily maximum temperature of 24.2°C, a mean daily minima of 9.9°C, and a mean annual rainfall of 471 mm. The highest average monthly temperature was recorded in January maximum temperatures (33°C), and the lowest in July (2.5°C).

JA3.0 DESCRIPTION OF THE PROJECT AREA AND SURROUNDS

JA 3.1 MINE SITE

The mine site is located in an area characterised by farm land, previously mined land, State Forest, Crown Reserve and Crown Land. Farming concentrates upon cropping, with some sheep and cattle grazing. Fifield State Forest, the Crown Reserve and Unoccupied Crown Land occupy a small part of the mine site within Mining Lease Application (MLA) 140 and MLA 132 (Figure JA-2).

Part of the north-eastern quarter of the mine site (within MLA 140, 132 and MLA 113) contains land that has previously been mined by open cut methods. The mining areas have been partly rehabilitated, but there still remains many open pits, some of which contain water. There are remnants of the old mining infrastructure scattered throughout this part of the mine site. Fifield State Forest appears to have been logged in the past, with few mature trees within this part of the mine site. There is a belt of trees through the centre of the mine site that is associated with low-lying land and indefinite water courses. Some trees have been cleared in recent years and the land used for cropping. As will be discussed later in the report, many of the trees in this area are older than that found in the State Forest. There are some mature trees retained within the Crown Land, particularly along an indefinite water course, to the east of the mine site.

JA 3.2 LIMESTONE QUARRY AND RAIL SIDING

The limestone quarry is located within a small area of cleared land adjacent to Route 64. The rail siding area north of Trundle supports an open woodland of box and pine, and a relatively dense ground cover of grasses.

JA 3.3 GAS AND WATER PIPELINES AND BOREFIELDS

Both the gas and water pipeline routes pass through a variety of landscapes, with the main feature being cleared farm land. Both pipeline routes pass along road corridors that still support remnants of the former woodland communities. Several water courses are traversed by the pipelines, including Humbug Creek, Wallaroi Creek, Wallamundry Creek, Nerathong Creek and the Lachlan River at Condobolin. The water pipeline will travel across the floodplains associated with the Lachlan River. The borefields at “Astron Park” are within cleared cropped land.

JA 3.4 ROUTE 64 AND FIFIELD BYPASS

Route 64 would be upgraded for the Syerston Project (Figure JA-1). Route 64 contains remnants of the original vegetation within the road reserve. The proposed Fifield bypass would pass through cleared agricultural land.

JA 4.0 METHODOLOGY

JA 4.1 SURVEY TIMING

The Project area was surveyed during the months listed:

Project Components	Months Surveyed
Mine Site	5-10 January 1999
Gas pipeline	7-14 November 1999 and March 2000
Water pipeline	7-14 November 1999 and March 2000
Route 64	7-14 November 1999
Fifield bypass	March 2000
Limestone quarry	7-14 November 1999
Rail siding and access road	7-14 November 1999
Borefields	March 2000

JA 4.2 CLIMATE

The weather during the fauna surveys undertaken in January 1999, was mainly hot and dry, with the final day experiencing some light rain. The weather during the November surveys was mainly cool and overcast, with some light rain experienced during the survey period. There had been widespread heavy rain prior to the November surveys. The temperatures and humidities during the surveys are shown in Table JA-1. Climatic conditions for March 2000 are not provided in Table JA-1 as the survey period was restricted to visual assessments.

TABLE JA-1: CLIMATE DURING SURVEYS

DATE	MAXIMUM TEMPERATURE (°C)	MINIMUM TEMPERATURE (°C)	MAXIMUM HUMIDITY (%)	MINIMUM HUMIDITY (%)
5.1.99	43.0	21.1	63	23
6.1.99	48.1	21.5	60	21
7.1.99	43.5	21.6	62	21
8.1.99	38.9	22.9	83	31
8.11.99	22.6	7.0	92	44
9.11.99	25.4	6.3	88	37
10.11.99	31.2	8.7	76	26
11.11.99	29.5	5.4	80	28

JA 4.3 FAUNA SURVEYS AND HABITAT ASSESSMENT

Due to the large area to be surveyed and the range of habitats and Project infrastructure components to be assessed, two approaches were used in this study, *viz.* Terrestrial fauna surveys and habitat assessment. These assessments are outlines below.

JA 4.3.1 Terrestrial Fauna Surveys

Sites were selected within the Project area to survey terrestrial fauna and included targeted surveys for threatened fauna. These sites were the mine site, the rail siding and a large area of woodland on the "Sunrise" property (Figure JA-3)[6]. Techniques used during the surveys included Elliott trapping, pit trapping, hair tubes, spotlighting, active searches, call playback and general observations.

- Elliott Trapping For Ground Mammals

Survey of Mine Site in January 1999

50 Elliott traps were placed in two areas (Sites M1 and M2) within the mine site. One site was within Fifield State Forest, within MLA 140, and the other site was within the belt of trees located within MLA 113 (Figure JA-3). The traps were laid in linear transects that sampled any clines[7] within each site. Traps were baited with rolled oats, peanut butter, bacon and aniseed essence. 500 trap-nights were completed during the survey.

Surveys of Infrastructure Areas in November 1999

6 Woodland on the "Sunrise" property was surveyed to assess a previous gas pipeline route which traversed this area. The fauna surveys indicated this area was of high habitat value and the pipeline was subsequently re-routed. Sites S1, S2 and S3 on the "Sunrise" property will not be affected by the proposed development (refer Figure JA-3).

7 A gradation of landscape and habitat characteristics within an area

Three sites (S1, S2 and S3) were located within a relatively large area of woodland in the "Sunrise" property (Figure JA-3). Another survey site was located at the rail siding, north of Trundle (Figure JA-3). 25 Elliott traps were placed at each of these sites in linear transects for four nights (400 trap-nights) and baited with rolled oats, peanut butter, fish oil and ginger essence.

- Elliott Trapping For Arboreal Marsupials

Every fifth Elliott trap was placed on a platform attached to a tree along each survey transect. The traps were baited with a rolled oats and peanut butter mixture, and a honey-water solution was sprayed on the traps and tree trunk daily.

- Pit Traps

Pit traps with four radiating drift fences were used at the Fifield State Forest site, whilst pit traps arranged in a line with a single drift fence were used within MLA 113. The pit traps consisted of 20 litre buckets and the drift fences were bronze fly screen mesh approximately 20 cm high. On the last night, a small amount of water was placed in each pit trap as an attractant.

- Hair Tubes

Hair tubes with 10 cm circumference entrances were baited with meat and fruit and placed on tree trunks and on logs at each site. Four hair tubes were used at each site and left out for five nights.

- Spotlighting

All accessible tracks were traversed by vehicle and spotlighted over four nights. Some walked spotlighting transects were undertaken at bodies of water and other areas. A total of 22 km were traversed over a period totaling approximately six hours. All survey sites were spotlighted.

- Herpetofauna

Reptiles were searched for under logs, bark, and rocks, as well as sheets of tin and other sources of potential habitat. Amphibians were searched for at several bodies of water formed within the used open mine pits, as well as within some creeks (Goobang Creek, Nerathong Creek, Wallamundry Creek, Wallaroi Creek, Humbug Creek) and ponds likely to be traversed by the pipelines. Calls of any amphibians were recorded and analysed.

- Call Playback

Calls of several species of nocturnal bird were broadcast during the night at all survey sites. Calls were broadcast through a loudspeaker for approximately five minutes, with a five minute listening time. Calls from the Powerful Owl, Masked Owl, Tawny Frogmouth, Barking Owl, Barn Owl, Southern Boobook, Australian Owlet-nightjar, Spotted Nightjar and the White-throated Nightjar were broadcast.

- General Observations

Any sightings of fauna within the Project area, and any observations of fauna reported by other people within the Project area (e.g. surveyors, mine engineers) were recorded. All fauna sightings were located using a Global Positioning System (GPS), and records kept of each location, together with a description of their associated habitat.

JA 4.3.2 Habitat Assessment

Habitat characteristics were measured and assessed at a series of sites within the Project area to determine the value of an area to terrestrial fauna, including threatened species.

- Habitat Assessment of Fauna Survey Sites

Two techniques were used to determine the habitat characteristics of the major habitat types within the fauna survey sites (i.e. within Fifield State Forest, MLA 113, rail siding and a large area of woodland on the “Sunrise” property). As each Elliott trap was laid, a description of the trap site was recorded. This provided information about the upper, middle and lower storey vegetation structure, as well as ground cover. In addition, a transect of varying length was walked through each survey site, as well as through selected ‘habitat assessment’ sites within the infrastructure areas. The assessment of habitat characteristics by transect is detailed below.

- Assessment of Habitat Characteristics by Transect

A transect of varying length was walked through sixteen sites within the Project area (Figure JA-3). The width of each transect varied from four to twenty metres, depending upon the size of the sample area and the density of vegetation. There are five main habitat types within the Project area:

- woodland associated with the level plains;
- woodland associated with hills;
- vegetation (including woodland) associated with indefinite water courses;
- large areas of open grassland (this comprises cleared paddocks, crops and old mining areas); and
- habitats associated with the bodies of open water.

Within the transect the following parameters were noted:

- Tree height
- Diameter Breast Height (DBH) of each tree
- Shrub height
- Sapling height
- Trees with large and small hollows
- Trees with scratches on the trunk[8]
- Stag density
- Log length and diameter (multiplied to give an approximate area)

Also measured at five 1/4m^2 quadrats were:

- % Grass cover
- % Forb cover
- % Litter cover
- % Stick cover[7]
- Grass height
- Forb height
- Litter weight

In addition, a 'spot' survey of fauna was undertaken at each habitat assessment site. A 'spot' survey comprised listing any bird species located during the habitat assessment survey (including indirect records e.g. nest, calls).

Using the results of the habitat assessment surveys, it was possible to place a form of ranking on the different sites, in terms of habitat value. If it is assumed that the habitat characteristics measured help to determine the habitat value of a site for vertebrate fauna, then a combination of ranked values for each characteristic may be used to calculate the value of each site.

The mean and standard deviation of each set of values for each characteristic was calculated, then the 25% and 75% percentile calculated. A rank was then placed on each percentile range (i.e. 0-25% percentile was ranked as being of Low habitat value, 26% to 75%, as having Moderate habitat value, and 75% to 100% as having High habitat value). This provides three ranks for each habitat characteristic that was then applied to the set of results from the surveys. This ranking method is tentative, as it ignores the limitations of a small data-set and the possibility of a normal distribution, and it does not weigh any habitat characteristic (i.e. one characteristic may be more important to determine faunal use than another). However, it does provide a picture of relative habitat values for each patch of natural habitat. The values for each percentile range are given in Table JA-2.

8 Although measured, the results were too low to be used in the analysis

The habitat characteristic measured at each site was then ranked as low, medium or high on the basis of the values in Table JA-2. Each rank was given a score of 1 (low), 2 (medium) or 3 (high), then summed and added to the total number of bird species located during the ‘spot surveys’. The 25% and 75% percentiles for the range of the final score values were then calculated and the score for each site ranked from low to high, depending upon where it occurred in the percentile range, to provide an estimate of the habitat value of each site sampled. This provided a basis for assessing each patch of bushland within the mine site and infrastructure areas.

TABLE JA-2: Percentile Values for Habitat Evaluation (16 Sites)

Parameter	Low (0-25%)	Medium (25-75%)	High (75-100%)
Tree height (m)	<6.0	6.1-9.9	>10.0
Tree density (/ha)	<138	139-650	>650
Tree DBH (cm)	<14	15-35	>35
% Tree hollows	<1	2-50	>50
Sapling density (/ha)	<31	32-150	>150
Shrub density (/ha)	<169	170-960	>960
Stag density (/ha)	<1	2-30	>30
Log density (/ha)	<40	41-200	>200
Log area	<2550	2551-7000	>7000
% Litter cover	<40	41-99	>99
% Grass cover	<5	6-40	>40
% Forb cover	<5	6-30	>30
Grass height (cm)	<19.5	20-41	>41
Forb height (cm)	<12	12.1-32	>32
Sapling height (cm)	<201	202-325	>325
Shrub height (cm)	<70	71-200	>200
Litter weight (gm/m^2)	<380	381-820	>820

- Visual Assessment of Vegetation Remnants

The sixteen sites sampled within the mine and infrastructure areas are taken as representative of many of the small and large remnants found in the Project area. In addition to the above transect assessments, a visual assessment was undertaken of other areas of remnant vegetation within the Project area, relating habitat values to those sites where quantitative estimates were derived. Areas of cleared land (induced grassland/croplands) were taken as having low to very low habitat value. The visual habitat assessment sites are shown on Figure JA-3.

JA 4.3.3 Fauna Distributional Data

Records of fauna known from the Project area and surrounds (location) were obtained for the 1:100 000 map sheets of Peak Hill, Tullamore, Bogan Gate, Condobolin and Boona Mount from the NPWS database, the Atlas of Birds in Western NSW[9] and from the NPWS publication of Threatened Species in Western NSW[10]. Information about the flora and fauna in the Parkes Shire was also useful[11]. The fauna species list in the Mid-Lachlan Regional Vegetation Management Plan Draft Report[12] was also used in this report.

JA 5.0 RESULTS

JA 5.1 FAUNA ASSEMBLAGES

There are records for 209 bird, 26 mammal, 37 reptile and 17 amphibian species from the general region. Many of these records are from an area near Peak Hill (mainly in Goobang National Park) and there are few records for the Fifield district. Many of the fauna records represent animal species with ranges centred in the eastern or western parts of NSW (i.e. there is an overlap in distribution between the more coastal species and those from inland NSW). This is illustrated with the assemblage of reptiles, where there are records for the Eastern Bearded Dragon and Eastern Blue-tongued Lizard, together with the more western Shingleback Lizard and Common Dwarf Skink. Similar patterns are seen with the birds, where the more coastal Noisy Miner, Eastern Rosella and Sulphur-crested Cockatoo are recorded with the western Yellow-throated Miner, Blue Bonnet and Little Corella. In general, there is a mix of fauna with ranges centred in the eastern and western divisions of NSW (i.e. both coastal and inland species).

A list of fauna known or considered likely to occur in the Project area and surrounds is presented in Attachment JA-A, together with each species population and conservation status and preferred habitats. Mammal, bird, reptile and amphibian species recorded within the Project area during the present surveys are highlighted within the tables. The distributions of records of these species, as extracted from the NPWS data-base for the five 1:100 000 map sheets for the region are given in Attachment JA-B.

9 R.M.Cooper and I.A.W.McAllan 1995 "The Birds of Western New South Wales: A Preliminary Atlas" NSW Bird Atlassers Inc, Albury

10 D.Ayres, S.Nash and K.Baggett 1996 "Threatened Species of Western New South Wales" NPWS, Hurstville

11 N.Schrader (editor) 1988 "The Flora and Fauna of the Parkes Shire" Parkes Naturalist Group, Parkes

12 Department of Land and Water Conservation 1999 *Mid-Lachlan Regional Vegetation Management Plan* Draft Report, March 1999

JA 5.2 FAUNA RECORDED WITHIN THE PROJECT AREA

JA 5.2.1 Avifauna

Of the 209 bird species recorded as occurring in the general region, 93 (44%) were recorded within the Project area (Attachment JA-A). Four of these species are new records for the general area (not listed in the NPWS Wildlife database). These were the Red-capped Robin, Pied Honeyeater, Blue-winged Parrot and White-breasted Woodswallow.

Many species are associated with the woodland habitat, with a range of middle and upper foliage feeders (honeyeaters, robins, thornbills) and other birds utilizing the branches and hollows for perching and nesting (White-wing Chough, Eastern Rosella, pigeons). Interestingly, there were few lower storey and ground birds located within some of the woodland habitat e.g. within the mine site. This may be due to the lack of lower storey vegetation (low shrubs, forbs) within the woodland, possibly as a result of stock grazing in the area. Three nocturnal birds were encountered within the Project area - a Spotted Nightjar was disturbed from its daytime roost within Fifield State Forest, a Barking Owl was spotlighted within woodland on the ‘Sunrise’ property, and a Barn Owl was found as a road kill in an area of cropped paddocks. There were no responses to the broadcasting of calls from nocturnal birds.

Hill woodland survey sites at ‘Sunrise’ showed different habitat characteristics and bird composition to the woodland habitat within the mine site. Both areas of woodland had a tree cover of about 35%, but the woodland within the mine area had a far lower middle strata density (shrub cover 8%, sapling cover 20%) compared to the woodland at ‘Sunrise’ (shrub cover 52%, sapling cover 16%). A greater diversity of birds was located within the woodland at ‘Sunrise’ (27) than in the wooded habitat in the mine area (19).

Three threatened bird species were located within the woodland area at ‘Sunrise’ (Barking Owl, Pied Honeyeater and Pink Cockatoo). Section JA6.0 describes the distribution and habitat preferences of these species.

There is a range of birds that utilize the extensive areas of grassland habitat. The Emu, Brown Songlark, Singing Bushlark, Richards Pipit and the introduced Common Starling were located within this habitat, together with two species of ibis. A variety of parrots feed within the grassland habitat, including the Galah, Little Corella, Cockatiel, Blue Bonnet, Australian Ringneck and Red-rumped Parrot, although these birds also use the woodland habitat. Eight species of raptor were observed hunting over the grassland habitat (Australian Hobby, Little Eagle, Black-shouldered Kite, Spotted Harrier, Swamp Harrier, Brown Falcon and Nankeen Kestrel), as well as other habitats. Five Swamp Harriers were observed hunting animals (presumably insects) displaced by flood waters along a road near Jemalong. The claws of a Wedge-tail Eagle tied to a fence line were seen, indicating the former presence of this raptor.

Together with the relatively high diversity of raptors, some of these species were in large numbers. The Nankeen Kestrel and Black-shouldered Kite were commonly seen during the November survey, although only one of each species was recorded during the January survey. One possible explanation for the differences in the numbers of sightings of raptors during the two surveys may be the more productive conditions during November. There had been good seasons (i.e. higher rainfall), prior to the November survey and more food was possibly available. This is true of the House Mouse population (see section on mammals) which had increased to a pest level for grain crops. Wide ranging exploitative species, such as the ravens and Australian Magpie, were common within the grasslands. The abundance of insects within the cropped lands, particularly during harvesting, would attract many of the birds seen in this habitat (including ibis).

There are two types of water body within the mine site. The main water body is the water-filled pits left from previous mining. These are steep-sided deep bodies of water with little plant growth around the edges. The other type of water body comprises farm dams scattered throughout the cropped lands within the mine site (e.g. within MLA 113). These are shallow, with gentle sides and supporting a variety of littoral vegetation. The differences in the habitat characteristics of the two types of water body reflect on the differences in the composition of birds utilizing them.

Few bird species were observed utilising the water-filled mine pits, the dominant birds being the Australian Grebe and the Darter. Both of these birds obtain food by diving deeply, whereas other water birds obtain their food from the surface or from shallow waters. In contrast, the farm dams supported a greater diversity of birds, including four species of duck, the Pacific Heron and the Great Egret. Other birds associated with farm dams include the Sacred Kingfisher and the Welcome Swallow. The ducks feed in shallow waters and the heron and egret hunt in the shallow waters and vegetation at the edge of the dam. Despite the large areas of water associated with the mine pits, no swallows or other aerial insect feeders were observed (this does not mean that they don’t occur, but that they are probably in low numbers). It is considered that the water filled pits are not as productive as the farm dams because of the steep sides and deep waters.

Another type of water habitat is that found within the watercourses traversed by the pipeline routes. The proposed water pipeline route travels west from two borefields near Forbes and passes through floodplains associated with the Lachlan River and its tributaries. During the November survey, this area was in flood and there were many large flocks (over 100 birds) of Straw-necked and Sacred Ibis, egrets and ducks.

Bird species recorded at the mine site and at each of the infrastructure areas are presented in Attachment JA-D.

JA 5.2.2 Mammals

Six native (40% of the species known from the region) and six introduced mammals were recorded during the surveys (Attachment JA-A). The most common mammal sighted was the Eastern Grey Kangaroo. This animal was seen in the grassland and woodland habitats. Although not in high numbers, this species was sighted in groups of two to four individuals, usually family groups. All kangaroos sighted appeared to be nervous of humans and moved rapidly away when observed. It is possible that the area is visited by shooters from nearby towns (there were many shotgun cartridges near farm dams). There were several sightings of Swamp Wallabies within the shrub and woodland near the water-filled pits on the mine site and to the south of the mine site on the 'Sunrise' property. A single Red-necked Wallaby was sighted crossing the road just south of Fifield.

The only arboreal marsupial located was the Common Brushtail Possum, despite extensive spotlighting transects and the use of hair-tubes (no hair found in the tubes). There were very few smooth-barked trees with scratch marks. These were within the timber associated with the water course near the mine area, the woodland area at 'Sunrise' and within some of the habitat sites selected within the infrastructure areas. There was evidence for the presence of the Short-beaked Echidna in Fifield State Forest and in the woodland at 'Sunrise'.

Daily trapping rates were slightly higher than the normal range for inland NSW and averaged 9.8% i.e. 9.8 captures per 100 traps per day. The trapping rates for the survey are given in Table JA-3, together with flesh measurements of the animals captured. Two mammal species were trapped, the native Common Dunnart (a young male within MLA 113 and a female at the rail siding site) and the introduced House Mouse which was trapped in relatively high numbers during the January and November surveys. An immature House Mouse was also captured in a pit trap at the mine site. The number of House Mice captured accounted for the relatively high trapping rates. The mean weights and sizes for the male House Mice are slightly lower than that for the females, possibly indicating a movement by young male mice into the trapping areas.

Mammals recorded at the mine site and at each of the infrastructure areas are presented in Attachment JA-D.

TABLE JA-3: RESULTS FROM TRAPPING SURVEYS

1. % Trapping Rates i.e. number captured per 100 traps each day

Date	House Mouse	Common Dunnart	Total
January	8.0	0.5	8.5
November	10.6	0.5	11.1
Overall	9.3	0.5	9.8

2. Flesh Measurements

	Sex	Head L (cm)	Head-Body L (cm)	Tail L (cm)	Foot L (cm)	Weight (g)	Number
Common Dunnart	F	2.85	7.5	7.95	1.6	27	
	F	2.99	6.94	8.02	1.67	17	
Means for House Mouse[13]							
	M	2.33	7.03	7.87	1.78	16.0	9
	F	2.43	6.92	8.82	1.92	17.0	4

JA 5.2.3 Reptiles

A total of eleven reptile species were located during the survey (28% of species known from region, see Attachment JA-A). Most were recorded in the woodland area in ‘Sunrise’, or within the infrastructure areas. Several goannas were recorded, including a Sand Monitor, a new record for the area. Tree Dtellas were mainly located underneath the bark of fallen ironbark trees, whilst most skinks were observed sunning on logs. Few reptiles were found in the mine site and this result may fit in with the low numbers of lower storey and ground birds found in this area. The lack of low growing shrubs and forbs and the history of clearing and other disturbances in the area may discourage the use of this area by reptiles.

Reptiles recorded at the mine site and at each of the infrastructure areas are presented in Attachment JA-D.

JA 5.2.4 Amphibians

Despite systematic searches (including listening sessions at most major bodies of water) the only frog species located within the mine site was the Common Eastern Toadlet. Three species of frog were recorded at Nerathong Creek (Spotted Grass Frog, Giant Banjo Frog, Long-thumbed Frog), and the Common Eastern Toadlet was heard calling from several temporary pools beside roads.

[13] Not all House Mice captured were measured

Amphibians recorded at the mine site and at each of the infrastructure areas are presented in Attachment JA-D.

JA 5.3 HABITAT EVALUATION

JA 5.3.1 Fauna Survey Sites

There are three major natural habitat types (excluding the aquatic environment and open grassland areas) within the Project area fauna survey sites: woodland on the level plains (found in Fifield State Forest and at the rail siding site); woodland associated with the low hills to the west of Fifield ('Sunrise'); and vegetation associated with indefinite water courses (MLA 113). The characteristics within these three habitat types are given in Table JA-4.

TABLE JA-4: CHARACTERISTICS OF THE THREE HABITAT TYPES

1. Defined by trap sites

Habitat Characteristic	Plains Woodland	Hill Woodland	Indefinite Watercourse
UPPER STOREY			
% Tree cover	39	35	52
MIDDLE STOREY			
% Saplings	20	16	16
%Shrubs	8	52	0
No middle storey	72	32	84
LOWER STOREY			
%Grass	51	43	56
% Forbs	22	40	0
No lower storey	27	17	44
GROUND COVER			
% Litter	64	95	100
No litter	36	5	0
% Logs	6	20	32

2. Defined by transects

Habitat Characteristic	Plains Woodland	Hill Woodland	Indefinite Watercourse
Tree density (trees/ha)	461	688	550
Tree height (m)	7.9	7.6	15.4
Tree DBH (cm)	31.4	18.2	34.9
% of trees with holes	25	3	18
Stag density (stags/ha)	0	106	150
Shrub density (shrubs/ha)	441	1218	0
Shrub height (cm)	136	134	-
Sapling density (saplings/ha)	970	134	1450
Sapling height (cm)	198	317	728
Log density (logs/ha)	268	235	150
Log area (cm^2)	5230	7153	4066
% Grass cover	12.5	8.5	20.4
% Forb cover	22	16	9
Grass height (cm)	24.1	20.5	27.4
Forb height (cm)	29.9	20.5	15.6
Litter weight (g/m^2)	458	700	1176

Analysis of the results of the habitat survey for the fauna survey sites shows the small patch of vegetation associated with an indefinite watercourse within MLA 113 contains older trees (larger) and more stags and saplings than the two woodland types. It has a lower density of logs but a higher litter cover and weight than the other areas. This area of vegetation is a patch of timber remaining after the surrounding land has been cleared for cropping. It possibly represents the type of timber cover associated with low lying areas that originally occurred in the region. However, the patch has been disturbed over the years, probably by grazing stock resulting in a loss of middle and lower storey vegetation (low shrub and forb cover).

Fauna surveys within the mine site did not reveal a high productivity. No native ground or arboreal mammals were located during the surveys (this does not mean that they aren't there, rather they may be in low numbers) and the bird diversity was not as high as within the other woodland sites. The small area of the site, combined with a history of disturbance by stock, may have kept faunal diversity low. The relatively high numbers of the introduced House Mouse caught at this site also indicates a disturbed environment.

Comparison between the areas of woodland on the plains and that on the hills in the Project area shows that the hill woodland supported a greater density of trees, although these appeared to be younger than those on the plains (Table JA-4). The larger diameter of the trees, and the higher proportion of trees with hollows, are indicators of more mature trees. However, there were no stags within the plains woodland sites. The hill woodland had a slightly better middle and lower storey vegetation cover, as well as a higher log cover, litter cover and litter weight. Such differences in these habitat characteristics indicate better faunal diversity in the hill woodland compared to the plains woodland. As pointed out above, the number of bird species observed was higher in the hill woodland area. Three threatened species were recorded from a hill woodland site (on the 'Sunrise' property) compared to none in the plains woodland sites.

JA 5.3.2 Assessment of Habitat Characteristics by Transect

The results of the transect habitat assessments are shown in Table JA-5 and detailed information about the habitat characteristics of each site sampled are given in Attachment JA-C. The sixteen sites sampled within the mine and infrastructure areas are taken as representative of many of the small and large remnants found in the Project area.

Table JA-5 shows that there are four sites that are considered to have high habitat values. These are:

- G34, a small patch of woodland along the gas pipeline route associated with Nerathong Creek;
- W2, a small patch of woodland along the water pipeline route south of Fifield; and
- Two sites (S1 and S3 of the woodland fauna survey sites) in the 'Sunrise' property.

There are eight sites considered to have moderate habitat values. These are:

- G30, very small patch of mature trees beside the road;
- G39, small patch of trees on western side of road, cleared on eastern side;
- W6, a strip of timber along the water pipeline route near 'Pleasant View';
- Site S2 of the woodland fauna survey sites on the ‘Sunrise’ property;
- R64/1, a line of timber along Route 64;
- R64/4, a line of timber along Route 64;
- M1, a woodland survey site in the mine area, in Fifield State Forest; and
- M2, a woodland survey site in the mine area, within MLA 113.

The remaining four sites (G41, G25, G28 and rail siding) are considered to have low conservation values.

Figure JA-3 shows the location of the above sites.

TABLE JA-5: ASSESSMENT OF TRANSECT HABITAT CHARACTERISTICS

SITES	Tree Height	Tree Density	DBH	% Holes	Log Area	Log D	Litter Wt	% Grass	% Forb	Sapling D	Stag D	Shrub D	Sapling Ht	Grass Ht	Forb Ht	Shrub Ht	% Litter	TOTAL	Bird S.R.	FINAL SCORE	RANK
G30	H	L	H	M	H	L	H	H	L	L	M	L	L	M	M	M	H	34	6	40	M
G34	M	M	M	L	H	M	M	M	H	M	M	L	M	M	M	M	M	33	14	47	H
G39	M	M	H	M	M	M	M	M	H	L	L	M	L	M	H	M	M	33	6	39	M
G41	M	L	H	M	L	M	L	L	H	L	L	M	L	M	H	L	M	28	9	37	L
G25	L	L	L	L	L	L	L	H	L	L	L	H	L	L	L	L	L	10	4	14	L
G28	M	M	M	L	H	L	M	L	L	L	L	M	L	L	M	L	M	22	6	28	L
W2	H	L	H	H	M	M	M	H	M	M	M	M	M	M	M	H	M	38	10	48	H
W6	M	M	M	L	H	L	M	H	M	L	L	M	M	M	M	H	M	32	8	40	M
S3	M	H	M	L	H	H	M	M	M	M	H	H	M	M	M	M	M	37	13	50	H
S2	M	H	M	L	M	H	M	M	M	M	L	H	M	L	M	M	M	33	11	44	M
S1	M	M	M	M	M	M	H	L	L	M	H	H	H	L	M	M	H	36	10	46	H
RAIL SIDING	M	L	H	M	M	L	L	M	H	M	L	M	H	M	M	M	L	31	5	36	L
R64/1	L	M	M	M	M	L	M	M	M	M	L	M	L	H	M	M	M	30	8	38	M
R64/4	M	M	M	M	L	M	M	M	M	M	M	L	M	H	M	M	H	34	5	39	M
M1	M	H	M	L	H	H	M	L	M	H	L	M	L	L	H	M	M	32	9	41	M
M2	H	M	M	M	M	M	H	M	M	H	H	L	H	M	M	L	H	36	7	43	M

JA 5.3.3 Visual Assessment of Vegetation Remnants

- Mine Site

The mine site mainly comprises highly disturbed land that has been affected by previous clearing, logging and/or mining activities. The few patches of natural vegetation remaining also show signs of disturbance. The woodland at Fifield State Forest has been logged and possibly cleared in the past, and consists almost entirely of regrowth trees. The patches of woodland within MLA 113 have been selectively logged in the past. The small stand of creek woodland within the mine site is cut by numerous tracks. Although this patch does have some characteristics of habitat in good condition (i.e. trees with hollows, good litter cover), the dominance of the ground mammal fauna by the introduced House Mouse indicates a disturbed habitat. Both habitat sites within the mine area (M1 and M2) are ranked as having moderate habitat value.

The productivity of the water-filled mine pits, in terms of avifauna, is very low. Considering the relatively large size and volume of water in an otherwise dry environment, it is remarkable that there is little use by fauna. However, the steep sides and deep water may discourage their use by many animals.

The proximity of several small towns to the mine site, has resulted in the use of the site for recreational purposes (including shooting and trail bikes). In addition, the amount of clearing, logging, mining and farming has led to land that can only be considered to be of low to moderate habitat value. The development of the area as an open cut mine will result in some loss of natural habitat and associated fauna, but these changes cannot be regarded as significant.

- Gas Pipeline Route

The gas pipeline route travels north from the existing Sydney to Moomba Gas Pipeline north of Ungarie to the mine site, a length of approximately 90 km. Descriptions of 49 sections of the route, based upon a 20 m wide survey limit are provided below. The sections are shown in Figure JA-3.

G1: Cleared cropped land between Fifield Road and road to “Eulegal”. Habitat value low.

G2: Cleared grazed land beside road to “Eulegal”. Supporting chenopods and grasses. Habitat assessment indicates low value (see Table JA-5).

G3: Timbered area in paddock on “Eulegal”. Most timber is regrowth, with few old trees remaining. Habitat assessment shows low value (see Table JA-5).

G4: Cleared land with a scatter of timber between road to “Eulegal” and Sydney to Moomba gas pipeline route. Habitat value low.

G5: Extensive area of woodland, some of which is in good condition. Ranked as having moderate to high habitat value. Three threatened bird species were recorded in this area. (No longer situated on the pipeline route – refer Figure JA-3).

G6: Cleared grazed area within the “Sunrise” property. Low habitat value. (No longer situated on the pipeline route – refer Figure JA-3).

G7: Some scattered mature trees at the trigonometry station could be avoided, if an alternative route is selected. Moderate habitat value. (No longer situated on the pipeline route – refer Figure JA-3).

G8: Cleared grazed land next to Fifield Road. Low habitat value.

G9: Area of woodland and cleared land along the boundary of "Eulegal". Moderate habitat value where timbered, and low habitat value in cleared land.

G10: Cleared land. Low habitat value.

G11: Some scattered trees within paddock. Considered of low to moderate value.

G12: Cleared land. Low habitat value.

G13: Natural bushland on each side of the road, including some good habitat trees and dense shrubs. Considered of moderate habitat value. The western side is in better condition than the eastern side. Parts of the eastern side are cleared.

G14: Mainly cleared with the occasional good habitat tree. Overall, low habitat value.

G15: Scattered trees on both sides. Considered as low to moderate value.

G16: Small patch of good habitat trees should be avoided where possible. Moderate habitat value.

G17: Mainly cleared, low habitat value.

G18: Good stand of trees on western side of road. Moderate habitat value. Cleared on eastern side.

G19: Cleared, low habitat value.

G20: Good habitat trees on western side of road for more than 7km, on eastern side for about 6km. This line of timber forms a good corridor extending from the Murda State Forest. Considered of high habitat value.

G21: Dense trees on western side, within Murda State Forest. Cleared on eastern side. Low habitat value.

G22: Young trees and shrubs on western side, cleared on eastern side. Low to moderate habitat value.

G23: Scattered trees on western side, cleared on eastern side. Low to moderate habitat value.

G24: Springvale Road to Condobolin, cleared land with few trees. Low habitat value.

G25: A clear strip of land along Goobang Creek, currently used for horse grazing. Low habitat value.

G26: Scattered large habitat trees along the Lachlan River near Condobolin. Moderate habitat value.

G27: Area of cleared land associated with showground. Low habitat value.

G28: Narrow strip of planted trees surrounded by cleared paddocks, with some young naturally regenerating trees. Considered of low habitat value.

G29: Cleared land. Low habitat value.

G30: Very small patch of mature trees beside the road. Survey results ranked patch as moderate habitat value.

G31: Cleared land. Low habitat value.

G32: Scattered large trees and stags beside water hole crossed by road. The timber is mainly on the western side of the road. Moderate habitat value.

G33: Cleared and cropped land. Low habitat value.

G34: A good stand of mature trees on each side of Nerathong Creek. Ranked as having high habitat value.

G35: Cleared land. Low habitat value.

G36: Patch of scattered trees close to road. Low to moderate habitat value.

G37: Small patches of dense trees and scattered trees on western side of road, cleared on eastern side. Low to moderate habitat value.

G38: Line of mature trees along Wallamundry Creek, on both sides of the road. Individual trees should be avoided, where possible. High habitat value for trees.

G39: Small patch of trees on western side of road, cleared on eastern side. Ranked as having moderate habitat value.

G40: Good habitat trees beside Wallaroi Creek at road crossing. The eastern side is mainly clear. Moderate to high habitat value.

G41: Small remnant patch of woodland, mainly on the eastern side. Ranked as having low habitat value, but contains several nests and tree hollows.

G42: Scattered trees on each side of the road. There is an existing track through the middle of this patch on the eastern side that could be used for the route. Low to moderate habitat value.

G43: Changes to hard soils and mallee vegetation. Much of this patch is regrowth with some scattered large trees of good habitat value. It is recommended that the pipeline be positioned close to the road so that individual mature trees are avoided, where possible. Low to moderate habitat value.

G44: Scattered trees within mainly cleared land. Low to moderate habitat value.

G45: Small patch of scattered timber on eastern side, with fewer trees on western side. Moderate habitat value.

G46: Line of trees at the crossing of Humbug Creek. Many of these trees are good habitat trees. Moderate to high habitat value.

G47: Long length of dense shrubs and trees (mainly casuarina) on both sides of road. Contains mistletoe and high bird usage. Considered habitat of high value. However, old cleared track on eastern side that could be used. Otherwise avoid if possible.

G48: Line of shrub with some trees. Similar to G47, but not as well developed, particularly on the southern side of the road. Habitat considered of moderate value.

G49: Scattered trees and tall shrubs on each side of road. The reserve is narrow (about one tree wide) and the habitat value is considered moderate, but it is considered an important corridor and it contains the only trees in area.

- Water Pipeline Route

The water pipeline route travels approximately north from two borefields at “Astron Park”, west of Forbes, to the mine site near Fifield, a length of about 65 km (Figure JA-3). A description of the route based on a 20 m wide survey limit follows. The location of each section described is shown in Figure JA-3.

W1: Located at the junction between Route 64 and the water pipeline route. Young pine trees on each side of the road, with older pine trees on the eastern side. Low to moderate value habitat.

W2: Line of good habitat trees and shrubs on each side of the road. Ranked as having high habitat value.

W3: Scatter of good habitat trees. Habitat classed as having moderate value.

W4: Scattered trees along road, with fewer on western side. Habitat of low to moderate value.

W5: Small patch of timber (mallee and ironbark), mainly on western side. Low to moderate habitat value.

W6: Many good habitat trees, particularly on eastern side of road. Scattered trees in surrounding paddocks. Ranked as having moderate habitat value.

W7: Less tree cover on top of hill, but remainder considered as good habitat. Moderate to high habitat value.

W8: Continuation of line of trees and shrubs on each side of road, with some cleared areas on eastern side. Moderate habitat value.

W9: Corridor of trees to the east joining the corridor along the road with a large patch of woodland habitat. Moderate to high habitat value.

FROM W6 TO W9

The line of trees and shrubs between W6 and W9 is considered to be an excellent corridor. It is recommended that the disturbance of vegetation in this area be kept to a minimum where ever possible.

W10: Trees becoming more scattered and mainly young and old pine. Habitat considered as low to moderate.

W11: Scattered trees and shrubs. Considered low habitat value.

W12: Scattered trees and shrubs within a wide reserve. Considered of low to moderate habitat value.

W13: Patch of good quality woodland with mature trees. Moderate to high habitat value.

W14: Few scattered trees and shrubs within a wide reserve. Low to moderate habitat value.

W15: Small area of planted native trees outside road reserve. Habitat value of reserve considered low.

W16: Mainly cleared land, with some scattered trees and shrubs. Low to moderate value.

W17: Good stand of mature habitat trees beside Goobang Creek. Trees considered of high habitat value. It is recommended that the pipeline be positioned as close to road and bridge as possible.

W18: Cleared grassland, with some scattered trees. Low habitat value.

W19: Dense stand of trees between Bumbuggan Creek and road. Cleared on western side i.e. between road and Mulguthrie Mountain. Habitat value low on west and high on east of the road.

W20: Cleared grassland with some scattered trees. Low habitat value.

W21: Scattered trees on both side of the road. Considered to be of low to moderate habitat value.

Where the pipeline route passes across the floodplains of the Lachlan River most of the habitat is grassland and is considered of low value.

W22: The borefields at “Astron Park” are within a large area of cleared and cropped grassland, with a scatter of low shrubs and an occasional tree. Considered as having a low habitat value.

- Route 64

Route 64 will be upgraded as a component of the Project. At present, the road is sealed, but is narrow for much of its length. During the time of the survey, the local council was removing many of the shrubs and young trees growing beside the road, as it was becoming unsafe for passing traffic. Descriptions of habitats along Route 64 follow, based upon a 20 m wide survey limit (the locations are shown on Figure JA-3).

R64/1: Scattered trees, many young with a few mature trees. Little understorey but dense grasses. The line of trees extends for about 6km, with some gaps of cleared reserve. Survey ranked the habitat value as moderate.

R64/2: Scattered trees, regrowth shrubs as well as saplings. Habitat value considered low.

R64/3: Scattered trees and shrubs, with some old trees and shrubs. This area has been cleared close to the road. Habitat value considered low.

R64/4: Cleared reserve, then scattered trees and regrowth shrubs. A narrow line of trees (some old habitat trees) close to fence. Survey ranked the habitat value as moderate.

R64/5: Scattered timber within a wide road reserve south of Fifield. Many of the shrubs have been cleared. Habitat value considered moderate.

- Fifield Bypass

B1: Mainly cleared with some scattered trees, saplings and shrubs beside road. Low habitat value.

B2: Small area of regrowth timber. Moderate habitat value.

B3: Cleared. Low habitat value.

B4: Cleared paddock, grassland with some scattered trees. Low habitat value.

B5: Small area of cypress pine trees, with ploughed ground underneath. Low habitat value.

B6: Cleared and cropped land with some scattered trees. Low habitat value.

- Limestone Quarry

The limestone quarry is to be located within a small area of cleared land adjacent to Route 64 (Figure JA-3). This area comprises improved grassland of low habitat value.

- Rail Siding Site

The rail siding area situated to the north of Trundle and to the east of the junction of Route 64 with the Tottenham Bogan Gate Road. The site supports an open woodland of box and pine, and a relatively dense ground cover of grasses. The area has been disturbed over the years by clearing and grazing and is ranked as having a low habitat value.

JA 6.0 THREATENED SPECIES

There is a total of 15 threatened species (excluding bats) known from the general region containing the Project area ("locality") and another 20 are predicted to occur in the region based on climate (Table JA-6). The distribution of records of threatened species taken from the NPWS Atlas of NSW Wildlife database is shown in Figures JA-4a and JA-4b. The list of 35 threatened species is given in Table JA-6.

Table JA-6
Threatened Species Known and Considered Likely to Occur in the General Region[14]

Common Name	Scientific Name	Schedule[1]	Known or Predicted
Brolga	*Grus rubicundus*	2	Known
Australian Bittern	*Botaurus poiciloptilus*	2	Predicted
Australian Bustard	*Ardeotis australis*	1	Predicted
Painted Snipe	*Rostratula benghalensis*	2	Predicted
Bush Stone-curlew	*Burhinus magnirostris*	1	Known
Malleefowl	*Leipoa ocellata*	1	Known
Black-necked Stork	*Ephipporhynchus asiaticus*	2	Predicted
Magpie Goose	*Anseranas semipalmata*	2	Known
Glossy Black-cockatoo	*Calyptorhynchus lathami*	2	Known
Red-tailed Black-cockatoo	*Calyptorhynchus magnificus*	2	Predicted
Pink Cockatoo	*Cacatua leadbeateri*	2	Known
Turquoise Parrot	*Neophema pulchella*	2	Known
Superb Parrot	*Polytelis swainsonii*	2	Known
Swift Parrot	*Lathamus discolor*	2	Known
Freckled Duck	*Stictonetta naevosa*	2	Known
Blue-billed Duck	*Oxyura australis*	2	Predicted
Gilberts Whistler	*Pachycephala inornata*	2	Predicted
Black-breasted Buzzard	*Hamirostra melanosternon*	2	Predicted

Table JA-6 (Continued)
Threatened Species Known and Considered Likely to Occur in the General Region[15]

[14] General Region covers the following 1:100 000 topographic maps: Tullamore, Peak Hill, Bogan Gate, Condobolin and Boona Mount, NSW Atlas of NSW Wildlife

Common Name	Scientific Name	Schedule[1]	Known or Predicted
Grey Falcon	*Falco hypoleucos*	2	Predicted
Osprey	*Pandion haliaetus*	2	Predicted
Square-tailed Kite	*Lophoictinia isura*	2	Predicted
Masked Owl	*Tyto novaehollandiae*	2	Predicted
Barking Owl	*Ninox connivens*	2	Known
Painted Honeyeater	*Grantiella picta*	2	Known
Regent Honeyeater	*Xanthomyza phrygia*	1	Predicted
Pied Honeyeater	*Certhionyx variegatus*	2	Predicted
Plains Wanderer	*Pedionomus torquatus*	1	Predicted
Koala	*Phascolarctos cinereus*	2	Known
Squirrel Glider	*Petaurus norfolcensis*	2	Known
Kultarr	*Antechinomys laniger*	1	Predicted
Tiger Quoll	*Dasyurus maculatus*	2	Predicted
Brush-tailed Phascogale	*Phascogale tapoatafa*	2	Known
Stripe-faced Dunnart	*Sminthopsis macroura*	2	Predicted
Brush-tailed Rock-wallaby	*Petrogale penicillata*	2	Predicted
Western Blue-tongued Lizard	*Tiligua occipitalis*	2	Predicted

[1] Listed under Schedule 1 or 2 of the *Threatened Species Conservation Act, 1995.*

Three threatened species were located during the fauna surveys, all within the woodland area on 'Sunrise' property *viz*. the Barking Owl, Pied Honeyeater and the Pink Cockatoo. The distribution and habitat preferences of the three species are presented below.

Barking Owl *Ninox connivens*

Mainly found in eastern NSW, with scattered records from the eastern part of the Western Division. Hunts within woodlands and open country and nests in tree hollows. An individual was spotlighted within the woodland area on the 'Sunrise' property (32°48'43"S, 147°23'22"E). This woodland area will not be affected by the proposed development.

Pied Honeyeater *Certhionyx variegatus*

Found throughout western NSW and associated with acacia shrub, mallee, spinifex and eucalypt woodlands. Mainly feeds on *Eromophila.* An individual observed flying into woodland area at 'Sunrise' (32°48'36"S, 147°23'37"E). This woodland area will not be affected by the proposed development.

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[15] General Region covers the following 1:100 000 topographic maps: Tullamore, Peak Hill, Bogan Gate, Condobolin and Boona Mount, NSW Atlas of NSW Wildlife

Pink Cockatoo *Cacatua leadbeateri*

Occurs throughout western NSW, east to Parkes and Griffith. Utilizes a variety of habitats, including mulga, mallee, cypress pine and casuarina woodlands, as well as grasslands near tree-lined watercourses. Uses large hollow limbs or holes in trees for nesting. A single bird was located on a tree in woodland on ‘Sunrise’ property (32º48’54”S, 147º23’09”E). This woodland area will not be affected by the proposed development.

Eight Part Tests of Significance have been conducted for a list of 18 threatened species known or considered likely to occur in the Project area and surrounds (including the three threatened bird species recorded during the surveys), and are presented in Appendix JB of the EIS.

JA 7.0 POTENTIAL IMPACTS OF THE PROJECT UPON TERRESTRIAL FAUNA

JA 7.1 MINE CONSTRUCTION AND OPERATION

Vegetation/Habitat Clearance

The major potential impact on fauna from the construction and operation of the Syerston Project would be from the loss of habitat. The removal and/or modification of areas of habitat relate to loss of resources that contribute to the lifecycle components of fauna (ie. breeding, foraging, dispersal etc.).

Table JA-7 presents the disturbance to the dominant vegetation types within the mine site.

Table JA-7
Disturbance of Dominant Vegetation Types

Dominant Vegetation Type	Existing (ha) Approx.	Disturbance (ha) Approx.
Endemic woodland	600	320
Cleared land with small disjunct patches of Wilga/Rosewood	150	75
Cleared grazing/cropping land with isolated trees	1,870	1,030
Land previously disturbed by mining with regenerating cypress pine and high incidence of weeds	40	25
Total Area	2,665*	1,450

* Addition error due to rounding

A relict of past and present land use, Table JA-7 indicates that the mine site is characterised by cleared grazing/cropping land with isolated trees (approximately 1,030 ha), areas of open woodland, disjunct patches of woodland and land previously disturbed by mining.

The habitat values within the mine site are considered to be mainly low, with some moderate habitat values associated with Fifield State Forest and a small patch of woodland within MLA 113.

The rehabilitation programme proposes to establish a greater extent of endemic vegetation on the mine site, which would increase the habitat opportunities for terrestrial fauna. The proposed rehabilitation programme for the mine site is detailed in Section A5 of the EIS.

The faunal assemblages located in the mine area during the surveys are not considered to be either diverse or unusual. The proposed loss of habitat within the mine area should not significantly affect the overall conservation of any faunal community or individual species, either locally or regionally.

Feral Species

There is potential for feral animals to be attracted to the mine site due to discarded food scraps and other rubbish, as well as non-participation in regional control programmes (eg. baiting, culling etc.). To discourage scavenging and reduce the potential for an increase in the population or concentration of feral animals in and around the mine site, it is recommended that a clean, rubbish-free environment be maintained, particularly around administration areas.

Noise Emissions

The proposed development has the potential to increase the existing level of noise during construction and operation and disrupt vertebrate fauna. Whilst some specific studies of the effects of noise on wildlife are reported in the scientific literature (Shaw, 1978[16]; Busnel, 1978[17]; Ames, 1978[18]; Lynch and Speak, 1978[19]; Allaire, 1978[20]; Streeter *et. al*, 1979[21]; Algers *et. al*, 1978[22]) there are no guidelines on the noise levels that may disturb or affect vertebrate fauna. The studies however, indicate that many species are well adapted to human activities and noises. Birds tend to habituate to constant steady noises, even of a relatively high level in the order of 70 decibels (dBA) (Richard Heggie Associates, 1997[23]).

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16 Shaw, E.A.G. (1978) *Symposium on the Effects of Noise on Wildlife* in Fletcher, J.L & Busnel, R.G. (Eds) *Effects of Noise on Wildlife*.

17 Busnel, R.G. (1978) *Introduction* in Fletcher, J.L & Busnel, R.G. (Eds) *Effects of Noise on Wildlife*.

18 Ames, D.R. (1978) *Physiological Responses to Auditory Stimuli* in Fletcher, J.L & Busnel, R.G. (Eds) *Effects of Noise on Wildlife*.

19 Lynch, T.E. & Speake, D.W. (1978) *Eastern Wild Turkey Behavioural Responses Induced by Sonic Boom* in Fletcher, J.L & Busnel, R.G. (Eds) *Effects of Noise on Wildlife*.

20 Allaire, P.N. (1978) *Effects on Avian Populations Adjacent to an Active Strip Mine*. Symposium on Surface Mining and Fish/Wildlife Needs in Eastern United States, West Virginia.

21 Streeter, I.P., Moore, R.T., Skinner, J.J., Martin, S.G., Terrel, T.L., Klimstra, W.D., Tate, J. Jnr and Nolde, M.J. (1979) *Energy Impacts and Wildlife Management: Which Way to Turn*? Proc. of the 44th North American Wildlife Conference.

22 Algers, B. et. al (1978) *The Impact of Continuous Noise on Animal Health*. Acta Veterinaria Scandinavia Suppl. 67 in Richard Heggie Associates (1997) *Cowal Gold Project Noise, Transportation and Blasting Impact Statement*. Report prepared for North Limited.

23 Richard Heggie Associates (1997) *Cowal Gold Project Noise, Transportation and Blasting Impact Statement*. Report prepared for North Limited.

Artificial Lighting

Little information is available on the potential impacts of lighting on wildlife. Potential impacts of the development are likely to relate to the alteration of forage zones, primarily for insectivorous bird species. Birds such as the Australian Owlet-nightjar (*Aegotheles eristatus*) and Kookaburra (*Dacelo novaeguineae*) are known to forage on insects around lights, and studies have shown that insects can be up to 40 times more prevalent around lights (street lights, low and high pressure sodium lamps) (Rydell, 1992[24]; Blake *et. al*., 1994[25]; Hickey and Fenton, 1990[26]).

Tailings, Surge Dam and Evaporation Pond Water

Large water bodies, including those that are man-made (such as evaporation basins and tailings storage facilities) have the potential to attract wildlife, particularly water birds (Roberts, 1995[27]; Bradford *et. al*, 1991[28]; Tanji *et. al*, 1992[29]; Tanner *et. al*, 1999[30]). The Syerston Project would include a tailings storage facility (approximately 215 ha), evaporation ponds (approximately 120 ha) and an evaporation surge dam (approximately 60 ha).

The tailings slurry produced from the process plant would be characterised by solids concentration of 48%, total dissolved solids (TDS) concentration of approximately 26,600 mg/L, and a temperature of approximately 80°C. Analysis of tailings indicates that the major constituents would include iron oxides, aluminium sulphate ($AlSO_4$ - alunite), calcium sulphate ($CaSO_4$ - gypsum) and silica, while the tailings liquor would principally consist of magnesium sulphate ($MgSO_4$ -Epsom salts) and calcium sulphate ($CaSO_4$ - gypsum).

Decanted waters removed from the tailings storage facility would be discharged into the evaporation pond system for evaporative disposal. The decanted waters would contain high levels of magnesium sulphate and calcium sulphate. The TDS concentration in the evaporation pond would remain between 100,000 – 200,000 mg/L. Only small volumes of liquor are to be transferred to the surge dam during the first 4 years, while the evaporation ponds fill. TDS concentrations in the surge dam would rise to the saturation level of 360,000 mg/L. These salts would crystalise out when salt concentrations are reached due to evaporative concentration.

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24 Rydell, J. (1991) Seasonal Use of Illuminated Areas by Foraging Northern Bats *Eptesicus nilssoni*. *Holarctic Ecology* 14: 203-207 in Greg Richards and Associates Pty Ltd (1997) *Cowal Gold Project: Significance of Operations on Threatened Bat Species.*

25 Blake, D., Hutson, A.M., Racey, P.A., Rydell, J & Speakman, J.R. (1994) Use of Lamplit Roads by Foraging Bats in Southern England. Journal of Zoology, London 234: 453-462 in Greg Richards and Associates Pty Ltd (1997) *Cowal Gold Project: Significance of Operations on Threatened Bat Species.*

26 Hickey, M.B.C & Fenton, M.B. (1990) Foraging by Red Bats (Lasiurus borealis): Do Intraspecific Chases Mean Territoriaility? *Canadian Journal of Zoology* 68: 2477-2482 in Greg Richards and Associates Pty Ltd (1997) *Cowal Gold Project: Significance of Operations on Threatened Bat Species.*

27 Roberts, J. (1995) Evaporation Basins are Wetlands. *Australian Journal of Environmental Management* March, pages 7 – 18.

28 Bradford, D.F., Smith, L.A., Drezner, D.S. and Shoemake, J.D. (1991) Minimizing contamination hazards to waterbirds using agricultural drainage evaporation ponds. *Environmental Management* 15(6): 785-795.

29 Tanji, K.K., Ong, C.G.H., Dahlgren, R.A. and Herbel, M.J. (1992) Salt Deposits in Evaporation Ponds: An Environmental Hazard? *Calif. Agric*. 46(6): 18-21.

30 Tanner, R., Glenn, E.P. and Moore, D. (1999) Food chain organisms in hypersaline, industrial evaporation ponds. *Water Environment Research* 71 (4): 494-505.

The available literature resources indicate the concentrations of magnesium sulphate (Epsom salts) and calcium sulphate (gypsum) in the storage facilities are not dissimilar to that found in some saline lake ecosystems of the world. Gypsum is precipitated from saline lakes in many parts of Australia including the salt lakes of southern South Australia (Warren, 1982[31]). Over 4 billion tonnes is estimated in Lake Eyre (,Hammer, 1986[32]). Calcium sulphate deposits are also found in the Dead Sea (Neev & Emery, 1967[33]), Chilean Altiplano (Hurlbert *et al*, 1976[34]) and Spanish saline lakes (Mur, 1978[35]). Magnesium sulphates are present in some saline lakes in Australia with concentrations ranging from 500 mg/L to 370,000 mg/L at saturation. Goodenough Lake in British Columbia and Hot Lake in Washington State contain almost pure concentrations of the salts (Hammer, 1986).

Very little information on mammal associations with salt lakes per se is available in the literature, however it is suggested that adequate vegetation for food must be present before use or colonisation could occur (Hammer, 1986).

Fish survival in saline lakes is limited by salinity as well as by specific ion concentrations (Hammer, 1986). There is usually limited access of fish species to saline lakes since they are located in closed basins. Increasing salinities are also known to limit the species diversity of invertebrates, and in turn, the species diversity of birds (*ibid*.). Birds are more likely to be attracted to and to utilise the numerous sediment and stock dams which would be available on the mine site (providing freshwater, with vegetated surrounds) than the unvegetated hot and exposed $MgSO_4$/$CaSO_4$ storage facilities. Although the storage facilities are not expected to be harmful to bird life, it is recommended that the storage facilities be inspected daily for fauna, as a precautionary measure, during the course of normal daily maintenance inspections. In the unlikely event that the storages become a focus for avifauna, additional hazing techniques (as adopted in the mining industry elsewhere) could be considered to minimise bird usage of the storages.

At the completion of mining, the tailings storage facility would most likely be rehabilitated with endemic woodland species while the evaporation ponds are proposed to be rehabilitated with pasture species. The surge dam, sediment dams and stock dams located on the mine site would remain as waterbodies. The rehabilitation philosophy and objectives for the mine site are outlined in Section A5 of the EIS.

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31 Warren, J.K. (1982) The hydrological setting, occurrence and significance of gypsum, in late Quaternary salt lakes in South Australia. *Sedimentology* 29: 609-637.

32 Hammer, U.T. (1986) *Saline Lake Ecosystems of the World*. Dr W. Junk Publishers, Dordrecht.

33 Neev, D. and Emery, K.D. (1967) The Dead Sea. Depositional processes and environments of evaporites. Israel Geol. Surv. Bull. 41, 147 pp in Hammer, U.T. (1986) *Saline Lake Ecosystems of the World*. Dr W. Junk Publishers, Dordrecht.

34 Hurlbert, S.H., Berry, R.W., Lopez, M. and Pezzani, S. (1976) Lago Verde and Lago Flaco: Gypsum-bound lakes of the Chilean Altiplano. *Limnol. Oceanogr*. 21: 637-645.

35 Mur, J.J.P. (1978) La precipitacion evaporica actual en las lagunas saladas del area: Bujaraloz, Sastago, Caspe, Alcaiz y Calanda (provincias de Zaragoza y Isruel). *Rev. Inst. Invest. Geol. Dip. Prov. Univ. Barcelona* 33: 5-56 in Hammer, U.T. (1986) *Saline Lake Ecosystems of the World*. Dr W. Junk Publishers, Dordrecht.

JA 7.2 CONSTRUCTION OF THE GAS AND WATER PIPELINES

JA 7.2.1 Removal of Habitat

The gas and water supply pipelines would be located within existing road corridors and would be designed to minimise the disturbance of trees and shrubs (ie. located within cleared areas where practicable). Notwithstanding, and due to the narrow width of some sections of the corridor, the construction of pipelines would necessitate the removal of some trees and middle and lower storey vegetation within the patches of remnant woodland identified during the surveys. It is estimated that there are more than 50 patches of trees along both routes. These patches range from scattered trees with densities less than 10 per ha to areas of trees with densities over 1000 trees per ha.

Removal of trees and shrubs as a result of pipeline construction would not be widespread and would not have a significant affect upon much of the existing habitat quality along the route corridors. Any trees of high habitat value (large, hollow bearing trees) are to be avoided, where possible. If there is the likelihood of the removal of any hollow-bearing trees, then it is recommended that these are inspected prior to disturbance and any animals found be relocated to suitable alternative habitat.

Some areas of bushland are considered to be of high habitat value and Black Range Minerals have advised that these areas are to be avoided or care adopted when laying the pipelines. These are:

G5:	Woodland within the "Sunrise" property (selection of an alternative route would avoid this remnant vegetation);
G20:	Continuous strip of woodland between "Elswick" and Murda State Forest, on Springvale Road;
G34:	Stand of trees on Nerathong Creek;
G38:	Stand of trees on Wallamundry Creek;
G40:	Trees on Wallaroi Creek;
G46:	Trees on Humbug Creek;
G47:	Length of shrubs along road between 'Burragong' and turn-off to gas pipeline;
W2:	Line of trees along road near turn-off from Route 64;
W6-W9	Line of trees along road between 'Pleasant View' and Kars;
W13:	Patch of woodland with mature trees, near 'Tilga'; and
W17:	Trees beside Goobang Creek.

In order to provide an estimate of the proportion of each habitat category (ie. high, moderate-high, moderate, low-moderate and low) in the road reserves, each route was digitized and the length of each section measured and described. The distance of each section was derived from a vehicle tripmeter and was not as accurate as the use of aerial photography. However, the relative sizes of the sections do provide an idea of the amount of habitat that would be traversed during the pipe-laying activities.

This analysis showed that the pipeline routes are composed of habitats of different values in the following proportions:

HABITAT VALUE	% OF ROUTE
High	10.7
Moderate-High	4.4
Moderate	28.7
Low-Moderate	15.9
Low	40.42

About 15% of the gas and water pipeline routes comprise habitat considered to have a relatively high value. It is recommended that care be taken when constructing the pipeline in these sections.

JA 7.2.2 Creation of Barriers to Movement

There is considerable information about the values of corridors to flora and fauna in Australia (Saunders and Hobbs, 1991[36]). A corridor has been defined as a "linear two-dimensional landscape element that connects two or more patches of wildlife habitat that have been connected in historical time" (Soule and Gilpin, 1991[37]).

The values of corridors include their use as:

- a means of dispersal of animals (and plants);
- a representation of a region's vegetation and fauna;
- habitat for wildlife;
- habitat for rare or threatened species; and
- a buffer against genetic isolation of populations.

Many road reserves are valuable strips of native vegetation in an otherwise altered landscape and provide corridors for wildlife. A potential impact associated with the gas and water pipelines is that the removal of trees during construction and maintenance of the pipelines can create a 'gap' in the linear habitat.

Often such a gap may not be important. Birds and larger arboreal mammals can still travel along the corridor without too much exposure to predators. However, the smaller animals (eg. reptiles, mice) need to have ground cover to avoid predation. Studies on road construction have shown that roads through natural habitat can create a barrier to small animals, with a resultant fragmentation and isolation of populations (Garland and Bradley, 1984; Andrews, 1990). This potential problem can be mitigated by encouraging the growth of forbs and grasses along the pipeline corridors, thus creating ground cover for small fauna.

The proposed development includes such measures, and as soon as the pipeline is laid, the disturbed area would be covered with the original topsoil and re-growth of vegetation would be

[36] Saunders, D.A. and Hobbs, R.K. (eds) (1991) *Nature Conservation – The Role of Corridors*. Surrey Beatty & Sons, Sydney.

[37] Soule, M.E. and Gilpin, M.E. (1991) *The Theory of Wildlife Corridor Capability* in Saunders and Hobbs *Nature Conservation – The Role of Corridors*. Surrey Beatty & Sons, Sydney.

expected. As the construction phase is short-lived, any disruption of corridors would also be expected to be short-lived.

Most of the pipeline routes pass along areas of timber (i.e. along road reserves), and not across linear areas of timber (eg. creek lines). Where the pipelines pass along timbered areas, it is unlikely that any wildlife corridors will be disrupted given the pipelines would be situated within the cleared section of the road reserves for the majority of their length, vegetation clearance would be minimised and the disturbance would be short-lived. However, to enhance the remnant vegetation in the Project area in the long-term Black Range Minerals propose to replant two trees for every tree removed as a result of pipeline development.

Where the pipelines pass across linear areas of timber, there is the potential for disrupting wildlife corridors by creating a 'gap' in the linear habitat. However, as much of the route covered by the pipeline is open land, and several of the areas of timber contain small tracks and clearings, it is unlikely that the relatively narrow clearing required for the pipelines would result in significant barriers to animal movement. In the case of creek crossings, large habitat trees in the vicinity of the proposed crossing should be identified and avoided where practicable.

There are several ways in which the potential effects from pipeline construction can be mitigated:

- The corridor to be kept as narrow as possible.
- Retention of mature trees beside the corridor to be encouraged, wherever possible.
- A pre-construction survey of the pipelines to highlight any trees worthy of retention.
- Following construction, the disturbance areas to be rehabilitated with native grasses and forbs.
- The pipeline to be positioned within the cleared section of the road reserve, wherever practicable.
- The planting of endemic shrubs and trees within the road reserve to replace trees and shrubs removed.

These measures are included in the proposed development.

JA 7.2.3 Temporary Creation of Trenches in the Ground

A trench approximately 2 m deep will be constructed to accommodate the gas and water pipelines. It is anticipated that the trench could remain open for a period of several days before the pipe is buried. The open trench has the potential to act as a "pit trap" for ground fauna moving across the pipeline routes (Ayers and Wallace, 1997[38]). Large animals (e.g. kangaroos and wallabies), could potentially be injured falling into the trench, whilst smaller animals may be trapped in the trench. Exposed trenches and uncapped exploration boreholes have been documented as the cause of significant fatalities for mammals and reptiles.

In order to minimise potential impacts on fauna during construction, it is recommended that the following measures be undertaken:

- The trenches be left exposed for as short a period as possible;
- The ends of trenches be ramped to allow larger sized fauna to escape;
- A member of the construction crew be made responsible for inspecting and if necessary clearing the trench of any fauna prior to the pipe being lowered into the trench for areas with low habitat potential; and
- Daily inspections of open trenches be undertaken whilst construction is occurring in moderate to high habitat value areas.
- Constructing temporary fencing along the exposed trench (eg. with shade cloth or silt fabric) has successfully been adopted elsewhere and could be considered for the high habitat areas identified in this study.

JA 7.3 UPGRADE OF ROUTE 64

Route 64 would be upgraded for use by vehicles travelling to and from the mine.

Upgrading in many places will result in the widening of the existing road, with some clearing of the surrounding road reserve. Much of the reserve associated with those roads to be upgraded is already cleared, or supports a scatter of the original trees and shrubs. Where there are areas of natural vegetation, it is recommended that large 'habitat' trees and major lengths of bushland ('wildlife corridors') be avoided where practicable. Those sections of Route 64 where care will be required are:

R64/1: Scattered mature trees along Route 64;
R64/4: Narrow line of mature trees along Route 64;and
R64/5: Scattered mature trees along Route 64.

If the removal of any hollow-bearing trees is required, then it is recommended that these are inspected during the construction activities and any animals found be relocated to a suitable alternative habitat.

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[38] Ayers, D. and Wallace, G. 1997 Pipeline trenches: an under-utilised resource for finding fauna in Hale, P. and Lamb, D. (eds) *Conservation Outside Nature Reserves.* Centre for Conservation Biology, The University of Queensland

In a similar exercise to the proposed gas and water pipeline routes, the proportion of the habitat types over the length of the proposed upgrade was estimated.

HABITAT VALUE	% OF ROUTE
Moderate	81.1
Low	18.9

JA 7.4 FIFIELD BYPASS

The proportions of habitat of different values along the Fifield Bypass, based on a 20 m wide survey limit, are:

HABITAT VALUE	% OF BYPASS
Moderate	5.8
Low	94.2

Although there are no areas considered of high habitat value along the roads to be upgraded, there are some areas of moderate to high habitat value, as well as areas where there are scattered habitat trees. It is recommended that these areas be retained, where practicable.

JA 8.0 CONCLUSIONS AND RECOMMENDATIONS

Overall, the Syerston Project should not significantly impact upon the fauna and its habitats found in the region (i.e. Cobar Peneplain IBRA Region and NSW South West Slopes IBRA Region). Historical land use practices have resulted in widespread disturbance of the mine area, and most of the infrastructure areas are within land that has been cleared for agriculture.

The following mitigation measures relating to the mine site are recommended:

- a clean, rubbish-free environment be maintained to reduce the potential for an increase in the population or concentration of feral animals;
- the tailings storage facility, evaporation ponds and surge dam be inspected daily for fauna, as a precautionary measure, during the course of normal daily maintenance inspections. In the unlikely event that the storages become a focus for avifauna, additional hazing techniques (as adopted in the mining industry elsewhere) could be considered to minimise bird usage of the storages.

The rehabilitation programme proposed would result in the expansion of habitat opportunities for terrestrial fauna species at the mine site, primarily due to the establishment of a greater extent of endemic vegetation.

Specific sections of bushland located along the proposed gas pipeline route that are considered to be of high habitat value are summarised below:

G20: Continuous strip of woodland between “Elswick” and Murda State Forest, on

	Springvale Road;
G34:	Stand of trees on Nerathong Creek;
G38:	Stand of trees on Wallamundry Creek;
G40:	Trees on Wallaroi Creek;
G46:	Trees on Humbug Creek; and
G47:	Length of shrubs along road between 'Burragong' and turn-off to gas pipeline.

Specific sections of bushland located along the proposed water pipeline route that are considered to be of high habitat value include:

W2:	Line of trees along road near turn-off from Route 64;
W6-W9	Line of trees along road between 'Pleasant View' and Kars;
W13:	Patch of woodland with mature trees, near 'Tilga'; and
W17:	Trees beside Goobang Creek.

Removal of trees and shrubs as a result of pipeline construction would not be widespread and would not have a significant affect upon much of the existing habitat quality along the route corridors.

Several measures can be implemented to mitigate the potential effects of pipeline construction:

- The corridor to be kept as narrow as possible.
- Retention of mature trees beside the corridor to be encouraged, wherever possible.
- A pre-construction survey of the pipelines to highlight any trees worthy of retention.
- Following construction, the disturbance areas to be rehabilitated with native grasses and forbs.
- The pipeline to be positioned within the cleared section of the road reserve, wherever practicable.
- The planting of endemic shrubs and trees within the road reserve to replace trees and shrubs removed.
- Inspection of hollow-bearing trees for fauna, prior to removal and the relocation of any animals founds to suitable habitat.
- The trenches be left exposed for as short a period as possible.
- The ends of trenches be ramped to allow larger sized fauna to escape.
- A member of the construction crew be made responsible for inspecting and if necessary clearing the trench of any fauna prior to the pipe being lowered into the trench for areas with low habitat potential.
- Daily inspections of open trenches be undertaken whilst construction is occurring in moderate to high habitat value areas.
- Constructing temporary fencing along the exposed trench (eg. with shade cloth or silt fabric) has successfully been adopted elsewhere and could be considered for the high habitat areas identified in this study.

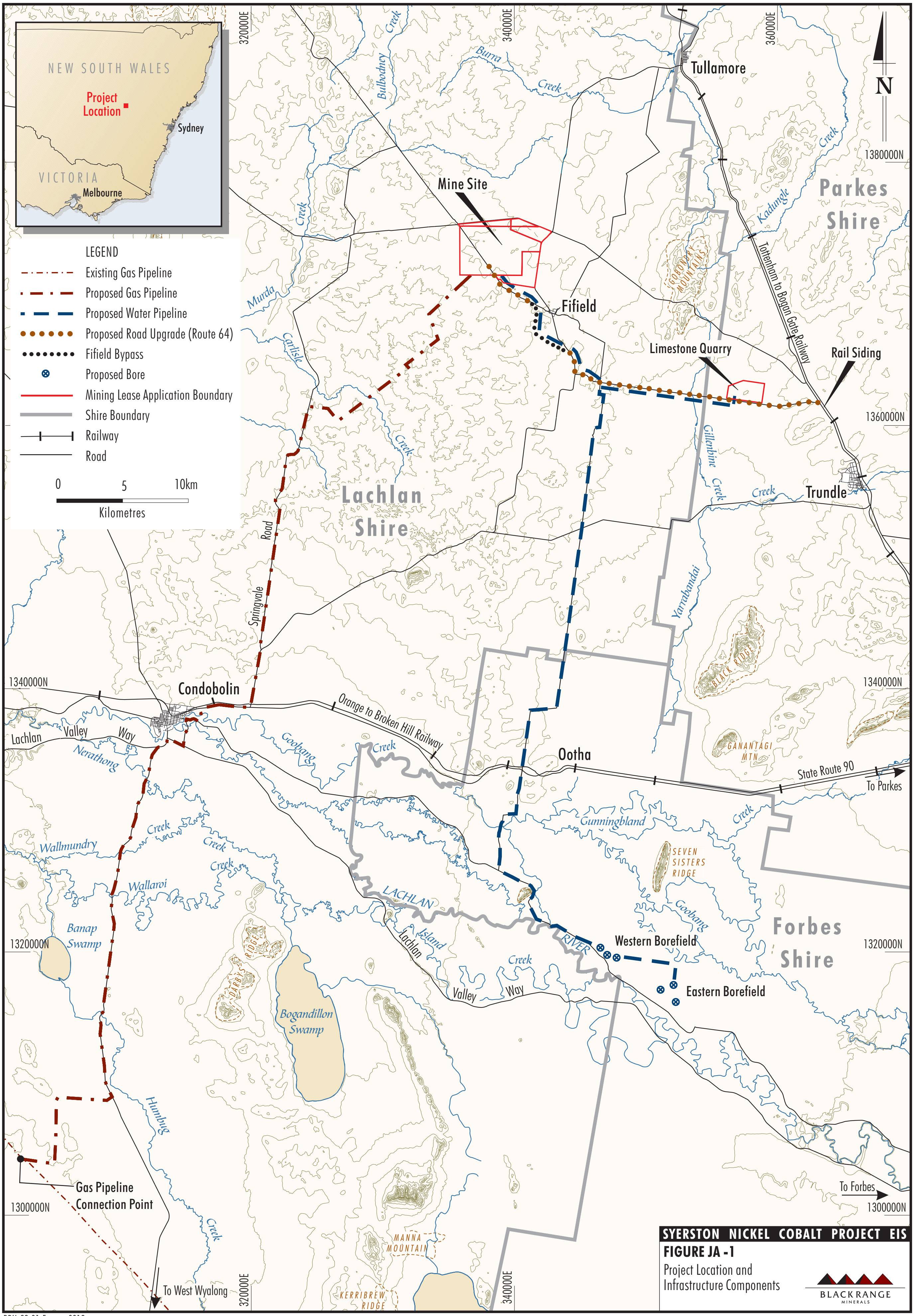
Specific sections of the proposed upgrade of Route 64 where high habitat was identified include:

R64/1: Scattered mature trees along Route 64;
R64/4: Narrow line of mature trees along Route 64; and
R64/5: Scattered mature trees along Route 64.

Trees with high habitat value (ie. large, hollow bearing trees) located within these areas should be avoided, where practicable. If there is the likelihood of the removal of any hollow-bearing trees, then it is recommended that these are inspected during the construction activities and any animals found be relocated to suitable alternative habitat.

Three threatened fauna species were identified during the surveys (Barking Owl, Pied Honeyeater and Pink Cockatoo). Eight Part Tests of Significance have been completed for these three species as a separate exercise and are presented in Appendix JB of the EIS.

FIGURES

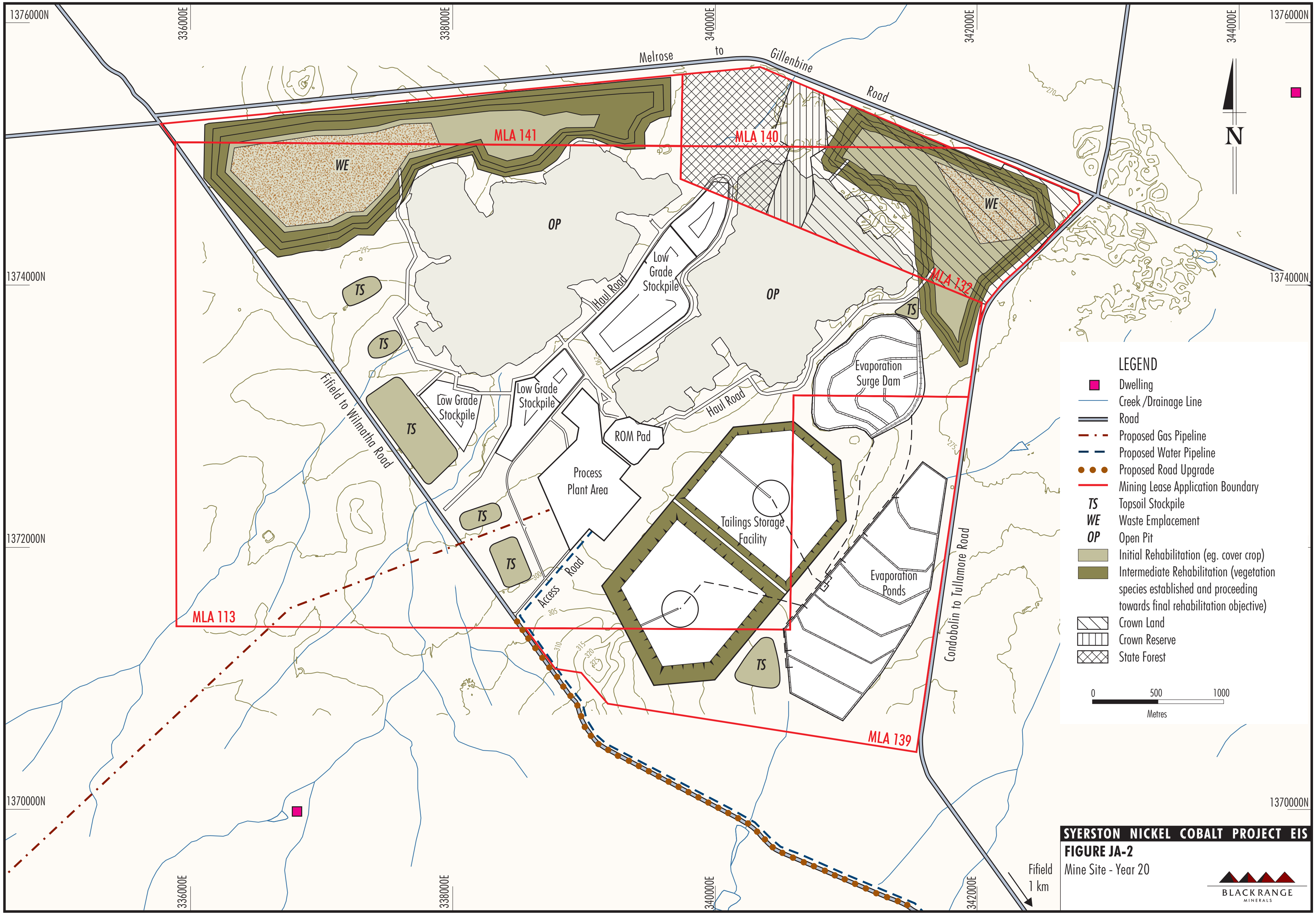


SYERSTON NICKEL COBALT PROJECT EIS

FIGURE JA - 1

Project Location and Infrastructure Components

BRM-98-01-Fauna _001G



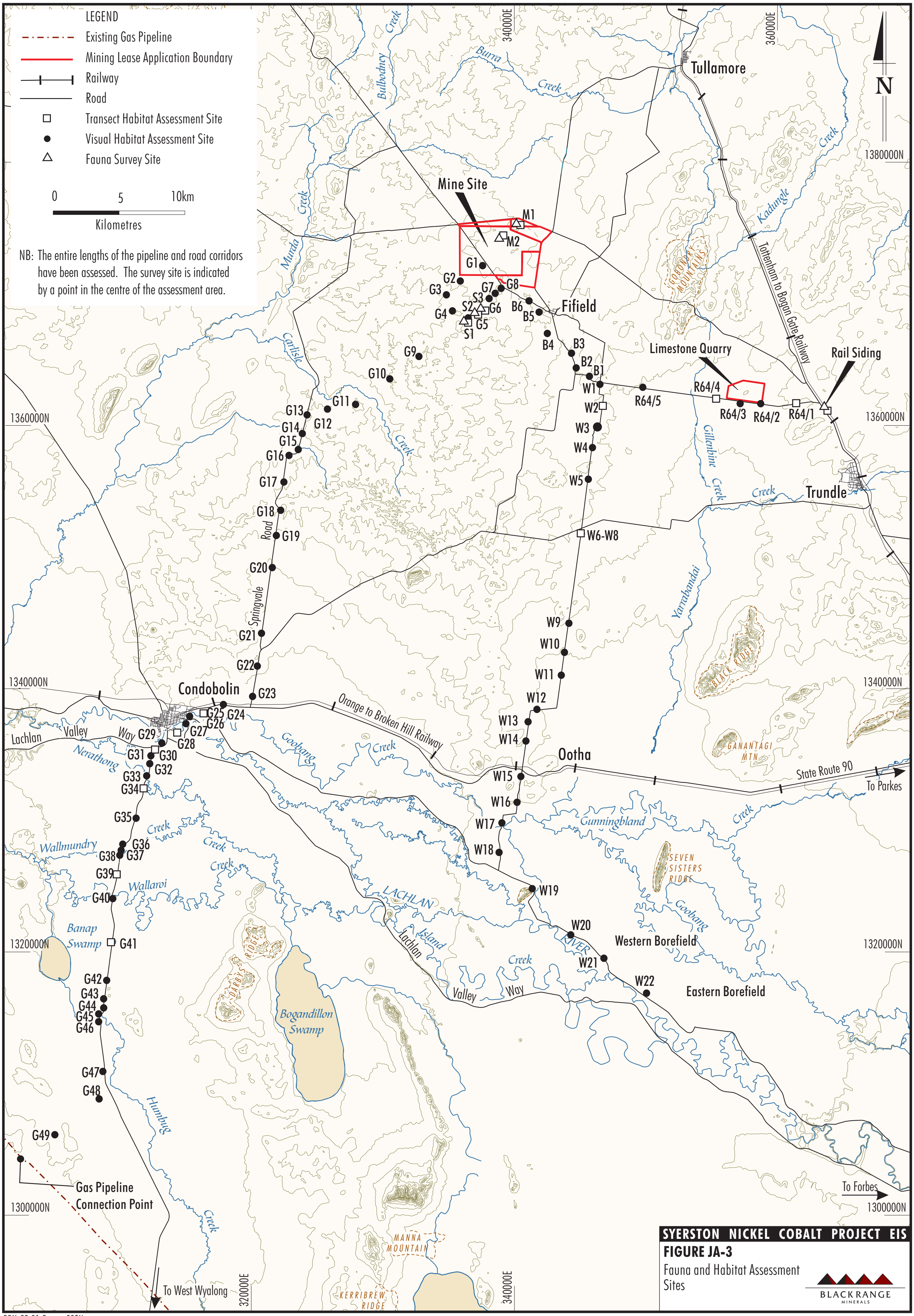
SYERSTON NICKEL COBALT PROJECT EIS

FIGURE JA-2

Mine Site - Year 20

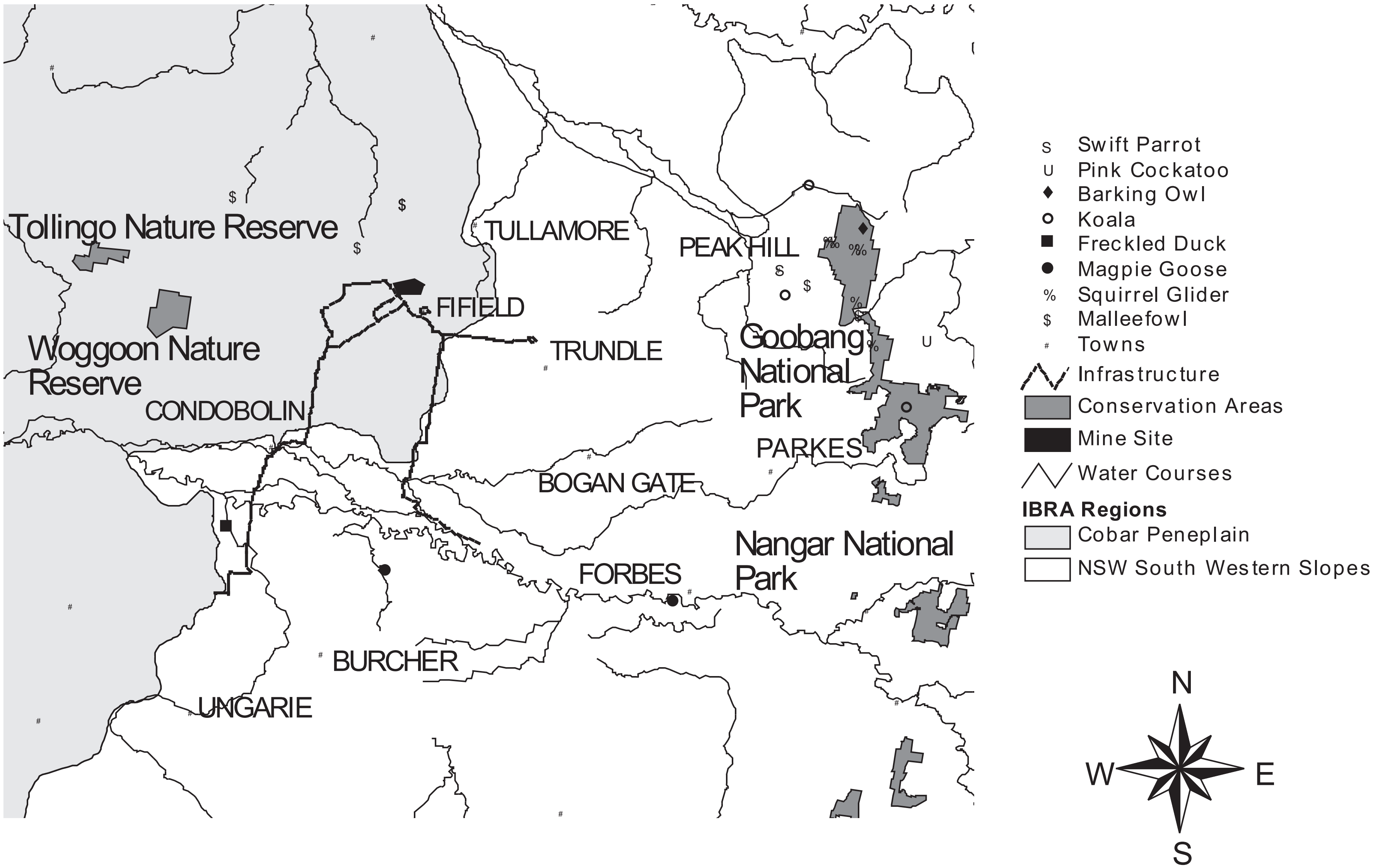
BLACK RANGE MINERALS

BRM-98-01-Fauna_003G



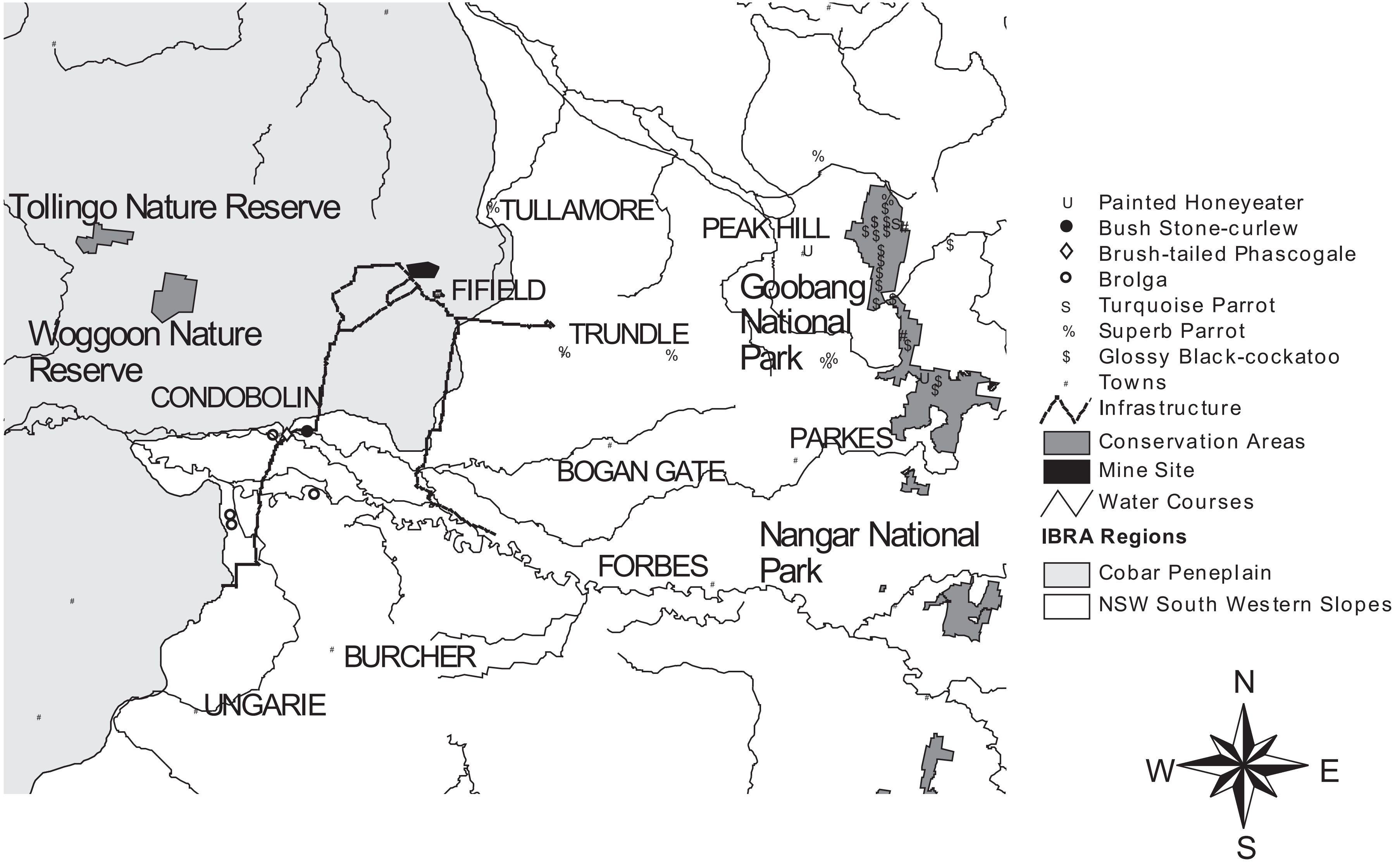
BRM-98-01-Fauna_002H

FigureJA-4a: Distribution of Threatened Species in General Region



BRM-98-01-Fauna-SR_001C

FigureJA-4b: Distribution of Threatened Species in General Region



BRM-98-01-Fauna-SR_002C

ATTACHMENT JA-A

FAUNA KNOWN OR CONSIDERED LIKELY TO OCCUR IN THE PROJECT AREA AND SURROUNDS

ATTACHMENT JA-A: FAUNA KNOWN OR CONSIDERED LIKELY TO OCCUR IN THE PROJECT AREA AND SURROUNDS

Bird Australian Population Status and Conservation Status from Lindsay[39] (1992)
Bird NSW Population Status from Morris *et al* (1981)

Mammal Australian Population Status and Conservation Status from Strahan (1992)

Reptile Australian Population Status and Conservation Status from Ehmann (1992)

Amphibian Australian Population Status and Conservation Status from Tyler (1992)

Australian and NSW Population Status
A – Abundant
C – Common
MC- Moderately Common
S – Scarce

Conservation Status
S – Secure
PS – Probably Secure
V – Vulnerable

(1) - Listed in Schedule 1 of the *Threatened Species Conservation Act, 1995*
(2) - Listed in Schedule 2 of the *Threatened Species Conservation Act, 1995*

39 References for Species lists: Strahan, R. 1992 *Encyclopedia of Australian Animals Mammals* Angus & Robertson, Sydney
Morris, A.K., A.R.McGill and G.Holmes 1981 *Handlist of birds in New South Wales*. NSW Field Ornithologists Club, Sydney
Lindsey, T.R 1992 *Encyclopedia of Australian Animals Birds* Angus & Robertson, Sydney
Ehmann, H. 1992 *Encyclopedia of Australian Animals Reptiles* Angus & Robertson, Sydney
Tyler, M.J. 1992 *Encyclopedia of Australian Animals Frogs* Angus & Robertson, Sydney

AVIFAUNA KNOWN FROM THE GENERAL REGION		Population Status		Conservation Status	Habitat	Project Area
COMMON NAME	SCIENTIFIC NAME	AUST	NSW			
Emu	*Dromaius novaehollandiae*	C	C	S	All habitats	X
Australasian Grebe	*Podiceps novaehollandiae*	A	A	S	Freshwater	X
Australian Pelican	*Pelecanus conspicillatus*	C	MC	S	Freshwater	
Darter	*Anhinga melanogaster*	S-C	MC	S	Freshwater	X
Little Black Cormorant	*Phalacrocorax sulcirostris*	A	A	S	Freshwater	
Little Pied Cormorant	*Phalacrocorax melanoleucos*	A	A	S	Freshwater	
Great Cormorant	*Phalacrocorax carbo*	A	C	S	Freshwater	
Pied Cormorant	*Phalacrocorax varius*	A	MC	S	Freshwater	
White-faced Heron	*Egretta novaehollandiae*	A	A	S	Water margins	X
Pacific Heron	*Egretta pacifica*	C	C	S	Water margins	X
Great Egret	*Egretta alba*	C	C	S	Water margins	X
Little Egret	*Egretta garzetta*	S	MC	S	Water margins	
Intermediate Egret	*Egretta intermedia*	C	MC	S	Water margins	
Nankeen Night Heron	*Nycticorax caledonicus*	C	MC	S	Water margins	
Royal Spoonbill	*Platalea regia*	S	MC	S	Water margins	
Yellow-billed Spoonbill	*Platalea flavipes*	C	MC	S	Water margins	X
Australian White Ibis	*Threskiornis aethiopica*	A	A	S	Water margins	X
Straw-necked Ibis	*Threskiornis spinicollis*	C	A	S	Water margins	X
Black Swan	*Cygnus atratus*	C	C	S	Aquatic	X
Wood Duck	*Chenonetta jubata*	A	A	S	Aquatic	X
Hardhead	*Aythya australis*	C	C	S	Aquatic	
Grey Teal	*Anas gracilis*	A	A	S	Aquatic	X
Chestnut Teal	*Anas castanea*	C	MC	S	Aquatic	
Australian Shoveler	*Anas rhynchotis*	S	MC	PS	Aquatic	X
Pacific Black Duck	*Anas superciliosa*	A	A	S	Aquatic	X
Plumed Whistling Duck	*Dendrocygna eytoni*	C	MC	S	Grassland	
Pink-eared Duck	*Malacorhynchus membranaceus*	S	MC	PS (1)	Aquatic	
Black-shouldered Kite	*Elanus notatus*	S	MC-C	PS	Woodland	X
Brown Falcon	*Falco berigora*	A	MC	S	Woodland	X
Nankeen Kestrel	*Falco cenchroides*	A	C	S	Grassland	X
Peregrine Falcon	*Falco peregrinus*	S	U	V	Rocky outcrops	
Black Falcon	*Falco subniger*	S	U	PS	Woodland	
Australian Hobby	*Falco longipennis*	C	MC	S	All habitats	X
Black Kite	*Milvus migrans*	C	MC	S	Woodland	
Wedge-tailed Eagle	*Aquila audax*	C	MC	S	All habitats	X
Whistling Kite	*Haliastur sphenurus*	A	MC	S	Woodland	
Collared Sparrowhawk	*Accipiter cirrhocephalus*	C	MC	PS	Woodland	
Brown Goshawk	*Accipiter fasciatus*	C	MC	S	Woodland	
Little Eagle	*Hieraaetus morphoides*	C	MC	S	Woodland	X
Spotted Harrier	*Circus assimilis*	C	U-MC	S	Grassland	X
Swamp Harrier	*Circus approximans*	S	MC	V	Wetlands	X
Malleefowl	*Leipoa ocellata*	VS	U	V (2)	Woodland/ Mallee	
Stubble Quail	*Coturnix pectoralis*	A	A	S	Grassland	
Brown Quail	*Coturnix australis*	C	C	PS	Grassland	
Painted Button-quail	*Turnix varia*	S	MC	PS	Woodland	
Red-chested Button-quail	*Turnix pyrrhothorax*	S	U-C	PS	Grassland	
Little Button-quail	*Turnix velox*	C	U-C	S	Woodland	
Silver Gull	*Larus novaehollandiae*	A	A	S	Water margins	
AVIFAUNA KNOWN FROM THE GENERAL REGION		Population Status		Conservation Status	Habitat	Project Area

COMMON NAME	SCIENTIFIC NAME	AUST	NSW			
Peaceful Dove	*Geopelia placida*	C	A	S	Woodland	X
Diamond Dove	*Geopelia cuneata*	C	MC	S	Woodland	
Bar-shouldered Dove	*Geopelia humeralis*	C	C	S	Woodland	
Rock Dove	*Columba livia*	A	A	S	Urban	X
Spotted Turtledove	*Streptopelia chinensis*	A	A	S	Urban	
Common Bronzewing	*Phaps chalcoptera*	C	A	S	Woodland	X
Brush Bronzewing	*Phaps elegans*	S	MC	PS	Woodland	
Crested Pigeon	*Ocyphaps lophotes*	A	A	S	Woodland	X
Masked Lapwing	*Vanellus miles*	A	A	S	Grassland	X
Black-tailed Native-hen	*Gallinula ventralis*	S	C	S	Water margins	
Dusky Moorhen	*Gallinula tenebrosa*	C	A	S	Water margins	
Eurasian Coot	*Fulica atra*	C	A	S	Aquatic	
Black-fronted Plover	*Charadrius melanops*	A	C	S	Water margins	X
Brolga	*Grus rubicundus*	C	S	S (2)	Grassland	
Koori Bustard	*Ardeotis australis*	C	R	V (2)	Grassland	
Bush Stone-curlew	*Burhinus magnirostris*	S	U	V (2)	Shrublands	
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	VS	MC	S (2)	Woodland	
Sulphur-crested Cockatoo	*Cacatua galerita*	C	C	S	Grassland	X
Galah	*Cacatua roseicapilla*	A	A	S	All habitats	X
Little Corella	*Cacatua sanguinea*	C	C	S	Grassland, woodland	X
Pink Cockatoo	*Cacatua leadbeateri*	S	MC	PS (2)	Woodlands	X
Australian King-Parrot	*Alisterus scapularis*	C	C	PS	Wet forest	
Cockatiel	*Nymphicus hollandicus*	C	A	S	Woodland	X
Red-winged Parrot	*Aprosmictus erythropterus*	C	C	S	Woodland	
Turquoise Parrot	*Neophema pulchella*	S	U	PS (2)	Woodland	
Mulga Parrot	*Psephotus varius*	S-C	MC	PS	Woodland	
Blue Bonnet	*Northiella haematogaster*	U	A	PS	Woodland	X
Australian Ringneck	*Barnardius barnardi*	C	A	S	Woodland	X
Blue-winged Parrot	*Neophema chrysostoma*	S-C	U	PS	Woodland	X
Superb Parrot	*Polytelis swainsonii*	U	MC	V (2)	Woodland	
Swift Parrot	*Lathamus discolor*	S	S-MC	V (2)	Woodland	
Eastern Rosella	*Platycercus eximius*	C	A	S	Woodland	X
Red-rumped Parrot	*Psephotus haematonotus*	A	A	S	Woodland	X
Musk Lorikeet	*Glossopsitta concinna*	S	MC	V	Woodland	
Rainbow Lorikeet	*Trichoglossus haematodus*	A	C	S	Woodland	
Budgerigar	*Melopsittacus undulatus*	A	A	S	Grassland	
Pallid Cuckoo	*Cuculus pallidus*	A	C	S	All habitats	
Fan-tailed Cuckoo	*Cuculus pyrrhophanus*	C	C	S	Woodland	
Black-eared Cuckoo	*Chrysococcyx osculans*	S	U	PS	Woodland	
Horsefield's Bronze-Cuckoo	*Chrysococcyx basalis*	S-C	MC-C	S	All habitats	
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	S-C	C	S	Woodland	
Tawny Frogmouth	*Podargus strigoides*	C	A	S	All habitats	
Barn Owl	*Tyto alba*	S-C	MC-C	S	Woodland	X
Barking Owl	*Ninox connivens*	R-S	U	PE (2)	Woodland	X
Southern Boobook	*Ninox novaeseelandiae*	C	C	S	All habitats	
Australian Owlet-Nightjar	*Aegotheles cristatus*	C	A	S	Woodland	
Spotted Nightjar	*Caprimulgus guttatus*	U	MC	PS	Woodland	X
White-throated Needletail	*Hirundapus caudacutus*	S	MC-A	S	Aerial	
Laughing Kookaburra	*Dacelo novaeguineae*	A	A	S	Woodland	X
Red-backed Kingfisher	*Todiramphus sanctus*	S-C	MC	S	Woodlands	
Sacred Kingfisher	*Halcyon sancta*	C	A	S	All habitats	X
Forest Kingfisher	*Halcyon macleayii*	S	U	S	Woodland	
Rainbow Bee-eater	*Merops ornatus*	C	A	S	Woodland	
Dollarbird	*Eurystomus orientalis*	C	MC	S	Woodland	

AVIFAUNA KNOWN FROM THE GENERAL REGION

COMMON NAME	SCIENTIFIC NAME	Population Status AUST	Population Status NSW	Conservation Status	Habitat	Project Area
Singing Bushlark	*Mirafra javanica*	S	C	S	Grassland	X
Welcome Swallow	*Hirundo neoxena*	C	A	S	Aerial	X
Fairy Martin	*Cecropis ariel*	C	A	S	Aerial	X
Tree Martin	*Cecropis nigricans*	C	A	S	Aerial	X
Richard's Pipit	*Anthus novaeseelandiae*	C	A	S	Grassland	X
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*	A	A	S	Woodland	X
White-bellied Cuckoo-shrike	*Coracina papuensis*	S-C	?	PS	Woodland	
White-winged Triller	*Lalage sueurii*	S-C	MC-A	S	Woodland	
Jacky Winter	*Microeca leucophaea*	C	A	PS	Woodland	X
Crested Shrike-tit	*Falcunculus frontatus*	S-C	C	PS	Woodland	
Grey Shrike-thrush	*Colluricincla harmonica*	C	A	S	Woodland	X
Crested Bellbird	*Oreoica gutturalis*	S-C	A	PS	Woodland	
Golden Whistler	*Pachycephala pectoralis*	C	A	S	Woodland	
Rufous Whistler	*Pachycephala rufiventris*	C	A	S	Woodland	X
Flame Robin	*Petroica phoenicea*	C	C	S	Woodland	
Scarlet Robin	*Petroica multicolor*	C	C	S	Woodland	
Red-capped Robin	*Petroica goodenovii*	C	A	S	Woodland	X
Eastern Yellow Robin	*Eopsaltria australis*	C	A	S	Woodland	X
Hooded Robin	*Melanodryas cucullata*	S-C	C	PS	Woodland	X
Satin Flycatcher	*Myiagra cyanoleuca*	S-C	MC	PS	Woodland	
Restless Flycatcher	*Myiagra inquieta*	S-C	A	PS	Woodland	X
Leaden Flycatcher	*Myiagra rubecula*	S-C	C	PS	Woodland	
Grey Fantail	*Rhipidura fuliginosa*	C	A	S	Woodland	X
Willie Wagtail	*Rhipidura leucophrys*	C	A	S	All habitats	X
Eastern Whipbird	*Psophodes olivaceus*	C	A	PS	Woodland	
Spotted Quail-thrush	*Cinclosoma punctatum*	S	MC	PS	Woodland	
Brown Songlark	*Cinclorhampus cruralis*	C	A	PS	Grassland	X
Rufous Songlark	*Cinclorhamphus mathewsi*	C	A	PS	Woodland	
White-browed Babbler	*Pomatostomus superciliosus*	C	A	S	Woodland	X
Grey-crowned Babbler	*Pomatostomus temporalis*	C	A	S	Woodland	
Clamorous Reed-Warbler	*Acrocephalus stentoreus*	C	A	S	Water margins	
Little Grassbird	*Megalurus gramineus*	C	C-A	PS	Water margins	X
Golden-headed Cisticola	*Cisticola exilis*	C	A	S	Grassland	
Superb Fairy-wren	*Malurus cyaneus*	C	A	S	Woodland	
Variegated Fairy-wren	*Malurus lamberti*	C	C	S	Woodland	X
Splendid Fairy-wren	*Malurus melanotus*	C	C	PS	Shrubland	
White-winged Fairy-wren	*Malurus leuconotus*	C	A	PS	Shrubland	
Chestnut-rumped Hylacola	*Hylacola pyrrhopygia*	S-C	MC	PS	Woodland	
Speckled Warbler	*Chthonicola sagittata*	C	C	PS	Woodland	
Weebill	*Smicrornis brevirostris*	C	A	S	Woodland	X
Western Gerygone	*Gerygone fusca*	S-C	C	S	Woodland	
White-throated Gerygone	*Gerygone olivacea*	S-C	A	S	Woodland	
Yellow-rumped Thornbill	*Acanthiza chrysoptera*	C	A	S	Woodland	X
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	C	A	S	Woodland	X
Striated Thornbill	*Acanthiza lineata*	C	A	S	Woodland	
Brown Thornbill	*Acanthiza pusilla*	C	A	S	Woodland	
Yellow Thornbill	*Acanthiza nana*	C	A	S	Woodland	X
Buff-rumped Thornbill	*Acanthiza reguloides*	C	A	S	Woodland	
Inland Thornbill	*Acanthiza apicalis*		A		Woodland	X
Southern Whiteface	*Aphelocephala leucopsis*	C	A	PS	Woodland	
Varied Sittella	*Neositta chrysoptera*	C	C	S	Woodland	
White-throated Treecreeper	*Climacteris leucophaea*	C	A	S	Woodland	
Brown Treecreeper	*Climacteris picumnus*	C	A	S	Woodland	X
Red Wattlebird	*Anthochaera carunculata*	C	A	S	Woodland	X
Striped Honeyeater	*Plectorhyncha lanceolata*	C	A	S	Woodland	
Little Friarbird	*Philemon citreogularis*	C	A	S	Woodland	X

Noisy Friarbird	*Philemon corniculatus*	C	A	S	Woodland	
AVIFAUNA KNOWN FROM THE GENERAL REGION		**Population Status**		**Conservation Status**	**Habitat**	**Project Area**
COMMON NAME	SCIENTIFIC NAME	AUST	NSW			
Noisy Miner	*Manorina melanocephala*	C	A	S	Woodland	X
Yellow-throated Miner	*Manorina flavigula*	C	A	S	Woodland	
Blue-faced Honeyeater	*Entomyzon cyanotis*	C	C	s	Woodland	X
Singing Honeyeater	*Meliphaga virescens*	C	A	PS	Woodland	X
Yellow-faced Honeyeater	*Lichenostomus chrysops*	C	A	S	Woodland	
White-eared Honeyeater	*Lichenostomus leucotis*	C	A	S	Woodland	
Yellow-tufted Honeyeater	*Lichenostomus melanops*	S	A	PS	Woodland	
Yellow-plumed Honeyeater	*Lichenostomus ornatus*	S-C	C	PS	Woodland	
White-plumed Honeyeater	*Lichenostomus penicillatus*	C	A	S	Woodland	X
Fuscous Honeyeater	*Lichenostomus fuscus*	C	A	PS	Woodland	
Black-chinned Honeyeater	*Melithreptus gularis*	S	MC	PS	Woodland	
Brown-headed Honeyeater	*Melithreptus brevirostris*	C	A	PS	Woodland	X
White-naped Honeyeater	*Melithreptus lunatus*	C	A	S	Woodland	
Brown Honeyeater	*Lichmera indistincta*	C	C	PS	Woodland	
Painted Honeyeater	*Grantiella picta*	S	MC	PS (2)	Woodland	
Eastern Spinebill	*Acanthorhynchus tenuirostris*	S-C	A	S	Woodland	
Spiny-cheeked Honeyeater	*Acanthorhynchus rufogularis*	C	A	S	Woodland	X
Pied Honeyeater	*Certhionyx variegatus*	S	S-U	PS (2)	Shrubland	X
Black Honeyeater	*Certhionyx niger*	S	U-MC	PS	Woodland	
Crimson Chat	*Ephthlianura tricolor*	S	U-C	S	Shrubland	
Mistletoebird	*Dicaeum hirundinaceum*	C	A	S	Woodland	X
Spotted Pardalote	*Pardalotus punctatus*	C	A	S	Woodland	
Striated Pardalote	*Pardalotus striatus*	C	A	S	Woodland	X
Silvereye	*Zosterops lateralis*	C	A	S	All habitats	
House Sparrow	*Passer domesticus*	A	A	S	Urban	X
White-browed Scrubwren	*Sericornis frontatis*	C	A	S	Woodland	
Red-browed Firetail	*Emblema temporalis*	S-C	A	PS	Woodland	
Diamond Firetail	*Emblema guttata*	S	C	V	Woodland	
Double-barred Finch	*Poephila bichenovii*	C	A	PS	Woodland	
Zebra Finch	*Poephila guttata*	C	A	S	Woodland	
Plum-headed Finch	*Aidemosyne modesta*	S-C	C	PS	Woodland	
Common Starling	*Sturnus vulgaris*	C	A	S	Grassland	X
Blackbird	*Turdus merula*	C	MC	S	Urban	X
Olive-backed Oriole	*Oriolus sagittatus*	C	C	S	Woodland	X
Spotted Bowerbird	*Chlamydera maculata*	R-C	MC	PS	Woodland	
White-winged Chough	*Corcorax melanorhamphos*	C	C	PS	Woodland	X
Apostlebird	*Struthidea cinerea*	C	A	PS	Woodland	X
Australian Magpie-lark	*Grallina cyanoleuca*	C-A	A	S	All habitats	X
White-browed Woodswallow	*Artamus superciliosus*	C	A	S	All habitats	X
Dusky Woodswallow	*Artamus cyanopterus*	C	A	S	Woodland	
Masked Woodswallow	*Artamus personatus*	C	C	S	All habitats	
Black-faced Woodswallow	*Artamus cinereus*	C	A	S	Woodland	
White-breasted Woodswallow	*Artamus leucorhynchus*	C	MC	S	Woodland	X
Grey Butcherbird	*Cracticus torquatus*	C	A	S	Woodland	X
Pied Butcherbird	*Cracticus nigrogularis*	C	A	S	Woodland	X
Australian Magpie	*Gymnorhina tibicen*	C	A	S	All habitats	X
Pied Currawong	*Strepera graculina*	C	A	S	All habitats	
Australian Raven	*Corvus coronoides*	C	A	S	All habitats	X
Little Raven	*Corvus mellori*	C	A	S	Woodland	X

MAMMALS KNOWN FROM THE GENERAL REGION

COMMON NAME	SCIENTIFIC NAME	Population Status AUST.	Conservation Status	Preferred Habitat	Project Area
Short-beaked Echidna	*Tachyglossus aculeatus*	C	S	All habitats	X
Yellow-footed Antechinus	*Antechinus flavipes*	A	S	Woodland	
Common Dunnart	*Sminthopsis murina*	C	S	Woodland	X
Common Wombat	*Vombatus ursinus*	S	S	Woodland	
Koala	*Phascolarctos cinereus*	VS	PS (2)	Woodland	
Common Wallaroo	*Macropus robustus*	A	S	Woodland	
Red-necked Wallaby	*Macropus rufogriseus*	C	S	Woodland	X
Eastern Grey Kangaroo	*Macropus giganteus*	A	S	Woodland	X
Swamp Wallaby	*Wallabia bicolor*	C	S	Woodland	X
Common Ringtail Possum	*Pseudocheirus peregrinus*	A	S	Woodland	
Sugar Glider	*Petaurus breviceps*	C	S	Woodland	
Squirrel Glider	*Petaurus norfolcensis*	C	PS (2)	Woodland	
Common Brushtail Possum	*Trichosurus vulpecula*	A	S	Woodland	X
Feathertail Glider	*Acrobates pygmaeus*	S	S	Woodland	
New Holland Mouse	*Pseudomys novaehollandiae*	C	S	Heath	
Black Rat	*Rattus rattus*	C	S	All habitats	
House Mouse	*Mus musculus*	A	S	All habitats	X
European Rabbit	*Oryctolagus cuniculus*	A	S	Grassland	X
Brown Hare	*Lepus capensis*	S-C	S	Grassland	X
Red Fox	*Vulpes vulpes*	A	S	All habitats	X
Cat	*Felis catus*	A	S	All habitats	
Dog	*Canis familiaris*	A	S	All habitats	X
Feral Pig	*Sus scrofa*	C	S	All habitats	X
Feral Goat	*Capra hircus*	S-A	S	All habitats	

REPTILES KNOWN FROM THE GENERAL REGION		Population Status	Conservation Status	Preferred Habitat	Project Area
COMMON NAME	SCIENTIFIC NAME	AUST.			
Eastern Long-necked Turtle	*Chelodina longicollis*	C	S	Aquatic	X
Stone Gecko	*Diplodactylus vIttatus*	S-C	S	Stony soils	
Ocellated Velvet Gecko	*Oedura monilis*	C	S	Woodland	
Bynoe's Gecko	*Heteronotia binoei*	A	S	Woodland	
Tree Dtella	*Gehyra variegata*	C-A	S	Woodland	X
Thick-tailed Gecko	*Underwoodisaurus milii*	S-C	S	Rocky areas	
Eastern Spiny-tailed Gecko	*Diplodactylus williamsi*	S-C	S	Woodland	
Burton's Snake-lizard	*Liasis burtonis*	C	S	Woodland	
Lace Monitor	*Varanus varius*	C	S	All habitats	X
Sand Monitor	*Varanus gouldii*	C	S	All habitats	X
Eastern Blue-tongued Lizard	*Tiligua scincoides*	C	S	Woodland	X
Copper-tailed Skink	*Ctenotus taeniolatus*	A	S	Rocky areas	
Striped Skink	*Ctenotus robustus*	A	S	Woodland	
Boulenger's Skink	*Morethia boulengeri*	A	S	Rocky soils	X
Red-throated Skink	*Bassiana platynota*	C	S	Rocky areas	
Tree Skink	*Egernia striolata*	A	S	Woodland	
White's Skink	*Egernia whitei*	C	S	Woodland	
Shingleback Lizard	*Trachydosaurus rugosus*	C-A	S	All habitats	X
Carnaby's Wall Skink	*Cryptoblepharus carnabyi*	C	PS	Woodland	X
Wood Mulch-slider	*Lerista muelleri*	C-A	S	Woodland	
Common Dwarf Skink	*Menetia greyi*	A	S	Woodland	X
Jacky Lizard	*Amphibolorus muricatus*	C	S	Woodland	
Nobbi	*Amphibolorus nobbi*	C	S	Sandy soils	
Eastern Bearded Dragon	*Pogona barbata*	C	S	Woodland	X
Olive Legless Lizard	*Delma inornata*	S	S	Woodland	
Blind Snake	*Ramphotyphlops bituberculatus*	VS-C	S	Sandy soil	
Yellow-faced Whipsnake	*Demansia psammophis*	C	S	All habitats	
Red-bellied Black Snake	*Pseudechis porphyriacus*	VS-A	S	Wettish areas	
Spotted Black Snake	*Pseudechis guttatus*	R-C	S	Wettish areas	
Eastern Brown Snake	*Pseudonaja textilis*	VS-C	S	All habitats	X

AMPHIBIANS KNOWN FROM THE GENERAL REGION		Population Status	Conservation Status	Project Area
COMMON NAME	SCIENTIFIC NAME	AUST		
Peron's Tree Frog	*Litoria peronii*	C	S	
Desert Tree Frog	*Litoria rubella*	A	S	
Green Tree Frog	*Litoria caerulea*	A	S	
Gunther's Frog	*Litoria latopalmata*	A	S	
Common Eastern Toadlet	*Crinia signifera*	A	S	X
Sloane's Froglet	*Crinea sloanei*	C	S	
Plains Toadlet	*Crinea parasignifera*	C	S	
Eastern Banjo Frog	*Limnodynastes dumerilii*	C	S	X
Spotted Grass Frog	*Limnodynastes tasmaniensis*	?	?	X
Northern Banjo Frog	*Limnodynastes terraereginae*	C	S	
Giant Banjo Frog	*Limnodynastes interioris*	S	S	X
Ornate Burrowing Frog	*Limnodynastes ornatus*	A	S	
Common Spadefoot Toad	*Neobatricus sudelli*	C	S	
Long-thumbed Frog	*Limnodynastes fletcheri*	C	S	X

ATTACHMENT JA-B

DISTRIBUTION OF FAUNA WITHIN THE GENERAL REGION

ATTACHMENT JA-B: DISTRIBUTION OF FAUNA WITHIN THE GENERAL REGION
(data taken from the five 1:100 000 map sheets surrounding the Project area as supplied by NPWS)

Avifauna

COMMON NAME	Condobolin	Tullamore	Boona Mount	Peak Hill	Bogan Gate
Emu	X	X		X	
Australasian Grebe				X	
Australian Pelican	X	X		X	
Darter	X			X	
Little Black Cormorant				X	
Little Pied Cormorant	X	X		X	
Great Cormorant					
Pied Cormorant					
White-faced Heron	X	X	X	X	
Pacific Heron	X	X	X	X	
Great Egret	X			X	
Little Egret	X			X	
Intermediate Egret				X	
Royal Spoonbill	X			X	
Yellow-billed Spoonbill	X	X		X	
Australian White Ibis				X	
Straw-necked Ibis		X		X	
Glossy Ibis	X		X		
Black Swan	X			X	
Wood Duck	X	X	X	X	
Hardhead	X			X	
Grey Teal	X	X		X	X
Chestnut Teal					X
Pacific Black Duck	X	X		X	X
Australian Shoveller	X			X	X
Magpie Goose	X			X	X
Freckled Duck	X			X	
Australian Shelduck	X				
Plumed Whislting Duck	X			X	
Pink-eared Duck	X			X	
Black-shouldered Kite				X	
Brown Falcon	X			X	
Nankeen Kestrel		X		X	
PeregrineFalcon				X	
Black Falcon					
Australian Hobby				X	
Black Kite				X	
Wedge-tailed Eagle	X	X	X	X	
Whistling Kite	X			X	
Collared Sparrowhawk			X	X	
Brown Goshawk			X		
Little Eagle				X	
Spotted Harrier				X	
Swamp Harrier	X			X	
Malleefowl			X	X	
Stubble Quail				X	X
Brown Quail				X	
Painted Button-quail				X	
COMMON NAME	Condobolin	Tullamore	Boona Mount	Peak Hill	Bogan Gate

Red-chested Button-quail					
Little Button-quail				X	
Silver Gull	X			X	
Peaceful Dove	X	X	X	X	
Diamond Dove				X	
Bar-shouldered Dove	X				
Rock Dove				X	
Spotted Turtledove				X	
Common Bronzewing	X	X	X	X	
Brush Bronzewing					
Crested Pigeon		X	X	X	
Masked Lapwing	X	X		X	
Black-tailed Native-hen					
Dusky Moorhen					
Eurasian Coot	X			X	
Black-fronted Plover					
Australian Pratincole	X				
Brolga	X			X	
Australian Bustard					
Bush Stone-Curlew	X				
Glossy Black-cockatoo				X	
Sulphur-crested Cockatoo				X	
Galah	X	X	X	X	
Little Corella					
Major Mitchell Cockatoo					
Australian King Parrot				X	
Cockatiel		X	X	X	
Red-winged Parrot					
Turquoise Parrot				X	
Mulga Parrot			X		
Blue Bonnet		X	X	X	
Australian Ringneck	X	X	X	X	
Blue-winged Parrot					
Superb Parrot		X		X	
Swift Parrot				X	
Eastern Rosella	X	X	X	X	
Red-rumped Parrot	X	X		X	
Musk Lorikeet				X	
Rainbow Lorikeet				X	
Little Lorikeet				X	
Budgerigar					
Pallid Cuckoo	X	X	X	X	
Fan-tailed Cuckoo				X	
Black-eared Cuckoo					
Horsefield's Bronze-Cuckoo				X	
Shining Bronze-Cuckoo				X	
Tawny Frogmouth		X		X	
Barn Owl	X			X	
Barking Owl				X	
Southern Boobook		X		X	
Australian Owlet-Nightjar			X	X	
Spotted Nightjar				X	
White-throated Needletail				X	
Azure Kingfisher	X				
Laughing Kookaburra	X	X	X	X	
Red-backed Kingfisher					
Sacred Kingfisher	X	X		X	
COMMON NAME	Condobolin	Tullamore	Boona Mount	Peak Hill	Bogan Gate

Forest Kingfisher				X	
Rainbow Bee-eater	X	X		X	
Dollarbird				X	
Singing Bushlark				X	
Welcome Swallow	X	X	X	X	
Fairy Martin		X			
Tree Martin	X		X	X	
Richards Pipit	X	X	X	X	
Black-faced Cuckoo-shrike	X	X		X	
White-bellied Cuckoo-shrike				X	
Ground Cuckoo-shrike	X			X	
White-winged Triller		X		X	
Jacky Winter		X	X	X	
Crested Shrike-tit				X	
Grey Shrike-thrush	X	X	X	X	
Crested Bellbird			X		
Golden Whistler	X	X		X	
Rufous Whistler	X	X	X	X	
Flame Robin				X	
Red-capped Robin	X	X	X	X	
Scarlet Robin				X	
Eastern Yellow Robin	X	X	X	X	
Hooded Robin		X	X	X	
Satin Flycatcher				X	
Restless Flycatcher		X		X	
Leaden Flycatcher				X	
Grey Fantail	X	X		X	
Willie Wagtail	X	X		X	
Spotted Quail-thrush				X	
Brown Songlark				X	
Rufous Songlark	X	X	X	X	
White-browed Babbler	X			X	
Grey-crowned Babbler		X	X	X	
Clamorous Reed-Warbler					
Little Grassbird					
Golden-headed Cisticola					
Superb Fairy-wren				X	
Variegated Fairy-wren		X	X	X	
Splendid Fairy-wren					
White-winged Fairy-wren	X				
Chestnut-rumped Hylacola				X	
Speckled Warbler		X	X	X	
Weebill	X	X	X	X	
Western Gerygone	X	X	X	X	
White-throated Gerygone				X	
Yellow-rumped Thornbill				X	
Chestnut-rumped Thornbill	X	X	X	X	
Striated Thornbill				X	
Brown Thornbill				X	
Yellow Thornbill	X	X	X	X	
Buff-rumped Thornbill				X	
Inland Thornbill	X	X	X	X	
Southern Whiteface	X			X	
Varied Sittella	X	X	X	X	
White-throated Treecreeper	X			X	
Brown Treecreeper	X	X	X	X	
Red Wattlebird				X	
COMMON NAME	Condobolin	Tullamore	Boona Mount	Peak Hill	Bogan Gate

Striped Honeyeater	X	X	X	X
Little Friarbird	X	X	X	X
Noisy Friarbird	X		X	X
Noisy Miner	X	X	X	X
Yellow-throated Miner	X	X		X
Blue-faced Honeyeater	X	X		X
Singing Honeyeater	X			
Yellow-faced Honeyeater				
White-eared Honeyeater		X	X	X
Yellow-tufted Honeyeater				X
Yellow-plumed Honeyeater		X		X
White-plumed Honeyeater	X	X	X	X
Fuscous Honeyeater				X
Black-chinned Honeyeater			X	
Brown-headed Honeyeater	X	X	X	X
White-naped Honeyeater				X
Brown Honeyeater				X
Painted Honeyeater				X
Eastern Spinebill				X
Spiny-cheeked Honeyeater	X	X	X	X
Pied Honeyeater				
Black Honeyeater				
Crimson Chat				
Mistletoebird	X			X
Spotted Pardalote		X	X	X
Striated Pardalote	X	X	X	X
Silvereye				X
House Sparrow				X
White-browed Scrubwren				X
Red-browed Firetail				X
Diamond Firetail			X	X
Double-barred Finch	X			X
Zebra Finch				X
Plum-headed Finch				
Common Starling	X			X
Blackbird				X
Olive-backed Oriole				X
Spotted Bowerbird				
White-winged Chough	X	X	X	X
Apostlebird	X	X	X	X
Australian Magpie-lark	X	X	X	X
White-browed Woodswallow	X			X
Dusky Woodswallow		X		X
Masked Woodswallow				
Black-faced Woodswallow	X	X		X
White-breasted Woodswallow				
Grey Butcherbird	X	X		X
Pied Butcherbird		X		X
Australian Magpie	X	X		X
Pied Currawong				X
Australian Raven		X		X
Little Raven				X

Mammals

Common Name	Condobolin	Boona Mount	Tullamore	Peak Hill	Bogan Gate
Short-beaked Echidna		X	X	X	
Yellow-footed Antechinus				X	
Brush-tailed Phascogale	X				
Common Dunnart				X	
Common Wombat				X	
Koala				X	
Common Wallaroo		X		X	
Red-necked Wallaby		X		X	
Eastern Grey Kangaroo	X		X	X	
Swamp Wallaby				X	
Common Ringtail Possum				X	
Sugar Glider				X	
Squirrel Glider				X	
Common Brushtail Possum	X			X	
Feathertail Glider			X	X	
Water Rat	X				
New Holland Mouse				X	
Black Rat				X	
House Mouse			X	X	
European Rabbit		X	X	X	
Brown Hare				X	
Red Fox			X	X	
Cat			X	X	
Dog			X	X	
Feral Pig	X			X	
Feral Goat	X	X		X	

Reptiles

Common Name	Condobolin	Boona Mount	Tullamore	Peak Hill	Bogan Gate
Eastern Long-necked Turtle				X	
Stone Gecko				X	
Ocellated Velvet Gecko				X	
Bynoe's Gecko		X			
Tree Dtella	X	X		X	
Thick-tailed Gecko		X		X	
Eastern Spiny-tailed Gecko				X	
Burton's Snake-lizard				X	
Lace Monitor	X			X	
Sand Monitor					
Eastern Blue-tongued Lizard	X			X	X
Southern Rainbow Skink				X	
Copper-tailed Skink				X	
Striped Skink	X			X	X
Brown-blazed Ctenotus					X
Boulenger's Skink	X	X		X	X
Red-throated Skink				X	
Tree Skink		X		X	
White's Skink				X	
Shingleback Lizard		X		X	
Carnaby's Wall Skink				X	
Wood Mulch-slider		X		X	
Common Dwarf Skink					
Jacky Lizard				X	
Nobbi				X	
Eastern Bearded Dragon				X	
Olive Legless Lizard	X		X	X	
Prong-snouted Blind Snake	X			X	
Proximus Blind Snake					X
Western Scaly-foot	X			X	
Yellow-faced Whipsnake				X	
Red-bellied Black Snake				X	
Spotted Black Snake	X			X	
Eastern Brown Snake				X	X
Red-naped Snake	X			X	
Bandy Bandy	X			X	X
Curl Snake	X			X	

Amphibians

Common Name	Condobolin	Boona Mount	Tullamore	Peak Hill	Bogan Gate
Peron's Tree Frog				X	X
Desert Tree Frog				X	X
Green Tree Frog				X	
Gunther's Frog				X	
Common Eastern Toadlet				X	
Sloane's Froglet				X	
Plains Toadlet				X	
Eastern Banjo Frog	X			X	X
Salmon-striped Frog	X			X	
Spotted Grass Frog				X	X
Northern Banjo Frog				X	
Giant Banjo Frog	X		X	X	
Ornate Burrowing Frog				X	
Common Spadefoot Toad	X			X	X
Long-thumbed Frog	X			X	
Cruxifex Frog	X			X	X
Water-holding Frog	X			X	

ATTACHMENT JA-C

DETAILS OF THE TRANSECT HABITAT ASSESSMENT SURVEY

ATTACHMENT JA-C: DETAILS OF THE TRANSECT HABITAT ASSESSMENT SURVEY

SITES	Tree Height	Tree Density	DBH	% Holes	Log Area	Log Density	Litter Weight	% Grass	% Forb	Sapling Density	Stag Density	Shrub Density	Sapling Height	Grass Height	Forb Height	Shrub Height	% Litter
G30	10.5	123	60.7	50	8300	31	910	86.2	3.0	31	15	169	185	38.7	16.7	97.3	100
G34	9.3	250	31.7	0	9966	94	760	36.7	33.7	47	30	62	203	37.5	16.0	78.7	70
G39	7.5	230	38.3	50	5277	173	610	10.0	58.7	0	0	960	-	30.2	38.7	77.0	99
G41	9.2	138	45.4	40	2475	111	380	5.0	40.0	0	0	862	-	35.0	35.5	68.8	74
G25	0	0	0	0	0	0	100	40	0	0	0	5000	-	6.5	-	34.9	17.5
G28	9.7	320	23.5	0	12000	40	700	2.5	1.5	0	0	440	-	14.0	21.5	68.6	87.5
W2	13.0	59	73.7	75	5589	134	810	45.0	11.2	75	15	447	318	28.0	21.7	240.0	97
W6	8.4	220	29.5	0	13700	40	740	48.7	27.5	20	0	680	300	30.2	14.5	202.0	74
S3	8.6	734	19.4	0	11425	267	650	11.7	27.5	133	267	1134	300	30.5	26.7	112.3	86
S2	6.3	680	15.2	0	4533	240	470	9.7	20.0	120	0	1120	320	12.7	17.7	92.4	59
S1	8.0	650	20.0	8	5500	200	980	4.0	1.5	150	50	1400	350	18.3	17.0	198.9	100
RAIL SIDING	6.7	73	44.0	50	3100	36	100	23.7	30.0	91	0	182	330	38.7	26.0	165.0	3
R64/1	5.8	427	17.5	9	3600	27	390	38.7	13.7	40	0	293	200	53.7	26.5	165.0	55
R64/4	7.4	650	23.3	4	1000	50	650	17.5	11.7	150	25	125	291	51.5	13.0	180.0	100
M1	9.1	850	18.8	0	7360	500	816	1.4	14.0	1850	0	700	197	9.5	33.8	107	
M2	15.4	550	34.9	18	4066	150	1176	20.4	9.0	1450	150	0	728	27.4	15.6	-	

ATTACHMENT JA-D

FAUNA RECORDED WITHIN THE PROJECT AREA

ATTACHMENT JA-D: FAUNA RECORDED WITHIN THE PROJECT AREA

COMMON NAME	Mine Site	Gas Pipeline	Water Pipeline	Route 64/ Fifield Bypass	Rail Siding	Limestone Quarry	Borefields
Birds							
Emu	X	X					
Australasian Grebe	X						
Darter	X	X	X				
White-faced Heron	X			X			
Pacific Heron	X		X	X			
Great Egret		X					
Yellow-billed Spoonbill			X				
Australian White Ibis			X	X			
Straw-necked Ibis		X	X	X			
Black Swan			X				
Wood Duck	X	X	X	X			
Grey Teal	X						
Pacific Black Duck	X		X				
Australian Shoveller	X						
Black-shouldered Kite	X			X	X		
Brown Falcon				X	X		
Nankeen Kestrel	X		X	X			
Australian Hobby	X						
Little Eagle	X	X					
Spotted Harrier	X						
Swamp Harrier			X				
Wedge-tailed Eagle	X						
Peaceful Dove		X					
Rock Dove		X			X		
Common Bronzewing		X		X			
Crested Pigeon	X	X	X	X	X		
Masked Lapwing	X	X					
Black-fronted Plover	X						
Sulphur-crested Cockatoo		X	X				X
Galah	X	X	X	X	X	X	X
Little Corella	X						
Pink Cockatoo		X					
Cockatiel	X	X	X	X			
Blue Bonnet		X		X			
Australian Ringneck		X					
Blue-winged Parrot		X					
Eastern Rosella	X	X	X	X			
Red-rumped Parrot	X		X	X	X		
Barn Owl				X			
Barking Owl		X					
Spotted Nightjar	X						
Laughing Kookaburra	X	X		X	X		
Sacred Kingfisher	X	X			X		
Singing Bushlark				X			
Welcome Swallow	X				X		
Fairy Martin	X	X					
Tree Martin			X				
Richards Pipit	X	X		X			
Black-faced Cuckoo-shrike	X	X		X			
Jacky Winter	X	X					
Grey Shrike-thrush	X	X		X			
Rufous Whistler	X	X	X				

COMMON NAME	Mine Site	Gas Pipeline	Water Pipeline	Route 64/ Fifield Bypass	Rail Siding	Limestone Quarry	Borefields
Birds (Continued)							
Red-capped Robin		X					
Eastern Yellow Robin	X	X					
Hooded Robin	X						
Restless Flycatcher		X					
Grey Fantail	X	X					
Willie Wagtail	X	X	X				
Brown Songlark	X						
White-browed Babbler		X			X		
Little Grassbird	X						
Variegated Fairy-wren		X	X				
Weebill	X	X					
Yellow-rumped Thornbill	X			X			
Chestnut-rumped Thornbill		X					
Yellow Thornbill	X						
Inland Thornbill	X	X					
Brown Treecreeper		X					
Red Wattlebird		X					
Little Friarbird		X					
Noisy Miner	X	X		X	X		
Blue-faced Honeyeater	X	X					
Singing Honeyeater		X					
White-plumed Honeyeater		X					
Brown-headed Honeyeater	X						
Spiny-cheeked Honeyeater	X	X					
Pied Honeyeater		X					
Mistletoebird		X					
Striated Pardalote		X					
House Sparrow		X	X	X			
Common Starling	X	X					
Blackbird		X					
Olive-backed Oriole		X					
White-winged Chough		X	X		X		
Apostlebird	X		X	X	X		
Australian Magpie-lark	X	X	X	X			
White-browed Woodswallow	X						
White-breasted Woodswallow		X					
Grey Butcherbird		X		X			
Pied Butcherbird	X	X			X		
Australian Magpie	X	X	X	X	X		
Australian Raven	X			X	X	X	X
Little Raven		X					
Mammals							
Short-beaked Echidna	X	X					
Common Dunnart	X				X		
Red-necked Wallaby		X					
Eastern Grey Kangaroo	X	X		X			
Swamp Wallaby	X	X					
Common Brushtail Possum	X	X					
House Mouse	X	X			X		
European Rabbit	X	X	X	X	X		
Brown Hare				X			
Dog	X			X			
Red Fox	X			X			
Feral Pig	X						

COMMON NAME	Mine Site	Gas Pipeline	Water Pipeline	Route 64/ Fifield Bypass	Rail Siding	Limestone Quarry	Borefields
Reptiles							
Eastern Long-necked Turtle			X				
Tree Dtella		X					
Lace Monitor		X	X				
Sand Monitor		X					
Eastern Blue-tongued Lizard	X						
Boulenger's Skink		X					
Shingleback Lizard	X	X		X			
Carnaby's Wall Skink		X					
Common Dwarf Skink	X						
Eastern Bearded Dragon		X	X				
Eastern Brown Snake	X						
Amphibians							
Common Eastern Toadlet	X	X					
Eastern Banjo Frog		X					
Spotted Grass Frog		X					
Giant Banjo Frog		X					
Long-thumbed Frog		X					

APPENDIX JB

SYERSTON NICKEL - COBALT PROJECT

TERRESTRIAL FAUNA EIGHT PART TESTS

DETERMINATION OF SIGNIFICANT EFFECTS ON THREATENED SPECIES, POPULATIONS OR ECOLOGICAL COMMUNITIES, OR THEIR HABITATS

PREPARED BY

MOUNT KING ECOLOGICAL SURVEYS AND RESOURCE STRATEGIES

JULY 2000
Project No. BRM-98-01/3.7
Document No. 8PTR-01-I.DOC

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JB1 INTRODUCTION

JB1.1 Background and Scope

This document assesses the Syerston Nickel-Cobalt Project for significant effects on threatened species, populations or ecological communities or their habitats in accordance with Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act), and accompanies the *Syerston Nickel-Cobalt Project Terrestrial Fauna Survey and Assessment* (Appendix JA of the Environmental Impact Statement [EIS]).

This document presents the 8 Part Tests of Significance applied to a list of threatened fauna species known or considered likely to occur in the Project area and surrounds (ie. subject species).

A list of subject species (Table JB-1) was generated with reference to:

- The National Parks and Wildlife Service (NPWS) Atlas of New South Wales Wildlife records for the Peak Hill, Tullamore, Bogan Gate, Condobolin and Boona Mount 1:100,000 map sheets (NPWS, 1999a);
- Ayers *et al.* (1996) *Threatened Species of Western New South Wales*;
- Fauna surveys in the area [Mount King Ecological Surveys (MKES), 2000];
- Atlas of Birds of western NSW (Cooper and McAllan 1995);
- Distribution and habitat descriptions in seminal text such as Simpson and Day (1996), Cogger (1999) and Strahan (1999);
- The Flora and Fauna of the Parkes Shire (Schrader 1988);
- Mid-Lachlan Regional Vegetation Management Plan (Department of Land and Water Conservation 1999).

Table JB-1
Threatened Fauna Records

Species	Common Name[+]	Conservation Status		Map Sheets Recorded				
		TSC Act[1]	EPBC Act[2]	Peak Hill	Tullamore	Bogan Gate	Condobolin	Boona Mount
Grus rubicundus	Brolga	V	-	x			x	
Botaurus poiciloptilus	Australian Bittern	V	-					
Ardeotis australis	Australian Bustard	E	-					
Burhinus magnirostris	Bush Stone-curlew	E	-				x	
Calyptorhynchus lathami	Glossy Black-cockatoo	V	-	x				
Calyptorhynchus magnificus	Red-tailed Black-cockatoo	V	-					
Cacatua leadbeateri	Major Mitchell's Cockatoo*	V	-	x				
Stictonetta naevosa	Freckled Duck	V	-	x			x	
Oxyura australis	Blue-billed Duck	V	-					
Pachycephala inornata	Gilbert's Whistler	V	-					
Falco hypoleucos	Grey Falcon	V	-					

Table JB-1 (Continued)
Threatened Fauna Records

Species	Common Name+	Conservation Status		Map Sheets Recorded				
		TSC Act[1]	EPBC Act[2]	Peak Hill	Tullamore	Bogan Gate	Condobolin	Boona Mount
Leipoa ocellata	Malleefowl	E	V	x				x
Tyto novaehollandiae	Masked Owl	V	-					
Ninox connivens	Barking Owl*	V	-	x				
Rostratula benghalensis	Painted Snipe	V	-					
Grantiella picta	Painted Honeyeater	V	-	x				
Certhionyx variegatus	Pied Honeyeater*	V	-					
Xanthomyza phyrgia	Regent Honeyeater	E	E					
Lophoictinia isura	Square-tailed Kite	V	-					
Neophema pulchella	Turquoise Parrot	V	-	x				
Polytelis swainsonii	Superb Parrot	V	V	x	x			
Lathamus discolor	Swift Parrot	E	E	x				
Hamirostra melanosternon	Black-breasted Buzzard	V	-					
Ephipporhynchus asiaticus	Black-necked Stork	E	-					
Anseranas semipalmata	Magpie Goose	V	-	x		x	x	
Pandion haliaetus	Osprey	V	-					
Pedionomus torquatus	Plains Wanderer	E	V					
Phascolarctos cinereus	Koala	V	-	x				
Petaurus norfolcensis	Squirrel Glider	V	-	x				
Antechinomys laniger	Kultarr	E	-					
Dasyurus maculatus	Tiger Quoll	V	V					
Phascogale tapoatafa	Brush-tailed Phascogale	V	-				x	
Sminthopsis macroura	Stripe-faced Dunnart	V	-					
Petrogale penicillata	Brush-tailed Rock-wallaby	V	V					
Tiligua occipitalis	Western Blue-tongued Lizard	V	-					

+ Nomenclature as per CSIRO (1997)
* Species recorded within the Project area and surrounds (MKES, 2000)
1 Listed under the NSW *Threatened Species Conservation Act, 1995*
2 Listed under the Commonwealth *Environment Protection* and *Biodiversity Conservation Act, 1999*
V Vulnerable
E Endangered

The list of species to be addressed was refined with consideration of fauna survey results, presence of suitable habitat resources, essential lifestyle components of candidate species (including breeding, foraging movement/migration) and the potential impacts of the Project on terrestrial fauna (ie. nature and extent of disturbance/impact) (Table JB-2).

Table JB-2
Syerston Project 8 Part Test – List of Threatened Fauna Species

Common Name+	Scientific Name
Square-tailed Kite	*Lophoictinia isura*
Grey Falcon	*Falco hypoleucos*
Major Mitchell's Cockatoo	*Cacatua leadbeateri*
Superb Parrot	*Polytelis swainsonii*
Swift Parrot	*Lathamus discolor*
Turquoise Parrot	*Neophema pulchella*
Painted Honeyeater	*Grantiella picta*
Bush Stone-curlew	*Burhinus grallarius*
Pied Honeyeater	*Certhionyx variegatus*
Barking Owl	*Ninox connivens*
Plains-wanderer	*Pedionomus torquatus*
Black-breasted Buzzard	*Hamirostra melanosternon*
Malleefowl	*Leipoa ocellata*
Glossy Black-cockatoo	*Calyptorhynchus lathami*
Koala	*Phascolarctos cinereus*
Squirrel Glider	*Petaurus norfolcensis*
Stripe-faced Dunnart	*Sminthopsis macroura*
Brush-tailed Phascogale	*Phascogale tapoatafa*

+ Nomenclature in accordance with CSIRO (1997)

In addition to the 18 species listed in Table JB-2, two additional threatened fauna species were proposed for consideration based on results of a search of the NPWS Atlas of NSW Wildlife, *viz*. the Freckled Duck (*Stictonetta naevosa*) and the Brolga (*Grus rubicundus*).

The following outlines why these species were excluded from consideration in an 8 Part Test.

Freckled Duck (*Stictonetta naevosa)*

Endemic to south-east and south-west Australia (Marchant and Higgins, 1993), the Freckled Duck is widespread in NSW, notably the north-west and Murray-Darling Basin areas (Braithwaite *et. al*, 1985; Frith, 1982; Morris *et. al*, 1981). One record of the Freckled Duck occurs in the region from Banap Swamp, approximately 20 km south-west of Condobolin and 60 km south-west of the mine site.

Nesting occurs in swamps characterised by growths of Cumbungi, Canegrass, Lignum or Ti-tree in either permanent swamps of freshly flooded areas (Frith, 1977 in Ayers *et. al,* 1996). Outside of the breeding season, Freckled Ducks are known to roost diurnally, typically on exposed mud banks, sand banks, dense cover, emergent snags and to a lesser extent, on the water (Marchant and Higgins, 1993). *S. naevosa* feed at the edge of wetlands or in shallow productive waters using a number of foraging mechanisms.

Only marginal potential habitat for *S. naevosa* occurs along watercourses in the region, such as the Lachlan River and Goobang, Wallaroi and Nerathong Creeks, with this species being more likely to utilise regional swamps/lakes such as Bogandillon Swamp and Lake Cowal. Given the lack of disturbance at creek crossings associated with the Project (ie. temporary period of disturbance, minimal vegetation clearance and marginal potential habitat) it is considered most unlikely that this species would be impacted by the Project and is therefore excluded from the eight part test assessment.

Brolga (*Grus rubicundus*)

The Brolga is widespread and generally abundant in northern and eastern Australia. In NSW it occurs along major river systems on the north-western slopes of the Great Dividing Range and Riverina (Marchant and Higgins, 1993) and within the region, one record occurs on the Lachlan River, one on Wallaroi Creek and two at Banap Swamp.

The Brolga typically occurs on extensive open wetlands, including shallow swamps, their margins and floodplains. Nesting usually occurs in shallow wetland areas with shelter, primarily on small islands in Canegrass, Lignum or sedge swamps (Bransbury, 1990 in Ayers *et. al*, 1996), while *G. rubicundus* roosts besides swamps, waterholes and lakes (Ayers *et. al*, 1996). Feeding mostly occurs near water although Brolgas are known to feed in grasslands, dry wetlands or cultivated areas (Kingsford, 1991). The Brolga is known to shift forage habitats in response to drought and subsequent reduction in food supply. The Brolga is partly migratory, dispersing in flocks between dry-season and wet-season breeding areas (Marchant and Higgins, 1993; Lindsey, 1992).

Similarly to the Freckled Duck, marginal, if any, potential habitat exists for the Brolga at the watercourses traversed by the gas and water pipelines. Given the lack of disturbance associated with the pipelines, it is considered most unlikely that this species would be impacted by the Project and is therefore excluded from the eight part test assessment.

Eight Part Tests of Significance for threatened bat species known or considered likely to occur in the Project area and surrounds have been prepared by Greg Richards & Associates and are presented in Appendices JC and JD of the EIS.

A detailed description of the Syerston Project (herein referred to as the Project) and the existing environment of the Project area and surrounds is presented in Volume 1 of the EIS.

JB2 SECTION 5A – ENVIRONMENTAL PLANNING AND ASSESSMENT ACT

JB2.1 Background

The following background information and discussion of the 8 Part Test of Significance process has been sourced from Resource Strategies *et al*. (1997).

The *Threatened Species Conservation Act, 1995* (TSC Act) was passed by the NSW Parliament on the 18 December 1995 and commenced on the 1 January 1996. It represents a major government initiative in the field of threatened species conservation (NPWS, 1996a).

The Act provides for the protection of all threatened plant and animal species (as listed in Schedules 1 and 2) and places specific responsibilities on applicants, proponents, consent and determining authorities in regard to environmental planning, development control, recovery planning and threat abatement.

Effectively replacing the legislative scheme introduced by the *Endangered Fauna (Interim Protection) Act, 1991* (EF Act), the TSC Act makes substantial amendments to the *Environmental Planning and Assessment Act, 1979* (EP&A Act) and the *National Parks and Wildlife Act, 1974* (NPW Act).

A provision of the TSC Act is the introduction of a set of factors (contained within Section 5A of the EP&A Act), to be considered when determining whether a proposed activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats. These eight (8) factors form a major component of the threatened species impact assessment process and collectively are referred to as the 8 part test (NPWS 1996a).

The 8 part test is as follows:

(a) *In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction;*

(b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;*

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;*

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;*

(e) *Whether critical habitat will be affected;*

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region;*

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatened process;*

(h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

JB2.2 Interpretation of the 8 Part Test

The following discussion of the 8 Part Test has been adapted from Resource Strategies (1999).

Part (a): In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction

It is considered that in order to assess the potential impacts of a Project on fauna, it is necessary to define what constitutes a "viable local population".

A population is defined in the TSC Act as "*a group of organisms, all of the same species, occupying a particular area*", however no definition of "viable" or "local" is provided. Similarly, the EP&A Act provides no definition of "viable local population".

In general, there is a degree of difficulty in defining the spatial distribution of a population of a given species and hence, in determining the viability or sustainability of that population. This is further complicated by the potential mobility of species and their particular essential behavioural patterns, which may vary in accordance with spatial and/or temporal factors.

Further to this, there are obvious difficulties in defining the boundaries of a local population. A small population of a certain species completely constrained by habitat availability, would enable easier definition as a local population. However, where large areas of habitat occur over many 1,000s of hectares, definition of local populations becomes more difficult and in fact may be better defined as local members of a regional population.

Thus an interpretation of behavioural patterns, habitat preferences and physical attributes may be required to ascertain a likely local population for certain species.

Further to this an understanding of the lifecycle of each of the threatened species within the study area, is required. For animals, important lifecycle components can include breeding, dormancy, roosting, feeding, migration and dispersal (NPWS, 1996a).

These components (or parts thereof) are largely dependent upon the habitat requirements and/or preferences of a particular species and hence, it is also important that there is an understanding of the mechanisms with which species utilise habitat and how they respond/react to existing disturbance regimes.

NPWS (1996a) lists the main components of species' habitats and the regimes of disturbance, which may be essential to lifecycles, as:

- hollow-bearing substrate;
- caves/rock crevices;
- water bodies (permanent/semi-permanent/ephemeral);
- forage resources; and
- fire and flood events.

Using this information, the NPWS (1996a) are able to define a local population as "*one that occurs within a study area, except in the case where the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the study area boundary, can be demonstrated"*. Study area is defined as "the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly".

A local population should be considered to be viable (ie. a population that has the capacity to live, develop and reproduce under normal conditions), unless the contrary can be conclusively demonstrated through analysis of records and references (NPWS, 1996a).

Part (b): In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

This part assesses endangered populations and the impacts of development on them.

It is noted that as per Part 2, Schedule 1 of the TSC Act, endangered populations currently listed are the:

- Riverina population of the Glossy Black-cockatoo (*Calyptorhynchus lathami*);
- Manly Point population of the Little Penguin (*Eudyptula minor*);
- Warrumbungles population of the Brush-tailed Rock-wallaby (*Petrogale penicillata*);
- North Head population of the Long-nosed Bandicoot (*Perameles nasuta*);
- Pittwater population of the Squirrel Glider (*Petaurus norfolcensis*) (on the Barrenjoey Peninsula, north of Bushrangers Hill);
- Hawks Nest and Tea Gardens population of the Koala (*Phascolarctus cinereus*) in the Pittwater local government area;
- Pittwater local government area population of the Koala (*Phascolarctus cinereus*);
- *Menippus fugitivus* population in the Sutherland Shire;
- Tadgell's Bluebell (*Wahlenbergia multicaulis*) in the local government areas of Auburn, Bankstown, Strathfield and Canterbury;
- *Hibbertia incana* in the local government area of Baulkham Hills;
- *Darwinia fascicularsis* subsp. *oligantha* populations in the Baulkham Hills and Hornsby local government areas;
- Gosford Wattle (*Acacia prominens*) in the Hurstville and Kogarah local government areas;
- Kemps Creek population of *Dillwynia tenuifolia*;
- *Cryptandra longistaminea* in the vicinity of Ellandgrove Road, South Grafton;
- *Pomaderris prunifolia* in the Parramatta, Auburn, Strathfield and Bankstown local government areas; and
- Low-growing form of *Zieria smithii*, Diggers Head.

Part (b) is therefore not applicable to the Syerston Project.

Part (c): In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed

It is considered necessary to clarify "regional" when discussing the distribution of habitat that affords opportunities for threatened species. Following a quantitative and qualitative assessment approach, the NPWS has delineated biogeographic regions within the state. These regions have been described following the findings of mapping contained within *An Interim Biogeographic Regionalisation of Australia (IBRA): A Framework for Setting Priorities in the National Reserves System Co-operative Program* (NPWS, 1996b).

In accordance with the regional mapping, the proposed Project area is located within the Cobar Peneplain and the NSW South Western Slopes IBRA regions. The Cobar Peneplain covers an area of 72,501 km^2, while the NSW South Western Slopes covers an area of 80,874 km^2 (Thackway and Cresswell, 1995).

In relation to endangered ecological communities, 27 ecological communities are listed in Part 3, Schedule 1 of the TSC Act. Twenty-three ecological communities are listed in Schedule 2 of the EPBC Act. None of the ecological communities listed are present in the vicinity of the Project area.

Part (d): Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community

Part (d) requires definition and discussion of known habitat areas, connectivity between habitat and mechanisms which act to isolate known habitats. When discussing areas of "*known habitat*" it is necessary to first define what constitutes habitat for threatened species, populations or ecological communities and hence, the requisites for ensuring interconnectivity between such areas.

The TSC Act defines habitat as "*an area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community and includes any biotic or abiotic component*".

In relation to the movement of fauna, species possess a variety of dispersal mechanisms by which they are able to colonise new habitats or maintain genetic health by interacting with different populations in a locality. For example amphibians, typically, are restricted to water bodies such as rivers, creeks or lagoons, however they may undertake forays across elevated terrain in damp conditions. Reptiles can generally disperse over many land types however preference is for areas where cover/protection from predators is available.

By comparison birds are highly mobile and are able to cover relatively large areas of land and have a distinct advantage over most other phyla. Tree cover is however, also important for many avifauna as a means of protection from raptors.

For mammals there is a wide diversity of sub-groups in terms of dispersal needs and abilities: small terrestrial mammals; medium terrestrial mammals; large terrestrial mammals; arboreal mammals; scansorial mammals; and aquatic mammals. Each of these sub-groups have differing dispersal capabilities however most will be constrained by the continuity or near availability of suitable habitat.

Factors such as habitat clearance, fire, damming, road/freeway construction, fences, mining/quarrying, etc. can create a barrier to the dispersal of some species. The type of barrier and the species involved will determine the level of impact on dispersal capability or the degree of isolation induced.

In terms of connectivity and the inter-relationships between habitat areas, Merriam (1991) indicates that if the need is for long-term movement over great distances, core habitat rather than corridors may be the solution. This statement pre-supposes that linear corridors or strips of vegetation can function to facilitate genetic exchange, demographic replenishment and the individual resource needs of fauna in core habitats.

Dimensional requirements for corridors or other connections are likely to be specific to ecological or behavioural groups of species (Merriam, 1991).

There are indications that corridor quality is an important element of connectivity. Henein and Merriam (1990) note that low quality corridors have the greatest probability of patch population extinction.

The conservation of corridor habitat should consider the area and variety of habitat types to be included. The retention of an array of required habitats (and connection of vital patches and landscape features), are fundamental safeguards for the integrity of large ecological units (Merriam, 1991). This statement assumes that a corridor is a viable habitat area in itself.

However, rather than view the vegetation linking two large ecological units as a corridor, which has a linear connotation, it is probably better to view the linkage as a "habitat connection", ie. a corridor which is a distinct ecological entity and which is able to sustain a diversity of faunal species and accommodate their ranging requirements and perhaps even their breeding needs. Simberloff *et al.* (1992) advocate a multiple use approach with core areas supplemented by a matrix of habitats and landuses over a large landscape. They indicate that this type of approach may be just as effective as continuous linear linkages of varying width.

Merriam (1991) notes that as the degree of connectivity between large ecological units increases, so may the use of corridors for breeding habitat.

At the limit, where corridors are used primarily as breeding habitat and not for linear movement, individuals may not be able to move between patches, but their genetic line, by reproduction along a linear habitat element, could complete the movement.

Part (e): Whether critical habitat will be affected

Part (e) considers whether a proposed development or activity is likely to affect land that is, or is part of, critical habitat.

In accordance with Division 1 of Part 3 of the TSC Act, habitat that is eligible to be declared to be critical habitat is as follows:

> "*the whole or any part or parts of the area or areas of land comprising the habitat of an endangered species, population or ecological community that is critical to the survival of the species, population or ecological community*."

There is no critical habitat within the vicinity of the Project area as designated by the Register of Critical Habitat held by the Director-General of the NSW NPWS.

Part (f): Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region

To evaluate whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region, it is necessary to analyse each species, population or ecological community, or their habitats in several contexts (NPWS, 1996a). Issues for consideration include biological and physical attributes, the extent of decline since European settlement, relative abundance and current distribution.

Information on representation in conservation reserves has been sourced from the NPWS Atlas of NSW Wildlife database, as well as a variety of other reference sources.

Part (g): Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process

Schedule 3 of the TSC Act makes provision for listing threatening processes as recognised by the NSW Scientific Committee. At present there are six key threatening processes listed within that schedule that affect fauna populations. These are:

- bushrock removal;
- high frequency fire;
- predation by *Gambusia holbrooki;*
- predation by the European red fox;
- predation by the feral cat; and
- predation from the Ship Rat on Lord Howe Island.

In addition, Schedule 3 of the *Endangered Species Protection Act* (ESP Act) lists the following key threatening processes:

- predation by the European red fox;
- dieback caused by the Root-rot fungus (*Pthytophthora cinnamomi*);
- predation by feral cats;
- competition and land degradation by feral rabbits; and
- competition and land degradation by feral goats.

Part (h): Whether any threatened species, population or ecological community is at the limit of its known distribution

In assessing species' distribution boundaries it is considered appropriate to access a wide range of relevant reference sources. To this end a number of databases and reference materials have been examined including Threatened Species of Western NSW (Ayers *et al*, 1996). Atlas of Birds of Western NSW (Cooper and McAllan, 1995); fauna of the Parkes Shire (Schrader 1988), Mid-Lachlan Regional Vegetation Management Plan (Department of Land and Water Conservation 1999), seminal texts (eg. Cogger, 1999; Strahan, 1999), field guides (eg. Slater *et al.*, 1999; Pizzey and Knight, 1999) as well as various scientific publications.

JB3 8-PART TESTS FOR THREATENED SPECIES KNOWN OR CONSIDERED LIKELY TO OCCUR IN THE PROJECT AREA AND SURROUNDS

JB3.1 Square-tailed Kite (*Lophoictinia isura*)

This species has not been recorded from the Project area or surrounds during the fauna surveys (MKES, 2000), and no records exist for the area (ie. Peak Hill, Tullamore, Bogan Gate, Condobolin and Boona Mount 1: 100,000 map sheets) in the NPWS Atlas of NSW Wildlife database.

Records of this species occur across most parts of NSW and, in the western zone, it is most commonly seen in riparian Eucalypt woodland (Debus *et al.,* 1993; Marchant and Higgins, 1993). Ayers *et al.* (1996) note that in the western region this species can be confused with the Black Kite (*Milvus migrans*).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

The Square-tailed Kite breeds from July to December (Lindsey, 1992, Pizzey & Knight, 1999) and while little is known of its requirements for breeding in terms of habitat, it appears to need a large wooded area (of the order of hundreds of hectares) (Marchant and Higgins, 1993).

It is unlikely that breeding pairs would be utilising the Project area as a breeding resource, given the absence of records and disjunct nature of woodland areas.

Foraging

This species specialises in taking small prey (small birds including nestlings, reptiles and insects) from the tree canopy (Schodde and Tidemann, 1995; Ayers *et al*., 1996). This raptor shows a preference for foraging in Eucalypt woodland (Marchant and Higgins, 1993; Debus and Czechura, 1989).

Resident pairs have a large territory (>100 km^2) (Slater *et al.,* 1999; Marchant and Higgins, 1993) and hence the Project area may offer potential foraging habitat. The nature of the disturbance associated with the Project is unlikely to significantly affect foraging behaviour of any *L. isura* in the area.

Nesting

Nests are generally large platforms of stick lined with eucalypt leaves, located in a mature (living) tree near an assured food supply and often within 100 m of a watercourse (Marchant and Higgins, 1993; Readers Digest, 1997). Square-tailed Kites may re-use a nest in successive years (Lindsey, 1992; Schodde and Tidemann, 1995). The Project area is unlikely to represent an assured food supply and given that there are no records of this species in the area, no local population is likely to be reliant on the Project area as a nesting resource.

Movement/Migration

Records suggest that this species moves north to tropical areas in winter (Blakers *et al*., 1984; Brouwer and Garnett, 1990), and Marchant and Higgins (1993) describe the species as migratory across much of its range. The areas of remnant woodland within and in close proximity to the Project area could constitute a "stepping stone" for a *L. isura* moving through the landscape. However, it is unlikely that the movements of this species would be impeded by the proposed Project.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

As previously stated, the territory size of a resident pair of Square-tailed Kites can be over 100 km^2. The Project would necessitate the removal of relatively small portions of potential habitat within the mine site, pipeline and road corridors and it is unlikely that the Project would modify or remove a significant area of known habitat.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

It is possible that *L. isura* could use the woodland within the Project area as a habitat resource, most notably for foraging. Given the open, disjunct nature of the remnant portions of woodland in the area and the nature of the disturbance associated with the Project, the proposed development is unlikely to further isolate potential habitat areas to the extent that *L. isura* would be affected.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

The Square-tailed Kite has been recorded in the Munghorn Gap, Ingalba and Mundoonan Nature Reserves and Sturt, Kinchega and Mutjiwingee National Parks (Ayers *et al,* 1996).

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Ayers *et al.* (1996) consider the following processes as potential threats to *L. isura*: clearing of matured eucalypts along watercourses; habitat fragmentation; grazing, logging and burning; and egg collecting and shooting.

The Project could potentially constitute a threatening process if a local population were to exist in the Project area. The lack of *L. isura* records from the region suggests that no resident pairs occur in the Project area.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent a distributional limit for this species based on mapping of *L. isura* ranges (Lindsey, 1992; Simpson & Day, 1996; Pizzey and Knight, 1999).

3.2 Grey Falcon (*Falco hypoleucos*)

This species has not been recorded from the Project area or surrounds during the fauna surveys (MKES, 2000), and no records exist for the five map sheets in the NPWS Atlas of NSW Wildlife database.

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

The Grey Falcon mainly breeds in the arid and semi-arid zone (Marchant and Higgins, 1993) where less than 250 mm annual rainfall occurs (Brouwer and Garnett, 1990) with strongholds in the Lake Eyre and Murray-Darling regions (Blakers *et al.*, 1984).

Foraging

Favouring lightly timbered plains and Eucalypt-lined watercourses, the Grey Falcon hunts either on the wing or from an exposed perch, feeding on birds, some small mammals and reptiles, occasional insects and rarely carrion (Slater *et al.*, 1999; Lindsey, 1992; Marchant and Higgins, 1993; Schodde and Tidemann, 1995; Olsen and Olsen, 1986; Barker and Vestjens, undated in Ayers *et al.,* 1996). Within the Project area potential foraging areas exist in the paddocks with scattered tree cover, however a local population (were one to exist) is unlikely to be reliant upon such areas.

Roosting/Nesting

This species roosts in live and dead trees, requiring large Eucalypts near water or a dry watercourse for nesting (Ayers *et al*., 1996). Nests built by other species, particularly corvids, are often reused (Olsen and Olsen, 1986; Lindsey, 1992). Potential roost/nest trees occur in the Project area, (eg. along Lachlan River, Bumbuggan Creek and Nerathong Creek), however the lack of records of this species in the area indicates that it is more likely to occur along the major watercourses to the north and west.

Movement/Migration

Some pairs of *F. hypoleucos* are resident, others are dispersive or migratory with parts of the population undergoing seasonal (autumn) movements north (Pizzey and Doyle, 1980 in Ayers *et. al*. 1996; Olsen and Olsen, 1986; Pizzey and Knight, 1999). In drought years it may be sighted throughout continental Australia including the central tablelands and east of the Great Dividing Range (Blakers *et al.*, 1984; Olsen and Olsen, 1986; Pizzey and Knight, 1999). Given the core distribution and habitat requirements of this species, it is unlikely that dispersion/migratory behaviour of a local population (were one to exist) would be significantly impacted by the proposed Syerston Project.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

Favoured habitat for this raptor occurs principally in the arid zone where it inhabits treeless or lightly timbered plains, especially *Acacia* shrublands, dissected by tree-lined watercourses (Brouwer and Garnett, 1990). While pastoral lands are occasionally used (Olsen and Olsen, 1986; Marchant and Higgins, 1993), the Project would be unlikely to affect a significant area of known habitat.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

While it is possible that vagrant *F. hypoleucos* may use the Project area and surrounds as a habitat resource during dispersal associated with drought conditions, the proposed disturbance associated with the Project is unlikely to significantly affect the habitat value of the area for the Grey Falcon.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

This species is known to occur in the more western conservation reserves (eg. Sturt and Kinchega National Parks), but is not well represented within reserves further to the east where it is considered a vagrant.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Clearing of mature trees close to watercourses or along floodplains is a potential threat to this species. The Project could potentially constitute a threatening process if a local population were to exist in the Project area, however, this is considered unlikely based on the knowledge of their distribution.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent the distributional limit for this species (distribution based on Ayers *et al.*, 1996; Pizzey and Knight, 1999).

JB3.3 Major Mitchell's Cockatoo (*Cacatua leadbeateri*)

This species has been recorded from the Project area and surrounds (within an area of woodland at the 'Sunrise' property, 32°48'54"S, 147°23'54'E) and north-east of Parkes (Peak Hill map sheet), and is the most commonly seen of all threatened species in the western zone (Ayers *et al.,* 1996).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

Maintaining breeding territories of around 500 ha, this species breeds from July to January (Lindsey, 1992; Ayers *et al*., 1996). A strongly territorial species, other pairs are not allowed within several kilometres of the nest (Schodde and Tidemann, 1995). This species was located within an area of woodland in the Project area, however this area will not be affected by the proposed activities.

Foraging

Feeding mainly on the ground, but also in trees and shrubs, the diet of the Major Mitchell's Cockatoo consists of seeds, nuts, fruits and roots, especially the seeds of the Cypress Pine (*Callitris glaucophylla*) and Acacia spp. Readers Digest, 1997; Schodde and Tidemann, 1995; Lindsey, 1992; Barker and Vestjens, undated in Ayers *et al.,* 1996). *Eucalyptus*, *Bassia* and *Casuarina* are also utilised (Schodde and Tidemann, 1995; Barker and Vestjens, undated in Ayers *et al.,* 1996). While potential forage habitat for this species occurs within the Project area, it is unlikely that any local populations would be dependent upon it.

Roosting/Nesting

This species nests in cavities in living or dead trees (Lindsey, 1992; Pizzey and Knight, 1999), generally close to water (Morcombe, 1992). Nests are generally found in old growth Mallee and Belah in the south of their range and in Bimble Box and other eucalypts in the north, or any other tree that provides hollows Pizzey and Doyle, 1980 in Ayers *et. al*., 1996). No nests were located during the fauna surveys, although there is potential nesting habitat within the older trees along many of the watercourses (eg. Lachlan River, Nerathong Creek and Goobang Creek).

Some trees potentially suitable for nesting/roosting may be removed as a result of the proposed development. The removal of older trees would be avoided, where practicable, during the construction of the pipelines and the upgrading of roads, however the small portion of vegetation to be removed is unlikely to significantly impact upon the nesting/roosting resources of *C. leadbeateri*.

Movement/Migration

This species is sedentary where there is a reliable supply of food and water but nomadic elsewhere (Pizzey and Doyle, 1980 in Ayers *et. al*., 1996). After fledging, young birds typically form wandering parties (Lindsey, 1992). The propensity for this species to relocate to suitable habitat indicates that the removal of small portions of potential habitat associated with the Project is likely to be insignificant for this species within the region. Hence, the movements of any local population is unlikely to be significantly affected by the proposed development.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

This species uses a variety of habitats including mulga, mallee, Cypress Pine and Sheoak woodlands, as well as grasslands (Resource Strategies *et al*., 1997). The proposed Project activities would result in a small loss of natural habitat that would not significantly affect the amount found regionally.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The proposed development would entail removal of a small portion of potential habitat for this species, but this loss is unlikely to result in the isolation of potential habitat areas.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

Known from Goobang National Park, Ingabla Nature Reserve and Warrumbungles National Park in the east and most reserves in the west of NSW.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

The Project could potentially constitute a threatening process. However, the nature of the disturbance and the occurrence of proximal habitat suggests a local population would not be placed at risk of extinction. The woodland area in which *C. leadbeateri* was recorded would not be disturbed by the proposed development.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent the distributional limit for this species (distribution based on Ayers *et al*, 1996).

JB3.4 Superb Parrot (*Polytelis swainsonii*)

There are records of the Superb Parrot to the north and east of the Project area (NPWS Atlas of NSW Wildlife database, Tullamore and Peak Hill map sheets). This parrot is mainly found through central NSW.

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

In NSW there are two main centres of breeding distribution (Ayers *et al..* 1996), once thought to be distinct but now known to be one population (Higgins, 1998 in ACT Government, 1999a). One concentration occurs in the Murray-Riverina district (i.e. Griffith, Wagga Wagga and Deniliquin). The other breeding population occupies the south-west slopes in an area bounded by Cowra, Rye Park and Yass in the east, and Grenfell, Young, Cootamundra and Coolac in the west (Weber & Ahern, 1992).

Breeding takes place from September to December (Lindsey, 1992; Pizzey and Doyle, 1980 in Ayers *et. al*., 1996), with favoured trees being River Red Gum (*E. camaldulensis*) and Box species (Ayers *et al.*, 1996; Pizzey and Knight, 1999). Breeding seems to be mostly restricted to the southern part of its range, along the Murray, Edward and Murrumbidgee Rivers and in the woodlands between Cootamundra and Canberra (Webster, 1988 in Garnett, 1993). Potential breeding habitat does occur in the Project area, however the failure to detect this species during the target surveys suggests that a local population does not utilise the area as a breeding resource.

Foraging

This species has a varied diet, foraging for seeds, fruits, nectar and insects on the ground or in trees (Lindsey, 1992). Cereal crops and spilt grain are also eaten (Webster, 1988 in Garnett, 1993; Lindsey, 1992).

In the South-West Slopes region, flowers, fruits and young buds of White Box (*E. albens*) and Bimble Box (*E. populnea*) are especially important (Ayers *et al.,* 1996; Webster, 1988 in Garnett, 1993). Understorey species sought for foraging include Wallaby Grass, numerous wattles (*Acacia acinacea, A. dealbata*), the acacia parasite Grey Mistletoe (*Amyema quandong*), Pale-fruited Ballart (*Exocarpus strictus*) and introduced species such as cereal grains, barley-grasses and Annual Veldt Grass (Weber & Ahern, 1992).

Given the relatively small-scale disturbance proposed, forage resources in the wider region and relative mobility of the species, it is considered that the loss of habitat as a result of the Project would not significantly affect the forage behaviour of local populations of *P. swainsonii*.

Roosting/Nesting

In the Murray-Riverina this species nests in Red River Gum (*E. camaldulensis*) forests located within 10 km of feeding sites (Webster, 1988 in Garnett, 1993). In the South West Slopes nesting is in a variety of eucalypt species, more often in dead trees and further from water than in the Murray-Riverina (Webster, 1988 in Garnett, 1993). A hollow is used, usually located in the tallest tree available (Garnett, 1993).

Loss of nest sites as a result of vegetation clearing, fragmentation and degradation is a primary threat to this species throughout the South Western Slopes (Garnett, 1993). It is possible that *P. swainsonii* may use the Project area as a nesting resource, however, the potential nesting resources nearby and in the wider region, coupled with the mobility of *P. swainsonii* suggests that any potential loss of roost resources is unlikely to place these populations at risk of extinction.

Movement/Migration

During breeding, *P. swainsonii* exhibits very high site fidelity, however, in the non-breeding season, this species is nomadic and a partial migrant (Ayers *et al.*, 1996), with part of the population moving to northern NSW in winter (Webster, 1988 in Garnett, 1993). Wooded landscape links are followed when birds are flying between foraging and breeding areas (Garnett, 1993).

The disjunct patches of remnant vegetation in the region may represent 'stepping stone' resources for *P. swainsonii* passing through the area. Given the limited extent of habitat removal proposed, the mobile nature of the species and the occurrence of proximal areas of habitat, suggest that movement of local populations are unlikely to be adversely affected to the extent they would be placed at risk.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

This species is primarily associated with eucalypt forest and open woodland throughout inland NSW. The proposed development would entail removal of a small amount of potential habitat for this species, however this loss is not considered to be significant in terms of ensuring the viability of local populations (were any to exist).

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The removal of a small amount of remnant vegetation may result in a slight contraction of habitat, however this habitat is relatively isolated and fragmented from the larger expanses of wooded areas in the region (eg. Goobang National Park to the east).

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

According to the Atlas of NSW Wildlife, the Superb Parrot has been recorded in the Big Bush, Buddigower, Flagstaff Memorial, The Charcoal Tank, Ingabla and Narrandera Nature Reserves, and Conimbla and Weddin Mountains National Parks.

Other public land on which this species occurs: Millewa State Forest, Tuppall State Forest, Moira State Forest, Gulpa Island State Forest, other State Forests along the Murrumbidgee, Murray and Lachlan Rivers and in the Cowra-Walgett district (Garnett, 1992).

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

The Project could potentially constitute a threatening process. However, the nature of the disturbance, the occurrence of proximal habitat and mobility of *P. swainsonii* suggests a local population would not be placed at risk of extinction.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent the distributional limit for this species (distribution based on Ayers *et al*, 1996).

JB3.5 Swift Parrot (*Lathamus discolor*)

There is a single *L. discolor* record near Peak Hill, and this species is mainly found in the eastern part of NSW. The Swift Parrot is generally regarded as an infrequent visitor to western NSW (Ayers *et al*, 1996).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

The Swift Parrot breeds in Tasmania and some of the islands in Bass Strait (Lindsey, 1992; Ayers *et al.*, 1996; Pizzey and Knight, 1999). In view of this, the breeding requirements of this species are not considered relevant to the Project area.

Foraging

This species is generally a canopy feeder, congregating where there is profuse flowering of eucalypts (Blakers *et al.*, 1984; Brouwer and Garnett, 1990). On the mainland, winter flowering eucalypts are particularly important, including Red Ironbark (*E. sideroxylon*), Yellow Gum (*E. leucoxylon*), White Box (*E. albens*) and Swamp Gum (*E. ovata*) (Brouwer and Garnett, 1990). Lerp and honeydew are also utilised (Brouwer and Garnett, 1990).

Webster (in Garnett, 1993) notes that *L. discolor* often occurs in remnant patches of mature eucalypts within extensive areas of agricultural land. During major flowering events, this species could potentially occur in the Project area. The proposed development would result in the removal of some potential forage habitat, however, this loss is not considered to be of an extent that a local population (were one to occur) of this highly mobile species would be put at risk of extinction.

Roosting/Nesting

Swift Parrots nest in tree cavities or hollows, usually high in a eucalypt (Lindsey, 1992; Pizzey and Knight, 1999). If sufficient food is available this species will remain in an area and return to the same tree to roost (Pizzey and Doyle, 1980 in Ayers *et. al*., 1996). Due to the fact that this species does not breed on mainland Australia, the proposed Project would not place local populations at risk of extinction.

Movement/Migration

This species is a winter migrant to south-eastern Australia, concentrating in Victoria (Lindsey, 1992). Occurrences elsewhere are highly erratic and dependent upon eucalypt flowering. Whilst the Project would entail removal of some potential forage habitat, the migratory patterns/movements of *L. discolor* passing through the area are unlikely to be significantly affected.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

This species can potentially use flowering eucalypts, particularly in Box woodlands, throughout south eastern Australia. The proposed Project activities would not modify or remove a significant area of known (or potential) habitat.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The Project area offers potential foraging habitat for the Swift Parrot. In view of its capacity for far-ranging dispersal, the amount of vegetation which would be removed as a result of the Project would not isolate interconnecting or proximate areas of habitat for this species.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

According to the Atlas of NSW Wildlife, the Swift Parrot has been recorded in Ingabla Nature Reserve, Big Bush Nature Reserve, Conimbla National Park and Munghorn Gap Nature Reserve.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

The proposed development could potentially constitute a threatening process if a local population were to occur in the Project area. However, the absence of records, the migratory behaviour of this species and the modified nature of the site suggest that this is unlikely.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area is approaching the western margin of the distribution of the Swift Parrot (Ayers *et al.*, 1996).

JB3.6 Turquoise Parrot (*Neophema pulchella*)

The Turquoise Parrot has been recorded along the eastern fringe of the western division north of the Lachlan River (Warrumbungle National Park to Parkes, including Goobang National Park) (Ayers *et al*, 1996).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

This species generally breeds from August to December (Lindsey, 1992; Schodde and Tidemann, 1995), nesting in low hollows in live or dead trees, stumps or posts (Ayers *et al.*, 1996; Higgins, 1998 in NPWS, 1999b) or logs lying on the ground (Quinn & Baker-Gabb, 1993). Potential breeding habitat exists within the Project area, however the loss of portions of this potential habitat is unlikely to place this species at risk of extinction, given the lack of records for this species in the area and availability of potential resources in the wider region.

Foraging

This species forages almost entirely on the ground, feeding on seeds of native and introduced grasses and herbs (Lindsey, 1992; Barker and Vestjens, undated in Ayers *et al.,* 1996). Specifically the diet includes seeds from Bearded Health (*Leucopogon microphyllas),* Dillwynia spp., Barley Grass (*Hordeum murinum*), Wild Mustard (*Sisymbrium* spp.), Wallaby Grass (*Danthonia semiannularis*), Stinging Nettle (*Urtica urens*) and Saffron Thistle (*Carthamus lanatus*) (Crome & Shields, 1992 in NPWS, 1999b). This species also requires a reliable supply of drinking water (Higgins, 1998 in NPWS, 1999b).

Although Turquoise Parrots may forage within the Project area, any local populations (were any to exist) are unlikely to be dependent upon it, given the occurrence of proximal habitat resources, the mobility of the species and the presence of more extensive habitat areas in the wider region.

Roosting/Nesting

Nests are constructed in a cavity in a small dead or living tree, or in a hole in a stump or fencepost, usually low to the ground (Forshaw, 1981; Lindsey, 1992; Ayers *et al.*, 1996). Potential nesting habitat exists in the Project area, however, the Project is unlikely to affect the nesting capacity of local populations of this species, were any to exist.

Movement/Migration

Distribution of *N. pulchella* is patchy and generally determined by areas of suitable habitat (NPWS, 1999b). Usually seen in pairs or small flocks (Ayers *et al.,* 1996), the Turquoise Parrot is mainly sedentary or locally nomadic (Lindsey, 1992; Pizzey & Knight, 1999). The movements of local populations of this species (were they to exist) are unlikely to be significantly affected by the proposed Project. The foraging habits of this species suggest it frequently undertakes forays across cleared, open areas and disturbance associated with the Project is unlikely to adversely affect the movement of this species.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

The Turquoise Parrot favours woodlands of Yellow Box - Blakely's Red Gum (*E. melliodora - E. blakelyi*) and White Box (*E. albens*) (Morris, 1980), close to permanent water (Pizzey and Knight, 1999). The proposed Project would result in the removal of a small portion of habitat for *N. pulchella*. However, in terms of regional distribution of habitat, the area is unlikely to represent a significant portion.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The clearing of Yellow Box - Blakely's Red Gum habitat associated with the Project is considered unlikely to isolate any interconnecting or proximate areas for resident or vagrant individuals of this species.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

The Turquoise Parrot has been recorded in Goobang National Park, Round Hill Nature Reserve, Cocoparra National Park, Warrumbungle National Park, Boginderra Hills Nature Reserve, Buddigower Nature Reserve, Conimbla National Park , Tabletop Nature Reserve, Gardens of Stone National Park, The Rock Nature Reserve, The Charcoal Tank Nature Reserve, Ingabla Nature Reserve, Munghorn Gap Nature Reserve, Weddin Mountains National Park and the Nangar Nature Reserve.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Grazing, timber cutting, predation (by cats and foxes) and competition from domestic stock are threatening processes relevant to this species. The Project could potentially constitute a threatening process if a local population were to exist in the study area, however the absence of records, the modified nature of the Project area and the prevalence of cats and foxes suggest this is unlikely.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent a distributional limit for this species (Ayers *et al.*, 1996).

JB3.7 Painted Honeyeater (*Grantiella picta*)

There are Atlas of NSW Wildlife records of the Painted Honeyeater in Goobang National Park and to the east of Peak Hill. This species is distributed throughout inland NSW, where it is more likely to be seen to the north in winter and the south during summer, as it follows the fruiting patterns of mistletoes (Ayers *et al.,* 1996).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

With a breeding season extending from October to March, the Painted Honeyeater may raise two successive broods (Lindsey, 1992). The dependence of this species upon mistletoe (*Amyema* spp.) indicates that it could occur in the Project area. However, the small amount of clearing associated with the Project is unlikely to impact upon any local populations.

Foraging

Foraging mainly in the upper canopy, this honeyeater is a specialist forager on mistletoe fruit of the genus *Amyema*, although it occasionally takes insects and nectar (Lindsey, 1992; Pizzey and Knight, 1999). The occurrence of mistletoe indicates that the Project area provides potential foraging habitat. However, the Project is unlikely to significantly affect any local populations of this species given the occurrence of forage resource in the wider region and the mobility of *G. picta*.

Roosting/Nesting

The nest is a frail cup made of plant fibres and rootlets bound by cobwebs (Lindsey, 1992; Pizzey and Knight, 1999). It is usually suspended from the outer foliage at a height of 3 - 20 m (Lindsey, 1992; Pizzey and Knight, 1999). Potential nesting material and sites occur on the Project area, however, the proposed Project activities are unlikely to place any local populations of this species at risk of extinction given the mobility of the species and the nature of the disturbance.

Movement/Migration

This species follows the fruiting of mistletoes across the eastern half of Australia (Pizzey and Knight, 1999; Lindsey, 1992). Following breeding in the south-eastern interior during summer, there is a migration to northern Queensland and the Northern Territory where the winter is spent (Blakers *et al*., 1984; Lindsey, 1992). The proposed Project is unlikely to put at risk any local populations of this highly mobile species.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

This species is found in open forest and woodland throughout eastern Australia. The proposed Project activities would not modify or remove a significant amount of known habitat used by this species.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The removal of a small amount of remnant vegetation may result in a slight contraction of habitat, however this habitat is relatively isolated and fragmented from the larger expanses of in the region (eg. Goobang National Park to the east).

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

The Painted Honeyeater has been recorded in Willandra National Park, Goobang National Park, Ingalba Nature Reserve, Munghorn Gap Nature Reserve and Weddin Mountains National Park.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

The Project could potentially constitute a threatening process. However, the nature of the disturbance, the occurrence of proximal habitat, and mobility of *G. picta* suggests a local population would not be placed at risk of extinction.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent a distributional limit for this species (Ayers *et al*, 1996).

JB3.8 Bush Stone-curlew (*Burhinus grallarius*)

A single record for the Bush Stone-curlew exists within the Project area and surrounds, to the east of Condobolin. This species is widely distributed throughout western NSW, but is mainly found within the central and eastern parts of the State.

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

B. grallarius is *f*ound in a variety of habitats, but mainly in grassy open woodlands where grass is short and patchy with a ground cover of logs and leaf litter. The species favours riverine woodlands and is rare in the cleared and settled parts of its range (Pizzey and Knight, 1999). The main area to be disturbed (mine site) has predominantly been cleared for grazing and it is unlikely that this species would occur there (none located despite three targeted surveys). The remaining scattered woodland found within the Project area would not be significantly affected by the Project activities.

Foraging

The diet of this species consists of invertebrates, small rodents, amphibians and reptiles, as well as seeds and fruit (Ayers *et al*, 1996). The Bush Stone-curlew feeds at night on the ground or by wading. The extent of potential foraging habitat that could be affected within the Project area is small and the proposed Project activities are unlikely to put any local population (if any occur) at risk.

Roosting/Nesting

This species roosts on open ground during the day and is active at night. Usually found as pairs, groups or loose flocks (Pizzey and Knight, 1999). Nests are a slight depression in bare ground and are located in the same area each year (Ayers *et al*, 1996). Open areas within the Project area have been subject to many years of cultivation and are unlikely to provide preferred roosting and nesting habitat.

Movement/Migration

B. grallarius is mainly sedentary, with local movements at night, and are considered locally dispersive (Pizzey and Knight, 1999). Given the absence of records and nature of the development, it is unlikely that the movement of any local population, if located, would be affected by the proposed Project activities.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

The Bush Stone-curlew is mainly associated with undisturbed open grassy woodland and grasslands. This habitat is widely distributed throughout the region, and the amount to be removed or modified as a result of the Project constitutes an insignificant area.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The proposed development would entail removal of a small portion of potential habitat for this species, however, this loss is unlikely to result in the isolation of potential habitat areas.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

The Bush Stone-curlew has been recorded from the following conservation reserves: Ingalba Nature Reserve, Towra Point Nature Reserve, Royal National Park, Washpool National Park, Mutjiwingee National Park and Toonumba National Park.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

The Project could potentially constitute a threatening process. However, the nature of the disturbance, and the occurrence of proximal habitat suggests a local population would not be placed at risk of extinction.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent the distributional limit for this species (distribution based on Ayers *et al*, 1996).

JB3.9 Pied Honeyeater (*Certhionyx variegatus*)

There are no records for this species in the NPWS Atlas of NSW Wildlife database, for the Peak Hill, Condobolin, Boona Mount, Bogan Gate and Tullamore map sheets, however a single bird was located during surveys of the Project area within an area of woodland on the 'Sunrise' property (32^{o}48'36"S, 147^{o}23'37"E). The Pied Honeyeater has a widespread distribution throughout arid and semi-arid Australia but is nomadic and irregularly seen (Ayers *et al.,* 1996).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

Pied Honeyeaters inhabit acacia shrub, mallee, spinifex and eucalypt woodlands, usually when shrubs are flowering (Pizzey and Knight, 1999). They use tall shrubs or trees, up to 5m high, for nesting and follow the erratic flowering of shrubs. *C. variegatus* breeds from September to February or after rains (Readers Digest, 1997). Potential breeding habitat exists within the Project area, however, the lack of records in this area suggest that the species is unlikely to be placed at the risk of extinction by the proposed Project. Although found in woodland within the Project area, the site would not be disturbed by the proposed Project activities.

Foraging

The diet of this species consists of nectar, predominantly from various species of *Eremophila*, as well as mistletoe and other shrubs (Ayers *et al*, 1996). In addition, they eat saltbush fruit, berries, seed, flowers and occasional insects (Readers Digest, 1997). The extent of potential foraging habitat that could be affected within the Project area is small and the proposed Project activities are unlikely to put any local population at risk.

Roosting/Nesting

The Pied Honeyeater nests in an untidy cup of grass in the fork of a shrub or tree up to 5 m high between September and November (Pizzey and Knight, 1999). Neither roosting or breeding habitat would be significantly affected by the proposed Project activities.

Movement/Migration

The Pied Honeyeater is considered locally common but highly nomadic, by following the erratic flowering of shrubs in bands of 2-8 individuals (Ayers *et al*, 1996). The proposed Project activities are unlikely to put at risk any local populations of this mobile species.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

The Pied Honeyeater is mainly associated with mallee shrubland and woodland. Woodland habitat is widely distributed throughout the region, and the amount to be removed or modified constitutes an insignificant area.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The removal of a small amount of remnant vegetation may result in a slight contraction of habitat, however this habitat is relatively isolated and fragmented from the larger expanses of wooded areas in the region (eg. Goobang National Park to the east).

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

The Pied Honeyeater is found in several conservation reserves in western NSW, including Tarawi Nature Reserve and Sturt National Park.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Clearing of shrubs providing nectar (*Eremophila* sp., *Grevillea* sp. and *Brachysema* sp.) and grazing are threatening processes relevant to this species. The Project could potentially constitute a threatening process, however the nature of the disturbance and modified nature of the Project area suggest this is unlikely. The woodland area in which *C. variegatus* was recorded would not be disturbed by the proposed development.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent the distributional limit for this species (distribution based on Ayers *et al*, 1996).

JB3.10 Barking Owl (*Ninox connivens*)

Known from Goobang National Park, near Peak Hill, the Barking Owl is found throughout most of NSW, with the main part of the range being west of the Divide (Debus, 1997). A single bird was spotlighted within the Project area and surrounds in an area of woodland on the 'Sunrise' property (32^{o}48'43"S, 137^{o}23'22"E).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

The Barking Owl primarily inhabits open forest and woodland in warm lowland areas on gentle terrain (Ayers *et al*, 1996), avoiding high altitudes and dense, wet escarpment forests (Debus, 1997). In the drier parts of western NSW it is found close to rivers and creeks***.*** *N. connivens* typically breeds from July to November with one brood per season (Readers Digest, 1997). Breeding takes place in traditional territories, in large hollows in old eucalypts (Ayers *et al,.* 1996). Although woodland habitat is found within the Project area, only a small proportion of potential breeding habitat would be affected and it is unlikely that the proposed Project activities would affect any viable local population.

Foraging

The Barking Owl hunts nocturnally for a variety of small to medium-sized mammals, birds and large insects within woodland and forest habitats (Higgins, 1998). The extent of potential foraging habitat that could be affected within the Project area is small and the proposed Project activities are unlikely to put any local population at risk.

Roosting/Nesting

Roosts by day in dense streamside galleries and thickets of acacia, casuarina and eucalypts, and forages in adjacent woodland (Ayers *et al.,* 1996). Nesting occurs in large hollows in big old eucalypts which may be used year after year. Nest entrances are typically 2 to 35 m above the ground on decayed debris (Higgins, 1998). *N. connivens* is also known to nest in rabbit burrows (Hollands, 1991 in Pizzey and Knight, 1999). A relatively small portion of potential habitat could potentially be removed by the proposed Project activities and any local populations are unlikely to be significantly affected due to impacts upon roosting/nesting resources. Large trees beside creeks would be avoided, where practicable.

Movement/Migration

The Barking Owl is assumed to be sedentary, living singly, in pairs, or in family groups of 3-5 in permanent territories containing several roost sites (Ayers *et al*, 1996). The proposed Project activities are considered unlikely to adversely impact upon local populations of this species due to disruption to dispersal routes or movement patterns.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

The Barking Owl is associated with woodland and forest, using mature eucalypts for nesting. In relation to the regional occurrence of such habitat, the area to be removed/modified constitutes an insignificant area.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The removal of a small amount of remnant vegetation may result in a slight contraction of habitat, however this habitat is relatively isolated and fragmented from the larger expanses of/in the region (eg. Goobang National Park to the east).

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

The Barking Owl has been recorded in Goobang National Park, Blue Mountains National Park, Munghorn Gap Nature Reserve and Kanangra-Boyd National Park.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

The Project could potentially constitute a threatening process. However, the nature of the disturbance, and the occurrence of proximal habitat suggests a local population would not be placed at risk of extinction. The woodland area in which *N. connivens* was recorded would not be disturbed by the proposed development.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent the distributional limit for this species (distribution based on Ayers *et al*, 1996).

JB3.11 Plains-wanderer (*Pedionomus torquatus*)

Not recorded on the NPWS Atlas of NSW Wildlife database for the Peak Hill, Condobolin, Tullamore, Bogan Gate and Boona Mount map sheets, but it is known from scattered occurrences in central and western NSW.

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

Found in sparse, treeless, lightly, grazed native grasslands and herbfields with bare ground; old cereal crops; short lucerne; sparse saltbush and low shrubland (Pizzey and Knight, 1999). Preferred habitats consist of approximately 50% bare ground, 10% fallen litter, and the remainder covered with low (<5 cm) vegetation with a smaller amount of taller vegetation, but not trees (Baker-Gabb, 1992). This habitat type is found within the Project area, however, there are no records of this species' presence, either historically, or during three recent targeted surveys. Much of the preferred habitat (grasslands) has been highly disturbed within the Project area from ploughing and cropping and cannot be considered of high value to the Plains-wanderer. The proposed Project activities are unlikely to put any local population (if any occurs) at risk.

Foraging

The Plains-wanderer feed at night on insects and seeds from a variety of ground plants (Ayers *et al*, 1996). These food sources are widely available throughout the region and any small loss within the Project area due to the proposed activities would not be significant to a local population.

Roosting/Nesting

This species constructs simple nests consisting of a grass-lined depression or scape under a low bush or grass tuft, sometimes with a woven canopy (Slater *et al*, 1999, Pizzey and Knight, 1999). Open areas within the Project area have been subject to many years of grazing and cultivation and are unlikely to provide preferred roosting and nesting habitat for this species.

Movement/Migration

The estimated home range size for this species has been estimated at 9 hectares, with individual birds having a home range of 12 ha, with some overlap between birds (Baker-Gabb, 1992). Plains Wanderers are nomadic when food is scarce, but will move long distances to find suitable habitat (Ayers *et al*, 1996). The proposed Project activities are unlikely to adversely impact upon local populations of this species (were they to exist) due to disruption to dispersal routes or movement patterns.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

The Plains-wanderer is mainly associated with undisturbed open grassy woodland and grasslands. This habitat is widely distributed throughout the region, and the amount to be removed or modified constitutes an insignificant area.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

The proposed development would entail disturbance to a small portion of potential habitat for this species, however, this loss is unlikely to result in the isolation of potential habitat areas.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

The Plains-wanderer is known from Willandra National Park and Mallee Cliffs National Park (Ayers *et al,* 1996).

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Cultivation, fire and habitat alteration by cattle, sheep, goats and rabbits are threatening processes relevant to this species. The modified nature of the Project area and the absence of records suggest that the Project is unlikely to constitute a threatening process.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent the distributional limit for this species (distribution based on Ayers *et al*, 1996).

JB3.12 Black-breasted Buzzard (*Hamirostra melanosternon*)

There are no records of the Black-breasted Buzzard in the five map sheets covering the general area (NPWS Atlas of NSW Wildlife database), but is wide-ranging over western NSW, where it is mainly located in the north and west (Marchant and Higgins, 1993).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

H. melanosternon is found in a variety of open habitats, such as grasslands, gibber deserts, timbered watercourses, woodlands and shrublands (Pizzey and Knight, 1999). They prefer tree-lined watercourses, billabongs and lakes and the open woodlands of floodplains (Marchant and Higgins, 1993). The Black-breasted Buzzard breeds from July to December and does not tolerate disturbance by human activity (Debus and Czechura, 1992). Given the absence of records and mobility of the species, the proposed Project activities are unlikely to put at risk any local populations of this species (should such exist) by disruption to the breeding component of its lifecycle.

Foraging

The Black-breasted Buzzard is predatory upon a range of ground species, including lizards, birds, mammals, amphibians and large insects, as well as nestlings of larger ground-nesting birds (e.g. Emus) (Ayers *et al*, 1996). The extent of potential foraging habitat that could be affected within the Project area is small and the proposed Project activities are unlikely to put any local population at risk.

Roosting/Nesting

This species nests in tall mature, dead or partially dead eucalypts, often along a timbered watercourse or near a waterhole (Debus and Czechura, 1992). Nests are constructed as large, flat platforms from dead sticks and are usually located in the horizontal forks of stout branches (on average 12m above the ground). No such nests were identified during the surveys of the Project area and it is unlikely that the proposed Project activities would put any local populations at risk by disruption to roosting/nesting resources given the nature of the disturbance. Large dead or partially dead trees at creeks would be avoided, where practicable, during construction of the gas and water pipelines.

Movement/Migration

The Black-breasted Buzzard has a large home range and is usually solitary (Ayers *et al*, 1996). This species may be sedentary when conditions permit, may disperse in times of drought, or are nomadic (*ibid*). The proposed Project activities are unlikely to adversely impact upon local populations of this species (were they to exist) due to disruption to dispersal routes or movement patterns.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

Preferred habitats of this species are widely distributed throughout the region and that occurring within the Project area has mainly been disturbed by human activities. In relation to the regional occurrence of such habitat, the area to be removed/modified constitutes an insignificant area.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

Key habitat features for this species are old, large, dead trees for breeding and open habitat for foraging. There are some potential corridors between larger areas of woodland (e.g. Murda State Forest), and along several of the creeks, however the small amount of potential habitat which would be removed as a result of the Project would not isolate interconnecting or proximate areas of habitat for this species.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

The Black-breasted Buzzard is mainly found in the more western conservation reserves (e.g. Sturt and Kinchega National Parks), and may be found in some of the newly created reserves such as along the Paroo and Culgoa Rivers.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Human disturbance, clearing (particularly of nesting trees along watercourses), grazing and cultivation are threatening processes relevant to this species. The Project could potentially constitute a threatening process if a local population were to exist in the study area, however the absence of records and the modified nature of the Project area suggest this is unlikely.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area does not represent the distributional limit for this species (distribution based on Ayers *et al*, 1996).

JB3.13 Malleefowl *(Leipoa ocellata)*

This species has been recorded from the Peak Hill and Boona Mount 1: 100,000 map sheets and is mainly found in the south-western parts of NSW.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

Breeding

This species breeds generally from September to April with pairs breeding permanently (Lindsey, 1992). Malleefowl predominantly inhabit mallee communities, preferring the tall, dense and floristically rich mallee found in higher rainfall (300-450 mm mean annual rainfall) areas (Marchant & Higgins, 1993). Given the depaucity of suitable habitat and lack of records for the Project area. It is unlikely that breeding pairs of Malleefowl would be present within the Project area.

Foraging

These birds forage mainly in open areas near mallee (Ayers *et al*, 1996) largely on insects, flowers and green shoots, as well as fruits and seeds of Acacias and other shrubs (Lindsey, 1992). The reduced floristic diversity of the Project area is unlikely to provide sufficient forage resources for local populations of this species (were any to occur).

Roosting/Nesting

This species uses trees and low bushes for roosting and perching at night (Marchant & Higgins, 1993; Lindsey, 1992). Nesting takes place in areas with light soils and abundant litter for constructing the egg-incubating mounds (Marchant & Higgins, 1993). The litter within the mounds must be dampened for it to decompose and provide heat for incubation, hence the preference by this species for mallee areas receiving reliable winter rainfall and not summer rains (Brickhill pers. comm., in Ayers *et al*, 1996). Mound construction begins in autumn and eggs are laid from September to March/April (Readers Digest, 1997).

The highly cleared nature of the greater majority of the Project area (*viz.* the almost complete absence of a shrub layer and minimal leaf litter accumulation) is likely to discount this species from nesting there.

Migration/Movement

Malleefowl are strongly sedentary and territorial (Lindsey, 1992; Marchant & Higgins, 1993) and therefore this component is not considered to be relevant to this species.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

Not applicable. Refer to Section 2.2.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

L. ocellata are known to prefer habitats consisting of light sandy to sand loam soils, a dense but continuous canopy (for leaf litter), a dense and variable shrub and herb layers and some open ground (Marchant and Higgins, 1993). This species is less frequently found in other eucalypt woodlands (Cypress Pine, Mulga and Gidgee woodlands) (*ibid*.). The proposed development would not remove a significant area of known habitat.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

Given the open, disjunct nature of the remnant portions of woodland in the area and the nature of the disturbance associated with the Project, the proposed development is unlikely to further isolate potential habitat areas to the extent that any local populations of *L. ocellata* (if they exist) would be affected.

(e) Whether critical habitat will be affected.

Not applicable. Refer to Section 2.2.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

The Action Plan for Australian Birds (Garnett, 1992), lists the following conservation reserves in which *L. ocellata* occurs in NSW:

- Buddigower Nature Reserve;
- Coolbaggie Nature Reserve;
- Goulburn River National Park;
- Ingalba Nature Reserve;
- Loughnan Nature Reserve;
- Mallee Cliffs National Park;
- Nombinnie Nature Reserve;
- Pilliga Nature Reserve;
- Pulletop Nature Reserve;
- Round Hill Nature Reserve; and
- Yathong Nature Reserve.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The Project could potentially constitute a threatening process if a local population were to exist in the Project area, however absence of records despite target surveys suggest that this is unlikely.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Project area does not represent a distribution limit of this species (Ayers *et. al*, 1996; Garnett, 1992).

JB3.14 Glossy Black-cockatoo (*Calyptorhynchus lathami*)

This species has been recorded from the Peak Hill map sheet and is predominantly found in eastern NSW.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

Breeding

C. lathami usually occurs in coastal forest and open inland woodland, timbered watercourses or wherever Casuarina's are common (Readers Digest, 1997; Pizzey and Knight, 1999). Glossy Black-cockatoo's breed from March to August and nest in a large deep cavity, lined with woodchips and dust (Lindsey, 1992; Pizzey and Knight, 1999).

Indications are that this species favours well-developed older growth vegetation for nesting.

Foraging

The Glossy Black-cockatoo appears to feed almost exclusively on casuarina seeds, although acacia, angophora and eucalypt seeds, angophora fruit, sunflower seeds and grubs found in some *Allocasuarina* and *Acacia* species have occasionally been recorded (Blakers *et. al*, 1984; Readers Digest, 1997; Barker and Vestjens undated a in Ayers *et. al*., 1996).

The feeding method is strongly ritualised, with the *Allocasuarina* spp. cone held in the left foot while it is being fragmented with the bill, resulting in the chaff falling to the ground (the resulting fragments on the ground produce a convenient method of detection) (Garnett, 1992; Clout, 1989). Due to bill structure and the highly specialised feeding technique, the birds rely heavily on *Allocasuarina* species with large cones such as *Allocasuarina stricta*, *A. littoralis*, and *A. torulosa* (Readers Digest, 1997). *A. luehmannii, A. diminuta, A. gymnanthera* and *A. verticillata* have also been recorded as food plants (Ayers *et. al*, 1996).

A. luehmannii occurs in the Project area at locations within the water and gas pipeline routes, Route 64 and the Fifield bypass. While potential forage habitat for this species occurs within the Project area, it is unlikely that the foraging behaviour of any local populations would be affected by the proposed development.

Roosting/Nesting

The Glossy Black-cockatoo roosts communally in groves of trees in close proximity to stands of *Allocasuarina* species (AMBS, 1995). This species requires roomy cavities in large trees, usually eucalypts, for nesting (Brouwer and Garnett, 1990; Schodde and Tidemann, 1995). Some trees potentially suitable for nesting/roosting may be removed as a result of the development, however it is unlikely a population of this species would be reliant upon these trees as a nesting/roosting resource.

Migration/Movement

Populations of *C. lathami* are more or less sedentary so long as the requirement of an adequate supply of seed crops exists, however they are nomadic when supplies fail for any reason (Schodde & Tidemann, 1995; Readers Digest, 1997). The extent of potential habitat to be removed as a result of the proposal is considered insignificant in a wider, regional sense, particularly given this species' ability to relocate to suitable habitat.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

Not applicable. Refer to Section 2.2.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The Project area does not constitute a significant area of known habitat for *C. lathami* and the proposed development would be unlikely to impact adversely on any local population of this species (were any to occur).

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

This species has very specialised habitat requirements. Marginal habitats exist within the Project area, however the Project is unlikely to represent an impediment to this species, which travels widely in search of fruiting *Allocasuarina*.

(e) Whether critical habitat will be affected.

Not applicable. Refer to Section 2.2.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

Based on available records, the Glossy Black-cockatoo appears to be reasonably well represented in conservation reserves in the region. This species has been recorded from the Blue Mountains National Park, Buddigower Nature Reserve, Conimbla National Park, Goobang National Park, Gardens of Stone National Park, Winburndale Nature Reserve and Kanangra-Boyd National Park.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The proposed development could potentially constitute a threatening process if a local population were to exist in the study area, however this is considered unlikely due to the nature of the disturbance, limited foraging resources in the Project area and the mobility of the species.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Project area does not represent a distributional limit for this species (Ayers et. al, 1996; Readers Digest, 1997; Slater *et. al*, 1999; Pizzey and Knight, 1999).

JB3.15 Koala (*Phascolarctos cinereus*)

The Koala has been recorded to the east of Peak Hill, as well as in Goobang National Park. This species is mainly found within eastern and central NSW, with some scattered populations further west.

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

Koalas breed in summer and generally females produce a single offspring each year (Martin and Handasyde, 1998). While there are a number of records of this species in the surrounding 1:100,000 map sheets according to the Atlas of NSW Wildlife, there were no signs of the Koala within the Project area. Given the paucity of woodland remnants in the Project area and the level of fragmentation, it is unlikely the area would be used by breeding Koalas.

Foraging

The tree species preferred by Koalas in NSW as their principal food source are presented in Table JB-3. Two preferred food trees, *viz.* Bimble Box (*Eucalyptus populnea*) and River Red Gum (*E. camaldulensis*) occur within the Project area, however none of the habitat can be classed as core Koala habitat (State Environmental Planning Policy [SEPP] 44 - Koala Habitat Protection). Koalas also use a range of other tree species (Lee and Martin, 1988), including some non-eucalypt species as secondary browse species (Woodward-Clyde, 1996). The absence of records and the fragmented nature of potential forage habitat suggests that local populations (if they occur) of *P. cinereus* are unlikely to utilise the Project area as a forage resource. The proposed Project activities are unlikely to place local populations (if they occur) at risk of extinction.

Table JB-3
Preferred Food Trees of Koalas in NSW

Scientific Name	**Common Name**
Eucalyptus punctata	Grey Gum
E. tereticornis	Forest Red Gum
E. robusta	Swamp Mahogany
E. microcorys	Tallowwood
E. viminalis	Ribbon or Manna Gum
E. camaldulensis	River Red Gum
E. haemastoma	Broad-leaved Scribbly Gum
E. signata	Scribbly Gum
E. albens	White Box
E. populnea	Bimble Box or Poplar Box

Source: State Environmental Planning Policy (SEPP) No. 44 - Koala Habitat Protection (1995)

Roosting

A nocturnal species, the Koala rests in tree forks during the day (Martin and Handasyde, 1998). Although it is not known if the abundance of rest sites has an influence on Koala presence, it has been suggested that mature trees may not be essential for resting (AMBS, 1995). The proposed Project activities are unlikely to impact upon this component of the lifecycle of any Koalas within the area.

Movement/Migration

A solitary species that spends most of its time in defined home ranges (Martin and Handasyde, 1998; Ayers *et al*., 1996), the Koala may travel considerable distances during the breeding season in order to find a mate (Woodward-Clyde, 1996). Koalas are known to travel across cleared land when moving between feed trees (Martin and Handasyde, 1998; S. Cox, unpublished data). In view of the lack of signs of activity of the Koala within the Project area it is considered unlikely that the movement of individuals within a local population would be affected by the Project to the point of it being placed at risk of extinction.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed*

The Project would not result in the removal of a significant portion of potential Koala habitat.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community*

The small patches of potential habitat in the Project area do not form part of a larger, contiguous corridor of *P. cinereus* habitat.

(e) *Whether critical habitat will be affected*

Not applicable. Refer to Section 2.2.

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region*

According to the Atlas of NSW Wildlife, the Koala has been recorded in Avisford Nature Reserve, Blue Mountains National Park, Bungonia State Recreation Area, Goobang National Park, Freemantle Nature Reserve, Hill End Historic Site, Narranderra Nature Reserve and Munghorn Gap Nature Reserve.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process*

The Project could potentially constitute a threatening process if a local population were to exist in the Project area, however absence of records despite target surveys suggest that this is unlikely.

(h) *Whether any threatened species, population or ecological community is at the limit of its known distribution*

The Project area does not represent a distributional limit for this species (Ayers *et al.*, 1996; Martin and Handasyde, 1998).

JB3.16 Squirrel Glider (*Petaurus norfolcensis*)

Known from Goobang National Park, near Peak Hill, and widespread throughout central and eastern NSW.

(a) *In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction*

Breeding

Requiring tree hollows for breeding, female Squirrel Gliders produce two offspring which remain in the pouch for around 30 days (Suckling, 1998). There is potential breeding habitat for this species within several of the patches of woodland in the Project area, but no evidence of its existence was found despite targeted surveying. The proposed Project activities are unlikely to put at risk any local population of this species (should such exist) by disruption to the breeding component of its lifecycle.

Foraging

The diet of this species consists of insects, acacia gum, eucalypt sap, nectar and pollen (Suckling, 1998). The extent of potential foraging habitat that could be affected within the Project area is small and the proposed Project activities are unlikely to put any local population at risk.

Roosting/Nesting

Living in family groups of up to ten animals, tree hollows are used for sheltering and breeding (Suckling, 1998). A number of tree cavities are often used within a home range (Quin, 1993 cited in Resource Strategies *et al*., 1997). The low number of tree hollows within the Project area and the fact that no evidence of the species was found, suggests that the proposed Project activities are unlikely to put at risk local populations due to impacts upon roosting/nesting resources.

Movement/Migration

The estimated home range size for this species varies from 2 - 13 hectares, with densities from 0.4-3 individuals per hectare (Quin, 1993 cited in Resource Strategies *et al*., 1997; Traill and Coates, 1993; Suckling, 1998). The clearing of woodland for agricultural pursuits is considered to have had a dramatic negative effect upon the Squirrel Glider (Suckling, 1998). The absence of records, prevalence of foxes and the relatively cleared, open nature of the Project area, suggests the proposed development is unlikely to result in the disruption to dispersal routes or movement patterns of this species.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

A species of dry sclerophyll forest and woodland (Suckling, 1998), critical habitat for the Squirrel Glider takes the form of mixed-species eucalypt forest, with an understorey of acacia (Menkhorst *et al*., 1988; Ayers *et al*., 1996). In relation to the regional occurrence of such habitat, the area to be removed/modified as a result of the Project constitutes an insignificant area of known (or potential) habitat.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

Key habitat features for this species are old, large, living and dead trees for shelter and breeding (Woodward-Clyde, 1996). There are some potential corridors between larger areas of woodland (e.g. Murda State Forest), and along several of the creeks, but these would not be significantly disrupted by the Project activities.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

According to the Atlas of NSW Wildlife, the Squirrel Glider has been recorded in Goobang National Park, Blue Mountains National Park, Tarlo River National Park, The Rock Nature Reserve and Kanangra-Boyd National Park.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Predation by cats and foxes are threatening processes relevant to this species. The Project could potentially constitute a threatening process if a local population were to exist in the study area, however the absence of records, the modified nature of the Project area and the prevalence of cats and foxes suggest this is unlikely.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area is approaching the western distributional limit for this species (Ayers *et al.*, 1996).

JB3.17 Stripe-faced Dunnart (*Sminthopsis macroura*)

There are no records for this species in the five map sheets (NPWS Atlas of NSW Wildlife database), and it is mainly found within the western parts of western NSW.

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

The Stripe-faced Dunnart is an arid-zone species that prefers a variety of open habitats, such as grasslands and shrublands. It is found in sandy, clay and loamy substrates and uses cracks in the soil or grass tussocks for shelter (Ayers *et al*, 1996; Morton, 1998). Such habitats are available within the Project area, but much has been disturbed by ploughing and cropping. Despite three targeted surveys, no Stripe-faced Dunnarts were found in the Project area (the Common Dunnart was located in grassland habitat). The proposed Project activities are unlikely to put at risk any local population of this species (should such exist) by disruption to the breeding component of its lifecycle.

Foraging

The diet of this species consists of invertebrates and small reptiles (Ayers *et al*, 1996). It appears to be independent of drinking water (Morton, 1998). The extent of potential foraging habitat that could be affected within the Project area is small and the proposed Project activities are unlikely to put any local population at risk.

Roosting/Nesting

Although little is known about the roosting/nesting requirements of this species, *S. macroura* shelters in cracks in the soil, under rocks, logs, sheets of tin or grass tussocks, probably in nests (Morton, 1998). Given the nature of the disturbance and the occurrence of potential habitat in the wider region, the proposed Project activities are unlikely to put at risk local populations (if any occur) due to impacts upon roosting/nesting resources.

Movement/Migration

The Stripe-faced Dunnart has a high level of mobility and will colonize areas after flooding or rainfall (Ayers *et al*, 1996; Morton, 1998). The absence of records and relatively cleared, disturbed nature of the Project area suggests the Project is unlikely to adversely impact upon local populations of this species (were they to exist) due to disruption to dispersal routes or movement patterns.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

This species is mainly found in grassland habitats. These are widely distributed throughout the region, although little could be considered either natural or undisturbed. In relation to the regional occurrence of such habitat, the area to be removed/modified as a result of the Project constitutes an insignificant area.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

Key habitat features for this species are grassland habitats that are widely distributed throughout the region. Links between such areas of grassland would not be significantly disrupted by the Project activities.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

Mainly found in the more western conservation reserves for example, Sturt National Park, Mutjiwingee National Park and Kinchega National Park.

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Grazing, cultivation, predation (by cats and foxes) and flooding are threatening processes relevant to this species. The modified nature of the Project area and the absence of records suggest that the Project is unlikely to constitute a threatening process.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area represents the eastern distributional limit for this species (Ayers *et al.*, 1996).

JB3.18 Brush-tailed Phascogale (*Phascogale tapoatafa)*

This species has not been recorded from the Project area or surrounds during the fauna surveys (MKES, 2000), however has been recorded from the Condobolin 1: 100,000 map sheet (NPWS Atlas of NSW Wildlife). The Brush-tailed Phascogale has a patchy distribution around the coast of Australia (Soderquist, 1998). Within NSW, the species appears to be most abundant in the north-east and south-east of the State, particularly within forest habitats on the Great Dividing Range (Ayers *et al*., 1996).

(a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction***

Breeding

This species mates usually in tree hollows, over a three week period between mid-May to early July, varying with locality (Soderquist, 1998; Cronin, 2000). Birth occurs after a 30 day gestation period and typically, more young are born than can be accommodated by the mother. As a result, birth mortality frequently occurs. Young are gradually weaned between 14 and 25 weeks (Cronin, 2000).

Despite targeted surveys, no evidence of Brush-tailed Phascogales was found in the Project area. The proposed Project activities are unlikely to put at risk any local population of this species (should such exist) by disruption to the breeding component of its lifecycle.

Foraging

The Brush-tailed Phascogale is a nocturnal species which feeds mainly on arthropods (such as spiders, centipedes and beetles), however small vertebrates and eucalypt nectar are also eaten (Cuttle, 1983; Traill and Coates, 1993; Soderquist, 1998). It forages over the trunks and major limbs of trees, taking arthropods from the bark surface and in shallow bark crevices. This species spends only 10% of its foraging time on the ground or on fallen logs (Cuttle, 1983; Soderquist, 1993b in Ayers *et. al*, 1996).

The extent of potential foraging habitat that could be affected within the Project area is small and the proposed Project activities are unlikely to put any local population at risk.

Roosting/Nesting

Nursery nests are built in large tree hollows, lined with leaves, shredded bark, feathers and fur (Cronin, 2000). Suitable hollows are 25-40 mm wide (Ayers *et al*., 1996) and are also used for shelter (Soderquist, 1998). *P. tapoatafa* are generally solitary, although pairs may share nests in the breeding season (Cronin, 2000). An individual may use more than 20 nests in a year, including hollow tree limbs, rotted stumps and even globular bird nests (Soderquist, 1998).

The low number of tree hollows within the Project area and the fact that no evidence of the species was found, suggests that the proposed Project activities are unlikely to put at risk local populations due to impacts upon roosting/nesting resources.

Movement/Migration

Females have home ranges of 20 – 70 hectares, sometimes shared with their female offspring. Juvenile males disperse and establish overlapping home ranges of more than 100 ha. In the breeding season males travel long distances searching for females, sometimes beyond its home range (Soderquist, 1998).

The absence of records, prevalence of foxes and the relatively cleared, open nature of the Project area, suggests the proposed development is unlikely to result in the disruption to dispersal routes or movement patterns of this species.

(b) ***In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised***

Not applicable. Refer to Section 2.2.

(c) ***In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed***

Formerly distributed throughout the dry sclerophyll forests and woodlands of temperate and tropical Australia, *P. tapoatafa* is thought to prefer open woodland with sparse ground cover of herbs, grasses, shrubs or leaf litter (Soderquist, 1998), ridges and rocky slopes to 1,500 m (Cronin, 2000). However, individuals may also inhabit heathland, swamps, rainforests and wet sclerophyll forest (Dickman & McKechnie, 1985). The species occurs primarily where the annual rainfall exceeds 500 mm (Traill & Coates, 1993).

Largely arboreal and nocturnal, these animals sleep during the day in tree hollows in dead and live trees, tree stumps, hollow tree limbs, under flaking bark, in grass nests in ground vegetation or globular bird nests (Ayers *et al*., 1996). In relation to the regional occurrence of such habitat, the area to be removed/modified as a result of the Project constitutes an insignificant area of known (or potential) habitat.

(d) ***Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community***

Key habitat features for this species are old, large, living and dead trees for shelter and breeding. There are some potential corridors between larger areas of woodland (eg. Murda State Forest), and along several of the creeks, but these would not be significantly disrupted by the Project activities.

(e) ***Whether critical habitat will be affected***

Not applicable. Refer to Section 2.2.

(f) ***Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region***

P. tapoatafa has been recorded in National Parks, Nature Reserves and State Recreation Areas on the south, mid-north and north coast and adjacent inland areas of NSW (NPWS, 1999c).

(g) ***Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process***

Predation by cats and foxes, habitat clearance and competition are threatening processes relevant to this species. The Project could potentially constitute a threatening process if a local population were to exist in the study area, however the absence of records, the modified nature of the Project area and the prevalence of cats and foxes suggest this is unlikely.

(h) ***Whether any threatened species, population or ecological community is at the limit of its known distribution***

The Project area represents the western extremity of the distribution of *P. tapoatafa* in NSW.

JB4 CONCLUSIONS

Fauna surveys have been undertaken within the Project area and immediate surrounds. Following consideration of the results of these surveys, species' distributions, presence of suitable habitat, essential lifestyle components of species and potential impacts of the Project, a list was compiled of threatened fauna species known to occur or considered likely to occur in the Project area (Table JB-2). The factors contained in Section 5A of the *Environmental Planning and Assessment Act, 1979* (as amended) were applied for each of these 18 species. Based on the application of the 8 Part Test of Significance, it was determined that:

- The potential loss of habitat associated with the Project (primarily associated with remnant roadside vegetation, open woodland and open grazing/cropping areas) is not considered to be of a nature or an extent that would place any viable, local population of a threatened species at risk of extinction. This is based on the relative mobility of the subject species, the results of a suite of target surveys in the area and surrounds, the disturbed nature of existing habitat resources, the occurrence of tracts of more extensive habitat in the wider region (eg. on the "Sunrise" property, Goobang National Park) and the nature/extent of the proposed disturbance.

- Certain species are known to occur in the Project area, however it is considered that the proposed works would not constitute a significant adverse impact on local populations of any of these species. The areas where the threatened species were found to occur (Major Mitchell Cockatoo, Barking Owl and Pied Honeyeater on 'Sunrise' property) would not be affected by any Project activity.

- Other species could potentially occur in the Project area, however it is considered that the proposed works would not constitute a significant adverse impact on local populations of any of these species. This is based on the occurrence of areas of more suitable habitat in the region, the relative mobility of many species and the high level of disturbance across much of the Project area.

- In view of the existing fragmentation of woodland remnants and nature of the disturbance associated with the Project, the proposed activities are unlikely to alienate movement corridors or limit dispersal options for any local populations of threatened species. Furthermore, it is unlikely that an area of known habitat for any threatened species is likely to become isolated from currently interconnecting or proximate areas of habitat.

Based on the information presented in the 8 Part Tests, it was determined that no threatened species would be significantly affected by the Syerston Project to the extent of undermining the viability of a local population of that species and hence, a Species Impact Statement is not required.

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APPENDIX JC

An assessment of the bat fauna at the proposed Syerston Nickel-Cobalt Project mine site, central New South Wales.

by G.C. Richards

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Wildlife Research and Ecological Assessment Consultants
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Document No. BATS-R02-I.DOC

Prepared for Black Range Minerals Ltd, January 1999, revised July 2000

CONTENTS

[1] This is a requirement of the consultant's insurance company.

EXECUTIVE SUMMARY

Greg Richards and Associates Pty Ltd was commissioned to conduct an assessment of the bat fauna in relation to the nickel-cobalt mining operation proposed by Black Range Minerals Ltd. The proposed mine is located approximately 2 km northwest of Fifield and approximately 45 km northeast of Condobolin, in central NSW.

A bat fauna survey was conducted in December 1998, encompassing the four major habitats at the mine site (Tall cypress pine/box woodland, low cypress pine forest, stock dams/waterholes, and pasture/cropland).

Database records showed that up to 17 bat species had the potential to be present in the area, and 12 species were recorded during the survey. Two threatened species listed as Vulnerable in the NSW *Threatened Species Conservation Act, 1995* (*Saccolaimus flaviventris* and *Chalinolobus picatus*) were recorded. Potential impacts upon local populations of these species were addressed in accordance with Section 5A of the Environmental Planning and Assessment Act (EPA Act), 1979 (Eight Part Tests of Significance).

The loss of habitat for bats, particularly the Low cypress forest and the Cypress/box association, was not expected to affect the foraging resources of the two threatened bat species.

It was also recommended that pre-clearing surveys be conducted to identify any tree hollow roosts for threatened species, and any that were found should be relocated. A strategy of supplementing the local roost resource with artificial roosts ("bat houses") was also recommended.

It was concluded that, assuming the adoption of recommendations for impact amelioration, there would be minimal impact upon the threatened bat fauna through the proposed Project.

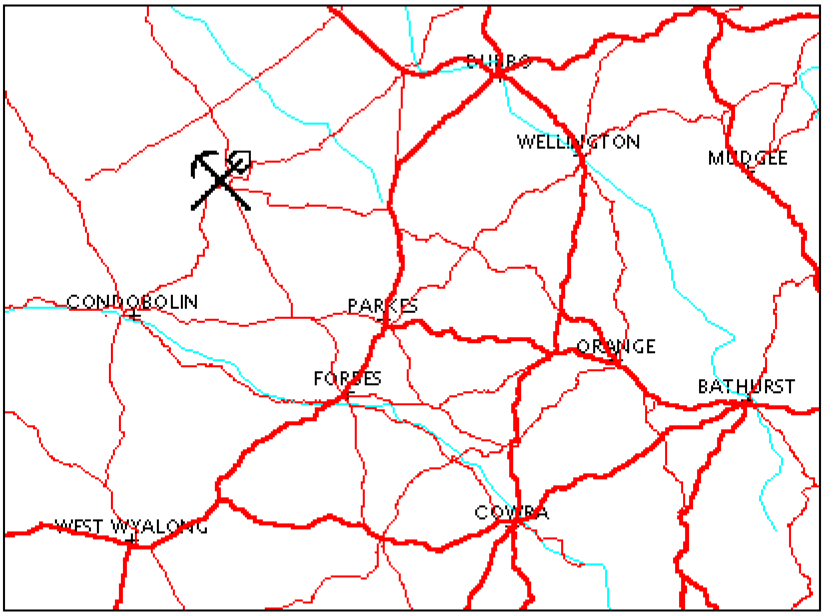
INTRODUCTION

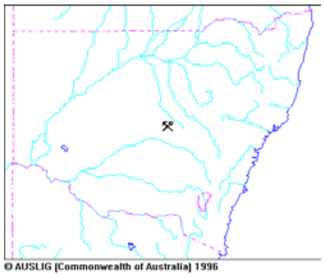
Greg Richards and Associates Pty Ltd was commissioned to conduct an assessment of the bat fauna in relation to the nickel-cobalt mining operation proposed by Black Range Minerals Ltd. The proposed mine is located approximately 2 km northwest of Fifield and approximately 45 km northeast of Condobolin, in central NSW (Figure 1).

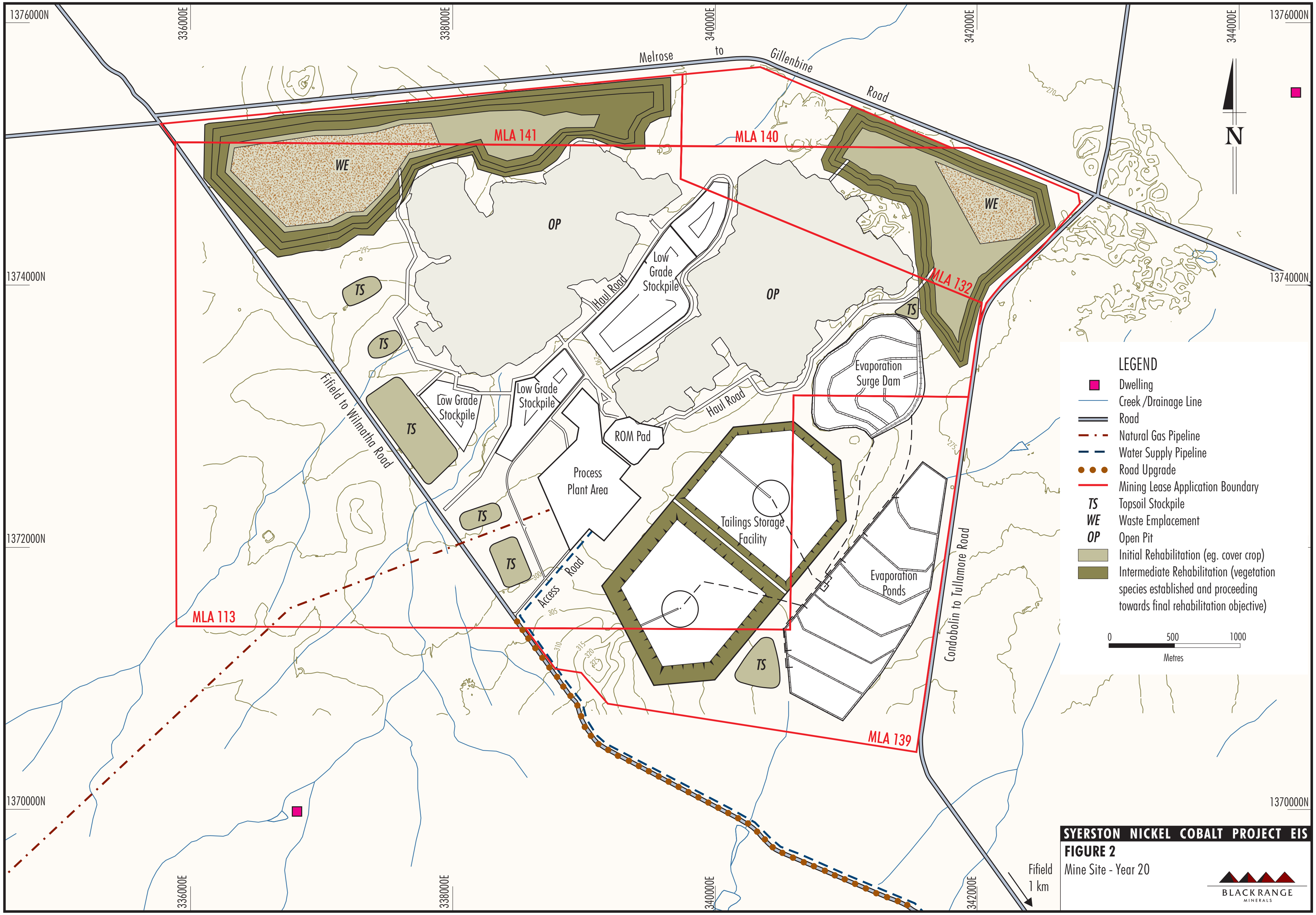
The mine site has an east-west axis of approximately 7 km, and a north-south axis of approximately 5 km. It incorporates Mining Lease Application (MLA) areas 113, 132, 139, 140 and 141, and is shown in Figure 2.

This report provides results of a bat fauna survey of the mine site conducted in December 1998, identifies threatened species known from records or database predictions to occur in the area, and assesses potential impacts upon them. Threatened species are assessed by Eight Part Tests of Significance in accordance with Section 5A of the *Environmental Planning and Assessment Act* (EPA Act) *1979.*

Figure 1 : General location of Syerston Project mine site near Fifield, central NSW.







SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 2

Mine Site - Year 20

BRM-98-01-Bat M_001D

METHODS

Background Information

Prior to the commencement of the survey, the consultant's database of bat distribution records was searched to extract records of bat species in the local area. This extensive database of approximately 17,000 bat distribution records has been compiled over the last 30 years, and includes museum specimen records, personal observations, information from colleagues, published records, and various other sources including the National Parks and Wildlife Service (NPWS) Wildlife Atlas.

A species list for the region surrounding the mine site was generated by interrogating a search block bounded by 35°25' to 34°30'S by 145°00' to 148°00'E.

Study Area - Habitats and Sampling Strategy

The mine site contains habitats that are typical of the central region of NSW. Those that were identified as being important for bats accounted for approximately 17% of the mine site area and included:

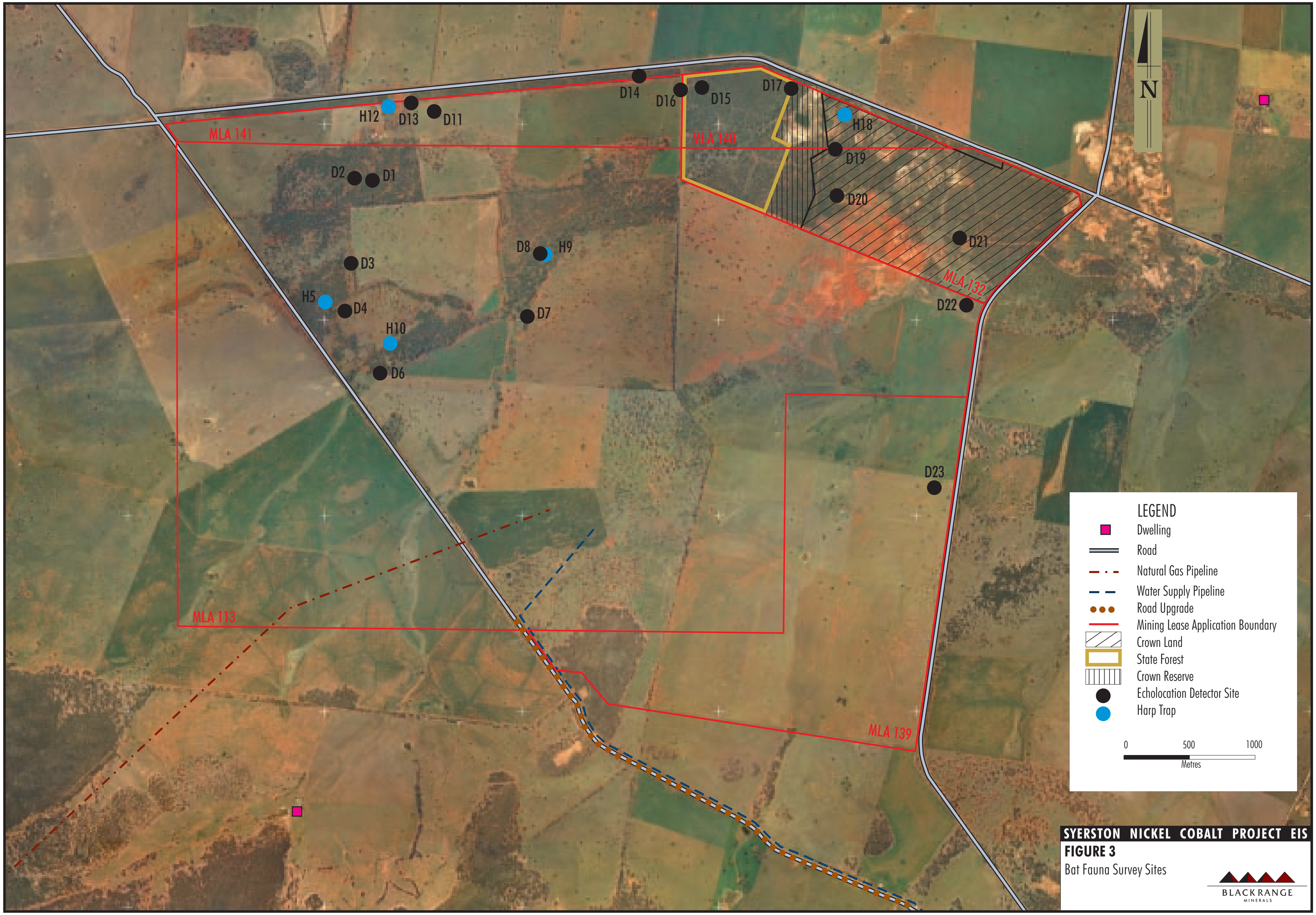
- Tall cypress pine/box woodland,
- Low cypress pine forest, and
- Stock dams and waterholes

The predominant habitat of the mine site is open pasture or cropland, which is not considered to be particularly favourable for the species complement expected in the area, especially for species that prefer to forage within or above forest or woodland (Richards 1994, Lumsden *et al*, 1995). Richards (1994) showed that (in temperate forests on the Great Dividing Range) the species composition of bat communities is related to habitat structure and stem density. This hypothesis was applied when sampling points were selected for the mine site.

In general terms, the mine site is a composite of rural landholdings, State Forest, Crown Reserve and Crown Land (Figure 3). Bat fauna monitoring sites were established in a pattern to cover all four areas, and replicated to ascertain species composition within each identifiable habitat. Sampling points are described in Table 1.

Field Survey

The bat fauna survey of the mine site was conducted in the first fortnight of December 1998. The survey encompassed the four major habitats of the mine site (Tall cypress pine/box woodland, low cypress pine forest, stock dams/waterholes, and pasture/cropland).



BRM-98-01-Bat M_002D

Table 1 : Sampling point locations and their habitats used to assess the bat fauna at the mine site. The prefix to the sampling site number indicates : D = detector site, H = harp trap site. Latitude and longitude were recorded with a Magellan global positioning system.

Site	Latitude	Longitude	Habitat and Description
D1	32°45’08”	147°23’55”	Tall cypress/box association south of homestead, detector set near large box tree with potential roost hollows
D2	32°45’08”	147°23’50”	Stock dam in Tall cypress/box association
D3	32°45’24”	147°23’55”	Stock dam at ecotone between low cypress forest and open cropland
D4	32°45’41”	147°23’47”	Ecotone of low cypress forest and open cropland, detector set near large tree with potential roost hollows
H5	32°45’39”	147°23’41”	Fire trail or track within large tract of cypress forest
D6	32°45’51”	147°24’00”	Stock dam in primarily box woodland adjacent to pasture and cropland
D7	32°45’42”	147°24’41”	Stock dam in pastureland with occasional large cypress either single or in patches with box
D8	32°45’27”	147°24’45”	Low cypress forest near harp trap (near H9)
H9	32°45’27”	147°24’46”	Fire trail or track through Low cypress pine forest (near D8)
H10	32°45’45”	147°23’55”	Track on edge of low cypress pine forest
D11	32°44’46”	147°24’13”	Open pasture/cropland on Syerston property
H12	32°44’43”	147°24’04”	Gap within tract of low cypress pine forest
D13	32°44’42”	147°24’08”	Open waterhole within bare ground near Syerston property main gate
D14	32°44’35”	147°25’13”	Tall cypress/box association near large tree with hollows
D15	32°44’39”	147°25’33”	Tall cypress/box association in Fifield State Forest
D16	32°44’38”	147°25’29”	Open ploughed cropland ecotone with Tall cypress/box association but detector pointing into cropland
D17	32°44’38”	147°26’08”	Large tract of eucalypts (box and stringybark) in Fifield State Forest
H18	32°44’48”	147°26’18”	Trap set along old track near boundary fence in Fifield State Forest in Tall cypress/box association
D19	32°44’55”	147°26’16”	Track in Tall cypress/box association in Fifield State Forest
D20	32°45’06”	147°26’17”	Track in Tall cypress/box association in Fifield State Forest
D21	32°45’18”	147°26’53”	100m off edge of road to current Fifield mine in Tall cypress pine/box with open areas
D22	32°45’38”	147°26’58”	Open cropland 300m west of main road on Kingsdale property
D23	32°46’21”	147°26’51”	Open pasture with a few scattered trees on Kingsdale property (in tailings area)

Sampling sites were monitored with echolocation call detector systems and harp traps. A total of 23 sampling sites were surveyed for bats (Figure 3). Table 1 lists the sampling points used during this study, with a broad description of the surrounding habitat. Electronic detectors were used at 18 sites, which equated to approximately 162 hours of sampling, and harp traps were used at the remaining five sites for one night at each. The extent of stratification and replication is shown in Table 2.

Sampling sites were monitored with Anabat™ echolocation call detector systems, each controlled by a call-activated switching device (a Titley Electronics delay switch). This allowed automatic operation of each detector from dusk to dawn, with calls being recorded onto cassette tape for later analysis from computer displays. Detecting sites were monitored this way for one night each.

Austbat™ harp traps were set at sampling points that bats were expected to use as flyways, or where flight may be restricted by gaps in vegetation. Richards (1996) showed that it is essential to use traps and detectors in tandem during bat surveys to encompass all ecological groups.

Table 2 : Stratification and replication of sampling within each identified habitat assessed at the mine site. Values indicate the number of sampling points. No suitable sites for harp traps were located in the Open pasture/cropland nor the Waterholes/dams habitats.

	Electronic detection	Harp trapping	Total replicates
Open pasture/cropland	4	-	4
Waterholes/dams	5	-	5
Low cypress forest	2	4	6
Tall cypress pine/box association (includes large tract of eucalypts)	7	1	8
Totals	18	5	23

RESULTS

Survey Conditions

Weather conditions during the period of field survey (the first fortnight of December 1998) were optimal for sampling bats. No rain fell during this period, the moon was absent, and nights were warm. Temperatures were not recorded but were typical of inland NSW in mid-summer.

Species Recorded

Database records showed that up to 17 bat species had the potential to be present in the area if habitat requirements (such as caves or lakes) and food resources (eucalypt blossom for flying foxes) were available. The NPWS Wildlife Atlas was also investigated. The 17 potential bat species, and the 12 that were recorded at the 23 sampling sites, are listed in Table 3. Two threatened species listed as Vulnerable under the *Threatened Species Conservation Act, 1995* (TSC Act) were recorded (*Saccolaimus flaviventris* and *Chalinolobus picatus*). The potential impacts upon local populations of these species are addressed in Section 5A (of the EPA Act, 1979) assessments (Eight Part Tests) in a later section of this report.

Table 3 : Species expected in the region and those that were recorded during the mine site survey (indicated by a tick). Species listed in the NSW TSC Act are shown in bold.

Family Pteropodidae		
Little Red Flying Fox	*Pteropus scapulatus*	
Family Emballonuridae		
Yellow-bellied Sheathtail-bat	***Saccolaimus flaviventris***	☐
Family Vespertilionidae		
Gould's Wattled Bat	*Chalinolobus gouldii*	☐
Chocolate Wattled Bat	*Chalinolobus morio*	☐
Little Pied Bat	***Chalinolobus picatus***	☐
Southern Myotis	***Myotis macropus***	
Lesser Longeared Bat	*Nyctophilus geoffroyi*	☐
Gould's Longeared Bat	*Nyctophilus gouldi*	☐
Greater Longeared Bat	***Nyctophilus timoriensis***	
Inland Broadnosed Bat	*Scotorepens balstoni*	☐
Little Broadnosed Bat	*Scotorepens greyii*	☐
Inland Forest Bat	***Vespadelus baverstocki***	
Southern Forest Bat	*Vespadelus regulus*	☐
Little Forest Bat	*Vespadelus vulturnus*	☐
Family Molossidae		
White-striped Freetail Bat	*Tadarida australis*	☐
Inland Freetail Bat[1]	*Mormopterus planiceps*	☐
Southern Freetail Bat[1]	*Mormopterus planiceps*	

[1] The taxonomy within the *Mormopterus planiceps* complex is currently in a state of flux. Two have been distinguished by Adams *et al* (1988) and are denoted by Churchill (1998) as *Mormopterus* sp. The Inland and Southern Freetail Bats are species 3 and 4 respectively in Adams *et al* (1988)

Species expected but not recorded were :

- Little Red Flying Fox (*P.scapulatus*) – Present in this region only in seasons when eucalypt blossom is available, and likely to be restricted to River Red Gum forests on the Lachlan River to the south of the mine site. No blossom was present at the time of survey, nor were any flying foxes heard squabbling at night.

- Southern Myotis (*M.macropus*) – The mine site provides limited foraging habitat (open water or large watercourses) and its presence would also be determined by the availability of subterranean roost sites.

- Greater Longeared Bat (*N.timoriensis*) – Expected at the mine site, and found elsewhere in the region (see Appendix JD of the EIS). Its absence can be considered a reality because other species of longeared bats were trapped at the mine site, indicating that the methodology was appropriate. Echolocation calls of *Nyctophilus* species are difficult to distinguish unless the bat has flown close to the detector microphone, so harp trapping generally provides the best recording method. Database records showed that this species had also been recorded at Lake Cowal, several conservation reserves (Buddigower Nature Reserve, Woggoon Nature Reserve, Yathong Nature Reserve, Cocoparra National Park) and Binya State Forest.

- Inland Forest Bat (*V.baverstocki*) – If present at the mine site *per se* it would have been recorded during the 160+ hours of electronic detection. The mine site would have been a considerable extension of range (see Churchill 1998).

- Southern Freetail Bat (*M.planiceps*) – Records of the sibling species, the Inland Freetail Bat, indicate that the methodology was appropriate to also record the Southern Freetail Bat, so its absence can assumed to be real. The mine site is west of this species normal range.

Habitat Utilisation

Although bat activity was greatest at water sources (stock dams and waterholes) during the survey, a higher number of species were recorded in vegetated areas such as the Low cypress forest and the Tall cypress/box association (Table 4). Bat activity within the low cypress forest and Tall cypress/box association, based on number of echolocation calls was less than half the number of records for the stock dams and waterholes. Open pasture and cropland was not suitable for the majority of species, with only four calls being recorded from two species (*C. gouldii* and *T. australis*).

The two cypress forest habitats at the mine site were utilised by the two threatened species, *S.flaviventris* and *C. picatus*. *C. picatus* also utilised the waterholes/dam habitat at the mine site. These species were among the least abundant at the mine site (Table 4).

Table 4 : Species recorded at the proposed mine site, classified by habitat utilised. Values indicate the number of echolocation calls (passes) recorded. The two species of *Nyctophilus* (*N.geoffroyi* and *N.timoriensis*) that are likely to be present have virtually indistinguishable echolocation calls, so harp traps were used to verify the presence of these species.

Species	Habitat: Low cypress forest		Tall cypress/ box association		Waterholes/ dams		Open pasture/ cropland		Total records		Total habitats
	D	H	D	H	D	H	D	H	D	H	
S.flaviventris	**1**	**0**	**3**	**0**	**0**	**-**	**0**	**-**	**4**		**2**
C.gouldii	8	1	11	1	13	-	2	-	36		4
C.morio	2	0	5	0	6	-	0	-	13		3
C.picatus	**2**	**1**	**2**	**0**	**3**	**-**	**0**	**-**	**8**		**3**
N.geoffroyi	0	2	0	5	0	-	0	-	7		2
N.gouldi	0	1	0	1	0	-	0	-	2		2
S.balstoni	2	0	3	0	5	-	0	-	10		3
S.greyii	2	0	2	0	8	-	0	-	12		3
V.regulus	6	1	4	0	6	-	0	-	17		3
V.vulturnus	7	2	7	1	42	-	0	-	59		3
T.australis	6	0	6	0	8	-	2	-	22		4
M.planiceps	5	0	3	0	13	-	0	-	21		3
Totals	41	8	46	8	104	-	4	-	211		

DISCUSSION

Assessment of Impacts and their Mitigation

- ***Potential loss of foraging habitat***

All 12 bat species recorded at the site utilised the Low cypress forest and Tall cypress/box association habitats. Based upon flight morphology and potential foraging range, these 12 species can be separated into three foraging groups[2]:

> Prey intercept – fast flying, wide ranging species such as *S.flaviventris, T.australis, M.planiceps* and *C.gouldii* (this species overlaps into the prey pursuit category).
>
> Prey pursuit – species with large home ranges that can forage 10 km or so from the roost; includes *C.gouldii, C.morio, C.picatus, S.balstoni, S.greyii, V.regulus and V.vulturnus.*
>
> Prey gleaning – species characterised by having short and broad wings, indicating slow and manouverable flight. All *Nyctophilus* species are in this category, and use their large ears to listen for the sounds made by insect prey, which is usually gleaned from substrates such as bark and foliage.

The prey pursuit and prey gleaning assemblages would potentially be affected by the loss of foraging habitat. Reference to aerial photographs (Figure 3) and the Year 20 mine site layout (Figure 2) indicates that the Project would necessitate clearing some 320 ha of the 600 ha of Low cypress forest and Tall cypress/box association foraging habitat present within the mine site area and disturbance to some existing stock dams within the mine site.

Low cypress forest and Tall cypress/box remnants are widespread throughout the region, including some relatively large areas within three kilometres of the mine site (see lower left hand corner of aerial photograph in Figure 3). It is likely that the response of the bat fauna to removal of forest or woodland remnants would be to access other habitats remaining in the mine site (such as those within MLA 140), or those within the vicinity. It is noteworthy that Lumsden *et al* (1995) proposed that "... the ability of bats to fly, their spatial scale of movement and their social organisation (e.g. their overlapping foraging areas, colonial roosting habits, interspecific tolerance) are key factors that enable these species to live successfully within the farmland environment and that have prevented regional extinctions ...".

It is recommended that replanting disturbed areas in addition to any available areas within the mine site with Tall cypress/box association and associated shrub layer be considered when the rehabilitation strategy for the Project is developed.

Planting of this vegetation association could not only replace lost habitat, but could be used to increase the patch size of remnants in the mine site area. This strategy follows

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2 These foraging groups were identified during the consultant's unpublished PhD studies of bats in temperate eucalypt forests.

the Greening Australia guidelines for the Vegetation Investment Project. This initiative aims to achieve a vegetation patch size of 10 ha and a 20% cover of shrubs for insectivorous bird conservation (Freudenberger 2000), which is based upon the "focal species" theory of Lambeck (1997).

Although some existing stock dams would be disturbed as a result of the Project, this type of foraging habitat would be increased within the mine site due to the provision of sediment dams.

- ***Potential loss of roost sites***

As with any development that involves the clearance of mature trees, potential exists for the loss of roost sites for hollow dwelling species. In the case of the mine site, it would appear that the Tall cypress/box association would have the highest potential for bat roost sites.

It is recommended that pre-clearance surveys be conducted to establish the number of roosts in trees destined for removal, and that these be relocated away from impact areas. A target of at least twice the number of natural roosts identified should be set as the number of artificial roosts ("bat houses") that should be constructed and placed at strategic locations in the mine site and surrounds.

Numerous studies have indicated that the use of artificial roosts can be an effective method of providing suitable roost sites for bats.

Extensive research into the effectiveness of "bat houses" to provide potential roost sites for bat fauna has been conducted in the USA (see www.batcon.org), and many of these now have maternity colonies in residence. There are also several long term studies in Victoria that have experimented with roost entry sizes, which have shown to be effective in the provision of roost resources (Bender and Irvine 2000; Schedvin, 2000).

There is also some evidence supporting the effectiveness of artificial roosts, from a single colony of *S.flaviventris* in an outer Brisbane agricultural area (Rhodes and Hall, 1997). The colony was residing in a branch of a hollow stag in a cleared paddock. When this tree was felled for firewood, the colony was contained in the branch and it was then suspended in adjacent woodland. To date the colony has remained there for several years, over at least three breeding seasons (L.S. Hall, University of Queensland, pers. comm. July 2000).

Therefore, the relocation of any known roosts and the provision of artificial roosts at the mine site would ameliorate any impacts and increase this resource in a region where it can be assumed that roosts would be in short supply (due to the extensive land clearance for crops and pasture).

- ***Potential impact of saline dams and ponds***

The tailings storage facility, evaporation ponds, and evaporation surge dam located in the southeast portion of the mine site would be constructed in what is currently crop and pastureland, shown in the bat survey to be of low value as foraging habitat. It is understood that these dams and ponds would contain water concentrated with calcium and magnesium sulphates and remain a low value foraging habitat for bats.

Most new sources of water in inland areas create new foraging habitat, but at the mine site, it is anticipated that these highly saline waterbodies and their immediate environs would become quite sterile and would not attract potential insect prey. Furthermore, it is considered that the bat fauna would be attracted to and would utilise the freshwater sediment and stock dams on the mine site in preference to the hot and exposed magnesium sulphate and calcium sulphate storage facilities.

The sediment and stock dams located on the mine site would remain as waterbodies at the completion of mining. The tailings storage facility would most likely be rehabilitated with endemic woodland species and pasture (each on selected areas). The evaporation ponds are proposed to be rehabilitated with pasture species.

SECTION 5A ASSESSMENTS

EIGHT PART TESTS UNDER THE EP&A ACT 1978

Three species listed as Vulnerable in the NSW *Threatened Species Conservation Act 1995* are addressed in the following Eight-Part Tests , including the Yellow-bellied Sheathtail Bat (*S.flaviventris*) and the Little Pied Bat (*C.picatus*), which were recorded at the mine site. The Precautionary Principle has been applied to also include the Greater Longeared Bat (*N.timoriensis*) in the Section 5A (EPA Act, 1979) Assessment. Although the species was not recorded at the mine site, it has been recorded at localities not far from the mine site.

These Eight-Part Tests have been conducted on the assumption that the recommendations outlined in the previous section will be adopted.

YELLOW-BELLIED SHEATHTAIL BAT *SACCOLAIMUS FLAVIVENTRIS*

Introduction

Very little is known about the biology of this species, though breeding has been studied from museum specimens by Chimimba and Kitchener (1987). The general ecology has been reviewed by Richards (1983a, 1995a) Rhodes and Hall (1997) and Churchill (1998).

This species has never been recorded in caves, and large colonies (around 40 individuals) have been found in tree hollow roosts (Rhodes and Hall 1997). It has been hypothesised, based on flight characteristics, that this species may be restricted to roosts in emergent trees because it needs a clear space below the roost to gain flight speed (Richards and Hall 1996, 1998).

S.flaviventris appears to be quite rare on a national scale, especially in southern latitudes. Field surveys by the consultant in the Murwillumbah-Lismore area indicated that a large foraging range may be required, because detector passes were low and it appeared from these data that just a few individuals were making large circuits (Richards, unpublished). Further, during an intensive survey in the Shoalwater Bay Military Training Area in central Queensland, that comprised 9 weeks of field work using 55 sites across two seasons, *S.flaviventris* was patchily distributed and restricted to densely vegetated habitats (Richards 1992, 1993).

This species is listed as Vulnerable in the NSW TSC Act, but is not listed in the draft national Bat Action Plan (Richards and Hall 1996) nor in the edited version (Duncan *et al* 1999) because of its widespread distribution. Dickman (1994) considers that the status of this species is “stable” in western NSW, as does Stephens (1992) for the Murray Mallee area. Lunney *et al* (1995) suspect that the original NSW statewide population has been reduced. Ayers *et al* (1996 and updates) list threats to this species in western NSW as the clearing of old trees with hollows which eliminates roost sites, severe grazing which reduces the regeneration of potential roost trees, and the localised impact of predation by feral cats at roost sites.

Section 5a Assessment (Eight Part Test)

(a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at the risk of extinction.*

In order to assess potential impacts on the life cycle of *S.flaviventris* it is necessary to address the primary components of its ecology, such as breeding, foraging, roosting and movement/migration.

Breeding

Females of this species have the typical pattern of breeding in summer (between December and mid-March), with a single young being weaned by the following early autumn (Chimimba and Kitchener 1987; Churchill 1998).

Foraging

This species can be assumed to forage primarily upon insects that hunted by aerial intercept, which is typical of species with long tapered wings (high aspect ratio) and a high wing loading. This indicates (supported by field observations) that flight is fast, with little manouverability, and given the loud, long-range echolocation call, insects would be captured by interception rather than being pursued. It is considered most likely that the mine site area is only part of the foraging range of individuals and that *S. flaviventris* would have large home ranges in this region.

Roosting

S.flaviventris roosts only in tree hollows, and as mentioned above, these are predicted to be large, located high in a tree, and situated such that there is enough clear space at the exit to allow an unencumbered drop until the bat attains normal flight speed. However, it is likely that there is some flexibility in roost site selection, based on the recent revelation by Churchill (1998) that "Several solitary animals have been found roosting in animal burrows, in cracks in dry clay and under slabs of rock in the Top End" of the Northern Territory. This publication also mentions the consultant's record of an individual captured whilst hanging on a wall in broad daylight (Richards 1983a, 1995a), which is now suspected to be an animal in the terminal stages of Lyssavirus infection. At a national level, this species is known to have a high incidence of this rabies-like virus in the population.

Movement/Migration

There is very little information available in relation to movement or migration patterns that this species may exhibit. Richards (1983c, 1995c), as mentioned in the paragraph above, concluded that because some *S.flaviventris* had been caught during the 1980's in situations where they appeared to be exhausted and in open view of the public, that they may have been undertaking pre-winter migrations. Because a higher than expected number of individuals have been recorded over the last few years to be afflicted with Lyssavirus these individuals observed may not have been exhausted but instead may have been diseased and unable to fly. The "migration" hypothesis therefore needs to be revised.

Summary

It is doubtful that the proposed development would have an effect upon the viability of the local population, considering the wide foraging range of this species and the proposed provision of roost sites. Should any colonies be present on the mine site, these will be identified and relocated through the recommendations for roost loss amelioration.

(b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

See discussion above re threats to this species at a local level.

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed*.

Given this species requires an extensive foraging range, the small remnants of habitat at the mine site are considered to merely be a small proportion of the area required for a few individuals. It is highly likely that in the mine site area, this species forages by "traplining" along the small tracts of foraging habitat. Because a relatively small proportion of habitat *per se* for this species will be removed, it is considered that no significant area of known habitat will be lost as a result of the Project.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population, or ecological community.*

Foraging habitat used by *S.flaviventris* at the mine site is already significantly fragmented. It is understood that no areas of habitat will become isolated by the Project to the extent that they could not be accessed by such a wide-ranging species as *S. flaviventris*.

(e) *Whether critical habitat will be affected*

Not applicable as it is understood that no critical habitat in the area has been identified and gazetted by the NSW Scientific Committee at the time of writing.

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.*

In NSW, *S.flaviventris* is known from Barakee, Barrington Tops, Blue Mountains, Botany Bay, Broadwater, Bundjalung, Bungawalbin, Cathedral Rock, Cottan-Bimbang, Eurobodalla, Fortis Creek, Gundabooka, Jervis Bay, Kinchega, Mount Pikapene, Mutawinji, Nightcap, Nocoleche, Nowendoc, Seven Mile Beach, South East Forests, Sturt, Tapin Tops and Yuragir National Parks. It is also known from Banyabba, Demon, Ironbark, Macquarie Marshes, The Glen, Tuckean, Wambina and Yathong Nature Reserves.

It is probably also present in the Willandra Lakes World Heritage Region, and Mungo and Mallee Cliffs National Parks. This would appear to be adequate representation, but because the biology of this wide-ranging species is relatively unknown, adequate representation cannot be inferred from the list above.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

None of the threatening processes listed in the TSC Act are applicable.

(h) *Whether any threatened species, population, or ecological community is at the limit of its known distribution.*

The mine site area is well within the widespread distribution of this species.

LITTLE PIED BAT, *CHALINOLOBUS PICATUS*

Introduction

The little that is known of the biology of *C.picatus* has been contributed by Richards (1979), and the species has been reviewed by Richards (1983b, 1995b) and Churchill (1998). It was originally considered to only require caves or their substitutes for roosting, but has also been found in buildings (Hall and Richards 1979), and has been radio-tracked to tree hollow roosts (Churchill 1998). Richards (1979) reported on a large breeding colony, numbering approximately 40, behind an open sliding door in an old building at Yathong Nature Reserve.

Apart from being very patchily distributed, *C.picatus* is also considered to be quite rare. As well as being listed as Vulnerable in the NSW Threatened Species Conservation Act, it is also listed in the IUCN category ‘Lower Risk - near threatened’ in the draft national Bat Action Plan (Richards and Hall 1996) and in the edited version (Duncan *et al* 1999). Dickman (1994) considers that the status of this species is "stable" in western NSW, as does Stephens (1992) for the Murray Mallee area. Ayers *et al* (1996 and updates) list threats to this species in western NSW as the clearing of hollow forming trees which may eliminate the species from woodlands. These authors also noted that although predation at roost sites by feral cats may have localised impacts, this factor “has yet to be quantified”.

Section 5a Assessment (Eight Part Test)

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at the risk of extinction.

In order to assess potential impacts on the life cycle of *C.picatus* it is necessary to address the primary components of its ecology, such as breeding, foraging, roosting and movement/migration.

Breeding

Females of this species give birth during November (Churchill 1998) and probably also early December, as do sibling species. Females "normally bear two young in the summer" (Richards 1983b, 1995b). Very little else is known about the breeding biology of this species.

Foraging

This species can be assumed to forage primarily upon insects that hunted by aerial pursuit, which is indicated by morphological characters that reflect this type of hunting, such as its wing aspect ratio and wing loading. Churchill (1998) states that “a single stomach content examination revealed only moths”.

Roosting

As mentioned above, *C.picatus* appears to be flexible in roost site selection, ranging from caves, disused mineshafts, tree hollows, and abandoned buildings. There are no known caves in the subject area (Matthews 1985).

Movement/Migration

There is no information available in relation to movement or migration patterns of this species. Females of a sibling species, *C.dwyeri*, separate from most of the males in a regional population during the summer breeding season, and by the following autumn the breeding colony disperses (Dwyer 1966). The breeding biology of *C.picatus* may be similar.

Summary

Although there is little known about the ecology of *C.picatus*, it is likely that the development would have a minimal effect upon the viability of the immediate local population, given the number of roosts in the local area will be increased as a result of the Project.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

See discussion above re threats to this species at a local level.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

C.picatus was recorded from the three major habitat types at the mine site: Low cypress forest, Tall cypress/box association, and stock dams. Given these habitats are widely distributed throughout the local area and the region, the potential loss of the habitat types in the Project area is not considered to be significant in terms of regional distribution of *C. picatus*.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population, or ecological community.*

Foraging habitat used by *C.picatus* at the mine site is already significantly fragmented. No areas of habitat will become isolated by the Project to the extent that they could not be accessed by such a wide-ranging species such as *C.picatus.*

(e) *Whether critical habitat will be affected*

It is understood that no critical habitat in the area has been identified and gazetted by the NSW Scientific Committee at the time of writing.

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.*

In New South Wales there are records of *C.picatus* from the Willandra Lakes World Heritage Region, Culgoa, Gundabooka, Kinchega, Mutawinji, Mungo, Mallee Cliffs and Sturt National Parks, as well as Booroolong, Buddigower, Nocoleche, Tarawi and Yathong Nature Reserves. The type locality is Depot Glen, near Milparinka, which is within Sturt National Park. One would suspect, given the broad distribution of this species in western NSW, that it would also occur in the remainder of the reserve network in this region.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

None of the threatening processes listed in the TSC Act are applicable.

(h) *Whether any threatened species, population, or ecological community is at the limit of its known distribution.*

The mine site is within the known distribution of this species, which in NSW is primarily the Murray-Darling Basin.

GREATER LONGEARED BAT, *NYCTOPHILUS TIMORIENSIS*

Introduction

This species was not recorded at the mine site, even though the methodology was appropriate to record sibling species (*N.geoffroyi* and *N.gouldi*). Nevertheless, because there are known records in the local area, the Precautionary Principle has been applied to include this species in the impact assessment process.

The little that is known of the biology of *N.timoriensis* is included in publications by Richards (1983c), Lumsden (1994) and Parnaby (1995). The latter author has unpublished taxonomic evidence (Parnaby 1988) to show that, although in earlier publications this species was considered to be distributed over southern Australia, it is in fact a complex of three morphologically distinct forms. One of these, dealt with below, is basically distributed throughout the Murray-Darling Basin.

Apart from being very patchily distributed, *N.timoriensis* is also considered to be quite rare, as exemplified by the studies of Lumsden *et al* (1995), during which only one individual was recorded in a total of 1556 captures of bats in rural Victoria. However, as more bat surveys are conducted in NSW with refined techniques, more records are coming to light.

As well as being listed as Vulnerable in the NSW Threatened Species Conservation Act, it is also listed in the IUCN category 'Vulnerable' in the draft national Bat Action Plan (Richards and Hall 1996) and the edited version (Duncan *et al* 1999).

Dickman (1994) considered that the status of this species is "stable" in western NSW. However, Stephens (1992) reported that *N.timoriensis* was "a species of serious concern" in the Murray Mallee area. Conversely, Lumsden *et al* (1995) in reference to this and other rural species proposed that "… the ability of bats to fly, their spatial scale of movement and their social organisation (e.g. their overlapping foraging areas, colonial roosting habits, interspecific tolerance) are key factors that enable these species to live successfully within the farmland environment and that have prevented regional extinctions". However, based on the collection of only one record in the region (approximately 9 km south of the mine site), the consultant preparing the following 8-part test does not agree that this statement would apply to *N.timoriensis* in central NSW, especially with its high level of cropping.

Ayers *et al* (1996 and updates) list threats to this species in western NSW as the clearing which eliminates roosting habitat if old trees are removed, grazing which can result in poor regeneration of hollow-producing trees (therefore affecting the long-term survival of this species), and predation by feral cats whilst these bats are roosting.

Section 5a Assessment (Eight Part Test)

(a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at the risk of extinction.*

In order to assess potential impacts on the life cycle of *N.timoriensis* it is necessary to address the primary components of its ecology, such as breeding, foraging, roosting and movement/migration.

Breeding

Richards (1983c), Lumsden and Bennett (1995), Parnaby (1995) and Churchill (1998) indicate that this species generally bears twin young in late spring and early summer. Lactation is usually completed by the following February. Very little else is known about the breeding biology of this species.

Foraging

This species can be assumed to forage primarily upon insects that gleaned from vegetation, as shown by morphological characters that indicate this type of hunting, especially low aspect ratio wings and large ears used for locating the sounds of insect calls (Hosken *et al* 1994). Churchill (1998) considers that this species may also spend some time hunting on the ground “as they have been captured in pitfall traps”.

Roosting

N.timoriensis have been found roosting in tree hollows, deep fissures and cracks in branches, and under sheets of dry bark on dead trees.

Movement/Migration

There is no information available in relation to movement or migration patterns of this species, but it is highly likely that populations are localised.

Summary

Although there is little known about the ecology of *N.timoriensis*, it is considered unlikely, given the proposed amelioration measures, that the development would have a significant impact upon this species, if this species were to occur at the mine site.

(b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

See discussion above re threats to this species at a local level.

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

N.timoriensis was not recorded from any of the major habitat types at the mine site, but if present it would probably focus upon the Low cypress forest and Tall cypress/box associations, as did the sibling species *N.geoffroyi* and *N.gouldi.* These habitats are widely distributed throughout the local area and the region.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population, or ecological community.*

No areas of habitat will become isolated by the Project to the extent that they could not be accessed by a mobile species such as *N.timoriensis.*

(e) *Whether critical habitat will be affected*

It is understood that no critical habitat in the area has been identified and gazetted by the NSW Scientific Committee at the time of writing.

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.*

In New South Wales there are records of *N.timoriensis* from the Willandra Lakes World Heritage Region; Ben Halls Gap, Cocoparra, Goobang, Goulburn River, Kosciusko, Mallee Cliffs, Mungo, Nangar and Warrumbungle National Parks; Buddigower, Monabalai, Pilliga, The Rock, Tollingo, Woggon and Yathong Nature Reserves; as well as Wallagaraugh Forest Reserve.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

None of the threatening processes listed in the TSC Act are applicable, apart from some potential for predation by the European fox, *Vulpes vulpes* (Ayers *et al* 1996 and updates) when feeding on the ground, as reported by Churchill (1998). However, considering that this feeding niche is probably the least utilised in the repertoire of this flying mammal, any impact would be expected to be low, and would only be an impact due to the development if the local population of European foxes increased as a result.

(h) Whether any threatened species, population, or ecological community is at the limit of its known distribution.

The mine site is well within the known distribution of this species, which in NSW is primarily the Murray-Darling Basin.

CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that there will be no significant impacts upon the foraging habitat used by the local bat fauna, particularly threatened species. It is recommended however, that the rehabilitation strategy for the Project consider revegetation of disturbed landforms, and other areas available within the mine site, with the Tall cypress/box association and associated shrub layer.

The removal of large trees that may contain roosting bats has the potential to impact upon local bat fauna, including threatened species. It is recommended that the following strategy be employed to accommodate this:

- Undertake pre-clearance surveys to establish the number of roosts in trees required to be removed and relocation of the roosts away from the impact areas.
- Provide a number of artificial roosts (bat houses) at strategic locations in the mine site and surrounds as a strategy to replace any roosts that would be lost.

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APPENDIX JD

An assessment of the bat fauna at the proposed Syerston Nickel-Cobalt Project infrastructure areas, central New South Wales.

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Document No. BATSR01-J.DOC

Prepared for Black Range Minerals Ltd, May 2000, revised July 2000

CONTENTS

[1] This is a requirement of the consultant's insurance company.

EXECUTIVE SUMMARY

Greg Richards and Associates was commissioned to conduct a bat fauna assessment of the infrastructure areas for the proposed Syerston Nickel-Cobalt Project, located near Fifield in central New South Wales.

Bat fauna within the infrastructure areas was assessed using the following strategy:

(a) regarding each corridor as a habitat transect along which co-ordinates were taken at points where the habitat changed, using a Global Positioning System, and measuring the length of each section of habitat with the satellite-based odometer in the GPS.

(b) automated electronic bat detectors were positioned in high quality habitat to optimise the chances of recording threatened species.

(c) after high quality habitat was assessed, lower quality habitat was then sampled with detectors to create a stratified sampling regime for the entire area, where each habitat type was replicated at least five times.

Each section of habitat was rated on a five-point scale according to foraging area quality, roost tree potential, and whether water was present to encourage high levels of insect prey.

Prior to the commencement of the study, a bat species list was compiled to ascertain the appropriate methodology to target each bat species likely to be present, particularly those species listed in the NSW *Threatened Species Conservation Act, 1995.*

Of the 13 microchiropteran bat species that were expected in the area, a total of 11 were recorded. Three threatened species (*Saccolaimus flaviventris, Chalinolobus picatus* and *Nyctophilus timoriensis*) were recorded during the study.

The study concluded that there will be no significant impacts upon the foraging habitat on the local bat fauna, particularly threatened species, given the gas and water pipelines are to be situated within the cleared section of the road reserves for the majority of their lengths.

The Project has the potential to impact upon bat fauna through the removal of large trees. If the removal of any large trees cannot be avoided, it is recommended they be inspected to ascertain if they contain bat colonies, particularly any threatened species, and any colonies found be relocated (particularly those found in hollow branches).

The Section 5A assessments for each threatened species concluded that the Project is not considered likely to have a significant impact on threatened bat fauna.

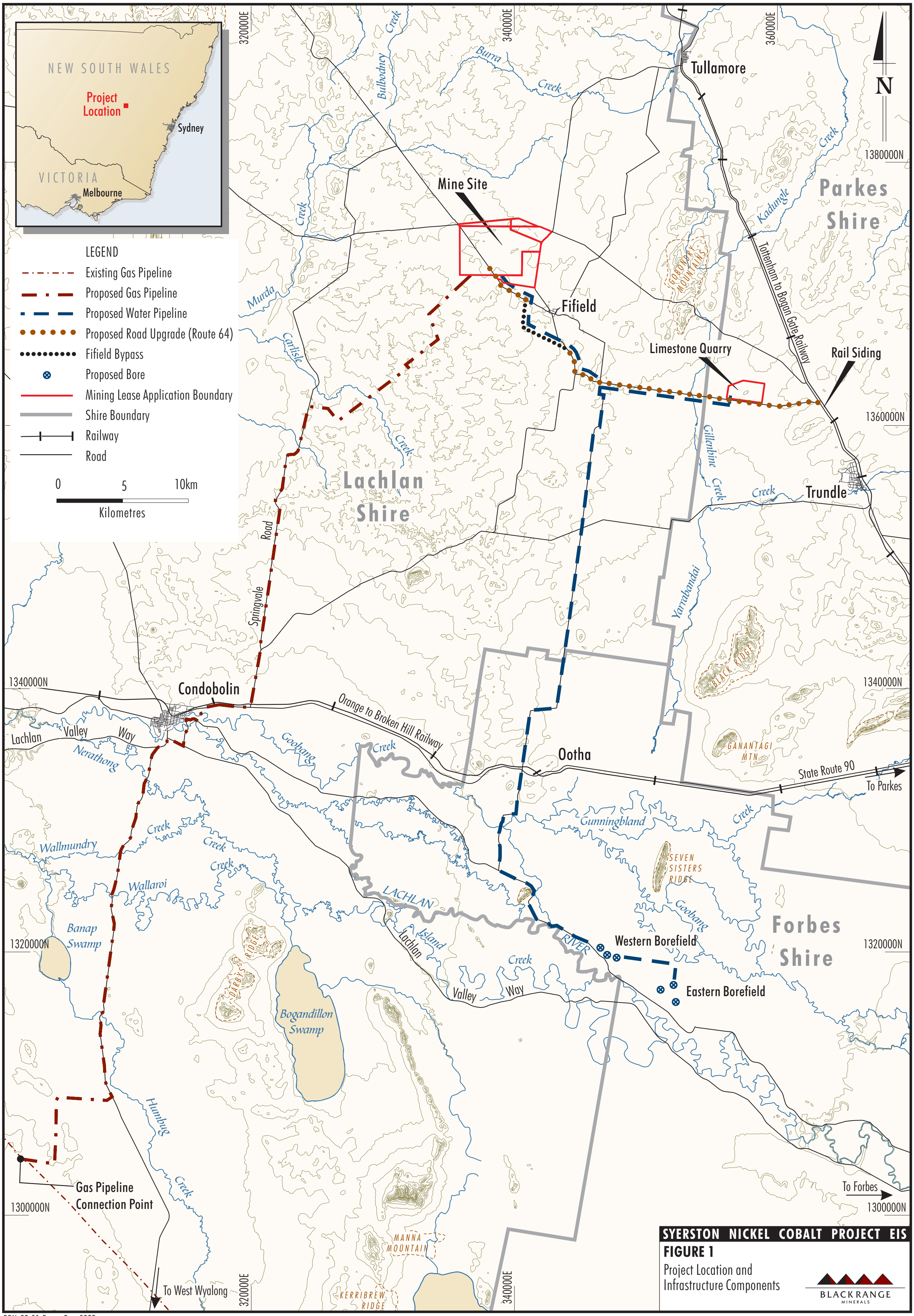
INTRODUCTION

Greg Richards and Associates was commissioned to conduct a bat fauna assessment of infrastructure areas associated with the proposed Syerston Nickel-Cobalt Project. The proposed mine site is located near Fifield, approximately 45 km northeast of Condobolin in central New South Wales. The bat fauna of the mine site is assessed in a separate report (Appendix JC of the Syerston Project Environmental Impact Statement [EIS]).

This report assesses the infrastructure areas associated with the Syerston Project, which includes the following components (Figure 1):

- a gas pipeline from the existing Sydney to Moomba pipeline (south of Condobolin) to the mine site (approximately 90 km);
- a water supply pipeline from two borefields located in the Lachlan Valley palaeochannel (west of Forbes) to the mine site (approximately 65 km), and an associated water spurline (approximately 10 km) to the limestone quarry;
- upgrade of Route 64;
- construction of the Fifield bypass;
- a limestone quarry situated approximately 10 km to the northwest of Trundle; and
- a rail siding and associated access road, north of Trundle.

This report assesses the local bat fauna and its relationships with habitat, and addresses the potential impacts from the infrastructure components. Threatened bat species are assessed with Eight Part Tests of Significance in accordance with Section 5A of the NSW *Environmental Planning and Assessment Act* (EPA Act*) 1979*.



SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 1

Project Location and Infrastructure Components

BLACK RANGE MINERALS

BRM-98-01-Fauna-Bat_003F

METHODS

Background

The assessment of the bat fauna within the infrastructure area and surrounds was conducted utilising the following strategy:

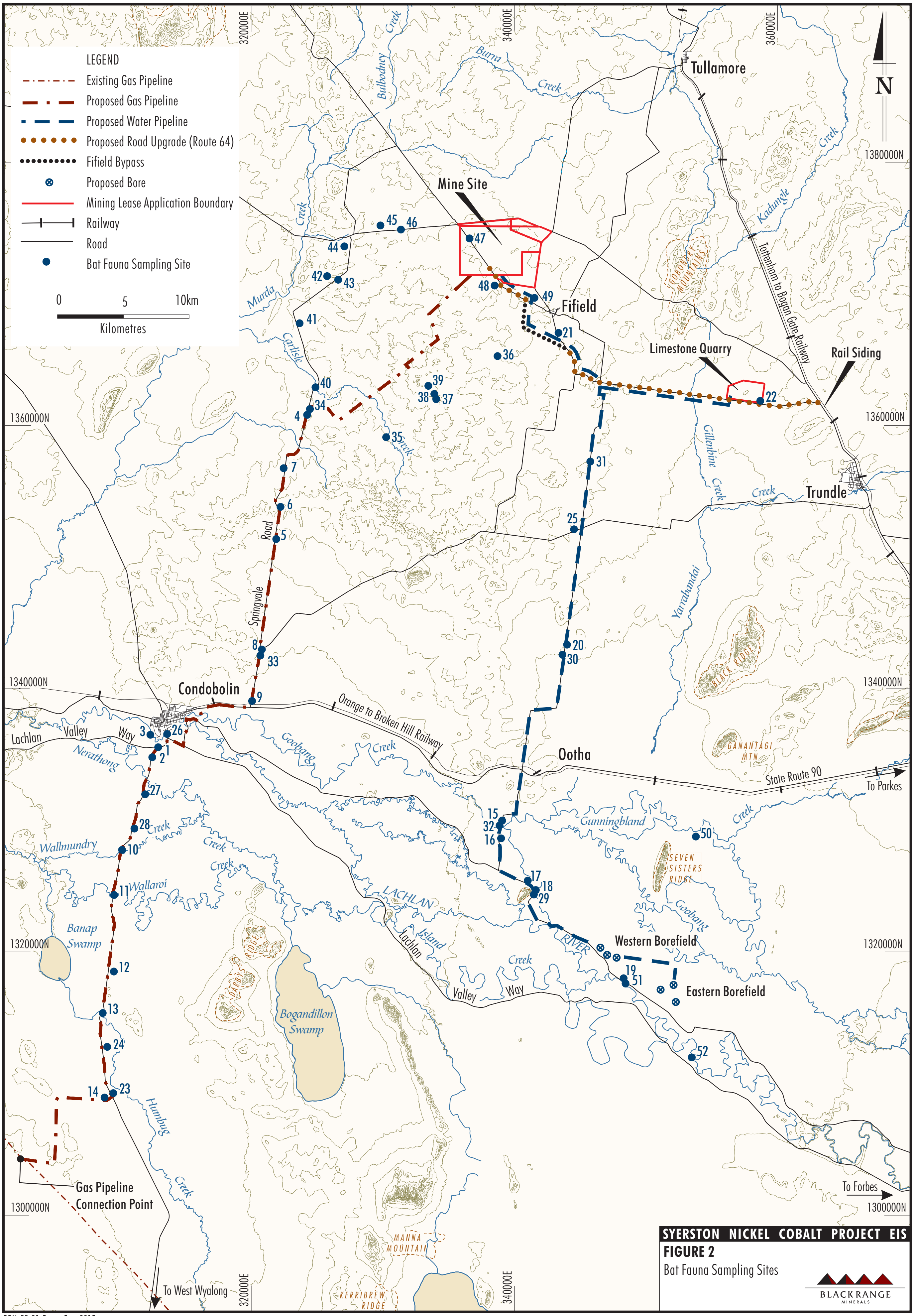
(a) Bat Habitat Assessment: In order to assess potential bat habitat within the Project area, each infrastructure area was regarded as a habitat transect and inspected from a vehicle at the commencement of the study. Along each corridor, co-ordinates were taken at points where the habitat changed, using a Global Positioning System. Each transect started from a known reference point, and the digital odometer in the GPS was used to record road distances from the reference point to each change in habitat. The habitat adjacent to the strip (over the fence on private or state-owned land) was also noted. Transects were not conducted in discrete areas such as the proposed limestone quarry rail siding and the borefields given the cleared nature and lack of suitable habitat at these sites.

(b) Bat Fauna Survey: GPS co-ordinates of suitable habitat locations for sampling the bat fauna were recorded during the initial habitat assessment, and automated electronic detectors were positioned on the return journey, or on following days.

After the bat habitat was assessed for all infrastructure areas and habitats of different quality had been classified, the stratification (by habitat type) of the sampling was re-assessed and detectors were later positioned where necessary to ensure adequate replication. The locations of the bat fauna survey sites are shown in Figure 2.

All infrastructure areas were assessed from 10th to 16th October 1999, with the exception of the northern section of the gas pipeline and the Fifield bypass (due to a change in corridor placement) which were assessed from 21st to 24th March 2000.

The habitat assessment and bat fauna survey allowed a complete assessment of the bat fauna in each habitat identified within the infrastructure areas, with the statistically rigorous stratified sampling providing an insight into species habitat requirements and the value for bats of each habitat type. Use of the digital odometer in the GPS allowed the total length of habitat to be ascertained for each infrastructure area, and for the local area as a whole. Details of the habitat assessment and bat fauna survey are provided below.



SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 2

Bat Fauna Sampling Sites

BLACKRANGE MINERALS

BRM-98-01-Fauna-Bat_001F

Habitat Assessment

The assessment of bat habitat was based on personal and published knowledge of the components of habitat that bats require; namely foraging area, roost sites, and the presence of water which provides high prey levels. Habitat relationships of bats in southeastern Australia have been extensively studied by Richards (1994). Each habitat identified in the infrastructure areas and surrounds was scored on a five point scale, as follows:

Foraging area quality

0 = No woody vegetation (applies to cropfields and pasture)

1 = A few scattered trees, open underneath (no shrub layer)

2 = A few scattered trees, closed underneath with a shrubby understorey

3 = Moderate tree density, open underneath

4 = Moderate tree density, many shrubs in understorey

5 = High tree density, very dense shrub understorey

Roost tree potential

0 = No suitable trees

1 = Very few potential roosts seen

2 = Approximately 25% of trees with potential hollows

3 = Approximately 50% of trees with potential hollows

4 = Approximately 75% of trees with potential hollows

5 = Approximately 100% of trees with potential hollows, plus stag trees or large dead branches that would provide suitable freefall for *Saccolaimus flaviventris* (a threatened species), if present.

Type of water body

0 = None present

1 = Creek bed devoid of water but with wet soil (likely to attract insect prey)

2 = Ephemeral waterhole, likely to dry out in summer

3 = Small semi-permanent creek or waterhole

4 = Large permanent creek or waterhole/billabong

5 = Large permanent flowing river

The scores for each of these categories were recorded for each portion of habitat. This method was intended to rate the quality of each aspect of the habitat, specifically for bats. The sum of the three scores also gave a further classification of quality. For example, cropland would score three zeros and a total of zero, which is an excellent indication of how poor it is for the bat fauna (Richards unpublished). Conversely, prime habitat such as a large river with a high density of surrounding eucalypts (with many potential roost hollows), a shrubby understorey, and many stag trees present (which are also ideal as roosts), would gain a score of 5 for each category, and a total of 15.

Replication of Bat Sampling Points

A total of 52 sampling points for assessing the bat fauna were established in the vicinity of the infrastructure areas: 39 in the October 1999 survey and 13 in the March 2000 assessment. The number of replicates in each bat habitat ranged from 3 to 7 in October 1999, and the opportunity was taken in March 2000 to increase the habitat replication to have a minimum of 5 detection sites (Table 1). As mentioned in the Background section, sampling points were initially established to optimise the recording of threatened species in what had been defined as “good” bat habitat, and detectors were also placed near trees with potential roost hollows.

Bat Fauna Survey

Prior to the commencement of the study, a species list was compiled from the consultant’s extensive distribution database, to ascertain the appropriate methodology to target each bat species likely to be present, particularly those species listed in the NSW *Threatened Species Conservation Act 1995*. Database output was also checked against distribution maps in Parnaby (1992) and the NPWS Atlas of NSW Wildlife database.

Based on detectability levels of species in the region (Richards 1996), the most appropriate method was considered to be the use of Anabat detectors that were automatically controlled by a delay switch, and these would record the species-specific echolocation calls of free-flying bats, and allow rapid sampling to be conducted. The delay switch operated each detector for the entire night (approximately 10 hours), as opposed to other switching methods that only allow recording for 45 minutes after dusk. Harp trapping was not conducted due to the unsuitability of the majority of sampling sites (narrow strips of roadside vegetation) to provide the necessary funnel effect, and the exposure of traps to the public[2].

[2] Scientific Investigation Licences issued under Section 120 of the National Parks and Wildlife Act 1974 require that discretion to be used when studying wildlife in public areas.

Table 1
Replication of Bat Sampling Points.

Habitat Type	Number of detection sites October 1999	March 2000	Total	Score total for habitat
Habitats without free water present				
No trees present	3	2	5	0
A few scattered trees, 100% with potential bat roosts, but no shrubby understorey	3	2	5	2
A few scattered trees, no roosts apparently available, many shrubs	3	2	5	4
A few scattered trees, many shrubs, roosts potentially in 25% of trees	5	-	5	4
Moderate tree density, no shrubs, roosts potentially in >50% of trees	7	-	7	6
High tree density, many shrubs, roosts potentially in 25% of trees	3	2	5	10
Undisturbed forest (large eucalypts, mallee), dense shrub understorey, high roost potential	3	2	5	10
Habitats with free water present				
A few scattered trees, roosts potentially in 25% of trees, usually at a waterhole	3	2	5	2-5
Moderate tree density, many potential roosts, no shrub understorey, usually at a waterhole	5	-	5	4-7
High tree density, many shrubs, many roosts, usually at a large creek or river	4	1	5	9
Total replicates	39	13	52	

Ten detector systems were available for use each night, and were positioned at appropriate locations during the preceding day. These systems were operated for one night, and provided approximately 10 hours of recording each time. Recordings from locations where high habitat quality was noted were analysed the following day, and recordings from less prospective sites were analysed after the completion of the survey. The number of sites sampled in this manner are shown in the Results section of this report.

Detectors were always located near a tree in each section or patch of habitat that was most likely to be a potential bat roost. The "delay switch" automatically commenced operation of the system (all ten detectors) at dusk. Delay switches also provide the real-time when a bat call was recorded, and the emergence of a bat colony from its roost can usually be recognised by a large number of calls a few seconds apart, and in the early part of the evening.

The Concept of Site Records for Bat Fauna Analysis

Many bat fauna assessments can be confused or rendered difficult to analyse when particular species congregate at sites with water present, where prey levels are higher than at dry sites. For example, it is difficult to compare a site where a species has been recorded by one or two passes (sequences of calls made as a bat flies past a detector) with another site where it may have been recorded by 100 passes. Although such data would reflect habitat quality, there is the problem that 100 passes could be made by 100 bats once in the sample, 10 bats 10 times, or 1 bat 100 times (or whatever combinations may arise).

For the purposes of this study, and to smooth out differences between watered and dry sites, the concept of site records was used. A site record is simply the notion that if a species is recorded at a site (irrespective of the number of occasions) then it registers usage of that habitat by that species. The extent of usage is obtained by assessing the number of replicates of any particular habitat. Hypothetically, if species "X" is recorded in all replicates of habitat "A", and species "Y" is only recorded in a small proportion of the replicates, then this shows a greater usage or dependence upon habitat "A" by species "X" than species "Y". This becomes important when attempting to define habitat utilisation by threatened species, as each species is given equal weighting in habitat comparisons, and the (typically) low number of passes by this group is not swamped in the dataset with non-threatened species.

The concept of site records has been used in past major faunal assessments such as at Shoalwater Bay Military Training Area (Richards 1992, 1993) and the Murwillumbah Management Area of State Forests of NSW (CSIRO 1996).

RESULTS and DISCUSSION

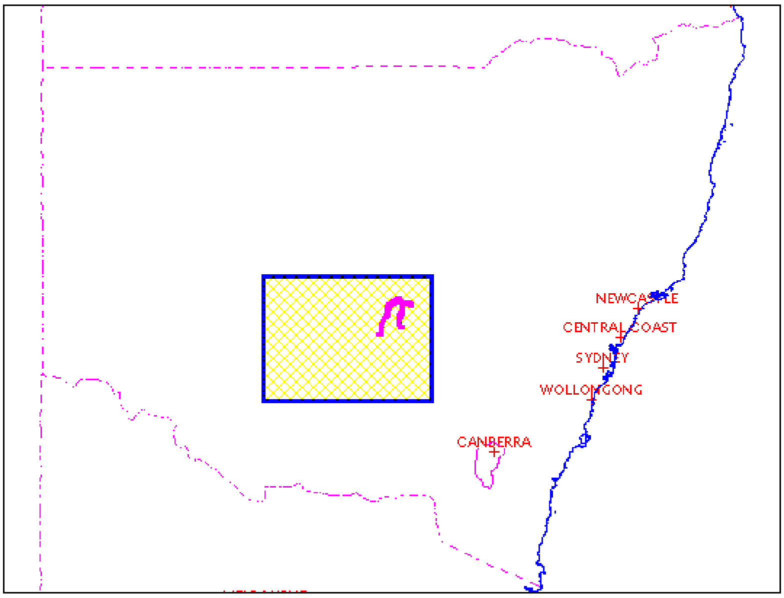
Background Information

Table 2 lists the 13 microchiropteran bat species that could be expected in the subject area, based on records from the consultant's distribution database, and using a search block bounded by 32°25' to 34°30' by 145°00' to 148°00'. This search block is shown in Figure 3, and is approximately 280 km on the east to west axis, and 230 km on the north to south axis. The subject site was deliberately not centred within the search block to ensure that the maximal number of records of the inland bat fauna would be obtained.

Table 2: Species that could be expected in the subject area, based on records from the consultant's distribution database, using the search block bounded by 32°25' to 34°30' by 145°00' to 148°00' (Figure 3). Species listed in the NSW *Threatened Species Conservation Act 1995* are shown in bold

Family Emballonuridae	
Yellow-bellied Sheathtail-bat	***Saccolaimus flaviventris***
Family Vespertilionidae	
Gould's Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Little Pied Bat	***Chalinolobus picatus***
Lesser Longeared Bat	*Nyctophilus geoffroyi*
Gould's Longeared Bat	*Nyctophilus gouldi*
Greater Longeared Bat	***Nyctophilus timoriensis***
Inland Broadnosed Bat	*Scotorepens balstoni*
Little Broadnosed Bat	*Scotorepens greyii*
Southern Forest Bat	*Vespadelus regulus*
Little Forest Bat	*Vespadelus vulturnus*
Family Molossidae	
White-striped Freetail Bat	*Tadarida australis*
Inland (or Southern) Freetail Bat	*Mormopterus planiceps*

Figure 3: Location of database search block used to elucidate species records from the consultant's database. The line within search block indicates approximate position of corridors.



Habitat Assessment

General assessment throughout the infrastructure area

The majority of habitat along the pipeline routes and Route 64 comprised thin bands of large eucalypts with varying densities of shrubby understorey. These thin bands were roadside remnants that usually abutted extensive cropfields and pastures, though some remnants were a continuum of the habitat adjacent to the corridor. In the areas south of Condobolin and Ootha, a large number of creeks and waterholes were present. Table 3 shows the amount of each habitat type in the entire corridor network.

In the vicinity of the corridors, there was 132.5 km of habitat without trees, which usually abutted cropfields or pasture. This proportion was 34.7% of the total 381.5 km of habitat strips. Poor bat habitat (including the treeless habitat, habitat containing a few scattered trees or moderate tree density without a shrub understorey, an overall low potential for roost hollows, and no surface water present) totalled 336.9 km (or 88.3%) of the habitat strips. Good bat habitat including habitats with water present, habitats with moderate or high tree density with a shrub understorey and undisturbed forest totalled 44.6 km (11.7%) of the habitat strips in the vicinity of the corridors.

Table 3: Quantity of each bat habitat type in the entire corridor network. Habitat that is considered to be high quality for bats is shown in bold. Roost site potential is an estimate of the percentage of trees that had hollow branches that would provide suitable roosts for bats.

Major habitat type	Understorey Description	Roost site potential	Length of strip (km)	Number of patches	Average patch length (km)
HABITATS WITHOUT WATER PRESENT					
No trees (crops, pasture)	None	None	132.5	99	1.33
A few scattered trees	None	None	47.8	17	2.81
	None	25%	0.8	2	0.40
	None	50%	14.3	7	2.04
	None	75%	1.9	1	1.90
	A few shrubs	None	28.5	12	2.38
	A few shrubs	25%	87.0	31	2.90
Moderate tree density	None	None	5.0	4	1.25
	None	25%	5.9	5	1.18
	None	50%	9.3	15	0.62
	None	75%	3.7	3	1.23
	None	>75%	0.6	2	0.30
Moderate tree density	**Many shrubs**	25%	15.6	9	1.73
High tree density	**Dense shrubs**	25%	0.8	2	0.40
	Dense shrubs	50%	1.5	3	0.50
Undisturbed forest	**Dense shrubs**	>75%	9.0	1	9.00
Total – habitats without water present			363.7	213	
Average – habitats without water present					1.71
Total – high quality bat habitat without water present (as shown in bold above)			26.9	15	
Average – high quality bat habitat without water present (as shown in bold above)					1.79

Major habitat type	Understorey Description	Water type	Roost site potential	Length of strip (km)	Number of patches	Average patch length (km)
HABITATS WITH WATER PRESENT						
A few scattered trees	**None**	Wet creek bed	25%	6.00	2	3.00
	None	Wet creek bed	50%	0.10	1	0.10
	None	Wet creek bed	75%	3.80	2	1.90
	None	Large creek	50%	0.20	2	0.10
Moderate tree density	**None**	Ephemeral waterhole	75%	0.80	**2**	0.40
	Many shrubs	Large creek	50%	0.40	2	0.20
	None	Small creek	75%	0.80	8	0.10
	None	Large creek	75%	3.60	**2**	1.80
	Many shrubs	Large creek	50%	0.10	1	0.10
	None	Large creek	>75%	0.2	2	0.1
	None	Large river	75%	0.20	1	0.20
High tree density	**Dense shrubs**	Wet creek bed	50%	0.10	1	0.10
	Dense shrubs	Large creek >	75%	1.00	1	1.00
	Dense shrubs	Large river	100%	0.60	2	0.30
Total – habitats with water present				17.9	29	
Average – habitats with water present						0.62
TOTAL – ALL HABITATS (with + without water present)				381.5	241	

The average size of each patch of habitat varied widely, but poor habitat was in 197 patches, with an average patch length of 1.61 ± 1.25 km, compared with good habitat which was in 44 separate patches with an average length of 1.22 ± [0.96] km. The median value for poor habitat was 1.20 km compared with 0.40 km for good habitat.

This analysis indicates that the majority of the corridors (88.3%) is of little value as bat habitat and bat fauna issues in proposed construction of the infrastructure need only be addressed in a small proportion of the corridors.

Of the 44.6 km of good bat habitat in the immediate vicinity of the corridors, approximately 9.0 km of this was comprised of undisturbed forest in which all three threatened species (*Saccolaimus flaviventris, Chalinolobus picatus* and *Nyctophilus timoriensis*) were recorded (refer to Section titled 'Threatened Species Distribution Analysis').

Therefore, for the purposes of assessing the impact of the proposed Project upon the bat fauna, the analysis of bat habitat can, in general terms be restricted to the total of 44.6 km of high quality bat habitat identified in 44 patches, over 25 of which are watercourse crossings.

The potential bat habitat of the infrastructure areas are discussed in more detail below.

Gas Pipeline

The corridors assessed for the gas pipeline contained 212.6 km of habitat strips, but of this 131.8 km (62%) was poor bat habitat such as pasture or crop fields, or scattered trees (Table 4). A total of 68.3 km (a further 32%) of moderate quality bat habitat was identified in 56 remnants with an average patch length of 1.22 km. A further 12.5 km (less than 6%) of high quality bat habitat was identified in 16 remnant patches.

Water Pipeline

The corridors assessed for the water pipeline contained 136.6 km of habitat strips, consisting of 73.5 km of poor bat habitat such as pasture or crop fields, or scattered trees, equating to 54% of the total, and in 50 individual remnants. A further 56.5 km (41%) of moderate quality bat habitat was recorded. Only 6.6 km (less than 5%) of high quality bat habitat, was identified within 14 remnants having an average patch length of 0.5 km.

Borefields

Although located in the vicinity of the riverine vegetation surrounding the Lachlan River, the borefields are characterised by pasture or cropping areas, which is regarded as low quality bat habitat.

Route 64

This component of the infrastructure consisted primarily of moderate quality bat habitat. Of the 32.4 km of habitat strips, 32.0 km consisted of scattered trees with a shrubby understorey, with approximately 25% of the trees estimated to have potential for roost hollows.

Fifield Bypass

Located within private property, the Fifield bypass is characterised by cleared pasture/cropping land and is therefore considered to be of low quality bat habitat.

Limestone Quarry

The proposed limestone quarry lies within cropfields that offer no potential foraging or roosting habitat for bats.

Rail Siding

The proposed rail siding is within an area considered to be of poor quality bat habitat (pasture and scattered trees) and offers no potential foraging or roosting habitat for bats.

A summary of the extent of habitat recorded in each infrastructure area is presented in Table 4.

Table 4: Extent of habitat recorded in infrastructure areas. Distances are the length of roadside strips classified as poor quality (total score = 0-3), moderate quality (total score = 4-7), and high quality (total score ≥ 8).

Zone	Parameter	Total habitat quality and score range		
		Poor 0 - 3	Moderate 4 - 7	High 8 +
Gas Pipeline	total length (km)	131.8	68.3	12.5
	no. of patches	77	56	16
	mean patch size (km)	1.7	1.2	0.8
Water Pipeline				
	total length (km)	73.5	56.5	6.6
	no. of patches	50	20	14
	mean patch size (km)	1.5	2.9	0.5
Route 64	total length (km)	32.0	0.4	-
	no. of patches	6	2	-
	mean patch size (km)	5.3	0.2	-

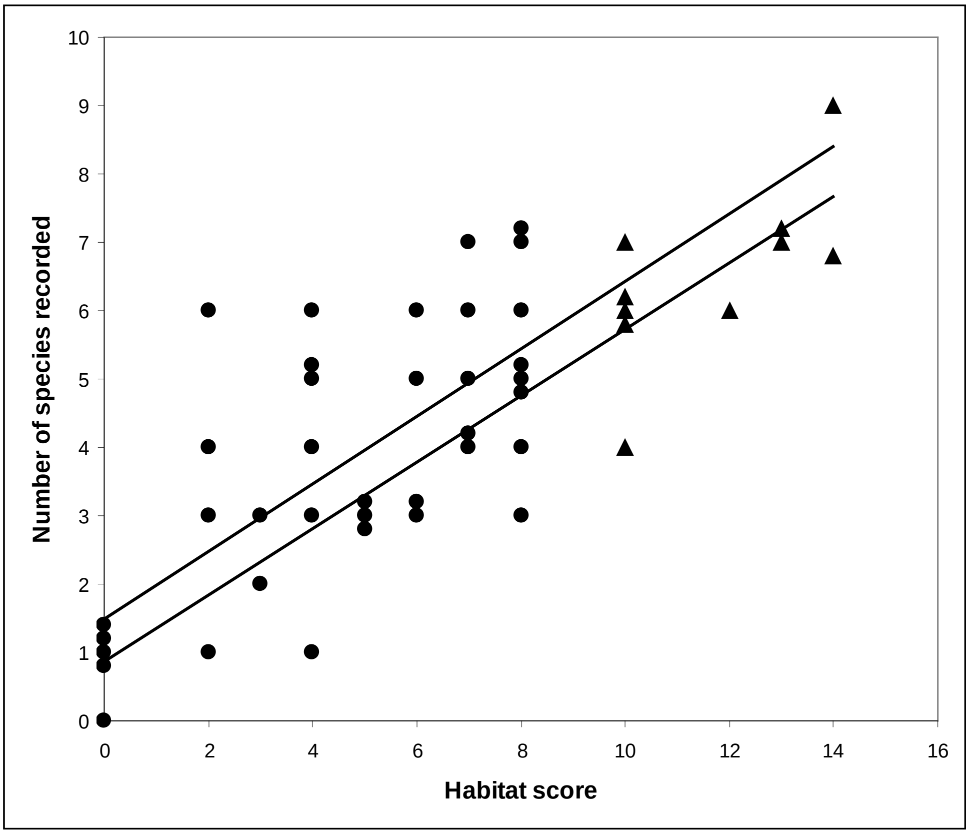
Bat Fauna Recorded

General assessment throughout the infrastructure area

Of the 13 microchiropteran bat species that were expected in the area (Table 1), only two were not recorded in the subject area (*N.gouldi* and *V.regulus*). Both of these species had been recorded at the proposed minesite near Fifield (Appendix JC), which had larger tracts of vegetation, particularly Cypress Pine, than present in the infrastructure areas surveyed.

Figure 4 indicates better quality habitat (based on the total score of the three habitat assessment categories - foraging area quality, roost tree potential and type of water body) supports a higher number of species. The trendlines have similar slopes, indicating that whether water is present or not, the more complex the habitat the more species (overall) will be supported in this region. However, the presence of water (which increases the habitat score) creates habitat that is utilised by more species than those without water.

Figure 4: Relationship between the number of bat species recorded at infrastructure survey sites and the habitat score of the site, separated as to whether water was present (triangles) or not (circles) at the time of survey. Although the R^2 values for each relationship are weak, there is a trend that indicates better quality habitat supports higher levels of species richness.



Threatened Species Distribution Analysis

Three species listed as threatened under the NSW *Threatened Species Conservation Act 1995* were recorded in the subject area at locations shown in Figure 5. These species were:

Saccolaimus flaviventris

> At three of the replicates sampled (Sites 37, 38 and 39), this species was recorded in undisturbed forest comprising a high density of understorey shrubs, a high roost potential and no water present. This species was also recorded at all four replicates in habitat described as high tree density with many roosts, many shrubs, along a permanent creek or river. Sites in this category were Bumbuggan Creek (Sites 18, 29 and 32) and the Lachlan River (Sites 3 and 51).

Chalinolobus picatus

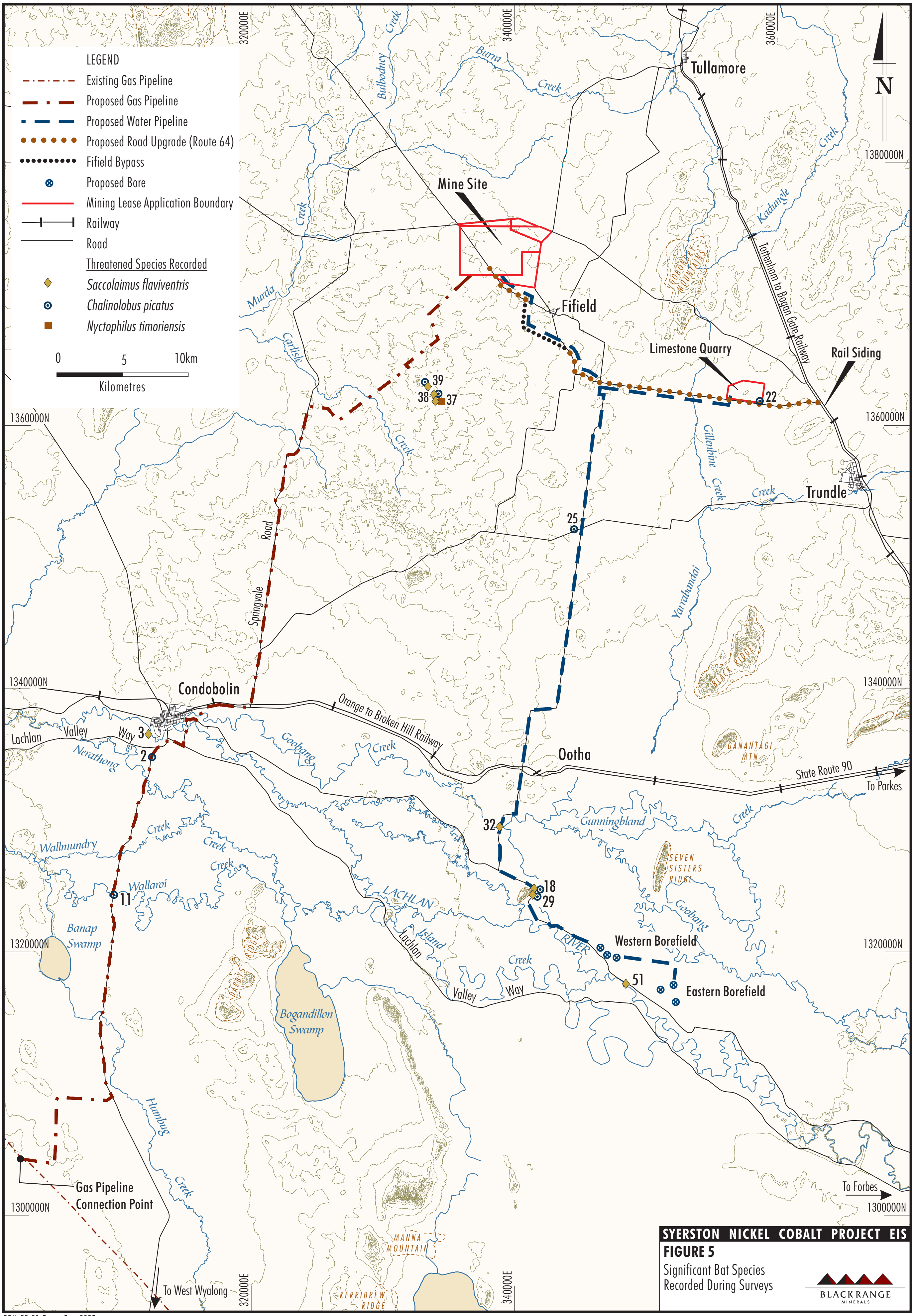
> *C. picatus* was recorded at a total of 8 sites including habitat described as scattered to high tree density with a dense shrub understorey but with low roost potential (Sites 22 and 25). The species was also recorded at two of the three replicates in the undisturbed forest that had a high density of understorey shrubs and a high roost potential (Sites 38 and 39). It was also recorded at sites with permanent water that had a moderate to high tree density, with or without a shrub understorey, and a high roost potential. Sites in this category were Bumbuggan Creek (Sites 18 and 29), Wallaroi Creek (Site 11), and a large waterhole in the Nerathong Creek/Lachlan River system (Site 2).

Nyctophilus timoriensis

> *N. timoriensis* was recorded at Site 37 in undisturbed forest comprising a high density of understorey shrubs and a high roost potential.

The location of sampling points where threatened bat species were recorded during the surveys are shown in Figure 5. It is important to note this documentation of specific locations for threatened bats does not imply that these are the only areas where threatened species could be found. It should be noted that in the degraded habitat of the infrastructure zones, some species (especially *S.flaviventris*) could have large home ranges that fluctuate from night to night. This is why habitat utilisation has been chosen as the parameter from which to infer likely impacts upon the threatened fauna.

Threatened species recorded during the surveys were restricted to habitats that had a total score of 4 or more, which indicates that cropland, pastureland and habitat with a few scattered trees were of low habitat value, and impacts of the Project on these habitats would not be significant in regard to threatened bat fauna. Habitats with a total score of 4 to 7 only supported one threatened species (irrespective of taxon), whereas higher quality habitats with a total score of 8 or higher supported at least two threatened species (refer Table 4).



SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 5

Significant Bat Species Recorded During Surveys

BLACK RANGE MINERALS

BRM-98-01-Fauna-Bat_002F

For the purposes of assessing impacts of the infrastructure on threatened bat fauna, the analysis in Table 4 gives a guide to the extent of areas where impact mitigation needs to be addressed. Table 4 indicates that moderate and high quality habitat accounts for 32% of the gas pipeline route. High quality habitat accounts for less than 6% of the gas pipeline corridor, and the average patch size is small (less than one kilometre in length). Moderate and high quality habitat along the water pipeline route accounts for 56% of the pipeline route in total. Although approximately 6.6% of the habitat strips of the water pipeline route are of high enough quality to have the potential to support two threatened species, again the patch size is small (in the order of 500 metres).

The habitats are separated further in the analysis shown in Table 5. *C.picatus* occupied a greater range of habitats than did *S.flaviventris* and *N.timoriensis*, the latter only recorded in the tract of undisturbed forest. *S.flaviventris* and *N.timoriensis* appeared to prefer to forage in high quality habitat only.

Summary of Assessments in Each Infrastructure Zone

Gas Pipeline Corridor

The gas pipeline corridor consists of very little high quality bat habitat (less than 6%), and there is a total length exceeding 260 km of habitat strips that are unsuitable for bats, with the exception of the wide-ranging *T.australis*. *S.flaviventris* and *C.picatus* have been recorded in this corridor (Figure 5), and can be expected in high quality habitat, with a focus on sites with water present.

Water Pipeline Corridor

A situation similar to the gas pipeline corridor exists with this corridor. The water pipeline corridor contains less high quality bat habitat (less than 5%), and there is a total length exceeding 140 km of habitat strips that are unsuitable for bats, again with the exception of the wide-ranging *T.australis*. *S.flaviventris* and *C.picatus* have been recorded in this corridor (Figure 5), and can be expected in high quality habitat, with a focus on sites where water is present. Along the water pipeline corridor, *S.flaviventris* appears to be restricted to watercourses south of Ootha, in the Lachlan River catchment.

Route 64

This corridor only had a small (less than 1 km) section of habitat that was of reasonable quality for the bat fauna, where *C.picatus* was recorded.

Fifield Bypass

Situated within cleared agricultural land, the Fifield bypass is considered to be poor quality bat habitat.

Table 5: Bat fauna recorded in each habitat type. Values in cells are the number of detection sites at which each species was recorded.

Habitat type	**Species recorded**											**Total Species**
	Threatened (n=3)			**Not threatened** (n=8)								
	Sfla	Cpic	Ntim	Cgou	Cmor	Ngeo	Sbal	Sgre	Vvul	Mpla	Taus	
Habitats without water present												
No trees present	-	-	-	-	-	-	-	-	-	-	2	1
Scattered trees, high roost potential, no shrubs	-	-	-	-	-	-	-	1	3	2	3	4
Scattered trees, no roosts, many shrubs	-	-	-	1	-	1	2	1	2	3	3	6
Scattered trees, many shrubs, low roost potential	-	1	-	5	1	1	1	4	3	3	4	9
Moderate tree density, no shrubs, mod roost potential	-	-	-	6	-	1	3	4	7	7	6	6
High tree density, many shrubs, low roost potential	-	1	-	2	2	1	-	3	3	3	3	8
Undisturbed forest, many shrubs, high roost potential	3	2	1	3	1	-	-	3	2	2	3	9
Habitats with water present												
Scattered trees, low roost potential, no shrubs	-	-	-	-	-	-	-	1	1	2	2	6
Moderate tree density, high roost potential, no shrubs	-	2	-	5	1	-	3	3	5	3	5	7
High tree density, many roosts, many shrubs	4	2	-	4	2	1	3	2	4	4	4	10
Total number of habitats utilised by each species	2	5	1	8	3	4	6	9	9	9	10	

Species mnemonics are : Sfla = *S.flaviventris*, Cpic = *C.picatus*, Ntim = *N.timoriensis*, Cgou = *C.gouldii*, Cmor = *C.morio*, Ngeo = *N.geoffroyi*, Sbal = *S.balstoni*, Sgre = *S.greyii*, Vvul = *V.vulturnus*, Mpla = *M.planiceps*, Taus = *T.australis*

Limestone Quarry

The proposed limestone quarry lies within cropfields which, as shown in previous analyses, offers no potential foraging or roosting habitat for any bats apart from (primarily) *T.australis*.

Rail Siding

The proposed rail siding is within an area that appears to be poor quality bat habitat (pasture and scattered trees) and offers no potential foraging or roosting habitat for bats.

Borefields

The proposed borefields are within an area that appears to be poor quality bat habitat (primarily pasture) and offers no potential foraging or roosting habitat for bats.

Potential Bat Roosts

As described in the Methods section, automated detector systems were located adjacent to trees in each sampling site that had the greatest potential to provide roost hollows for bats.

No call detection data was collected that would indicate that a bat colony exited at a sampling site.

Potential Impacts Upon Bat Fauna and Mitigation

Potential impacts upon bat fauna associated with the Project include:

- clearance of woody vegetation, particularly shrubs and on some occasions large trees.
- disturbance at watercourses, where the gas and water pipelines would be buried.
- other construction factors such as noise and dust during trench excavation.

The removal of large trees that may contain roosting bats has the potential to impact upon local bat fauna including threatened species. To ameliorate the potential impacts of any vegetation clearance required, it is recommended that during the surveying of the final alignment of the pipelines, any large trees that are expected to be removed (around which the pipelines cannot be re-aligned) be identified with the view to assessing whether any bat colonies are present. Colonies can be identified by call detection and/or dusk observation, or by using drainpipe inspection videography. In the event that colonies are identified, these should be relocated, a strategy that has already proven to be successful for *S.flaviventris* in the outer Brisbane area (L.S. Hall, pers. comm.).

It is recommended that erosion and sediment controls be implemented at pipeline watercourse crossings to minimise potential prey reduction impacts. Given any potential impacts would be localised it would not be expected to significantly reduce local insect prey for bats.

Construction factors such as noise or dust during trench excavation for the pipelines are not considered likely to have a significant impact upon the bat fauna in general, nor upon any hollow-roosting colonies that may be resident nearby during daylight hours, given the temporary nature of the construction.

The evaluation of impacts upon the three threatened species recorded in the subject area is detailed in the following assessments in accordance with Section 5A of the NSW *Environmental Planning and Assessment Act 1979*.

SECTION 5A ASSESSMENTS (Eight Part Tests)

YELLOW-BELLIED SHEATHTAIL BAT *SACCOLAIMUS FLAVIVENTRIS*

Introduction

Very little is known about the biology of this species, though breeding has been studied from museum specimens by Chimimba and Kitchener (1987). The general ecology has been reviewed by Richards (1983a, 1995a) Rhodes and Hall (1997) and Churchill (1998).

This species has never been recorded in caves, and large colonies (around 40 individuals) have been found in tree hollow roosts (L.S. Hall, pers. comm.). It has been hypothesised, based on flight characteristics, that this species may be restricted to roosts in emergent trees because it needs a clear space below the roost to gain flight speed (Richards and Hall 1996, 1998).

S.flaviventris appears to be quite rare on a national scale, especially in southern latitudes. Field surveys by the consultant in the Murwillumbah-Lismore area indicated that a large foraging range may be required, because detector passes were low and it appeared from these data that just a few individuals were making large circuits (Richards, unpublished). During an intensive survey in the Shoalwater Bay Military Training Area in central Queensland, that comprised 9 weeks of field work using 55 sites across two seasons, *S.flaviventris* was patchily distributed and restricted to densely vegetated habitats (Richards 1992, 1993).

This species is listed as Vulnerable in the NSW TSC Act, but is not listed in the draft national Bat Action Plan (Richards and Hall 1996) nor in the edited version (Duncan *et al* 1999) because of its widespread distribution. Dickman (1994) considers that the status of this species is "stable" in western NSW, as does Stephens (1992) for the Murray Mallee area. Lunney *et al* (1995) suspect that the original NSW statewide population has been reduced. Ayers *et al* (1996 and updates) list threats to this species in western NSW as the clearing of old trees with hollows which eliminates roost sites, severe grazing which reduces the regeneration of potential roost trees, and the localised impact of predation by feral cats at roost sites.

Section 5A Assessment (Eight Part Test)

(a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at the risk of extinction.*

In order to assess potential impacts on the life cycle of *S.flaviventris* it is necessary to address the primary components of its ecology, such as breeding, foraging, roosting and movement/migration.

Breeding

Females of this species have the typical pattern of breeding in summer (between December and mid-March), with a single young being weaned by the following early autumn (Chimimba and Kitchener 1987; Churchill 1998).

Foraging

This species can be assumed to forage primarily upon insects that hunted by aerial intercept, which is typical of species with long tapered wings (high aspect ratio) and a high wing loading. This indicates (supported by field observations) that flight is fast, with little manouverability, and given the loud, long-range echolocation call, insects would be captured by interception rather than being pursued.

Roosting

S.flaviventris roosts only in tree hollows, and as mentioned above, these are predicted to be large, located high in a tree, and situated such that there is enough clear space at the exit to allow an unencumbered drop until the bat attains normal flight speed. However, it is likely that there is some flexibility in roost site selection, based on the recent revelation by Churchill (1998) that "Several solitary animals have been found roosting in animal burrows, in cracks in dry clay and under slabs of rock in the Top End" of the Northern Territory. However, this publication also mentions the consultant's record of an individual captured whilst hanging on a wall in broad daylight (Richards 1983a, 1995a), which is now suspected to be an animal in the terminal stages of Lyssavirus infection. At a national level, this species is known to have a high incidence of this rabies-like virus in the population.

Movement/Migration

There is very little information available in relation to movement or migration patterns that this species may exhibit. Richards (1983c, 1995c), as mentioned in the paragraph above, concluded that because some *S.flaviventris* had been caught during the 1980's in situations where they appeared to be exhausted, and in open view of the public, that they may have been undertaking pre-winter migrations. Because a higher than expected number of individuals have been recorded over the last few years to be afflicted with Lyssavirus these individuals observed may not have been exhausted but instead may have been diseased and unable to fly. The "migration" hypothesis therefore needs to be revised.

Summary

Given the high potential for successful roost relocation, it is considered unlikely that the proposed development would have an effect upon the viability of the local population if pre-trenching surveys for roost sites are conducted.

(b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

See discussion above with respect to threats to this species at a local level.

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed*.

Considering that this species requires an extensive foraging range (Richards, unpublished) the narrow sections of habitat in the pipeline and roadwork corridors may merely be a small proportion of the area required for a few individuals. It is highly likely that in the subject area, this species forages along watercourse vegetation strips, or along corridors of high quality habitat. Because very little habitat will be removed, it is considered that no significant area of known habitat will be lost as a result of the Project.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population, or ecological community.*

As shown in the analysis of habitat quality and distribution, the corridors currently comprise a mosaic of habitat patches, many of which have already become isolated by past agricultural practices. Given pipeline construction and roadworks will require a relatively small amount of clearing, no areas of habitat will become isolated by the Project to the extent that they could not be accessed by such a wide-ranging species such as *S.flaviventris.*

(e) *Whether critical habitat will be affected*

Not applicable as it is understood that no critical habitat in the area has been identified and gazetted by the NSW Scientific Committee at the time of writing.

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.*

In NSW, *S.flaviventris* is known from Barakee, Blue Mountains, Botany Bay, Broadwater, Bundjalung, Bungawalbin, Cathedral Rock, Cottan Bimbang, Eurobodalla, Fortis Creek, Goonengerry, Gundabooka, Jervis Bay, Kinchega, Mount Pikapene, Mutawintji, Nightcap, Nowendoc, Seven Mile Beach, South East Forest, Sturt, Tapin Tops and Yuragir National Parks; Banyabba, Demon, Ironbark, Macquarie Marshes, Nocoleche, The Glen, Tuckean, Wambina and Yathong Nature Reserves; and Amaroo Forest Reserve.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The narrow corridor required for the gas and water pipelines and road upgrades and the construction of a narrow trench within the pipeline corridors are not considered to be processes that would significantly impact *S.flaviventris*, given the recommended amelioration of roost sites.

(h) *Whether any threatened species, population, or ecological community is at the limit of its known distribution.*

As mentioned above, the Project area is well within the widespread distribution of this species.

LITTLE PIED BAT, *CHALINOLOBUS PICATUS*

Introduction

The little that is known of the biology of *C.picatus* has been contributed by Richards (1979), and the species has been reviewed by Richards (1983b, 1995b) and Churchill (1998). It was originally considered to only require caves or their substitutes for roosting, but has also been found in buildings (Hall and Richards 1979), and has been radio-tracked to tree hollow roosts (Churchill 1998). Richards (1979) reported on a large breeding colony, numbering approximately 40, behind an open sliding door in an old building at Yathong Nature Reserve.

Apart from being very patchily distributed, *C.picatus* is also considered to be quite rare. As well as being listed as Vulnerable in the NSW Threatened Species Conservation Act, it is also listed in the IUCN category 'Lower Risk - near threatened' in the draft national Bat Action Plan (Richards and Hall 1996) and in the edited version (Duncan *et al* 1999). Dickman (1994) considers that the status of this species is "stable" in western NSW, as does Stephens (1992) for the Murray Mallee area. Ayers *et al* (1996 and updates) list threats to this species in western NSW as the clearing of hollow forming trees which may eliminate the species from woodlands. These authors also noted that although predation at roost sites by feral cats may have localised impacts, this factor "has yet to be quantified".

Section 5A Assessment (Eight Part Test)

(a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at the risk of extinction.*

In order to assess potential impacts on the life cycle of *C.picatus* it is necessary to address the primary components of its ecology, such as breeding, foraging, roosting and movement/migration.

Breeding

Females of this species give birth during November (Churchill 1998) and probably also early December, as do sibling species. Females "normally bear two young in the summer" (Richards 1983b, 1995b). Very little else is known about the breeding biology of this species.

Foraging

This species can be assumed to forage primarily upon insects that hunted by aerial pursuit, which is indicated by morphological characters that reflect this type of hunting, such as its wing aspect ratio and wing loading. Churchill (1998) states that "a single stomach content examination revealed only moths".

Roosting

As mentioned above, *C.picatus* appears to be flexible in roost site selection, ranging from caves, disused mineshafts, tree hollows, and abandoned buildings. There are no known caves in the subject area (Matthews 1985).

Movement/Migration

There is no information available in relation to movement or migration patterns of this species. Females of a sibling species, *C.dwyeri*, separate from most of the males in a regional population during the summer breeding season, and by the following autumn the breeding colony disperses (Dwyer 1966). The breeding biology of *C.picatus* may be similar.

Summary

Although there is little known about the ecology of *C.picatus*, it is likely that the development would have a minimal effect upon the viability of the immediate local population, if the recommended roost site amelioration measures are implemented.

(b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

See discussion above with respect to threats to this species at a local level.

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

C.picatus was recorded from a number of high quality habitat types in the subject area, including scattered trees and high tree density roadside vegetation, both with a high shrub density and an absence of water, the large tract of undisturbed forest, and at rivers or waterholes with moderate to high tree density. However, given pipelines are to be situated for the majority of their length within cleared areas of the road reserves, it is considered that no significant area of known habitat will be removed by the proposed Project.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population, or ecological community.*

The analysis of habitat quality and distribution indicates the corridors currently comprise a mosaic of habitat patches, many of which have already become isolated by past agricultural practices. Given the nature of the Project, it is considered unlikely that areas of habitat will become isolated by the Project to the extent that they could not be accessed by a species with the flight characteristics and commuting ability as *C.picatus.*

(e) *Whether critical habitat will be affected*

It is understood that no critical habitat in the area has been identified and gazetted by the NSW Scientific Committee at the time of writing.

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.*

In New South Wales there are records of *C.picatus* from Culgoa, Gundabooka, Kinchega, Mallee Cliffs, Mungo, Mutawintji and Willandra National Parks, as well as Booroolong, Buddigower, Nocoleche, Tarawi and Yathong Nature Reserves. The type locality is Depot Glen, near Milparinka, which is within Sturt National Park. One would suspect, given the broad distribution of this species in western NSW, that it would also occur in the remainder of the reserve network in this region.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The vegetation clearance required for gas and water pipelines and roadworks, and the construction of a narrow trench within the pipeline corridors, is not considered to be a process that would severely impact *C.picatus*, if the proposed impact amelioration strategy is implemented.

(h) *Whether any threatened species, population, or ecological community is at the limit of its known distribution.*

The Project area is well within the known distribution of this species, which in NSW is primarily the Western Division and the Murray-Darling Basin.

GREATER LONGEARED BAT, *NYCTOPHILUS TIMORIENSIS*

Introduction

The little that is known of the biology of *N.timoriensis* is included in publications by Richards (1983c), Lumsden (1994) and Parnaby (1995). The latter author has unpublished taxonomic evidence (Parnaby 1988) to show that, although in earlier publications it was considered to be distributed over southern Australia, this taxon is in fact a complex of three morphologically distinct forms. One of these, dealt with below, is basically distributed throughout the Murray-Darling Basin.

Apart from being very patchily distributed, *N.timoriensis* is also considered to be quite rare, as exemplified by the studies of Lumsden *et al* (1995), during which only one individual was recorded in a total of 1556 captures of bats in rural Victoria. However, as more bat surveys are conducted in NSW with refined techniques, more records are coming to light. As well as being listed as Vulnerable in the NSW Threatened Species Conservation Act, it is also listed in the IUCN category ‘Vulnerable’ in the draft national Bat Action Plan (Richards and Hall 1996) and the edited version (Duncan *et al* 1999).

Dickman (1994) considered that the status of this species is "stable" in western NSW. However, Stephens (1992) reported that *N.timoriensis* was “a species of serious concern" in the Murray Mallee area. Conversely, Lumsden *et al* (1995) in reference to this and other rural species proposed that "… the ability of bats to fly, their spatial scale of movement and their social organisation (e.g. their overlapping foraging areas, colonial roosting habits, interspecific tolerance) are key factors that enable these species to live successfully within the farmland environment and that have prevented regional extinctions". However, based on the collection of only one record in the subject area, it is difficult to agree that this statement would apply to *N.timoriensis* in central NSW with its high level of cropping.

Ayers *et al* (1996 and updates) list threats to this species in western NSW as the clearing which eliminates roosting habitat if old trees are removed, grazing which can result in poor regeneration of hollow-producing trees (therefore affecting the long-term survival of this species), and predation by feral cats whilst these bats are roosting.

However, it should be noted that once the single location where *N.timoriensis* was recorded was identified, will not be disturbed by the proposed development (refer Figure 5).

Section 5A Assessment (Eight Part Test)

(a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at the risk of extinction.*

In order to assess potential impacts on the life cycle of *N.timoriensis* it is necessary to address the primary components of its ecology, such as breeding, foraging, roosting and movement/migration.

Breeding

Richards (1983c), Lumsden and Bennett (1995), Parnaby (1995) and Churchill (1998) indicate that this species generally bears twin young in late spring and early summer. Lactation is usually completed by the following February. Very little else is known about the breeding biology of this species.

Foraging

This species can be assumed to forage primarily upon insects that gleaned from vegetation, as shown by morphological characters that indicate this type of hunting, especially low aspect ratio wings and large ears used for locating the sounds of insect calls (Hosken *et al* 1994). Churchill (1998) considers that this species may also spend some time hunting on the ground "as they have been captured in pitfall traps".

Roosting

N.timoriensis have been found roosting in tree hollows, deep fissures and cracks in branches, and under sheets of dry bark on dead trees.

Movement/Migration

There is no information available in relation to movement or migration patterns of this species, but it is highly likely that populations are localised.

Summary

Although there is little known about the ecology of *N.timoriensis*, it is considered unlikely given the proposed amelioration measures, that the development would have a significant impact upon this species.

(b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

See discussion above with respect to threats to this species at a local level.

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

N.timoriensis was recorded from one site in a large tract of undisturbed forest, in the vicinity of the gas pipeline route, which will not be disturbed by the proposed development. The Project is not considered likely to have a significant impact on known habitat, given the habitats are widely distributed throughout the region.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population, or ecological community.*

Given the nature of the Project, no areas of habitat will become isolated to the extent that they could not be accessed by mobile species such as *N.timoriensis.*

However, it is notable that no records of this species were collected from habitat patches other than the undisturbed forest, which may indicate the species may already have suffered from fragmentation and isolation of habitat.

(e) *Whether critical habitat will be affected*

It is understood that no critical habitat in the area has been identified and gazetted by the NSW Scientific Committee at the time of writing.

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.*

In New South Wales there are records of *N.timoriensis* from Ben Halls Gap, Cocoparra, Goobang, Goulburn River, Kosciusko, Mallee Cliffs, Mungo, Nangar, and Warrumbungle National Parks; as well as Buddigower, Monabalai, Pilliga, The Rock, Tollingo, Woggon and Yathong Nature Reserves, and Wallagaraugh Forest Reserve.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The narrow corridor required for the gas and water pipelines and road upgrades, and the construction of a narrow trench within it, is not considered to be a process that would significantly impact *N.timoriensis*, given the proposed amelioration measures of relocating roost sites identified within disturbance areas (including dead trees with dry bark attached).

(h) *Whether any threatened species, population, or ecological community is at the limit of its known distribution.*

The Project area is well within the known distribution of this species, which in NSW is primarily the Murray-Darling Basin.

CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that there will be no significant impacts upon the foraging habitat on the local bat fauna, particularly threatened species, given the gas and water pipelines are to be situated within the cleared section of the road reserves for the majority of their lengths.

The Project has the potential to impact upon bat fauna through the removal of large trees. If the removal of any large trees cannot be avoided it is recommended they be inspected to ascertain if they contain bat colonies, particularly any threatened species, and any colonies found be relocated (particularly those found in hollow branches).

The Section 5A assessments for each threatened species concluded, that the Project is not considered likely to have a significant impact on threatened bat fauna.

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