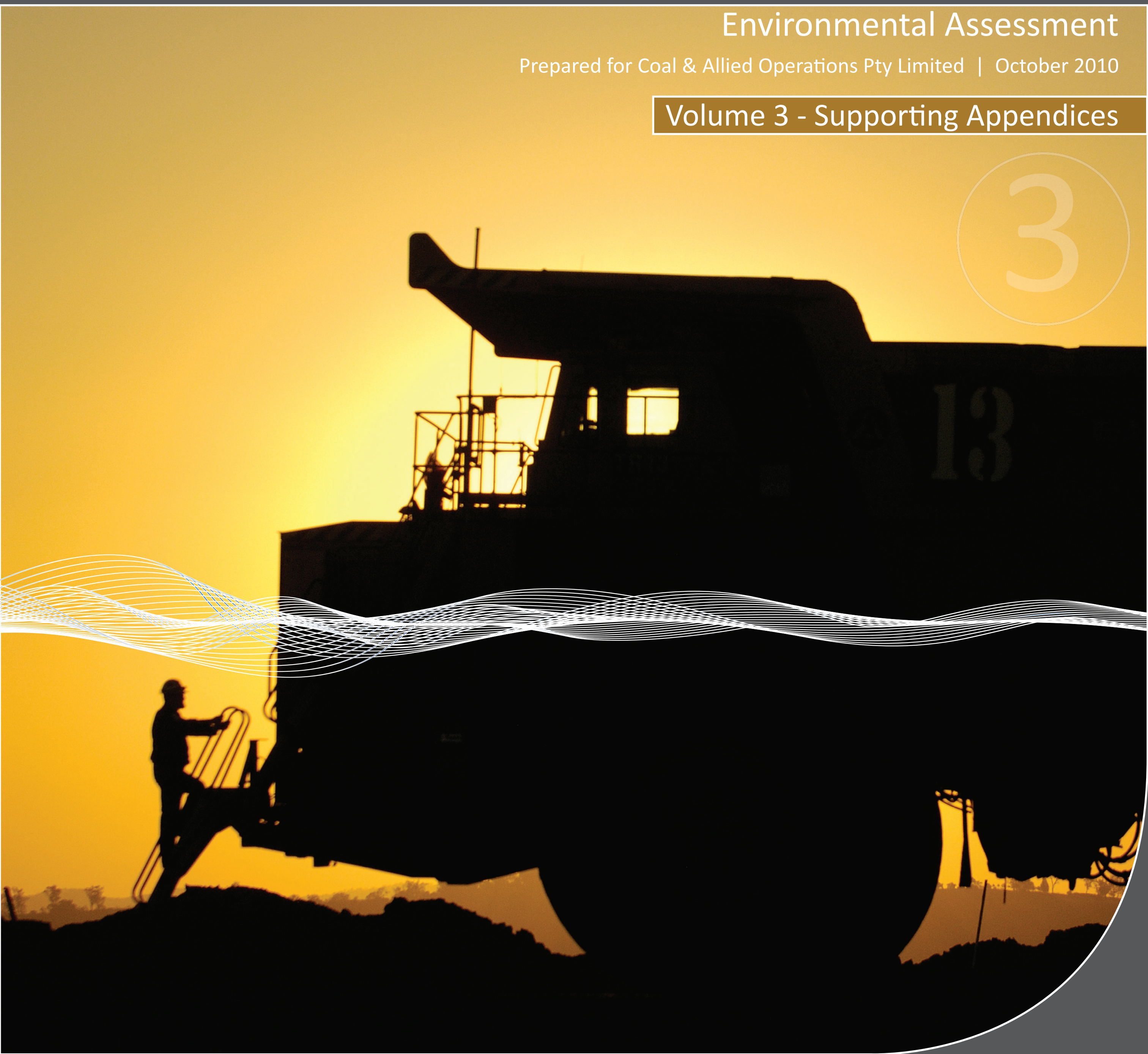
CARRINGTON WEST WING

Environmental Assessment

Prepared for Coal & Allied Operations Pty Limited | October 2010

Volume 3 - Supporting Appendices

3



COAL & ALLIED

Managed by Rio Tinto Coal Australia

3
Appendices

Appendix G - Air quality study

Appendix H - Aboriginal cultural heritage study

Appendix I - Ecology study

www.coalandallied.com.au

Appendix G

Air quality study

www.coalandallied.com.au

AIR QUALITY IMPACT ASSESSMENT

CARRINGTON WEST WING

EMGA Mitchell McLennan

Job No: 3412

24 August 2010

A PEL Company

PROJECT TITLE:	**CARRINGTON WEST WING**
JOB NUMBER:	**3412**
PREPARED FOR:	Luke Stewart **EMGA MITCHELL MCLENNAN**
WRITTEN BY:	Jane Barnett and Phil Henschke
DISCLAIMER & COPYRIGHT:	This report is subject to the copyright statement located at www.paeholmes.com © PAEHolmes a Division of Queensland Environment Pty Ltd ABN 86 127 101 642

DOCUMENT CONTROL

VERSION	DATE	AUTHOR/S	MODELLING	GREENHOUSE	REVIEWED BY
Working Draft V1	23.12.09	J Barnett P Henschke	J Barnett P Henschke	P Henschke	J Cox
Final Draft V2	24.03.10	J Barnett P Henschke	J Barnett P Henschke	P Henschke	J Cox
Final Draft V3	06.05.10	J Barnett P Henschke	J Barnett P Henschke	P Henschke	J Cox
Final Draft V4	26.05.10	J Barnett P Henschke	J Barnett P Henschke	P Henschke	J Cox
Final	16.06.10	J Barnett P Henschke	J Barnett P Henschke	P Henschke	J Cox
Final V1	25.08.10	J Barnett P Henschke	J Barnett P Henschke	R Kellaghan	J Cox

PAEHolmes a Division of Queensland Environment Pty Ltd
ABN 86 127 101 642

SYDNEY:
Suite 2B, 14 Glen Street
Eastwood NSW 2122
Ph: +61 2 9874 8644
Fax: +61 2 9874 8904

BRISBANE:
Level 1, La Melba, 59 Melbourne Street South Brisbane Qld 4101
PO Box 3306 South Brisbane Qld 4101
Ph: +61 7 3004 6400
Fax: +61 7 3844 5858

Email: info@paeholmes.com

Website: www.paeholmes.com

EXECUTIVE SUMMARY

This report has been prepared by PAEHolmes on behalf of EMGA Mitchell McLennan Pty Limited (EMGA MM) for Coal & Allied Operations Pty Limited (Coal & Allied). The proposal is referred to as the Carrington West Wing proposal which for the purposes of modelling includes all operations at HVO North. This report assesses the potential for impact on air quality as a consequence of the proposal.

A detailed modelling assessment has been undertaken for Year 1 and 5 of the proposal which represent worst case scenarios with regard to air quality.

Predictions of air quality impacts considered the effects of surrounding mines as well as other non-mining sources of dust. Model predictions at privately owned residential receptors were compared with applicable air quality criteria. Predictions equal to or below these criteria indicate an acceptable air quality impact.

Analysis of the dispersion modelling results indicated that the proposal would exceed the 24-hour average PM_{10} DECCW criteria at a single residential receptor. Further analysis, however, showed that the DoP acquisition criterion was not predicted to be exceeded at that receptor.

HVO North will take steps to mitigate and manage potential dust impacts associated with the proposal through a range of controls and continued monitoring of air quality in the area surrounding the mine.

The main source of greenhouse gas emissions identified from the proposal would be: the end use of the coal, fugitive emissions, diesel, electricity and explosives use, and transport of coal. The average annual estimated emissions generated from the proposal are 0.65 Mt of carbon dioxide equivalent [CO_2-e]. Expressed as a proportion of the global CO_2-e atmospheric load [3,000 Gt], the proposal would contribute 0.0002% annually. The proposal itself would therefore have no noticeable effect on global warming.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

This report has been prepared by PAEHolmes on behalf of EMGA Mitchell McLennan Pty Limited (EMGA MM) for Coal & Allied Operations Pty Limited (Coal & Allied). Coal & Allied owns the Hunter Valley Operations (HVO) mining complex located in the Hunter Valley, New South Wales (NSW). The mining and processing activities at HVO are geographically divided by the Hunter River into HVO north of the Hunter River (HVO North) and HVO south of the Hunter River (HVO South).

The operations at HVO North comprise the Carrington and West Pits. Carrington Pit is a truck and shovel operation, approved to mine 10 million tonnes per annum (mtpa) of run of mine coal (ROM). The pit is well developed with significant areas of rehabilitation established. Planning Approval for Carrington Pit was obtained in August 2000, and in 2004 the Carrington Mine Planning Approval was integrated into the West Pit Extension and Minor Modifications consent (Development Consent No. DA 450-10-2003). An opportunity has been identified to extend mining operations in the Carrington Pit to the south west, requiring a modification to Development Consent No. DA 450-10-2003. The proposal is referred to as the Carrington West Wing proposal. This report assesses the potential for impact on air quality as a consequence of the proposal, which for the purposes of modelling includes all operations at HVO North

1.1 Scope of Work

This report provides information on the following:

- relevant air quality goals;
- meteorological and climatic conditions in the area;
- a discussion of the existing air quality conditions in the area;
- the methods used to estimate dust emissions from the proposal;
- the predicted dispersion and dust fallout patterns due to emissions from the proposal and a comparison with the Department of Environment, Climate Change and Water (DECCW) assessment criteria and the Department of Planning (DoP) acquisition criteria;
- greenhouse gas assessment; and
- mitigation and monitoring.

2 PROJECT DESCRIPTION

2.1 Pit Extension Area

The location of the proposed pit extension area and surrounding mines is shown in **Figure 2.1**. This figure also shows the current dust monitoring network in the area, the locations of the nearest receptors and Coal & Allied's two weather stations, located at HVO North and HVO South.

The proposed pit extension area is typically rural grassland. There is a significant terrain feature, or ridgeline, immediately west of the proposed pit extension area, between the project area and the township of Jerrys Plains. **Figure 2.2** presents a pseudo 3-dimensional terrain plot of the project area and surrounds, including the active pits at other mine sites.

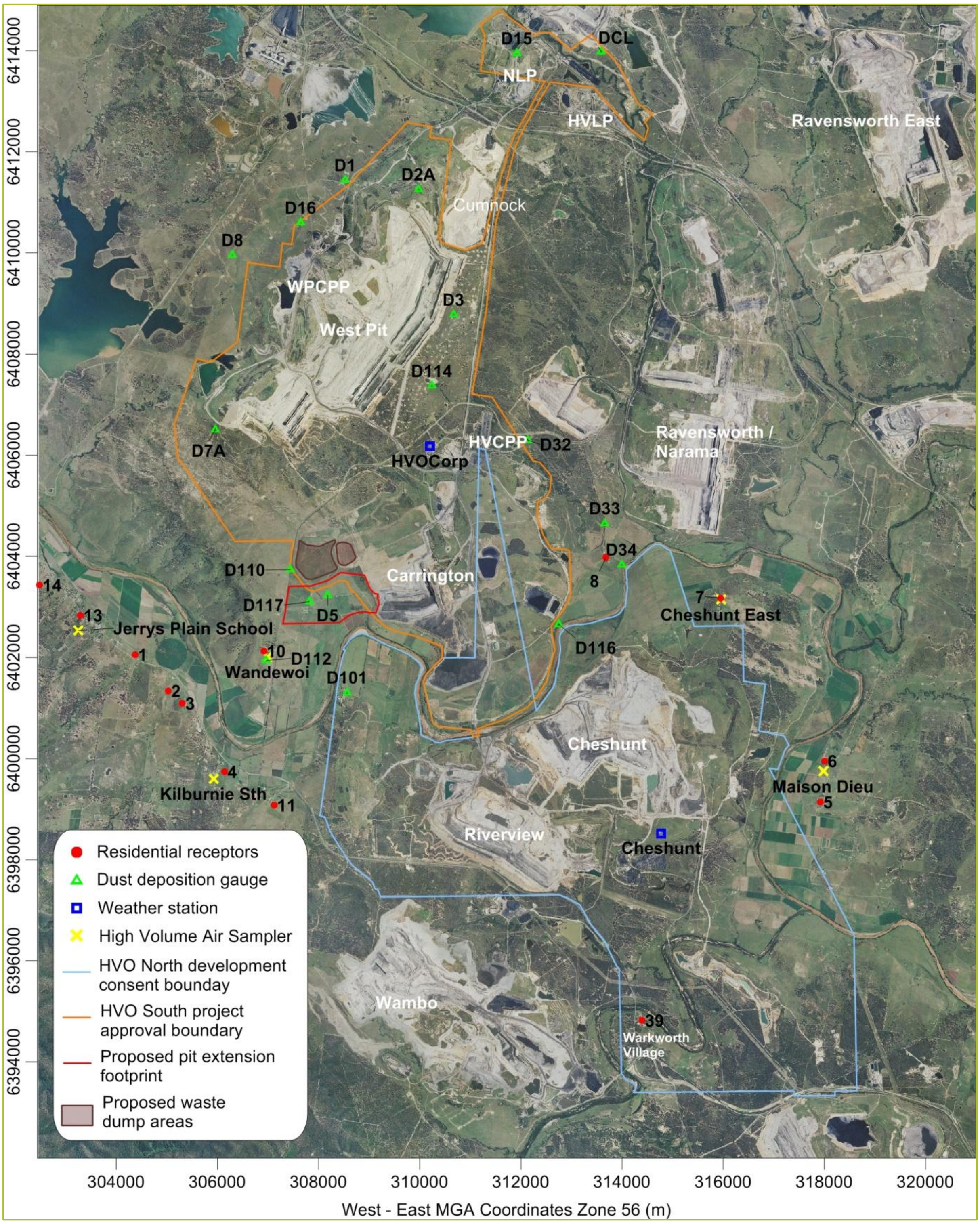


Figure 2.1: Location of the project area and surrounding landuse

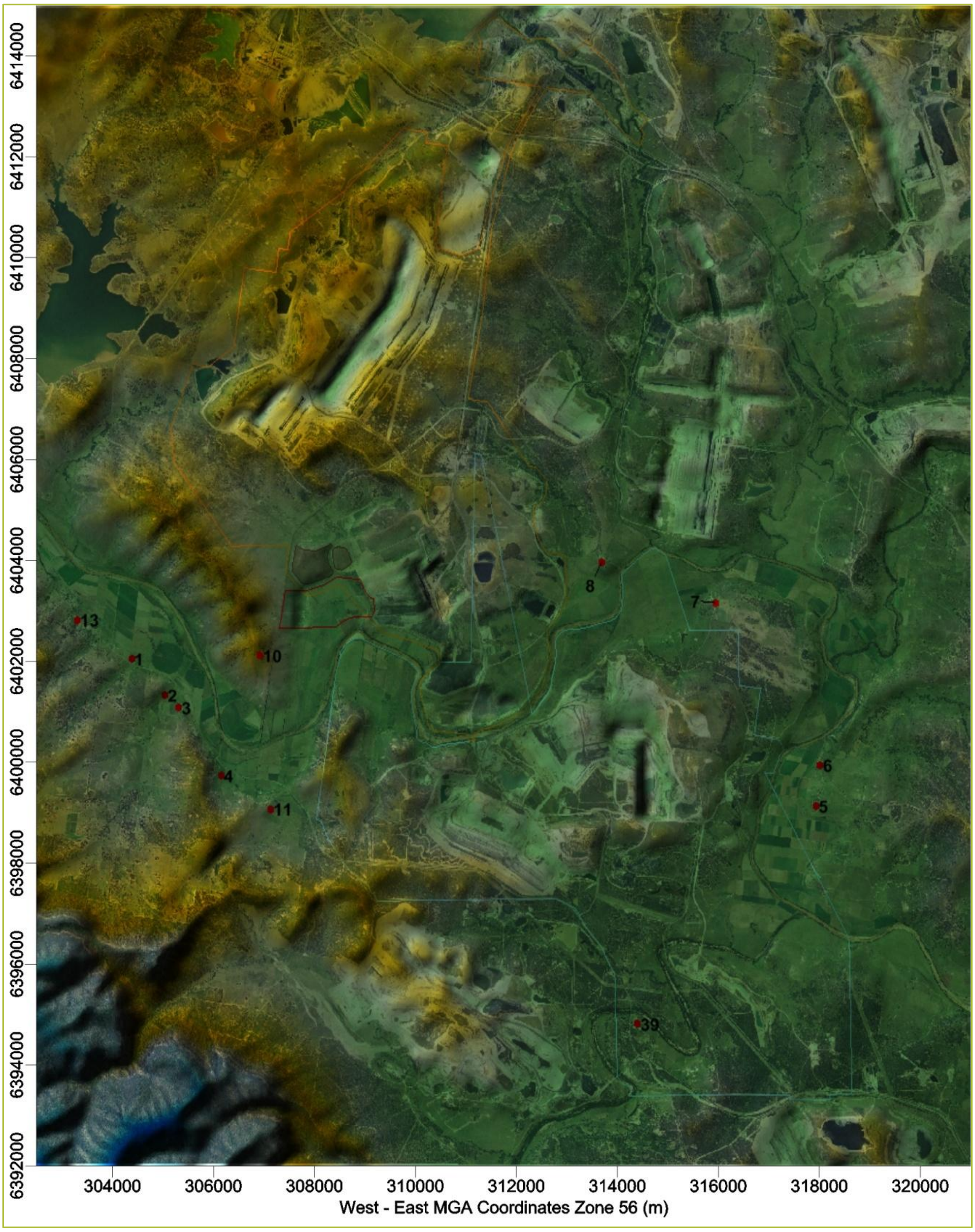


Figure 2.2: Pseudo 3D-plot of terrain surrounding project area

2.2 Proposed Development

The proposed pit extension area comprises a surface area of approximately 137 hectares (ha) and is predominantly cleared of native vegetation. The extension will allow for the extraction of approximately 17 million tonnes of in-situ coal from the Broonie, Bayswater and Vaux seams.

The proposed extension will have a life of approximately six years. Mining will be completed within the existing development consent period, which is currently approved to 2025.

As part of the proposal, two out-of-pit overburden emplacement areas are proposed to be established on rehabilitated land immediately north of the proposed pit extension area, in addition to in-pit disposal. For the purposes of this environmental assessment, references to overburden generally include both overburden and interburden.

Supplementary activities proposed to support the extension include the following.

- The approved footprint of the Carrington Pit evaporative sink is proposed to be extended for long term management of groundwater post-mining;
- The impermeable groundwater barrier wall previously assessed for the western paleochannel will be realigned further south to prevent groundwater migration from the Hunter River into the mine, and migration of water from the mine into the Hunter River alluvium;
- A two stage, temporary levee and diversion system will be established to ensure that the proposed pit extension area is protected from flooding and to enable the diversion of an unnamed tributary of the Hunter River that presently runs in a southerly direction across the footprint of the extension; and
- A service corridor will be constructed along the southern boundary of the proposed pit extension area. This may incorporate water pipelines, an all weather access road, mining equipment, substations and other services.

The proposal will not result in a change to the mining extraction rates, the life of mine, mining methods, mining equipment, employment, processing or mine services, product transport, operating hours or environmental management systems. The project area is entirely on land owned by Coal & Allied.

3 AIR QUALITY CRITERIA

Extraction of coal by open-cut mining requires the clearing of land and excavation of overburden material to recover the coal by heavy earthmoving equipment. These operations generate fugitive dust emissions in the form of particulate matter described as total suspended particulate matter (TSP)[a], particulate matter with equivalent aerodynamic diameters 10 µm or less (PM_{10})[b] and 2.5 µm and less ($PM_{2.5}$). In addition, combustion engines from vehicles and machinery release emissions through exhausts including carbon monoxide (CO) and minor quantities of sulfur dioxide (SO_2) and nitrogen dioxide (NO_2). In practice, emissions of CO, SO_2 and NO_2 from open-cut mines are too small and too widely dispersed to give rise to significant off-site concentrations. For this reason these pollutants are not considered further in this report.

This section provides information on the air quality criteria used to assess the impact of particulate matter emissions. The assessment criteria provide benchmarks, which if met, are intended to protect the community against the adverse effects of air pollutants. These criteria are generally considered to reflect current Australian community standards for the protection of health and protection against nuisance effects.

3.1 Particulate Matter

3.1.1 Introduction

For the reasons discussed above, the focus of this study is on the potential effects of particulate matter emissions. Particulate matter has the capacity to affect health and to cause nuisance effects.

Particulate matter can be categorised by size and/or by chemical composition. The potential for harmful effects depend on both.

The human respiratory system has in-built defensive systems that prevent particles larger than approximately 10 µm from reaching the more sensitive parts of the respiratory system. Particles with aerodynamic diameters less than 10 µm are referred to as PM_{10}. Particles larger than 10 µm, while not able to affect health, can dirty the materials they land on and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particulate matter suspended in the air. This is referred to as TSP. In practice, particles larger than 30 to 50 µm settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 µm and TSP includes PM_{10}.

[a] TSP refers to all particles suspended in the air. In practice, the upper size range is typically 30 to 50 µm.

[b] PM_{10} refers to all particles with the equivalent aerodynamic diameters of less than 10µm, that is, all particles that behave aerodynamically in the same way as spherical particles with a unit density.

3.1.2 DECCW Criteria

The health-based assessment criteria used by DECCW have, to a large extent, been developed by reference to epidemiological studies undertaken in urban areas with large populations where the primary pollutants are the products of combustion. This means that, in contrast to dust of crustal[c] origin, such as that generated by open-cut mining operations, the particulate matter from urban areas would be composed of smaller particles and would generally contain acidic and carcinogenic substances that are associated with combustion.

Table 3.1 summarises the air quality goals for concentrations of particulate matter that are relevant to this study. The air quality goals for TSP and annual average PM_{10} relate to the total dust burden in the air and not just the dust from the proposal. In other words, consideration of background dust levels needs to be made when using these goals to assess potential impacts. This is discussed further in **Section 6.3**.

The 24-hour average PM_{10} dust burden from the proposal alone is applied by government to assess the potential for adverse impacts.

Table 3.1: DECCW air quality standards / goals for particulate matter concentrations

Pollutant	Averaging period	Standard / Goal	Agency
Total suspended particulate matter (TSP)	Annual mean	90 $\mu g/m^3$	• National Health and Medical Research Council (NHMRC)
Particulate matter with an equivalent aerodynamic diameter less than 10 µm (PM10)	24-hour maximum	50 $\mu g/m^3$	• NSW DECCW impact assessment criteria • National Environmental Protection Measure (NEPM) reporting goal, allows five exceedences per year
	Annual mean	30 $\mu g/m^3$	• NSW DECCW impact assessment criteria

Notes: $\mu g/m^3$ – micrograms per cubic metre, µm – micrometre

3.1.3 Department of Planning Acquisition Criterion for PM_{10}

While the DECCW applies the maximum 24-hour average PM_{10} level in any year to assess the potential for impacts from the proposal, the DoP in contemporary project approvals has invoked requirements for acquisition, negotiated agreements and the like if the DECCW criterion is exceeded on more than 5 days in any year (a 98.6 percentile level of compliance). Acquisition is also typically required when the DECCW annual average PM_{10} criterion is exceeded. A summary of the DoP acquisition criterion are outlined in **Table 3.2**.

Table 3.2: DoP acquisition criterion for PM_{10}

Pollutant	Averaging period	Criterion	Condition
Particulate matter (PM_{10})	24-hour maximum	50 $\mu g/m^3$	Allows five exceedences per year
	Annual mean	30 $\mu g/m^3$	-

Notes: $\mu g/m^3$ – micrograms per cubic metre, µm – micrometre

[c] The term crustal dust is used to refer to dust generated from materials that constitute the earth's crust, such as topsoil, overburden and coal.

3.1.4 Further Comments

In May 2003, the National Environment Protection Council (NEPC) released a variation to the NEPM (**NEPC, 2003**) to include advisory reporting standards for $PM_{2.5}$. The advisory reporting standards for $PM_{2.5}$ are a maximum 24-hour average of 25 µg/m³ and an annual average of 8 µg/m³, however, there is no time line for compliance. The objective was to gather sufficient data nationally to facilitate the review of the Air Quality NEPM which commenced in 2005. The variation includes a protocol setting out monitoring and reporting requirements for particles as $PM_{2.5}$. At this stage, the advisory reporting $PM_{2.5}$ standards are not part of the NSW DECCW assessment criteria. Accordingly, while predictions have been made as to the likely contribution that emissions from HVO North would make to ambient $PM_{2.5}$ concentrations, these predictions have not been assessed against the proposed advisory standard. Predictions of $PM_{2.5}$ concentrations are provided in **Appendix A**.

3.2 Dust Deposition

In addition to potential health impacts, airborne dust has the potential to cause nuisance effects by depositing on surfaces and possibly vegetation/crops. **Table 3.3** shows the maximum acceptable increase in dust deposition over the existing levels and the maximum total dust deposition levels, from an amenity perspective. These criteria for dust fallout levels are set to protect against nuisance impacts (**DEC, 2005**).

Table 3.3: DECCW criteria for dust (insoluble solids) fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

4 EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing air quality in the area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment requires information about the air dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[d] and mixing height[e].

The DECCW has listed requirements for meteorological data that are used for air dispersion modelling in its *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**DEC, 2005**). The requirements are as follows:

- data must span at least one year;

[d] In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme, as used in this study, there are six stability classes A through to F.

[e] The term mixing height refers to the height of the turbulent layer of air near the earth's surface into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

- data must be at least 90% complete; and
- data must be representative of the area in which emissions are modelled.

Coal & Allied operates a weather station within the HVO North development consent boundary at the location shown in **Figure 2.1**. It records 10-minute values of wind speed, wind direction and sigma-theta (a measure of the fluctuation of the horizontal wind direction). These data have been used in this assessment. However, no information for temperature has been collected at the HVO North weather station since October 2006. Consequently, hourly temperature data from the HVO South weather station at Cheshunt, (shown in **Figure 2.1**) were used in this assessment.

Data from February 2006 to January 2007 (inclusive) were used for this assessment. These data contain all the necessary parameters required to determine stability class and were processed into a file containing hourly averages, suitable for the dispersion model. There were 8,544 hourly records available which satisfies the DECCW's requirement of 90% data recovery in the year (8,760 hours represents 100 per cent of one year). Annual and seasonal windroses have been prepared from these data and are shown in **Figure 4.1**.

The windroses in **Figure 4.1** show that the most common winds in the area are from the west-northwest and southeast. This pattern of winds is evident in autumn and spring to various degrees. Very few winds blow from the southwest or northeast due to the channelling effects of the surrounding terrain. Winds during the summer are predominantly from the southeast and east-southeast, with very few winds originating from the northwestern quadrant. In winter this pattern is reversed. The percentage of calms throughout the year (that is, winds less than or equal to 0.5 m/s) is measured to be less than 4% of the time. The mean wind speed from the 2006/2007 data was 3.14 m/s.

To use these wind data to assess dispersion, it is also necessary to have data available on atmospheric stability. The term atmospheric stability refers to the dispersive capacity of the atmosphere. In this study, a classification scheme referred to as the Pasquill-Gifford scheme has been used, using sigma-theta, according to the method recommended by the United States Environment Protection Authority (US EPA) (**US EPA, 1986**).

The Pasquill-Gifford scheme classifies the atmosphere into six (sometimes seven) classes, A to F (or G in the extended scheme);

- Class A occurs in the day with light winds, strong solar radiation and strong convection; dispersion is rapid.
- Class D, also known as "neutral conditions" occurs with moderate to strong winds and/or overcast skies; again dispersion is rapid.
- Class F (and G) occurs under light winds with clear skies at night. These conditions are conducive to the formation of ground-based inversions; dispersion is slow.
- Classes B and C are intermediate between A and D, and E is intermediate between D and F.

Table 4.1 shows the frequency of occurrence of the stability classes expected in the area, using the HVO North data. The most common stability class in the area was determined to be D class at 56%. Under these conditions, emissions disperse rapidly. Joint wind speed, wind direction and stability class frequency tables for the HVO North data are provided in **Appendix B**.

Table 4.1: Frequency of occurrence of stability classes at HVO North

Stability Class	Percentage occurrence (%)
A	7.2
B	4.2
C	15.5
D	56.0
E	12.7
F	4.5
Total	**100**

Mixing height was determined using a scheme defined by **Powell** (**1976**) for day-time conditions and an approach described by **Venkatram**, (**1980**) for night-time conditions. These two methods provide a good estimate of mixing height in the absence of upper air data. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

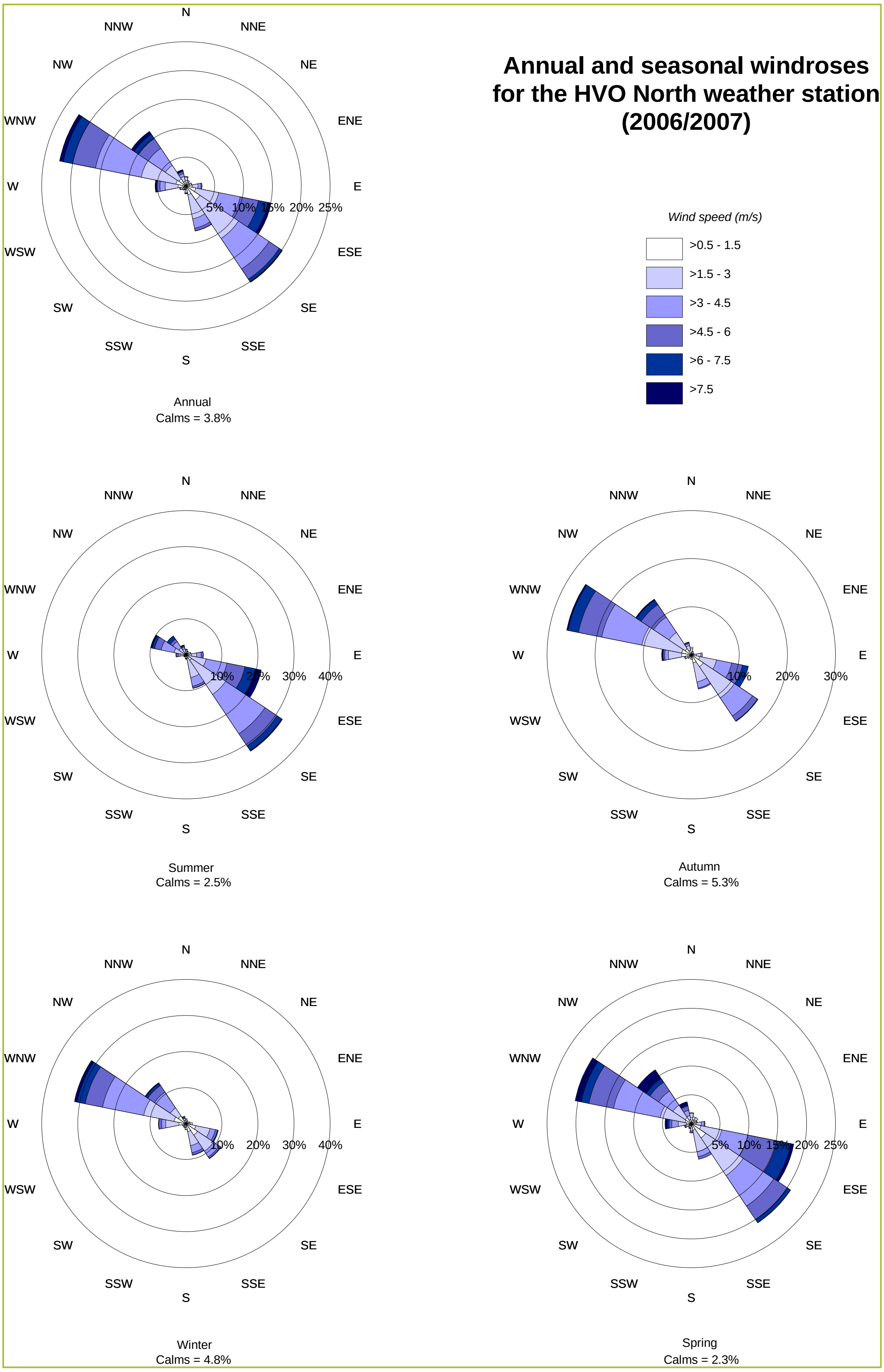


Figure 4.1: Annual and seasonal windroses for the HVO North weather station in 2006/2007

4.2 Climate Data

Temperature and humidity data for the local area, Jerrys Plains, are presented in **Table 4.2**. These data were obtained from the Bureau of Meteorology's weather station operated at the Jerrys Plains Post Office, which has collected data since 1884 and thus provides a useful historical record over the longer term.

These data show that January is the warmest month experiencing a mean monthly maximum temperature of 31.7°C. July is the coolest month experiencing a mean monthly minimum temperature of 3.8°C.

Annual average relative humidity at 9 am is 69%. Annual average 3 pm humidity is 47%. Mean annual rainfall is 641.7 mm. January is the wettest month with an average rainfall of 76.9 mm and August is the month with lowest average rainfall (36.4 mm).

Table 4.2: Temperature, humidity and rainfall data for Jerrys Plains Post Office

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Daily Maximum Temperature (°C)													
Mean	31.7	30.9	28.9	25.3	21.3	18.0	17.4	19.4	22.9	26.3	29.1	31.3	25.2
Daily Minimum Temperature (°C)													
Mean	17.1	17.1	15.0	10.9	7.5	5.3	3.8	4.4	7.0	10.3	13.1	15.7	10.6
9 am Relative Humidity (%)													
Mean	67	72	72	72	77	80	78	71	64	59	60	61	69
3 pm Relative Humidity (%)													
Mean	46	50	49	49	52	54	51	45	42	42	42	42	47
Rainfall (mm)													
Mean	76.9	72.5	59.1	44.1	40.4	47.6	43.3	36.4	41.7	52.2	59.9	67.6	641.7

Station number 061086; Commenced: 1884, Last record: 2009
Latitude (deg S): - 32.5; Longitude (deg E): 150.9; Elevation: 90 m

Source: Bureau of Meteorology (2009)

4.3 Existing Air Quality

The introduction to **Section 3** indicated that the relevant air quality parameters for this assessment are particulate matter emissions. This section provides an overview of the existing, or background, dust levels in the area based on data drawn from the monitoring network shown in **Figure 2.1**, which provide measurements of 24-hour average concentrations of TSP and PM_{10} on a six-day cycle and monthly averages of dust fallout levels.

4.3.1 Particulate Matter Concentrations

Twenty-four hour average concentrations of TSP and PM_{10} (on a six-day cycle) have been measured over various periods at five High Volume Air Samplers (HVAS) monitoring sites in the area; Jerrys Plains School, Kilburnie South, Wandewoi, Cheshunt East and Maison Dieu. The available data are summarised below:

- Jerrys Plains School PM_{10} – February 2005 to May 2009
- Kilburnie South PM_{10} – January 2005 to May 2009
- Wandewoi PM_{10} – January 2005 to May 2009
- Cheshunt East PM_{10} – April 2006 to May 2009
- Maison Dieu PM_{10} – January 2006 to May 2009
- Jerrys Plains School TSP – April 2005 to May 2009
- Kilburnie South TSP – February 2005 to May 2009
- Wandewoi TSP – January 2004 to May 2009
- Cheshunt East TSP – August 2008 to May 2009
- Maison Dieu TSP – January 2006 to May 2009

The results for both PM_{10} and TSP measurements are shown in **Figure 4.2** and **Figure 4.3**, respectively. These graphs show a data point for each 24-hour average, as measured every sixth day, and a line indicating the running annual average calculated from these 24-hour average values. **Table 4.3** provides a summary of the annual average PM_{10} and TSP values for the five sites. Values for 2009 have not been included as they were only available up to May 2009 at the time of preparing this report.

Table 4.3: Annual average PM_{10} and TSP concentrations at High Volume Air Sampling (HVAS) sites

Monitoring Site	2004	2005	2006	2007	2008
PM_{10} (µg/m^3)					
Jerrys Plains School	-	14	15	18	16
Kilburnie South	-	16	17	20	15
Wandewoi	-	17	18	19	17
Cheshunt East	-	-	25	24	22
Maison Dieu	-	-	23	21	18
TSP (µg/m^3)					
Jerrys Plains School	-	30	52	49	52
Kilburnie South	-	33	45	52	37
Wandewoi	39	42	49	47	40
Maison Dieu	-	-	68	57	51

Note – TSP monitoring data for the Cheshunt East HVAS is not included in this table as there is no complete year of monitoring data available for that site.

As can be seen in **Figure 4.2**, the majority of 24-hour average PM_{10} concentrations (dot points) are well below 50 µg/m^3, and the running annual averages (lines) for all sites are below 30 µg/m^3. The annual average PM_{10} concentrations listed in **Table 4.3**, range from 14 to 25 µg/m^3, with the highest level of 25 µg/m^3 recorded at Cheshunt East in 2006.

The highest annual average TSP concentration of 68 µg/m^3 was measured at the Maison Dieu monitor in 2006. Levels at this site were generally higher than at the other three sites. There are no exceedances of the annual average 90 µg/m^3 level over the monitoring period. This can also be seen in graphical form in **Figure 4.3**.

A distinct seasonal trend can be seen in both the PM_{10} and TSP data, as shown in **Figure 4.2** and **Figure 4.3**. Concentrations are lower in the cooler months in the latter part of the year and reach their peak over summer and early autumn. This is a typical pattern seen in the Hunter Valley.

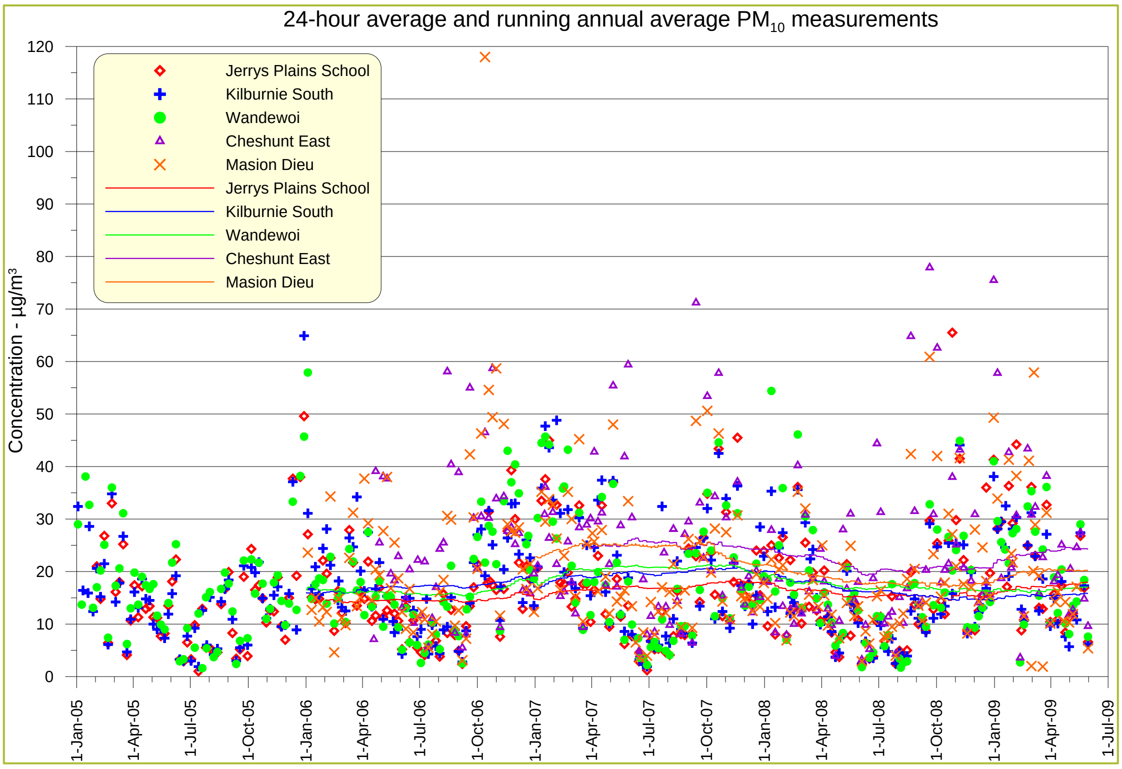


Figure 4.2: PM_{10} monitoring data from January 2005 to May 2009

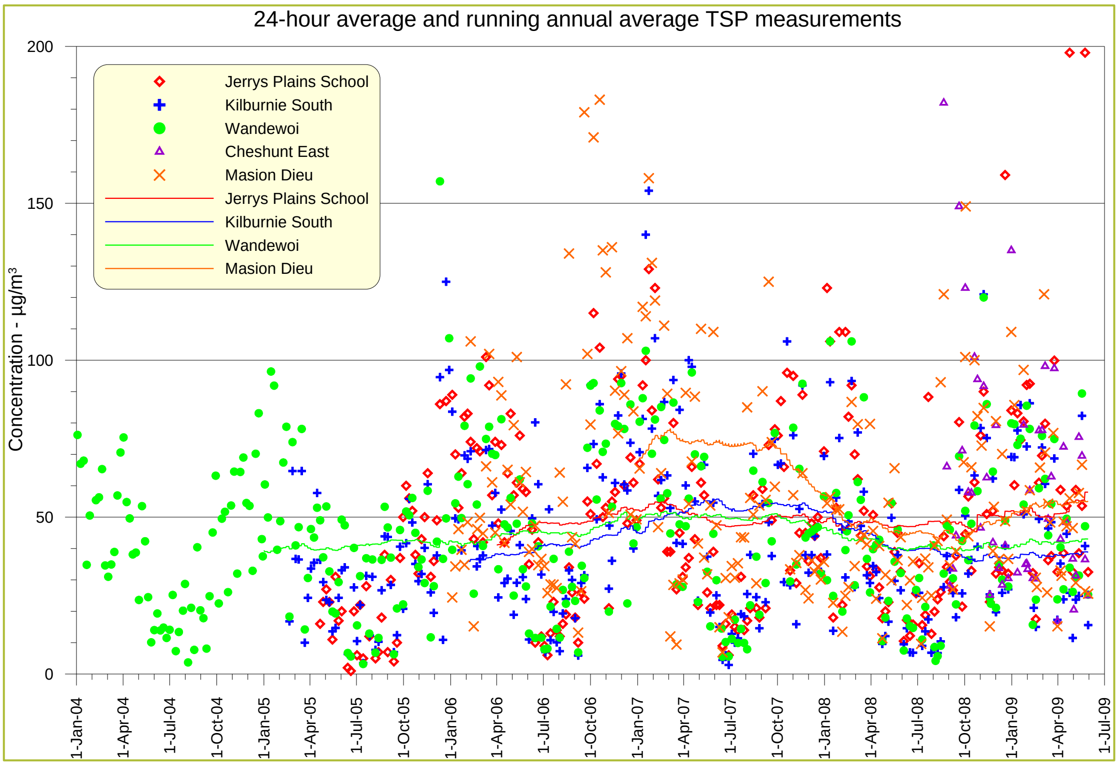


Figure 4.3: TSP monitoring data from January 2004 to May 2009

4.3.2 Dust Deposition

Dust deposition is monitored using dust deposition gauges at 18 locations in the vicinity of the project area (refer to **Figure 2.1** for the locations). Dust deposition gauges use a simple device consisting of a funnel and bottle to estimate the rate at which dust settles onto the surface over periods approximating one month. The measured dust fallout levels to date include the effects of all existing sources of particulate matter including the existing mining operations.

The complete monthly data set for each of the 10 monitoring locations are shown in **Appendix C**, and these data are summarised in **Table 4.4**.

Table 4.4: Annual average dust deposition levels at HVO North monitoring sites

Gauge	2004	2005	2006	2007	2008	Average
D1	2.6	2.5	2.7	4.0	3.2	**3.0**
D2A	4.2	6.1	5.0	3.2	4.0	**4.5**
D3	3.6	5.2	4.1	3.5	7.2	**4.7**
D5	2.5	4.5	2.9	9.0	4.6	**4.6**
D7A	1.6	3.2	2.6	1.8	1.9	**2.2**
D8	1.8	4.2	4.7	5.4	2.6	**3.7**
D15	1.5	3.5	2.8	3.2	2.7	**2.8**
D16	3.3	3.7	3.6	3.0	5.5	**3.8**
D32	2.7	4.9	3.3	2.9	3.0	**3.3**
D33	1.7	3.1	2.2	1.7	1.5	**2.0**
D34	2.3	2.3	2.1	2.0	1.9	**2.1**
D101	0.9	1.9	2.1	1.8	1.0	**1.5**
D110	1.7	1.8	1.7	1.9	1.3	**1.7**
D112	1.1	1.0	2.0	1.7	0.8	**1.3**
D114	3.3	3.6	3.5	3.8	3.4	**3.5**
D116	3.4	3.7	2.8	3.2	4.6	**3.6**
D117	1.3	2.0	2.2	2.2	1.2	**1.8**
DCL	2.3	4.5	2.8	3.3	9.8	**4.5**

Monitoring data from over half of these gauges indicate levels of deposition, consistently close to or above the DECCW's annual criterion of 4 g/m^2/month. These locations are D1, D2A, D3, D5, D8, D16, D32, D114, D116 and DCL. Six of these ten gauges (D1, D2A, D3, D8, D16 and D114) are in very close proximity to the West Pit, near the northern boundary of HVO North and will be greatly influenced by emissions from that pit. As such, they will not be representative of ambient air quality in the area. While D32 is further from the West Pit, it lies in the prevailing wind direction along the northwest-southeast axis and will be influenced by activities at the pit. Likewise, D116 will be influenced by emissions from both the existing Carrington Pit and the Cheshunt Pit (located within HVO South).

It is not clear why the levels at D5 are high relative to measurements at nearby D110 and D117 which show annual averages consistently around 2 g/m^2/month or less. The notes accompanying the monitoring data indicate that there was significant grazing activity at the D5 site in 2007 and a large amount of insect and bird dropping contamination during some of these months. If these samples are removed from the analysis, the annual average for 2007 is reduced from 9.0 to 3.1 g/m^2/month, more in line with nearby gauges.

Another location which shows elevated levels of deposited dust is the DCL site. This site is very close to the Newdell Coal Preparation Plant (NCPP) and is also in the prevailing wind direction. It is therefore likely to be highly influenced by emissions from that area.

The remaining eight deposition monitors show annual averages well below 4 g/m^2/month. Even though some of these sites are relatively close to mining activities (such as D7, D33 and D34), they do not lie in the prevailing wind direction and are therefore not as affected by those activities. These sites are likely to be most representative of conditions at Receptors 5, 6 and 7. The sites which are likely to be the most representative of ambient dust deposition levels at the remaining residences and the township of Jerrys Plains are D101, D110, D112 and D117.

5 ESTIMATED DUST EMISSIONS

Dust emissions arise from various activities at open-cut coal mines. Total dust emissions due to the proposal have been estimated by analysing the activities taking place at the project area during the selected years of operation.

Emission factors developed both locally and by the US EPA have been applied to estimate the amount of dust produced by each activity identified as being potentially dust-generating. These emission factors are considered to be the most applicable and representative methods for determining dust generation rates for the proposed activities. The fraction of fine, inhalable and coarse particles likely to be generated by each activity has been taken into account for the dispersion modelling.

The assessment has considered two mine plan years to represent the proposal. Year 1 represents the early stage of mining while the existing Carrington Pit is still operational and mining activities in the proposed pit extension area are closest to Jerrys Plains, while Year 5 represents the final stage when the exposed dump areas are at their maximum. Years 1 and 5 also represent the two highest levels of waste production. As such, these years represent worst-case operating scenarios thereby facilitating a conservative assessment of the potential impacts from the proposal on the area surrounding the mine.

The proposed operations have been analysed to determine haul road distances and routes, stockpile and pit areas, activity operating hours, truck sizes, blast areas and other details that are necessary to estimate dust emissions for each year.

The significant dust generating activities from the proposal have been identified and the dust emission estimates for Years 1 and 5 are presented below in **Table 5.1**. Other operations within HVO North (West Pit and the existing Carrington Pit) have been included in the assessment of the proposal, as reflected in **Table 5.1**. Some operations which are also part of HVO North, such as those occurring at the Hunter Valley CPP (HVCPP) and West Pit CPP (WPCPP), are combined and have been listed as such.

Details of the calculations of the dust emissions are presented in **Appendix D**. The estimated emissions take account of proposed air pollution controls including passive controls such as those incorporated into the mine plan, including stockpile size and alignment, length of haul roads and active controls which include the intensity of watering and the extent of rehabilitation. **Appendix E** provides a summary of estimated dust emissions and assumptions used in estimating the emissions.

In addition to assessing the potential impacts from HVO North, including the proposal, the nearby mining operations were included in the modelling in order to assess cumulative effects. Emissions from other mines were derived from estimates provided in past air quality impact assessments and these totals are presented in **Table 5.2**.

It should be emphasised that cumulative impacts depend on the scheduling of mine development and there are significant uncertainties in some of the assumptions made concerning scheduling of other mines. A conservative approach was taken in the cumulative assessment whereby the estimated maximum value of annual TSP emissions for the other mining operations were used.

Table 5.1: Estimated TSP emissions due to proposal (kg/year)

Activity	Year 1	Year 5
Carrington West Wing		
OB - Dozers/Excavators (including stripping topsoil)	180,978	180,978
OB - Drilling	12,390	12,390
OB - Blasting	87,107	87,107
OB - Excavator loading OB to haul truck	60,265	44,405
OB - Hauling to emplacement area out of pit	66,538	0
OB - Hauling to emplacement area in pit	232,885	214,498
OB - Emplacing at out of pit emplacement area	12,053	0
OB - Dumping inside the pit	48,212	44,405
OB - Rehandle Shovel/Excavators/FELs Loading	603	444
CL - Dozers ripping/pushing/clean-up	124,092	124,092
CL - Sh/Ex/FELs Loading ROM to trucks	155,051	155,051
CL - Hauling ROM to HVCPP dump hopper	154,054	154,054
CL - Hauling ROM to WPCPP dump hopper	17,838	17,838
WE - OB dump area	133,152	0
WE - Pit dump area	63,072	192,720
WE - Exposed pit area	63,072	70,080
Grading roads	10,783	61,547
Existing Carrington Pit		
OB - Dozers/Excavators (including stripping topsoil)	230,440	0
OB - Drilling	14,496	0
OB - Blasting	104,150	0
OB - Excavator loading OB to haul truck	59,736	0
OB - Hauling to emplacement area in pit	549,626	0
OB - Dumping inside the pit	59,736	0
OB - Rehandle Shovel/Excavators/FELs Loading	597	0
CL - Dozers ripping/pushing/clean-up	110,618	0
CL - Sh/Ex/FELs Loading ROM to trucks	119,715	0
CL - Hauling ROM to HVCPP dump hopper	118,945	0
CL - Hauling ROM to WPCPP dump hopper	13,773	0
WE - Pit dump area	35,040	0
WE - Exposed pit area	175,200	0
Grading roads	10,463	0
West Pit		
OB - Dozers (including stripping topsoil)	17,920	17,920
OB - Drilling	18,344	29,607
OB - Blasting	96,994	121,604
OB - Shovel/Excavators/FELs Loading	110,318	151,277
OB - Hauling to West Pit emplacement area	710,169	973,843
OB - Hauling from North Pit to Alluvials	25,000	0
OB - Hauling from south of river to Alluvials	25,000	0
OB - Emplacing at West Pit dump	110,318	151,277
OB - Emplacing at Alluvials	7,767	0
OB - Dozers	275,268	358,098
OB - Dragline	892,533	911,865
CL ROM - Drilling in West Pit	2,156	4,075
CL ROM - Blasting in West Pit	11,268	27,044
CL ROM - Dozers ripping in West Pit	328,794	427,730
CL ROM - Loading ROM to trucks in West Pit	438,529	492,592
CL ROM - Hauling from West Pit to HVCPP dump hopper	183,053	284,363
CL ROM - Hauling from West Pit to WPCPP dump hopper	113,333	113,333

Activity	Year 1	Year 5
CL ROM - Hauling from south of river to HVCPP dump hopper	666,667	666,667
WE - West Pit	1,752,000	1,752,000
WE - Alluvials Pit	175,200	0
WE - West Pit OB dump	1,752,000	1,752,000
WE - Alluvials OB dump	175,200	0
OB - Dozers (including stripping topsoil)	17,920	17,920
Combined activities		
Unloading ROM at HVCPP dump hopper	8,243	8,504
Unloading ROM at WPCPP dump hopper	1,139	1,103
Rehandle ROM at HVCPP hopper	1,484	1,531
Rehandle ROM at WPCPP hopper	205	198
Transport product coal to user/loadout point - HVCPP to NLP	17,434	17,985
Transport product coal to user/loadout point - WPCPP to NLP	827,702	801,553
Unloading coal from conveyers or trucks at HVLP	6,365	6,567
Unloading coal from conveyers or trucks at NLP	952	926
Loading trains at HVLP	6,365	6,567
Loading trains at NLP	952	926
Total	**11,783,354**	**10,440,763**

(OB – overburden, CL – coal, WE – Wind erosion)

Table 5.2: Estimated TSP emissions due to other nearby mining operations (kg/year)

Mine / Pit	Year 1	Year 5
Ravensworth/Narama ALL OPERATIONS	1,248,000	1,248,000
Wambo ALL OPERATIONS	5,122,771	5,139,243
Cheshunt ALL OPERATIONS	2,600,000	2,600,000
Riverview ALL OPERATIONS	1,560,000	1,560,000
Cumnock ALL OPERATIONS	2,406,642	2,406,642
Total	**12,937,413**	**12,953,885**

Note – emission estimates for these mines were sourced from *Air Quality Assessment – Carrington Pit Extension, HAS 2005*

6 APPROACH TO ASSESSMENT

The assessment for the proposal has generally followed the DECCW's "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (Approved Methods) (**DEC, 2005**). The Approved Methods specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from a proposal.

6.1 The Model

The only deviation to the Approved Methods relates to the use of the ISCMOD model instead of the AUSPLUME, CALPUFF and TAPM models named in the document. The ISCMOD model has been specially developed from the US EPA's ISCST3 model to give improved performance in the prediction of short-term PM_{10} concentrations. It has been accepted for use in NSW by the DECCW for a number of years for mining and quarry assessments, including large Hunter Valley mines.

The ISCMOD model has been derived from the ISCST3[f] model by applying changes to the horizontal and vertical dispersion curves following recommendations made by the American Meteorological Society (AMS) Expert Panel on Dispersion Curves (**Hanna et al., 1977**) (see **HAS, 2007**). The ISCST3 model is fully described in the user manual and the accompanying technical description (**US EPA, 1985**). The modelling has been based on the use of three particle-size categories (0 to 2.5 µm - referred to FP (fine particulates), 2.5 to 10 µm - referred to as CM (coarse matter) and 10 to 30 µm - referred to as the Rest (all remaining particles)). Emission rates of TSP have been calculated using emission factors derived from **US EPA (1985)** and **SPCC (1983)** work (see **Appendix D**).

The distribution of particles has been derived from measurements in the **SPCC (1986)** study. The proportion of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.7% of the TSP;
- $PM_{2.5-10}$ (CM) is 34.4% of TSP; and
- PM_{10-30} (Rest) is 60.9% of TSP.

6.2 Methodology

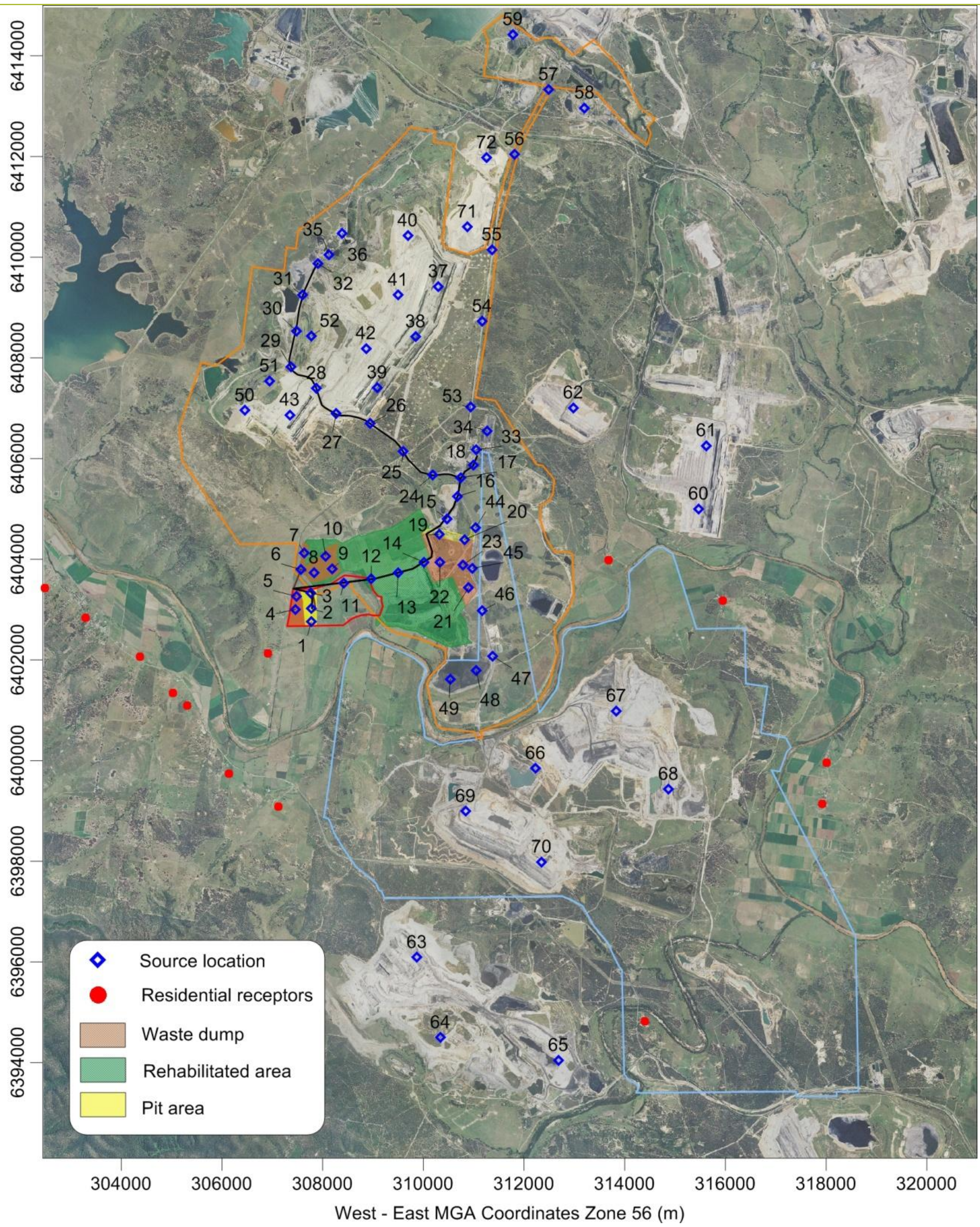
Modelling was undertaken using three ISCMOD source groups. Each group corresponded to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 µm. The predicted concentration in the three plot output files for each group were then combined according to the weightings in the dot points above to determine the concentration of PM_{10} and TSP.

The ISC models also have the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions from mining or quarry operations where wind speed is an important factor in determining the rate at which dust is generated.

For the current study, the operations were represented by a series of volume sources located according to the location of activities for the modelled scenarios (see **Figure 6.1** and **Figure 6.2**). Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISC models to ensure that long-term average emission rates are not combined with worst-case dispersion conditions, which are associated with light winds. Light winds at a mine site would correspond with periods of low dust generation (because wind erosion and other wind-dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

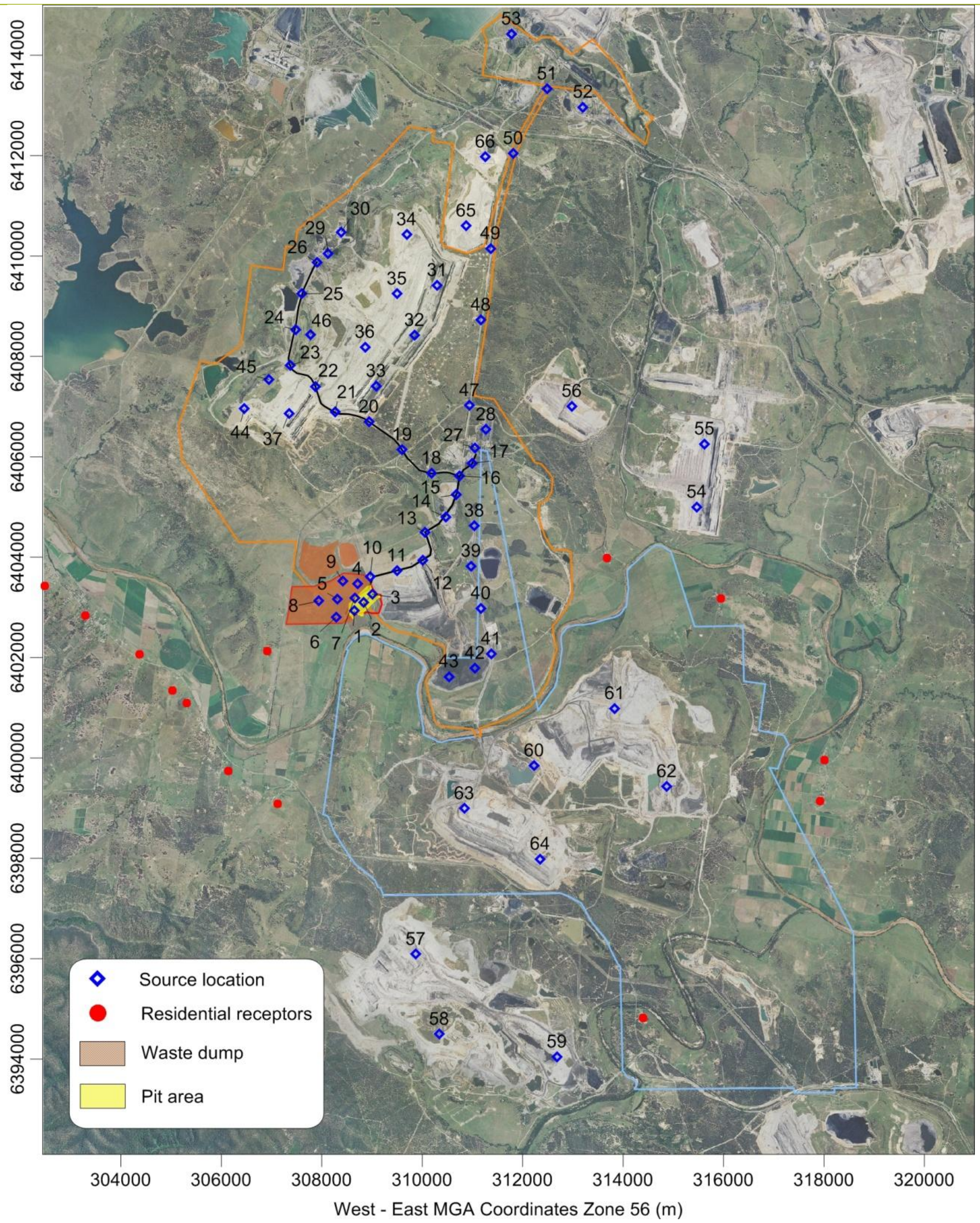
In the cumulative assessment, each neighbouring mine has been treated as a number of volume sources, located at points of major emission as estimated from the locations of the pits and/or major dust sources at the mine.

[f] In subsequent text, when referring to the operation of the ISCMOD or ISCST3 model, where the structure of the models is identical, the acronym ISC will be used.



Species:	Location:	Scenario:	Modelling Year:	Plot:
Dust Sources	HVO North	N/A	Year 1	J Barnett

Figure 6.1: Location of modelled dust sources – Year 1



Species:	Location:	Scenario:	Modelling Year:	Plot:
Dust Sources	HVO North	N/A	Year 5	J Barnett

Figure 6.2: Location of modelled dust sources – Year 5

Dust concentrations and deposition rates have been predicted over the extent of the modelling domain shown in **Figure 2.1**. Model predictions have been made at discrete receptors, including residential locations, located in the area. The co-ordinates for each of these residential locations are listed in **Table 6.1**. The location of these receptors has been chosen to provide finer resolution closer to sensitive areas whilst still maintaining acceptable model run times.

Table 6.1: Locations of residential receptors as used in the modelling

ID	Property owner	Easting	Northing
1	Hayes (Jerrys Plains closest residence)	304370	6402057
2	Skinner	305031	6401340
3	Gee	305309	6401091
4	Muller	306145	6399742
5	Bowman	317920	6399141
6	Moxey	318008	6399952
7[1]	Stapelton	315949	6403170
8[3]	Ravensworth Operations	313683	6403978
10[2]	Moses	306916	6402126
11[3]	Wambo owned	307123	6399079
13[4]	Jerrys Plains Centre	303294	6402832
14[4]	Jerrys Plains North	302484	6403431
39	Warkworth Village Representative	314396	6394821

Notes:

1. *These private residences are currently inside a zone of affectation or subject to a private land holder agreement with mines other than HVO.*
2. *These private residences are currently inside a HVO zone of affectation or subject to a private land holder agreement.*
3. *Mine owned.*
4. *Additional Jerrys Plains locations were added to provide a better representation of the area.*

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. All activities have been modelled for 24 hours per day. **Appendix F** provides a summary of how dust emissions were used in the modelling.

To assess the air quality impacts of the proposal, the activities associated with HVO North (West Pit, existing Carrington Pit and proposed pit extension area) have been modelled in isolation. Contour plots were created from the results in order to assess the contribution of the proposal to local air quality. Model predictions were then compared to the DECCW criteria for 24-hour PM_{10} that are taken to be project specific in order to assess the impacts.

For assessment of the cumulative impacts of the proposal, a separate set of model results have been presented which consider the combined contribution of the proposal with other mines in the area as well as other local sources of dust. These results were viewed in conjunction with estimated background levels as discussed in **Section 6.3**.

Modelled sources associated with mines outside the HVO North lease have been considered in three classes as follows:

- Wind erosion sources
- Wind sensitive sources
- Wind insensitive sources

6.3 Accounting for Background Levels

As discussed in **Section 4.3**, the monitoring data give us an understanding of the existing levels of dust in the air and deposited on the surface, but are not able to separate the mining sources from the non-mining sources. These background levels were better represented by modelling mining activities from Wambo, HVO South, existing HVO North, Ravensworth/Narama and Cumnock Mines and then determining the difference between these predictions and monitoring results. This difference will give an indication of the magnitude of the contribution from all non-mining sources.

As expected, the model predicted values lower than those measured at the monitoring stations, indicating dust sources in the area other than mining. The average difference between monitoring and modelled results for each of the monitoring station sites has been taken as the background (or emission from all non-mining activities) in the surrounding area. These include such things as farming, stock movement, vehicle movements, among others.

Historically, for air assessments in the Hunter Valley, a value of 10 µg/m^3 has been used to account for non-modelled sources of TSP. A study for HVO (**HAS, 2007**) examined model predictions and measurements and found that the non-modelled contribution to annual average TSP levels could be higher than 10 µg/m^3. It is believed that the explanation for the higher non-modelled TSP contribution is that TSP measurements are dominated by localised activities with a high coarse particle fraction. The same argument applies to dust deposition measurements. By contrast, particles in the PM_{10} size range remain in the atmosphere for much longer than the coarse fraction of TSP and so travel much further. The result is a more uniform distribution of PM_{10} concentration. From an air dispersion modelling perspective it is not possible to account for all localised activities, such as ploughing of fields, cattle grazing, farming activities and the like. A revision to the assumed TSP uniform constant background TSP level was therefore considered to be appropriate and a figure of 36 µg/m^3 has been used instead of 10 µg/m^3.

For non-modelled dust sources, the uniform constant background levels for annual average TSP, PM_{10} and dust deposition were as follows:

- 36 µg/m^3 for annual average TSP;
- 11 µg/m^3 for annual average PM_{10}; and
- 1 g/m^2/month for annual average dust deposition.

In addition to the consideration of annual averages, the DECCW guidelines require an assessment against 24-hour PM_{10} concentrations. In other words, it requires that the predicted 24-hour average PM_{10} concentration from the proposal should be less than 50 µg/m^3 at the nearest residential location. A background concentration estimate is therefore not required for this short-term assessment.

7 ASSESSMENT OF IMPACTS

Dust concentrations and deposition rates for the two scenarios assessed, that is Year 1 and Year 5 of operations, are presented as isopleth diagrams showing the following:

1. Predicted annual average PM_{10} concentration from the proposal[9];
2. Predicted annual average TSP concentration from the proposal[9];
3. Predicted annual average dust deposition from proposal[9];
4. Predicted cumulative annual average PM_{10} concentration;
5. Predicted cumulative annual average TSP concentration; and
6. Predicted cumulative annual average dust deposition.

It is important to note that the isopleth figures are presented to provide a visual representation of the predicted impacts. To produce the isopleths it is necessary to make interpolations, and as a result the isopleths will not always match exactly with predicted impacts at a specific location. The actual predicted impacts at the sensitive receptors are presented in tabular form.

Contour plots of the maximum 24-hour PM_{10} concentration have not been included because they cannot be reasonably presented to show the dispersion pattern for any particular day, but would show the highest modelled predicted 24-hour average concentrations that occurred at any point for the worst day in the year. Data presented in this way can be misleading.

To assist in assessing the air quality impacts in detail, and prevent misinterpretation of the 24-hour PM_{10} information, the dispersion model results have been presented in tabular form (**Table 7.1** to **Table 7.3**) showing the modelled predictions at each of the nearest residential receptors.

7.1 Assessment Criteria

The air quality criteria applied to assess air quality impacts are specified in **Section 3** and are listed in **Table 3.1** and **Table 3.3**.

The relevant assessment criteria are:

- 50 µg/m^3 for 24-hour PM_{10} for the proposal considered alone[9];
- 30 µg/m^3 for annual average PM_{10} due to the proposal and other sources;
- 90 µg/m^3 for annual average TSP concentrations due to the proposal[9] and other sources;
- 2 g/m^2/month for annual average deposition (insoluble solids) due to the proposal considered alone[9]; and
- 4 g/m^2/month for annual predicted cumulative deposition (insoluble solids) due to the proposal[9] and other sources.

A predicted level above any of these air quality criteria at a privately owned residence was taken to represent an adverse air quality impact.

[9] This includes other HVO North operations, as listed in the table of estimated emissions.

The DoP, in its acquisition criteria, also considers the number of days annually that the 24-hour average PM_{10} criteria is exceeded when assessing projects. An assessment of this is also provided in the following sections. It is important that the criteria the DoP applies should not be confused with DECCW impact assessment criteria.

7.2 Model Predictions

7.2.1 Year 1

Model results for Year 1 are presented in **Table 7.1**. These results include background levels (noted at the end of **Section 6.3**) for cumulative annual average PM_{10} and TSP, and for total deposition. As discussed previously, background is not relevant for the 24-hour PM_{10} scenario.

Table 7.1: Modelling predictions Year 1

Receptor ID	24-hr average PM_{10} HVO North only (µg/m³)	Annual average PM_{10} Cumulative plus non-mining background (µg/m³)	Annual average TSP Cumulative plus non-mining background (µg/m³)	Annual average dust deposition (g/m²/month)	
				HVO North only	Cumulative plus non-mining background
DECCW Criteria ⇨	***50***	***30***	***90***	***2***	***4***
Non-mining background ⇨	***N/A***	***11***	***36***	***N/A***	***1***
1	15.1	17.4	42.8	0.03	1.2
2	17.2	18.0	43.4	0.02	1.2
3	18.3	18.3	43.7	0.02	1.2
4	19.6	19.7	45.2	0.02	1.3
5	13.6	20.5	46.3	0.2	1.6
6	17.1	19.1	44.7	0.2	1.4
7[1]	29.5	20.8	46.5	0.4	1.5
8[3]	44.4	24.5	50.9	0.04	1.9
10[2]	**50.5**	22.0	48.0	0.1	1.4
11[3]	17.8	22.3	48.2	0.02	1.4
13[4]	15.7	16.6	41.9	0.04	1.2
14[4]	12.2	16.1	41.4	0.04	1.2
39	15.5	20.8	46.6	0.05	1.5

Notes:
1. *These private residences are currently inside a zone of affectation or subject to a private land holder agreement with mines other than HVO.*
2. *These private residences are currently inside a HVO zone of affectation or subject to a private land holder agreement.*
3. *Mine owned.*
4. *Additional Jerrys Plains locations were added to provide a better representation of the area.*

7.2.1.1 Predicted maximum 24-hour average PM_{10} concentrations

The relevant DECCW impact assessment criterion for maximum 24-hour average PM_{10} concentrations is 50 µg/m^3. As shown in **Table 7.1**, the only residence predicted to exceed this criterion is Receptor 10, which exceeds by 0.5 µg/m^3.

Further analysis was conducted on Receptor 10 to determine the number of days that the 50 µg/m^3 criterion would be exceeded in accordance with the DoP acquisition criteria. From this analysis it was determined that the 50 µg/m^3 is exceeded on one occasion only. The next highest predicted 24-hour PM_{10} concentration is 36 µg/m^3. This can also be seen in **Figure 7.1**, a time series plot of predictions at Receptor 10 over the entire modelling period, where the majority of predictions are below 30 µg/m^3.

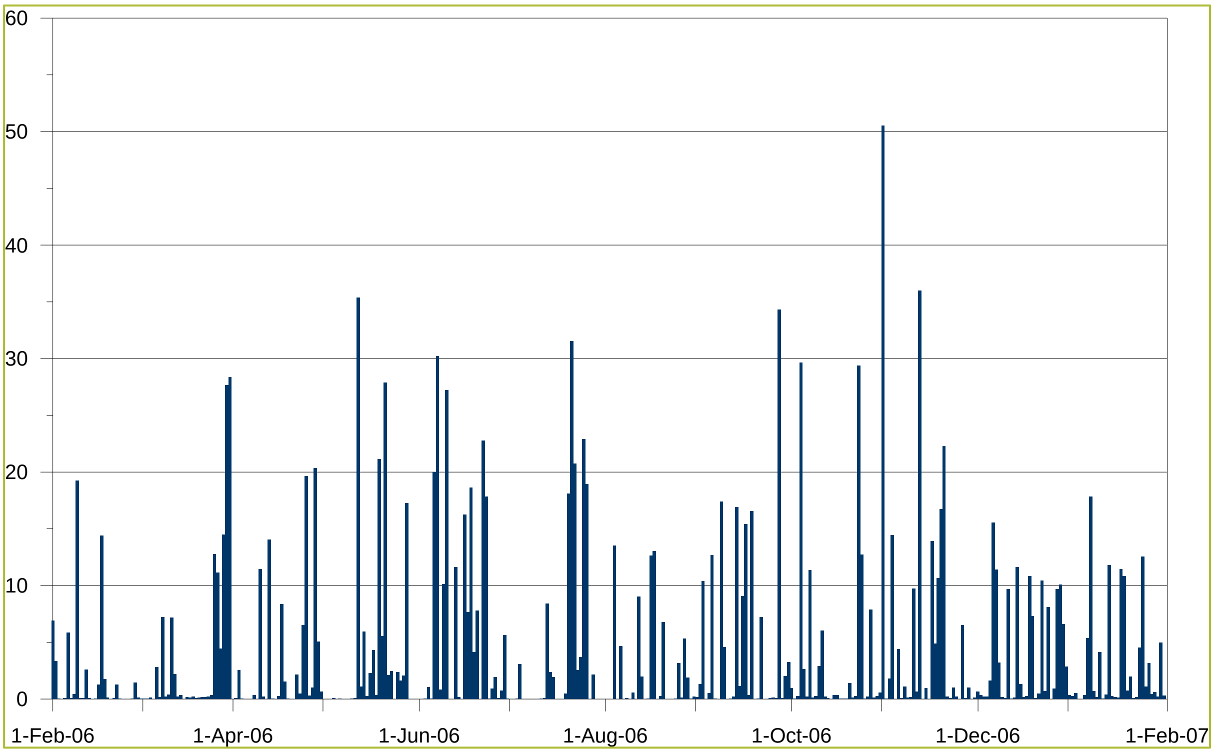


Figure 7.1: Predicted 24-hour average PM_{10} concentrations for each modelled day at Receptor 10

7.2.1.2 Predicted annual average PM_{10} concentrations

Figure 7.2 shows the predicted cumulative annual PM_{10} concentrations due to HVO North and other sources. It can be seen that the 30 µg/m^3 level is not exceeded at any of the nearest residential receptors. When adding a background of 11 µg/m^3, as shown in **Table 7.1**, the DECCW criterion is not exceeded at any of the residential receptors.

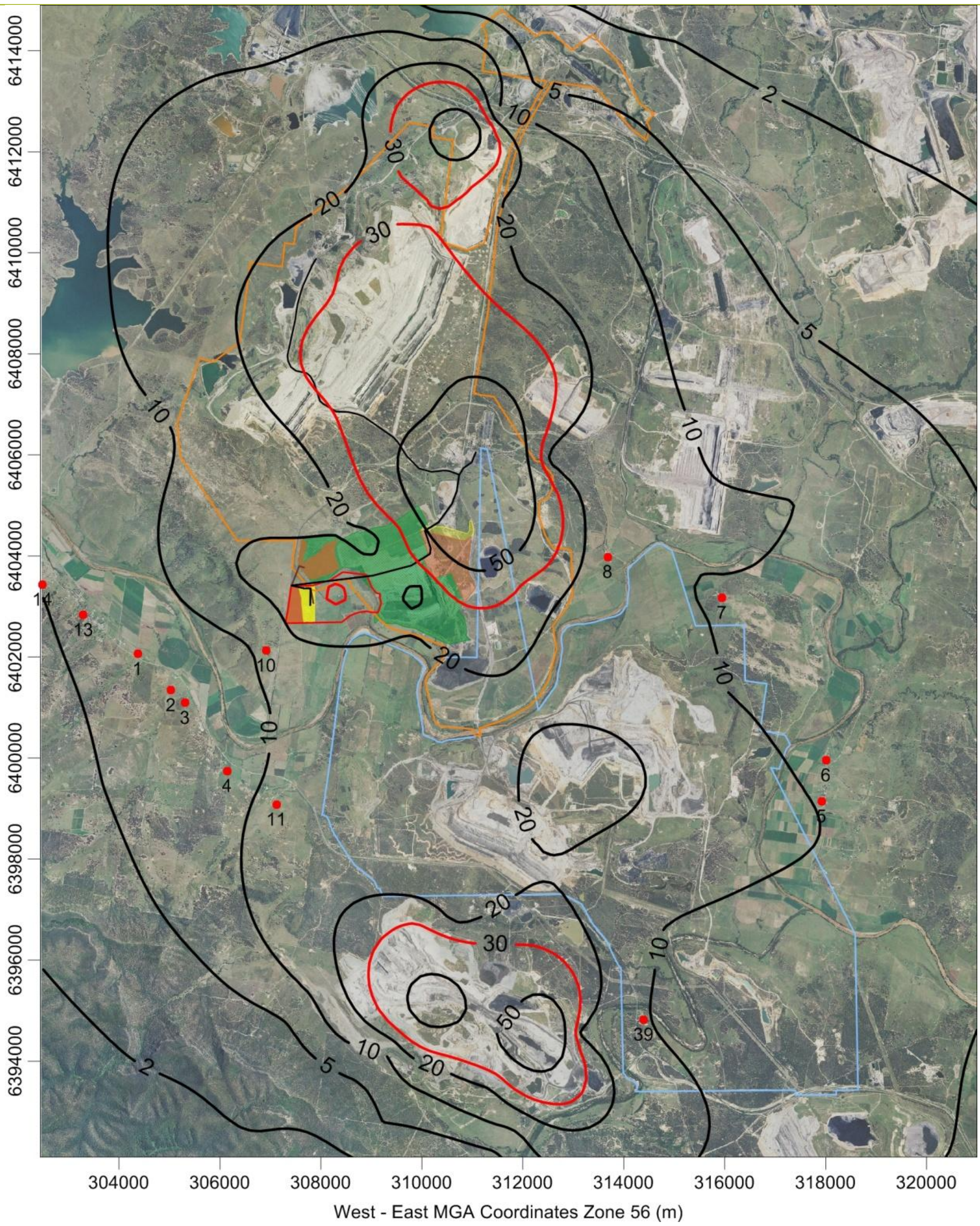
7.2.1.3 Predicted annual average TSP concentrations

Figure 7.3 shows the predicted cumulative annual average TSP concentrations due to HVO North and other sources. Before adding background levels, the annual average TSP concentrations are predicted to be below the DECCW criterion of 90 µg/m^3. This is still the case when adding a background of 36 µg/m^3, as shown in **Table 7.1**.

7.2.1.4 Predicted annual average dust deposition (insoluble solids)

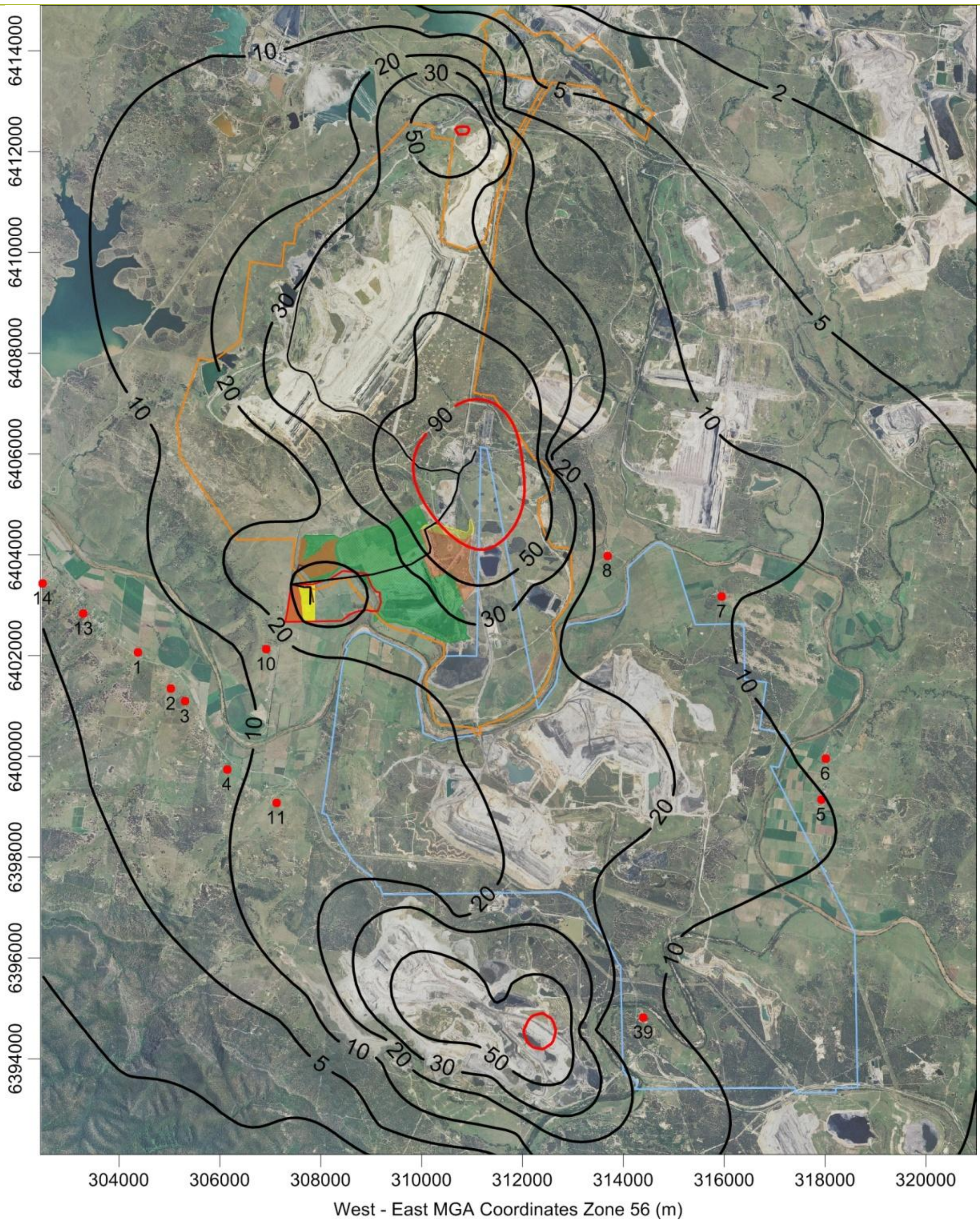
Figure 7.4 shows the predicted annual average dust deposition rate for Year 1 due to HVO North alone. The assessment criterion is 2 g/m^2/month (annual average). No residential receptors are predicted to experience annual average dust deposition levels due to HVO North that are above 2 g/m^2/month in Year 1.

Figure 7.5 shows the predicted annual average dust deposition rate for Year 1 due to HVO North considered with other sources. The assessment criterion is 4 g/m^2/month (annual average) and is not exceeded at any of the residential receptors, even when added to estimated background levels.



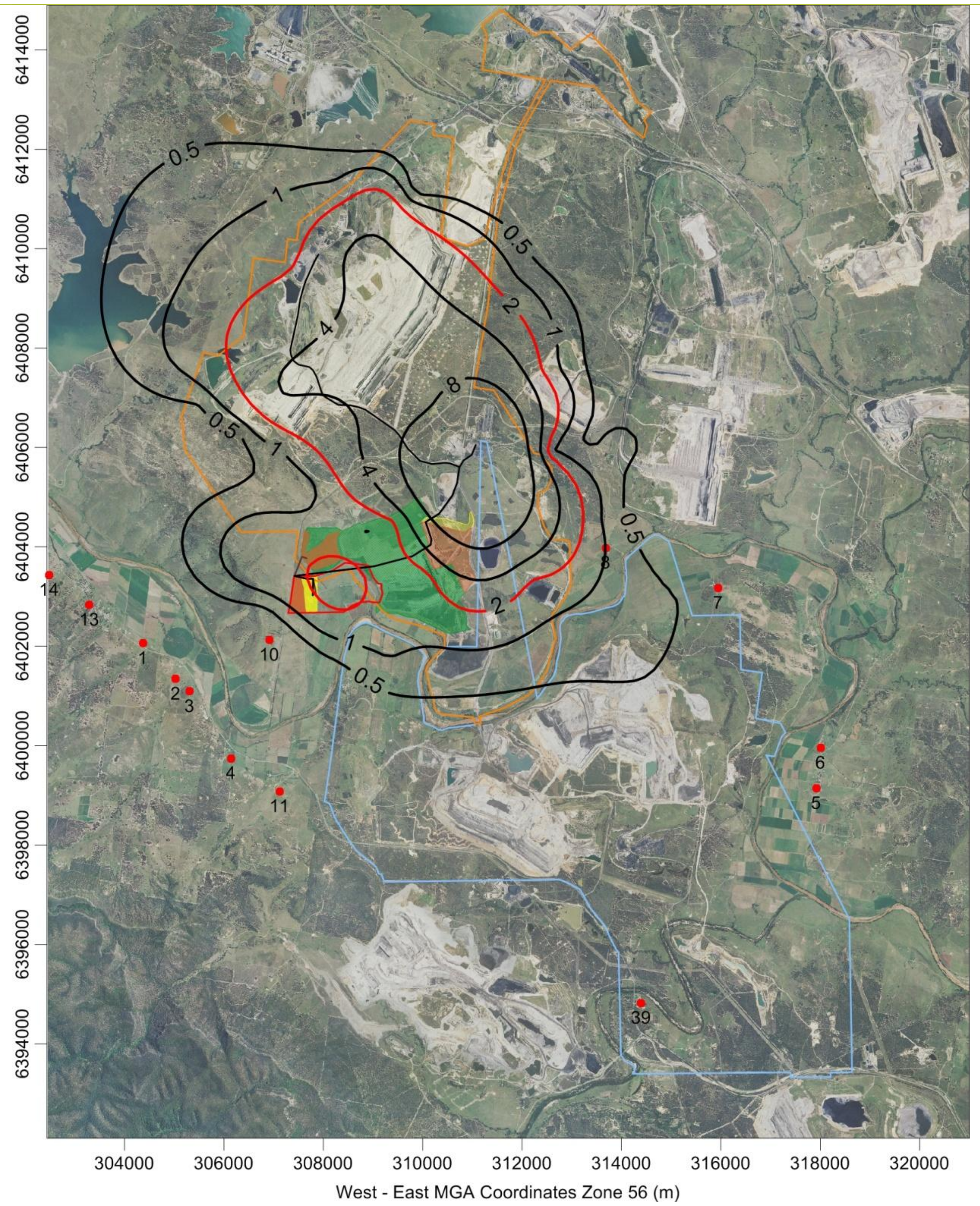
Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	HVO North	Year 1 – cumulative (no background)	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m³	30 µg/m³	2006/2007	J. Barnett

Figure 7.2: Predicted annual average PM_{10} concentrations due to emissions from HVO North and other sources in Year 1



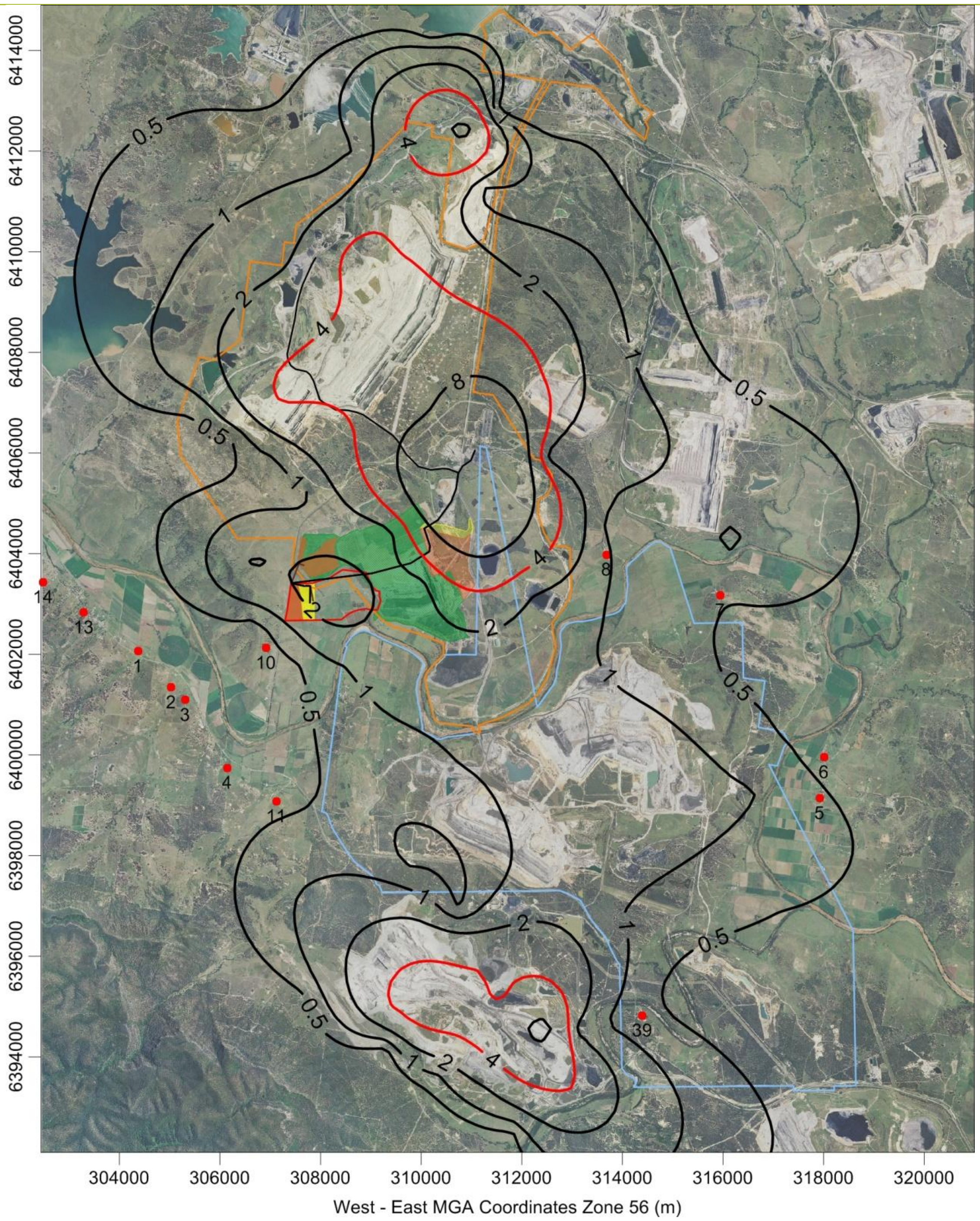
Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
TSP	HVO North	Year 1 – cumulative (no background)	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m³	90 µg/m^3	2006/2007	J. Barnett

Figure 7.3: Predicted annual average TSP concentrations due to emissions from HVO North and other sources in Year 1



Species: Deposition	Location: HVO North	Scenario: Year 1 – HVO North only	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** g/m^2/month	**Guideline:** 2 g/m^2/month	**Met Data:** 2006/2007	**Plot:** J. Barnett

Figure 7.4: Predicted annual average dust deposition levels due to emissions from HVO North alone in Year 1



Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
Deposition	HVO North	Year 1 – cumulative (no background)	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	g/m^2/month	4 g/m^2/month	2006/2007	J. Barnett

Figure 7.5: Predicted annual average dust deposition levels due to emissions from HVO North and other sources in Year 1

7.2.2 Year 5

Model results for Year 5 are presented in **Table 7.2**. These results include background levels for cumulative annual average PM_{10} and TSP, and for total deposition. As discussed previously, background is not relevant for the 24-hour average PM_{10} scenario.

Table 7.2: Modelling predictions Year 5

Receptor ID	24-hr average PM_{10} HVO North only (µg/m³)	Annual average PM_{10} Cumulative plus non-mining background (µg/m³)	Annual average TSP Cumulative plus non-mining background (µg/m³)	Annual average dust deposition (g/m²/month) HVO North only	Annual average dust deposition (g/m²/month) Cumulative plus non-mining background
DECCW Criteria ⇨	***50***	***30***	***90***	***2***	***4***
Non-mining background ⇨	***N/A***	***11***	***36***	***N/A***	***1***
1	13.0	17.0	42.4	0.02	1.2
2	10.8	17.7	43.0	0.02	1.2
3	10.6	18.0	43.4	0.02	1.2
4	15.5	19.3	44.9	0.01	1.3
5	9.7	19.8	45.5	0.1	1.5
6	10.5	18.2	43.7	0.1	1.4
7[1]	19.2	18.9	44.5	0.3	1.4
8[3]	25.3	20.4	46.4	0.6	1.7
10[2]	24.6	20.2	45.8	0.04	1.3
11[3]	13.4	21.9	47.7	0.01	1.4
13[4]	13.5	16.2	41.5	0.02	1.2
14[4]	10.6	15.7	40.9	0.02	1.2
39	12.6	20.5	46.3	0.03	1.5

Notes:
1. *These private residences are currently inside a zone of affectation or subject to a private land holder agreement with mines other than HVO.*
2. *These private residences are currently inside a HVO zone of affectation or subject to a private land holder agreement.*
3. *Mine owned.*
4. *Additional Jerrys Plains locations were added to provide a better representation of the area.*

7.2.2.1 Predicted maximum 24-hour average PM_{10} concentrations

The relevant DECCW impact assessment criterion for maximum 24-hour average PM_{10} concentrations is 50 µg/m³. There are no residences predicted to exceed this criterion in Year 5.

7.2.2.2 Predicted annual average PM_{10} concentrations

Figure 7.6 shows the predicted cumulative annual average PM_{10} concentrations from due to HVO North and other sources in Year 5. It can be seen that the 30 µg/m³ level is not exceeded at any of the residential receptors. When adding a background of 11 µg/m^3, as shown in **Table 7.2**, the DECCW criterion is not exceeded at any of the nearest residences.

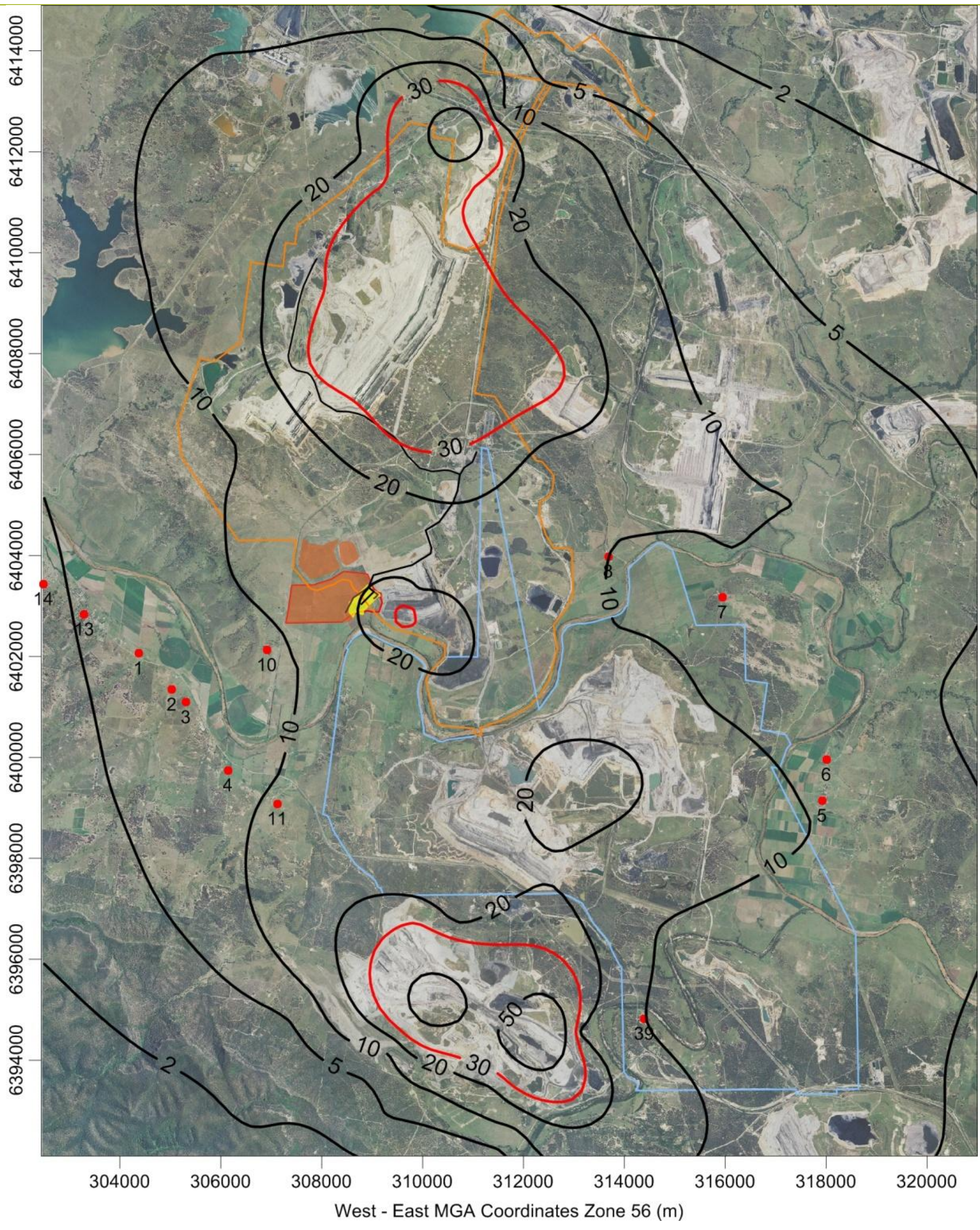
7.2.2.3 Predicted annual average TSP concentrations

Figure 7.7 shows the predicted cumulative annual average TSP concentration due to HVO North and other sources in Year 5. The annual average TSP concentrations are predicted to be below the DECCW criterion of 90 µg/m^3, both before and after adding a background 36 µg/m^3, as shown in **Table 7.2**

7.2.2.4 Predicted annual average dust deposition (insoluble solids)

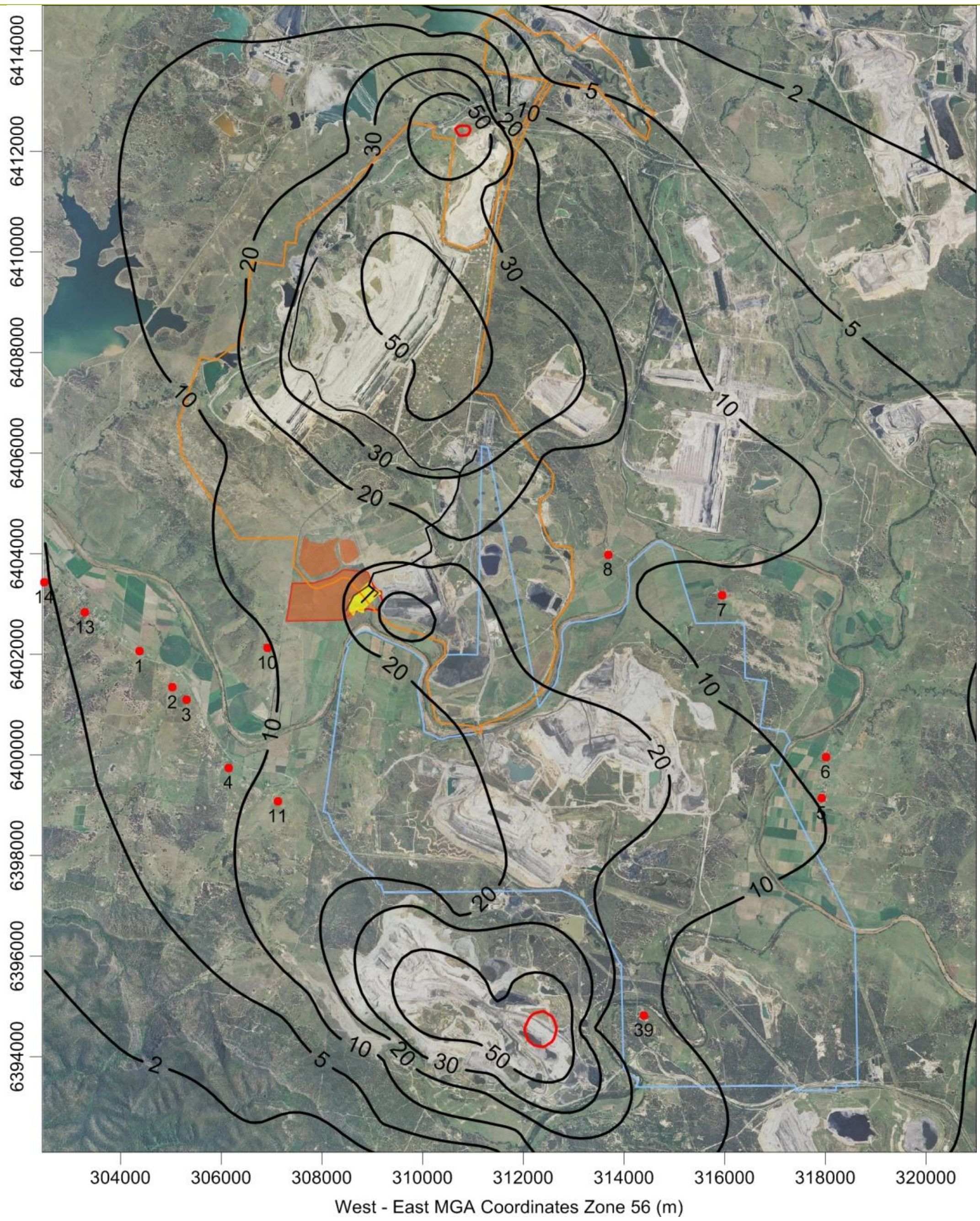
Figure 7.8 shows the predicted annual average dust deposition rate for Year 5 due to HVO North alone. The assessment criterion is 2 g/m^2/month (annual average). No residential receptors are predicted to experience annual average dust deposition levels due to HVO North that are above 2 g/m^2/month in Year 5.

Figure 7.9 shows the predicted annual average dust deposition rate for Year 5 due to HVO North considered with other sources. The assessment criterion is 4 g/m^2/month (annual average) and is not exceeded at any of the residential receptors, even when added to estimated background levels, as shown in **Table 7.2**.



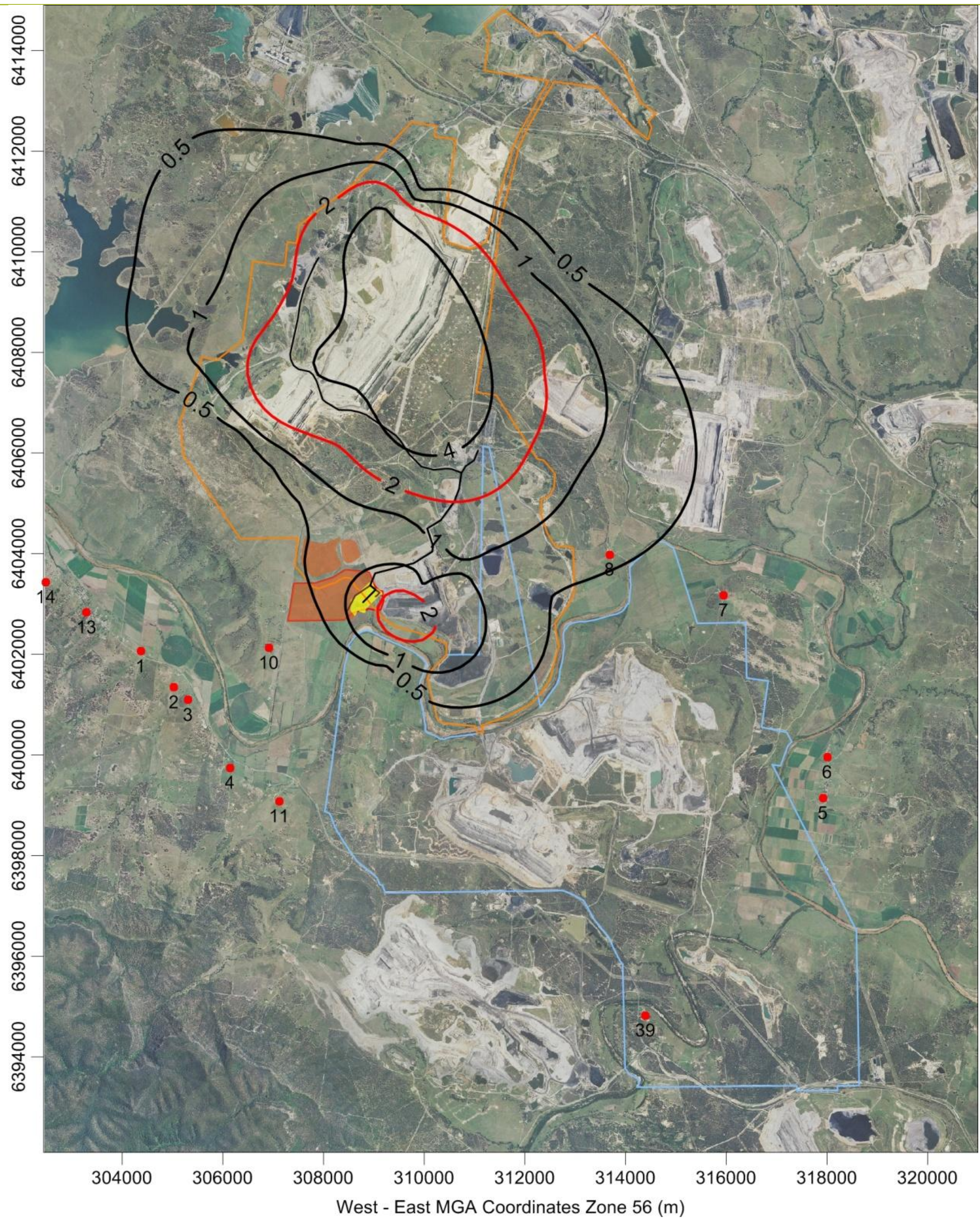
Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	HVO North	Year 5 – cumulative (no background)	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m³	30 µg/m³	2006/2007	J. Barnett

Figure 7.6: Predicted annual average PM_{10} concentrations due to emissions from HVO North and other sources in Year 5



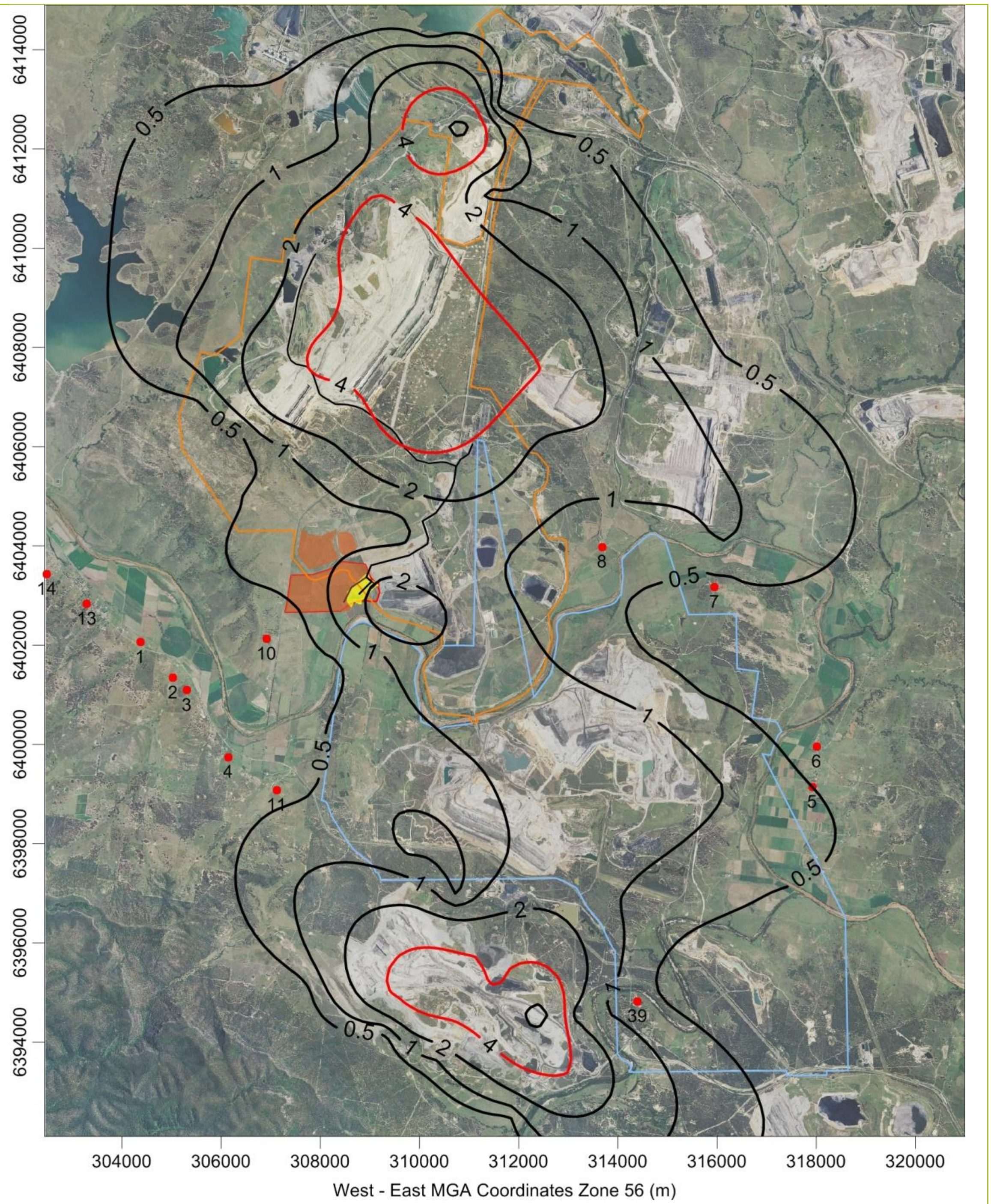
Species:	Location:	Scenario:	Percentile:	Averaging Time:
TSP	HVO North	Year 5 – cumulative (no background)	N/A	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m³	90 µg/m³	2006/2007	J. Barnett

Figure 7.7: Predicted annual average TSP concentrations due to emissions from HVO North and other sources in Year 5



Species: Deposition	Location: HVO North	Scenario: Year 5 – HVO North only	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** $g/m^2/month$	**Guideline:** 2 $g/m^2/month$	**Met Data:** 2006/2007	**Plot:** J. Barnett

Figure 7.8: Predicted annual average dust deposition levels due to emissions from HVO North alone in Year 5



Species: Deposition	**Location:** HVO North	**Scenario:** Year 5 – cumulative (no background)	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** g/m^2/month	**Guideline:** 4 g/m^2/month	**Met Data:** 2006/2007	**Plot:** J. Barnett

Figure 7.9: Predicted annual average dust deposition levels due to emissions from HVO North and other sources in Year 5

8 GREENHOUSE GAS ASSESSMENT

8.1 Introduction

In November 2006, the NSW Land and Environment Court handed down a landmark decision (the judgement of Her Honour Pain J in the matter of *Gray v The Minister for Planning and ors NSWLEC 720*) which requires all new industrial developments to undertake a global warming impact study following the principles of ecologically sustainable development (ESD).

For the purposes of this report, the ESD principles have been taken to be those defined by the DoP (**DUAP, 2000**), and are as follows.

- The precautionary principle – namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- Inter-generational equity – namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- Conservation of biological diversity and ecological integrity.
- Improved valuation and pricing of environmental resources.

This section examines the scientific principles that relate greenhouse gases (GHGs) to the global warming effect and estimates emissions of GHGs associated with the proposal.

This assessment should be viewed as supplementary to a more detailed GHG assessment conducted for HVO, which was published as an annex in the Environmental Assessment for Hunter Valley Operations South Coal Project, 2007 (**HAS, 2007**). The purpose of this assessment is to estimate GHG emissions for the proposal during the approximate six year life of the proposed pit extension area.

It is demonstrated that when all categories (that is, Scopes 1, 2 and 3) of GHG emissions from the proposal are taken into account, the proposal will comply with the principles of ESD. Scope 1 and Scope 2 emissions are emissions due to the actual operation of the proposal and Scope 3 emissions are emissions that would result from the off-site transport and burning of the coal produced by the proposal.

8.2 Science of Global Warming

The technical assessment reports produced approximately every five years by the Intergovernmental Panel on Climate Change (IPCC) are regarded as the most authoritative and comprehensive documents dealing with the science of global warming. To date, the IPCC has published five technical assessment reports, the most recent being in 2007 (**IPCC, 2007**). These documents represent the scientific community's consensus view on climate change. They also provide a useful database to help to understand the significance of various human activities in the context of climate change. They include quantitative information on the production and fate of GHGs and estimates of the expected increases in global temperatures for a range of feasible futures. These scenarios are chosen to illustrate the range of uncertainty in the predictions of temperature increases.

The Garnaut Climate Change Review, commissioned by Australia's Commonwealth, State and Territory governments, released a final report in September 2008 which suggested that emissions are tracking the upper bounds of the scenarios modelled by the IPCC (**Garnaut, 2008**).

The temperature of the earth's atmosphere is determined almost entirely[h] by the balance between radiation received from the sun and that re-radiated to outer space (see for example **IPCC, 2001**).

The parts of the radiation spectrum through which the earth can re-radiate and lose energy to outer space depends on the composition of the atmosphere. Certain gases including water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and a range of other gases absorb electromagnetic energy in the infrared spectrum. Solar radiation from the sun contains most of its energy in the infrared, visible and ultraviolet parts of the spectrum.

Sunlight passes through the atmosphere and warms both the atmosphere and the earth's surface. Clouds and the earth's surface directly reflect some of the sun's radiation back to space, but much of the sun's radiation is absorbed by the earth's surface and some by the atmosphere, which are warmed. The warmed earth and its atmosphere then re-radiate this energy back to space. For the average global temperature to remain constant, the incoming radiation from the sun must be balanced by the outgoing energy radiated from the earth and atmosphere.

Global warming (and associated climate change) is considered to occur because of the changing composition of the atmosphere, specifically the increasing concentrations of GHGs, in particular CO_2, CH_4 and N_2O. These gases reduce the parts of the electromagnetic spectrum through which energy can be re-radiated from the earth. In response, the earth's temperature must increase to allow the rate of energy loss from the earth to increase and thereby allow the incoming and outgoing radiation to be brought back into balance.

In summary, GHGs absorb electromagnetic energy and change the radiation balance of the earth causing the temperature to increase so that the radiation balance is restored.

Without the presence of any GHGs, the earth's average temperature would be extremely cold (-18 ^{o}C) (**Seinfeld and Pandis, 1998**) and most of the planet would be uninhabitable. However, the effect of increasing GHGs is to change existing climates and this may place stresses on current ecological systems that have adapted to current climate regimes.

Increasing concentrations of CO_2, CH_4 and other GHGs may cause the temperature of the atmosphere to increase but, because the earth transports heat from the equator towards the poles in a complicated way via ocean currents and winds, the precise effect of increasing concentrations is difficult to estimate for any particular location.

Increasing concentrations of CO_2 and CH_4 are largely attributable to growth in the worldwide use of fossil fuels to provide energy for increasing populations, which also have increasing per capita consumptions of energy. However, land clearing on a global scale is also an important cause in changes to CO_2 concentrations.

[h] The words "almost entirely" are used because the residual heat from the earth's formation and from the decay of radioactive elements in the earth have some effect on the earth's temperature.

8.3 Quantifying greenhouse effects

Scientific publications sometimes refer to the quantity of carbon stored in the atmosphere or may refer to the equivalent quantity of carbon dioxide. In this context, 1.0 tonne (t) of carbon is the same as 3.67 t of CO_2. Most of the analysis in this report will refer to CO_2 rather than carbon, as this appears to be the most common approach used in Australia.

The estimated quantity of carbon dioxide stored in the atmosphere now is approximately 3,000 Gigatonnes (Gt). The International Energy Agency estimates that in 2007, global emissions of CO_2 from burning fossil fuels were 28,962 Mt, of which Australia's emissions of CO_2 from burning fossil fuels were 396.3 Mt CO_2 (i.e. approximately 1.4% of the global anthropogenic, or human-related, total) (**IEA, 2009**).

Because the relationship between global warming and GHG concentrations is not linear[i] there is no accepted method to determine the contribution that a given emission of GHG might make to global warming.

To understand this point it is useful to consider the following discussion from Section 1.3.1 of the Second Scientific Assessment Report prepared by the IPCC (**IPCC, 1996**).

> *"The amount of carbon dioxide in the atmosphere has increased by more than 25% in the past century and since the beginning of the industrial revolution, an increase which is known to be in large part due to the combustion of fossil fuels and the removal of forests (Chapter 2 [*of the report*]). In the absence of controls, projections are that the future rate of increase in carbon dioxide amount may accelerate and concentrations could double from pre-industrial values within the next 50 to 100 years (**IPCC, 1994**).*
>
> *The increased amount of carbon dioxide is leading to climate change and will produce, on average, a global warming of the Earth's surface because of its enhanced greenhouse effect – although the magnitude and significance of the effects are not yet fully resolved. If, for instance, the amount of carbon dioxide in the atmosphere were suddenly doubled, but with other things remaining the same, the outgoing long-wave radiation would be reduced by about 4 Wm^{-2}. To restore the radiative balance, the atmosphere must warm up and, in the absence of other changes, the warming at the surface and throughout the troposphere would be about 1.2 ^oC. However, many other factors will change, and various feedbacks come into play (see Section 1.4.1* [of the report]*), so the best estimate of the average global warming for doubled carbon dioxide is 2.5 ^oC (**IPCC, 1990**). Such a change is very large by historical standards and would be associated with major climate changes around the world.*
>
> *Note if carbon dioxide were removed from the atmosphere altogether, the change in out going radiation would be about 30 Wm^{-2} – 7 to 8 times as big as the change for doubling – and the magnitude of the temperature change would be similarly enhanced. The reason is that the carbon dioxide absorption is saturated over part of the spectral region where it absorbs, so the amount of absorption changes at a much smaller rate than the concentration of the gas (Chapter 2* [of the report]*). If the concentrations of carbon dioxide are more than doubled, then the relationship between radiative forcing and*

[i] The warming effect of a given quantity of greenhouse gases to the atmosphere is less and less as the concentration become higher and higher.

concentration is such that each further doubling provides a further radiative forcing of about 4 Wm^{-2}."

8.4 Greenhouse Gas Inventories

Greenhouse gas inventories are calculated according to a number of different methods. The procedures specified under the Kyoto Protocol United Nations Framework Convention on Climate Change are the most common.

The protocol nominates the following GHGs:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs); and
- Perfluorocarbons (PFCs).

From the point of view of the proposal, only CO_2, CH_4 and N_2O are relevant.

Gases CO_2 and N_2O are formed and released during the combustion of gaseous, liquid and solid fuels. They are liberated when fuels are burnt in diesel powered equipment and in the generation of electrical energy that will be used during the mining operation. Methane is released as a fugitive emission during the extraction of coal.

Inventories of GHG emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion.

The global warming potentials assumed by Commonwealth Department of Climate Change (DCC) (**DCC, 2008**) are as follows;

- CO_2 – 1
- CH_4 – 21
- N_2O – 310

When the global warming potentials are applied to the estimated emissions then the resulting estimate is referred to in terms of CO_2-equivalent (CO_2-e) emissions.

8.5 Emission factors

The National Greenhouse Accounts (NGA) Factors published by the DCC (**DCC, 2009a**) have been used to convert fuel usage and electricity consumption into CO_2-e emissions. The relevant emission factors are summarised in **Table 8.1**.

Table 8.1: Summary of GHG emission factors

Type of Fuel and Electricity		Emission factor		GHG	Scope	Source
Diesel - on-site activities [a]		69.2	kg CO_2-e/GJ	CO_2	1	Table 3 DCC, 2009a
		0.1	kg CO_2-e/GJ	CH_4	1	
		0.2	kg CO_2-e/GJ	N_20	1	
		5.3	kg CO_2-e/GJ	-[b]	3	Table 38 DCC, 2009a
		38.6	GJ/kL	Energy content factor		
Explosives use[c]	ANFO	0.17	t CO_2-e/tonne	-	1	Table 4 DCC, 2008
	Heavy ANFO	0.18	t CO_2-e/tonne	-	1	Table 4 DCC, 2008
	Emulsion	0.17	t CO_2-e/tonne	-	1	Table 4 DCC, 2008
Electricity[d]		0.89	kg CO_2-e/kWh	-	2	Table 5 DCC, 2009a
		0.18	kg CO_2-e/kWh	-	3	Table 39 DCC, 2009a
Extraction of coal		0.045	t CO_2-e/tonne In-situ coal	CH_4	1	Table 8 DCC 2009a
Transport of Coal (Rail)		11[e]	t CO_2-e/Mt.km	-	3	Proponent
Transport of Coal (Ship)		Various[f]	t CO_2-e/Mt.km	-	3	Proponent

Notes:

(a) The emission factors for diesel use include Scope 1 emission (i.e. those activities associated with actual use of fuel) and Scope 3 emissions (those associated the production, processing and transport of diesel fuel to the site).

(b) Refers to all equivalent GHGs where applicable.

(c) As the calculation of emissions from explosives use are no longer required under the NGER reporting requirements, the GHG emissions factor for explosives use has been removed from NGA Factors published June 2009 (**DCC, 2009a**). Therefore the factors published in February 2008 (**DCC, 2008**) have been used.

(d) The emission factors for electrical energy include Scope 2 emissions (i.e. those associated with generating the electricity) and Scope 3 emissions (those associated with producing the fuel for the power station and the distribution losses involved in delivering electricity to the mine).

(e) The emission factor associated with the transport of coal via rail has been obtained from the Proponent.

(f) The emission factor associated with the transport of coal using ships has been provided by the Proponent. This varies depending on type of ship used (see **Section 8.6.2**).

8.6 Greenhouse Emissions from the Proposal

CO_2-equivalent (CO_2-e) emissions from the proposal are expected to result from the following sources:

1. The extraction and processing of the coal, the use of diesel-powered equipment, blasting and electricity usage.
2. The transport of the product coal to the Port of Newcastle and the transport of the product coal to overseas customers.
3. The combustion of the product coal in power generating facilities and use in steel manufacture.

The following sections estimate the CO_2 emissions from each of these sources.

8.6.1 Emissions from Extraction and Processing of Coal

Information has been provided by Coal & Allied on the estimated usage of electrical energy, explosives and diesel fuel over the life of the proposal and the amount of in-situ coal extracted. **Table 8.2** summarises the information provided.

Table 8.2: Summary of electricity, explosives, diesel and in-situ coal for the proposal

Year	Electricity use (MWh)*	Explosives			Diesel use (kl)	In-situ Coal (t)
		ANFO (t)	Heavy ANFO (t)	Emulsion (t)		
1	0	174,999	1,013,027	2,478,746	8,000	3,000,000
2	0	174,999	1,013,027	2,478,746	8,000	3,000,000
3	0	174,999	1,013,027	2,478,746	8,000	3,000,000
4	0	174,999	1,013,027	2,478,746	8,000	3,000,000
5	0	174,999	1,013,027	2,478,746	8,000	3,000,000
6	0	118,299	684,806	1,675,632	5,408	2,027,000
Total	**0**	**993,294**	**5,749,941**	**14,069,362**	**45,408**	**17,027,000**

*Note: No additional electrical energy will be used for the proposed modification.

Table 8.3 summarises the estimated annual average CO_2 equivalent emissions from the proposal due to extraction and processing using the above emissions factors.

Table 8.3: Summary of estimated CO_2 emissions from mining and processing of coal from the proposal (tonnes/year)

Year	CO_2-e from diesel usage		CO_2-e from blasting (ANFO)	CO_2-e from blasting (Heavy ANFO)	CO_2-e from blasting (Emulsion)	CO_2-e from CH_4 released during mining	Total CO_2-e from mining and processing coal
	Scope 1	**Scope 3**	**Scope 1**	**Scope 1**	**Scope 1**	**Scope 1**	
1	21,462	1,637	29,750	182,345	421,387	135,000	791,581
2	21,462	1,637	29,750	182,345	421,387	135,000	791,581
3	21,462	1,637	29,750	182,345	421,387	135,000	791,581
4	21,462	1,637	29,750	182,345	421,387	135,000	791,581
5	21,462	1,637	29,750	182,345	421,387	135,000	791,581
6	14,508	1,106	20,111	123,265	284,857	91,215	535,062
Total	**121,818**	**9,291**	**168,861**	**1,034,990**	**2,391,792**	**766,215**	**4,492,967**

8.6.2 Emissions from Off-site Transport of Product Coal

The coal will need to be transported to Port Newcastle or to a customer outside the project area. For the purpose of this analysis, it is assumed that all coal is carried by rail to Port Newcastle a distance of approximately 110 km (one way). The CO_2-e emission factor for rail transportation provided by the Proponent is 11 t CO_2-e/Mt.km. This is comparable to an emission factor of 12.3 g/net tonne-km derived from a study conducted by Queensland Rail comparing greenhouse gas emissions for intermodal rail and road transport (**QR Network Access, 2002**).

Conservatively we have also assumed that emissions generated from the return journey of the train will equal the emissions of the journey to the Port of Newcastle.

Using this information, **Table 8.4** presents a summary of the CO_2 emissions from transporting the product coal from the project area to Port Newcastle and the return journey. Product coal sent for export has been assumed to be 100% of the total product coal.

Table 8.4: Summary of estimated CO_2 emissions from transport of product coal for export (t/y)

Year	Product coal for export* (t/y)	Total CO_2-e from rail transport to Port of Newcastle (t)	Total CO_2-e from rail transport (including return) (t)
		Scope 3	**Scope 3**
1	2,340,000	2,831	5,662
2	2,340,000	2,831	5,662
3	2,340,000	2,831	5,662
4	2,340,000	2,831	5,662
5	2,340,000	2,831	5,662
6	1,581,840	1,914	3,828
Total	**13,281,840**	**16,069**	**32,138**

* These volumes are based on a 78% yield of the total in-situ production

There will also be emissions associated with the shipping of the product coal to overseas customers and the use of the product coal overseas. Estimating emissions from these activities are difficult to calculate for the life of the proposal as the final destination and use of the product will vary.

Table 8.5 details the approximate distance travelled, the type of ship used and the associated emission factor for each ship, provided by the Proponent. The percentage of product coal distributed to each of these destinations has been calculated from the tonnage of coal carried by each ship in 2009. These percentages have been applied to each year of the proposal, however, it should be noted that these distributions will vary and it is impossible to accurately estimate.

Table 8.5: Summary of product coal transport to overseas customers

Destination	Ship type	Approximate Distance (km)	Emission Factor (t CO_2-e/Mt.km) Scope 3	Percentage of total product coal distribution (based on 2008 figures)
Europe	Panamax	21,000	3.459	1.8
Asia	Panamax	6,500	3.459	47.0
	Bulk Carrier	6,500	2.09	51.2

Using the information provided in **Table 8.5**, CO_2-e emissions have been estimated for the proposal and are presented in **Table 8.6**.

Table 8.6: Summary of estimated CO_2–e emissions from transport of product coal overseas (t)

Year	Europe Panamax CO_2-e (t)	Asia Panamax CO_2-e (t)	Asia Bulk Carrier CO_2-e (t)	Total CO_2-e (t)	Total CO_2-e (t) (including return)
	Scope 3	Scope 3	Scope 3	Scope 3	Scope 3
1	2,987	24,733	16,286	44,006	88,012
2	2,987	24,733	16,286	44,006	88,012
3	2,987	24,733	16,286	44,006	88,012
4	2,987	24,733	16,286	44,006	88,012
5	2,987	24,733	16,286	44,006	88,012
6	2,019	16,719	11,010	29,748	59,496
			Total	**249,778**	**499,556**

8.6.3 Emissions from the Use of Coal

Coal & Allied's customers will make use of the coal, and there will inevitably be GHG emissions associated with the end use. The emissions from burning the product coal will be much larger than those associated with the extraction and processing of the coal. The adopted convention is that these emissions are attributed to the user of the coal not the producer, however, to address the recent the judgement of her Honour Pain J in the matter of *Gray v The Minister for Planning*, estimates of the GHG emissions associated with the use of the coal have been made.

The convention of not including these emissions avoids double counting of the emissions: leaving the accounting of the emissions from the use of the coal to the end user is also desirable as emissions due to the end use depend on the method by which the coal is used to produce energy and any control measures that might be in place. Various methods of burning will be used by different customers. As all of the coal from the proposal is to be exported, any assessment of GHG emissions by its use in those other jurisdictions will be speculative and potentially unreliable.

The quantity of CO_2 emitted can be estimated with a reasonable degree of reliability if the carbon content of the coal is known. It is reasonable to assume that all of the carbon will be converted to CO_2 and that minor emissions of CO will be converted to CO_2 reasonably rapidly (in 1 to 4 months) (**Seinfeld and Pandis, 1998**). There will, however, be some uncertainty as to the production of N_2O, which depends not only on the nitrogen content in the fuel but the temperature of the combustion process. Some small quantity of carbon will also be retained in the ash from combustion in power stations.

For the purposes of this assessment it is assumed that approximately 80% of the coal would be used in a power station and that the power station would have similar emissions to a power station in NSW burning black coal. The emissions can then be estimated using the NGA emission factor of 88.43 kg CO_2-equivalent/GJ and an energy content factor of 27 GJ/t (Table 1, Scope 1 of **DCC, 2009a**).

Table 8.7 summarises the estimated CO_2 emissions for each year of the proposal due to usage of the product coal at a power station.

Table 8.7: Summary of estimated CO_2–e emissions from usage of coal in power generation (t)

Year	Coal used in Power Generation (t)	CO_2-e from Power Generation (t)
	Scope 3	**Scope 3**
1	1,872,000	4,469,606
2	1,872,000	4,469,606
3	1,872,000	4,469,606
4	1,872,000	4,469,606
5	1,872,000	4,469,606
6	1,265,472	3,021,454
Total	**10,625,472**	**25,369,484**

It is assumed that the remaining 20% of coal would be used in steel manufacturing. There is insufficient information available to use the detailed method defined in **DCC, 2009** to calculate emissions from usage in steel production, therefore the default emission factor for metallurgical (coking) coal has been used. The NGA emission factor is 90.22 kg CO_2-equivalent/GJ (Table 1, Scope 1 of **DCC, 2009**) and the energy content is 30 GJ/t.

Table 8.8 summarises the estimated CO_2 emissions for each year of the proposal due to usage of the product coal at steel making.

Table 8.8: Summary of estimated CO_2–e emissions from usage of coal in steel manufacture (t)

Year	Coal used in Steel Manufacture (t)	CO_2-e from Steel Manufacture (t)
	Scope 3	**Scope 3**
1	468,000	1,268,280
2	468,000	1,268,280
3	468,000	1,268,280
4	468,000	1,268,280
5	468,000	1,268,280
6	316,368	857,357
Total	**2,656,368**	**7,198,757**

8.7 Total CO_2-equivalent Emissions

Table 8.9 summarises the total emissions from all sources.

Table 8.9: Summary of total estimated CO_2–e emissions from all sources (t/y)

Year	CO_2-e Mining and extraction (t)			CO_2-e Transport of product coal - rail and ship (t)	CO_2-e Usage of product coal (t)	Total CO_2-e (t)	
	Scope 1	Scope 2	Scope 3	Scope 3	Scope 3	Scopes 1 & 2	Scope 3
1	789,944	0	1,637	93,674	5,737,886	789,944	5,833,197
2	789,944	0	1,637	93,674	5,737,886	789,944	5,833,197
3	789,944	0	1,637	93,674	5,737,886	789,944	5,833,197
4	789,944	0	1,637	93,674	5,737,886	789,944	5,833,197
5	789,944	0	1,637	93,674	5,737,886	789,944	5,833,197
6	533,956	0	1,106	63,324	3,878,811	533,956	3,943,241
						4.5	**33.1**
					Total (Mt)	**37.6**	
					Annual average (Mt/y)	**6.3**	

Note: some figures not exact due to rounding

8.8 Important additional considerations

While it is possible to assess the significance of these emissions by comparing them with other sources of GHGs, it is also important to note that the efficiency with which the coal is used is also very important. All other things being equal[j], global CO_2-e emissions could be halved if power station efficiencies were doubled, or halved if the efficiency by which end users' consumed electricity was doubled or waste was reduced and so on.

Different customers will use the coal in power plants of different thermal efficiencies. The Australian Coal Association provides some typical statistics for power station efficiencies on its web site (**ACA, 2006**).

The web site notes the following:

> "*Industry has continuously* striven to *increase efficiencies of conventional plant; for example, the average thermal efficiency of US power stations has increased from 5% in 1900, to around 35% currently. In China, most power plants are relatively small, average efficiency is about 28% compared to an OECD average of 38%. New conventional* [pulverised fuel] *PF power plants achieve above 40% efficiency.*
>
> *Advanced modern plants use specially developed high strength alloy steels, which enable the use of supercritical and ultra-supercritical steam (pressures >248 bar and temperatures >566°C) and can achieve, depending on location, close to 45% efficiency.*
>
> *Application of new advanced materials to PF power plant should enable efficiencies of 55% to be achieved in the future. This results in corresponding reductions in CO_2 emissions as less fuel is used per unit of electricity generated".*

Coal & Allied does not propose, nor does its application seek approval, to burn any of the coal produced directly.

8.9 Contribution of Greenhouse Gas Emissions from the Proposal to State, National and Global Emissions

This section provides a discussion on the contribution of the proposal to global emissions. Because the relationship between global warming and GHG concentrations is not linear, there is no accepted method to determine the contribution that a given emission of GHGs might make to global warming.

To understand this point, it is useful to consider the discussion from Section 1.3.1 of the Second Scientific Assessment Report prepared by the IPCC (**IPCC, 1996**), which was provided earlier in **Section 8.3**.

At any point in time, it would be reasonably simple to compare the estimated emission of CO_2-e from the various activities with the 3,000 Gt of CO_2-e currently estimated to be stored in the atmosphere. On this basis, average annual emissions over the lifetime of the proposal from the mining and burning of coal (including mining, transporting the coal to the Port of Newcastle and usage of the coal) are estimated to be 0.0002% of the current global CO_2–e atmospheric load.

[j] Population remaining fixed and the per capita consumption of energy being fixed.

Thus, the proposal could be considered to contribute 0.0002% to the increase in global temperatures caused by the increase in GHG emissions as they are currently. This invites the question as to what temperature rise might be attributed to the GHG emissions from the proposal.

Based on the IPPC estimate that a doubling of the CO_2-e concentration in the atmosphere would lead to a 2.5°C increase in global average temperature (see **Section 8.3**), and that the current global CO_2–e load is approximately 3,000 Gt, it can be estimated that the annual average emissions (Scope 1, 2 and 3) during the life of proposal (including mining, transporting the coal to the Port of Newcastle and overseas and usage of the coal) could lead to an annual increase in global temperature of 0.000005 °C (0.0002% of 2.5°C).

The total CO_2–e emissions for the State of NSW in 2007 were 162.7 Mt CO_2 –e (**DCC, 2009b**). The average annual emissions estimated for the lifetime of the proposal (Scopes 1 and 2) is 0.75 Mt CO_2–e. This equals approximately 0.5% of the total emissions for NSW in 2007.

In 2007, Australia's total GHG emissions were estimated at 541.2 Mt CO_2-e (**DCC, 2009b**). When comparing emissions for (Scope 1 and 2) associated with the proposal project, the predicted increase is 0.14% of total 2007 Australian emissions.

Based on the above, there is not likely to be any measurable environmental effect due to the emissions of GHGs from the proposal, i.e. the contribution of the project to GHG emissions will be negligible. Given this, the proposal will comply with the principles of ESD.

In practice, of course, the effects of global warming and associated climate change are the cumulative effect of many thousands of such sources and it is the cumulative effects that pose a threat to ESD principles.

9 MITIGATION MEASURES

9.1 Introduction

Environmental aspects of Coal & Allied's activities are managed under Rio Tinto Coal Australia's Health, Safety, Environment and Quality Management System which is certified to the international standard ISO:14001(2004). In addition, the HVO Dust / Air Quality Management Plan is used for HVO including Carrington Pit.

The proposal will generate dust. It is therefore prudent to take reasonable and practicable measures to prevent or minimise dust impacts at sensitive receptors. This section outlines the procedures proposed for the management and control of dust emissions for the proposal.

9.2 Proposed dust management and control procedures

There are currently management measures and existing plans utilised for all operations (both HVO North and HVO South) and these are outlined in the environmental management report for HVO South (**ERM, 2008**). The following procedures are proposed to minimise dust emissions from the proposal. Dust is generated from two primary sources, these being:

- Wind-blown dust from exposed areas; and
- Dust generated by mining activities.

Table 9.1 and **Table 9.2** list the different sources of wind-blown and mining-generated dust respectively, and the proposed controls.

Table 9.1: Control Procedures for Wind-blown Dust

Source	Control Procedures
Areas disturbed by mining	Disturb only the minimum area necessary for mining. Reshape, topsoil and rehabilitate completed overburden emplacement areas as soon as practicable after the completion of overburden tipping.
Coal handling areas / stockpiles	Maintain coal handling areas / stockpiles in a moist condition to minimise wind-blown and traffic-generated dust.
ROM Coal Stockpiles	Have available water sprays on ROM coal stockpiles and use sprays to reduce airborne dust, as required.

Table 9.2: Mine-generated Dust and Controls

Source	Control procedures
Haul Road Dust	All roads and trafficked areas will be watered as required using water trucks to minimise the generation of dust. All haul roads will have edges clearly defined with marker posts or equivalent to control their locations, especially when crossing large overburden emplacement areas. Obsolete roads will be ripped and re-vegetated.
Minor roads	Development of minor roads will be limited and the locations of these will be clearly defined. Minor roads used regularly for access etc will be watered. Obsolete roads will be ripped and re-vegetated.
Topsoil Stripping	Access tracks used by topsoil stripping equipment during their loading and unloading cycle will be watered.
Topsoil Stockpiling	Long term topsoil stockpiles, not used for over 3 months, will be re-vegetated.
Drilling	Dust aprons will be lowered during drilling. Drills will be equipped with dust extraction cyclones, or water injection systems. Water injection or dust suppression sprays will be used when high levels of dust are being generated.
Blasting	Adequate stemming will be used at all times. Restriction of blasting during unfavorable weather conditions will occur, where practicable.

9.3 Energy efficiency and GHG emission reduction measures

Coal & Allied has plans and standards to minimize energy usage and GHG emissions from its operations, including HVO. This currently includes the Greenhouse and Energy Efficiency Plan for HVO and the Rio Tinto Coal Australia Climate Change Action Plan. These plans include objectives, commitments, procedures and responsibilities for:

- researching and promoting low emission coal technologies;
- improving energy use and efficiency and reducing GHG emissions from the mining, processing and use of coal;
- designing projects to recognise climate change risks and opportunities; and
- raising awareness and building support amongst key stakeholders groups, including government agencies.

Coal & Allied has targets for GHG emissions and energy use, as well as legal requirements for monitoring and reporting on these. The existing energy saving and GHG emission reduction measures and projects will continue to be implemented at HVO, inclusive of the proposal, and will be revised as required to respond to new information, technologies and policies as they evolve.

9.4 Waste Minimisation and Management

In addition to the plans and standards outlined in **Section 9.3**, waste is managed across HVO in accordance with the waste management plans which form part of Rio Tinto Coal Australia's Health, Safety, Environment and Quality Management System. Waste generated from the proposal would be managed in conformity with these plans. Such waste management contributes to energy efficiency through measures such as the following:

- planning when purchasing items to avoid or minimise waste so that preference is given to products that are recyclable or reusable over products that are either not recyclable or reusable, as well as products that have the minimum of packaging and/or packaging which is reusable or recyclable;
- segregating waste to facilitate maximum reuse or recycling, including segregation of scrap metals and waste grease and lubricants and general recyclables such as glass and paper;
- awareness through environmental training to ensure that relevant employees are aware of waste management procedures;
- a waste tracking system; and
- disposal of waste by a licensed contractor.

10 CONCLUSIONS

This report has assessed the potential impacts on air quality from the proposal (including HVO North). Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to the dust generating activities that would occur as part of the proposal. The modelling took account of the local meteorology and terrain and used dust emission estimates to predict the air quality impacts for two mining scenarios, namely Year 1 and Year 5. These scenarios were determined to be most representative of worst case emissions based on the amount of overburden removed, length of haul roads and distance of operations from the nearest residential receptors.

Predictions of air quality impacts considered the effects of other mines in the area as well as other non-mining and non-modelled sources of dust. Model predictions at residential receptors were compared with the relevant air quality criteria for both the DECCW and the DoP.

Analysis of the dispersion modelling results indicates that all residential receptors except one, would comply with the DECCW assessment criteria. This single receptor showed an exceedance of the 24-hour PM_{10} criterion on one occasion in Year 1. Further analysis showed that the DoP criterion for acquisition was not exceeded at that location, as an exceedance of the 24-hour average PM_{10} criterion was only predicted to occur on one day over a one year period.

Coal & Allied will continue to manage potential air quality impacts from HVO, including the proposal, through a range of dust controls and continued monitoring of air quality in the area surrounding the mine.

A GHG assessment was also carried out and it was found that there are not likely to be any measurable environmental effects due to the emissions of GHGs from the proposal.

11 REFERENCES

ACA (2006)

http://www.australiancoal.com.au/cleantech.htm

Bureau of Meteorology (2009)

Climatic Averages Australia, Bureau of Meteorology website
http://www.bom.gov.au/climate/averages/

Buonicore, A and Davis, W (1992)

"Air Pollution Engineering Manual". Air and Waste Management Association.

DEC (2005)

"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW", August 2005

DCC (2008)

"National Greenhouse Account (NGA) Factors" January 2008. Published by the Department of Climate Change. http://www.climatechange.gov.au/

DCC (2009a)

"National Greenhouse Account (NGA) Factors" June 2009. Published by the Department of Climate Change. http://www.climatechange.gov.au/

DCC (2009b)

"State and Territory Greenhouse Gas Inventories 2007". May 2009. Published by the Department of Climate Change. Available from http://www.climatechange.gov.au/

DUAP (2000)

"Coal mines and associated infrastructure – EIS guideline" Department of Urban Affairs and Planning (now Department of Planning), 23-33 Bridge Street (GPO Box 39) Sydney, NSW 2001.

ERM (2008)

Hunter Valley Operations South Coal Project Environmental Assessment.

Garnaut (2008)

"The Garnaut Climate Change Review. Final Report", Ross Garnaut
www.garnautreview.org.au

Hanna S. R., Briggs G. A., Deardorff J. C., Egan B. A., Gifford F. A. and Pasquill F. (1977)

AMS Workshop on Stability Classification Schemes and Sigma Curves - Summary of Recommendations" concerning the adjustment of sigma-curves, Bulletin American Meteorological Society, Volume 58, Number 12, 1305-1309.

HAS (2005)

Air Quality Assessment – Carrington Pit Extension. Prepared by Holmes Air Sciences for ERM Australia, October 2005.

HAS (2007)
Air Quality Assessment : Hunter Valley Operations South Coal Project. Prepared by Holmes Air Sciences for ERM Australia, February 2007.

IEA (2009)
"CO2 Emissions from Fuel Consumption 2009" International Energy Agency ISBN 92-64-10891-2. Available from http://www.iea.org/co2highlights/.

IPCC (1990)
"Climate Change 1990 – The Science of Climate Change: - The IPCC Scientific Assessment" Edited by Houghton, J T, Jenkins J J, Ephraums J J, Cambridge University Press, UK 365 pp.

IPCC (1994)
"Climate Change 1994 – Radiative Forcing of Climate Change and an Evaluation of IPCC IS92 Emissions Scenarios" Edited by Houghton, J T, Meira Filho L G, Bruce J, Lee, H, Callender B A, Haites E, \ Harris N and Maskell K, Cambridge University Press, UK 339 pp.

IPCC (1996)
"Climate Change 1995 – The Science of Climate Change – Contribution of Working Group 1 to the Second Assessment Report of the Intergovernmental Panel on Climate Change" Edited by Lakeman J A, Published by Cambridge University Press, ISB 0 521 56436 0.

IPCC (2001)
"Climate Change 2001: The Scientific Basis". Contribution of Working Group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Nouger, P.J. van der Linden, X.

IPCC (2007)
"Climate Change 2007: Synthesis Report". An Assessment of the Intergovernmental Panel on Climate Change.

NEPC (2003)
"Variation to the National Environment Protection (Ambient Quality) Measure for Particles as PM2.5", May 2003.

Powell, D.C. (1976)
"A Formulation of Time-varying Depths of Daytime Mixed Layer and Night-time Stable Layer for Use in Air Pollution Assessment Models", Annual Report for 1976, Part 3, Battelle PNL Atmospheric Sciences, 185-189.

QR Network Access (2002)
"Comparison of Greenhouse Gas Emissions by Australian Intermodal Rail and Road Transport" QR Network Access, 127 Creek Street, Brisbane, Queensland 4000.

Seinfeld J H and Pandis S N (1998)
"Atmospheric Chemistry and Physics" Published by John Wiley & Sons Inc

SPCC (1983)
Air Pollution from Coal Mining and Related Developments, State Pollution Control Commission.

SPCC (1986)

Particle size distributions in dust from open cut coal mines in the Hunter Valley, Report Number 10636-002-71, Prepared for the State Pollution Control Commission of NSW (now DECCW) by Dames & Moore, 41 McLaren Street, North Sydney, NSW 2060.

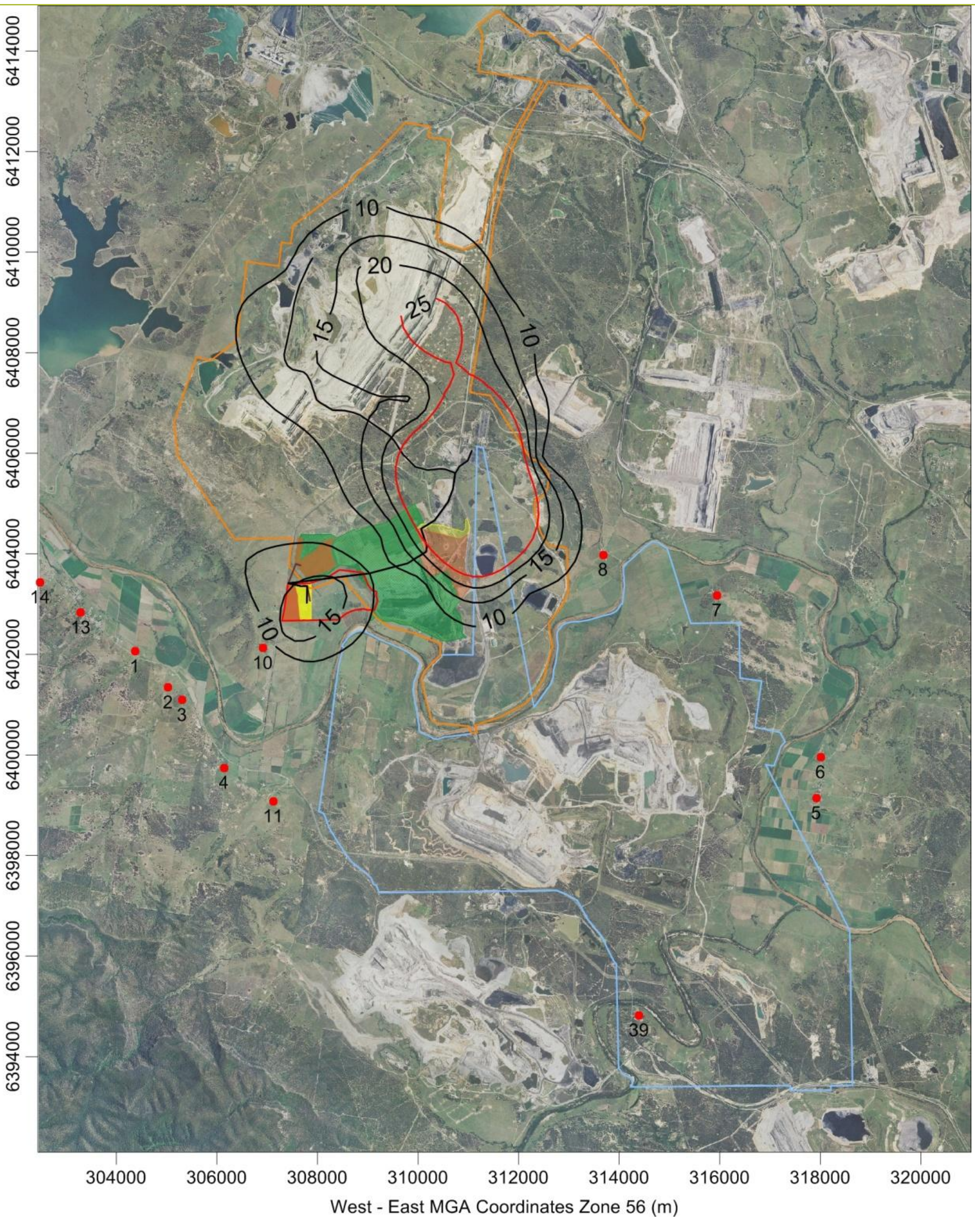
US EPA (1985 and updates)

Compilation of Air Pollutant Emission Factors, AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711. Note this reference is now a web-based document.

Venkatram, A. (1980)

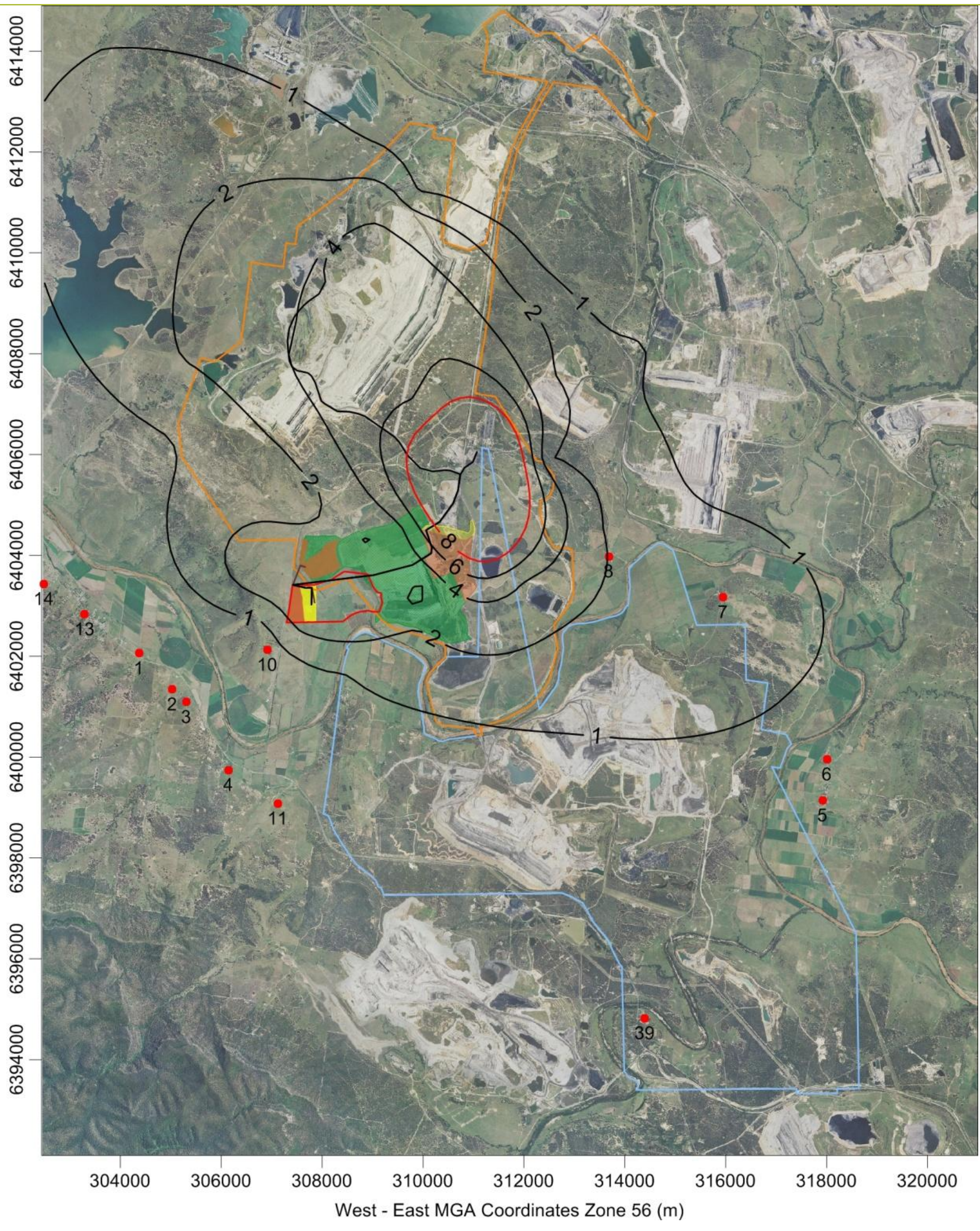
"Dispersion from an elevated source in a convection boundary layer", Atmospheric Environment, Volume 10, 1-10.

Appendix A: Contour plots of predicted $PM_{2.5}$ concentrations due to HVO North operations only



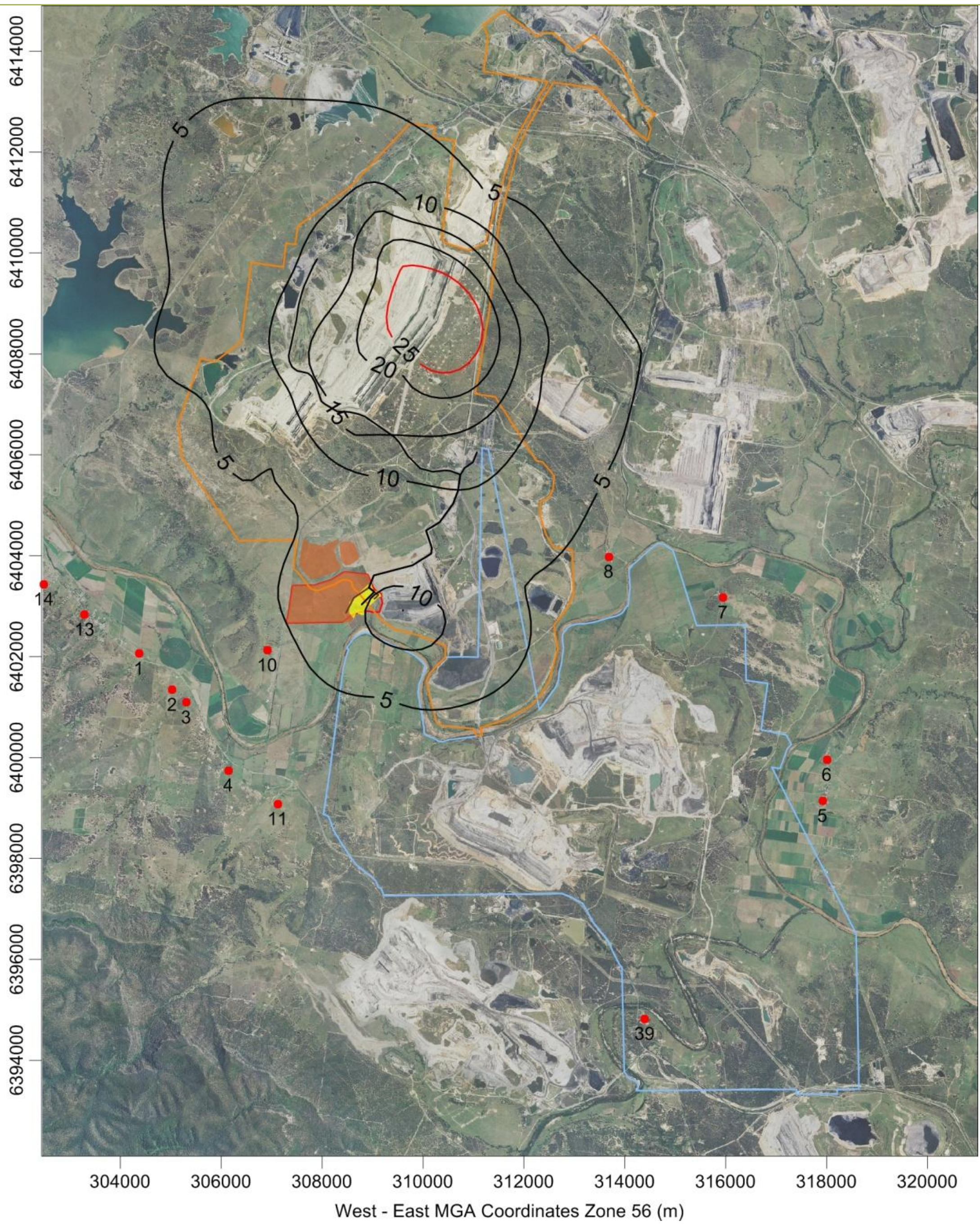
Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	HVO North	Year 1 – HVO North only	Maximum	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m³	NEPC = 25 µg/m³	2006/2007	J. Barnett

Figure A.1: Predicted 24-hour average $PM_{2.5}$ concentrations due to emissions from HVO North in Year 1 of the proposal



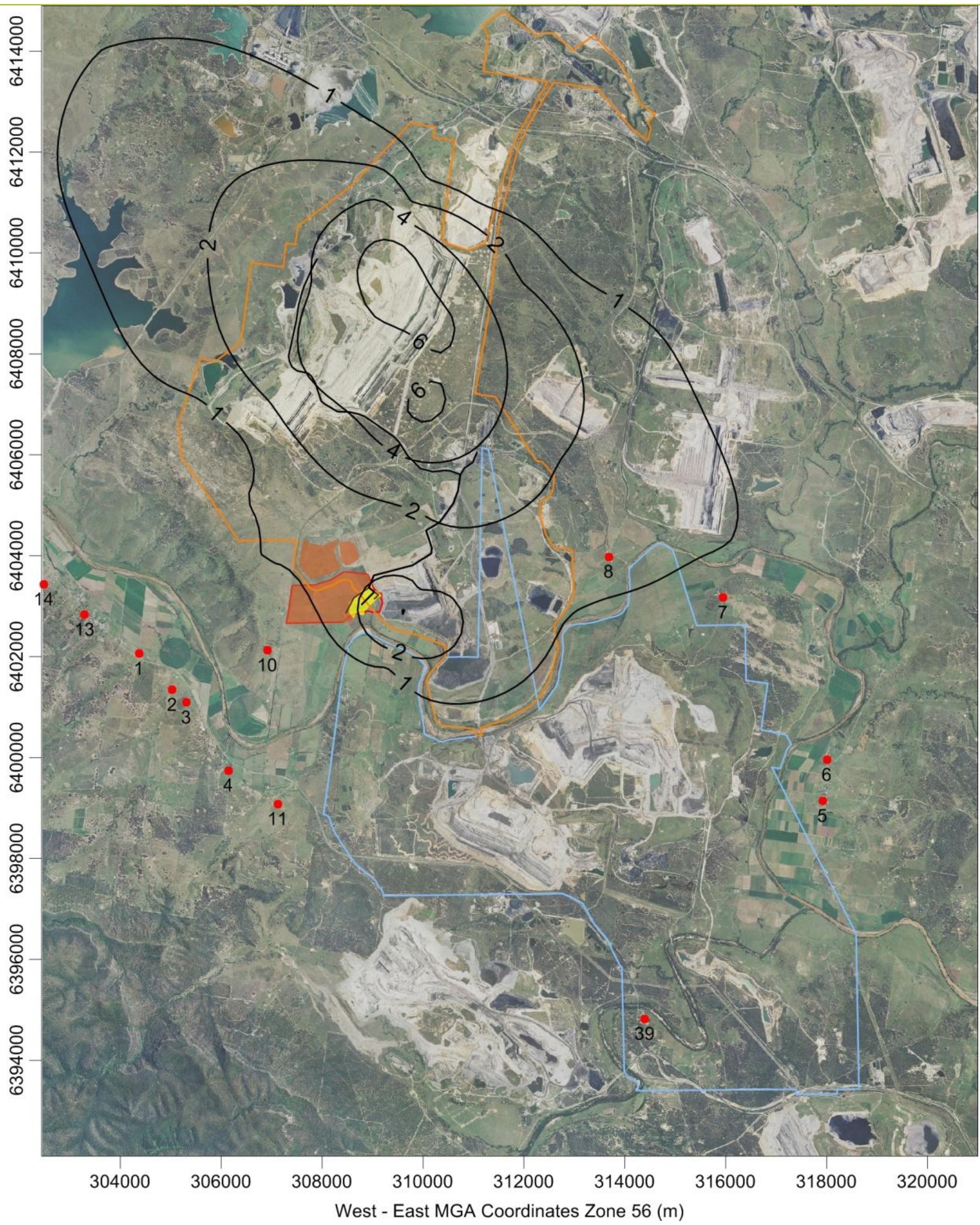
Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	HVO North	Year 1 – HVO North only	Maximum	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m³	NEPC = 8 µg/m³	2006/2007	J. Barnett

Figure A.2: Predicted annual average $PM_{2.5}$ concentrations due to emissions from HVO North in Year 1 of the proposal



Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	HVO North	Year 5 – HVO North only	Maximum	24-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m³	NEPC = 25 µg/m³	2006/2007	J. Barnett

Figure A.3: Predicted 24-hour average $PM_{2.5}$ concentrations due to emissions from HVO North in Year 5 of the proposal



Species:	Location:	Scenario:	Percentile:	Averaging Time:
$PM_{2.5}$	HVO North	Year 5 – HVO North only	Maximum	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m³	NEPC = 8 µg/m³	2006/2007	J. Barnett

Figure A.4: Predicted 24-hour average $PM_{2.5}$ concentrations due to emissions from HVO North in Year 5 of the proposal

Appendix B: Joint wind speed, wind direction and stability class frequency tables for HVO North

STATISTICS FOR FILE: C:\Jobs\3412_Carrington_West_Wing\Metdata\hvo_0607.isc
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001404	0.001990	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003394
NE	0.001404	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002341
ENE	0.001522	0.001522	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003043
E	0.002692	0.004213	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006905
ESE	0.002341	0.009012	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011353
SE	0.001990	0.006320	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008310
SSE	0.001522	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002458
S	0.000702	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001053
SSW	0.000702	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001053
SW	0.000468	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000819
WSW	0.000468	0.000468	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000936
W	0.000468	0.000819	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001287
WNW	0.001287	0.003394	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004682
NW	0.003394	0.007491	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010885
NNW	0.001287	0.003979	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005267
N	0.001873	0.003511	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005384
CALM									0.002458
TOTAL	0.023525	0.045646	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.071629

MEAN WIND SPEED (m/s) = 1.78
NUMBER OF OBSERVATIONS = 612

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000234
NE	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000351
ENE	0.000585	0.000234	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.001053
E	0.001053	0.000936	0.001287	0.000000	0.000000	0.000000	0.000000	0.000000	0.003277
ESE	0.000234	0.004331	0.004682	0.000000	0.000000	0.000000	0.000000	0.000000	0.009246
SE	0.001170	0.004448	0.001404	0.000000	0.000000	0.000000	0.000000	0.000000	0.007022
SSE	0.000468	0.000936	0.000819	0.000000	0.000000	0.000000	0.000000	0.000000	0.002224
S	0.000234	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000351
SSW	0.000117	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000234
SW	0.000117	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000351
WSW	0.000000	0.000351	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.000585
W	0.000351	0.000585	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.001287
WNW	0.000468	0.003277	0.003511	0.000000	0.000000	0.000000	0.000000	0.000000	0.007257
NW	0.001522	0.001756	0.002809	0.000000	0.000000	0.000000	0.000000	0.000000	0.006086
NNW	0.000117	0.000351	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.000702
N	0.000234	0.000117	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.000585
CALM									0.001170
TOTAL	0.007257	0.017790	0.015801	0.000000	0.000000	0.000000	0.000000	0.000000	0.042018

MEAN WIND SPEED (m/s) = 2.52
NUMBER OF OBSERVATIONS = 359

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000585	0.000234	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000936
NE	0.000000	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000117
ENE	0.000468	0.000585	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001053
E	0.001170	0.001053	0.001873	0.000702	0.000000	0.000000	0.000000	0.000000	0.004799
ESE	0.001053	0.004682	0.014630	0.009949	0.000000	0.000000	0.000000	0.000000	0.030314
SE	0.001404	0.015684	0.015215	0.006437	0.000000	0.000000	0.000000	0.000000	0.038741
SSE	0.000351	0.005267	0.007140	0.002458	0.000000	0.000000	0.000000	0.000000	0.015215
S	0.000000	0.000351	0.000234	0.000702	0.000000	0.000000	0.000000	0.000000	0.001287
SSW	0.000117	0.000117	0.000117	0.000117	0.000000	0.000000	0.000000	0.000000	0.000468
SW	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000117
WSW	0.000117	0.000351	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000585
W	0.000585	0.001287	0.001873	0.000468	0.000000	0.000000	0.000000	0.000000	0.004213
WNW	0.000936	0.007374	0.012992	0.012523	0.000000	0.000000	0.000000	0.000000	0.033825
NW	0.001170	0.003862	0.006203	0.005969	0.000000	0.000000	0.000000	0.000000	0.017205
NNW	0.000936	0.000351	0.000702	0.001287	0.000000	0.000000	0.000000	0.000000	0.003277
N	0.000000	0.000117	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000234
CALM									0.002224
TOTAL	0.009012	0.041433	0.061330	0.040613	0.000000	0.000000	0.000000	0.000000	0.154611

MEAN WIND SPEED (m/s) = 3.58
NUMBER OF OBSERVATIONS = 1321

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002224	0.000000	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.002458
NE	0.001287	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002224
ENE	0.001756	0.000702	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.002692
E	0.002809	0.002575	0.001990	0.000936	0.000117	0.000000	0.000000	0.000000	0.008427
ESE	0.008310	0.019663	0.018141	0.022355	0.016971	0.003628	0.001522	0.000234	0.090824
SE	0.015449	0.042369	0.047168	0.014630	0.005969	0.000702	0.000000	0.000000	0.126287
SSE	0.007842	0.028441	0.008544	0.002224	0.000468	0.000000	0.000000	0.000000	0.047519
S	0.002692	0.003511	0.000585	0.000117	0.000117	0.000000	0.000000	0.000000	0.007022
SSW	0.001053	0.000585	0.000468	0.000000	0.000000	0.000000	0.000000	0.000000	0.002107
SW	0.001170	0.000936	0.000117	0.000117	0.000000	0.000117	0.000000	0.000000	0.002458
WSW	0.001053	0.001873	0.000936	0.000117	0.000000	0.000117	0.000000	0.000000	0.004096
W	0.004565	0.011470	0.005969	0.004799	0.001287	0.001053	0.000351	0.000351	0.029846
WNW	0.005852	0.027154	0.051849	0.027505	0.016503	0.005033	0.000936	0.000351	0.135183
NW	0.002575	0.011119	0.023993	0.014279	0.009129	0.003160	0.001756	0.000936	0.066948
NNW	0.001873	0.002107	0.004096	0.002341	0.001404	0.001287	0.000585	0.000117	0.013811
N	0.003394	0.000702	0.000234	0.000234	0.000000	0.000000	0.000000	0.000000	0.004565
CALM									0.013343
TOTAL	0.063904	0.154143	0.164560	0.089654	0.051966	0.015098	0.005150	0.001990	0.559808

MEAN WIND SPEED (m/s) = 3.70
NUMBER OF OBSERVATIONS = 4783

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001170	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001404
NE	0.001287	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001639
ENE	0.001170	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001287
E	0.001990	0.000702	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002692
ESE	0.003394	0.002458	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.006203
SE	0.007022	0.011236	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.018258
SSE	0.003160	0.006437	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009597
S	0.000585	0.000819	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001404
SSW	0.001053	0.000585	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001639
SW	0.001522	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001756
WSW	0.001873	0.001287	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003160
W	0.005267	0.007491	0.000819	0.000000	0.000000	0.000000	0.000000	0.000000	0.013577
WNW	0.006203	0.017907	0.012406	0.000468	0.000000	0.000000	0.000000	0.000000	0.036985
NW	0.003862	0.003511	0.002575	0.000000	0.000000	0.000000	0.000000	0.000000	0.009949
NNW	0.002926	0.001404	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004331
N	0.002926	0.001053	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003979
CALM									0.009012
TOTAL	0.045412	0.055829	0.016152	0.000468	0.000000	0.000000	0.000000	0.000000	0.126873

MEAN WIND SPEED (m/s) = 1.84
NUMBER OF OBSERVATIONS = 1084

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001287	0.000468	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001756
NE	0.000351	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000468
ENE	0.000819	0.000234	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001053
E	0.000936	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001287
ESE	0.001522	0.000468	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001990
SE	0.001639	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001990
SSE	0.001522	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002458
S	0.001053	0.001170	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002224
SSW	0.001170	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001522
SW	0.001873	0.001053	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002926
WSW	0.001522	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002458
W	0.002575	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003511
WNW	0.003277	0.002224	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005501
NW	0.002692	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003043
NNW	0.001170	0.000468	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001639
N	0.001639	0.000117	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001756
CALM									0.009480
TOTAL	0.025047	0.010534	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.045061

MEAN WIND SPEED (m/s) = 1.12
NUMBER OF OBSERVATIONS = 385

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.006905	0.002926	0.000351	0.000000	0.000000	0.000000	0.000000	0.000000	0.010183
NE	0.004682	0.002458	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007140
ENE	0.006320	0.003394	0.000468	0.000000	0.000000	0.000000	0.000000	0.000000	0.010183
E	0.010651	0.009831	0.005150	0.001639	0.000117	0.000000	0.000000	0.000000	0.027388
ESE	0.016854	0.040613	0.037804	0.032303	0.016971	0.003628	0.001522	0.000234	0.149930
SE	0.028675	0.080407	0.063787	0.021067	0.005969	0.000702	0.000000	0.000000	0.200609
SSE	0.014864	0.042954	0.016503	0.004682	0.000468	0.000000	0.000000	0.000000	0.079471
S	0.005267	0.006320	0.000819	0.000819	0.000117	0.000000	0.000000	0.000000	0.013343
SSW	0.004213	0.002107	0.000585	0.000117	0.000000	0.000000	0.000000	0.000000	0.007022
SW	0.005267	0.002809	0.000117	0.000117	0.000000	0.000117	0.000000	0.000000	0.008427
WSW	0.005033	0.005267	0.001287	0.000117	0.000000	0.000117	0.000000	0.000000	0.011821
W	0.013811	0.022589	0.009012	0.005267	0.001287	0.001053	0.000351	0.000351	0.053722
WNW	0.018024	0.061330	0.080758	0.040496	0.016503	0.005033	0.000936	0.000351	0.223432
NW	0.015215	0.028090	0.035581	0.020248	0.009129	0.003160	0.001756	0.000936	0.114115
NNW	0.008310	0.008661	0.005033	0.003628	0.001404	0.001287	0.000585	0.000117	0.029026
N	0.010066	0.005618	0.000585	0.000234	0.000000	0.000000	0.000000	0.000000	0.016503
CALM									0.037687
TOTAL	0.174157	0.325375	0.257842	0.130735	0.051966	0.015098	0.005150	0.001990	1.000000

MEAN WIND SPEED (m/s) = 3.14
NUMBER OF OBSERVATIONS = 8544

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 7.2%
B : 4.2%
C : 15.5%
D : 56.0%
E : 12.7%
F : 4.5%

Appendix C: Monthly dust deposition data

Monthly dust deposition data from 2004 to 2009 - g/m²/month																		
Date	**DCL**	**D15**	**D2A**	**D1**	**D16**	**D8**	**D3**	**D114**	**D7A**	**D32**	**D33**	**D34**	**D116**	**D110**	**D5**	**D117**	**D112**	**D101**
Jan-04	3.2	-	-	4.0	-	3.6	-	2.8	-	-	2.2	2.9	3.5	2.3	2.5	1.8	1.7	-
Feb-04	-	-	6.5	3.1	-	2.6	-	-	3.1	3.7	2.9	1.9	4.7	1.6	1.5	1.5	2.2	0.7
Mar-04	3.3	0.7	2.4	-	-	2.7	-	8.1	1.3	1.5	1.2	1.7	3.5	1.6	-	1.6	0.8	1.8
Apr-04	3.9	2.6	2.9	7.7	4.3	1.7	4.9	4.5	3.8	3.5	1.7	5.0	3.1	1.8	3.0	1.8	0.9	1.0
May-04	-	2.4	2.3	1.8	2.9	1.3	3.5	2.6	0.8	2.6	2.1	1.8	4.5	1.6	2.8	1.1	1.8	0.7
Jun-04	-	1.0	2.9	1.6	2.8	0.7	-	1.8	0.3	-	1.4	1.8	2.0	1.5	-	0.3	0.3	0.3
Jul-04	1.9	1.1	4.5	1.5	1.7	0.7	5.6	3.0	0.7	-	1.9	3.3	-	0.4	-	0.6	0.2	0.4
Aug-04	1.8	1.6	6.3	1.1	3.3	1.5	-	2.9	0.9	2.8	1.4	1.9	2.6	1.1	-	1.4	0.6	0.9
Sep-04	1.1	0.9	5.1	0.5	-	1.4	2.7	2.7	0.8	2.1	1.2	1.3	3.6	3.0	-	1.6	0.6	0.7
Oct-04	1.6	1.2	3.6	2.1	5.0	1.2	2.3	1.5	1.6	2.4	1.2	2.1	3.1	1.7	2.6	0.9	1.0	0.8
Nov-04	2.1	2.4	5.1	3.6	-	2.6	4.2	3.5	2.9	-	-	2.4	4.8	2.1	-	2.1	1.4	1.6
Dec-04	1.7	1.0	-	2.0	-	1.1	2	-	1.5	-	1.0	1.2	1.8	-	-	1.3	1.3	1.0
Jan-05	2.5	1.5	-	1.6	4.3	-	1.5	5.3	2.0	2.3	1.8	1.1	2.8	2.1	2.0	2.6	0.6	3.3
Feb-05	4.4	2.0	8.8	2.6	5.4	3.7	6.4	-	3.6	5.6	2.1	2.9	-	3.0	5.3	1.8	2.2	-
Mar-05	3.0	1.8	5.5	3.1	3.8	1.7	3.2	1.9	2.4	2.3	2.9	1.3	3.4	4.5	4.7	1.9	0.9	2.0
Apr-05	3.3	3.6	3.3	2.1	2.8	3.0	-	2.0	2.7	1.5	2.6	1.8	4.6	1.4	-	2.3	1.4	1.1
May-05	3.7	1.6	5.8	2.5	2.1	2.9	4.7	2.2	1.6	1.2	1.9	1.4	2.4	1.1	2.0	3.1	1.0	1.0
Jun-05	2.9	2.8	5.7	2.4	2.3	3.2	5.3	3.1	1.8	8.5	2.6	2.4	3.0	1.1	6.3	1.2	0.6	1.1
Jul-05	2.5	-	10.1	1.1	2.2	3.8	4.5	3.2	2.5	2.9	2.3	2.1	1.5	0.7	-	0.9	0.8	1.9
Aug-05	5.1	4.5	2.6	2.1	2.7	2.1	5.6	3.5	2.0	4.2	2.3	3.3	5.1	1.5	-	1.6	-	1.4
Sep-05	6.3	2.3	3.1	1.9	2.7	1.4	4.8	4.1	1.9	4.9	2.4	2.6	3.6	1.6	7.5	4.1	1.3	1.9
Oct-05	2.7	10.3	3.5	2.5	6.2	3.2	4.9	3.8	3.1	2.9	2.1	2.3	3.3	1.3	3.0	1.4	0.8	1.0
Nov-05	12.2	2.9	10.9	2.6	7.1	7.2	9.0	3.7	7.9	16.1	3.3	2.8	3.6	1.4	7.2	1.7	0.8	1.2
Dec-05	4.9	5.3	8.2	5.2	2.7	14.4	7.7	6.3	6.3	6.0	10.7	4.1	7.1	1.4	2.4	1.3	0.4	5.3
Jan-06	0.9	1.2	7.1	2.7	4.3	15.7	3.2	4.6	2.4	4.1	2.6	1.0	3.1	1.9	3.3	1.3	0.7	2.7
Feb-06	1.3	0.3	8.2	4.6	4.0	4.6	5.0	3.6	3.2	3.3	3.1	1.7	3.1	2.9	4.8	3.0	1.0	2.1
Mar-06	3.2	2.1	6.2	2.3	2.8	3.4	2.6	2.6	3.4	2.3	3.7	1.9	3.0	1.6	5.3	1.9	3.5	1.4
Apr-06	2.1	1.2	1.7	0.9	2.0	1.9	2.3	2.3	1.3	2.5	1.0	1.4	2.4	0.7	1.2	1.6	0.3	1.2
May-06	4.0	2.8	3.3	1.7	2.9	4.5	3.3	3.4	2.7	3.8	2.4	2.1	2.6	2.3	2.4	1.6	7.8	2.3
Jun-06	4.1	2.3	2.9	1.0	2.9	9.6	4.0	2.5	4.5	3.0	1.7	3.6	2.0	1.1	3.3	1.5	0.6	1.1
Jul-06	2.3	1.8	2.7	0.9	1.9	4.0	1.9	3.9	1.3	2.5	1.0	1.1	1.5	1.0	1.4	1.9	1.3	1.7
Aug-06	4.0	2.5	7.0	1.8	3.7	2.7	8.7	6.5	2.0	6.2	2.1	1.7	2.5	0.7	1.7	1.3	0.8	1.9
Sep-06	3.1	1.6	3.4	2.2	4.1	2.5	5.0	5.0	2.0	3.8	2.5	3.5	3.3	1.3	0.9	6.0	1.3	1.8

Oct-06	2.2	11.5	6.5	7.5	5.3	2.6	4.7	2.9	2.5	1.4	2.1	2.5	3.5	1.8	0.9	1.2	2.1	2.4
Nov-06	4.3	4.3	6.9	4.0	2.5	2.5	4.2	2.8	2.8	4.2	2.4	2.0	5.2	2.4	7.2	3.1	2.9	4.4
Dec-06	1.8	1.8	4.5	2.2	6.5	2.3	3.9	2.4	2.5	2.2	2	2.3	1.9	2.3	17.2	2.2	1.7	2.4
Jan-07	1.9	5.4	3.5	2.8	2.6	2.8	2.0	2.4	3.6	2.1	1.8	1.9	4.5	1.4	10.0	2.9	1.2	2.8
Feb-07	1.5	1.1	4.9	1.3	7.3	3.3	0.9	1.8	2.1	0.5	1.3	1.1	1.1	0.6	4.6	1.9	1.1	2.2
Mar-07	6.6	3.2	4.7	4.1	2.7	3.2	5.6	3.8	2.2	4.5	2.5	2.6	9.5	1.9	16.3	2.0	1.7	2.0
Apr-07	3.7	1.9	5.8	3.1	4.1	5.2	5.8	3.6	2.2	2.6	1.9	1.9	3.6	2.1	15.9	1.5	1.3	1.9
May-07	6.2	2.9	3.1	3.0	3.7	-	-	6.9	2.2	5.5	1.9	3.9	3.5	1.4	16.9	-	8.6	2.4
Jun-07	3.8	4.0	1.7	22.7	1.3	31.4	3.1	3.3	0.8	2.2	1.0	1.2	1.1	0.8	14.0	0.8	0.5	1.2
Jul-07	4.3	5.7	2.2	3.3	0.9	1.2	3.2	4.9	1.2	1.3	2.8	1.7	3.1	8.3	0.8	9.1	0.4	3.2
Aug-07	3.0	-	2.5	1.8	1.2	2.2	3.5	4.8	1.1	3.9	1.5	2.2	2.7	0.8	2.7	0.9	0.4	0.8
Sep-07	4.1	3.1	4.5	0.7	2.5	4.6	3.5	3.5	1.1	4.4	1.2	2.0	3.1	1.2	-	0.9	1.0	1.6
Oct-07	1.1	1.2	1.4	0.8	1.2	1.4	2.5	2.6	1.0	2.6	0.9	1.8	2.0	1.4	2.7	0.8	0.9	1.0
Nov-07	1.5	5.3	1.4	2.2	3.2	2.6	3.8	1.9	2.5	1.2	1.7	0.9	1.3	2.0	4.5	1.3	2.1	1.1
Dec-07	2.3	1.9	2.7	1.9	4.8	2.0	4.6	5.8	2.0	4.0	2.4	3.0	3.3	1.3	11	-	0.9	1.6
Jan-08	6.3	1.3	3.1	3.8	11.3	1.9	7.0	0.7	2.7	1.4	0.6	1.6	1.5	0.5	2.1	-	0.7	0.7
Feb-08	3.6	1.8	3.0	6.1	23.8	0.6	3.2	3.7	1.0	2.8	2.9	1.4	2.4	1.7	8.4	1.9	1.0	1.3
Mar-08	4.0	2.8	6.5	4.0	6.9	2.1	9.2	1.4	2.7	1.3	0.5	1.4	2.9	0.7	3.1	0.6	0.3	0.5
Apr-08	4.9	2.0	2.6	4.0	3.2	3.2	4.3	2.3	1.7	2.4	1.3	2.2	3.9	1.4	4.4	1.5	0.6	0.8
May-08	5.2	2.5	3.9	2.4	2.2	1.6	7.0	5.8	3.2	3.9	1.6	2.2	6.7	0.9	4.8	0.7	0.5	0.9
Jun-08	24	2.5	4.8	4.1	1.7	1.4	4.2	2.1	1.5	2.4	1.2	2.5	3.6	1.1	3.5	1.0	0.4	1.2
Jul-08	21.4	6.3	3.9	2.0	1.1	1.2	13.0	2.6	1.0	3.3	2.0	2.3	4.3	2.1	9.2	0.8	0.9	0.8
Aug-08	6.4	4.4	2.8	4.8	0.9	3.4	13.8	5.1	1.0	4.9	1.4	1.9	3.4	0.5	1.4	0.8	0.4	0.9
Sep-08	8.2	2.1	2.9	2.4	4.5	3.6	-	4.8	1.4	3.2	1.7	1.4	17.4	1.3	2.9	1.2	1.1	0.7
Oct-08	8.5	3.5	3.0	2.2	3.3	2.1	5.2	4.3	2.0	3.3	1.9	2.3	3.0	1.5	1.7	0.2	1.1	1.4
Nov-08	2.5	3.0	5.1	2.8	3.5	4.3	5	2.5	2.5	2.6	1.5	1.7	3.1	1.5	1.3	2.3	0.8	1.4
Dec-08	22.4	0.7	6.0	0.3	3.9	5.4	7.2	4.9	2.5	4.2	1.5	1.8	3.4	2.0	12.7	1.9	1.5	1.2
Jan-09	9.0	2.2	6.3	3.9	6.0	2.8	7.5	2.3	2.5	4.4	2.3	2.7	6.7	1.9	4.6	2.7	2.8	2.0
Feb-09	4.2	2.1	4.9	6.3	4.3	4.5	3.6	3.1	2.7	1.9	1.3	1.0	4.4	1.3	6.8	2.4	1.8	1.4
Mar-09	6.1	2.5	3.0	2.5	2.9	2.4	6.8	6.7	2.9	4.7	1.8	1.8	2.9	1.9	7.8	2.2	1.7	1.2
Apr-09	7.2	2.6	3.0	1.7	3.7	2.5	5.0	3.7	2.6	3.5	1.5	1.1	2.6	0.9	7.7	3.2	0.9	1.3
May-09	8.9	3.8	3.0	4.7	3.1	1.4	5.1	3.4	1.3	8.2	1.9	1.8	2.2	1.6	3.5	2.0	1.2	2.1

Appendix D: Emission calculations

The dust emissions from the mine have been estimated from the operational description of the proposed mining activities provided. Emission factor equations that relate the quantity of dust liberated from particular activities to the intensity of the activity and the properties of the material being handled and/or the prevailing meteorological conditions are used to estimate the emissions. Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below.

OVERBURDEN

DOZERS/EXCAVATORS (INCLUDING STRIPPING TOPSOIL)

Emissions of Total Suspended Particles (TSP) were estimated using the emission factor for top soil removal of 14 kg per scraper hour (**SPCC, 1983**).

DRILLING OVERBURDEN

Emissions from drilling operation were estimated using the emission factor for drilling of 0.59 kg/hole (**US EPA, 1985**)

BLASTING OVERBURDEN

Emissions from blasting overburden were estimated using the following emission factor equation (**USEPA, 1985**):

$$EF = 0.00022 \times A^{1.5}$$

where:

EF	=	Emission factor for TSP from blasting	(kg/blast)
A	=	Area to be blasted	(m^2)

LOADING/EMPLACING OVERBURDEN

Loading overburden to trucks will generate emissions of TSP. The rate of emission is dependent on the wind speed and the moisture content of the overburden. Emissions were estimated using the following emission factor equation (**US EPA, 1985**):

$$EF = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right)$$

where:

EF	=	Emission factor for TSP from loading overburden to trucks	(kg/tonne)
k	=	Particulate size specific factor for batch loading operations (k_{TSP} = 0.74)	(kg/tonne)
U	=	Wind speed	(m/s)
M	=	Moisture content of material loaded	(%)

HAULING OVERBURDEN ON UNSEALED SURFACES

The uncontrolled emission factor for vehicles travelling on unsealed road is estimated to be 4 kg/VKT (**SPCC, 1983**). **Buonicore and Davis (1992)** show the level of control that can be achieved through the application of water and or chemical stabilisers. Controls of up to 95% can be achieved provided the moisture content of the surface material is maintained at 9%. For the current assessment a control of 75% has been assumed.

DOZERS ON OVERBURDEN

Emissions from dozers on overburden have been calculated using the US EPA emission factor equation (**US EPA, 1985**). The equation is as follows:

$$EF = 2.6 \times \frac{S^{1.2}}{M^{1.3}}$$

EF	=	Emission factor for TSP from dozer operation on overburden	(kg/hour)
S	=	Silt content	(%)
M	=	Moisture content of material loaded	(%)

COAL

DRILLING

Same as overburden drilling.

BLASTING

Same as overburden blasting.

DOZERS RIPPING ON COAL

Emissions from dozers on coal have been calculated using the US EPA emission factor equation (**US EPA, 1985**). The equation is as follows:

$$EF = 35.6 \times \frac{s^{1.2}}{M^{1.4}}$$

EF	=	Emission factor for TSP from dozer operation on overburden	(kg/hour)
S	=	Silt content	(%)
M	=	Moisture content of material loaded	(%)

LOADING COAL TO TRUCKS

Emissions from dozers on coal have been calculated using the US EPA emission factor equation (US EPA, 1985). The equation is as follows:

$$EF = \frac{0.580}{M^{1.2}}$$

EF	=	Emission factor for TSP from loading operation on coal	(kg/hour)
M	=	Moisture content of material loaded	(%)

HAULING COAL ON UNSEALED SURFACE

Same as hauling overburden on unsealed surface.

WIND EROSION

Emissions of TSP from wind erosion and conveying were estimated using the emission factor for exposed areas of 0.4 kg/ha/hr (**SPCC, 1983**).

GRADING ROADS

Estimated TSP emissions from grading roads have been made using the US EPA (1985 and updates) emission factor equation (Equation 5).

$$EF = 0.0034 \times S^{2.5}$$

where,

EF	=	Emission factor for TSP from grading operation on overburden	(kg/VKT)
S	=	Speed of grader	(km/hr)

Appendix E: Emission Inventories

Year 1

ACTIVITY	TSP emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Dozers/Excavators (including stripping topsoil)	180,978	12,927	h/y	14.0	kg/h						
OB - Drilling	12,390	21,000	holes/y	0.59	kg/hole						
OB - Blasting	87,107	46	blasts/y	1894	kg/blast	42000	Area of blast in square metres				
OB - Excavator loading OB to haul truck	60,265	30,496,800	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	2.0	moisture content in %		
OB - Hauling to emplacement area out of pit	66,538	6,099,360	t/y	0.01091	kg/t	220	t/load	2.4	km/return trip	1.0	kg/VKT
OB - Hauling to emplacement area in pit	232,885	24,397,440	t/y	0.00955	kg/t	220	t/load	2.1	km/return trip	1.0	kg/VKT
OB - Emplacing at out of pit emplacement area	12,053	6,099,360	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	2.0	moisture content in %		
OB - Dumping inside the pit	48,212	24,397,440	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	2.0	moisture content in %		
OB - Rehandle Shovel/Excavators/FELs Loading	603	304,968	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	2.0	moisture content in %		
CL - Dozers ripping/pushing/clean-up	124,092	3,693	h/y	33.6	kg/h	7.5	moisture content in %	10	silt content		
CL - Sh/Ex/FELs Loading ROM to trucks	155,051	3,000,000	t/y	0.05168	kg/t	7.5	moisture content in %				
CL - Hauling ROM to HVCPP dump hopper	154,054	2,850,000	t/y	0.05405	kg/t	185	t/load	10	km/return trip	1.0	kg/VKT
CL - Hauling ROM to WPCPP dump hopper	17,838	150,000	t/y	0.11892	kg/t	185	t/load	22	km/return trip	1.0	kg/VKT
WE - OB dump area	133,152	38	ha	0.4	kg/ha/h	8760	h/y				
WE - Pit dump area	63,072	18	ha	0.4	kg/ha/h	8760	h/y				
WE - Exposed pit area	63,072	18	ha	0.4	kg/ha/h	8760	h/y				
Grading roads	10,783	17,520	km	0.6	kg/km	8	speed of graders in km/h				
Existing Carrington Pit											
OB - Dozers/Excavators (including stripping topsoil)	230,440	16,460	h/y	14.0	kg/h						
OB - Drilling	14,496	24,570	holes/y	0.59	kg/hole						
OB - Blasting	104,150	55	blasts/y	1894	kg/blast	42000	Area of blast in square metres				
OB - Excavator loading OB to haul truck	59,736	30,229,404	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	2.0	moisture content in %		
OB - Hauling to emplacement area in pit	549,626	30,229,404	t/y	0.01818	kg/t	220	t/load	4.0	km/return trip	1.0	kg/VKT
OB - Dumping inside the pit	59,736	30,229,404	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	2.0	moisture content in %		
OB - Rehandle Shovel/Excavators/FELs Loading	597	302,294	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	2.0	moisture content in %		
CL - Dozers ripping/pushing/clean-up	110,618	3,292	h/y	33.6	kg/h	7.5	moisture content in %	10	silt content		
CL - Sh/Ex/FELs Loading ROM to trucks	119,715	2,316,302	t/y	0.05168	kg/t	7.5	moisture content in %				
CL - Hauling ROM to HVCPP dump hopper	118,945	2,200,487	t/y	0.05405	kg/t	185	t/load	10	km/return trip	1.0	kg/VKT
CL - Hauling ROM to WPCPP dump hopper	13,773	115,815	t/y	0.11892	kg/t	185	t/load	22	km/return trip	1.0	kg/VKT
WE - Pit dump area	35,040	10	ha	0.4	kg/ha/h	8760	h/y				
WE - Exposed pit area	175,200	50	ha	0.4	kg/ha/h	8760	h/y				
Grading roads	10,463	17,000	km	0.6	kg/km	8	speed of graders in km/h				

Year 1, continued

Combined Activities (Carrington WW, Carrington Existing, West Pit, HVO South)											
Unloading ROM at HVCPP dump hopper	1,569	5,050,487	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Unloading ROM at WPCPP dump hopper	83	265,815	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Rehandle ROM at HVCPP hopper	282	909,088	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Rehandle ROM at WPCPP hopper	15	47,847	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Transport product coal to user/loadout point - HVCPP to NLP	3,317	39,394	t/y	0.08421	kg/t	38	t/load	3.2	km/return trip	1.0	kg/VKT
Transport product coal to user/loadout point - WPCPP to NLP	60,018	207,336	t/y	0.28947	kg/t	38	t/load	11	km/return trip	1.0	kg/VKT
Unloading coal from conveyers or trucks at HVLP	1,211	3,899,986	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Unloading coal from conveyers or trucks at NLP	77	246,729	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Loading trains at HVLP	1,211	3,899,986	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Loading trains at NLP	77	246,729	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
HVO West Pit Operations (2011)	**TSP Emission**										
OB - Dozers (including stripping topsoil)	17,920										
OB - Drilling	18,344										
OB - Blasting	96,994										
OB - Shovel/Excavators/FELs Loading	110,318										
OB - Hauling to West Pit emplacement area	710,169										
OB - Hauling from North Pit to Alluvials	25,000										
OB - Hauling from south of river to Alluvials	25,000										
OB - Emplacing at West Pit dump	110,318										
OB - Emplacing at Alluvials	7,767										
OB - Dozers	275,268										
OB - Dragline	892,533										
CL ROM - Drilling in West Pit	2,156										
CL ROM - Blasting in West Pit	11,268										
CL ROM - Dozers ripping in West Pit	328,794										
CL ROM - Loading ROM to trucks in West Pit	438,529										
CL ROM - Hauling from West Pit to HVCPP dump hopper	183,053										
CL ROM - Hauling from West Pit to WPCPP dump hopper	113,333										
CL ROM - Hauling from S of river to HVCPP dump hopper	666,667										
WE - West Pit	1,752,000										
WE - Alluvials Pit	175,200										
WE - West Pit OB dump	1,752,000										
WE - Alluvials OB dump	175,200										

Year 5

ACTIVITY	TSP emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	source type
OB - Dozers/Excavators (including stripping topsoil)	180,978	12,927	h/y	14.0	kg/h							1
OB - Drilling	12,390	21,000	holes/y	0.59	kg/hole							1
OB - Blasting	87,107	46	blasts/y	1894	kg/blast	42000	Area of blast in square metres					1
OB - Excavator loading OB to haul truck	44,405	22,471,200	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in n	2.0	moisture content in %			2
OB - Hauling to emplacement area out of pit	0	0	t/y	0.01091	kg/t	220	t/load	2.4	km/return trip	1.0	kg/VKT	1
OB - Hauling to emplacement area in pit	214,498	22,471,200	t/y	0.00955	kg/t	220	t/load	2.1	km/return trip	1.0	kg/VKT	1
OB - Emplacing at out of pit emplacement area	0	0	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in n	2.0	moisture content in %			2
OB - Dumping inside the pit	44,405	22,471,200	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in n	2.0	moisture content in %			2
OB - Rehandle Shovel/Excavators/FELs Loading	444	224,712	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in n	2.0	moisture content in %			1
CL - Dozers ripping/pushing/clean-up	124,092	3,693	h/y	33.6	kg/h	7.5	moisture content in %	10	silt content			1
CL - Sh/Ex/FELs Loading ROM to trucks	155,051	3,000,000	t/y	0.05168	kg/t	7.5	moisture content in %					1
CL - Hauling ROM to HVCPP dump hopper	154,054	2,850,000	t/y	0.05405	kg/t	185	t/load	10	km/return trip	1.0	kg/VKT	1
CL - Hauling ROM to WPCPP dump hopper	17,838	150,000	t/y	0.11892	kg/t	185	t/load	22	km/return trip	1.0	kg/VKT	1
WE - OB dump area	0	0	ha	0.4	kg/ha/h	8760	h/y					3
WE - Pit dump area	192,720	55	ha	0.4	kg/ha/h	8760	h/y					3
WE - Exposed pit area	70,080	20	ha	0.4	kg/ha/h	8760	h/y					3
Grading roads	61,547	100,000	km	0.6	kg/km	8	speed of graders in km/h					1
Existing Carrington Pit												
OB - Dozers/Excavators (including stripping topsoil)	0	0	h/y	14.0	kg/h							1
OB - Drilling	0	0	holes/y	0.59	kg/hole							1
OB - Blasting	0	0	blasts/y	1894	kg/blast	42000	Area of blast in square metres					1
OB - Excavator loading OB to haul truck	0	0	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in n	2.0	moisture content in %			2
OB - Hauling to emplacement area in pit	0	0	t/y	0.01818	kg/t	220	t/load	4.0	km/return trip	1.0	kg/VKT	1
OB - Dumping inside the pit	0	0	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in n	2.0	moisture content in %			2
OB - Rehandle Shovel/Excavators/FELs Loading	0	0	t/y	0.00198	kg/t	1.669	average of (wind speed/2.2)^1.3 in n	2.0	moisture content in %			1
CL - Dozers ripping/pushing/clean-up	0	0	h/y	33.6	kg/h	7.5	moisture content in %	10	silt content			1
CL - Sh/Ex/FELs Loading ROM to trucks	0	0	t/y	0.05168	kg/t	7.5	moisture content in %					1
CL - Hauling ROM to HVCPP dump hopper	0	0	t/y	0.05405	kg/t	185	t/load	10	km/return trip	1.0	kg/VKT	1
CL - Hauling ROM to WPCPP dump hopper	0	0	t/y	0.11892	kg/t	185	t/load	22	km/return trip	1.0	kg/VKT	1
WE - Pit dump area	0	0	ha	0.4	kg/ha/h	8760	h/y					3
WE - Exposed pit area	0	0	ha	0.4	kg/ha/h	8760	h/y					3
Grading roads	0	0	km	0.6	kg/km	8	speed of graders in km/h					1

Year 5, continued

Combined Activities (Carrington WW, Carrington Existing, West Pit, HVO South)											
Unloading ROM at HVCPP dump hopper	885	2,850,000	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Unloading ROM at WPCPP dump hopper	47	150,000	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Rehandle ROM at HVCPP hopper	159	513,000	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Rehandle ROM at WPCPP hopper	8	27,000	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Transport product coal to user/loadout point - HVCPP to NLP	1,872	22,230	t/y	0.08421	kg/t	38	t/load	3.2	km/return trip	1.0	kg/VKT
Transport product coal to user/loadout point - WPCPP to NLP	33,868	117,000	t/y	0.28947	kg/t	38	t/load	11	km/return trip	1.0	kg/VKT
Unloading coal from conveyers or trucks at HVLP	684	2,200,770	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Unloading coal from conveyers or trucks at NLP	43	139,230	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Loading trains at HVLP	684	2,200,770	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
Loading trains at NLP	43	139,230	t/y	0.00031	kg/t	1.669	average of (wind speed/2.2)^1.3 in m	7.5	moisture content in %		
HVO West Pit Operations (2014)	**TSP Emission**										
OB - Dozers (including stripping topsoil)	17,920										
OB - Drilling	29,607										
OB - Blasting	121,604										
OB - Shovel/Excavators/FELs Loading	151,277										
OB - Hauling to West Pit emplacement area	973,843										
OB - Hauling from North Pit to Alluvials	0										
OB - Hauling from south of river to Alluvials	0										
OB - Emplacing at West Pit dump	151,277										
OB - Emplacing at Alluvials	0										
OB - Dozers	358,098										
OB - Dragline	911,865										
CL ROM - Drilling in West Pit	4,075										
CL ROM - Blasting in West Pit	27,044										
CL ROM - Dozers ripping in West Pit	427,730										
CL ROM - Loading ROM to trucks in West Pit	492,592										
CL ROM - Hauling from West Pit to HVCPP dump hopper	284,363										
CL ROM - Hauling from West Pit to WPCPP dump hopper	113,333										
CL ROM - Hauling from S of river to HVCPP dump hopper	666,667										
WE - West Pit	1,752,000										
WE - Alluvials Pit	0										
WE - West Pit OB dump	1,752,000										
WE - Alluvials OB dump	0										

Appendix F: Emission summary for sources used in the modelling

```
-------------------------------- Dec-2009
  DUST EMISSION CALCULATIONS V2
 -------------------------------

 Output emissions file  :
C:\Jobs\3412_Carrington_West_Wing\ISC\y1_emiss.da
t
 Meteorological file    :
C:\Jobs\3412_Carrington_West_Wing\Metdata\hvo_060
7.isc
 Number of dust sources : 72
 Number of activities   : 78
 No-blast conditions    : None
 Wind sensitive factor  : 1.695 (1.695 adjusted
for activity hours)
 Wind erosion factor    : 69.493

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : OB - Dozers/Excavators
(including stripping topsoil)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 180978 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Drilling
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 12390 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Blasting
 ACTIVITY TYPE : Blasting
 DUST EMISSION : 87107 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Excavator loading OB to
haul truck
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 60265 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Hauling to emplacement area
out of pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 66538 kg/y
 FROM SOURCES  : 8
1 2 3 6 7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Hauling to emplacement area
in pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 232885 kg/y
 FROM SOURCES  : 5
1 2 3 4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Emplacing at out of pit
emplacement area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 12053 kg/y
 FROM SOURCES  : 5
6 7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Dumping inside the pit
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 48212 kg/y
 FROM SOURCES  : 2
4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Rehandle
Shovel/Excavators/FELs Loading
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 603 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL - Dozers
ripping/pushing/clean-up
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 124092 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL - Sh/Ex/FELs Loading ROM to
trucks
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 155051 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL - Hauling ROM to HVCPP dump
hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 154054 kg/y
 FROM SOURCES  : 11
1 2 3 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL - Hauling ROM to WPCPP dump
hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 17838 kg/y
 FROM SOURCES  : 16
11 12 13 14 15 16 17 24 25 26 27 28 29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : WE - OB dump area
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 133152 kg/y
 FROM SOURCES  : 5
6 7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : WE - Pit dump area
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 63072 kg/y
 FROM SOURCES  : 2
4 5
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : WE - Exposed pit area
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 63072 kg/y
 FROM SOURCES  : 3
1 2 3
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 10783 kg/y
 FROM SOURCES  : 27
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 24
25 26 27 28 29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Dozers/Excavators
(including stripping topsoil)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 230440 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Drilling
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 14496 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Blasting
 ACTIVITY TYPE : Blasting
 DUST EMISSION : 104150 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Excavator loading OB to
haul truck
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 59736 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Hauling to emplacement area
in pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 549626 kg/y
 FROM SOURCES  : 5
19 20 21 22 23
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Dumping
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 59736 kg/y
 FROM SOURCES  : 3
21 22 23
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Rehandle
Shovel/Excavators/FELs Loading
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 597 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL - Dozers
ripping/pushing/clean-up
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 48063 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL - Sh/Ex/FELs Loading ROM to
trucks
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 119715 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL - Hauling ROM to HVCPP dump
hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 118945 kg/y
 FROM SOURCES  : 6
15 16 17 18 19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL - Hauling ROM to WPCPP dump
hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 13773 kg/y
 FROM SOURCES  : 14
15 16 17 19 20 24 25 26 27 28 29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : WE - Pit dump area
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 35040 kg/y
 FROM SOURCES  : 3
21 22 23
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : WE - Exposed pit area
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 175200 kg/y
 FROM SOURCES  : 2
19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 10463 kg/y
 FROM SOURCES  : 14
19 20 21 22 23 24 25 26 27 28 29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM at HVCPP dump
hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 8243 kg/y
 FROM SOURCES  : 1
33
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM at WPCPP dump
hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1139 kg/y
 FROM SOURCES  : 1
35
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Rehandle ROM at HVCPP hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1484 kg/y
 FROM SOURCES  : 1
34
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Rehandle ROM at WPCPP hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 205 kg/y
 FROM SOURCES  : 1
36
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transport product coal to
user/loadout point - HVCPP to NLP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 17434 kg/y
 FROM SOURCES  : 6
53 54 55 56 57 59
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transport product coal to
user/loadout point - WPCPP to NLP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 827702 kg/y
 FROM SOURCES  : 16
17 24 25 26 27 28 29 30 31 32 53 54 55 56 57 59
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading coal from conveyers or
trucks at HVLP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 6365 kg/y
 FROM SOURCES  : 1
58
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading coal from conveyers or
trucks at NLP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 952 kg/y
 FROM SOURCES  : 1
59
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading trains at HVLP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 6365 kg/y
 FROM SOURCES  : 1
58
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading trains at NLP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 952 kg/y
 FROM SOURCES  : 1
59
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Dozers (including stripping
topsoil)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 17920 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Drilling
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 18344 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Blasting
 ACTIVITY TYPE : Blasting
 DUST EMISSION : 96994 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Shovel/Excavators/FELs
Loading
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 110318 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Hauling to West Pit
emplacement area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 710169 kg/y
 FROM SOURCES  : 10
37 38 39 40 41 42 43 50 51 52
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : OB - Hauling from North Pit to
Alluvials
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 25000 kg/y
 FROM SOURCES  : 4
46 47 48 49
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Hauling from south of river
to Alluvials
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 25000 kg/y
 FROM SOURCES  : 7
48 49 66 67 68 69 70
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Emplacing at West Pit dump
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 110318 kg/y
 FROM SOURCES  : 7
40 41 42 43 50 51 52
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Emplacing at Alluvials
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 7767 kg/y
 FROM SOURCES  : 2
48 49
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Dozers
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 275268 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : OB - Dragline
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 892533 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL ROM - Drilling in West Pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2156 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL ROM - Blasting in West Pit
 ACTIVITY TYPE : Blasting
 DUST EMISSION : 11268 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL ROM - Dozers ripping in West
Pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 328794 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL ROM - Loading ROM to trucks
in West Pit
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 438529 kg/y
 FROM SOURCES  : 3
37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL ROM - Hauling from West Pit
to HVCPP dump hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 183053 kg/y
 FROM SOURCES  : 10
17 18 24 25 26 27 28 37 38 39
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL ROM - Hauling from West Pit
to WPCPP dump hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 113333 kg/y
 FROM SOURCES  : 5
28 29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : CL ROM - Hauling from S of river
to HVCPP dump hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 666667 kg/y
 FROM SOURCES  : 7
16 17 18 44 45 46 47
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : WE - West Pit
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1752000 kg/y
 FROM SOURCES  : 7
37 38 39 40 41 42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : WE - Alluvials Pit
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 175200 kg/y
 FROM SOURCES  : 2
48 49
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : WE - West Pit OB dump
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1752000 kg/y
 FROM SOURCES  : 6
41 42 43 50 51 52
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : WE - Alluvials OB dump
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 175200 kg/y
 FROM SOURCES  : 2
48 49
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Ravensworth/Narama ALL
OPERATIONS WI
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 913536 kg/y
 FROM SOURCES  : 3
60 61 62
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Ravensworth/Narama ALL
OPERATIONS WD
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 168480 kg/y
 FROM SOURCES  : 3
60 61 62
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Ravensworth/Narama ALL
OPERATIONS WE
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 165984 kg/y
 FROM SOURCES  : 3
60 61 62
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wambo ALL OPERATIONS  WI
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3749868 kg/y
 FROM SOURCES  : 3
63 64 65
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wambo ALL OPERATIONS  WD
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 691574 kg/y
 FROM SOURCES  : 3
63 64 65
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wambo ALL OPERATIONS  WE
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 681329 kg/y
 FROM SOURCES  : 3
63 64 65
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Cheshunt ALL OPERATIONS   WI
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1903200 kg/y
 FROM SOURCES  : 3
66 67 68
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Cheshunt ALL OPERATIONS   WD
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 351000 kg/y
 FROM SOURCES  : 3
66 67 68
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Cheshunt ALL OPERATIONS   WE
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 345800 kg/y
 FROM SOURCES  : 3
66 67 68
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Riverview ALL OPERATIONS  WI
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1141920 kg/y
 FROM SOURCES  : 2
69 70
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Riverview ALL OPERATIONS  WD
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 210600 kg/y
 FROM SOURCES  : 2
69 70
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Riverview ALL OPERATIONS  WE
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 207480 kg/y
 FROM SOURCES  : 2
69 70
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Cumnock ALL OPERATIONS  WI
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1761662 kg/y
 FROM SOURCES  : 2
71 72
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Cumnock ALL OPERATIONS  WD
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 324897 kg/y
 FROM SOURCES  : 2
71 72
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Cumnock ALL OPERATIONS  WE
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 320083 kg/y
 FROM SOURCES  : 2
71 72
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

Appendix H

Aboriginal cultural heritage study

www.coalandallied.com.au

Carrington West Wing

Aboriginal Cultural Heritage Assessment Report

Prepared for

Rio Tinto Coal Australia

Central Queensland Cultural Heritage Management Pty Ltd

Director: Dr Luke Godwin

16 Moren St, Rockhampton Qld 4701

ph: 07 4926 2035

email: lgodwin@irock.com.au

21 May 2010

Table of Contents

List of Figures

List of Tables

Abbreviations

ACHMP	Aboriginal Cultural Heritage Management Plan
AHIP	Aboriginal Heritage Impact Permit
AMBS	Australian Museum Business Services Pty Ltd
ATSIHP Act	Aboriginal and Torres Strait Islander Heritage Protection Act 1984
CHIMA	Cultural Heritage Indigenous Management Agreement
CHMD	Cultural Heritage Management Database
CHMS	Cultural Heritage Management System
CHWG	(Upper Hunter Valley Aboriginal) Cultural Heritage Working Group
CM-CD1	Carrington Mine, Colluvial Deposit 1
CQCHM	Central Queensland Cultural Heritage Management Pty Ltd
DECCW	Department of the Environment, Climate Change and Water
DEWHA	Department of Environment, Water, Heritage and the Arts
DMO	Data Management Officer
EIS	Environmental Impact Statement
EMGAMM	EMGA Mitchell McLennan Pty Limited
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment protection and Biodiversity Conservation Act 1999
ERM	Environmental Resources Management Australia Pty Limited
HVO	Hunter Valley Operations
MCH	McCardle Heritage Management Pty Ltd
MOP	Mine Operating Plan
NPW Act	National Parks and Wildlife Act 1974
NPWS	National Parks and Wildlife Service
OS	Older Stratum
WLALC	Wanaruah Local Aboriginal Land Council
WTC	Wonnarua Tribal Council
YS	Younger Stratum

Executive Summary

This report has been commissioned by Rio Tinto Coal Australia as part of the preparation of an Environmental Assessment for the proposed Carrington West Wing modification (hereafter referred to as the proposal) under the provisions of Part 3A of the New South Wales *Environmental Planning and Assessment Act 1979* (EP&A Act).

Coal and Allied Operations Pty Limited (Coal & Allied), owners of the Hunter Valley Operations (HVO) mining complex which includes the Carrington mining area, has commissioned a series of comprehensive cultural heritage investigations (including surveys, mitigation and excavation research programs) that variously include portions of the project area over a period spanning 1997 to 2010. This work forms part of Rio Tinto Coal Australia and Coal & Allied's commitment to minimise to the greatest extent possible the potential impact of its operations on Aboriginal cultural heritage. This work has been undertaken in consultation with Aboriginal community representatives and with their active participation.

Rio Tinto Coal Australia and Coal & Allied have developed and implemented a suite of comprehensive Aboriginal cultural heritage management policies, protocols and procedures for their operations in the Upper Hunter Valley. Since 2005, a key component in consultation with the Aboriginal community has been through the Upper Hunter Valley Aboriginal Cultural Heritage Working Group (CHWG) which oversees cultural heritage management across all Rio Tinto Coal Australia projects throughout the Upper Hunter Valley.

The report provides:

- an outline of Aboriginal cultural heritage management practice as it applies to the current Carrington operations;
- an outline of the research that has been conducted into Aboriginal cultural heritage in the current and proposed project area, including the participation of Aboriginal community members;
- an assessment of Aboriginal cultural heritage in the proposed extension area, potential impacts and impact management proposals, including the views of the Aboriginal community; and
- management and monitoring measures to mitigate potential adverse impacts associated with the proposed extension area upon Aboriginal cultural heritage.

Additionally, the report also makes note of the process that Coal & Allied and the CHWG have commenced to identify various Coal & Allied owned lands throughout the Upper Hunter Valley that will be managed permanently for the conservation of Aboriginal cultural heritage in addition to any other biodiversity conservation values. The core lands for inclusion in this 'Conservation Area' have already been identified and additional areas are intended to be added to it as technical investigations are completed. Initially the Conservation Area will be managed by Coal & Allied in collaboration with the CHWG and in accordance with a management strategy specific to the area. The CHWG and Rio Tinto Coal Australia / Coal & Allied have jointly developed a set of key objectives and principles on which the management strategy will be based. A key objective will be to establish a co-management regime for the Conservation Area in partnership with the Aboriginal community through the development of a comprehensive and well considered management strategy supported by an appropriate community based governance structure.

The proposal includes a series of elements. With the exception of the proposed extension area, other elements of the proposal, such as out-of-pit overburden emplacements and extensions to the evaporative sink, lie in areas that have been previously mined or otherwise disturbed from mining related activities. Thus the key focus of the report is on the management of impacts on Aboriginal cultural heritage within the currently undisturbed proposed extension area.

In terms of the Aboriginal cultural heritage areas, objects and values within the proposed extension area, there are six key studies that inform this report and provide data for the assessment of the significance and management of Aboriginal cultural heritage material and the management of impacts upon it. These studies are:

- The Aboriginal cultural heritage assessment prepared for the EIS for the Carrington Mine's operational area in 1999 (ERM Mitchell McCotter 1999a and b);
- The geomorphological assessment of the Carrington Mine in 1999 (Huonbrook 1999);
- The excavation report from investigations into CM-CD1 under s87 permit #SZ288 in 1999 (Huonbrook 2000);
- The Aboriginal cultural heritage assessment of the Carrington Mine in 1999/2000 (Junburra 2000);
- The Aboriginal cultural heritage assessment prepared for the Statement of Environmental Effects for the Carrington Mine Extension area in 2004 (ERM 2005);
- The Aboriginal cultural heritage assessment prepared prior to the Environmental Assessment for the current proposal in 2009 (MCH 2009).

The methodologies and key findings of these studies, including consultation with and participation of the Aboriginal community are presented in this report.

Additionally, a series of cultural heritage agreements have been entered into that include cultural heritage places and values in the Carrington mining area. Although all are reviewed within the report, principle among these with regard relevance to the proposal is the 2002 *'Cultural Heritage Indigenous Management Agreement'* (CHIMA) which covers the CM-CD1 area. The provisions and current status of this is detailed further within the report.

The area known as CM-CD1 includes an area some 450m long and up to 25m in width and lies in the northeastern portion of the proposed extension area. This area was originally identified as having the potential to contain sub-surface cultural material that may have been of Pleistocene (i.e. older than 10,000 years) antiquity. A comprehensive archaeological and geomorphological excavation program was undertaken in several stages throughout 1999. While this work identified that sub-surface cultural material was present, the nature of the deposits and the cultural material did not allow for further insights in to the antiquity of this deposit although it is seemed unlikely that they were Pleistocene in age. Further, while it was noted that additional sub-surface material may be present, it was considered unlikely that this would be present across the entirety of the CM-CD1 area. Although all required investigations were completed, the area within which CM-CD1 has not previously been required for mining.

Associated with this area (and likewise located within the proposed extension area), two surface stone artefact scatters (CM1 and CM2) have also been identified. The majority of the material within CM2 has previously been mitigated under a finalised s90 Consent to Destroy issued under the *National*

Parks and Wildlife Act 1974 (NPW Act). Subsequent investigations of these areas have noted little cultural material although ground surface visibility has been observed as a constraint in this endeavor.

Also dating to the earliest cultural heritage investigations across the broader Carrington mining area, two additional areas containing isolated stone artefact/s (CM19 and CM32) were also identified. Several previous attempts to relocate this material have been unsuccessful.

All of the above mentioned cultural heritage places (i.e. CM1, CM2, CM19, CM32 and CM-CD1) are variously covered by the CM-CD1 CHIMA or the current development consent conditions for the Carrington mining area (DA 450-10-2003) and are actively managed accordingly. Additionally, they have been the subject of ongoing discussions through the CHWG.

Further cultural heritage investigations within the Carrington mining area were undertaken in 2009 and 2010. These included the remaining previously unsurveyed portions of the project area. These identified five additional areas, again, containing isolated stone artefact/s of which four (HVO-1121 to 1124) are located within or immediately adjacent the proposed extension area. Management arrangements for these have been agreed directly between Rio Tinto Coal Australia / Coal & Allied and the CHWG.

The entirety of the proposed extension area has been the subject of Aboriginal cultural heritage investigations. From these, the above nine extant cultural heritage places have been identified as being located either within or immediately adjacent. Given the restricted size of the proposed extension area and the nature of the proposed development activities within it, the entirety of this area and, and therefore over time the cultural heritage places within, will likely be impacted.

Following extended consultation with the local Aboriginal community of the Upper Hunter Valley through the CHWG, a series of general and specific management actions have been agreed for these places in the event that they are to be impacted by the proposed mining activities. The details of these commitments are detailed within the report.

Aboriginal community representatives have on a number of occasions expressed the view that cultural heritage areas and objects of all kinds are of significance to them as they represent one of the few remaining tangible links that they have with their ancestors and their country. The position they have generally expressed is that they would prefer to have no disturbance to such places. However, in the consultation undertaken as part of the proposal, they have accepted an approach based on the limits of acceptable change and the desirability of achieving long term and secure management of a range of significant sites, such as the Bulga Bora Ground, and other individual places and cultural landscapes that have a high significance in the regional context. Rio Tinto Coal Australia / Coal & Allied and the CHWG are pursuing this in the context of the Conservation Area lands project described further within the report.

1. INTRODUCTION AND BACKGROUND

Coal & Allied Operations Pty Limited (Coal & Allied) owns the Hunter Valley Operations (HVO) mining complex located 24 km north west of Singleton (***Figure 1***). HVO has expanded through a process of extension of existing mines and acquisition of additional mines.

The mining and processing activities at HVO are geographically divided by the Hunter River into HVO South and HVO North, with movements of coal, coarse and fine reject, overburden, topsoil, equipment, water, materials, and personnel between the two areas. While HVO South and HVO North each have separate approvals, HVO is owned and managed as one operation.

HVO North comprises the active Carrington, West and North Pits. Carrington Pit is a truck and shovel operation, approved to mine 10 million tonnes (mt) of run of mine coal per annum. The pit is well developed with significant areas of rehabilitation established. An opportunity has been identified to extend mining operations in the Carrington Pit to the southwest (***Figure 2***). The approximately 137 hectare proposed extension area will allow for the recovery of approximately 17mt of *in-situ* coal. Other than this proposed extension area, the remaining elements of the project area, such as out-of-pit overburden emplacements, extension to the evaporative sink, and levees in areas that have been previously mined or otherwise disturbed from mining related activities.

The proposal will allow mining to continue within the Carrington Pit and provide for the efficient transition from mining within the existing pit into the proposed extension area. The proposal will enable the efficient extraction of an economic resource, promote security of employment, provide for continued local and regional economic benefits, and result in significant government royalties.

In 2003, under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), an Environmental Impact Statement (EIS) was prepared for the extension of West Pit; the consolidation of 18 separate consents that related to HVO North; and the integration of operations within HVO North. This was approved under DA 450-10-2003 (West Pit Extension and Minor Modification EIS, ERM 2003).

In 2006, DA 450-10-2003 was modified to enable the extension of the Carrington Pit to the south (60 hectares) and east (80 hectares). The project included a services corridor and ancillary infrastructure, levees, a barrier wall and change to the final void.

Section 75W of the EP&A Act regulates the modification of a Project Approval under Part 3A. The process for the proposal will be to modify the existing Part 4 development consent (DA 450-10-2003) under this Part of the Act and the relevant provisions in clause 8J(8) of the *Environmental Planning and Assessment Regulation 2000*. The Minister for Planning will be the approval authority. EMGA Mitchell McLennan Pty Limited (EMGAMM) has been engaged by Rio Tinto Coal Australia to prepare the Environmental Assessment for the proposal.

Rio Tinto Coal Australia provides management services to all Coal & Allied operations. This includes Aboriginal cultural heritage management services which are provided through the External Relations Department. Rio Tinto Coal Australia has comprehensive policies, standards and protocols in place to guide Aboriginal cultural heritage management across all of its operations. In the context of the Upper Hunter Valley, these policies are applied consistently and in close consultation with the Aboriginal

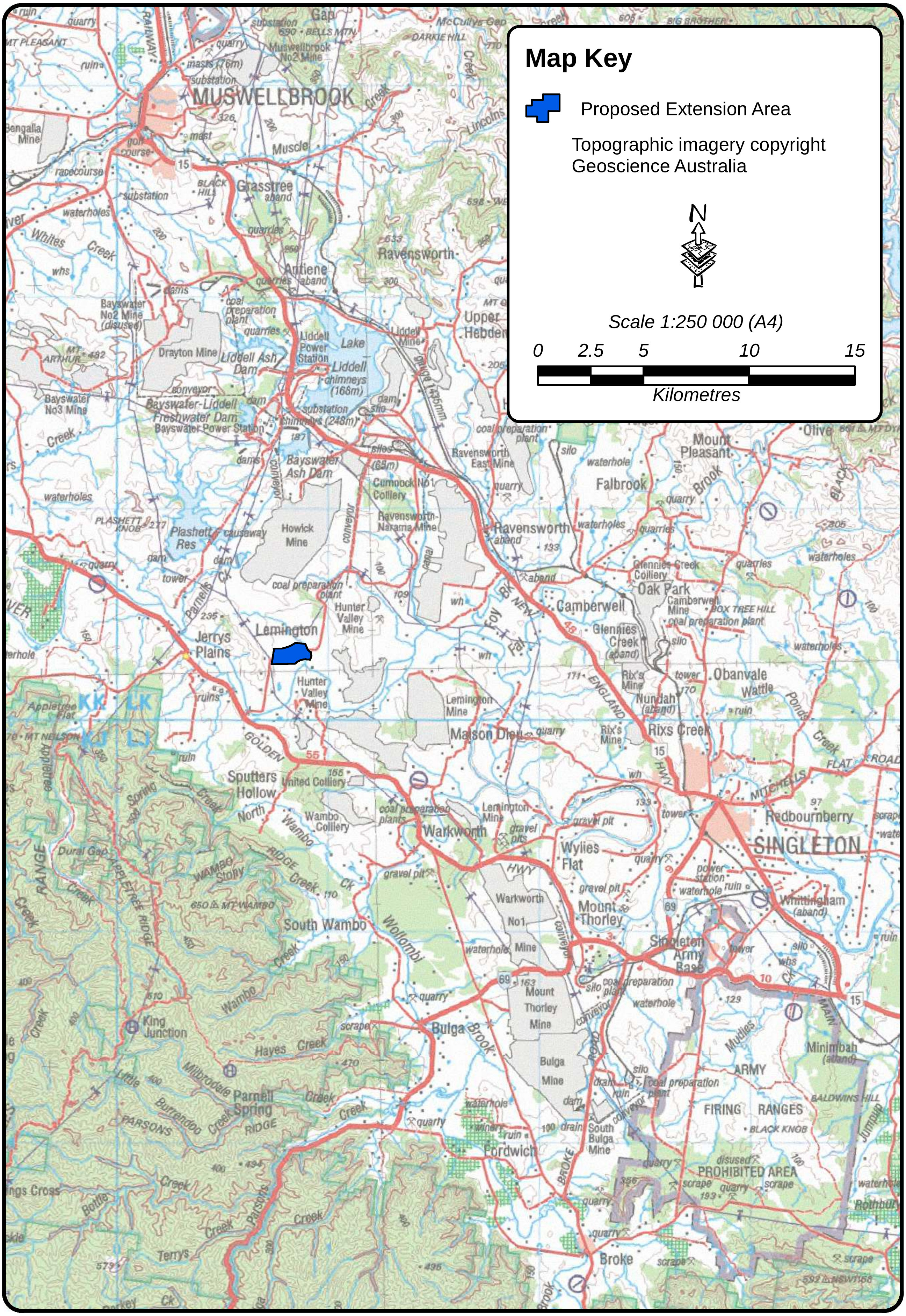


Figure 1: Location of the proposed extension area.

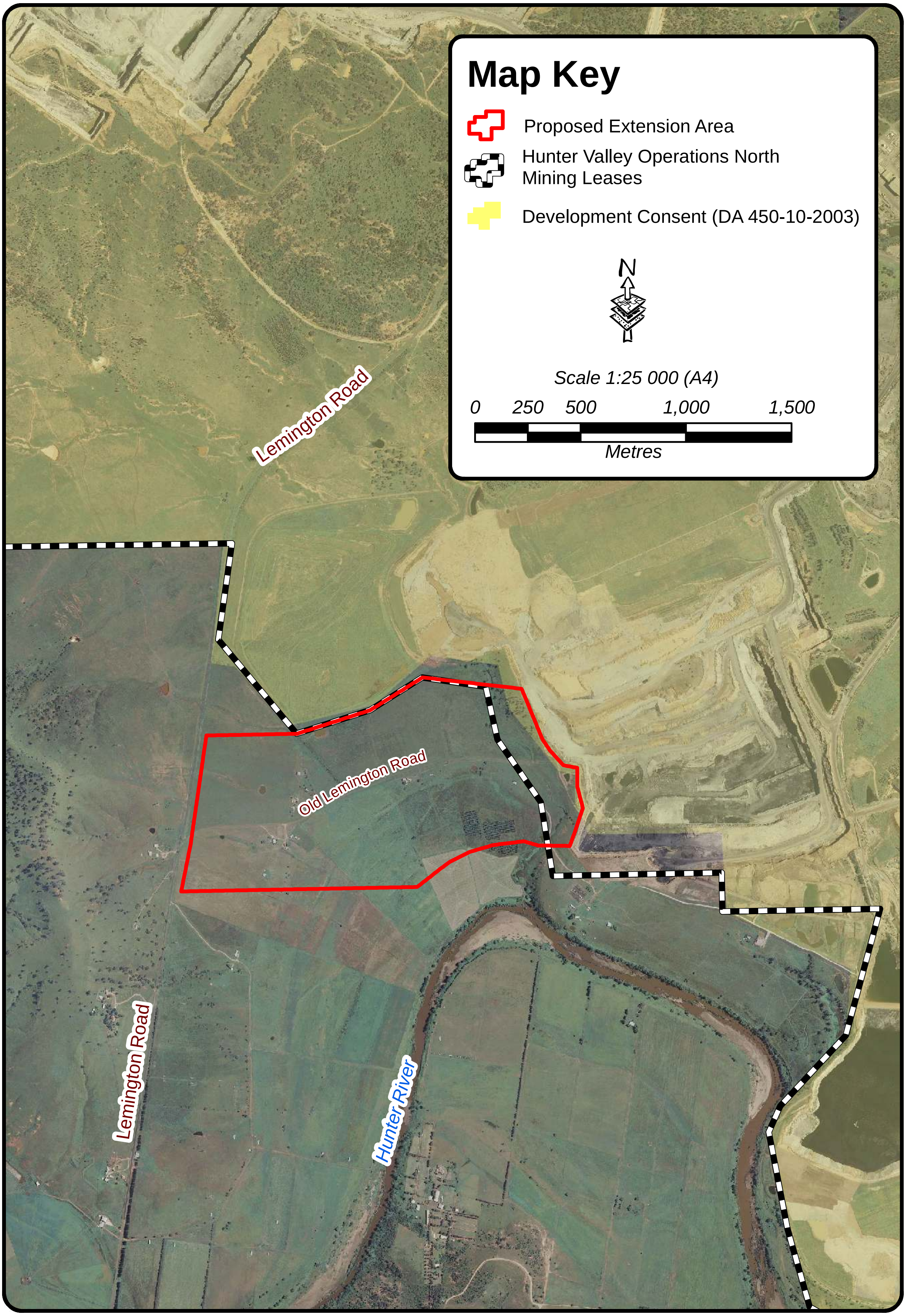


Figure 2: Proposed extension area in relation to current mining leases and development consent area.

community who has interests in this region (which includes the Carrington mining area) and with whom Coal & Allied and Rio Tinto Coal Australia have well developed and active formal relationships.

Central Queensland Cultural Heritage Management Pty Ltd (CQCHM) has worked closely with Rio Tinto Coal Australia providing advice on the development and implementation of policies, protocols and procedures for Aboriginal cultural heritage management across its operations, including within the Upper Hunter Valley. CQCHM has been appointed by Rio Tinto Coal Australia to prepare this report on Aboriginal cultural heritage for the proposal Environmental Assessment.

This report has been prepared to:

- provide an outline of Aboriginal cultural heritage management practice as it applies to the current Carrington operations;
- outline the research that has been conducted into Aboriginal cultural heritage in the current and proposed expanded Carrington operational area, including the participation of Aboriginal community members;
- provide an assessment of Aboriginal cultural heritage in the proposed extension area, potential impacts and impact management proposals, including the views of the Aboriginal community; and
- provide management and monitoring measures to mitigate potential adverse impacts associated with the proposal upon Aboriginal cultural heritage.

2. LEGISLATIVE AND REGULATORY FRAMEWORK FOR ABORIGINAL CULTURAL HERITAGE MANAGEMENT

This section presents a brief discussion of the legal and regulatory framework in which Aboriginal cultural heritage is managed and protected in New South Wales.

2.1 Commonwealth Legislation

Although Commonwealth legislation has a potential role in Aboriginal cultural heritage management and protection in New South Wales this is generally focused on particular cultural heritage places (also referred to as ‘sites’) and situations as opposed to the more comprehensive management and protective focus, and the strong consultative element contained within State legislation and policy.

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) came into force in July 2000 and in doing so replaced several other Commonwealth Acts. It provides a framework to protect nationally significant flora, fauna, ecological communities and heritage places. The EPBC Act establishes both a National Heritage List and Commonwealth Heritage List of protected places. These lists may include Indigenous cultural sites or sites in which Indigenous people have interests.

In looking to achieve its stated protection and conservation goals, the EPBC Act introduced new national environmental assessment and approvals processes and integrated the management of important natural and cultural places under those processes. While this system is separate and distinct from State systems, it does not affect the validity or conduct of State-based environmental and development assessments and approvals. State Acts and systems are neither replaced nor altered by the EPBC Act. Rather, the EPBC Act establishes a parallel environmental assessment and approval system to State systems.

The assessment and permitting processes of the EPBC Act are triggered when a proposed activity or development could potentially have an impact on one of the matters of national environment significance listed under the Act. National heritage places are one such matter. No such heritage places are involved in the area of the proposal.

The Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (ATSIHP Act) is aimed at the protection from injury and desecration of areas and objects that are of significance to Indigenous Australians. This legislation has usually been invoked in emergency and conflicted situations. It is generally acknowledged that the legislation has not been successful and that it is not in accord with contemporary practice. It is at odds with the relationships and protocols that have become the standard between Government agencies, developers and representative Aboriginal organisations for the protection of Aboriginal cultural heritage.

The Commonwealth *Protection of Movable Cultural Heritage Act 1986* includes legislation that prevents objects of cultural heritage significance, such as those that are sacred to Indigenous people's heritage, from being exported out of Australia.

All of the Commonwealth legislation aimed at the protection of Aboriginal heritage is currently under review. The ATSIHP Act and the *Protection of Movable Cultural Heritage Act 1986*, in particular, have been under review for some time. In August 2009 the Commonwealth released a Discussion Paper (Commonwealth Department of Environment, Water, Heritage and the Arts [DEWHA], 2009) on the ATSIHP Act setting out its perceived shortcomings and the need for reform and calling for submissions from the public. The Discussion Paper (DEWHA 2009:7) sets out a series of proposals:

> *... designed to clarify responsibilities for protecting Indigenous heritage, to set standards of best practice nation-wide, to remove duplication of state and territory decisions that meet the standards, and to improve processes for Australian Government decisions about protection when the standards are not met.*

2.2 New South Wales Legislation

There are two principal elements to the legislative and regulatory framework for Aboriginal cultural heritage management as it is affected by development proposals in New South Wales. These are:

- the *Environmental Planning and Assessment Act 1979* (the EP&A Act)*;* and
- the *National Parks and Wildlife Act 1974* (the NPW Act).

In summary the EP&A Act establishes the framework for assessment to determine the existence of Aboriginal cultural heritage material in an area proposed for development activity and any impact upon it. The NPW Act establishes the framework for protection and management of Aboriginal cultural heritage material in any situation or across any tenure. The application and practical effects of these two pieces of legislation and their associated policies are discussed below.

2.2.1 Environmental Planning and Assessment Act 1979

As outlined above (see Section 1), development consent for the proposal is being sought under the EP&A Act. Reform of the legislation in 2005 established:

- a new part of the Act, known as Part 3A, which defines the assessment approach for major projects, and
- a new environmental planning instrument, known as the State Environmental Planning Policy (Major Projects) 2005 (the Major Projects SEPP) which defines the projects that are subject to Part 3A and require ministerial approval.

Section 75W of the EP&A Act provides a process for modifying a Minister's approval granted under art 3A of the EP&A Act. Clause 8J(8)(a) of the *Environmental Planning and Assessment Regulation 2000* provides the Minister for Planning the power to modify development consents issued under Part 4 of the EP&A Act (such as is the case for the current development consent that includes the Carrington mining area – DA 450-10-2003) as if the existing development consent were originally granted under Part 3A. This is, however, contingent on two factors: firstly, that the existing project the subject of the proposed modification is able to meet the same criteria that apply to projects applying under Part 3A (i.e. the requirements established under the Major Projects SEPP); and the agreement of the Minister to the development modification being considered in this way. The proposal for the existing development consent has satisfied these two requirements.

Although this path has the same reporting requirements and process trajectories as a Part 3A development application, any modified development consent does not become a Part 3A approval.

Following the agreement of the Minister to consider the proposal under s75 of the EP&A Act, Coal & Allied submitted the relevant modification approval application to the Director-General of the Department of Planning. As a result, the Director-General prepared Environmental Assessment Requirements with respect to the proposal that must be complied with before the application will be considered by the Minister. The Environmental Assessment Requirements establish the framework for the Environmental Assessment of the proposal and the format in which the assessment is presented for consideration.

The Environmental Assessment Requirements for the proposal require Coal & Allied to provide a comprehensive description of the existing environment and current operations, the nature and impacts of the proposed development and impact mitigation and management proposals with respect to a number of key issues. Aboriginal cultural heritage is included in this list of key issues for examination. The Environmental Assessment Requirements also require consultation with affected parties and stakeholders. For the key issue of Aboriginal cultural heritage, consultation is required to be conducted with relevant Aboriginal communities and organisations and with the NSW Department of the Environment, Climate Change and Water (DECCW) which has a key role as the Department responsible for the administration of the NPW Act (see below).

The Department of Planning maintains a Register of Development Assessment Guidelines for the use of councils, developers, consultants and the general public for the purposes of development assessment. The Register includes two guidelines for Aboriginal cultural heritage prepared by DECCW in its role as the administering authority for the NPW Act:

- Aboriginal Cultural Heritage Standards and Guidelines Kit; and
- Interim Community Consultation Requirements for Applicants.

2.2.2 National Parks and Wildlife Act 1974

The NPW Act is the primary legislation concerned with the protection of Aboriginal cultural heritage in NSW. As outlined above, the Act is administered by DECCW and provides protection for all Aboriginal objects (broadly defined) and for declared Aboriginal places. Aboriginal Heritage Impact Permits (AHIPs) are required for impacts to Aboriginal objects and places in New South Wales. AHIPs may be issued under either s87 and/or s90 of Part 6 of the NPW Act following application by proponents for activities that will have the effect of disturbing or destroying Aboriginal cultural heritage material.

A permit under s87 of the Act is required to disturb, move and or take possession of an Aboriginal object or disturb land for the purpose of discovering an Aboriginal object. A consent under s90 of the Act is required to destroy, damage or deface an Aboriginal object or Aboriginal place. DECCW is the decision maker for the purpose of determining the issue of AHIPs.

DECCW provides expert advice to the Department of Planning on major projects that are being assessed under Part 3A of the EP&A Act. The requirement for AHIPs is suspended for projects that are assessed under Part 3A with these generally superseded by a condition of the Part 3A project approval requiring the preparation of an Aboriginal Cultural Heritage Management Plan (ACHMP).

DECCW released the Aboriginal Cultural Heritage Consultation Requirements for project proponents in April 2010 (DECCW, 2010). These requirements provide a framework for consultation to be carried out by proponents with Aboriginal people who have knowledge about or have interests in sites that might be the subject of applications for AHIPs. The requirements replaced Interim Community Consultation Requirements for Applicants that had been in force for some years. Transitional arrangements apply for projects which had begun consultation prior to the introduction of the 2010 requirements.

DECCW's policy approach places strong emphasis on the involvement of the Aboriginal community in all Aboriginal cultural heritage assessment and management decision making processes associated with a development project. Key policy requirements include informing Aboriginal community members about the nature of a project and fully involving them in the assessment of both tangible and intangible Aboriginal cultural heritage, the determination of its significance, proposals for the management of project impacts upon the material and the process of reporting on cultural heritage for the purposes of Part 6 the Act.

This policy approach has formed the basis of the proponent's approach to consultation with the Aboriginal community on the management of cultural heritage potentially affected by the proposal, including cultural heritage in the project area.

Consultation on cultural heritage for the Carrington Mine area, including consultation for this proposal, commenced under the Interim Guidelines and all consultation notices issued to the Aboriginal community about the project predate the commencement of the 2010 consultation requirements.

3. RIO TINTO COAL AUSTRALIA’S APPROACH TO ABORIGINAL CULTURAL HERITAGE MANAGEMENT

Rio Tinto and Rio Tinto Coal Australia have developed and implemented a suite of policies and processes in the areas of community engagement, heritage management, relationships with Aboriginal communities, and ground disturbing operations that have direct relevance to their approach to Aboriginal cultural heritage management. These policies are regularly updated and have the status of work standards at all Rio Tinto Coal Australia’s projects and operations including HVO North. These policies include:

- Rio Tinto Communities Policy and Standard;
- Rio Tinto Cultural Heritage Management Standard for Australian Businesses;
- Rio Tinto Cultural Heritage Management System Guidance for Australian Businesses;
- Rio Tinto Coal Australia Aboriginal Cultural Heritage Management System Manual;
- Rio Tinto Procedure for Cultural Heritage Management Business Conformance Audits (under development);
- Rio Tinto Coal Australia Cultural Heritage Management and Investigation Agreements;
- Rio Tinto Coal Australia Cultural Heritage Management Plans; and
- Rio Tinto Coal Australia Indigenous Land Use Agreements.

3.1 The Rio Tinto Coal Australia Cultural Heritage Management System

Rio Tinto Coal Australia has developed an Aboriginal Cultural Heritage Management System (CHMS) that conforms with the Rio Tinto Cultural Heritage Management Standard for Australian Businesses (September 2007) and the Rio Tinto Cultural Heritage Management System Guidance for Australian Businesses (2007). Rio Tinto Coal Australia’s CHMS provides a comprehensive set of processes and procedures for the efficient management of Aboriginal cultural heritage that apply across all Rio Tinto Coal Australia’s development activities and land tenures, including the Carrington mining area.

Rio Tinto Coal Australia’s CHMS has been developed to ensure that all activities and ground disturbances associated with the company’s development activities and operations comply with the Rio Tinto Cultural Heritage Management Standard, Rio Tinto Cultural Heritage Management System Guidance for Australian Businesses, State and Commonwealth legislation, and other statutory regulations and agreements governing the management of Aboriginal cultural heritage.

The overarching objective of the Rio Tinto Coal Australia CHMS is to efficiently manage and mitigate the risks associated with Aboriginal cultural heritage in order to provide mine sites and projects timely and authorised access to Rio Tinto Coal Australia lands for mining and associated development activities. The CHMS policy states that:

> *RTCA will manage its projects and operations to comply with the RTCA Cultural Heritage Management System based upon the guiding principle of causing zero harm to Aboriginal cultural heritage. Where development requirements necessitates impacts on cultural heritage RTCA will ensure that all necessary and reasonable measures are implemented in order to mitigate those impacts in compliance with statutory requirements, cultural heritage agreements, Rio Tinto policies and standards, and in consultation with our Aboriginal communities.*

3.2 Aboriginal Consultation Processes for the Proposal

Rio Tinto Coal Australia and Coal & Allied personnel and contractors have legal obligations under the NPW Act not to harm or disturb Aboriginal objects and places. Rio Tinto Coal Australia and Coal & Allied are committed by the CHMS to working with Aboriginal communities to identify, manage and protect Aboriginal places of significance that may be within or in proximity to their mining operations.

Aboriginal communities who have interests in areas and projects owned, leased and/or operated by Rio Tinto Coal Australia, including the Carrington mining area, are fully involved in the identification, significance assessment, mitigation and ongoing management of their cultural heritage on lands associated with Rio Tinto Coal Australia and Coal & Allied operations.

In September 2005 Rio Tinto Coal Australia established the Upper Hunter Valley Aboriginal Cultural Heritage Working Group (CHWG). This working group is comprised of Rio Tinto Coal Australia and Coal & Allied representatives, and representatives from Upper Hunter Valley Aboriginal community groups, corporations and individuals. The CHWG was established so that Rio Tinto Coal Australia, Coal & Allied and the Aboriginal community could develop and implement an improved cultural heritage consultation and management process in the Upper Hunter Valley. This approach is centred upon a direct and ongoing engagement between Rio Tinto Coal Australia and Coal & Allied personnel and the Upper Hunter Valley Aboriginal community rather than outsourcing this relationship to a third party. In this, Rio Tinto Coal Australia’s objectives are to develop a robust relationship with the Upper Hunter Valley Aboriginal community and to cooperatively develop Aboriginal cultural heritage management programs which the Aboriginal community are encouraged to jointly design, implement and manage with the Rio Tinto Coal Australia and Coal & Allied.

The CHWG provides a regular forum for discussions on all matters pertaining to cultural heritage associated with Rio Tinto Coal Australia and Coal & Allied owned and operated lands, projects and operations in the Upper Hunter Valley. The CHWG regularly reviews the progress and outcomes of Rio Tinto Coal Australia’s cultural heritage process and management program in the Upper Hunter Valley, revising and refining elements of the process by consensus.

Rio Tinto Coal Australia is committed to active, meaningful and transparent engagement with the Aboriginal community as the basis for successful management of cultural heritage issues for all projects and operations.

3.3 Current and Proposed Aboriginal Cultural Heritage Management Processes

As a condition of the development consent for the Carrington Pit DA 106-6-99 an Aboriginal Archaeology and Cultural Heritage Management Plan (ACHMP) was developed to control the management of Aboriginal sites in the Carrington mining area. The ACHMP sets out protocols for managing Aboriginal cultural heritage issues affected by the operations. A key management protocol arising from the ACHMP is the Cultural Heritage Indigenous Management Agreement (CHIMA) established in August 2002 which provides management measures specific to archaeological place CM-CD1 (see discussion in Section 4).

Rio Tinto Coal Australia and its associated companies remain committed to their present leading practice standards and policies of engagement and consultation with the Aboriginal community and Aboriginal cultural heritage management in the Upper Hunter. Rio Tinto Coal Australia accepts as a threshold principle that it is for the relevant Aboriginal people to define the cultural meaning and significance of material and places that are affected by mining operations and that those Aboriginal people must have the key role in establishing cultural heritage management regimes that are put in place to meet regulatory requirements and other obligations. A robust and maturing relationship has been established with the Aboriginal community in the Upper Hunter Valley.

Nevertheless some shortcomings in the current standard heritage assessment and mitigation management approach, as mandated by State Government regulators, can be identified:

- there remains an emphasis on the identification, collection and curation of stone artefacts as the centrepiece of cultural heritage management activities. Aboriginal people regard artefacts as culturally significant and tangible evidence of their connection with their country and their ancestors;
- while this approach provides an avenue of cultural engagement for Aboriginal people and involves economically important employment opportunities, it does little to address the importance of critical regional cultural heritage places to Aboriginal people or to assist in the development of a sense of empowerment over the management of such important places;
- it also does not address the potential for community benefits and intergenerational equity that might arise from active engagement in the long-term management of cultural places;
- the focus on material culture can also divert attention from the fact that Aboriginal people themselves are the repositories of historical and cultural information that is important to the community and is under threat as older members of the community age and pass on; and
- there is a lack of certainty both for Aboriginal people and development proponents as the revision of mine plans brings potential impacts on cultural heritage areas and objects into focus over time. Cultural places that are regarded as protected from disturbance may lose this status as mining plans are revised to reflect new economic circumstances. While absolute and permanent certainty in land use requirements is an elusive concept, a more regional approach to cultural heritage management and planning with a focus on long-term management of critical areas could bring greater certainty to both sides and better outcomes for the Aboriginal community rather than what is currently a somewhat piecemeal and incremental approach.

Rather than dealing with the management of a particular development proposal's impacts on cultural heritage as a one dimensional localised problem, it can be more useful to approach the issue from the standpoint of the limits of acceptable change. People will often accept changes that have an impact on their cultural heritage once they have set that impact within a broader context relating to the socio-cultural wellbeing of their community. A cultural heritage situation that appears intractable when viewed in isolation can be resolved when set within a larger, more holistic model of community engagement, mitigation and empowerment. The reality is that seemingly intractable cultural heritage issues can be ameliorated through the development of well-designed and effectively implemented cultural heritage management arrangements that place control for determining significance and mitigation strategies with Aboriginal people and include other complementary elements such as:

- the opportunity to provide for long-term management of significant regional cultural heritage sites;
- access to traditional lands for cultural purposes; and
- other socioeconomic benefits such as employment and training opportunities.

It is this approach that is now anticipated for the proposal and other Coal & Allied operations in the Upper Hunter Valley. Members of the CHWG have expressed the desire to address cultural heritage at a landscape scale and consultations on the proposed proposal have incorporated this approach. As well as discussing cultural heritage impacts and their management within the proposed extension area, consultations have also occurred with respect to Coal & Allied's Aboriginal cultural heritage conservation areas strategy initially focusing on the proposed Aboriginal cultural heritage ‘Conservation Area’ to be established near Coal & Allied’s Mount Thorley Warkworth Operations on Coal & Allied owned lands along Wollombi Brook.

Coal & Allied and the CHWG have commenced a consultation process to identify various Coal & Allied owned lands that can be managed permanently for the conservation of the Aboriginal cultural heritage values (along with any biodiversity values). As outlined above, the initial core lands for inclusion in the Conservation Area strategy estate have already been identified and additional areas are intended to be added to it as the consultation and assessment process with the CHWG are completed.

Initially the Conservation Area will be managed by Coal & Allied in collaboration with the CHWG and in accordance with a management strategy specific to the area. The CHWG and Rio Tinto Coal Australia / Coal & Allied have jointly developed a set of key objectives and principles on which the management strategy will be based. A key objective will be to establish a co-management regime for the Conservation Area in partnership with the Aboriginal community through the development of a comprehensive and well considered management strategy supported by an appropriate community based governance structure.

The proposed Conservation Area provides an opportunity for key stakeholders including the Aboriginal community, Rio Tinto Coal Australia, Coal & Allied and Government agencies to reconsider the approach to Aboriginal cultural heritage management associated with Coal & Allied projects and operations in the Upper Hunter Valley.

It is proposed that an agreement or accord for the Conservation Area between Rio Tinto Coal Australia/Coal & Allied and the Aboriginal community could deliver long term secure protection of significant cultural places, access to country, intergenerational equity and enhance greater cultural and social strength and cohesion within the Aboriginal community of the Upper Hunter Valley.

4. CULTURAL HERITAGE INVESTIGATIONS ASSOCIATED WITH THE PROPOSED EXTENSION AREA

The proposed extension area has been the subject of a number of previous cultural heritage investigations. These date back to the initial development of the Carrington Pit in the late 1990s, the first extension of mining activities in 2004/5, and the current proposal. The works undertaken and results emanating from these investigations are reviewed below under these three general banners. The location and extent of these previous study areas and how they relate to the currently proposed extension area is provided in ***Figure 3***.

4.1 Initial Carrington Mining Area (Authority 435)

The initial Carrington Mine investigations are made up of several related studies. Each of these is reviewed in the following sections.

4.1.1 Carrington EIS Investigations (1997-1999)

The initial Carrington mining study area (also described as the Authorisation 435 area but also including an area noted as being the 'domestic surge bin' some distance to the north), was subject to Aboriginal cultural heritage investigations in 1997 and 1999 as part of the compilation of an EIS for the project (ERM Mitchell McCotter 1999a and b).

These investigations were not systematic in nature, rather focusing on exposures around 'creeks, watercourses and dams' (ERM Mitchell McCotter 1999a:11.9). Despite this, the study area was divided up into a series of survey areas (loosely based on landscape units) within which a representative sample was investigated. A mixture of foot transects and vehicle inspections were completed. The resulting report (presented as Chapter 11 of the Carrington Mine EIS) notes that 32 hectares had enough exposure to detect cultural heritage places, almost ten percent of the survey area.

Aboriginal community representatives were noted as being involved in both fieldwork periods. Two representatives from each of the Wanaruah Local Aboriginal Land Council (WLALC) and Wonnarua Tribal Council (WTC) were involved in the 1997 fieldwork. The 1999 fieldwork was undertaken with two representatives from the WTC. Draft reports of this fieldwork were provided to the WTC for further consultation with the broader Aboriginal community.

A total of 46 cultural heritage places (designated CM1-46) were identified and recorded. These predominantly consisted of areas containing stone artefacts, recorded both as scatters (n=34) and isolated finds (n=10). The two remaining places were scarred trees (one noted as being possible only) associated with stone artefact scatters. At least four places (CM 2, 3, 4 and 37) were identified as being also associated with the source stone used in the manufacture of the artefacts present. On this basis, one of these (CM37) was thought to be a possible quarry. Although not explicitly stated, it is implied that the general area that encompasses places CM2-4 has a similar function. Place CM4 also contains the positively identified scarred tree. As a result, these two general areas (but specifically CM2 and 37) were considered to be the most significant cultural areas identified during the investigations (ERM Mitchell McCotter 1999a:11.32). Of these, CM1, 2, 19 and 32 lie within the proposed extension area.

It was observed (ERM Mitchell McCotter 1999a:11.33) that, with the exception of places CM1, 19 and 32 (which were to be protected), the remaining identified cultural heritage places would be affected by the proposed mining activities, as understood at the time, and recommended that consents

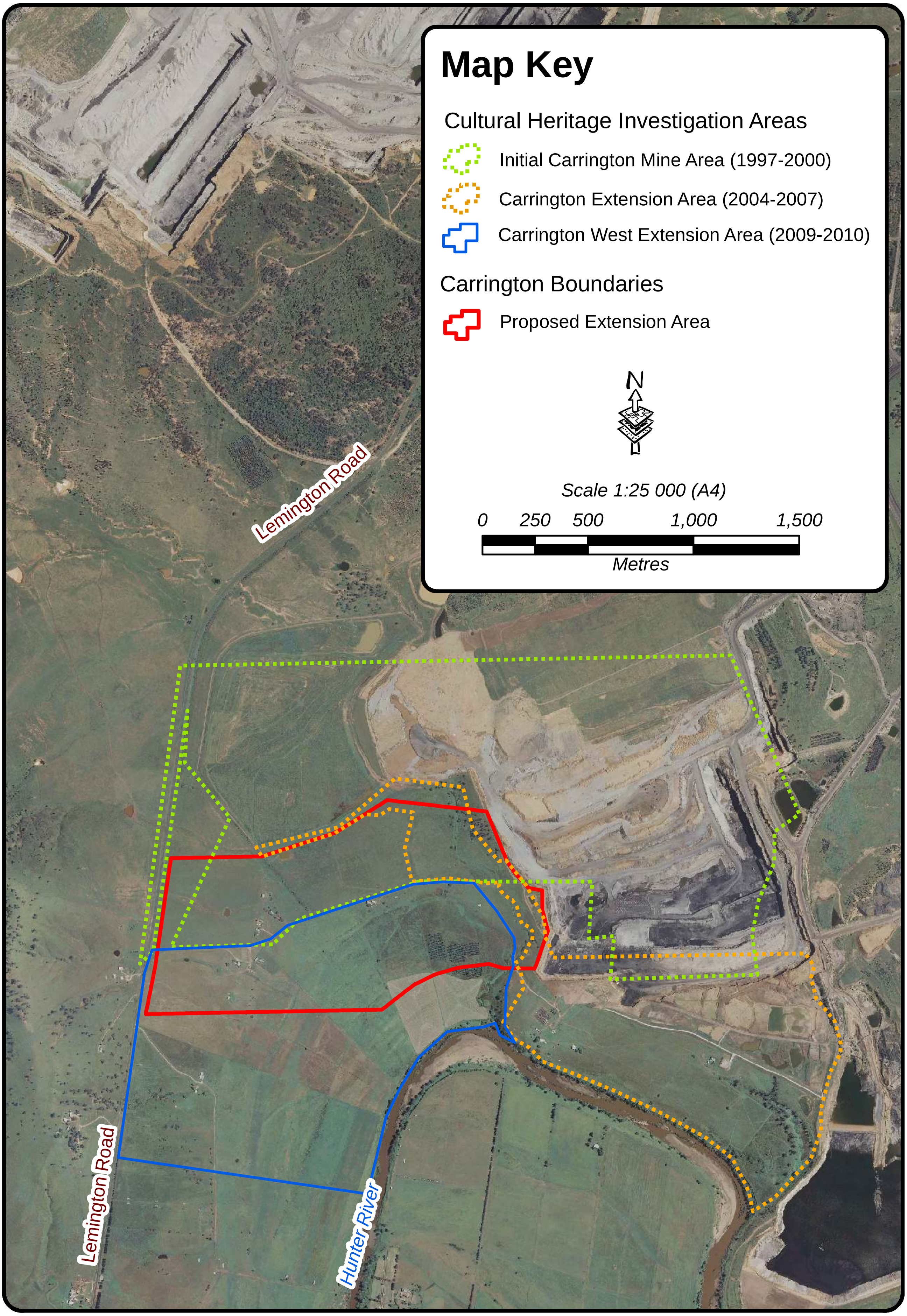


Figure 3: Proposed extension area in relation to cultural heritage investigation areas.

to destroy be sought for these. The report notes that the establishment of a conservation area based around Places CM2 and 4 was seriously considered by Coal & Allied, but that ultimately the mining expansion was considered unfeasible without the inclusion of the area that includes these places within the overall mine plan (ERM Mitchell McCotter 1999a:11.35).

Further work cataloguing surface artefacts from places CM2 and 37 was recommended with a view to confirming the similarity between the two. Additionally, further recording and consultations with the Aboriginal community was required to be undertaken with regard the scarred tree (CM4).

This report also discusses the potential for sub-surface material to exist within the study area, noting that this is considered most likely along the edge and slopes of a ridgeline in the vicinity of CM2 (as colluvial deposition) as well as across the valley floor along the entire length of the Hunter River (as alluvial deposition) both within and extending beyond the study area (ERM Mitchell McCotter 1999a:11.33). Given this distribution and the fact that it was considered that mining could not sensibly avoid the places and material at Carrington, the report considers that little would be served by undertaking further subsurface investigations (ERM Mitchell McCotter 1999a:11.35). None is recommended.

Chapter 17 of the final EIS-related documentation (ERM Mitchell McCotter *et. al.* 2000) considers further the 'archaeological potential' of the four landscape units identified within the Carrington study area. In this, the colluvium along the base of the western flank of the ridge that contains CM2 (defined as part of the 'Low Ridge' landscape unit) is noted as having the potential to contain stratified archaeological deposits dating back to the Pleistocene (ERM Mitchell McCotter *et. al.* 2000:17.1). The other identified landscape units are described as having a low to negligible potential for either surface or sub-surface cultural material. Contrasting with the survey report presented in Chapter 11, this assessment does not include the Lower Flats unit that includes the areas along the Hunter River, noting that these would not have been suitable as foci of Aboriginal occupation (ERM Mitchell McCotter *et. al.* 2000:17.2).

4.1.2 Follow-Up Geomorphological Investigations

Following the presentation of the Carrington EIS, two aspects of the study area were considered to be of particular interest and which required additional follow-up work and the provision of supplementary information. While the first related to the presence of the two identified 'quarry' areas (stated as being a rare place-type in the Hunter Valley at that time), the second related to the 'archaeologically-promising' (Huonbrook 1999:1) subsurface deposits contained within the study area.

Although not explored in any detail, the proximity of the area of colluvial deposits to the quarries (notably CM2 - presumably owing to its higher concentrations of cultural material which were recorded as averaging about 12/m^2) lead to the consideration that these deposits had a 'high probability' of containing *in situ* Pleistocene deposits (Huonbrook 1999:1). The basis for this probable antiquity was discussions with the Department of Geography and Environmental Science at the University of Newcastle, which observed that while older river terraces along the Hunter River are characterised by weathered gravels, the younger, better preserved terraces of Pleistocene and Holocene age, consist of sand, silt and clay, often overlying gravels (Huonbrook 1999:1).

As a result of these observations, Hughes was engaged to undertake a geomorphological investigation of the Carrington study area in order to assist in the interpretation of the archaeological record available from the surface surveys undertaken as part of the EIS. Within this broad aim there was a specific requirement to identify possible alluvial or colluvial deposits which might contain archaeological deposits within the study area.

As part of the background material provided within his report, Hughes notes that it is generally accepted that the alluvial or colluvial parent material for the B horizons of soils such as those found throughout the study area 'must' be at least 20,000 years old and can be much older. In this assertion he briefly reviews Erskine's work at Nowlands Creek among others (Huonbrook 1999:4-8). Further, he notes that there is generally an abrupt transition between the A and B horizons.

As part of his initial investigation into the geomorphology of the Carrington mining area, Hughes reviewed data collected from a range of exploration and geotechnical activities undertaken through the study area between the late 70s and late 90s. Following this he spent two days in the field in June 1999. In this time he undertook a visual inspection of the study area as well as excavating 13 backhoe pits in 'key areas' to examine the subsurface sediments. Each of these pits was approximately 2m long by 0.7m wide and excavated to a maximum depth of 1.5m (stated as being required under Rio Tinto Coal Australia's safety requirements).

Ten of the pits (1-8 and 11-12) were dug along a transect that extended from the ridge containing the previously recorded Place CM2 (one of the quarry places) in the east, across the low alluvial flats west to the hill-slope with Place CM37 (the other possible quarry). The other 3 (9-10 and 13) were dug variously around and to the east of CM2, with one of these (Pit 9) being located immediately below CM2 (Huonbrook 1999:Figure 1). The information available in this report is not such that the location of these pits can be plotted with any degree of accuracy.

Hughes (Huonbrook 1999:9) notes that his interpretation provided regarding the geomorphology of the study area was undertaken on basis of the fieldwork observations alone with no laboratory analyses of sediment samples being conducted. Further in this regard, Hughes notes that the excavated profiles were hard to characterise in detail owing to them being dry and tending to crack.

This fieldwork generally, but particularly the results obtained from Pit 9 in the CM2 area, identified that a colluvial deposit of possibly Pleistocene age (on the basis of the assumptions outlined previously above) was likely located immediately below Place CM2 (Huonbrook 1999:12 and 16).

Adjacent and to the west of CM2 there is a creekline which Hughes thought may have been in existence in the late Pleistocene and as such may well have been a focus for occupation through this period as well as the Holocene. If this was the case, then, Hughes (Huonbrook 1999:16) considered, the colluvial deposits immediately below CM2 and its associated river cobbles and silcrete outcrop have the potential to contain late Pleistocene stone artefact assemblages resulting from the exploitation of the locally available raw materials. With this in mind, Hughes rated the Pleistocene archaeological potential of these deposits as being moderate.

As a result of these investigations, Hughes recommended an excavation program be undertaken to test for the presence of *in situ* Pleistocene archaeological deposits in the colluvial deposits downslope from CM2. He suggested that this work should involve the excavation of 3-5 test pits each being $1m^2$ in area and located along the footslopes of the ridge in this area. It was noted that these excavations be dug in controlled spits (notionally 100mm in depth) but should follow the natural stratigraphy as encountered. It was stated (Huonbrook 1999:17) that if appreciable amounts of sub-surface archaeological material were found within this colluvium during this work, larger scale excavations 'might' be warranted.

On the basis of the results of this fieldwork, Hughes notes no requirements for other such excavations to be undertaken elsewhere within the Carrington study area.

4.1.3 Subsequent Archaeological Excavations and Additional Test Pitting

Hughes returned to the Carrington mining area to assist with these recommended excavations which were undertaken over an 11 day period in late November 1999 (***Figure 4***). The field team for this work included three archaeologists and a team from the WTC. It was noted (Huonbrook 2000:6) that on average five WTC representatives worked as part of the team each day. The work was undertaken under National Parks and Wildlife Service (NPWS) Preliminary Research Permit #SZ288.

As outlined above (see Section 4.1.2), Hughes' Pit 9 excavated at the junction of the footslopes of the low ridge below CM2 in 1999 had contained what was identified as being colluvial deposits of possible Pleistocene age. These deposits were titled the 'Older Stratum' (OS) and it is these that were targeted during the excavations undertaken as part of this research program. The excavations were undertaken using a mixture of trowel, shovel, crowbar and backhoe (***see Figure 4***). Irrespective of the excavation method employed it was noted that the deposits were removed systematically and that they were sieved.

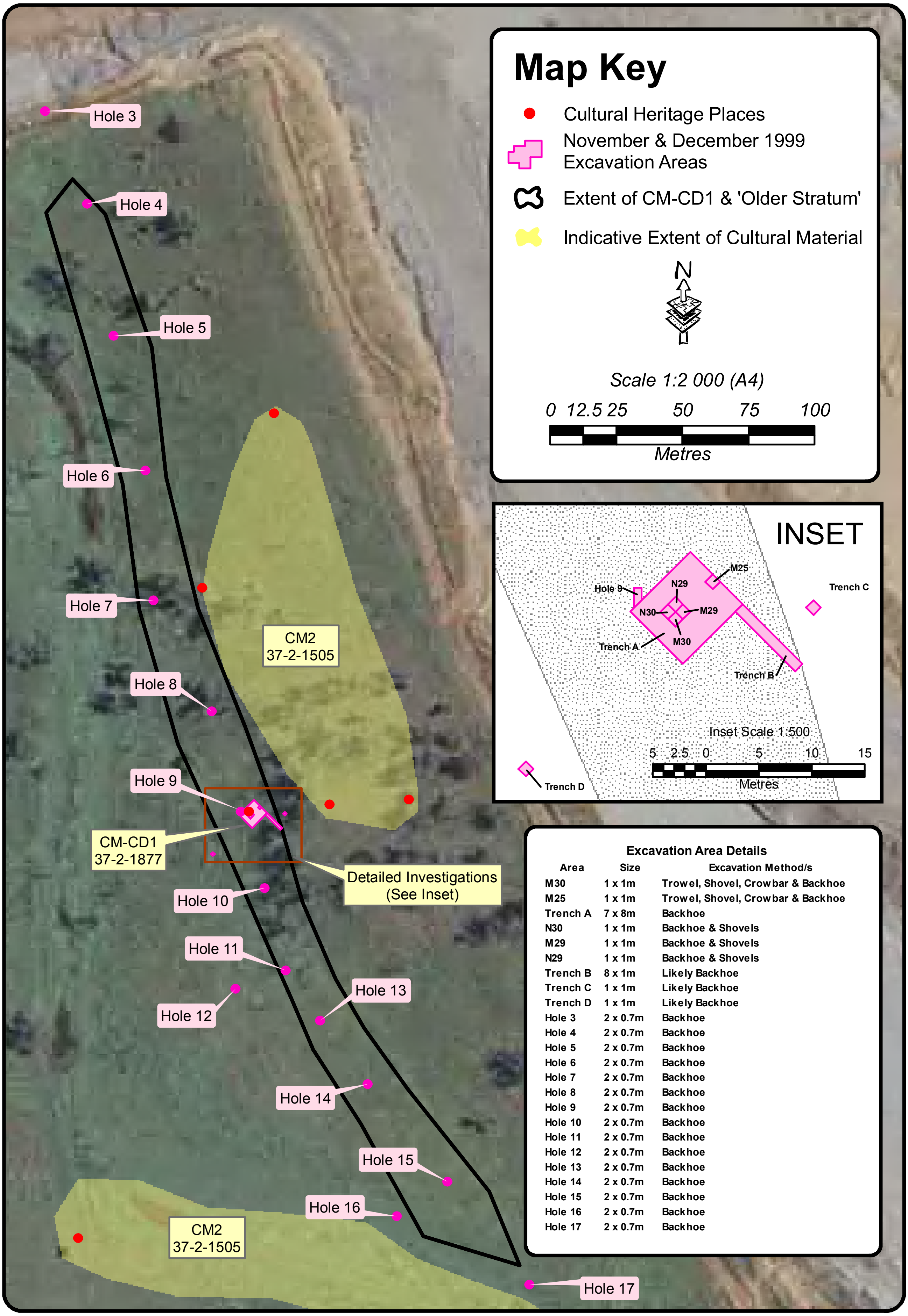
The excavations were undertaken in two stages. The first involved the excavation of two 1 by 1m squares (designated M25 and M30 based on their position within a grid established across the area) to the base of the upper or 'Younger Stratum' (YS). Deposits were removed in spits no greater than 100mm in depth. Seven spits were excavated from M25 (the upslope square) to the base of the YS about 370mm below the surface. This square was not excavated into the OS.

The downslope square (M30), some five metres from M25, was also removed in 7 spits to the base of YS which was reached at about 580mm depth (indicating some 210mm of colluvial accumulation between the two areas). Another 50mm of deposits (Spit 8) consisted of the transition zone between the YS and OS.

While within these squares, stratigraphic units 1-3 were excavated by shovel and trowel, from Unit 4 onwards it had to be broken up with shovels and spaded into buckets. Unit 5 (the OS) within M30 was noted as being too hard to break up even with crowbar and so permission was sought (and granted) to excavate the OS with a backhoe. This excavation method was undertaken for deposits below Spit 8 (the YS / OS transitional zone).

The second stage in the excavations involved the opening up of four 1m by 1m squares (M29 and 30 and N29 and 30). This meant that a 2m by 2m continuous excavation area was placed into the OS in this area. To avoid possible contamination, all of the upper deposits (including the YS and the YS / OS transitional zone) were removed with a backhoe across an area 7m by 8m. This area encompassed all of the excavated squares, was roughly centred on M30 and was referred to as Trench A. This material was not removed systematically nor was it sieved (Huonbrook 2000:11).

The Unit 5 (OS) deposit in each square was loosened with the backhoe which was then shovelled into buckets for removal and sieving. Deposits to a depth of about 450mm into this Unit were removed systematically from each square in 3 spits each about 150mm thick. From these 3 spits about 8.8m^3 of material was removed. The excavation of the OS ceased when massive, stony/rocky material (described as Unit 7) was encountered.



Area	Size	Excavation Method/s
M30	1 x 1m	Trowel, Shovel, Crowbar & Backhoe
M25	1 x 1m	Trowel, Shovel, Crowbar & Backhoe
Trench A	7 x 8m	Backhoe
N30	1 x 1m	Backhoe & Shovels
M29	1 x 1m	Backhoe & Shovels
N29	1 x 1m	Backhoe & Shovels
Trench B	8 x 1m	Likely Backhoe
Trench C	1 x 1m	Likely Backhoe
Trench D	1 x 1m	Likely Backhoe
Hole 3	2 x 0.7m	Backhoe
Hole 4	2 x 0.7m	Backhoe
Hole 5	2 x 0.7m	Backhoe
Hole 6	2 x 0.7m	Backhoe
Hole 7	2 x 0.7m	Backhoe
Hole 8	2 x 0.7m	Backhoe
Hole 9	2 x 0.7m	Backhoe
Hole 10	2 x 0.7m	Backhoe
Hole 11	2 x 0.7m	Backhoe
Hole 12	2 x 0.7m	Backhoe
Hole 13	2 x 0.7m	Backhoe
Hole 14	2 x 0.7m	Backhoe
Hole 15	2 x 0.7m	Backhoe
Hole 16	2 x 0.7m	Backhoe
Hole 17	2 x 0.7m	Backhoe

Figure 4: Location and extent of excavations at CM-CD1.

In the south eastern corner of Trench A river gravels were encountered throughout the stratigraphy from the top to the base of the trench (described as Unit 6). Another trench (B) aligned running away from Trench A) was removed with a backhoe to examine the relationship of these gravels to the overall stratigraphic sequence. This trench is stated as being 3.5m long (Huonbrook 2000:11) but in all likelihood was in fact 8m in length on the basis of the straitgraphic sections (eg. Huonbrook 2000:14) and other mapping provided in the report (eg. Huonbrook 2000:8). At the base of this layer a hole was dug in the bottom of the trench to expose the underlying deposits. To examine how far these deposits extended upslope, a small trench (Trench C) was also excavated about 5m upslope of Trench B.

Likewise, to examine how far the stratigraphic sequence identified in Trench A extended further downslope, Trench D was excavated 20m west of M30. While it is unclear from the report, it seems most likely that trenches C and D were about $1m^2$ (based on the excavation plan provided within the report: Huonbrook 2000:8) and were excavated by backhoe.

All deposits from the two squares systematically excavated into the YS (M25 and M30) and the four squares into the OS (M29 and 30 and N29 and 30) were sieved and analysed. Excavated materials were pre-soaked for between 10 and 30 minutes to facilitate the break-up of material which were then wet-sieved. Sieve sizes used were 10, 5.5 and 2mm respectively.

From the YS (stratigraphic units 1-4) seven stone artefacts were identified: five flakes, one core and a flaked piece. These were recovered from an area 2m by 2m by 800mm in depth (about $3.2m^3$) providing a stone artefact density of some 2.2 artefacts/m^3 within the YS. It was noted that five of the seven artefacts were recovered from the spit immediately above the OS.

This is in contrast to the four excavation squares into the OS (Unit 5). From these excavations 65 artefacts were identified: 58 flakes (three of which exhibited evidence of having been retouched) and 7 flaked pieces. Coming from an area 4m by 4m by 450mm in depth ($7.2m^3$) provides a stone artefact density of 9/m^3.

The percentages of raw materials are highly consistent between both the stratums: 85 percent silcrete and 15 percent mudstone in the YS; and 84 percent silcrete, 11 percent mudstone and single examples each of porcelainite, quartz and chert in the OS.

The report states (Huonbrook 200034): that no elements of the stone artefact assemblage are indicative of particular time periods, although it is considered that the OS sediments of Unit 5 do not provide any indication that they were deposited under environmental conditions different to those of the late Holocene (Huonbrook 2000:37). Within the OS, weathering was not considered to be pronounced (although it was considered that this layer was reasonably permeable with the weathering observed being attributable to continual periods of wetting and drying) and supporting this was that all artefacts had a fresh appearance.

Disturbance to the excavated deposits was noted generally, with a number of areas considered ‘highly’ disturbed, mostly by massive living tree roots (Huonbrook 2000:14). Additionally, it is considered that all of the cultural material present within this area (both as excavated and potentially remaining) will have moved downslope and as such will not be in its original depositional context (Huonbrook 2000:20, 23 and 31).

With the results of the research program showing that the identified colluvial deposits of the OS contained stone artefacts, the area was described and registered as a new Aboriginal cultural heritage place, CM-CD1 (Carrington Mine, Colluvial Deposit 1).

The key results of this work can be summarised as follows:

- The geomorphological interpretation of the colluvial deposits within the Carrington mining area outlined a stratigraphic sequence containing five units, with the upper four being collectively referred to as the 'Younger Stratum' (YS), and a lower unit (Unit 5) being the 'Older Stratum' (OS);
- These deposits overlie two older units (6 and 7). These were exposed in the larger scale backhoe excavations;
- Although accepted as being unknown, it is considered that the river gravels that make up Unit 6 are 'likely to be at least 100,000 years old and possibly much older' (Huonbrook 1999:2);
- The excavation showed that the YS consisted of stratified colluvial and alluvial sediments up to 800mm thick;
- These deposits were considered to have undergone little post-depositional weathering, which lead to the conclusion that the YS is entirely of Holocene age but would seem to be at least 2,000 years old (Huonbrook 1999:37).
- Only small numbers of stone artefacts (n=7) were identified within this upper stratum;
- A charcoal sample was taken from the lower half of Unit 3 (within the YS) and submitted for AMS dating (Beta-137093). The resulting determination was 930+/-40 years BP (Huonbrook 1999:36), consistent with an overall age of the YS being some 2,000 years;
- The OS consists of yellow and red, very compact and coarse textured gravely sand, about 450mm thick;
- These deposits appeared to have undergone a much higher degree of post-depositional weathering and induration. The induration was considered to be physical rather than chemical as the sediments disintegrated readily upon soaking. This was seen as relating more to the regular inundation periods and cycles of wetting and drying that the Unit would receive. These processes were noted as being conducive to rapid weathering (Huonbrook 1999:37);
- No dateable material was recovered from the OS but the degree of weathering and induration lead to the consideration that the deposits were likely to be at least early Holocene in age, and more probably late Pleistocene (Huonbrook 1999:37);
- The OS was about 450mm thick and contained artefacts throughout at maximum densities of about $15/m^2$;
- Sixty five stone artefacts were recovered from the excavations within the OS;
- Most artefacts were made of silcrete and mudstone from sources that were considered to be available locally;
- The recovered assemblage consisted mostly of unmodified flakes with a small number (n=3) of retouched flakes. No cores were recovered. This and the absence of flakes smaller than 6-8mm (both in length and width) led to the conclusion that the artefacts were made elsewhere and transported to CM-CD1 (Huonbrook 1999:32).
- The report questions whether cultural material extends to the full limits of the extent of Unit 5 (and hence the OS at CM-CD1). In this they state that there is no evidence to suggest that it does, offering instead that such areas may be small in area and/or consist of a number of clusters of artefacts within the unit (Huonbrook 1999:38).

Hughes again returned to the CM-CD1 area in December 1999, to investigate and determine the extent of the OS in this area. This work involved 29 additional backhoe pits that were excavated along the base of the low ridge below CM2 over a distance of 1.5km from near its northern end to the Hunter River. As with the previous investigations, these were 2m by 0.7m and generally 1.5m deep. These pits were labelled ‘Hole’ rather than ‘Pit’ to distinguish them from the original series of pits that he had previously excavated in June 1999. All holes were backfilled afterwards.

Of the total 29, 11 (Holes 4-8, 10-11 and 13-16 – ***see Figure 4***) were determined as containing the same YS / OS stratigraphy as recorded during the excavations (Huonbrook 2000:34). The results of this program determined that the colluvial deposit thought to contain archaeological potential extended in a narrow strip for about 450m along the base of the western flank of the ridge and to the north of the then alignment of Lemington Road (***see Figure 4***). Throughout this area the OS was shown to be around 25m wide and appeared to have been truncated by fluvial erosion along its western margin away from the ridge. It is this area that has become the accepted extent of CM-CD1.

One of the other holes (Hole 22) dug about 900m to the south of CM-CD1 (on the southern side of the previous alignment of Lemington Road) produced a depositional sequence considered to be similar to that identified for the CM-CD1 area (ie. the YS / OS stratigraphic relationship). Although small (~25m^2), this was the only other area observed with the potential to contain sub-surface archaeological material (Huonbrook 2000:36).

Falling outside of the previously sought development consent areas associated with the Carrington Pit, this area has not been further commented upon or considered. It should be noted that this area likewise does not fall within the proposed extension area and is located within the Hunter River offset zone. Despite this, it does falls within the boundaries of the Carrington West Extension cultural heritage study area (conducted to include unassessed portions of the proposed extension area) that has recently been completed (see Section 4.3 below).

4.1.4 Aboriginal Consideration of the Initial Carrington Studies

Coal & Allied commissioned Junburra Aboriginal Consultancy Services to conduct an Aboriginal heritage assessment and provide recommendations and management conditions concerning cultural heritage places that will be affected by the Carrington mine proposal. This was undertaken between September 1999 and January 2000.

The assessment report notes (Junburra Aboriginal Consultancy Services 2000:3) that the local traditional land owners were represented by the WTC who at that time were involved in ‘all major development in both the Upper and Lower valley areas’. Representatives of the WTC were consulted as part of the assessment undertaken by Junburra. Indeed the four member consultancy team included the then chairman of WTC, one other WTC representative, with the remaining two individuals being WTC members (Junburra Aboriginal Consultancy Services 2000:6-8). Further, it is noted that the Wonnarua people had fully endorsed Junburra to act as an independent consultant on their behalf and that while Junburra was to make recommendations, decisions regarding Wonnarua cultural heritage could only be made by the WTC.

In addition to undertaking a review of the EIS documentation prepared for the Carrington project, including the results of some of the supplementary work undertaken as part of its finalisation (it should be noted that while the excavations and additional test-pitting at CM-CD1 (see Section 4.1.3) – which at that time was still referred to as being part of the CM2 area - had been completed, the reporting of this had not been finalised), Junburra undertook a field assessment of both the results of these previous investigations and their own surveys. The main focus, however, was to relocate the recorded cultural heritage places and assess them from an Aboriginal perspective. This fieldwork was undertaken, with the assistance of the WTC, between 6-9 and 13-15 September 1999. Survey transects were undertaken both by vehicle and on foot over the 7 day period (Junburra Aboriginal Consultancy Services 2000:12). It was also observed that not all of the previously recorded places were able to be relocated and re-recorded.

Sixteen cultural heritage places considered to be new were located and recorded during the fieldwork, although it is acknowledged (Junburra Aboriginal Consultancy Services 2000:21) that some of these were likely in fact to have been previously recorded during the initial surveys (and for a number, the originally recorded place number is provided in addition to a new identifier). Copies of both the Junburra field recording forms and completed NPWS site cards are included within the report (Junburra Aboriginal Consultancy Services 2000:Appendices 4 and 5).

The report notes that Aboriginal occupation of the Carrington mining area appears to have been quite intensive around the old river channel which runs east to west and connects with the present Hunter River. It was also observed that the two areas described as being quarries (CM2 and CM37) were considered unique and requiring of further investigation. It is suggested that raw material was procured from CM37 and taken to the 'larger and more accommodating' (Junburra Aboriginal Consultancy Services 2000:28) CM2 area for further reduction.

The Aboriginal significance assessment for the Carrington mining area as provided within this report focuses on the two quarry areas as well as the possibility of older material being present as sub-surface cultural deposits within the alluvial flats (Junburra Aboriginal Consultancy Services 2000:28). In addition to these specific areas the report notes the presence within the study area of animals such as kangaroos, goanna, wallaby and bird life important to the Wonnarua people.

While it is acknowledged that the vast majority of the identified cultural heritage places would be affected by the mine as proposed at that time (including CM2 and CM37), the report notes that if the development is given consent, then Coal & Allied 'must do its best to preserve all of the sites not affected by the mine' (Junburra Aboriginal Consultancy Services 2000:28).

Junburra believed that the correct people (i.e. those with local connection and knowledge) had been consulted in regards to the assessment of Aboriginal cultural heritage for the Carrington project. With this in mind the report makes a number of conditions and recommendations that it notes would have to be agreed to by the broader Wonnarua community. Acceptance of these by Coal & Allied would form the basis for the provision of a letter from the Aboriginal community to (at that time) the NPWS supporting the Carrington development and any associated consent to destroy application. The conditions (Junburra Aboriginal Consultancy Services 2000:29-30) included:

- That the WTC community be provided funds to record all of the sites on video. This was to be undertaken with a view to reinstating these once mining had been completed;
- That the WTC be given an opportunity to tender for tree planting and fencing jobs around the new mine;
- That WTC employ three field assistants to help Australian Museum Business Services Pty Ltd (AMBS) to collect parts of a number of cultural heritage places identified as being HC21,22 and 24, and all of HC25;

- That WTC be allowed to tender for and employ an archaeologist to assist them in all salvage work.

A summary of the specific recommendations provided (Junburra Aboriginal Consultancy Services 2000:30-31) include that:

- consents to destroy be granted for 13 places which were identified as being isolated finds;
- consents to destroy be granted for a further 28 places on the condition that the parties meet to agree the strategies for the collections;
- consents to destroy be granted for another 11 sites provided that enough time is set aside for collections undertaken to the satisfaction of WTC;
- Coal & Allied provides all resources to undertake the required works;
- the parties develop a management plan for sites CM1, CM2, CM19 and CM32;
- WTC be supplied with a detailed map including grid references of all known sites within the Carrington lease area;
- a map and plan be prepared and presented to the (then) Department Urban Affairs and Planning containing the agreed management arrangements;
- once the coal mining has taken place and the rehabilitation is about to commence, the WTC are to replace all the artefacts back in their original positions in the landscape. All artefacts collected and salvaged must be recorded and stored away until their replacement back inside the newly rehabilitated land. The storage and placement of these artefacts is to be negotiated with Coal & Allied prior to the consent to destroy being granted. Further, this point was stated as having to be agreed to as a condition of any consent being granted, with the Wonnarua consent agreement being forfeited if this recommendation is not agreed to and finalised as stated; and
- because the identified sites are to be destroyed, Coal & Allied is to negotiate for funds to be donated to a trust account administered by the elders of the Wonnarua people.

Although WTC state that they are happy with the Junburra report, a letter from them and included within the assessment (Junburra Aboriginal Consultancy Services 2000:Appendix 3) notes that the issue of the CM2 heritage area is unresolved and that following a meeting of their membership (on 11 February 2000) note that they are not prepared to make comment on the rest of the project until the future of the CM2 area is resolved.

4.2 Previous Carrington Extension Studies

As outlined in further detail below, additional cultural heritage investigations were completed across the Carrington extension area as part of the Consolidated Development Consent process for DA 450-10-2003. This work included a review of the remaining places related to the initial Carrington cultural heritage surveys, and for which consents to destroy had not been sought and such work completed. The following review focuses on this work as it relates to these places.

4.2.1 Initial Investigations

The initial surveys of the 141 hectares Carrington extension area were undertaken on 26-27 October 2004 by ERM and a team of 7 Aboriginal community representatives (ERM 2005). Surveys were undertaken both by vehicles and on foot. Ten previously unrecorded cultural heritage places were identified during these surveys (C1-C10). These were described as being seven artefact scatters, two isolated finds and one scarred tree (ERM 2005:33). A total of 78 stone artefacts (62 flakes, 11 cores and 5 retouched flakes) were identified (ERM 2005:37). The scarred tree had likely been dead for some considerable time when recorded. It was standing and contained a single scar 30cm long and 15cm wide (ERM 2005:35).

Only two of these places (C8 and 10) are located within the proposed extension area. These are described within the report (ERM 2005:36) as being two stone artefact scatters of similar sizes (15 by 10m and 10 by 20m respectively) located in the upper western slopes of a low ridge approximately between 20 and 50m east of a minor creek. These places are located some 200m apart.

The stone artefacts identified at C8 included 17 flakes (two of which had evidence of having been retouched) and one core (ERM 2005:Annex D2-3). Despite the earlier description of Place C10 containing three stone artefacts, an appendix to the report (ERM 2005:Annex D3) lists 11 artefacts. It is likely that this has been mislabelled and is in fact C9 (which was noted as having 11 artefacts). This table also contains three artefacts labelled as C12 (ERM 2005:D4), a place number not referenced anywhere else in the report. The two flakes and one core recorded here are likely to be the C10 material.

With the exception of Places C5-7 (located to the south adjacent to the Hunter River), the remaining places identified as being located within the extension study area were likely to be impacted by the proposed mining extension. This included places CM1, the remaining portion of CM2, and CM45 and 46 from the initial Carrington studies. It was recommended that five of the newly recorded places (including C8 and 10) be destroyed following salvage work; the scarred tree be removed and relocated in consultation with the Aboriginal community; and that C4 be destroyed without any further requirements (ERM 2005:55).

As outlined above, CM1, 2, 45, 46 and CM-CD1, recorded during the initial Carrington study (see Section 4.1.1 above), were also visited and, where appropriate, re-recorded and assessed during this expansion fieldwork. The only other places remaining extant from these initial Carrington assessments at the time of this work, CM19 and CM32, were noted as not being able to be relocated during the surveys (ERM 2005:i). Given that they were located outside the extension study area, they were not considered any further. Being directly relevant to the proposed extension area, the reassessment of three of these places (CM1, 2 and CM-CD1) is considered further below.

CM1 was originally recorded as an extensive scatter of stone artefacts covering around 2.5 hectares and including 300m along the banks of the creek in this area. During the initial recordings, 214 stone artefacts were identified. Although ground surface visibility at the time of this review was noted as being fairly poor (ERM 2005:31), only a single artefact was found across this area during the reassessment. ERM (2005:42) considers that the criteria for identifying stone artefacts during the initial Carrington study was responsible for inflated artefact numbers.

With much of CM2 lying outside the extension study area, it was stated that no systematic attempt was made to establish its extent within or outside of the extension study area (ERM 2005:33). This was originally recorded as covering an area 120m long and 50m wide across the crest and slopes of the ridgeline in this area. Silcrete, with at least some considered to have been obtained from nodules naturally outcropping along the ridgeline, was the dominant raw material with a smaller amount of mudstone.

Only 17 stone artefacts were identified and recorded during the review undertaken. Most of these (n=14) were recorded within one relatively small area measuring 10 by 10m. The remaining artefacts

were noted as being found in areas near the silcrete outcrops on the slopes. Although a lot of broken stone was observed across this area, it was noted that non-artefactual fragments of silcrete were much more common than stone artefacts (ERM 2005:33). The majority of the original extent of this place was noted as having been previously collected under consent #SZ311 (ERM 2005:19).
Although within the Carrington extension study area, CM-CD1 was not examined in any detail as it was noted, firstly as being covered by the CHIMA, and secondly, was not planned to be impacted by the proposed extension. It was observed that it had been fenced.

The report recommended that CM1 be fenced to protect it, while the portion of CM2 located within the CM-CD1 buffer zone was to be protected by it being maintained as such. The remaining portions of CM2 were recommended as being able to be destroyed without any further work. Additionally CM45 and CM46 (which were unable to be relocated) were also to be destroyed without any further work being undertaken (ERM 2005:56).

4.2.2 Salvage Program

Over three days in March or April 2007 (see ERM 2007:1 cf ERM 2007:10), following the issue of s90 NPW Act Consent (DEC #2547), members of the Upper Hunter Valley Aboriginal community undertook a cultural heritage salvage within the Carrington extension study area. This work focused on the collection of cultural material from a series of places identified during the initial surveys in 2004 that were recommended for further such salvage work (i.e. Places C1, 2 and 8-10).

As recommended and approved within the then Department of Environment and Conservation consent, no further work was required to be undertaken at Places C4 from the 2004 surveys or places CM45 and 46 (which could not be relocated) from the initial Carrington studies. Although included within the Consent the scarred tree, C3, was not mitigated at the time of this work, rather being protected until August 2007 when it was salvaged (AHIP #2547) and relocated to a safe storage area at HVO when the area was required for mining activities. No work was undertaken at CM1 or CM2 (from the initial Carrington studies) which are explicitly excluded from this Consent.

As is generally the case during such work, more material was located during the 2007 collections than had been originally recorded in 2004 (ERM 2007:19). In the case of C8 and 10 (located within the project area), 114 and seven stone artefacts were collected respectively. In the case of C8 this is a marked difference from the 18 originally identified.

Additionally, the CM45 and 46 areas where no cultural material could be relocated during the 2004 investigations, were reinvestigated during this work. Although no material could again be located in the CM45 area, seven were identified and collected from the original CM46 (ERM 2007:19).

4.3 Carrington West Extension Indigenous Archaeological Assessments (2009-2010)

As part of examining the feasibility of pursuing the current proposal, a cultural heritage assessment was undertaken across a broader area that included the remaining sections of the proposed extension area that had not previously been the subject of cultural heritage investigations. This total study area (identified as the Carrington West Extension Area; McCardle Cultural Heritage Management Pty Ltd 2009 (MCH)) was some 120 hectares of which some 71 hectares falls within the proposed extension area. A Terms of Reference for these surveys were agreed with the CHWG prior to the fieldwork.

Twelve 100m wide transects were designed ahead of the fieldwork that would provide for 100 percent coverage of the study area. These totalled some 14.6km. The survey of these was undertaken over a two day period at the beginning of September 2009. The field team consisted of six Aboriginal representatives, their technical adviser (MCH) and a Rio Tinto Coal Australia Data Management Officer (DMO). The DMO was responsible for recording the identified Aboriginal cultural heritage locations and features on a Global Positioning System-based mobile mapping system for incorporation into existing Geographic Information Systems databases for the broader HVO mining area.

Owing to the presence of barley crops at the time of the fieldwork, two of the planned transects and the southern section of a third, were unable to be surveyed (MCH 2009:27). These total almost 1.4km of the designed survey transects, or some 12 hectares of the study area. The portion of this that lies within the project area is approximately 3.4 hectares. Following removal of the crop, these remaining areas were surveyed in February 2010 (see below).

Five places containing Aboriginal cultural heritage were identified. These were identified as HVO-1121 to 1125 (***Figure 5***). Four of these (HVO-1121-1124) were located in the higher slopes of the northwestern portions of the study area above the Hunter River floodplain, while the fifth was found along the edges of a tributary creek of the Hunter River near their confluence. In all cases these were described as being isolated stone artefact findsites with a total of six stone artefacts identified and recorded. Only one place (HVO-1121) contained more than one artefact: a broken mudstone flake that had evidence of having been retouched to facilitate continued use and a mudstone flaked piece (MCH 2009:33). The remaining identified material includes three other mudstone flakes (one containing retouch) and a single flake manufactured from silcrete (MCH 2009:33-34). It was noted that the condition of these places was ‘poor’ with all having been impacted by a range of natural and anthropogenic impacts (MCH 2009:34).

In addition to these items of Aboriginal cultural heritage, an area containing the potential to contain archaeological deposits (referred to as a PAD) was identified. Although having been cleared of its original vegetation, this area was noted as having the potential to contain subsurface cultural material that was not visible on the surface during the surveys. It was described as being approximately 400m in length and up to 50m in width (MCH 2009:35). It is located in the extreme southern portion of this study area along the Hunter River and was named PAD 1 (***see Figure 5***). No other areas containing the potential for sub-surface cultural material (including within areas were surface cultural material was observed: MCH 2009:34) were identified during the study.

MCH (2009:43-44) observes that all of the places identified containing cultural heritage material (i.e. HVO-1121-1125) were found in highly disturbed contexts, had little research potential and were otherwise well represented elsewhere in the Hunter Valley. As a result, conservation of these places was not considered to be warranted (MCH 2009:44). Despite this, the report (MCH 2009:46 and 47) recommends that they be fenced as a protective measure. If the places are not to be impacted by the proposed extension these places are to remain fenced and *in situ*. If they are to be disturbed by the proposed development activities, then it is recommended that a s90 Consent to Destroy under the NPW Act be applied for and the identified material be collected.

With regard PAD 1, MCH (2009:44-45) recommends that, should the area be required for future mining activities, sub-surface testing be undertaken to evaluate the observed potential for cultural material. While the scale or methodology for this proposed work was not detailed, it was noted that additional consultation with the Aboriginal community would be warranted prior to the application for a s87 AHIP under the NPW Act for such work.

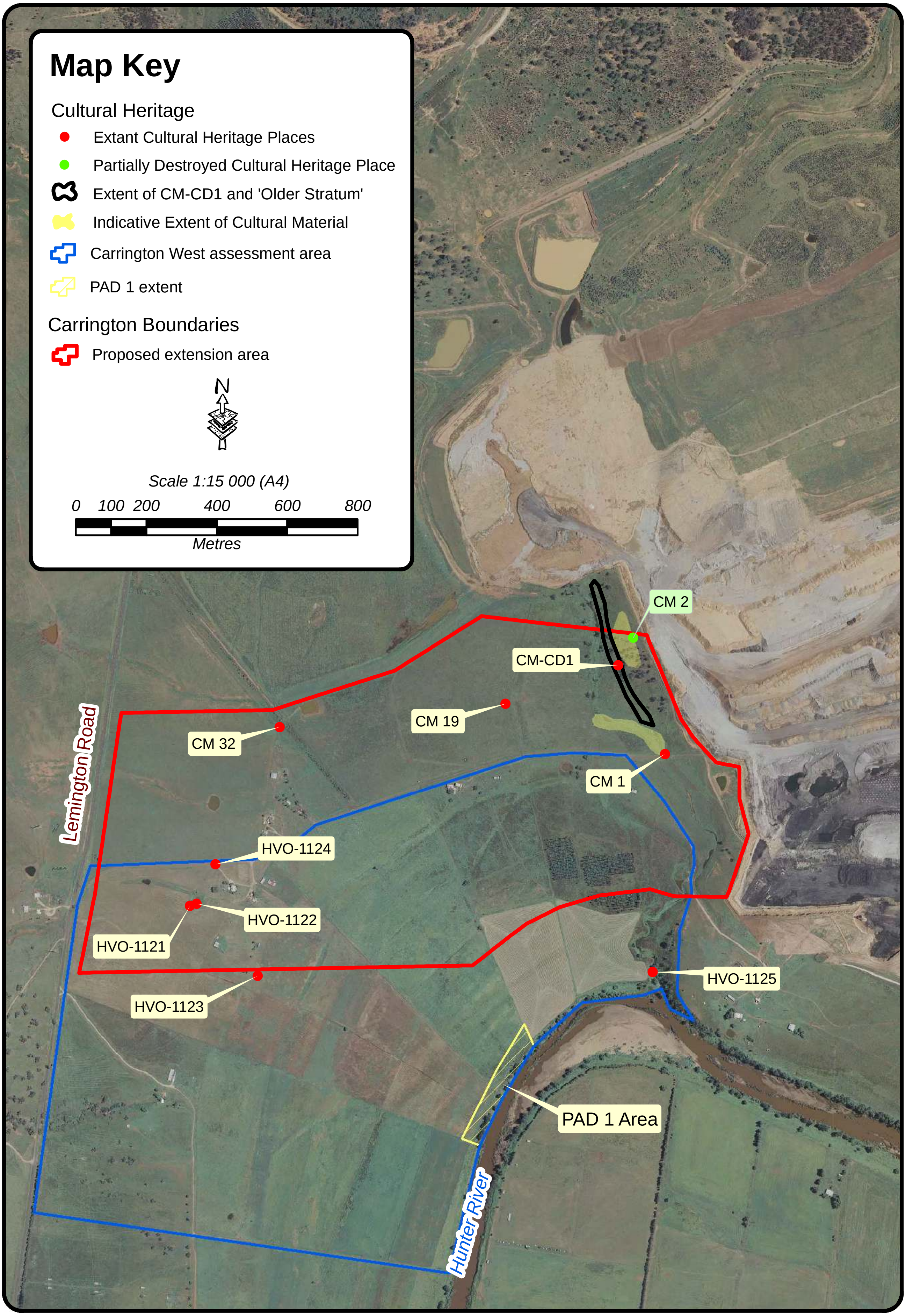


Figure 5: Location and management status of Aboriginal cultural heritage places within the proposed extension area and other places referred to in the text.

Three of the areas containing either identified cultural heritage material or the potential to contain this (HVO-1121-1122 and 1124) are located within the proposed extension area, while a fourth (HVO-1123) is located less than 20m from the southern boundary. This is also an area that may be impacted by the construction of a levee bank. Places HVO-1125 and PAD 1 are located outside of the proposed extension area and will not be impacted by the proposed development activities (***see Figure 5***).

Subsequent to this assessment, an additional buffer area to the south was surveyed in February 2010 (***see Figure 5***) along with the areas that were unable to be surveyed owing to crops in 2009. Four 100m wide transects were designed ahead of the fieldwork that would provide for 100 percent coverage of the study area. These totalled some 7.2km. The survey of these was undertaken over one day on 10 February 2010. The field team consisted of six Aboriginal representatives, their technical adviser (MCH), a Rio Tinto Coal Australia site supervisor and a Rio Tinto Coal Australia Data Management Officer (DMO). No additional places containing Aboriginal cultural heritage were identified.

A series of meetings with the CHWG has taken place regarding the management of the places identified during these extension studies. An overview of these meetings is provided in Section 6.

5. ABORIGINAL COMMUNITY CONSULTATION, CULTURAL HERITAGE MANAGEMENT AGREEMENTS AND CONSENT MODIFICATIONS

Aboriginal community consultation surrounding development activities in the Carrington mining area has been an integral and on-going process as development activities have progressed and been redefined over the years. These are reviewed in the following sections generally arranged chronologically and in accordance with the major stages of development of the Carrington mining area. The provided discussions focus on the management requirements for Aboriginal cultural heritage places and management issues as they intersect with the proposed extension area.

5.1 Initial Carrington Mining Area

Formally commencing in late 1999 following the submission of the Junburra report and its proposed conditions and recommendations (see Section 4.1.4 above), and continuing through until mid 2002, a series of comprehensive discussions and negotiations were held with the WTC regarding the development of several cultural heritage agreements that have included cultural heritage places within the proposed extension area.

The first of these was the development of an agreement titled only as ***'Cultural Heritage Agreement'***. This agreement provided a package of benefits through until 2009 and covers several development consents at HVO, and also Mount Thorley. These benefits include direct cash payments (to be used for motor vehicle purchases and cultural heritage work salaries) and the establishment of a number of trust funds across a range of activities (e.g. business development, community programs and education).

Several other matters (including land for a keeping place, joint venture arrangements for tree planting projects, and the development of a region-wide CHIMA) are outlined as being additional activities that could be explored within an expanded agreement. This agreement was finalised and agreed in mid February 2001.

The Cultural Heritage Agreement covers specific works within the Mount Thorley, and the HVO South, Howick and Carrington Pit areas. With regard to the Carrington mining area, the agreement specifically excludes CM-CD1 (including the extent of the OS as outlined above) from the development application lodged for this project. At this time, Coal & Allied agreed to maintain a 60m buffer zone around this area until what was then described as a 'Cultural Heritage Management Agreement or similar' is developed for this area in consultation with the WTC. It notes that the parties intended to have such an agreement finalised before the end of December 2001.

In July 2000 (ahead of the formal February 2001 signing of the Cultural Heritage Agreement) Coal & Allied and the WTC advised the then Department of Urban Affairs and Planning that they had reached in principle agreement regarding the Cultural Heritage Agreement. From this development consent (DA 106-6-99) was issued for the Carrington Pit.

In the period between the July 2000 in principle agreement to the Cultural Heritage Agreement, and late 2001 (when it was finalised), Coal & Allied in consultation with WTC and NPWS developed an ***'Aboriginal Archaeology and Cultural Management Plan'*** in accordance with the consent conditions for the Carrington Pit. This plan has as its objectives to: manage Aboriginal sites in consultation with the WTC; and comply with the requirements of the NPWS Act in terms of heritage assessment, management and protection. While the plan is noted as principally applying to the Carrington mining area, it also includes some areas on the existing Howick lease (i.e. the current West Pit area).

This plan contains an overview of consultation with and the involvement of the WTC and 'Wonnaruah' throughout the Carrington mining area to the time of it being finalised and is a useful reference in this regard.

As additional background to the impacts of the mining activities within the Carrington Pit on known cultural heritage places, the Archaeology and Cultural Management Plan notes that consents to destroy with salvage have been granted for a series of places (including those areas, among others, identified as being conditions of the development consent granting for Carrington in the Junburra report – see Section 4.1.4 above). This work was undertaken under NPW Act s90 Consent to Destroy #SZ300 by AMBS and representatives of the WTC in August/September 2000. The WTC also carried out a separate cultural salvage project which involved the preparation of a video and collection and recording of cultural places.

Also in September 2000, a further s90 Consent to Destroy (#SZ311) was also granted for an additional series of cultural heritage places within the Carrington mining area. As a result of the significant archaeological investigations already carried out in the area (i.e. the work undertaken by Hughes and Hiscock - see Sections 4.1.2 and 4.1.3 above), no cultural salvage was proposed in the prefacing application. Coal & Allied did however commission the WTC to undertake a cultural salvage project which included both additional collections and salvage of recorded places and the preparation of a video.

The Archaeology and Cultural Management Plan also outlines a range of cultural heritage places within the Carrington mining area which it was agreed were not to be impacted by the proposed development. This includes Places CM1 (which was to be left as it was), Places CM19 and CM32 (which were not able to be relocated during relocation and fencing works undertaken by the WTC in September/October 1999), and CM-CD1 (including the extent of the OS).

A series of control measures for each of the above places is outlined below. These are provided primarily as a general set of management arrangements in an appendix of the plan that was to include:

- an Environmental Induction for all new contractors;
- no disturbance until the granting of consents to destroy;
- contingency arrangements for the discovery of new cultural heritage material;
- the requirements for all major contracts to prepare a Safety and Environmental Risk Assessment prior to commencing work on site;
- the development of what is now called a CHIMA (Cultural Heritage Indigenous Management Agreement) for CM-CD1 but which 'may' also include CM1, 19 and 32;
- the fencing and signposting of the above places and their recognised extents (it is previously noted that at the time of the plan being prepared, CM-CD1 had already been fenced); and
- continued consultation with the WTC regarding the management of Aboriginal places.

The plan also outlines reporting and performance outcomes and review procedures.

Finally, in August 2002 the specific agreement to cover CM-CD1, was executed by Coal & Allied and WTC as a ***'Cultural Heritage Indigenous Management Agreement'*** (CHIMA). Under the substantive provisions of this agreement, Coal & Allied agreed to exclude CM-CD1 (including the extent of the OS) from mining activities for a period of three years from 7 August 2002. As part of this, Coal & Allied agreed not to mine within 60m of this defined exclusion area (i.e. the extent of the OS at CM-CD1 plus a 60m buffer – becoming the 'Exclusion Zone').

Following the expiration of this three year period (being on 7 August 2005), the agreement notes that Coal & Allied is free to apply for a NPW Act s90 Consent to Destroy with the support of the WTC providing that all other development consent conditions have been satisfied. Further, the WTC will not require any further cultural heritage assessment within either CM-CD1 or the Exclusion Zone. It also notes that if any additional excavations be required by a third party prior to applying for a Consent to Destroy, the WTC will be afforded the opportunity to be involved in such work.

Once a Consent to Destroy has been issued for CM-CD1, the CHIMA also provides for WTC to be afforded the opportunity to salvage artefacts from this area and to undertake video recordings both prior to and during disturbance. The salvage process is to be agreed either directly with the WTC, in consultation with the relevant regulatory department(s), or following agreement with DECCW as they are presently. The CHIMA contains agreed timeframes and personnel requirements for this work.

Like the Cultural Heritage Agreement, the CHIMA also provides a resourcing package as part of its agreed terms. These payments were made in accordance with the terms of the agreement.

At the present time a Consent to Destroy has not been lodged for CM-CD1 and consultations with the CHWG have been held in this regard. These are outlined in more detail below in Section 5.2.

5.2 Carrington Extension, Subsequent HVO North Consolidation and Development Consent Modifications

As previously described in Section 1, ERM (2003) prepared the HVO West Pit Extension and Minor Modifications EIS which provided, among a number of other matters, for the expansion of mining within the West Pit area. With respect to the Carrington Pit, this included an increase of approved production capacity from 6Mtpa to 10Mtpa.

The granted development consent attached to this development application (DA 450-10-2003) contained six conditions with respect to Aboriginal cultural heritage (numbers 37-41). The focus of these related to the requirements for Coal & Allied to apply for consents to destroy a range of listed places and the development of a salvage program with (then) DEC and the Aboriginal communities, and the (by then) standard requirement to provide monies to the Hunter Aboriginal Cultural Heritage Trust Fund.

Conditions 40 and 41 relate to CM-CD1 (including the OS) with the former requiring that Coal & Allied continue the agreed CHIMA. Although not provided for within the CHIMA, this consent condition notes that consideration 'may' be given to permanent conservation status for CM-CD1, as well as CM1, part of CM2, CM19 and CM32. With the exception of CM2, these places are mentioned within the Aboriginal Archaeology and Cultural Management Plan as possibly being included within a subsequent CHIMA, but ultimately the agreed CHIMA relates to only CM-CD1 and its exclusion buffer. At this time (2004) a significant portion of CM2 was protected by virtue of it residing within the designated Exclusion Zone attached to CM-CD1. In this regard, condition 41 states that Coal & Allied will not mine within 60m of the area of CM-CD1 and the extent of the OS 'unless otherwise agreed by a CHIMA', in which it refers to the preceding condition.

Condition 5 of the development consent, although not directly related to cultural heritage matters, notes that within three months of the submission of the revised West Pit extension Mine Operating Plan (MOP), Coal & Allied will surrender all existing development consents and use rights associated with HVOs mining operations and facilities north of the Hunter River. This area included the Carrington Pit and CM-CD1.

In January 2006 the Department of Planning accepted the surrender of 12 development consents (including DA 106-6-99 that included the original Carrington consent conditions outlined above), five development application modifications, and two existing use rights.

Subsequent to its granting in 2004, modifications were made to the consent conditions for DA 450-10-2003 on at least two occasions; in August 2005 and June 2006 (the latter modification both extended the Carrington Pit mining area and changed the Development Consent Boundary). These later changes were supported by a series of specific investigations associated with the Carrington Pit extensions, notably the 'Statement of Environmental Effects' in October 2005, and the 'Response to Submissions Report' and 'Summary of Commitments for Carrington Pit as Extended', both in May 2006. These included the results of additional cultural heritage investigations completed across the Carrington extension area and a review of the remaining places in the initial Carrington mining area for which consents to destroy had not been sought (see Section 4.2 above for the details of this work).

Conditions 37-42 of the June 2006 modifications to DA 450-10-2003 relate to Aboriginal cultural heritage with many being virtually the same as the 2004 consent conditions, albeit with the list of required consents to destroy increased following the cultural heritage investigations undertaken in support of these modifications.

Conditions that specifically relate to the CM-CD1 area are as follows:

> 40. The Applicant shall continue the Cultural Heritage Indigenous Management Agreement developed in consultation with, and to the satisfaction of, the Wonnarua Tribal Council, particularly in relation to the management of Aboriginal site 37-2-1877 (ie CM-CD1) and the Older Stratum as shown in Drawing 002 – Revision A which may include consideration of permanent conservation status for the sites CM-CD1, and also sites 37-2-1504 (ie CM1), part of 37-2-1505 (CM2), 37-2-1522 (CM19), and 37-2-1535 (CM32). Details of any agreement shall be provided to the Director-General within 14 days of any final agreement(s).
> 41. The Applicant shall not mine within 15 metres of the Aboriginal site 37-2-1877 (CM-CD1) and the Older Stratum, as measured from the margin of the predicted maximum extent of those deposits as identified in Drawing 002-Revision A, dated 4 August 2000.

Significant among these modifications was the reduction in the size of the mining exclusion buffer surrounding the CM-CD1 area (including the extent of the OS), to 15m. This management regime and its ensuing arrangements remain in place to the present time.

6. CURRENT CULTURAL HERITAGE STATUS OF THE PROPOSED EXTENSION AREA AND ASSESSMENT OF THE LIKELY IMPACTS

The entirety of the proposed extension area has been the subject of Aboriginal cultural heritage investigations. From these, a total of nine cultural heritage places have been identified as being located either within, or immediately adjacent and which have not previously been destroyed under a finalised NPW Act s90 consent (***Table 1***).

Given the restricted size of the proposed extension area and the nature of the proposed development activities within it, the entirety of this area will be impacted. This will include the eight extant cultural heritage places located within the proposed extension area and, in the context of a levee being considered to be constructed, a ninth (Place HVO-1123) lying immediately adjacent to the southern boundary of the proposed extension area. Details of these places and their current composition and management status are also provided in ***Table 1***, see also ***Figure 5***.

In the case of cultural heritage places CM1, the remaining portion of CM2 (i.e. that lying within the CM-CD1 Exclusion Zone), CM19, CM32 and CM-CD1 (including the OS), these places are actively managed in accordance with both the provisions of the formalised cultural heritage agreements, the existing development consent conditions, and ongoing discussions through the CHWG.

Management arrangements for the cultural heritage places identified as part of the Carrington West Extension investigations (including HVO-1121-1124 associated with the proposed extension area) have been agreed directly between Rio Tinto Coal Australia / Coal & Allied, and the CHWG.

AHIMS ID	Place ID	Report	Initial Place Description	Recent Assessment / Management Notes	Status
37-2-1504	CM1	ERM Mitchell McCotter 1999 Carrington Mine EIS (see Section 4.1.1)	Described as an open campsite consisting of 214 stone artefacts. It commenced near a culvert alongside Lamington Road and continued northwest along the banks of the creek for a distance of approx. 300m	Revisited and reassessed during the ERM 2005 study; a single stone artefact was identified. Area fenced and managed as per CHIMA. It is subject to current development consent conditions.	Extant
37-2-1505	CM2	ERM Mitchell McCotter 1999 Carrington Mine EIS (see Section 4.1.1)	Described as a possible stone working area some 120m long and 50m wide and containing a large number of artefacts. Majority of surface material has previously been salvaged	Partially destroyed under Permit #SZ311. Revisited and reassessed during the ERM 2005 study; seventeen stone artefacts, mostly within one small area, were identified. Remaining area within fenced CHIMA Exclusion Zone and as such subject to current development consent conditions.	Partially Destroyed
37-2-1522	CM19	ERM Mitchell McCotter 1999 Carrington Mine EIS (see Section 4.1.1)	Single large mudstone flaked piece located in natural clearing adjacent to fenceline	Unable to be relocated by Junburra 2000 or ERM 2005 studies. Area fenced and managed as per CHIMA. It is subject to current development consent conditions.	Extant
37-2-1535	CM32	ERM Mitchell McCotter 1999 Carrington Mine EIS (see section 4.1.1)	Described as an open campsite consisting of five mudstone and one silcrete flakes that had been disturbed by vehicle and stock movements. No indication of area is provided	Unable to be relocated by Junburra 2000 or ERM 2005 studies. Area fenced and managed as per CHIMA. It is subject to current development consent conditions.	Extant
37-2-1877	CM-CD1	Huonbrook 2000 Carrington Archaeological and Geomorphological Excavations (see section 4.1.3)	Potential archaeological deposits up to 450m long and 25m wide along the base of a low ridge below CM2. Area, including 15m mining exclusion buffer is enclosed by fencing	Revisited during the ERM 2005 study. Area of the OS and broader Exclusion Zone fenced and managed as per CHIMA. It is subject to current development consent conditions.	Extant
TBA	HVO-1121	MCH 2009 Carrington West Extension (see Section 4.3)	Single retouched mudstone flake and mudstone flaked piece recorded	n/a	Extant
TBA	HVO-1122	MCH 2009 2009 Carrington West Extension (see Section 4.3)	Single silcrete flake recorded	n/a	Extant
TBA	HVO-1123	MCH 2009 Carrington West Extension (see Section 4.3)	Single retouched mudstone flake recorded	n/a	Extant
TBA	HVO-1124	MCH 2009 Carrington West Extension (see Section 4.3)	Single mudstone flake recorded	n/a	Extant

Table 1: Cultural heritage places identified as being located within the proposed extension area and their current management status.

7. CONSULTATION WITH THE ABORIGINAL COMMUNITY ON CULTURAL HERITAGE IMPACT MANAGEMENT IN THE PROPOSED EXTENSION AREA

This section of the report summarises consultation with the Aboriginal community regarding the management of cultural heritage impacts within the proposed extension area, including consultations on the contents of this report.

7.1 The Upper Hunter Valley Aboriginal Cultural Heritage Working Group

As previously outlined, the CHWG was established in 2005 by agreement between Rio Tinto Coal Australia and members of the Upper Hunter Valley Aboriginal community. Membership of the CHWG and attendance at its meetings is open to all Aboriginal people who notify their interest in the lands on which Rio Tinto Coal Australia companies conduct operations in the Upper Hunter Valley.

The CHWG currently includes representatives from the following Aboriginal corporations:

- Aboriginal Native Title Consultants
- Buda Mada Koori Women Aboriginal Corporation
- Bullem-Bullem Consultants
- Cacatua Culture Consultants
- Carrawonga Consultants
- Culturally Aware
- Giwiirr Consultants
- Hunter Traditional Owner Environmental Management Services
- Hunter Valley Aboriginal Corporation
- Hunter Valley Cultural Surveying
- Kayaway Eco-Cultural and Heritage Services
- Lower Hunter Wonnarua Council
- Lower Wonnarua Tribal Consultancy Pty Ltd
- Mingga Consultants
- Ungooroo Aboriginal Corporation
- Ungooroo Cultural and Community Services
- Upper Hunter Heritage Consultants
- Upper Hunter Wonnarua Council
- Valley Culture
- Wanaruah Aboriginal Custodians Corporation
- Wanaruah Local Aboriginal Land Council
- Wattaka Wonnarua Cultural Consultants Service
- Wonnarua Nation Aboriginal Corporation
- Wonn1 Contracting
- Yarrawalk Aboriginal Corporation
- Yinarr Cultural Services

The CHWG provides advice on cultural heritage management for all Rio Tinto Coal Australia Hunter Valley Operations, develops Terms of Reference for cultural heritage investigations, considers technical reports and administers cultural heritage field work programs. CHWG members undertake field work as cultural heritage field officers through a roster arrangement agreed upon by the stakeholders through the auspices CHWG. The CHWG met and discussed the proposal and associated heritage assessment and management issues on three occasions during 2009, 27 August, 1 October and 9 December, and twice in 2010, 12 February and 22 April. Minutes of the discussions and their outcomes are provided in Section 7.2 below.

7.2 Summary of Working Group Discussions of the Proposal

Rio Tinto Coal Australia and the Aboriginal community of the Upper Hunter Valley have discussed the proposal with particular reference to the proposed extension at five CHWG meetings. Their dates and a summary of the discussion conclusions are provided below. Further details are included in the meeting minutes provided in ***Appendix 1***.

- **27 August 2009** – introduction of the proposal to the community and the additional cultural heritage assessment that would be required to ensure coverage of the proposed extension area. Brief mention of CM-CD1 and its heritage significance.

- **1 October 2009** – introduction of the proposal Environmental Assessment study manager, presentation of the results from the additional cultural heritage assessment, and a history of the previous assessments and investigations into CM-CD1, and the CHIMA regarding CM-CD1. Management recommendations from the community included collection of surface materials, clearing of vegetation and grader scrapes across CM-CD1 (including CM1 and 2), production of a cultural video, and fencing of the sites to be left undisturbed.

- **9 December 2009** – review of previous discussions and the evidence for the age of CM-CD1, and announcement that the draft proposal Environmental Assessment report would be available for community review prior to the next CHWG meeting.

- **12 February 2010** – review of previous discussions and recommendations, presentation of the results from the additional cultural heritage assessment of buffer areas recently completed (including the previous barley crops within the proposed extension area), and discussion of offsets. Community agree in principle to endorse the cultural heritage report for the proposal Environmental Assessment with the inclusion of the statement:

  'The CHWG want to note that the site CM-CD1 [AHIMS 37-2-1877] is very significant to the community and regardless of the offsets being considered in the CNA heritage conservation areas strategic plan, the CHWG desire that a requirement for a heritage offset area for the loss of CM-CD1 be included in the plan of management for the Extension area, because of the high significance of this site, something beyond the existing strategy needs to be determined. The offset area needs to be outside the current mining leases and mining areas, which could be on private property and be land that the community could manage ourselves or some other lands considered appropriate for an offset by the CHWG and CNA.'

- **22 April 2010** – project report update, review of previous discussions and confirmation that CHWG heritage offset conservation area requirement statement (above from 12th February meeting) was included in the Aboriginal Cultural Heritage Assessment report. CNA also confirmed that it supported the CHWG heritage offset conservation area requirement statement.

8. ABORIGINAL CULTURAL HERITAGE IMPACT MANAGEMENT COMMITMENTS FOR THE PROPOSED EXTENSION AREA

8.1 Aboriginal Cultural Heritage Management Principles

Clear principles guide the management of Aboriginal cultural heritage for all Rio Tinto Coal Australia and Coal & Allied operations. These principles will be applied to the proposal and comprise:

- the CHWG is the primary entity with which Rio Tinto Coal Australia and Coal & Allied will engage and consult with the Aboriginal community with regard to the management of all matters pertaining to Aboriginal cultural heritage (in this it should be noted that WTC – signatories to the CM-CD1 CHIMA - no longer exists);
- the active engagement of Aboriginal people in all aspects of the management of their cultural heritage will be a primary objective;
- all Aboriginal cultural heritage management activity will comply with the CHMS developed by Rio Tinto Coal Australia to conform with the Rio Tinto Cultural Heritage Management Standard for Australian Businesses (September 2007) and the Rio Tinto Cultural Heritage Management System Policy and Guidelines (2005);
- wherever possible operations should cause zero harm to Aboriginal cultural heritage;
- mine development and land use activities within the Carrington mining area (including the proposed extension area) will be controlled by an Aboriginal cultural heritage zoning plan;
- no ground disturbing activity will be permitted unless it is assessed as complying with the cultural heritage zoning plan;
- cultural heritage management protocols will be developed for:
    - salvage of the range of cultural heritage places that have been identified within the proposed extension area;
    - storage, care and control of salvaged cultural heritage material;
    - buffering and other protective measures for cultural heritage places where they are not to be impacted; and
- compliance monitoring of cultural heritage management performance is the key to its success.

A range of information relating to all of the extant cultural heritage places that have been identified within the proposed extension area has been collated into a cultural heritage management database (CHMD). The CHMD documents the specific management requirements for each cultural heritage site (e.g. object, site or place). As a minimum requirement the database includes the following information:

a. a unique identifying number and AHIMS register number where available;
b. place type (e.g. isolated find/s, artefact scatter, scarred tree etc);
c. place description and values (e.g. number/density and attributes);
d. place extent (e.g. 10m diameter);
e. date recorded and personnel undertaking recording;
f. grid references (GDA94 Zone 56);
g. management option A (if place is NOT disturbed by development); and
h. management option B (if place is to be disturbed by development).

The CHMD is a key element for the preparation and operation of Aboriginal cultural heritage management strategies across all Rio Tinto Coal Australia and Coal & Allied owned lands and will be utilised during the management of Aboriginal cultural heritage for the proposal.

8.2 Specific Management Commitments

The following commitments have been developed in a manner consistent with the current Carrington development consent conditions with respect to Aboriginal cultural heritage for those areas that intersect with the proposed extension area, provisions of the CM-CD1 CHIMA agreed between Coal & Allied and WTC, Rio Tinto Coal Australia's cultural heritage management standards and policies, and consultation with the CHWG.

Coal & Allied will look to design mining activities in such a way as to avoid the cultural heritage places that have been identified as being at risk from the proposed development activities. With this in mind, it should be noted that for a number of areas avoidance will not be possible as the proposed extension will progress in a south and westerly direction from the current mining footprint. This will make it highly unlikely that the extant cultural heritage places in the east of the proposed extension area (i.e. CM1, the remaining portion of CM2, CM19 and CM-CD1) will be able to be avoided.

Any required salvage of Aboriginal objects from the proposed extension area will be undertaken on the basis of a staged approach over time subject to operational requirements. As a general management principle these stages will align with a minimum three year and maximum five year mine operating plan mitigation buffer ahead of mining impacts. NPW Act s90s will be applied for each salvage stage.

Specific management measures for each cultural heritage place in the event that they will be impacted by mining activities are as follows.

1. CM-CD1 Precinct

This precinct includes CM1, the remaining portion of CM2 that lies within the CM-CD1 Exclusion Zone (i.e. 15m surrounding the extent of the OS), and CM-CD1.

Across these three areas ground surface visibility has been previously noted and remains a constraint. Coal & Allied will commit to providing an opportunity for the Aboriginal Community to undertake a cultural salvage of surface stone artefacts.

Following this a series of progressive machine scrapes will be instated across these areas to provide additional opportunities to this exercise.

The details and resourcing requirements of this salvage strategy will be agreed directly with the CHWG in consultation with DECCW in accordance with the provisions of the CM-CD1 CHIMA.

2. CM19 and CM32

On several occasions the cultural heritage material originally identified and recorded at these two places has been unable to be relocated. Despite this, if these areas are to be impacted, the Aboriginal community will be provided with an opportunity to inspect these areas and, should any cultural material be identified, undertake a salvage of that material.

3. HVO-1121-1124

A salvage collection of the isolated stone artefacts that have been identified and recorded at these four locations will be undertaken with the Aboriginal community.

4. Care and Control Plan Permit

The existing Care and Control permit (#2863 valid until 16 January 2013) for the Hunter Valley Operations will be modified to include the cultural material salvaged under any new permits associated with the proposal.

9. CONCLUSION

Much of the area the subject of the proposal has been previously impacted by the ongoing mining and mining-related activities of the Carrington Pit. The proposed extension area, however, has not. The entirety of this area has been the subject of systematic and comprehensive Aboriginal cultural heritage investigations, and management / research programs across an extended period commencing in 1997.

The entireties or portions of nine Aboriginal cultural heritage places are extant within or immediately adjacent the proposed extension area. The management of five of these (CM1, the remaining portion of CM2, CM19, CM32 and CM-CD1) is variously covered by the CM-CD1 CHIMA or the current Development Consent conditions for the Carrington mining area (DA 450-10-2003) and are actively managed accordingly. The remaining four (HVO-1121-1124) were identified during recent fieldwork completed in 2009-2010.

Given the restricted size of the proposed extension area and the nature of the proposed development activities within it, the entirety of this area and, therefore over time the above nine cultural heritage places, will likely be impacted. Following extended consultation with the local Aboriginal community of the Upper Hunter Valley through the CHWG, a series of general and specific management actions have been agreed for these places in the event that they are to be impacted by the proposed mining activities. Rio Tinto Coal Australia and Coal & Allied have committed to implement these management actions in full in cooperation with the CHWG.

References

Commonwealth Department of Environment, Water, Heritage and the Arts. 2009. *Indigenous Heritage Law Reform: possible reforms to the legislative arrangements for protecting traditional areas and objects.* Commonwealth of Australia, Canberra.

ERM Mitchell McCotter Pty Ltd. 1999a. Carrington Mine Environmental Impact Statement. Prepared for Coal & Allied Operations Pty Ltd.

ERM Mitchell McCotter Pty Ltd. 1999b. Carrington Mine Supplementary Archaeological Information. Prepared for Coal & Allied Operations Pty Ltd.

ERM Mitchell McCotter Pty Ltd, P. Hughes and P. Hiscock. 2000. Carrington Mine EIS and Supplementary Archaeological Information. Response to NPWS Queries. Prepared for Coal & Allied Operations Pty Ltd.

Environmental Resources Management Australia Pty Ltd (ERM). 2003. Hunter Valley Operations West Pit Extension and Minor Modifications EIS. Report prepared for Coal & Allied.

Environmental Resources Management Australia Pty Ltd(ERM). 2005. Carrington Extension, Hunter Valley Operations Cultural Heritage Assessment. Report prepared for Coal & Allied.

Environmental Resources Management Australia Pty Ltd (ERM). 2005. Carrington Pit Extended Statement of Environmental Effects. Report prepared for Coal & Allied Operations Pty Ltd.

Environmental Resources Management Australia Pty Ltd (ERM). 2007. Hands on Culture – Aboriginal Heritage at Carrington, Hunter Valley. Cultural Heritage Salvage Report. Report prepared for Rio Tinto Coal Australia.

Huonbrook Environment & Heritage Pty Ltd. 1999. A Geomorphological Assessment of the Proposed Carrington Mine Site, Hunter Valley, NSW. Report prepared for ERM Mitchell McCotter Pty.

Huonbrook Environment & Heritage Pty Ltd. 2000. Archaeological and Geomorphological Excavations at the Proposed Carrington Mine Site, Hunter Valley, NSW. Report prepared for Environmental Resources Management Australia Pty Ltd.

Junburra Aboriginal Consultancy Services. 2000. Wonnarua Cultural Heritage Assessment for Carrington Mine, Hunter Valley, NSW.

McCardle Cultural Heritage Pty Ltd. 2009. Carrington West Extension Study Area Indigenous Archaeological Assessment. Report prepared for Rio Tinto Coal Australia.

Appendices

APPENDIX 1

COMMUNITY CONSULTATION

CHRONOLOGY OF CONSULTATION WITH UPPER HUNTER VALLEY CULTURAL HERITAGE WORKING GROUP REGARDING THE PROPOSAL

	COMMUNITY EVENT	LETTER & INFORMATION SENT	NOTICE ADVERTISED	MEETING HELD	ISSUES DISCUSSED
1	Cultural Heritage Working Group Meeting	22 July 2009	19-21 August 2009	27 August 2009	o introduction of the proposal to the community and the additional cultural heritage assessment that would be required to ensure coverage of the proposed extension area. Brief mention of CM-CD1 and its heritage significance.
2	Cultural Heritage Working Group Meeting	7 September 2009	23-25 September 2009	1 October 2009	o introduction of the proposal Environmental Assessment study manager, presentation of the results from the additional cultural heritage assessment, and a history of the previous assessments and investigations into CM-CD1, and the CHIMA regarding CM-CD1. Management recommendations from the community included collection of surface materials, clearing of vegetation and grader scrapes across CM-CD1 (including CM1 and 2), production of a cultural video, and fencing of the sites to be left undisturbed.
3	Cultural Heritage Working Group Meeting	17 November 2009	2-4 December 2009	9 December 2009	o review of previous discussions and the evidence for the age of CM-CD1, and announcement that the draft proposal Environmental Assessment report would be available for community review prior to the next CHWG meeting.
4	Cultural Heritage Working Group Meeting	22 January 2010	3-5 February 2010	12 February 2010	o review of previous discussions and recommendations, presentation of the results from the additional cultural heritage assessment of buffer areas recently completed (including the previous barley crops within the proposed extension area), and discussion of offsets. Community agree in principle to endorse the cultural heritage report for the proposal Environmental Assessment
5	Cultural Heritage Working Group Meeting	7 April 2010	14-16 April 2010	22 April 2010	o project report update, review of previous discussions and confirmation that CHWG heritage offset conservation area requirement statement (above from 12th February meeting) was included in the Aboriginal Cultural Heritage Assessment report. CNA also confirmed that it supported the CHWG heritage offset conservation area requirement statement.

Public Notice for CHWG Meeting 27th August 2009

Public Notice

Coal & Allied and Indigenous Interests in the Upper Hunter Valley

A public meeting of Aboriginal stakeholders will be held at 10:00 am on Thursday 27th August 2009 at Coal & Allied's Howick Training Centre (Pikes Gully Road, Liddell) to continue discussions regarding:

- MTW Warkworth Sandsheet s90 AHIPs 1103070 & 2801 sites salvage results
- HVO South Riverview Pit s90 AHIP 1102088 sites salvage results
- HVO Plashett Dam pipeline assessment survey
- MTW South-West assessment survey
- Bulga Bora Ground (BBG) management strategy
- Mt Pleasant Stage 5 assessment survey
- Xstrata Ravensworth Project CNA lands assessment
- Administrative Coordination & rostering

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

All interested Aboriginal stakeholders and representatives of community based Aboriginal organisations are invited to attend.

For further information or to register your interest in attending this meeting please write to:

Elspeth Mackenzie
Cultural Heritage Advisor
Rio Tinto Coal Australia Pty Limited
GPO Box 391, Brisbane Qld 4001

Registrations of interest must include current contact details and be received by close of business on 26th August 2009

Rio Tinto

Rio Tinto Coal Australia Pty Limited
GPO Box 391
Brisbane Queensland 4001
Australia
T +61 (0) 7 3361 4200
F +61 (0) 7 3361 4370

Private and confidential

[NAME AND ADDRESS]

22 July 2009

Dear **[NAME]**

UPPER HUNTER VALLEY CULTURAL HERITAGE WORKING GROUP – COMMUNITY MEETING 27th AUGUST 2009

I am writing to invite you to attend the rescheduled Cultural Heritage Working Group (CHWG) community meeting on Thursday 27th August 2009 at 10.00am at Coal & Allied's (CNA) Howick Training Centre, Grevillea Room, to continue discussions regarding:

- MTW Warkworth Sandsheet s90 AHIPs 1103070 & 2801 sites salvage program (see enclosed copy of AHIP 1103070)
- MTW South-West assessment survey
- Bulga Bora Ground management strategy
- HVO South Riverview Pit s90 AHIP 1102088 sites salvage program (see enclosed copy of AHIP 1102088)
- HVO Plashett Dam pipeline assessment survey
- HVO Ravensworth CNA lands assessment survey
- Mt Pleasant MLA 100 Stage 5 assessment survey
- Administrative coordination and rostering

RioTinto

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

The Upper Hunter Valley CHWG community meeting details are as follows (see also attached public notice):

Date: Thursday 27th August 2009
Time: 10.00am to 2.30pm
Venue: Howick Training Centre, Grevillea Room, Pikes Gully Road, Liddell

- Morning tea and lunch will be provided.

Please advise me of your availability at your earliest convenience (or by close of business 26th August 2009) or if you have any queries about the community meeting.

If you are unable to attend the meeting you may lodge comments, queries and feedback on these or other topics associated with CNA's cultural heritage management program via letter, fax, email or phone prior to the scheduled date of the CHWH meeting.

Yours sincerely,

David Cameron

Dr David Cameron
Principal Advisor Cultural Heritage

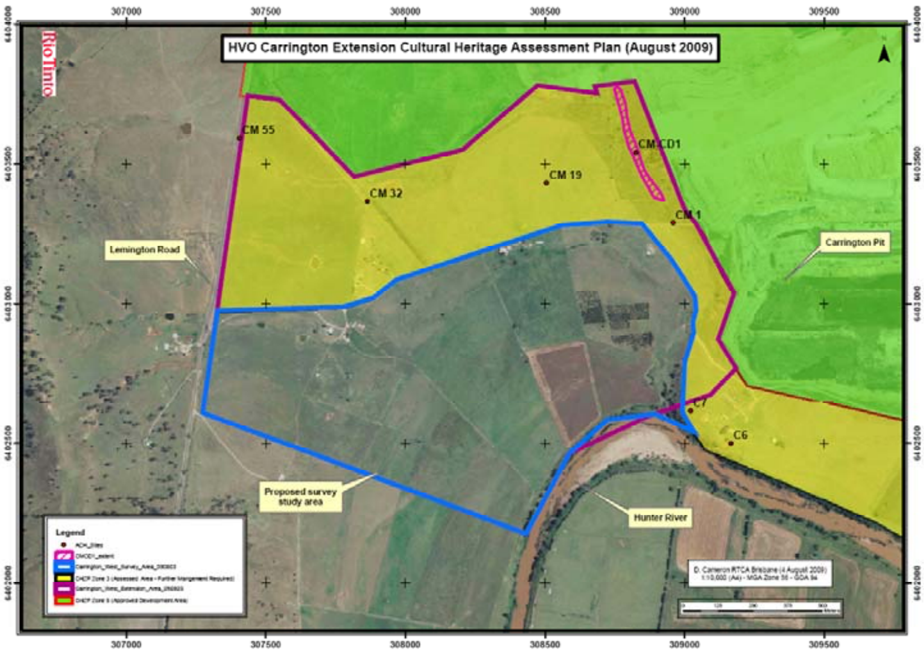
Rio Tinto Coal Australia Pty Limited
Level 3 – West Tower, 410 Ann Street, Brisbane
GPO Box 391, Brisbane, Qld 4001, Australia
Phone: 07 3361 4279
Mob: 0407 649 205
Fax: 07 3361 4370
david.cameron@rtca.riotinto.com.au

Extract of Presentation to CHWG Meeting 27th August 2009

6. HVO Carrington Pit Extension Assessment

- HVO investigating options for extending Carrington Pit to the west
- Northern half of area previously assessed including CMCD 1 site
- Southern section to be assessed in September
- Assessment to inform development of EA study report

10



11

Rio Tinto

Extract of Minutes of CHWG Meeting 27th August 2009

Meeting commenced: 10.10am

Present:
Dr David Cameron – RTCA Principal Advisor Cultural Heritage
Elspeth Mackenzie – RTCA Cultural Heritage Advisor
Dr Luke Godwin – CQCHM
Dan Gillespie – Tallegalla Consultants
Dr Michael Slack – Scarp Archaeology
Helen Selimiotis – Scarp Archaeology
Arthur Fletcher – Wonn1 Contracting
Darrel Matthews – UHHC
Michele Stair - Giwiirr
Kathleen Steward/Kinchela – Yinarr Cultural Services
Nicole Smith - HVAC
Suzie Worth - WLALC
Rhoda Perry – UHWC
Des Hickey – Wattaka WCCS
Irene Hickey – HTO
Gordon Swan - Yarrawalk

Apologies:
Donna Sampson – Cacatua
George Sampson - Cacatua
Tracey Skene – Culturally Aware
Margaret Matthews – ANTC
John Matthews – ANTC
Mick Matthews – Mingga
Allen Paget – Ungooroo AC
Barry French - Yarrawalk

Welcome and Introductions

David thanked everyone for coming to the meeting today, and there was a one minute silence to acknowledge those no longer with us. Noted Luke Godwin, Michael Slack, Helen Selimoitis & Dan Gillespie attending as technical advisors.

Item 5 HVO Carrington Pit West Wing Extension options assessment process

David: At Hunter Valley Operations they are also looking to get approval to extend the Carrington Pit. There are some major constraints over the alluvial lands near the river. We will be surveying the small area that hasn't previously been surveyed, the area to the south down towards the river flats (showed plan). Noted ToR for work.
The land is currently being grazed and cultivated but heritage management will take precedence over other activities once we have concluded the assessment process.
The area includes the site CM-CD1 which you probably remember. A CHIMA was signed not to disturb the site for several years, after which an s90 would be supported. The agreement expired by in August 2005.

Arthur	Is it a quarry?
David	It is a silcrete outcrop with some material associated with a paleo-channel. There were some questions over whether this was a Pleistocene age site but archaeological investigations found no evidence of this age.
Arthur	I’m interested in the educational potential of source stone.
David	We can discuss that as a management outcome. We will discuss this project further at the next meeting in October. I just wanted to raise it with you to think about as work will be happening in this area in the near future.

Public Notice for CHWG Meeting 1st October 2009

Public Notice

Coal & Allied and Indigenous Interests in the Upper Hunter Valley

A public meeting of Aboriginal stakeholders will be held at 10:00 am on Thursday 1st October 2009 at Coal & Allied's Howick Training Centre (Pikes Gully Road, Liddell) to continue discussions regarding:

- MTW Extension options assessment process
- HVO Carrington Pit West Wing Extension options assessment process
- Administrative Coordination & rostering

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

All interested Aboriginal stakeholders and representatives of community based Aboriginal organisations are invited to attend.

For further information or to register your interest in attending this meeting please write to:

Elspeth Mackenzie

Cultural Heritage Advisor

Rio Tinto Coal Australia Pty Limited

GPO Box 391, Brisbane Qld 4001

Registrations of interest must include current contact details and be received by close of business on 30th September 2009.

Letter of Invitation for CHWG Meeting 1st October 2009

Rio Tinto Coal Australia Pty Limited
GPO Box 391
Brisbane Queensland 4001
Australia
T +61 (0) 7 3361 4200
F +61 (0) 7 3361 4370

Private and confidential

[NAME AND ADDRESS]

7 September 2009

Dear **[NAME]**

UPPER HUNTER VALLEY CULTURAL HERITAGE WORKING GROUP – COMMUNITY MEETING 1st OCTOBER 2009

I am writing to invite you to attend the Cultural Heritage Working Group (CHWG) community meeting on Thursday 1st October 2009 at 10.00am at Coal & Allied's (CNA) Howick Training Centre, Grevillea Room, to continue discussions regarding:

- Warkworth Extension options assessment process
- HVO Carrington Pit West Wing Extension options assessment process
- Administrative coordination and rostering

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

The Upper Hunter Valley CHWG community meeting details are as follows (see also attached public notice):

Date: **Thursday 1st October 2009**
Time: 10.00am to 2.30pm
Venue: Howick Training Centre, Grevillea Room, Pikes Gully Road, Liddell

- Morning tea and lunch will be provided.

Please advise me of your availability at your earliest convenience (or by close of business 30th September 2009) or if you have any queries about the community meeting.

If you are unable to attend the meeting you may lodge comments, queries and feedback on these or other topics associated with CNA's cultural heritage management program via letter, fax, email or phone prior to the scheduled date of the CHWH meeting.

Yours sincerely,

Dr David Cameron
Principal Advisor Cultural Heritage

Rio Tinto Coal Australia Pty Limited
Level 3 – West Tower, 410 Ann Street, Brisbane
GPO Box 391, Brisbane, Qld 4001, Australia
Phone: 07 3361 4279
Mob: 0407 649 205
Fax: 07 3361 4370
david.cameron@rtca.riotinto.com.au

Extract of Presentation to CHWG Meeting 1st October 2009

RIO TINTO

COAL AUSTRALIA

RioTinto

Upper Hunter Valley Aboriginal Cultural Heritage Working Group Meeting

(1st October 2009)

1

RIO TINTO

COAL AUSTRALIA

RioTinto

3. HVO Carrington Pit Extension Assessment

- **HVO investigating options for extending Carrington Pit to the west**
- **Northern half of area previously assessed including CMCD 1 site**
- **Southern section was assessed in September**
- **Assessment to inform development of EA study report**

11

RIO TINTO
COAL AUSTRALIA

RioTinto

6. HVO Carrington Pit Extension Assessment

- Cultural heritage assessment & management plan consultation process for EA being conducted by study manager Scott L'Oste-Brown

- Review of results of previous & recent West Wing Sept 2009 survey assessments & management recommendations

Key management issues:

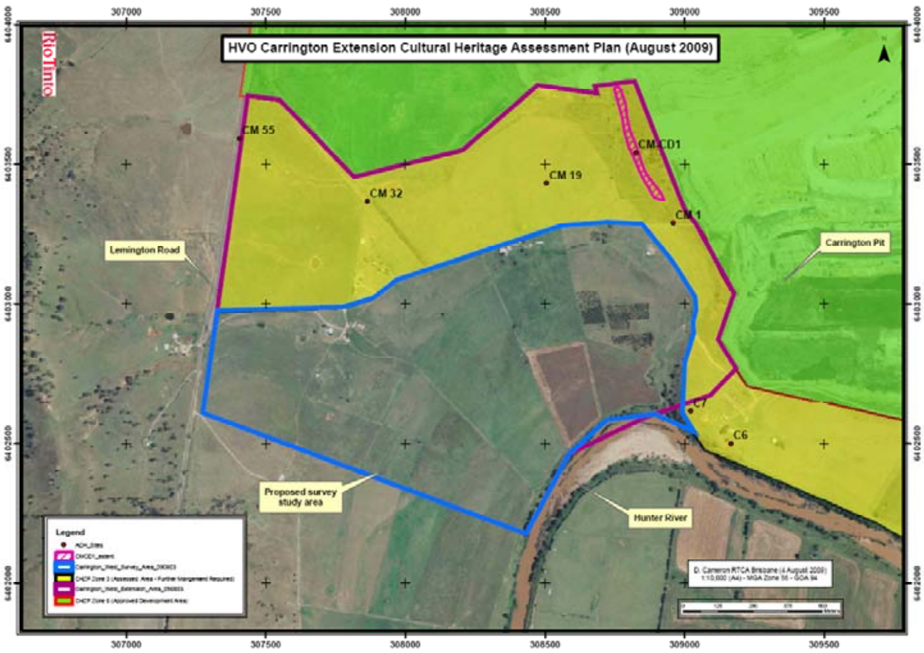
- Destruction of Site CMCD 1

- Ongoing management of sites in new consent area for life of mine

12

RIO TINTO
COAL AUSTRALIA

RioTinto



13

Rio Tinto

Extract of Minutes of CHWG Meeting 1st October 2009

Meeting commenced: 10.05am

Present:
Dr David Cameron – RTCA Principal Advisor Cultural Heritage
Dan Gillespie – Tallegalla Consultants
Scott L'Oste-Brown – Central Queensland Cultural Heritage Management
Arthur Fletcher – Wonn1 Contracting
Darrel Matthews – UHHC
Rodney Matthews - Giwirr
Donna Sampson – Cacatua
Coleen Stair – HVCC
Suzie Worth - WLALC
Rhoda Perry – UHWC
Des Hickey – Wattaka WCCS
Lloyd Matthews – Bullem Bullem
Justin Matthews – Carrowonga
Margaret Matthews – ANTC
John Matthews – ANTC

Apologies:
Michele Stair - Giwirr
George Sampson - Cacatua
Tracey Skene – Culturally Aware
Mick Matthews – Mingga
Allen Paget – Ungooroo AC
Barry French - Yarrawalk
Kathleen Steward/Kinchela – Yinarr Cultural Services

Welcome and Introductions

David thanked everyone for coming to the meeting today, and there was a one minute silence to acknowledge those no longer with us. Noted Dan Gillespie & Scott L'Oste-Brown attending as technical advisors.

Review of Minutes from last CHWG meeting (27 August 2009)

David noted that meeting agenda and minutes from the last meeting in August had been sent to stakeholders, with items covering issues arising from the minutes. DC also tabled copies of all including a power point presentation of today's agenda.

David asked for any comments, corrections or business arising from minutes of 27th August meeting other than for issues covered under today's meeting agenda items.

(There were no comments, corrections or business arising)

David then ran through the meeting agenda items (a Powerpoint Point presentation – PPT - was projected and hardcopies distributed for review during the meeting).

Item 2 **HVO Carrington Pit West Wing Extension options assessment process**

David — As discussed at the last CHWG meeting in August, Hunter Valley Operations are also looking to get approval to extend the Carrington Pit. Dave noted Scott L'Oste-Brown the study manager appointed for the project. There are some major constraints over the alluvial lands near the river. We have completed a survey of the unassessed portion (southern section) of the proposed extension area down towards the river flats (showed plan). A small section not walked as this was under barley crop. The land is currently being grazed and cultivated but heritage management will take precedence over other activities once we have concluded the assessment process.

Scott — Provided a history of previous ACH investigations in the area which included substantial excavations at the CM-CD1 site as well as a CHIMA which established management arrangements. The detailed investigations had established that the occupation of the sites was in the Holocene, that no Pleistocene material was present and that the material was disturbed and translocated. The recent survey in the southern section had recorded a total of 6 artefacts in five sites. The area includes the site CM-CD1 which you probably remember. A CHIMA was signed not to disturb the site for several years, after which an s90 would be supported. The agreement expired by in August 2005.

The proposed extension would involve the destruction of CM-CD1, CM19 and CM32, however, four of the five recently recorded sites in the southern section can be preserved. Under the terms of the CHIMA agreement CNA may apply for a s90 permit to destroy the sites. The CHWG need to consider the cultural salvage requirements.

Some representatives felt that as the previous investigations were conducted some years ago and site conditions may have altered new survey work should be conducted.

Dave Cameron reiterated that there had been very extensive assessment and archaeological excavation work carried out and that no further assessment or archaeological field work was required. The issue now before CHWG was the salvage/mitigation work required for the sites to be destroyed and this needed to be included in the ACH report for the EA. The salvage/mitigation work could be tailored to satisfy CHWG's requirements. Discussion turned to salvage approaches:

- possible clearing of heavy vegetation to improve artefact visibility – technical problems may outweigh any benefits – e.g. fire bans in mine sites, prohibition on use of herbicides near water courses;
- grader scrapes to test for subsurface material;
- videoing is an option prior to salvage
- CHWG members acknowledged that if development is approved they will need to resolve final salvage/mitigation approach
- The four sites in the southern section that are to be preserved can be fenced out immediately

Public Notice for CHWG Meeting 9th December 2009

Public Notice

Coal & Allied and Indigenous Interests in the Upper Hunter Valley

A public meeting of Aboriginal stakeholders will be held at 10:00 am on Wednesday 9th December 2009 at Coal & Allied's Howick Training Centre (Pikes Gully Road, Liddell) to continue discussions regarding:

- Review of the draft Warkworth Mine Extension Aboriginal cultural heritage assessment report for the Environmental Assessment
- Review of updated concept plan and management options for the Wollombi Brook Aboriginal Cultural Heritage Conservation Area
- Update on Hunter Valley Operations South Aboriginal Cultural Heritage Management Plan approval process requirements
- Discussion with SKM team conducting audit into CNA Cultural Heritage Management System seeking community input into audit review

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

All interested Aboriginal stakeholders and representatives of community based Aboriginal organisations are invited to attend.

For further information or to register your interest in attending this meeting please write to:

Elspeth Mackenzie

Cultural Heritage Advisor

Rio Tinto Coal Australia Pty Limited

GPO Box 391, Brisbane Qld 4001

Registrations of interest must include current contact details and be received by close of business on 8th December 2009.

Rio Tinto

Letter of Invitation for CHWG Meeting 9th December 2009

Rio Tinto Coal Australia Pty Limited
GPO Box 391
Brisbane Queensland 4001
Australia
T +61 (0) 7 3361 4200
F +61 (0) 7 3361 4370

Private and confidential

[NAME AND ADDRESS]

17 November 2009

Dear **[NAME]**

UPPER HUNTER VALLEY CULTURAL HERITAGE WORKING GROUP – COMMUNITY MEETING 9th DECEMBER 2009

I am writing to invite you to attend the Cultural Heritage Working Group (CHWG) community meeting on Wednesday 9th December 2009 at 10.00am at Coal & Allied's (CNA) Howick Training Centre, Grevillea Room, to continue discussions regarding:

- Review of the draft Warkworth Mine Extension Aboriginal cultural heritage assessment report for the Environmental Assessment
- Review of updated concept plan and management options for the Wollombi Brook Aboriginal Cultural Heritage Conservation Area
- Update on Hunter Valley Operations South Aboriginal Cultural Heritage Management Plan approval process requirements
- Discussion with SKM team conducting audit into CNA Cultural Heritage Management System seeking community input into audit review

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

The Upper Hunter Valley CHWG community meeting details are as follows (see also attached public notice):

Date: **Wednesday 9th December 2009**
Time: 10.00am to 2.30pm
Venue: Howick Training Centre, Grevillea Room, Pikes Gully Road, Liddell

- Morning tea and lunch will be provided.

Please advise me of your availability at your earliest convenience (or by close of business 8th December 2009) or if you have any queries about the community meeting.

If you are unable to attend the meeting you may lodge comments, queries and feedback on these or other topics associated with CNA's cultural heritage management program via letter, fax, email or phone prior to the scheduled date of the CHWG meeting.

Yours sincerely,

Dr David Cameron
Principal Advisor Cultural Heritage

Rio Tinto Coal Australia Pty Limited
Level 3 – West Tower, 410 Ann Street, Brisbane
GPO Box 391, Brisbane, Qld 4001, Australia
Phone: 07 3361 4279
Mob: 0407 649 205
Fax: 07 3361 4370
david.cameron@rtca.riotinto.com.au

Extract of Presentation to CHWG Meeting 9th December 2009

RioTinto

5. HVO Carrington West report

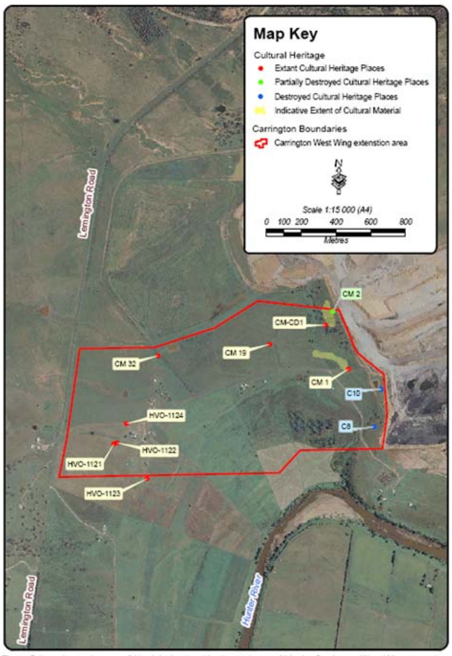
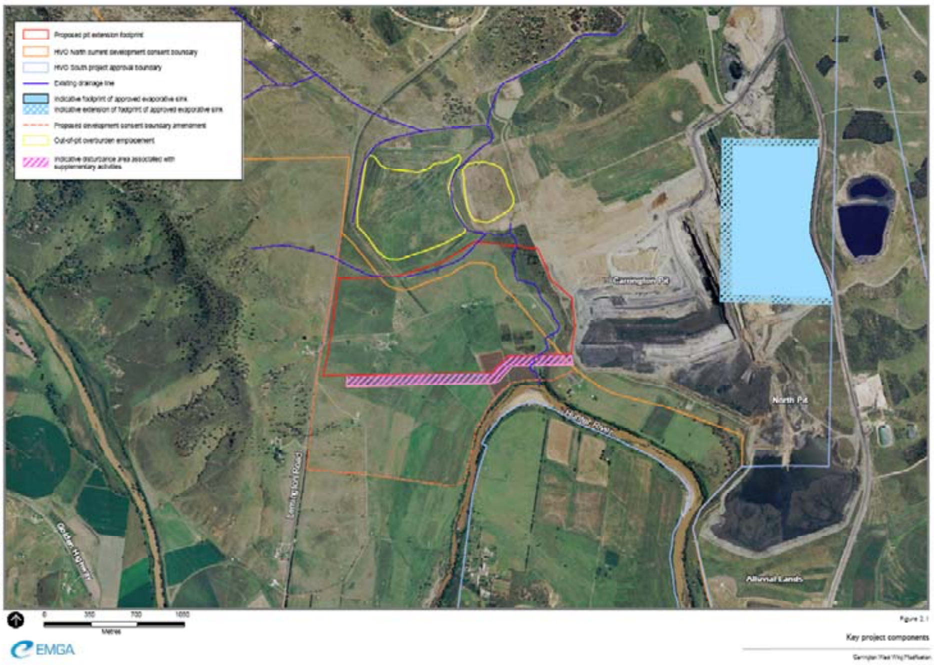


Figure 6: Location and status of Aboriginal cultural heritage places within the Carrington West Wing extension area.

RioTinto

5. HVO Carrington West report



5. HVO Carrington West report

- Small area to be surveyed that was under crop & also want to extend survey further south to align with revised Dev Consent boundary outside of proposed Extension disturbance area (Feb-Mar 2010)
- Draft report to be sent to Stakeholders for review in January
- Finalise management recommendations & ACH report (Feb 2010)
- Carrington Extension EA report to be submitted to DoP in March

5. HVO Carrington West report

- HVO Carrington Extension EA ACH assessment report being drafted
- Assessment survey conducted Sept 2009
- Survey results, Aboriginal significance & management reviewed at CHWG meeting 1st Oct
- McCardle consultation meeting held 13th Nov 2009
- Extension impacts still being determined (mine plans to be finalised)
- Extension area includes all sites recorded except PAD 1 & HVO1125
- Management recommendations fence sites & if to be impacted by development salvage all sites, with machine scrapes for CMCD 1 (CM2 & CM1) area

Rio Tinto

Extract of Minutes of CHWG Meeting 9th December 2009

Meeting commenced: 10.20am

Present:	Dr David Cameron – RTCA Principal Advisor Cultural Heritage Elspeth Mackenzie – RTCA Cultural Heritage Advisor Laura Harkins – RTCA Graduate Community Relations Celeste Baldwin – RTCA Vacation Student Cultural Heritage Trent Jordan - SKM Julie Ling - SKM Kathleen Steward-Kinchela – Yinarr Cultural Services Ronda Ward – Ungooroo Aboriginal Cultural & Community Services Maree Waugh – Wonnarua Nation Norm Archibald – Wanaruah Local Aboriginal Land Council Victor Perry – Upper Hunter Wonnarua Council Laurie Perry – Wonnarua Nation Allen Paget – Ungooroo AC Rhoda Perry – Upper Hunter Wonnarua Council Donna Sampson – Cacatua Culture Consultants Darrel Matthews – Upper Hunter Heritage Consultants
Apologies:	Arthur Fletcher – Wonna 1 Consultants Tracey Skene – Culturally Aware Des Hickey – Wattaka WCCS

Welcome and Introductions

Elspeth introduced Celeste and Laura to the meeting.

David introduced Trent and Julie (SKM auditors) and thanked everyone for coming to the meeting today, and there was a one minute silence to acknowledge those no longer with us.

David noted that meeting agenda and minutes from the last meeting in October and the Workshop on the Conservation Area had been sent to stakeholders, with items covering issues arising from the minutes. DC also tabled copies of all including a power point presentation of today's agenda.

David then ran through today's agenda.

Item 3 HVO Carrington West report

David [DC ran through map showing area and sites under discussion, including brief history of CM-CD1 and the conditions of the CHIMA].
At the last couple of meetings I detailed the scope and extent of the Carrington Extension and review of the assessment survey report from September. We discussed impact on sites within the proposed mining area and mitigation measures, including cultural salvage of CMCD 1.

Rio Tinto

CNA are looking at extending the Development Control Plan boundary area further to the south (DC showed map of the area) so we will survey this additional area early next year. Most of the area has been heavily cultivated so there would not be anything likely in the near vicinity that would be useful as a cultural heritage offset, so we will be including this in the broader strategy and will endeavour to find areas that have value to you to add to the Conservation Area.

Previous discussions have included general management strategy to salvage the sites as required, including CM-CD1, which may involve some other collection such as grader scrapes etc.

Victor — Are you aware that this is a Pleistocene site?

David — All the archaeological work that has happened there over the last 10 years of so has identified that there are sediments that date to the Pleistocene, but that there has been substantial mixing and turbation within the alluvial and colluvial deposits which means that any associated artefacts are not able to be dated reliably to Pleistocene or Holocene age.

Victor — I was there at that work and that is what we were told by Phil Hughes at the time that the artefacts he was showing us were from the Pleistocene layers.

David — The actual results of the field work analysis are in the various reports of the detailed excavations. I will get a summary report produced and send out for your information, based on the findings of the reports from Hughes and all the other studies that have happened at this site. Aside from this issue of age, which has been comprehensively dealt with in these previous studies, there is an approved Cultural Heritage Indigenous Management Agreement signed off by CNA, NPWS and Aboriginal groups at that time in 2002 that acknowledges the archaeological work has been completed and consents to CNA seeking a s90 for Consent to Destroy after three years (2005) with provisions for conducting cultural salvage activities to be conducted before the s90 is implemented.

In fact we have already discussed at previous CHWG meetings and this is in the draft report, making provision for cultural salvage of the CMCD 1 and other sites in the proposed extension area.

Victor — I don’t argue with that, but you should acknowledge it is a Pleistocene site.

David — We will discuss it further at another meeting once you have all had a chance to review the reports again, but in any event whether the site is Pleistocene or not is a moot point as there is no requirements for further archaeological work just the cultural salvage requirements need addressing. The draft report will be finalised in early January and sent out for your review ahead of the next CHWG meeting to held in early February.

Public Notice for CHWG Meeting 12th February 2010

COAL & ALLIED

Managed by Rio Tinto Coal Australia

Public Notice

Coal & Allied and Indigenous Interests in the Upper Hunter Valley

A public meeting of Aboriginal stakeholders will be held at 10:00 am on Friday 12th February 2010 at Coal & Allied's Howick Training Centre (Pikes Gully Road, Liddell) to continue discussions regarding:

- Briefing on HVO Cheshunt cultural heritage site disturbance incident
- HVO Carrington Extension EA heritage assessment report review
- HVO South PA-06-0261 Aboriginal Cultural Heritage Management Plan review
- Update on WML Extension Project (EA report, Conservation Area)
- HVO Coal Handling & Preparation Plant electricity sub-station assessment survey
- Briefing on the CNA 2010 cultural heritage work program

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

All interested Aboriginal stakeholders and representatives of community based Aboriginal organisations are invited to attend.

For further information or to register your interest in attending this meeting please write to:

Elspeth Mackenzie

Cultural Heritage Advisor

Rio Tinto Coal Australia Pty Limited

GPO Box 391, Brisbane Qld 4001

Registrations of interest must include current contact details and be received by close of business on 11th February 2010.

Letter of Invitation for CHWG Meeting 12th February 2010

Rio Tinto Coal Australia Pty Limited
GPO Box 391
Brisbane Queensland 4001
Australia
T +61 (0) 7 3361 4200
F +61 (0) 7 3361 4370

Private and confidential

[NAME AND ADDRESS]

22 January 2010

Dear **[NAME]**

UPPER HUNTER VALLEY CULTURAL HERITAGE WORKING GROUP – COMMUNITY MEETING 12th FEBRUARY 2010

I am writing to invite you to attend the Cultural Heritage Working Group (CHWG) community meeting on Friday 12th February 2010 at 10.00am at Coal & Allied's (CNA) Howick Training Centre, Grevillea Room, to continue discussions regarding:

- Briefing on HVO Cheshunt cultural heritage site disturbance incident
- HVO Carrington Extension EA heritage assessment report review
- HVO South PA-06-0261 Aboriginal Cultural Heritage Management Plan review
- Update on WML Extension Project (EA report, Conservation Area)
- HVO Coal Handling & Preparation Plant electricity sub-station assessment survey
- Briefing on the CNA 2010 cultural heritage work program

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

The Upper Hunter Valley CHWG community meeting details are as follows (see also attached public notice):

Date: **Friday 12th February 2010**
Time: 10.00am to 2.30pm
Venue: Howick Training Centre, Grevillea Room, Pikes Gully Road, Liddell

- Morning tea and lunch will be provided.

Please advise me of your availability at your earliest convenience (or by close of business 11th February 2010) or if you have any queries about the community meeting.

If you are unable to attend the meeting you may lodge comments, queries and feedback on these or other topics associated with CNA's cultural heritage management program via letter, fax, email or phone prior to the scheduled date of the CHWG meeting.

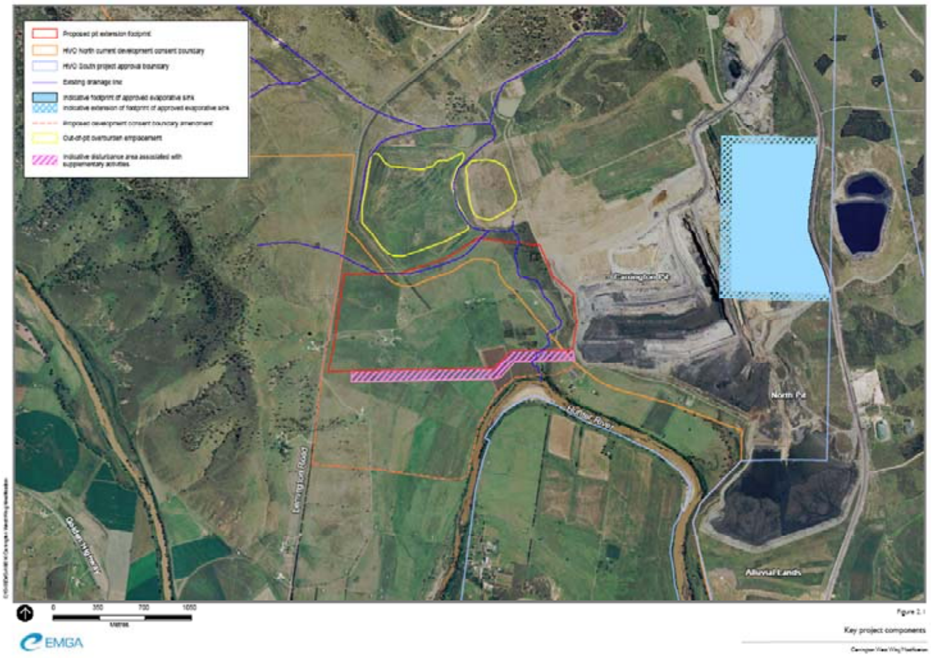
Yours sincerely,

Dr David Cameron
Principal Advisor Cultural Heritage

Rio Tinto Coal Australia Pty Limited
Level 3 – West Tower, 410 Ann Street, Brisbane
GPO Box 391, Brisbane, Qld 4001, Australia
Phone: 07 3361 4279
Mob: 0407 649 205
Fax: 07 3361 4370
david.cameron@rtca.riotinto.com.au

Extract of Presentation to CHWG Meeting 12th February 2010

3. HVO Carrington West Environmental Assessment report consultation review



13

3. HVO Carrington West Environmental Assessment report consultation review

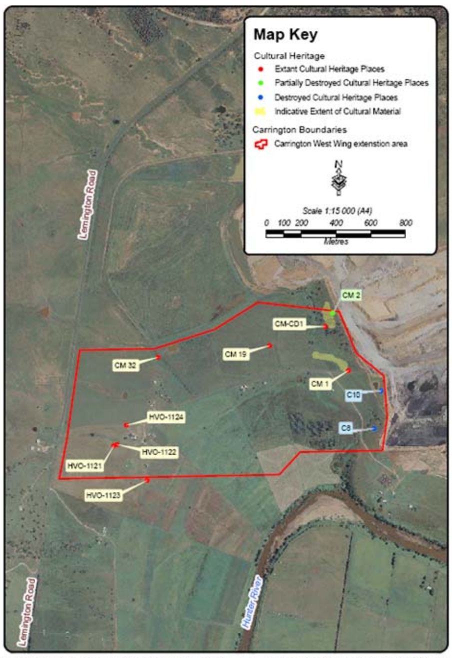


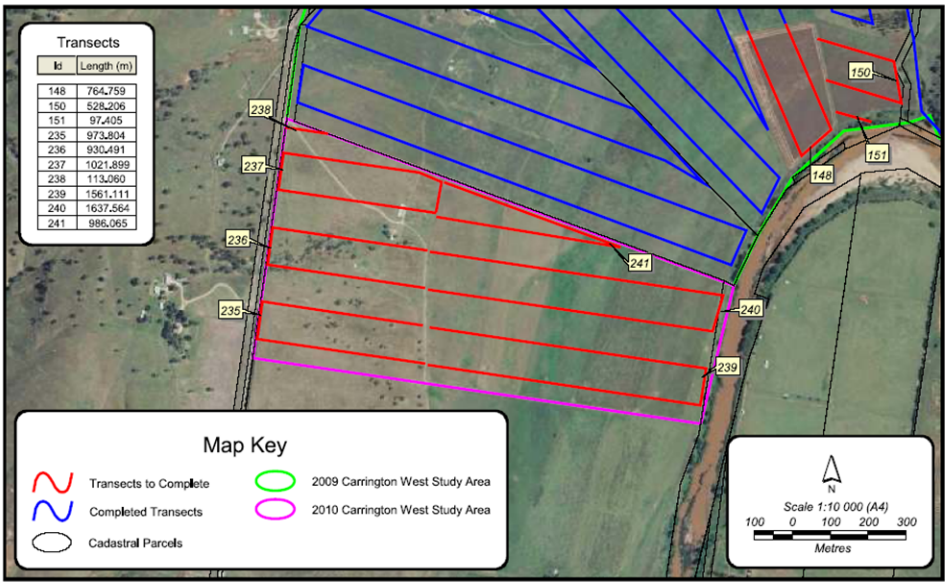
Figure 5: Location and status of Aboriginal cultural heritage places within the Carrington West Wing extension area.

14

RioTinto

3. HVO Carrington West Environmental Assessment report consultation review

Hunter Valley Operations
2010 Carrington West Extension Cultural Heritage Surveys



15

RioTinto

3. HVO Carrington West Environmental Assessment report consultation review

- Consultation draft HVO Carrington West Wing Extension Environmental Assessment (EA) Aboriginal cultural heritage assessment report sent to CHWG for review & feedback 22 January 2010
- Assessment survey conducted Sept 2009 (follow up survey conducted earlier this week – review results today)
- Additional buffer area surveyed south of the Extension area will not be impacted by Extension development
- September survey results, Aboriginal significance & management options reviewed at CHWG meeting 1st Oct 2009
- McCardle stakeholder consultation meeting held on 13th Nov 2009

16

RioTinto

3. HVO Carrington West Environmental Assessment report consultation review

- Extension development **will impact** sites HVO-1121-1124, CM1, CM2 (partially salvaged), CM19, CM32 & CMCD1
- Extension development **will not impact** PAD 1 & HVO1125
- Management recommendations to fence sites, & if to be impacted by development, then salvage collection of all sites
- For site CMCD 1 (including adjacent sites CM2 & CM1) machine scrapes &/or other sampling salvage methods (e.g. spray ground cover) to be applied
- A detailed analysis of the previous cultural & archaeological assessments & investigations of CMCD1 is provided in the report which demonstrates no further archaeological investigation warranted

17

RioTinto

3. HVO Carrington West Environmental Assessment report consultation review

- Cultural mitigation & salvage activities to be developed for CMCD1 & other sites (e.g. salvage collection, landscape video)
- Next step to incorporate CHWG feedback into final report & submit to RTCA project team for internal technical review (end of February)
- After internal review report will be incorporated into the HVO Carrington West Wing Extension Environmental Assessment report to be submitted to DoP in March/April 2010

18

Extract of Minutes of CHWG Meeting 12th February 2010

Meeting commenced: 10.00am

Present:

Dr David Cameron – RTCA Principal Advisor Cultural Heritage
Elspeth Mackenzie – RTCA Cultural Heritage Advisor
Scott L'Oste-Brown – CQCHM
Dan Gillespie - CQCHM
Arthur Fletcher – Wonna 1 Consultants
George Sampson – Cacatua Culture Consultants
Rick Coles – Hunter Traditional Owners EMS
Colleen Stair – Hunter Valley Culture Consultancy
Barry French – Hunter Valley Aboriginal Corporation
John Matthews – Upper Hunter Heritage Consultants
Margaret – Aboriginal Native Title Consultants
Lloyd Matthews – Bullem Bullem Consultants
Suzie Worth – Wanaruah Local Aboriginal Lands Council
Des Hickey – Wattaka WCCS
Rhonda Ward – Ungooroo Aboriginal Cultural & Community Services
Maree Waugh – Wonnarua Nation
Laurie Perry – Wonnarua Nation
Keith Rogers – Keith Rogers Consulting
Gay Horton – Muswellbrook CC
Joshua Hickey
Mark Hickey - Kayaway
Darrel Matthews – Upper Hunter Heritage Consultants
Melissa Matthews – Upper Hunter Heritage Consultants
Allen Paget – Ungooroo AC
Rhoda Perry – Upper Hunter Wonnarua Council
Justin Matthews – Carrawonga
Mick Matthews - Mingga
Michael Matthews – Mingga
Malcolm Moodie – Mingga
Tom Miller – Lower Hunter Wonnarua Council
Luke Hickey – Hunter Valley Cultural Surveying
Noel Downs – Wanaruah Local Aboriginal Lands Council

Apologies: Kathleen Steward-Kinchela – Yinarr Cultural Services

Welcome and Introductions

David thanked everyone for coming to the meeting today, ran through some house-keeping and Arthur Fletcher led meeting for one minute silence mark of respect to acknowledge those ancestors and elders no longer with us.

David introduced Scott & Dan (and later Keith Rogers) and noted that meeting agenda and minutes from the last meeting had been sent to stakeholders, with items covering issues arising from the minutes. DC also tabled copies of all including a power point presentation of today's agenda.

David then ran through today's agenda.

Item 2 **HVO Carrington West Environmental Assessment**

David: As we have discussed at previous meetings the HVO Carrington West Wing Extension project Environmental Assessment has been in progress for a couple of months now and we are preparing to finalise and submit the Aboriginal heritage assessment report. We have discussed development impacts and management options at meetings and these have been incorporated into the draft consultation report sent to you all for review ahead of this meeting today.

Just this week we completed the survey of the barley paddock, which was under crop during the September survey and also the supplementary lands to the south outside of the Extension mining area to see if PAD1 extends further south along the river bank.

[DC ran through the results of recent and previous surveys showing maps and text information on the results]

The consultation report details the results of the surveys and management recommendations and the consultation report that was sent to you for your review and comment. There has been a community consultation meeting with the technical advisor and the management recommendations were discussed at the last CHWG meeting.

The recommendations were to fence all sites and salvage collection of these sites if they are to be disturbed. The Extension development will impact sites HVO-1121-1124, CM1, CM2 (partially salvaged), CM19, CM32 & CMCD1. The Extension development will not impact PAD 1 & HVO1125. For CM-CD1, CM1 & CM2 recommendations from the last meeting included machine scrapes and/or other sampling salvage methods for these sites.

Next step is to incorporate CHWG feedback for the salvage methodologies from today and produce a final report which will be sent to the internal review team and incorporated into the EA report to be submitted to DoP in March/April 2010.

A Cultural Heritage Management Plan will be developed in response to the development consent conditions established by DoP after they review the assessment report and management recommendations.

Laurie: Where is the heritage offset?

David: There isn't one specifically in this area. But as I noted at the last meeting (Dec 2009) we will be identifying other areas to include in the CNA Upper Hunter Valley Conservation Area strategy, and we will continue with our workshops on developing the Conservation Area estate on CNA owned lands. The first thing to do is to identify suitable lands with cultural values and have you assessment them. There are no suitable lands located adjacent to the Extension area.

Laurie: We want to note that this site (CM-CD1) is very significant to the community and regardless of the offset in the strategic plan we need to note that this be put inside the plan of management for an offset for CM-CD1, and because of the high significance something beyond the strategy needs to be determined. It needs to look outside the current leases and mining areas and other options inside the lease considering no specific offset proposals have been drafted in the initial report. It could be private property land that we could manage ourselves or something else.

Des	Who would manage it? That would cause even more problems.
David	I believe what Laurie is suggesting is that this recommendation is to be included in the heritage assessment report to be submitted to DoP.
Laurie	That's right. Number one, they don't have an offset here, number two they have a lot of land outside the mining leases. We need to include in the report that Coal & Allied need to sign off on an appropriate offset on land outside of the leases before the community signs off on the destruction of this highly significant area. This is probably the biggest negotiating part we are going to have in the area.
Noel	I think the land needs to be equitably valuable as well as culturally valuable.
Scott	That is an interesting question as it is always very difficult to value cultural aspects. The community need to think about what criteria of value that they feel would supply like for like, e.g. Soil and vegetation, cultural practices, business opportunities. The people who are losing values need to determine how to measure value, as the western valuing system has failed dismally.
Laurie	There are a lot of things that we have to weigh up. We are negotiating one of the most significant sites in the Valley.
David	Ok I'll ask Elspeth to read out the statement for inclusion in the report recommendations: 'The CHWG want to note that the site CM-CD1 [AHIMS 37-2-1877] is very significant to the community and regardless of the offsets being considered in the CNA heritage conservation areas strategic plan, the CHWG desire that a requirement for a heritage offset area for the loss of CM-CD1 be included in the plan of management for the Extension area, because of the high significance of this site, something beyond the existing strategy needs to be determined. The offset area needs to be outside the current mining leases and mining areas, which could be on private property and be land that the community could manage ourselves or some other lands considered appropriate for an offset by the CHWG and CNA.' Are people in agreement with the wording and intent of the recommendation for the CM-CD1 offset area? [Meeting agreed with the recommendation] Ok, I will incorporate that recommendation statement into the Extension heritage assessment report and send a copy of the recommendation to you for review before it is submitted to DoP and then the next step will depend on their response and decision on consent conditions. Are there any other further comments or feedback on the draft report that people wish to add to the report? [No responses] In that case I note that the meeting has no further comments to add to the draft report and it will be finalised and submitted for internal CNA technical review prior to being submitted as a part of the Carrington West Wing Extension Environmental Assessment.

Luke Can we minute that the community endorse the offset recommendation statement? Does everyone agree?

Noel The WLALC agrees in principle

Laurie Do we all agree or agree in principle?

[Yes all agree or agree in principle with the offset recommendation statement]

Public Notice for CHWG Meeting 22nd April 2010

COAL & ALLIED

Managed by Rio Tinto Coal Australia

Public Notice

Coal & Allied and Indigenous Interests in the Upper Hunter Valley

A public meeting of Aboriginal stakeholders will be held at 10:00 am on Thursday 22nd April 2010 at Coal & Allied's Howick Training Centre (Pikes Gully Road, Liddell) to continue discussions regarding:

- Briefing on CHWG and DECCW consultation on HVO South cultural heritage site disturbance incident
- Review of draft Mt Pleasant-Bengalla Conveyor study survey report
- Progress report on Mt Pleasant Conservation Area assessment survey
- Briefing on final HVO Carrington West Wing EA heritage assessment report
- Briefing on implementation of approved HVO South PA-06-0261 ACHMP
- Proposed HVO rail loader conveyor firebreak assessment survey
- Update on WML Extension Project (EA report, Conservation Area)
- Update on the ongoing CNA 2010 cultural heritage management work program

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

All interested Aboriginal stakeholders and representatives of community based Aboriginal organisations are invited to attend.

For further information or to register your interest in attending this meeting please write to:

Elspeth Mackenzie

Cultural Heritage Advisor

Rio Tinto Coal Australia Pty Limited

GPO Box 391, Brisbane Qld 4001

Registrations of interest must include current contact details and be received by close of business on 21st April 2010.

Rio Tinto

Letter of Invitation for CHWG Meeting 22nd April 2010

Rio Tinto Coal Australia Pty Limited
GPO Box 391
Brisbane Queensland 4001
Australia
T +61 (0) 7 3361 4200
F +61 (0) 7 3361 4370

Private and confidential

[NAME AND ADDRESS]

7 April 2010

Dear **[NAME]**

UPPER HUNTER VALLEY CULTURAL HERITAGE WORKING GROUP – COMMUNITY MEETING 22nd APRIL 2010

I am writing to invite you to attend the Cultural Heritage Working Group (CHWG) community meeting on Thursday 22nd April 2010 at 10.00am at Coal & Allied's (CNA) Howick Training Centre, Grevillea Room, to continue discussions regarding:

- Briefing on CHWG and DECCW consultation on HVO South cultural heritage site disturbance incident
- Review of draft Mt Pleasant-Bengalla Conveyor study survey report
- Progress report on Mt Pleasant Conservation Area assessment survey
- Briefing on final HVO Carrington West Wing EA heritage assessment report
- Briefing on implementation of approved HVO South PA-06-0261 ACHMP
- Proposed HVO rail loader conveyor firebreak assessment survey
- Update on WML Extension Project (EA report, Conservation Area)
- Update on the ongoing CNA 2010 cultural heritage management work program

Discussions are to be held in accordance with the Department of Environment and Climate Change January 2005 Interim Community Consultation Requirements for Applicants.

The Upper Hunter Valley CHWG community meeting details are as follows (see also attached public notice):

Rio Tinto

Date: **Thursday 22nd April 2010**
Time: 10.00am to 2.30pm
Venue: Howick Training Centre, Grevillea Room, Pikes Gully Road, Liddell

- Morning tea and lunch will be provided.

Please advise me of your availability at your earliest convenience (or by close of business 21st April 2010) or if you have any queries about the community meeting.

If you are unable to attend the meeting you may lodge comments, queries and feedback on these or other topics associated with CNA's cultural heritage management program via letter, fax, email or phone prior to the scheduled date of the CHWG meeting.

Yours sincerely,

David Cameron

Dr David Cameron
Principal Advisor Cultural Heritage

Rio Tinto Coal Australia Pty Limited
Level 3 – West Tower, 410 Ann Street, Brisbane
GPO Box 391, Brisbane, Qld 4001, Australia
Phone: 07 3361 4279
Mob: 0407 649 205
Fax: 07 3361 4370
david.cameron@rtca.riotinto.com.au

Extract of Presentation to CHWG Meeting 22nd April 2010

Agenda

Welcome & minute's silence mark of respect

1. Review minutes of previous meeting (12th Feb 2010)
2. DECCW Aboriginal cultural heritage consultation requirements for proponents 2010
3. Briefing on CHWG & DECCW consultation on HVO South cultural heritage site HVO-138 (37-6-1769) disturbance incident
4. Review of draft Mt Pleasant-Bengalla Conveyor study survey report
5. Progress report on Mt Pleasant Conservation Area assessment survey
6. Briefing on final HVO Carrington West Wing EA heritage assessment report
7. Briefing on implementation of approved HVO South PA-06-0261 ACHMP
8. Update on Warkworth Extension Project (EA report, Conservation Area)
9. Proposed HVO rail loader conveyor firebreak assessment survey
10. CNA lands AHIMS database search request
11. Update on the CNA 2010 cultural heritage work program
12. Status of Administrative Coordinators and work roster
13. Other Business and Community Feedback/Issues

2

RioTinto

6. Briefing on final HVO Carrington West Wing EA heritage assessment report

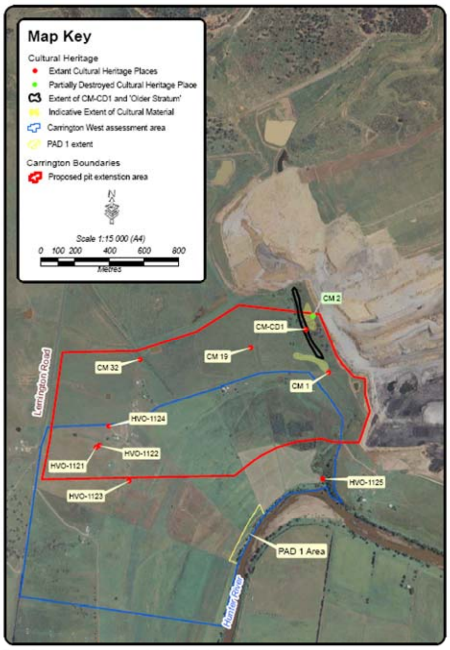


Figure 5: Location and management status of Aboriginal cultural heritage places within the proposed pit extension area and other places referred to in the text.

16

RioTinto

6. HVO Carrington West Environmental Assessment report consultation review

- Consultation draft HVO Carrington West Wing Extension Environmental Assessment (EA) Aboriginal cultural heritage assessment report sent to CHWG for review & feedback 22 January 2010
- Assessment survey conducted Sept 2009 (follow up survey conducted earlier this week – review results today)
- Additional buffer area surveyed south of the Extension area will not be impacted by Extension development
- September survey results, Aboriginal significance & management options reviewed at CHWG meeting 1st Oct 2009
- McCardle stakeholder consultation meeting held on 13th Nov 2009

17

RioTinto

6. HVO Carrington West Environmental Assessment report consultation review

- Extension development **will impact** sites HVO-1121-1124, CM1, CM2 (partially salvaged), CM19, CM32 & CMCD1
- Extension development **will not impact** PAD 1 & HVO1125
- Management recommendations to fence sites, & if to be impacted by development, then salvage collection of all sites
- For site CMCD 1 (including adjacent sites CM2 & CM1) machine scrapes &/or other sampling salvage methods (e.g. spray ground cover) to be applied
- A detailed analysis of the previous cultural & archaeological assessments & investigations of CMCD1 is provided in the report which demonstrates no further archaeological investigation warranted

18

RioTinto

6. HVO Carrington West Environmental Assessment report consultation review

- Cultural mitigation & salvage activities to be developed for CMCD1 & other sites (e.g. salvage collection, landscape video)
- Feedback from Feb CHWG meeting incorporated into report, most notably CHWG motion with respect to a conservation 'offset' area :
- *'The CHWG want to note that the site CM-CD1 [AHIMS 37-2-1877] is very significant to the community and regardless of the offsets being considered in the CNA heritage conservation areas strategic plan, the CHWG desire that a requirement for a heritage offset area for the loss of CM-CD1 be included in the plan of management for the Extension area, because of the high significance of this site, something beyond the existing strategy needs to be determined. The offset area needs to be outside the current mining leases and mining areas, which could be on private property and be land that the community could manage ourselves or some other lands considered appropriate for an offset by the CHWG and CNA.' (CWW Aboriginal Heritage Report, Section 7.2, p.43)*

19

Rio Tinto

Extract of Minutes of CHWG Meeting 22nd April 2010

Meeting commenced: 10.00am

Present:

Dr David Cameron – RTCA Principal Advisor Cultural Heritage
Elspeth Mackenzie – RTCA Cultural Heritage Advisor
Dan Gillespie – Central Queensland Cultural Heritage Management
Arthur Fletcher – Wonna 1 Consultants
Kathleen Steward-Kinchela – Yinarr Cultural Services
George Sampson – Cacatua Culture Consultants
Darrel Matthews – Upper Hunter Heritage Consultants
John Matthews – Upper Hunter Heritage Consultants
Margaret Matthews – Aboriginal Native Title Consultants
Laurie Perry – Wonnarua Nation
Allen Paget – Ungooroo Aboriginal Corporation
Luke Hickey – Hunter Valley Cultural Surveying
Mark Hickey – Kayaway eco-Cultural and Heritage Services
Noel Downs – Wanaruah Local Aboriginal Lands Council
Suzie Worth – Wanaruah Local Aboriginal Lands Council
Rhoda Perry – Upper Hunter Wonnarua Council
Des Hickey – Wattaka Wonnarua Traditional Owner

Apologies:

Tom Miller – Lower Hunter Wonnarua Council
Paulette Ryan – Hunter Traditional Owner Environmental Management Services

Welcome and Introductions

David thanked everyone for coming to the meeting today, and Arthur Fletcher led meeting for one minute silence as a mark of respect to acknowledge those ancestors and elders no longer with us. David then ran through some house-keeping.

He acknowledged that there is a full agenda, and that it would be necessary to wrap-up by 1:30pm due to Brisbane flights, and mentioned that an alternative venue would be necessary after this meeting as the room we have been using will be used as a permanent training centre, we will alternate meetings between Singleton and Muswellbrook.

David noted that meeting agenda and minutes from the last meeting had been sent to stakeholders, with items covering issues arising from the minutes. DC also tabled copies of all including a power point presentation of today's agenda.

David then ran through today's agenda.

Item 6 Briefing on final HVO Carrington West Wing EA heritage assessment report

David As I mentioned before, you have a copy of the pages from the draft report in front of you that shows where your statement has been included.

Laurie Is there a commitment by Coal & Allied to abide by the statement regarding an offset area?

David There is a commitment to providing an offset. The type, size and area of it will be agreed to by the company and the CHWG.

Noel But that should be agreed to before we provide our endorsement.

David The statement says the offset area needs to be considered appropriate by the CHWG and CNA, I don't know how much more it can say.

Noel I would like to see a statement that CNA agree to the CHWG statement.

David I will include a statement that Coal & Allied agree with and support this motion. If the project is approved then we commit whether or not it is included as a consent condition. We also commit to providing an area that is not already under consideration for existing offsets or Conservation Areas.

APPENDIX 2

CULTURAL HERITAGE ASSESSMENT REPORTS

There are six key studies and resulting reports that inform this report and provide data for the assessment of the significance and management of Aboriginal cultural heritage material throughout the Carrington mining area. These studies are as follows:

- The Aboriginal cultural heritage assessment prepared for the EIS for the Carrington Mine's operational area in 1999 (ERM Mitchell McCotter 1999a and b);
- The geomorphological assessment of the Carrington Mine in 1999 (Huonbrook 1999);
- The excavation report from investigations into CM-CD1 under s87 permit #SZ288 in 1999 (Huonbrook 2000);
- The Aboriginal cultural heritage assessment of the Carrington Mine in 1999/2000 (Junburra 2000);
- The Aboriginal cultural heritage assessment prepared for the Statement of Environmental Effects for the Carrington Mine Extension area in 2004 (ERM 2005);
- The Aboriginal cultural heritage assessment prepared prior to the Environmental Assessment for the Carrington West Wing Extension in 2009 (MCH 2009).

Copies of these reports are attached to this Appendix in electronic format.

APPENDIX 3

CULTURAL HERITAGE INDIGENOUS MANAGEMENT AGREEMENT FOR CM-CD1

Cultural Heritage Indigenous Management Agreement (CHIMA)

This Agreement is made on this 28th day of August 2002

BETWEEN:

COAL & ALLIED OPERATIONS PTY LTD of Lemington Road, Lemington

And

WONNARUA TRIBAL COUNCIL INC of 17/174 John St, Singleton

1.0 BACKGROUND

a) This agreement has been prepared to allow Coal & Allied Operations Pty Ltd (Coal & Allied) and the Wonnarua Tribal Council Inc. (Wonnarua Tribal Council) to achieve mutually beneficial outcomes for the management of Aboriginal cultural heritage at Site CM-CD1, Carrington Pit, Hunter Valley Operations.

b) The agreement applies to land owned or managed by Coal & Allied or related companies at the Hunter Valley Operations. In particular:

- The archaeological site CM-CD1 (including the area defined as the extent of the Older Stratum) as shown in Drawing 002 – Revision A of the Development Application (DA 106-6-99). A copy of the site in relation to the Hunter Valley Operations is shown in the attached Figure.

c) A Consent Condition requirement of DA 106-6-99 is to develop a Cultural Heritage Indigenous Management Agreement in consultation with and to the satisfaction of the Wonnarua Tribal Council, in relation to the management of Site CM-CD1 and Older Stratum. The Management framework is detailed below.

JM

2.0 CULTURAL HERITAGE INDIGENOUS MANAGEMENT AGREEMENT

a) Coal & Allied agrees to exclude archaeological site CM-CD1 (including the area defined as the extent of the Older Stratum) for a period of three (3) years, from 7 August 2002, until 7 August 2005. As part of this exclusion zone, Coal & Allied shall not mine within 60 metres of the area CM-CD1 and the Older Stratum, being measured from the margin of the predicted maximum extent of that deposit as identified in Drawing 002 – Revision A, for the 3 year period as outlined above.

b) After 7 August 2005, Coal & Allied is free to apply for a Section 90 consent to destroy, with the support of the Wonnarua Tribal Council, providing all other development consent conditions have been satisfied. The Wonnarua Tribal Council will not require further Cultural Heritage assessment within the CM-CD1 Site, or the exclusion zone. The previously prepared Wonnarua Cultural Heritage Assessment for Carrington Mine (Jan. 2000) will be submitted to support the application for Consent to Destroy, when required.

c) In the event that further archaeological excavations are required, prior to applying for Consent to Destroy, the Wonnarua Tribal Council will be provided the opportunity to work along side the relevant archaeologists.

d) The Wonnarua Tribal Council will be provided the opportunity to salvage artefacts from the CM-CD1 site for which the Section 90 consents are obtained, and to record the site on video, both prior to and during disturbance. The timeframe for this salvage will not exceed 10 (ten) days for 4 (four) persons. The salvage process will be agreed with the Wonnarua Tribal Council, in consultation with the relevant regulatory department(s). OR FOLLOWING AGREEMENT WITH NPWS.

e) Within two weeks (14 days) of the signing of this CHIMA, Coal & Allied will make a single payment of A$90,000.00 to the Wonnarua Tribal Council Trust, to be distributed as follows:

- Payment of A$40,000.00 to the Upper Hunter Wonnarua Council Inc;
- Payment of A$40,000.00 to the Lower Hunter Wonnarua Council Inc;
- Payment of A$10,000.00 to the Wonnarua Tribal Council Inc.

JM

Signed for and behalf of **the Wonnarua Tribal Council** by its duly Authorised Officers

Chairman J Miller

Treasurer L. Miller

Secretary Tracy Skene

in the presence of (MICHAEL E LOVELY)

Signed for and behalf of **Coal & Allied Operations Pty Ltd** by its duly Authorised Officers

secret

~~in the presence of~~

Director

JM

Appendix I

Ecology study

BIOSIS
RESEARCH

Carrington West Wing Ecology Assessment

September 2010

BIOSIS
RESEARCH

Report for:

Rio Tinto Coal Australia, Coal & Allied Operations Pty Limited.

Carrington West Wing Ecology Assessment

September 2010

Ballarat:
449 Doveton Street North, Ballarat VIC 3354
Ph: (03) 5331 7000 Fax: (03) 5331 7033
email: ballarat@biosisresearch.com.au

Melbourne:
38 Bertie Street, Port Melbourne VIC 3207
Ph: (03) 9646 9499 Fax: (03) 9646 9242
email: melbourne@biosisresearch.com.au

Canberra:
Unit 16 / 2 Yallourn Street, Fyshwick NSW 2609
Ph: (02) 6228 1599 Fax: (02) 6280 8752
email: canberra@biosisresearch.com.au

Sydney:
18-20 Mandible Street, Alexandria NSW 2015
Ph: (02) 9690 2777 Fax: (02) 9690 2577
email: sydney@biosisresearch.com.au

Wangaratta
26a Reid Street Wangaratta VIC 3677
Ph: 03 5721 9453 Fax: 03 5721 9454
email: wangaratta@biosisresearch.com.au

Wollongong:
8 Tate St. Wollongong NSW 2500
Ph: (02) 4229 5222 Fax: (02) 4229 5500
email: wollongong@biosisresearch.com.au

Project no: s11916

The findings of this assessment are based on the assumption that adequate offset measures (in prep, Mark Nolan) and all mitigation measures recommended within this report will be implemented. Any additional threatened species identified on site during subsequent survey or incidentally, will require further assessment and the implementation of appropriate offset measures.

***BIOSIS** RESEARCH Pty. Ltd. A.C.N. 006 175 097*
Natural & Cultural Heritage Consultants

ABBREVIATIONS / DEFINITIONS

CAMBA	China-Australia Migratory Bird Agreement
DEC	NSW Department of Environment and Conservation (now part of NSW Department of Environment, Climate Change and Water)
DECCW	NSW Department of Environment, Climate Change and Water (formerly NSW Department of Environment and Climate Change)
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts (formerly Department of Environment and Water Resources)
I&I NSW	NSW Department of Industry and Investment
EEC	Endangered Ecological Community
EP&A Act	*Environmental Planning and Assessment Act* 1979
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
FM Act	*Fisheries Management Act* 1994
IBRA	Interim Biogeographic Regionalisation of Australia
JAMBA	Japan-Australia Migratory Bird Agreement
KTP	Key Threatening Process
LGA	Local Government Area
Locality	5km radius of study area
MNES	Matter of National Environmental Significance
NPWS	NSW National Parks and Wildlife Service (now part of DECCW)
PCD	*Psittacine circoviral* disease
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
Study area	Area of direct impact and any areas subject to potential indirect impacts
Subject site	Area of direct impact
TSC Act	*Threatened Species Conservation Act* 1995
sp.	species (singular)
spp.	species (plural)
subsp.	subspecies
var.	variety

CONTENTS

TABLES

FIGURES

PLATES

1.0 SUMMARY

Biosis Research Pty. Ltd. was commissioned by EMGA Mitchell McLennan Pty Limited on behalf of Coal & Allied to carry out a terrestrial and aquatic ecology assessment of the proposed Carrington West Wing modification (hereafter referred to as 'the proposal') involving an extension of mining operations to the south west of the existing Carrington Pit at the Hunter Valley Operations North (HVO) mining complex. This assessment has been undertaken to determine any potential impacts on biodiversity as a result of the proposal.

The aim of the assessment is to identify issues of conservation significance associated with the proposal. The specific objectives are to:

- Gather existing information regarding terrestrial and aquatic flora and fauna within and surrounding the study area, focussing on threatened species, populations and ecological communities;
- Examine the nature, extent and condition of fauna habitats and vegetation associations within the study area, through a combination of desktop and field studies;
- Identify areas supporting vegetation associations that are, or are likely to be, of conservation significance, or support resources that may be utilised by species or populations of conservation significance;
- Assess the potential occurrence of flora and fauna species or populations of conservation significance, in particular, threatened species and populations;
- Identify areas that may be of importance as habitat corridors;
- Assess the potential impacts of the proposal on biodiversity with particular emphasis on threatened species and populations (including their habitats) and endangered ecological communities; and,
- Recommend appropriate design features and/or impact mitigation and environmental management measures to avoid or minimise potential impacts on threatened species and their habitats across the study area.

The current terrestrial ecological field investigations were conducted over two days during August 2009. Surveys were carried out using a combination of habitat-based assessment and targeted sampling techniques including plot based surveys and anabat recording. Aquatic habitat assessments were carried out on 4 February 2010 using available survey data (including photographic records) and applying relevant indices to assess the relative health of the aquatic habitat.

The study area is predominantly cleared of native vegetation and is currently used for agricultural purposes including cattle grazing, cropping and plantation timber. An unnamed ephemeral tributary traverses the eastern portion of the study area running from north to south and into the Hunter River. Vegetation identified within the study area and surrounds includes: Hunter Valley River Oak Forest, Central Hunter Box – Ironbark Woodland, Derived Native Grassland, Wetland (creekline vegetation), planted areas and weeds and exotics.

Direct impacts resulting from the proposal include vegetation clearing (including approximately 100 remnant native trees) and the diversion of the unnamed ephemeral tributary of the Hunter River (hereafter referred to as the ‘unnamed tributary’). Given that the study area is largely surrounded by cleared and disturbed land, the potential for edge effects and/or the fragmentation and isolation of flora and fauna habitats is considered unlikely to result from the proposal. However, potential indirect impacts on flora and fauna values may include changes in surface and subsurface hydrology, water quality, noise and vibration (such as from blasting), dispersal of dust, erosion and the deposition of sediments.

The results of survey and impact assessment on threatened species (including migratory species), populations and communities as listed under the NSW *Threatened Species Conservation Act* 1995 (TSC Act), *Fisheries Management Act* 1994 (FM Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) are summarised in the following.

Endangered ecological communities (EECs)

One EEC was recorded in the study area and would be impacted by the proposal, consisting of approximately 1.06ha of Central Hunter Box – Ironbark Woodland (0.89ha directly and 0.17ha indirectly). This EEC was considered to be in a moderate to poor condition within the study area, with a sparse canopy, absence of the shrub layer and scattered weed infestations. Given the small area to be impacted and the current degree of isolation and fragmentation of this patch of vegetation, which is already subject to indirect impacts from existing land uses, it is considered unlikely that the proposal would result in a significant impact on this community.

Flora

Two plant species recorded in the study area, the Tiger Orchid (*Cymbidium canaliculatum*) and River Red Gum (*Eucalyptus camaldulensis*) are listed under Schedule 1 of the TSC Act as part of endangered populations in the Hunter catchment. A further threatened plant species, Tricolour Diuris (*Diuris tricolor*) listed under the TSC Act has potential habitat in the study area but was not found, however it is regarded as a cryptic or difficult to detect species. An additional targeted survey for *D. tricolor* was undertaken in potential habitat within the subject site on 22 September 2010, when a known population in the region was in flower. *D. tricolor* was not detected during this survey. Impact assessments following the Guidelines for Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act* 1979 (EP&A Act) were prepared for each of these species.

The results of flora impact assessment determined that the proposal would not have a significant impact upon the River Red Gum (*Eucalyptus camaldulensis*) or Tricolour Diuris (*Diuris tricolor*). The proposal would have a significant impact on the local population of Tiger Orchid (*Cymbidium canaliculatum*). It should be noted that approximately 1,261ha of potential habitat for the species has been mapped as occurring in the locality and that further searches within these areas of potential habitat may yield additional local records of the species. Mitigation measures (e.g. translocation) have been prescribed in Section 6.0 to reduce the likely impacts on the local population of this species.

Fauna

Fauna habitat within the study area ranges from predominantly cleared areas which have low habitat quality, to areas of poor to moderate habitat quality including fragmented patches of native vegetation (including important habitat features such as tree hollows), riparian vegetation, feeding resources, rocky shelters, water bodies and buildings.

A total of 51 vertebrate species listed under the TSC and/or EPBC Act, or their habitat, have been previously recorded within a 10km radius of the study area. Five threatened and no migratory species were recorded during the field surveys. Based on existing records and the presence of identified habitat preferences, known and/or potential habitat exists within the study area for 21 threatened and 11 migratory species.

Impacts to the potential habitat of 14 threatened species were considered negligible (Table 5) and therefore, significance assessments were not conducted for these species. Impact assessments were carried out for the remaining seven threatened animal species; the Part 3A impact assessments for TSC Act-listed species concluded a major impact as a result of the proposal is unlikely. Consideration against the Significant Impact Criteria for EPBC Act-listed species concluded a significant impact as a result of the proposal is unlikely. A Referral to the Federal Environment Minister is therefore not required for any threatened fauna species.

Similarly, impacts to the potential habitat of the 11 migratory species were considered negligible. Individuals of those species that may occur in the study area were not considered likely to be an ecologically significant proportion of the population. Furthermore, potential habitat in the study area was not considered important for the migratory species. A Referral to the Federal Environment Minister is not recommended for any migratory fauna.

Aquatic Flora and Fauna

Aquatic fauna habitat within the study area ranges from semi permanent pools to a dry eroded creek bed which provides poor to marginal habitat quality including areas with large woody debris, submerged macrophytes and scattered paddock trees within the riparian zone.

Database searches indicated that no known occurrences of threatened fish species have been recorded within a 10km radius of the study area. However, the Purple-spotted Gudgeon (*Mogurnda adspersa*) has been recorded in the Goorangoola and Dawleys Creeks located approximately 15km from the study area. No potential aquatic habitat for the Purple-spotted Gudgeon is considered present in the study area.

Wildlife Corridors and Connectivity

The majority of the study area is covered by cleared areas and grazed paddocks that contain little to no native vegetation. Therefore, wildlife corridors in the study area are limited, and the connectivity of the remaining native vegetation is scant. The riparian vegetation along the Hunter River is the remaining connecting link in the study area and this riparian vegetation will not be directly impacted by the proposal.

Despite the previous clearing of native vegetation, the predominantly isolated stands of trees occurring in the study area may still provide limited value as stepping-stones and/or refugia for highly mobile species throughout the study area. These stepping-stones/refugia would be removed by the proposal; however, species with the ability to access them are unlikely to be significantly affected by their loss and/or may make use of the Hunter River riparian vegetation corridor. Over time, these stepping stones may be returned through progressive rehabilitation.

Mitigation

Rio Tinto Coal Australia, as part of its broader operations within the Hunter Valley, is currently managing and/ or developing 2742.2 hectares (ha) of Woodland as biodiversity offsets for its operations in the region. These conservation areas aim to offset potential losses of biodiversity in the region as a result of mining operations. Additionally Coal & Allied has developed a comprehensive River Red Gum Rehabilitation and Restoration Strategy (Umwelt

2010) for stands of River Red Gums in the region, including at the nearby Carrington Billabong. The goals of this strategy include the enhancement of the River Red Gum population through management of these stands.

The current expansion proposal also includes measures to reduce the significance of potential impacts on specific threatened species, including translocation of the single tree harbouring the Tiger Orchid colony away from the disturbance area to an area to be conserved for biodiversity. The proposal aims also to rehabilitate and reinstate the unnamed tributary as well as more than 50ha of woodland for biodiversity purposes (see Appendix 6), to be located at the out-of-pit overburden emplacement areas and the proposed pit extension area. Rehabilitation objectives include ‘post-mining land use compatible with surrounding land uses, capable of supporting viable grazing and ecological values and providing environmental and community benefits’ (EMGA Mitchell McLennan, 2010). Accordingly, the restoration aims to provide a net gain in woodland locally in the medium to long term, with the objective of improving habitat for the local biodiversity.

In acknowledgement of the proposed removal of 0.89ha of Central Hunter Box – Ironbark Woodland, the proposal includes post-mining rehabilitation of a nominal four hectares of this community. This is proposed to be located within the area of rehabilitated woodland at the out-of-pit overburden emplacement areas.

Other mitigation measures will also be implemented in order to minimise the potential impacts of the proposal on threatened species values. Mitigation will be implemented in accordance with Coal & Allied's existing environmental procedures. Additional mitigation measures proposed include:

- Weed management across the operational and conserved lands;
- Landscape disturbance and rehabilitation; and,
- Sediment and erosion controls.

In order to report on the results of mitigation, monitoring will be undertaken throughout the life of the proposal, including during post mine rehabilitation efforts. The results of monitoring will be incorporated into the Annual Environmental Monitoring Report provided to stakeholders with appropriate adaptive management undertaken as required.

2.0 INTRODUCTION

2.1 Background

Coal & Allied Operations Pty Limited (Coal & Allied) owns the Hunter Valley Operations (HVO) mining complex located 18km west of Singleton. Rio Tinto Coal Australia (RTCA) manages the complex for Coal & Allied.

The mining and processing activities at HVO are geographically divided by the Hunter River into HVO South and HVO North, with movements of coal, coarse and fine reject, overburden, topsoil, equipment, water for operations, materials and personnel between the two areas. While HVO South and HVO North each have separate approvals, HVO is managed as an integrated operation.

HVO North comprises the active West, Carrington and North Pits. In addition, three coal preparation plants are located in Hunter Valley Operations North; Hunter Valley Coal Preparation Plant, Newdell Coal Preparation Plant and Howick Coal Preparation Plant.

Coal & Allied is proposing to extend mining operations in the Carrington Pit to the south west (Figure 2). The key drivers for the proposal include extending the life of the Carrington Pit, transition out of the current mining area and realisation of mining efficiencies, and the extraction of the resource. The project life is estimated to be approximately six years.

A small portion of the proposed extension area is subject to existing approval for a services corridor in relation to Carrington Pit. This area includes approximately 20 trees (ERM 2005a) and has been re-assessed as part of the proposal.

2.2 Report objectives

Biosis Research Pty. Ltd (Biosis Research) was engaged to investigate potential terrestrial and aquatic flora and fauna issues in relation to the proposal. The terrestrial flora and fauna study involved two major components:

a) Preliminary constraints analysis; and,

b) Detailed investigations (this report).

The overall objective of this report is to present the results of surveys and the assessment of potential impacts upon terrestrial and aquatic flora and fauna values within the study area. The potential impacts are assessed in accordance with relevant state and federal threatened species legislation.

The specific objectives of this study are to:

a) Gather existing information regarding terrestrial and aquatic flora and fauna within and surrounding the study area, focussing on threatened species, populations and ecological communities;

b) Examine the nature, extent and condition of fauna habitats and vegetation associations within the study area, through a combination of desktop and field studies;

c) Determine areas that may be of importance as habitat or wildlife corridors and identify potential impacts to these corridors;

d) Assess the potential and actual occurrence of flora and fauna species and populations of conservation significance, in particular, threatened species, populations and endangered ecological communities;

e) Evaluate the impact of the proposal by undertaking impact assessments following the Part 3A Guidelines for Threatened Species Assessment (DEC & DPI 2005) of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) for threatened biota as listed in the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and the *Fisheries Management Act* 1994 (FM Act) including the Environmental Assessment Requirements (EARs) for the project;

f) Evaluate the impact on Matters of National Environmental Significance (MNES) under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) for the proposal through consideration of the Significant Impact Criteria for threatened biota and migratory species as outlined in *EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Significance* (DEH 2006); and,

g) Recommend appropriate design features and/or impact mitigation and environmental management measures to avoid or minimise impacts on the natural environment, including in particular threatened species and their habitats.

2.3 Legislative framework

NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act)

The EP&A Act and Regulations 2000 provide the statutory context for environmental assessment of the proposal and ultimately planning approval. The current proposal is to be assessed under Part 3A and other relevant provisions of the EP&A Act.

One objective of the EP&A Act is to encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities and their habitats. A second objective is to encourage the principles of ecologically sustainable development, including the precautionary principle as defined under the *Protection of the Environment Administration Act* 1991.

The main features of the approved operations at HVO North will not be affected by the proposal. There will be not change to the approved mining extraction rates, the life of mine, mining methods, mining equipment, employment, processing or mine services, product transport, operating hours or environmental management systems. The project area is entirely on land owned by Coal & Allied. Accordingly, Coal & Allied is seeking to have the extension of the Carrington Pit approved as a modification of the relevant development consent (DA 450-10-2003), as provided for under clause 8(J)8 of the EP&A Act and Regulations 2000 and Section 75W of the EP&A Act.

***Threatened Species Conservation Act* 1995 (NSW) (TSC Act)**

The TSC Act protects all threatened plants and animals native to NSW (with the exception of fish and marine plants). It provides for the identification, conservation and recovery of threatened species and their populations and communities. It also aims to reduce the threats faced by those species.

If a planned development or activity will have an impact on a threatened species, population or ecological community listed under the TSC Act this must be taken into account in the development approval process. In some cases, the Minister for the Environment will also need to be consulted.

***Fisheries Management Act* 1994 (NSW) (FM Act)**

The object of the FM Act is to conserve threatened species, populations and ecological communities of fish and marine vegetation native to NSW and to promote ecologically sustainable development, including the conservation of biological diversity. It also aims to reduce the threats faced by native fish and marine vegetation in NSW.

If a planned development or activity will have an impact on ecological communities, threatened species, populations or their potential habitats as listed under the FM Act, this must be taken into account in the development approval process. In some cases, the Minister for the Environment will also need to be consulted.

***Environmental Protection and Biodiversity Conservation Act* 1999 (Commonwealth) (EPBC Act)**

The EPBC Act is a Commonwealth mechanism that requires proposed actions to be assessed in terms of their potential impact upon “Matters of National Environmental Significance” (MNES). MNES currently listed under the EPBC Act are:

- World Heritage properties;
- Natural heritage places;
- Wetlands of international importance;
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and,
- Nuclear actions (including uranium mining).

Where a potential impact on a MNES is likely to occur as a result of a proposed action, the significance of that impact must be assessed. Guideline criteria for determining whether an impact is significant are provided under the Act. Where a proposed action will, or is likely to, have a significant impact on a MNES, a Referral to the Commonwealth Environment Minister must be prepared. The purpose of the Referral is to determine whether a proposed action requires approval and/or controls under the EPBC Act 1999.

2.4 Study area

2.4.1 Definitions

NSW threatened species legislation applies particular definitions to the site of a proposed development and the area likely to be impacted by a proposed development. In addition, the present NSW and Commonwealth Government approach to biodiversity conservation recognises a system of “bioregions” and “subregions”. In order to provide clarity of reporting and consistency with current legislation and policy, the following definitions apply throughout this document.

Proposal – proposed extension of open cut mining operations and supplementary activities to support the extension of mining.

Subject site – the area to be directly affected by the proposal (i.e. the development "footprint").

Study area – the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. In the case of the proposed extension, the study area includes the subject site and buffer extending south of the study area to the Hunter River to account for any potential indirect impacts on threatened species values.

Locality – for the purposes of this report, the "locality" is defined as the area within a 5km radius of the perimeter of the study area.

Region – the region and sub-region in which the proposal would be located, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA). The IBRA is based on Thackway and Cresswell (1995) and Morgan and Terry (1992) and periodically updated by Parks Australia. IBRA version 6.1 (DEH 2004a, b) was current at the time of this study. The current proposal is located in the north of the Sydney Basin Bioregion.

Threatened biota - threatened species, populations and ecological communities, or their potential habitats, as listed under the TSC Act, FM Act or EPBC Act.

2.4.2 Description of the proposal

The extension comprises a surface area of approximately 137ha and is predominantly cleared of native vegetation. The extension will allow for the extraction of approximately 17 million tonnes of in-situ coal from mining of coal reserves in the Broonie, Bayswater and Vaux seams. The proposed extension will have a life of approximately six years. Mining will be completed within the existing development consent period, which is currently approved to 2025.

As part of the extension, two out-of-pit overburden emplacements are proposed on rehabilitated land immediately north of the proposed pit extension area (Figure 2), in addition to in-pit disposal.

Supplementary activities proposed to support the extension include:

- The approved footprint of the Carrington evaporative sink will be extended for the long term management of groundwater post-mining;

- The impermeable groundwater barrier wall previously assessed for the western paelochannel will be realigned further south, to prevent groundwater migration from the Hunter River into the mine, and migration of water from the mine into the Hunter River alluvium;

- A two stage, temporary levee and diversion system will be established to ensure that the proposed extension area is protected from flooding and to enable the diversion of the unnamed tributary, which presently runs in a southerly direction across the footprint of the extension. Specific details associated with the unnamed tributary diversion are provided within the surface water assessment (WRM 2010); and,

- A service corridor will be constructed along the southern boundary of the proposed extension area. This may incorporate water pipelines, an all weather access road and other services.

The proposal will not result in change to the mining extraction rates, the life of mine, mining methods, mining equipment, employment, processing or mine services, product transport, operating hours or environmental management systems. The project area is entirely on land owned by Coal & Allied.

2.4.3 Description of the study area

The study area is predominantly cleared of native vegetation and is currently used for agricultural purposes including cattle grazing, cropping and plantation timber (Plate 1). Remnant trees are sparsely scattered across the study area with a disturbed patch of remnant woodland (Plate 2) in the north east of the study area.

An ephemeral unnamed tributary of the Hunter River with a catchment area of approximately 20km^2 traverses the eastern portion of the study area draining from the north and west (Figure 2) (Plate 4) to south (Plate 3). The northern portion of the unnamed tributary includes semi permanent pools (Plate 4) with the southern portion represented by a dry and eroded creek bed (Plate 3) near the confluence with the Hunter River. Much of the unnamed tributary to the north of the proposed pit extension area has been subject to previous diversion and or alteration as a result of the existing overburden emplacements and farm dams.

No conservation reserves occur within or adjacent to the study area with the closest being Yengo and Wollemi National Parks, approximately 6km to the south west of the study area.

2.4.4 Extent of the study area

The proposal is located to the south west of the HVO North mining complex at Lemington in the Singleton Local Government Area (LGA) (Figure 1). The proposed extension area is bounded by the existing approved Carrington Pit in the east, the Hunter River in the south (approximately 200m south), Lemington Road to the west and rehabilitating emplacement areas to the north.

The study area is defined by the extent of direct and indirect impacts on flora and fauna that have the potential to occur as a result of the proposal. In accordance with standard impact assessment definition, the subject site includes all areas that would be directly impacted by the proposal. The study area includes the subject site and an area of potential indirect impacts. The potential indirect impacts of the proposal have been defined with reference to NSW impact assessment guidelines for coal mines and associated infrastructure (DUAP 2000), compliance audits of the NSW coal mining sector (DEC 2004) and reasoning as detailed below. Further discussion of potential impacts associated with the proposal is provided in Section 5.1.

In the case of the current proposal the potential indirect impacts on flora and fauna values may include changes in surface and subsurface hydrology (including dewatering of groundwater dependent vegetation), water quality, noise and vibration (such as from blasting), dispersal of dust, erosion and the deposition of sediments. Detailed assessment of these impacts including appropriate mitigation measures are addressed separately to this ecological assessment.

The study area is already subject to potential indirect impacts as a result of current agricultural land uses and the existing adjacent mining operation. Furthermore, given that the study area is largely surrounded by cleared and disturbed land, increased edge effects and or the fragmentation and isolation of flora and fauna habitats are unlikely to result from the proposal.

Limited data is available on the appropriate distance that indirect impacts on flora and fauna (including habitats) are likely to extend from a coal mine or its associated handling facilities. For the purposes of this assessment, the potential indirect impact zone has been extended to areas down slope and downstream of the subject site to the Hunter River (see Figure 2). Indirect impacts in these areas may result from the proposed diversion of the unnamed tributary and the potential alteration of hydrology down slope of the study area.

A small portion of the proposed extension area is subject to existing approval for clearing, pursuant to 450-10-2003 M2, granted by the NSW Department of Planning on 25 June 2000 associated with a services corridor to the existing Carrington Pit. This area includes approximately 20 trees (ERM 2005a) and has been re-assessed as part of the proposal.

Acknowledgements: This product contains Data which is copyright to the Commonwealth of Australia (c.2003-)

BIOSIS RESEARCH
Biosis Research Pty. Ltd.
18-20 Mandible Street
Alexandria
NEW SOUTH WALES
2015

Figure 1: Location of the study area

Date: 14 April 2010	Drawn By: RS
File ID: S5421	Checked By: BJS/KMC
Location:5421\Mapping\S5421 F1_region.mxd	

0 1.25 2.5 5
Kilometers

N

Biosis Research Pty. Ltd.
18-20 Mandible Street
Alexandria
NEW SOUTH WALES
2015

Acknowledgements:
Aerial photography provided by
Rio Tinto Coal Australia

Figure 2: Overview of the study area

Date: 14 April 2010	Drawn by: RS
File number: S5421	Checked by: BJS/KMC
Location: ..5421\Mapping\S5421 F2_overview.mxd	

0 0.125 0.25 0.5 0.75 1 1.25 1.5
Kilometres
Scale: 1:25,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

3.0 METHODS

The location and extent of the study area are shown on Figure 2. The study involved three key stages: a desktop examination; field surveys; and impact assessment reporting. The desktop study involved gathering and reviewing existing information regarding the flora and fauna of the study area. Field surveys were undertaken for the purpose of ground-truthing information obtained during the desktop examination and to gather additional data from parts of the study area selected for further investigation. The combined information from field and desktop studies was then used to assess the impacts of the proposal on terrestrial and aquatic flora and fauna values within the study area.

3.1 Desktop study

Existing information regarding the flora and fauna of the study area was obtained from a range of sources, including: databases; aerial photographs and maps; previous studies carried out in the vicinity of the study area; and consultation with local experts and government agencies. A list of documents cited in this report is located in the references section.

Relevant flora and fauna studies for the study area and surrounds include:

- *Carrington Pit Extended - Flora and Fauna Assessment* (ERM 2005a);
- *Hunter Valley Operations West Pit Extension and Minor Modifications Environmental Impact Statement* (ERM 2003);
- *Avifauna Survey Hunter Valley Operations* (HLA-Envirosciences Pty Ltd 2006);
- *Hunter Valley Operations River Red Gum Rehabilitation and Restoration Strategy* (Umwelt 2010);
- *Survey of River Red Gums at Hunter Valley Operations and Mt Thorley – Warkworth, Hunter Valley* (Umwelt 2008);
- *Independent Inquiry in the Hunter River System* (Healthy Rivers Commission of New South Wales 2002);
- *Fish and Rivers in Stress. The NSW Rivers Survey* (Harris and Gehrke 1997);
- *Assessment of the Current status and Recommendations for Management Strategies and Recovery Actions for Endangered Population of River Red Gum (Eucalyptus camaldulensis) in the Hunter Valley* (Umwelt 2007a);

- *Threatened Flora and Fauna of Hunter Valley Operations North, Hunter Valley Operations South and Mount Thorley Warkworth. Literature Review and Gap Analysis* (ERM 2008); and,
- *The Vegetation of the Central Hunter Valley, New South Wales, A Report on the Findings of the Hunter Remnant Vegetation Project. Volume 2: Profiles of Vegetation Communities* (Peake 2005).

Database records were obtained for the study area and the landscape within a 10km radius of the perimeter of the study area. Database searches included:

a) Records of threatened flora and fauna species listed on the schedules of the TSC Act obtained from the then NSW Department of Environment Climate Change and Water (DECCW) Atlas of NSW Wildlife in August 2009;

b) Records of MNES listed under the provisions of the Commonwealth EPBC Act obtained from the Commonwealth Department of the Environment Heritage Water and the Arts (DEWHA) Protected Matters Database in September 2009;

c) Records of bird species obtained from the Birds Australia New Atlas of Australian Birds in August 2009; and,

d) Records of species listed in under the FM Act were obtained from Bionet online and the NSW Department of Primary Industries (DPI), Fisheries database.

Spatial information from previous studies carried out in the vicinity of the study area that was examined included:

a) Aerial photographs and geo-referenced development footprint of the study area and surrounds, supplied by EMGA Mitchell McLennan Pty Limited;

b) Topographic and orthophoto maps (Land and Property Management Authority, formerly Department of Lands, 1:25,000 map of Jerrys Plains); and,

c) The Vegetation of the Central Hunter Valley, New South Wales (Digital vegetation map layer) (Peake 2005).

3.2 Current flora survey

The study area was inspected on 27 and 28 August 2009 by senior botanist Brendan Smith (see CV in Appendix 1). Plant species and their habitat were surveyed by undertaking general habitat assessments, plot surveys and targeted searches. Survey effort was most rigorous within areas identified as containing potential habitat for threatened plant species, namely those areas retaining native vegetation cover. A description of each of the survey methods is provided below.

3.2.1 Targeted searches

Targeted searches for threatened plant species involved random meander transects as described by (Cropper 1993), carried out in selected areas of known or potential habitat. Random meander transects were undertaken by one botanist traversing the site over two days, focussing on areas retaining native vegetation. The locations of random meander transects are shown on Figure 3.

During the random meander surveys, an inventory of all observed plant species was recorded (Appendix 2). Where threatened plants were detected, the number of individuals present was counted and the extent and geographic location of each population recorded using a hand-held non differential Global Positioning Systems (GPS). Where plant species could not be identified in the field, a representative sample was collected and preserved for later identification by the Royal Botanic Gardens, Sydney Herbarium.

3.2.2 Plot based survey (quadrats)

In order to comprehensively describe the structure and floristics of each sampled plant community, plot-based surveys were used. Plot-based surveys also provided a concentrated search area for the detection of inconspicuous plant species that may be present at a particular site. The structure and floristics exhibited by each plant community present in the study area was sampled using four $400m^2$ quadrats (20m X 20m). The locations of the quadrats are shown on Figure 3. A modified Braun-Blanquet cover abundance scale (Moore 1955) was assigned to each of the species collected within any one quadrat. For this assessment a seven-division cover abundance scale was used (Table 1).

Table 1 Modified Braun Blanquet cover abundance scale (Moore 1955)

Cover Abundance score	Cover abundance estimate (% cover of any species within each quadrat)
1	<5% - 3 or less individuals
2	<5% - more than 3 individuals but sparsely scattered consistent throughout plot
3	<5% - many individuals throughout plot and any number less than 5% cover abundance
4	Species covers between 5% and 25% of the plot
5	Species covers between 25% and 50% of the plot
6	Species covers between 50% and 75% of the plot
7	Species covers between 75% and 100% of the plot

Survey data were compared with existing vegetation maps of the study area (Peake 2005) in order to confirm the identification and extent of plant communities, particularly those that correspond to Endangered Ecological

Communities (EECs). The results of the plot based surveys and random meander transects were used to further refine vegetation mapping and plant community boundaries for the study area. Fine scale edits to the mapped extent of native vegetation were undertaken to update vegetation mapping (Peake 2005) for the study area and immediate surrounds based on field surveys and aerial photo interpretation.

3.2.3 Condition assessment

The condition of the vegetation was assessed according to the degree to which it resembled relatively natural, undisturbed vegetation, using the following criteria:

a) Species composition (species richness, extent of weed invasion); and,
b) Structure (representation of each of the original layers of vegetation).

Plant community condition was categorised as follows:

Good: containing a high number of indigenous species; no weeds present or weed invasion restricted to edges and track margins; vegetation community containing original layers of vegetation; vegetation layers (ground, shrub, canopy etc.) intact.

Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation modified; vegetation layers (ground, shrub, canopy etc.) largely intact.

Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation highly modified; one or more original vegetation layers (ground, shrub, canopy etc) modified or missing.

Unnatural landscape: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; unable to be regenerated to natural condition; high input intervention required to revegetate.

3.3 Current fauna survey

The study area was inspected on 27 and 28 August 2009 by consultant zoologist Jennifer Charlton (see CV in Appendix 1). Animal species and their habitat were surveyed by undertaking general habitat assessments (see Section 3.3.1 below) whilst traversing the study site. Survey effort was most concentrated within areas identified as containing potential habitat for threatened animal species, namely those areas retaining native vegetation cover and water bodies. Figure 3 shows the location of the fauna survey transects.

In addition to the habitat assessment, animal species and/or their habitat were surveyed by:

- Active searching for herpetofauna by opportunistically over-turning surface rocks[1] and fallen timber along the fauna survey transect;
- Active searching and listening for birds along the fauna survey transect. Birds were surveyed by direct observation using 10 x 42 field binoculars or by their calls;
- Active searching and listening for frogs along the fauna survey transect with a particular focus on water bodies. Frogs were surveyed by direct observation or by their calls;
- Recording hollow-bearing trees and hollow characteristics within the study area;
- Inspecting trees for scratch marks;
- Searching for roost sites;
- Ultrasonic call recording (two Anabats targeting microchiropteran bats were deployed at two sites within the study area (Figure 3) for one full night each);
- Spotlighting for nocturnal mammals (ten-minute spotlight using a 50-watt spotlight was conducted along the unnamed tributary from its confluence with the Hunter River upstream for 200m); and,
- An incidental species list was compiled over the course of the site visit, allowing both diurnal and nocturnal species to be recorded. Both indirect (e.g. bones, scats, owl pellets) and direct evidence (e.g. direct observation or identification by species' calls) of fauna was recorded and used to identify species presence.

As the field survey was comprised primarily of habitat-based assessments, no trapping or nocturnal surveys in addition to ultrasonic call recording and spotlighting were conducted.

[1] Rocks were not disturbed within identified cultural heritage sites.

3.3.1 Fauna habitat assessment

The habitat assessment was based on the presence of one or more of the following features:

- Vegetation cover;
- Size range and abundance of tree hollows;
- Rock outcrops, overhangs or crevices;
- Freestanding water bodies, ephemeral drainage or seepage areas;
- Disturbances, including weed invasion, clearing, rubbish dumping or fire;
- Potential foraging, nesting or roosting resources;
- Connectivity to off site habitats; and,
- Surrounding habitat.

The three categories used to evaluate habitat value were Good, Moderate or Poor, as detailed below:

Good: ground flora containing a high number of indigenous species; plant community structure, ground, log and litter layer intact and undisturbed; a high level of breeding, nesting, feeding and roosting resources available; a high richness and diversity of native animal species.

Moderate: ground flora containing a moderate number of indigenous species; plant community structure, ground log and litter layer moderately intact and undisturbed; a moderate level of breeding, nesting, feeding and roosting resources available; a moderate richness and diversity of native fauna.

Poor: ground flora containing a low number of indigenous species, plant community structure, ground log and litter layer disturbed and modified; a low level of breeding, nesting, feeding and roosting resources available; a low richness and diversity of native animal species.

Other habitat features, such as the value of the study area as a habitat corridor, the presence of remnant communities or unusual ecological plant community structures were also used to assess habitat quality.

3.3.2 Aquatic habitat and condition assessment

The habitat assessment was based on the presence and condition of the following features:

- Pool substrate characterisation;
- Pool variability;
- Channel flow status;
- Bank vegetation (score for each bank);
- Bank stability (score for each bank);
- Width of riparian zone (score for each bank); and,
- Epifaunal substrate / available cover.

The aquatic habitat within the unnamed tributary was described in terms of four category types (Fairfull and Witheridge 2003; Barbour *et al.* 1999). The four categories used to evaluate habitat value were Optimal, Suboptimal, Marginal or Poor, as detailed below:

Optimal: watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.

Suboptimal: watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought although, become greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.

Marginal: watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.

Poor: water courses or drainages that only flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

3.4 Weather conditions

During the current two-day terrestrial field survey the weather was sunny and warm with clear skies and no rain. The following weather conditions were recorded at Jerrys Plains weather station, approximately 7.7km from the study area (Bureau of Meterology). The temperature ranged from 7.1 – 26.2 ^{o}C on 27 August and from 2.2 – 26.9 ^{o}C on 28 August. Relative humidity was 19 and 17 per cent up to 3pm respectively over the two days and up to 38 per cent overnight (up to 9am). North westerly and westerly 10km/h winds prevailed over the two days, with westerly 37km/h winds overnight.

3.5 Previous flora and fauna surveys conducted within the locality

A number of previous terrestrial flora and fauna surveys have been conducted within and surrounding the study area and in the wider locality. These surveys span various seasons and years allowing for greater opportunity to record seasonal and migratory species that may occur within the region and locality giving a greater understanding of the potential occurrence of threatened biota within the current study area. Each study highlights the biodiversity of the locality but also relates in varying degrees to the potential ecological values of current subject site.

Survey techniques, survey effort, personnel and weather conditions recorded from these past projects are summarised below (where the information was available). The proximity to the current subject site, related ecological communities, and/or threatened species occurrence is also given to inform the biodiversity assessment of the significance of the current study area in a local and regional context.

3.5.1 Carrington Environmental Impact Statement (1999 ERM)

Surveys involved broad vegetation, bird and habitat assessments and review of existing work for areas immediately adjacent to the current study area. Fauna surveys included hair funnels, which were out for 15 nights. Other fauna survey techniques were undertaken during three nights in June and two nights in October and included, spotlighting, stag watching, owl call playback, anabat detection, opportunistic bird surveys, searches for the Green and Golden Bell Frog *Litoria aurea* and recording of scats, tracks and other signs and habitat features. No threatened flora or fauna species were recorded during these surveys.

The above information was obtained from ERM (2003). Unfortunately no other details of the survey effort were available.

3.5.2 Hunter Valley Operations West Pit Extension and Minor Modifications Environmental Impact Statement (2003 ERM)

Ecological field surveys for this project targeted HVOs mining activities north of the Hunter River. All survey sites occurred between 1.6 and 5.3km north of the current study area.

A targeted vegetation survey was undertaken over one day in October 2002. A five day and four night general field survey and targeted surveys for threatened species and communities were undertaken in November 2002. Supplementary vegetation surveys were undertaken in December 2002, and January and February 2003 (ERM 2003). However, due to drought conditions over the summer of 2002/03, optimum survey conditions for some plants (e.g. some orchids, herbs and grasses) and the Green and Golden Bell Frog were not available. Therefore the precautionary principle was employed for such species during the impact assessment (ERM 2003).

The October 2002 survey was undertaken on the 23rd by one botanist for five hours and targeted Illawarra Greenhood Orchid (*Pterostylis gibosa*), Slaty Red Gum (*Eucalyptus glaucina*) and *Diuris tricolor* using the random meander method (ERM 2003).

The November 2002 survey was undertaken between the 18th and 22nd. Survey techniques included targeted and general flora surveys, ground Elliott trapping (A-size traps), arboreal Elliott trapping (B-size traps), ground hair funnels, spotlighting, ultrasonic bat detection, bird transect surveys during early morning and evening, owl and frog call playback and active reptile and amphibian searches. Flora and fauna were also recorded while driving and walking between sites (ERM 2003).

Six 20m X 20m quadrats were placed within representative locations in broad vegetation communities to target significant flora. Random meander transects were conducted in addition to the quadrats. Microhabitat diversity for fauna (habitat assessments) was also assessed within the quadrats. Active searching for owl pellets, scats, raptor nests, tracks, diggings, road kill, scratches on trees and animal pathways was carried out during the entire survey period (ERM 2003).

One hundred Elliott A traps were placed along five ground transects (20 traps at 10m intervals per transect) for a total of 400 trap nights. One hindered *Faunatech* hair funnels were placed alongside the Elliot As for 21 nights, giving 2,100 hair funnel ‘trap’ nights. Fifty Elliott B traps were placed in five tree transects adjacent to the ground transects (10 traps at 20m intervals per transect) for a total of 200 trap nights. Traps were placed on brackets 1.5 – 2m high on the western side of the trunk. Ground and tree traps were checked each morning and all traps and funnels were baited with a mixture of rolled oats, peanut butter and honey (as well as vanilla essence for the tree traps) (ERM 2003).

Four wandering bird survey transects were conducted for 30 minutes each between 8:00am and 10:00am each morning. Birds were also surveyed at dusk each night at water bodies. All incidental bird observations were recorded throughout the field survey (ERM 2003).

Two Anabat detectors (using a delay switch) were used over four nights from dusk to dawn. Two different sites were surveyed by one detector each at the same time for two nights, totalling four different survey sites (ERM 2003).

Spotlighting was undertaken by two ecologists on the evenings of 18 to 22 November 2002. This activity commenced just before, and continued for an hour after dusk, and was also undertaken after owl call playback later in the night. A total of eight dedicated person hours of spotlighting were carried out on foot. Opportunistic spotlighting was also undertaken when driving between sites (ERM 2003).

Owl call playback was undertaken at two sites over four nights. The surveys commenced between 8:00pm and 9:00pm (first site) and between 10:00pm and 11:00pm (second site) each night. Calls of the Barking Owl *Ninox connivens* and Masked Owl *Tyto novaehollandiae* were broadcast. Playback involved an initial 10 minute listening period, followed by 5 minutes of playback and 10 minutes of listening, per species. Spotlighting for owls was then undertaken (ERM 2003).

Nocturnal reptiles were surveyed by two ecologists for at least 40 minutes between 9:30pm and 10:30pm on the nights of 18 to 22 November. Diurnal herpetofauna was surveyed by two ecologists for 30 minutes by turning rocks during the days of 21 and 22 November. Specific searches for the Green and Golden Bell Frog were conducted around farm dams both during the day and at night. The dedicated survey effort was 5.3 person hours, and opportunistic survey effort was 2 person hours (ERM 2003).

The December 2002 survey was undertaken on the 9th and 10th by one ecologist. Two supplementary quadrats were surveyed during this period and the hair funnels collected.

The January 2003 survey was undertaken on the 8th by one ecologist. Twelve quadrats were surveyed.

The February 2003 survey was undertaken on the 25th by one ecologist. The boundary of each area of White Box was recorded using GPS.

Surveys were carried out by ERM ecologists Dr Alison Hunt and Will Introna.

It was generally warm to hot during the days and warm to mild in the evenings with the highest temperatures in the early afternoon. There was minimal rainfall and low wind and the cloud cover varied from clear sky to full cloud cover daily and nightly. A full moon phase during the November Anabat surveys may have affected bat activity (ERM 2003).

Relevant results of the study

The current study took into account relevant outcomes of the ERM 2003 study. Notably, four Threatened Fauna were recorded: Speckled Warbler (*Pyrrholaemus sagittata*); Grey-crowned Babbler (*Pomatostomus temporalis temporalis*); Large Bentwing-bat (*Miniopterus schreibersii oceanensis*) and the Eastern Freetail-bat (*Mormopterus norfolkensis*). Additionally Box-gum Woodland was recorded as well as River Red Gum woodland. All EECs and threatened species assessed were unlikely to be significantly impacted by the proposal.

3.5.3 Carrington Pit Extended Statement of Environmental Effects (2005 ERM)

Field investigations were carried out by three ecologists between 18 and 20 October 2004 immediately east of the current study area (and extending up to 1.75km to the east), as well as along the unnamed tributary within the current study area (starting approximately 300m upstream of its confluence with the Hunter River and continuing northward through the current study area). Survey techniques included:

- Compiling a list of dominant flora species;
- Meandering surveys through paddocks and traverses of woodland, the billabong and riparian vegetation;
- Opportunistic sightings of fauna;
- Collection of scats and hair samples (samples identified by Barbara Triggs of Dead Finish);
- Birds were surveyed by one ecologist during the morning and late afternoon, and opportunistically over the three-day survey period;
- Call playback for Green and Golden Bell Frog on 18 October 2004 at the billabong. Call playback was discontinued due to absence of water and calling frogs;
- Anabat detectors were placed at the billabong and along the Hunter River for two consecutive nights and calls analysed by Glenn Hoye of Fly By Night Bat Surveys;
- Habitat assessments; and,
- Number of hollow-bearing trees surrounding the billabong was recorded.

The level of survey effort was considered appropriate given the disturbed nature of the study area and surrounding areas, current land use and lack of native fauna habitat (ERM 2005b; ERM 2005a).

Relevant results of the study

Key outcomes of relevance to the current study were the conservation of Carrington Billabong to maintain the River Red Gum stand and recording of the Eastern Freetail Bat (*Mormopterus norfolkensis*). It was determined that the proposal would not significantly impacts on these species.

3.5.4 Avifauna Survey Hunter Valley Operations (2006 HLA-Envirosciences Pty Limited

HLA-Envirosciences Pty Limited (HLA) were commissioned by Coal and Allied to undertake an avifauna survey for eight dams in four areas located within the Hunter Valley Operations property. All dams occurred between 3.5 and 6.5km north west, north east and/or south east of the current study area.

The fieldwork was undertaken between 9 -11 November 2005. The duration of the survey at each dam was between half an hour and two hours, depending on the size, vegetation complexity and number of species observed at each dam (HLA-Envirosciences Pty Ltd 2006). Surveys were conducted throughout the days, between the hours of 8:30am and 5:00pm.

A vantage point was chosen that allowed the discrete observation of the dams without disturbing the bird life utilising the aquatic habitat. The vantage point was chosen so that the sun was behind the observer and, if possible, elevated. This task took approximately 30 minutes where all birds observed were identified and number of each species estimated. This was then followed by a slow pedestrian based circumnavigation of the aquatic habitat where additional species were recorded (HLA-Envirosciences Pty Ltd 2006).

The weather during the survey period was partly cloudy, warm to hot, with periods of gusty winds. Rain fell briefly on the afternoon of 9 November 2005. A storm with very strong winds and heavy rain quickly passed through the study area during the afternoon of 10 November 2005. The average maximum and minimum temperatures recorded during survey times were 31.37^{o}C and 28.90^{o}C, respectively. The average maximum and minimum relative humidity recorded during survey times were 43.76 and 41.78 per cent, respectively. The average maximum and minimum wind speeds recorded during survey times were 6.8m/s and 4.13m/s, respectively. The above weather conditions were recorded at the Cheshunt weather station (HLA-Envirosciences Pty Ltd 2006).

Relevant results of the study

Two species listed as migratory species on the EPBC Act were recorded: the Red-necked Stint (*Calidris ruficollis*) and Marsh Sandpiper (*Tringa stagnatilis*)

3.5.5 Survey of River Red Gums at Hunter Valley Operations and Mt Thorley – Warkworth, Hunter River (2008 Umwelt)

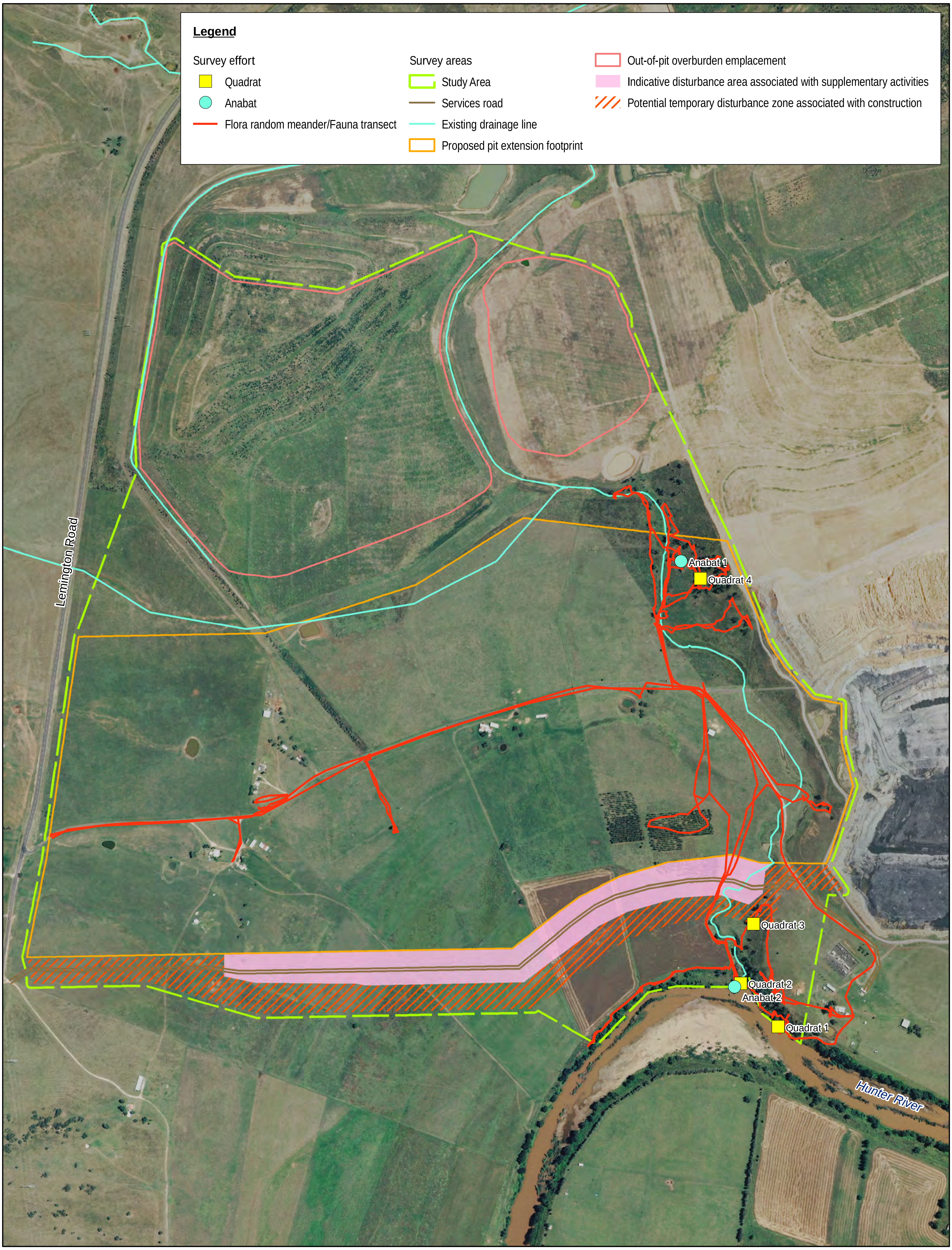
River Red Gums are of conservation significance in the Hunter Valley, therefore to maintain the population within the region; Coal & Allied undertook a comprehensive survey of all their operations in the region to identify the best locations for conservation of this species. Potential Red River Gum stands were visited over the course of three days in April-May 2007 and a further three days in October 2007 (Umwelt 2008). Field reconnaissance was primarily carried out by vehicle, with on-foot inspections limited due to time constraints. The field results in conjunction with aerial photographic interpretation were used to map stands of River Red Gums.

The Carrington Billabong (approximately 1.2km east of the current study area) was found to have the best local stand of River Red Gums and has been established as a conservation site for this species. Permanent monitoring sites (20m X 20m plots) were established, including a control site. One permanent monitoring site occurs within the current study area (on the edge of the Hunter River), with an additional 30 sites spread over the remainder of the HVO and Mt Thorley – Warkworth areas. Baseline monitoring was carried out to provide baseline data for a future monitoring program (Umwelt 2008). Attributes of tree health of adult River Red Gums that were assessed included age class, diameter at breast height, canopy percentage density, canopy health, evidence of flowering and/or fruiting, number of hollows, extent of epicormic growth, number of mistletoes, evidence of insect and/or fungal damage and other relevant information. Repeatable photo stations were also set-up at 15 of the permanent monitoring sites (Umwelt 2008).

Weather details and names of ecologists were not provided.

3.5.6 Warkworth Mine Extension Environmental Assessment (2010 Cumberland Ecology)

Flora and fauna surveys were conducted during June, July and September 2009 (Cumberland Ecology 2010) between 9.4 and 19.4km south east of the current study area. Detailed methodologies are not provided in this report due to its relative distance from the study area, however are available in the Cumberland Ecology (2010) Ecology Study. Outcomes of the Cumberland Ecology study have been considered in the current study, where relevant.



Biosis Research Pty. Ltd.
18-20 Mandible Street
Alexandria
NEW SOUTH WALES
2015

Acknowledgements:
Aerial photography provided by Rio Tinto Coal Australia

Figure 3: Flora and fauna survey locations

Date: 14 April 2010	Drawn by: RS
File number: S5421	Checked by: BJS/KMC
Location: ..5421\Mapping\S5421 F3_surveys.mxd	

Scale: 1:8,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

3.6 Taxonomy

The plant taxonomy (classification) used in this report follows the most recent Flora of New South Wales (Harden 1990; Harden 1992; Harden 1993; Harden 2002). All doubtful species names were verified with the on-line Australian Plant Name Index (Australian National Botanic Gardens 2007). In the body of this report, plant species are generally referred to by their common names (where available) and scientific names. All plant common names and scientific names have been included in threatened species tables and the complete flora list in Appendix 2.

Names of vertebrates follow the Census of Australian Vertebrates (CAVs) maintained by DEWHA (DEWHA 2009). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendices.

3.7 Limitations

Some plant species that occur in the local area are annuals (completing their life cycle within a single season) and are present only in the seed bank for much of the year. Some species do not appear or flower inconsistently each season or from one year to the next. Other plant species are perennial, but are inconspicuous unless flowering or in fruit. Furthermore, some animal species are only detectable at certain times of the year. Therefore, given that seasonal surveys were not undertaken during the current assessment, it is possible that some species that are present on the site were not detected. Despite these limitations, the assessment of impact is based on the presence or absence of suitable habitat for threatened flora and fauna, and as such, species are taken into account during the assessment even though they may not have been detected during the survey.

Assessment of aquatic ecology associated with the unnamed tributary is based on a desktop study only. Therefore, no fish trapping, macroinvertebrate surveys or water quality data was gathered as part of this assessment. The potential presence of aquatic fauna, including threatened species, is therefore based on assumptions in relation to the presence of potential habitat as determined by the desktop assessment. Furthermore, assessment of any potential changes in water quality and aquatic ecology to the nearby Hunter River are not included in this report. More detailed discussion of potential impacts to the Hunter River, and the proposed measures to address these is provided in the WRM (2010) report.

4.0 RESULTS

Lists of the flora and fauna recorded during the surveys of the study area are provided in Appendices 2 and 3 respectively.

4.1 Geology and soils

The soil landscapes of the study area are mapped at a 1:250,000 scale under the Dartbrook (db), Liddell (ld) and Hunter (hu) soil landscapes (Kovac and Lawrie 1991).

The Dartbrook soil landscapes occur on smooth undulating rises and low hills which are typical of the study area. Parent rock is typically calcareous shale and sandstone with some alluvial sediments. Soils are considered the subject of minor to moderate soil erosion risk, with sheet erosion potential occurring on some hill slopes (Kovac and Lawrie 1991). This soil landscape typically supported box gum woodlands although much has been extensively cleared for grazing.

The Liddell soil landscapes cover undulating low hills in vicinity of the Liddell power station, located approximately 13km north of the study area. Parent rock for this soil type is of varied origin including lithic sandstone, shale, mudstone, conglomerate, siltstone and coal seams. Minor to severe sheet erosion is common, with moderate gully erosion occurring in drainage lines (Kovac and Lawrie 1991) such as that observed in the study area. Native vegetation typical of this soil landscape grouping includes open woodlands represented by ironbarks, box gum, bull oak and swamp oak.

The Hunter River soil landscapes are typical of the level plains and river terraces of the Hunter River where alluvial brown clays and black earths have been deposited. Minor stream bank erosion occurs on present watercourses with minor sheet and gully erosion on adjacent terraces (Kovac and Lawrie 1991). Vegetation of this soil landscape has largely been cleared for intensive agriculture such as that currently undertaken in the study area.

Soils to the north and east of the study area have been disturbed and a significant portion is no longer representative of the above soil types. Soil in these areas is represented by disturbed terrain which has been extensively altered by human activity, including complete disturbance, removal or covering of soil and emplacement of mine overburden.

Small portions of the study area where topsoil remains intact include native vegetation that is attributable to the mapped soil landscapes (Kovac and Lawrie 1991) and vegetation mapping (Peake 2005) for the locality.

4.2 Flora

4.2.1 Vegetation mapping

Vegetation of the study area and locality has been mapped and described by Peake (2005) as part of the Hunter remnant vegetation project which covers the Central Hunter region from Broke in the south to Wingen in the north. Peake (2005) mapped one community within the subject site, namely Central Hunter Box - Ironbark Woodland (Figure 4).

Further vegetation was identified within the study area and surrounds during the surveys and includes: Hunter Valley River Oak Forest, Derived Native Grassland, Semi-permanent Pools (unnamed tributary), Planted Areas and Weeds and Exotics. A description of vegetation recorded within the study area is provided below, including reference to community's structure, species composition and condition.

4.2.2 Current vegetation survey

Plant communities recorded in the study area are generally consistent with the broad scale map unit descriptions attributed by Peake (2005) for vegetation occurring in the region. Fine scale modification to the mapped extent and occurrence of native vegetation was undertaken for the study area and immediate surrounds as illustrated in Figure 4 and described in the following. The approximate area of each community is provided in Table 4.

Planted Areas, Weeds and Exotic Pasture

The vast majority of the study area is represented by a completely modified landscape in poor condition with little or no native vegetation (Plate 1). These areas have been subject to historic and ongoing grazing and cropping. Planted areas include the revegetated overburden emplacement in the north of the study area, a windbreak in the north west of the study area and barley crops and a Eucalypt plantation in the south east of the study area.

A variety of exotic weeds occur within the cleared areas, with dominant species comprising Blue Storksbill (*Erodium crinitum*), Patterson's Curse (*Echium plantagineum*), Variegated Thistle (*Silybum marianum*), Cobblers Pegs (*Bidens pilosa*), Field Mustard (*Brassica rapa*), Prairie Grass (*Bromus catharticus*), Kikuyu (*Pennisetum clandestinum*) and Curled Dock (*Rumex crispus*).

The revegetated overburden emplacement in the north of the study area is represented by immature plantings including *Allocasuarina leumanii* (Bulloak) along with various Eucalypt and Acacia species. The height of revegetation ranges between one and three metres. The ground layer is dominated by exotic perennial grass species.

Central Hunter Box – Ironbark Woodland

Central Hunter Box – Ironbark Woodland is listed as an Endangered Ecological Community under the NSW TSC Act.

A small 0.89ha patch of remnant Central Hunter Box - Ironbark Woodland occurs on the eastern boundary of the study area (Plate 2, Figure 4). The size of this remnant has been revised down from that delineated in the original vegetation mapping by Peake (2005) based on ground truthing during the field survey. Further small fragments of the community were also identified on the steep slope to the south east of the study area (Plate 6).

The 0.89ha patch in the study area is largely represented by a sparse native canopy and ground layer occurring within an area fenced off for heritage site protection from the surrounding areas and has therefore been subject to reduced grazing pressures. The dominant canopy included remnant Grey Box (*Eucalyptus moluccana*) with Narrow Leaf Ironbark (*E. crebra*) with an average diameter at breast height (DBH) ranging between 75 and 100cm. Little evidence of canopy species recruitment was observed and many trees were in various stages of dieback or senescence. A native small tree and shrub layer is absent, probably a result of previous clearing and grazing.

A moderately diverse native ground layer dominated by grasses and herbs was present and included Slender Bamboo Grass (*Austrostipa verticillata*), Windmill Grass (*Chloris truncata*), Yellow Burr-daisy (*Calotis lappulacea*) and Climbing Saltbush (*Einadia nutans*). Weed species were common in the ground layer and included the perennial shrubs and herbs: Paddys Lucerne (*Sida rhombifolia*), Cobblers Pegs (*Bidens pilosa*), Fireweed (*Senecio madagascariensis*) and *Galenia pubescens*.

Despite historic and ongoing disturbances, including clearing and grazing, the fenced portion of this community exhibited a reasonable capacity for the regeneration of native vegetation. However, given the existing degree of fragmentation and evidence of modification, the extent of this community within the study area is considered to be in a moderate to poor condition (see condition categories prescribed in Section 3.2.3.).

Semi-permanent Pool / Ephemeral unnamed tributary

An unnamed ephemeral tributary of the Hunter River flows from north to south across the eastern portion of the study area. Historic clearing and ongoing disturbances, including grazing by both native mammals (Kangaroos) and cattle, are likely to have significantly altered natural hydrological regimes of the unnamed tributary. The majority of the unnamed tributary is devoid of native vegetation and subject to gully erosion which is particularly evident at the southern end (Plate 3).

The northern portion of the unnamed tributary within the study area includes semi-permanent pools (Plate 4). Native macrophytes occurring within, and adjacent to, the semi-permanent pools in the north of the unnamed tributary included sedges and rushes such as Common Spike Rush (*Eleocharis acuta*), Billabong Rush (*Juncus usitatus*), Broadleaf Cumbungi (*Typha orientalis*) and floating attached species Swamp Lily (*Ottelia ovalifolia*). Weeds species are a dominant feature of the adjoining vegetation with the exotic perennial grass, Kikuyu (*Pennisetum clandestinum*), common throughout. Scattered remnant Yellow Box (*Eucalyptus melliodora*) and dead stags were present in proximity of the northern portion of the unnamed tributary.

Given the high degree of disturbance and prevalence of weeds, vegetation along the creekline is considered to be in poor condition.

Hunter Valley River Oak Forest

Vegetation within the riparian zone of the Hunter River to the south of the study area is predominantly cleared and disturbed and has not been mapped by Peake (2005). However, plant species composition is consistent with plant community profile for Hunter Valley River Oak Forest (Peake 2005). Approximately 0.85ha of this community occurs within the study area, none of which occurs within the subject site.

Patches of regrowth native trees growing as a narrow band along the Hunter River are predominantly represented by River Oak (*Casuarina cunninghamiana*) with an average DBH range between 21 and 30cm (Plate 5). Other common native species include the small tree, Cooba (*Acacia salicina*). Exotic species dominate this community and include extensive stands of woody weeds such as Willow’s (*Salix* spp.) and Tree Tobacco (*Nicotiana glauca*) and Castor Oil Plant (*Ricinus communis*). Ground layer vegetation is predominantly herbaceous weeds such as Giant Nettle (*Urtica dioica*), Goosegrass (*Galium aparine*), Ramping Fumitory (*Fumaria capreolata*); climbers such as Balloon Vine (*Cardiospermum grandiflorum*) and exotic perennial grasses including Rhodes Grass (*Chloris gayana*), Panic Veldtgrass (*Ehrharta erecta*) and Prairie Grass (*Bromus catharticus*). Occasional patches of emergent aquatic reeds represented by Common Reed (*Phragmites australis*) were recorded along the river edges.

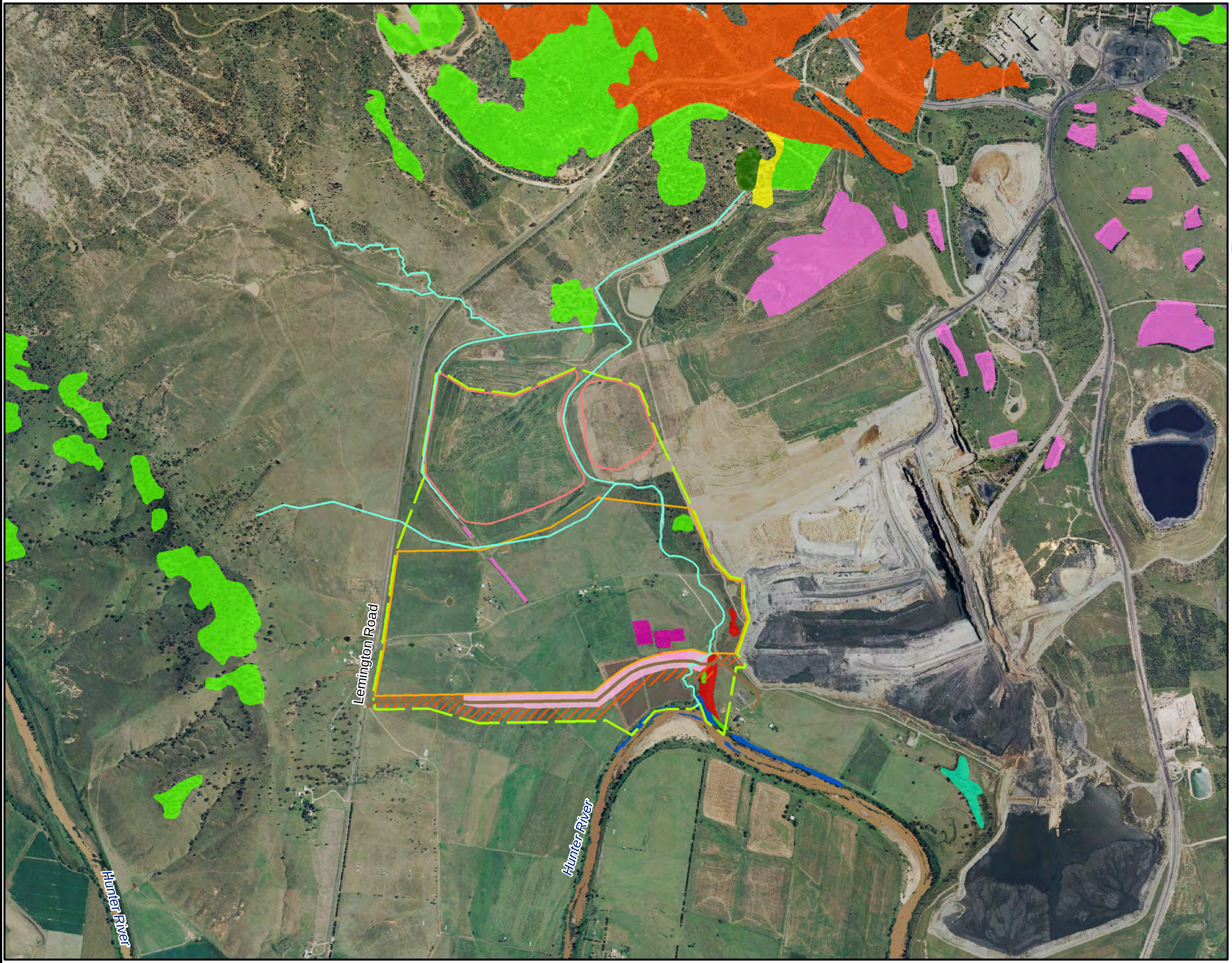
The Hunter River riparian zone exhibited varying degrees of erosion, with significant accumulation of woody debris deposited during floods. Riparian vegetation exhibited little or no capacity for the regeneration of the natural structural layers of the Hunter Valley River Oak community. Given the dominance of weed species within most structural layers, occurrences of this community in the study area are considered to be in poor condition.

Derived Native Grassland

A steep embankment in the south east of the study area (Plate 6) is dominated by native grass species and has been mapped during the current assessment as a Derived Native Grassland. This term derived or secondary vegetation community is used to describe native vegetation where structural components are significantly altered and or removed. In this case the Derived Native Grassland appears to have developed as a result of previous clearing, moderate grazing pressure (in relation to other portions of the study area), the absence of significant pasture improvement and a reduced degree of soil disturbance. Approximately 2.42ha of this community occurs within the study area, 1.25ha of which is within the subject site.

Dominant native grass species include Spear Grass (*Austrostipa* spp.), Windmill Grass (*Chloris* spp.) and Purple Wiregrass (*Aristida ramosa*). Native herbs and twiners including Bluebush (*Maireana microphylla*), Climbing Saltbush (*Einadia nutans*) and Variable Glycine (*Glycine tabacina*) were also common. Herbaceous weed species such as Patterson's Curse (*Echium plantagineum*), *Galenia pubescens*, Fireweed (*Senecio madagascariensis*) and the exotic grass Perennial Ryegrass (*Lolium perenne*) are scattered throughout this community.

Given the high degree of modification inherent in a ‘derived community’, this community is considered to be in poor condition.



Legend

Plant communities
- Central Hunter Box - Ironbark Woodland
- Central Hunter Bulloak Forest Regeneration
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest
- Central Hunter Swamp Oak Forest
- Derived Native Grassland
- Eucalypt Plantation/Planted areas
- Hunter Floodplain Red Gum Woodland Complex
- Hunter Valley River Oak Forest
- Narrabeen Footslopes Slaty Box Woodland
- Planted areas
- Semi-permanent Pools

Survey areas
- Study Area
- Services road
- Existing drainage line
- Proposed pit extension footprint
- Out-of-pit overburden emplacement
- Indicative disturbance area associated with supplementary activities
- Potential temporary disturbance zone associated with construction

BIOSIS RESEARCH

Biosis Research Pty. Ltd.
18-20 Mandible Street
Alexandria
NEW SOUTH WALES
2015

Figure 4: Vegetation mapping (adapted from Peake 2005)

Date: 14 April 2010	Drawn by: RS
File: S5421	Checked by: BJS/KMC
Location: ..5421\Mapping\S5421 F4_veg.mxd	

Acknowledgements:
Aerial photography provided by Rio Tinto Coal Australia
This product contains Data which is copyright to
the Commonwealth of Australia (c.2003-)

0 0.25 0.5 1 1.5
Kilometres

Scale: 1:20,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

4.2.3 Plant species

Overall, a total of 109 vascular plant species were recorded from the study area, comprising 54 (49 per cent) locally indigenous species and 55 (51 per cent) exotic species. A list of plant species recorded is provided in Appendix 2.

Quadrats undertaken within each plant community provide a general indication of species composition in terms of the ratio between native to exotic plant species. Species composition within Hunter River Oak Forest was represented by 73 per cent exotic weed species to 27 per cent native (based on two plots). Derived native grassland included 22 per cent exotic species and 77 per cent native (based on one plot): Central Hunter Box – Ironbark Woodland included 24 per cent exotic species to 76 per cent native (based on one plot). Based on general observation and random meander transects within cleared and exotic pasture, most areas were 100 per cent exotic.

Seven exotic weed species recorded in the study area and surrounds are listed as noxious weeds in the Singleton LGA as follows:

Weed species	Common Name	Noxious Weed Class
Echium plantagineum	Paterson's Curse	4
Lycium ferocissimum	African Boxthorn	4
Opuntia stricta	Prickly Pear	4
Oxalis sp.	Oxalis	5
Romulea rosea	Onion Grass	5
Rosa rubiginosa	Sweet Briar	4
Salix sp.	Willow	5

The legal requirements of these noxious weed classes include:

Class 4 - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority; and,

Class 5 - The requirements in the *Noxious Weeds Act* 1993 for a notifiable weed must be complied with.

Given that survey effort was focussed within areas of native vegetation, it is considered highly likely that further noxious weed species would occur within cleared and disturbed portions of the study area.

4.2.4 Significant flora

A total of 11 plant species listed on the TSC and/or EPBC Act, or their habitats have been identified for consideration in relation to the study area (Table 2).

Two significant plant species, Tiger Orchid (*Cymbidium canaliculatum*) and River Red Gum (*Eucalyptus camaldulensis*) were recorded in the study area. Both species are listed under Schedule 1 of the TSC Act as part of endangered populations in the Hunter catchment. On this basis, assessments of impact following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act have been carried out for each of these species (see Appendix 4).

Furthermore, due to the proximity of previous records and/or the presence of identified habitat preferences, potential habitat may exist within the study area for four threatened plant species (including endangered populations): Weeping Myall (*Acacia pendula*),White-flowered Wax Plant (*Cynanchum elegans*), Tricolour Diuris (*Diuris tricolor*) and Slaty Gum (*Eucalyptus glaucina*).

These species have been considered further in Section 5.0 (Impact Assessment) of this report.

Table 2: **Threatened flora likely to occur within 10km of the study area**

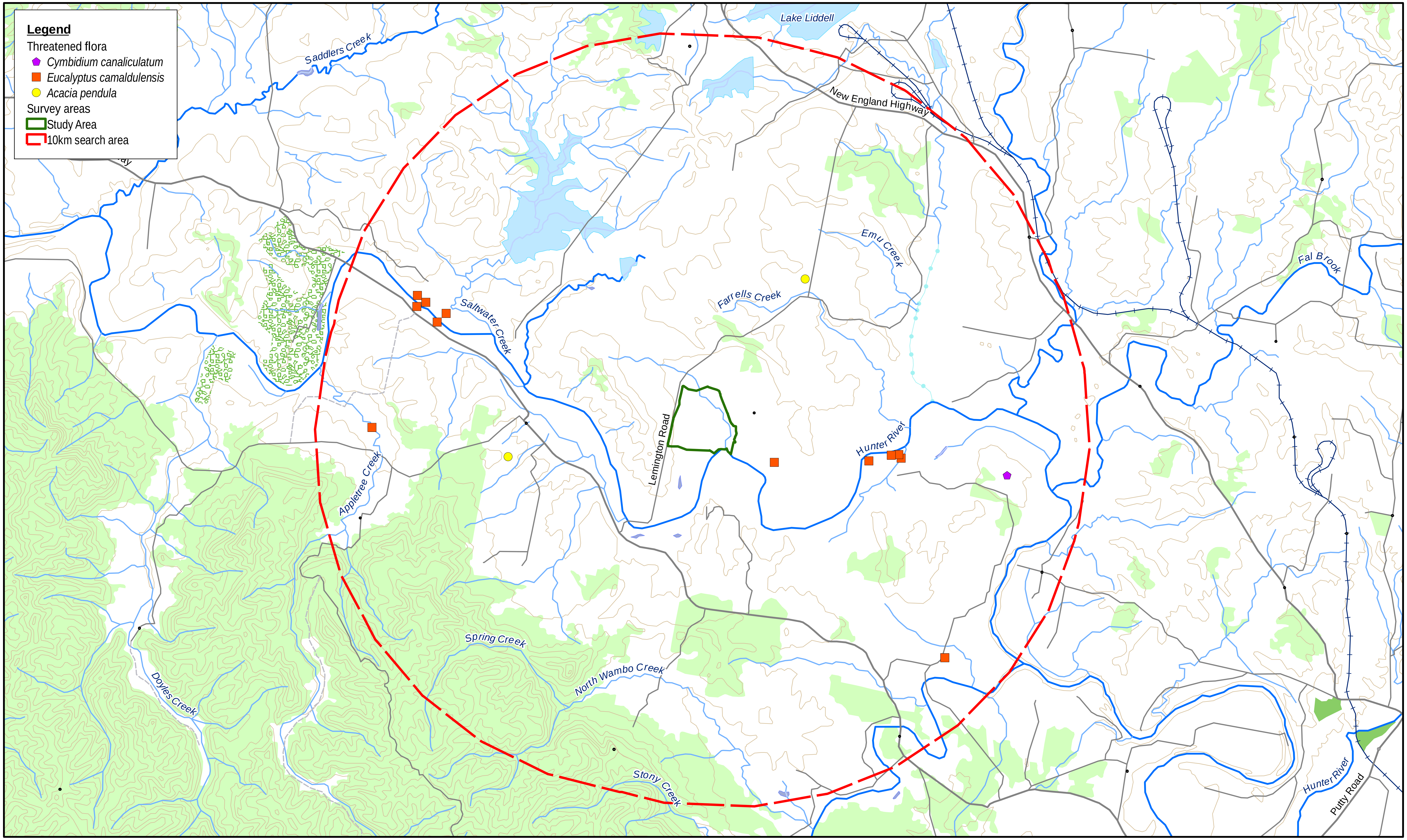
Key: 1) Listed on the EPBC Act as Endangered (E), Critically Endangered (Z) or Vulnerable (V)
2) Listed on the TSC Act as Endangered (E1) or Vulnerable (V)

+Latin Name/ Common Name	EPBC Act[1]	TSC Act [2]	Habitat	Potential Habitat?
Acacia pendula Weeping Myall / Boree	-	E1	Within the Hunter catchment the species typically occurs on heavy soils, sometimes on the margins of small floodplains, but also in more undulating locations (NSW Scientific Committee 2005). Common component of EEC Hunter Valley Weeping Myall Woodland. Hunter population is known to occur naturally as far east as Warkworth, and extends northwest to Muswellbrook and to the west of Muswellbrook at Wybong. The Hunter population of *Acacia pendula* is fewer than 1000 individuals, from six locations - Jerrys Plains, Edderton, Wybong, Appletree Creek, Warkworth and Appletree Flat.	Yes. Potential habitat within Central Hunter Box – Ironbark Woodland and Hunter Valley River Oak Forest
Cynanchum elegans White-flowered Wax Plant	E	E1	Catchment Management Regions include Hawkesbury/Nepean , Hunter/Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan (DEC 2005s). The species has been recorded as far west as Merriwa in the upper Hunter River valley. In the Hunter/Central Rivers catchment this species is known to be associated with Grey Box - Narrow-leaved Ironbark shrubby woodland (DEC 2005s). *Cynanchum elegans* usually occurs on the edge of dry rainforest vegetation.	Yes. Potential habitat within Central Hunter Box – Ironbark Woodland
Cymbidium canaliculatum Tiger Orchid	-	E1	Epiphytic orchid found in dry sclerophyll forest or woodland where it grows in tree hollows, in clumps of fern or sometimes on rocks. Most commonly found in *Eucalyptus albens* dominated woodland, typically between 2 and 6 m above the ground. Also, but less-commonly found on *E. moluccana, Angophora floribunda*, *Acacia salicina* and other species (NSW Scientific Committee 2006) . Current population estimate is 90 plants, however this could be as high as 300-500. (NSW Scientific Committee 2006). Also recorded in Wollemi and Goulburn River National Parks, although 90% of known population occurs on non-conservation land. (NSW Scientific Committee 2006)	Yes. Recorded in association with Central Hunter Box – Ironbark Woodland within the study area (Figure 6)

+Latin Name/ Common Name	EPBC Act[1]	TSC Act [2]	Habitat	Potential Habitat?
Digitaria porrecta Finger Panic Grass	E	E1	Finger Panic Grass occurs in NSW and Queensland. In NSW it is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran. It largely occurs on private land. It occurs in Native grassland, woodlands or open forest with a grassy understorey, on richer soils. Often found along roadsides and travelling stock routes where there is light grazing and occasional fire. In NSW, the most frequently recorded associated tree species are *Eucalyptus albens* and *Acacia pendula*.	No. Study area is outside of species known range
Diuris tricolor Tricolour Diuris	*	V	*Diuris tricolor* grows in grassy sclerophyll forest or woodland usually with Callitris spp. (Harden 1993; Bishop 1996). This species usually grows among grass in sclerophyll forest, or woodland in well-drained sandy soils and on low forested ridges in laterite in flat areas or on top of small hills (Bishop 1996). In the Hunter CMA, this species is known to occur in Grey Box - Narrow-leaved Ironbark and various Derived Native Grasslands (DEC 2005a). The Pine Donkey Orchid is distributed sporadically but may be locally common. It occurs predominantly on the western slopes from Narrandera, north to Toowoomba (Jones 2006). It can be difficult to detect because of its specific flowering season (Peake 2005) of Sept - Nov (Jones 2006). Disturbance regimes are not known, although the species is usually recorded from disturbed habitats (DEC 2005a).	Yes. Potential habitat within Central Hunter Box – Ironbark Woodland and Derived Native Grassland * Removed from EPBC Act threatened list 19 August 2010
Eucalyptus camaldulensis River Red Gum	-	E2	Most occurrences are on private land and there are no known occurrences in conservation reserves. Occurs on the Hunter River floodplain and associated tributaries. May occur with *Eucalyptus tereticornis, Eucalyptus melliodora, Casuarina cunninghamiana* subsp. *cunninghamiana* and *Angophora floribunda.* (DEC 2005q).	Yes. Recorded on floodplain within the study area (Figure 6)
Eucalyptus glaucina Slaty Red Gum	V	V	Occurs near Casino and from Taree to Broke where it is locally common but very sporadic. Found in grassy woodland on deep, moderately fertile and well watered soil (Harden 2002). Previously recorded within Central Hunter Riparian Forest (mu13) (NPWS 2004).	Yes. Potential habitat within Central Hunter Box – Ironbark Woodland and Hunter Valley River Oak Forest
Olearia cordata	V	V	NSW endemic with a scattered distribution generally restricted to the south-western Hunter Plateau, eastern Colo Plateau, and the far north-west of the Hornsby Plateau near Wisemans Ferry east of Maroota. Most known populations occur within conservation reserves. Catchment Management Authority Regions include: Hawkesbury/Nepean, and Hunter/Central Rivers (DEC 2005m). Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges (DEC 2005m). Soils are shallow or skeletal and are usually neutral to slightly acidic.	No

+Latin Name/ Common Name	EPBC Act[1]	TSC Act [2]	Habitat	Potential Habitat?
Pomaderris brunnea Rufous Pomaderris	V	V	*Pomaderris brunnea* is found in a very limited area around the Nepean and Hawkesbury Rivers, including the Bargo area. Occurs in the Central West, Hawkesbury/Nepean and Hunter/Central Rivers Catchments. Within the Hunter/Central Rivers catchment areas, this species occurs in wet sclerophyll forests (DEC 2005n).	No
Thesium australe Austral Toad-flax	V	V	Found in very small to large populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. The nearest known record of this species to the study area is in the Upper Hunter near Cassilis, approximately 110km to the north west of the study area. It is often found in damp sites in association with *Themeda australis*, but also found on other grass species at inland sites (G. Leonard pers. obs.). Occurs on clay soils in grassy woodlands or coastal headlands (James *et al.* 1999).	No
Wollemia nobilis Wollemi Pine	E	E1	Plants emergent above warm-temperate coachwood-sassafras rainforest, in a deep sheltered gorge in a remote part of the Wollemi National Park (Harden and Murray 2000).	No

+**List derived from DECCW Atlas of NSW Wildlife, DEWHA EPBC online database and literature review (see also Figure 5).**



BIOSIS RESEARCH

Biosis Research Pty. Ltd.
18-20 Mandible Street
Alexandria
NEW SOUTH WALES
2015

Figure 5: Threatened flora records within 10km

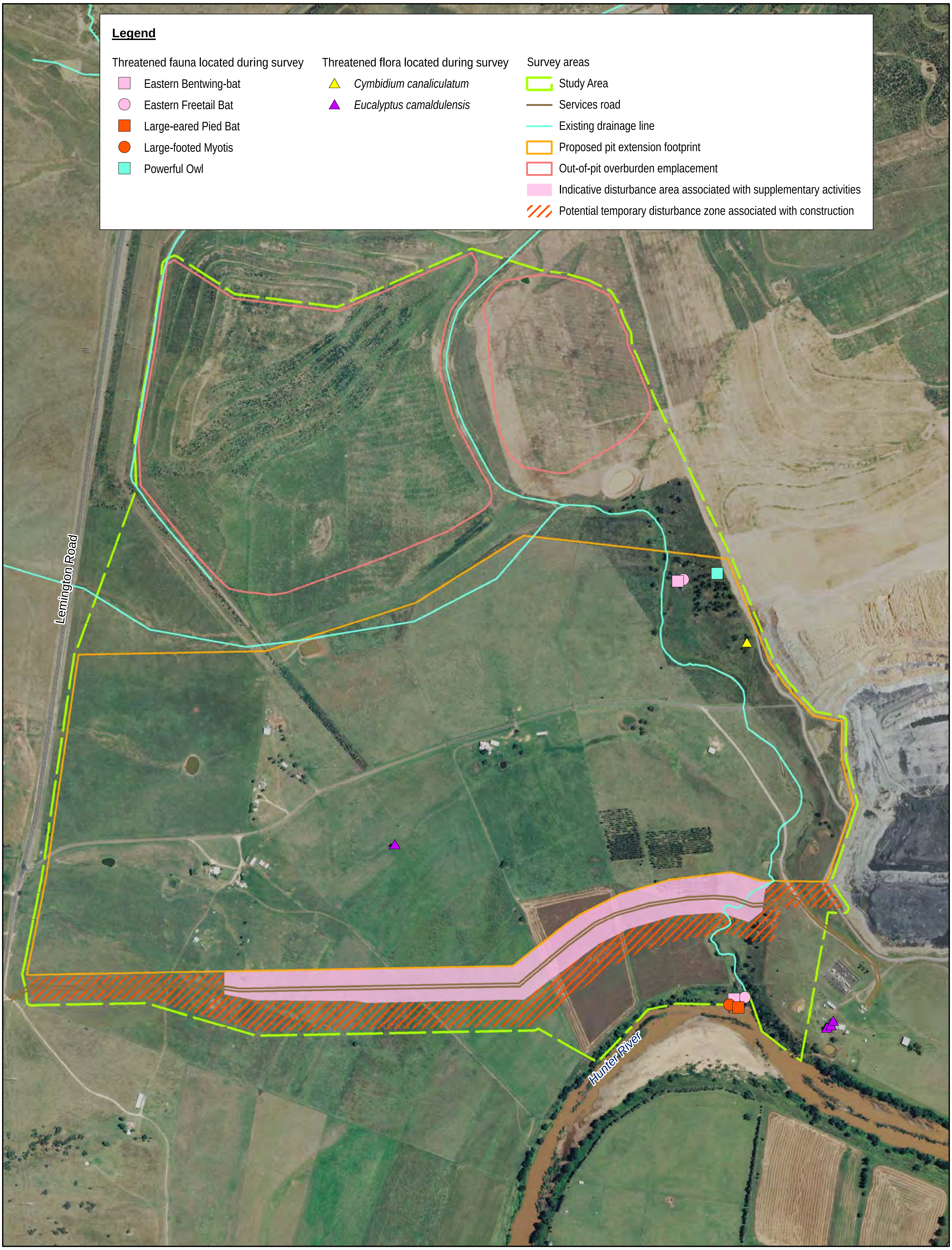
Date: 23 August 2010	Drawn by: ANP
File: S5421	Checked by: BJS/KMC
Location: ..5421\Mapping\S5421 F5_flora.mxd	

Acknowledgements:
Species data from DECCW and Biosis Research Pty. Ltd.
This product contains Data which is copyright
to the Commonwealth of Australia (c.2003-)

0 1 2 4 6 8
Kilometres

N

Scale: 1:100,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56



Biosis Research Pty. Ltd.
18-20 Mandible Street
Alexandria
NEW SOUTH WALES
2015

Acknowledgements:
Aerial photography provided by Rio Tinto Coal Australia

Figure 6: Threatened species records

Date: 14 April 2010	Drawn by: RS
File number: S5421	Checked by: BJS/KMC
Location: ..5421\Mapping\S5421 F6_survey_spp.mxd	

0 0.05 0.1 0.2 0.3 0.4 0.5 0.6
Kilometres

Scale: 1:8,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

4.3 Fauna

4.3.1 Fauna habitat

Fauna habitats within the study area broadly correspond to the vegetation types and conditions described in Section 4.2.2.

Exotic pasture

The majority of the study area consists of agricultural land including grazed paddocks and planted crops (Plate 1). These predominantly cleared areas provide limited resources for fauna with very few foraging, nesting or breeding opportunities. Common birds recorded within the grazed paddocks during the field survey include Richard’s Pipit *Anthus novaeseelandiae*, Common Starling *Sturnus vulgaris* (introduced) and Australian Magpie *Gymnorhina tibicen*. Small mammals, such as the introduced House Mouse *Mus musculus* (recorded during field survey), and common reptiles, such as snakes and skinks, may occur within the grassy paddocks. Common birds of prey, such as the Black-shouldered Kite *Elanus axillaris*, Nankeen Kestrel *Falco cenchroides* and Wedge-tailed Eagle *Aquila audax* were recorded foraging over the exotic pasture within the study area during the field survey. Other birds of prey such as the threatened Spotted Harrier *Circus assimilis* and Little Eagle *Hieraaetus morphnoides*, or migratory White-bellied Sea-eagle *Haliaeetus leucogaster* may also forage over the exotic pasture within the study area.

The exotic pasture is considered to be in poor condition in terms of fauna habitat.

Woodland and scattered trees

Remnant woodland and scattered native trees (including approximately 100 mature trees), and planted trees occur within the study area. They provide only limited connectivity throughout the landscape which is likely to be unsuitable for most arboreal mammals and less mobile birds (e.g. Squirrel Glider, Koala and Grey-crowned Babbler *Pomatostomus temporalis temporalis*).

<u>Central Hunter Box – Ironbark Woodland</u>

A stand of remnant Central Hunter Box – Ironbark Woodland occurs within the eastern boundary of the study area (Plate 2). The stand is represented by mature and senescent eucalypts along with several dead trees or stags. Approximately 85 per cent of the trees within the woodland, including the surrounding scattered trees, contain hollows. The shrub layer is absent and the ground layer dominated by grasses. A number of surface rocks occur within the woodland and fallen, hollow logs are sparse. A large stick nest was observed high in a Narrow Leaf Ironbark.

The numerous tree hollows vary in size from small (e.g. 2cm x 2cm) to moderate (e.g. 10cm x 15cm). A number of birds were observed nesting in the hollows during the field survey including the Galah *Cacatua roseicapilla* and Tree Martin *Hirundo nigricans*. An Anabat placed within the woodland recorded common hollow-dwelling microchiropteran bats including Gould's Wattled Bat *Chalinolobus gouldii*, Chocolate Wattled Bat *C. morio*, Little Forest Bat *Vespadelus vulturnus*, Southern Forest Bat *V. regulus* and White-striped Freetail Bat *Tadarida australis*. One threatened hollow-dwelling microchiropteran bat, the Eastern Freetail Bat (*Mormopterus norfolkensis*), was also recorded at this site. These bats may roost within the tree hollows. A Lace Monitor *Varanus varius* was observed sheltering in a tree hollow within the woodland during the field survey.

The woodland and scattered trees within the study area provide a foraging resource (i.e. nectar, pollen, insects) for common birds such as the Yellow-faced Honeyeater *Lichenostomus chrysops*, White-naped Honeyeater *Melithreptus lunatus*, Eastern Rosella *Platycercus eximius* and Spotted Pardalote *Pardalotus punctatus* (all recorded during the field survey). These trees may also provide a limited foraging resource for mobile threatened birds such as the Regent Honeyeater *Anthochaera phrygia*, Swift Parrot *Lathamus discolor*, Little Lorikeet *Glossopsitta pusilla* and Turquoise Parrot *Neophema pulchella*. Grey Box (dominant tree within the woodland) is a preferred feed tree species for the Regent Honeyeater and Swift Parrot. The threatened Grey-headed Flying-fox *Pteropus poliocephalus* may also forage within the woodland from time to time.

An owl pellet possibly belonging to the threatened Powerful Owl (as identified by Barbara Triggs of Dead Finish) was found beneath a roost tree within the patch of Central Hunter Box – Ironbark Woodland. No hollows of suitable size for nesting for this species were observed within the study area, however, the study area is likely to form part of the species' large foraging range. Similarly, while no breeding habitat occurs within the study area for the Masked Owl *Tyto novaehollandiae*, this species may forage among the woodland and grassy paddocks. These owls feed upon small to medium mammals (both arboreal and terrestrial) as well as birds and reptiles. It should be noted that the non threatened Barn Owl *Tyto alba* was recorded in the study area and while the pellet was identified by Barbara Triggs of Dead Finish as a Powerful Owl, the pellet may also have represented a regurgitated pellet of a Barn Owl. Given the uncertainty associated with pellet identification, a precautionary approach has been adopted and the pellet assumed to have been that of the Powerful Owl.

Other native trees occurring within the study area such as Rough-barked Apple (*Angophora floribunda*), River Oak (*Casuarina cunninghamiana*) and Bull Oak (*Allocasuarina luehmannii*) may also provide limited foraging resources for mobile birds.

In terms of fauna habitat condition, the remnant woodland and scattered trees within the study area (excluding riparian trees) range in condition from poor (isolated, no hollows) to moderate (hollows present, native ground layer, part of a larger patch, yet connectivity still low).

Plantation and revegetated areas

A Eucalypt plantation occurs within the south eastern portion of the study area. Trees within the plantation are immature and do not provide hollows. The plantation may provide limited foraging habitat for mobile birds as well as a stepping-stone and refuge area within the fragmented and largely open landscape. Eastern Grey Kangaroos *Macropus giganteus* were observed during the field survey taking shelter within the plantation. Common birds recorded within the plantation during the field survey include Galah, Eastern Rosella, Red-rumped Parrot *Psephotus haematonotus*, Noisy Miner *Manorina melanocephala*, Crested Pigeon *Ocyphaps lophotes* and Pied Butcherbird *Cracticus nigrogularis*.

A linear strip of planted trees (wind break) and revegetated emplacement areas are also present within the study area. Trees within these areas are generally immature Eucalypts and Acacias. These areas provide limited resources for fauna as with the plantation area described above.

The plantation and revegetated areas are considered to be in poor condition, providing very few resources for fauna.

Semi-permanent Pool / Ephemeral Unnamed Tributary

An ephemeral unnamed tributary runs along the eastern side of the study area and into the Hunter River in the south. The unnamed tributary was predominantly dry for much of its length at the time of survey. From its confluence with the Hunter River, the unnamed tributary has steep sides with eroded and exposed, vertical dirt banks (Plate 3). Some cracks provide potentially suitable habitat for the migratory Rainbow Bee-eater *Merops ornatus* (previously recorded close to the study area) and some microchiropteran bats (e.g. Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*). The banks are mostly bare with only a few scattered Casuarinas and Acacias. The ground layer is dominated by short grass and weeds. This section was dry at the time of survey and considered unlikely to provide habitat for threatened frogs, even if water was present. The common Double-barred Finch *Taeniopygia bichenovii* and Silvereye *Zosterops lateralis* were observed in this part of the unnamed tributary.

In the north of the study area, the unnamed tributary becomes flatter and remains dry until it reaches the Grey Box – Ironbark woodland area. Parallel to the woodland, the unnamed tributary broadens out in some places and includes a series of semi permanent pools (Plate 4) ranging between approximately 1 and

4m wide. Emergent and fringing sedges and weeds were present and provide habitat for common frogs, such as the Common Eastern Froglet *Crinia signifiera* and Eastern Dwarf Tree Frog *Litoria fallax* (both recorded during the field survey). Common waterbirds observed using the unnamed tributary and wetlands include the Australian Wood Duck *Chenonetta jubata*, Grey Teal *Anas gracilis* and White-faced Heron *Egretta novaehollandiae*. The semi-permanent pools and unnamed tributary may provide potential habitat for the threatened Australian Painted Snipe *Rostratula australis* and migratory Latham's Snipe *Gallinago hardwickii*.

The semi-permanent pool and unnamed tributary are considered to be in poor condition in terms of terrestrial fauna habitat.

Hunter River

Part of the Hunter River occurs within the study area, outside the area of direct impact (i.e. subject site). Within the study area, the Hunter River is approximately 20 – 30m wide (Plate 5). The bank opposite the study area is largely cleared with intermittent small patches of trees and shrubs. The bank within the south eastern portion of the study area is steep and rocky. Large boulders are present, particularly on the eastern side of the confluence with the unnamed tributary. Outcropping rocks and boulder piles may provide potential habitat for cave-dwelling microchiropteran bats (e.g. Large-eared Pied Bat *Chalinolobus dwyeri*). Denning opportunities among the boulders for the Spotted-tailed Quoll are considered to be non-existent. However, the riparian vegetation and boulders may provide connectivity between areas of suitable habitat or temporary shelter sites for this species.

The riparian vegetation was dominated by scattered River Oak (*Casuarina cunninghamiana*). Some small tree hollows were present. The shrub layer was patchy with large expanses of weeds. The ground layer consisted mainly of grasses and herbs along with flood deposited woody debris. The common Superb Fairy-wren *Malurus cyaneus*, Grey Fantail *Rhipidura albiscapa*, Welcome Swallow *Hirundo neoxena*, Red-bellied Black Snake *Pseudechis porphyriacus* and Eastern Water Skink *Eulamprus quoyii* were recorded within the riparian vegetation during the field survey. The non-threatened Barn Owl *Tyto alba* was recorded roosting in a low tree adjacent to the Hunter River. The Hunter River riparian vegetation may provide potential habitat for the threatened Diamond Firetail *Stagonopleura guttata* and migratory Rainbow Bee-eater.

In-stream habitats are few but include isolated boulders and dead wood. These microhabitats provide perch sites for waterbirds such as the Great Cormorant *Phalacrocorax carbo* and basking sites for the Eastern Long-necked Tortoise *Chelodina longicollis* (both recorded during the field survey). The threatened Large-footed Myotis *Myotis macropus* forages above waterways for fish. This species, as well as the Eastern Bentwing-bat, Eastern Freetail Bat and Large-eared Pied Bat, were recorded by an Anabat set up on the bank of the Hunter River. Fringing vegetation such as reeds was uncommon. The Hunter River within the study area is considered unlikely to provide potential habitat for any threatened frogs.

The Hunter River and associated riparian vegetation within the study area is considered to range in condition from poor (weed-dominated) to moderate (high level of connectivity along the river, presence of microhabitats such as tree hollows, rocky areas and foraging resources). These areas will not be disturbed by the proposed mining activities.

Farm dams

A number of dams occur within the study area. Some were dry and some contained varying levels of water at the time of survey. Each dam was isolated with exposed dirt banks and no fringing vegetation. Very few trees occur close to the dams with most having no surrounding or over-hanging trees. Grassy seepage areas were rare, providing only very limited potential habitat for snipes. The dams do not provide potential habitat for any threatened frogs. One common frog, the Spotted Grass Frog *Limnodynastes tasmaniensis*, was recorded during the field survey and may use the farm dams.

The farm dams are considered to be in poor condition in terms of fauna habitat.

Buildings/sheds

A number of buildings including occupied houses, abandoned houses and farm sheds occur in the study area. The abandoned buildings and sheds have corrugated iron ceilings. The sheds were fairly open and exposed to the elements. Some microchiropteran bats are known to roost under eaves and corrugated tin roofs of buildings (e.g. Eastern Bentwing-bat *Miniopterus schreibersii oceanensis* and Eastern Cave Bat *Vespadelus troughtoni*). However, the buildings within the study area are unlikely to provide breeding habitat given their poor thermoregulatory properties.

The buildings and sheds within the study area are considered to be in poor condition, providing no breeding or foraging resources and only limited roosting opportunities.

4.3.2 Animal species

A list of fauna recorded within the study area is provided in Appendix 3 and includes 46 species of bird (including three introduced species), 15 mammals (including three introduced), four reptiles and three frogs.

The fauna surveys generally focused on habitats with a greater potential to contain native species, e.g. remnant native vegetation, water bodies (Hunter River, unnamed tributary, wetlands, farm dams) and rocky outcrops. Less effort was expended on highly modified areas such as grazing paddocks and cropped pastures.

4.3.3 Significant fauna

A total of 51 threatened and/or migratory animal species or their habitat have been previously recorded within a 10km radius of the study area (DECCW Atlas of NSW Wildlife, DEWHA Online EPBC Database and Birds Australia New Atlas of Australian Birds)(Table 3). Of these, 38 animal species are listed under the TSC Act and 25 animal species are listed under the EPBC Act (12 threatened and 14 migratory)[2]. Thirty-seven threatened and/or migratory species have been previously recorded within 10km of the study area (Figure 7).

Five threatened species were recorded during the current field surveys of the study area (Figure 6) comprising:

- Powerful Owl *Ninox strenua* (recorded with probable confidence from an owl pellet);
- Eastern Freetail Bat *Mormopterus norfolkensis* (recorded with definite confidence using an Anabat);
- Eastern Bentwing-bat *Miniopterus schreibersii oceanensis* (recorded with definite confidence using an Anabat);
- Large-footed Myotis *Myotis macropus* (recorded with definite confidence using an Anabat); and,
- Large-eared Pied Bat *Chalinolobus dwyeri* (recorded with possible confidence using an Anabat).

Potential habitat for an additional 26 species is considered present in the study area (Table 3). Species with known and/or potential habitat have been considered further in Section 5 (Impact Assessment) of this report.

[2] An individual species may be listed under one or both Acts and may be listed as threatened and/or migratory.

Table 3: Terrestrial fauna listed on the TSC and/or EPBC Acts that may occur in the local area

Key: 1) Listed on the EPBC Act as Endangered (E), Vulnerable (V) or covered under migratory provisions (M) of the Act
2) Listed on the TSC Act as Endangered (E1), Vulnerable (V) or as a Preliminary Determination as Vulnerable (PD(V))

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Amphibians					
Litoria aurea Green and Golden Bell Frog	V	E1	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC. The species is found in marshes, dams and stream sides, particularly those containing bulrushes or spike rushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS 1999b; White and Pyke 1996), although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land. Breeding usually occurs in summer. Tadpoles, which take approximately 6 weeks to develop, feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species (DEC 2005b).	11/12/2000	No
Litoria booroolongensis Booroolong Frog	E	E1	Found in upland rivers, montane creeks and lowland rivers and creeks. This species is associated with rocky western flowing streams and rivers on the slopes and tablelands of NSW (Barker *et al.* 1995; NSW Scientific Committee 2008a; Lintermans and Osborne 2002). Often found in daylight on rocks by the waters edge (Barker *et al.* 1995; NSW Scientific Committee 2008a).	Not previously recorded within 10km	No
Litoria littlejohni Littlejohn's Tree Frog	V	V	Occurs in wet and dry sclerophyll forests associated with sandstone outcrops between 280 and 1000m on the eastern slopes of the Great Dividing Range (Barker *et al.* 1995). Prefers rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats.	Not previously recorded within 10km	No
Reptiles					
Hoplocephalus bungaroides Broad-headed Snake	V	E1	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996; Webb and Shine 1998).	Not previously recorded within 10km	No
Birds					

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Ardea alba Great Egret	M	-	Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent water bodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, salt marshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990).	Not previously recorded within 10km	Yes
Ardea ibis Cattle Egret	M	-	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1990).	21/10/2005	Yes
Circus assimilis Spotted Harrier	-	V	Open and wooded country with grassland nearby for hunting. Habitat types include open grasslands, spinifex, open shrublands, saltbush, very open woodlands, crops and similar low vegetation. More common in drier inland areas, nomadic part migratory and dispersive, movements linked to abundance of prey species. Nest in open or remnant woodland (Marchant and Higgins 1993). Unlike other harriers nests in trees.	28/05/2001	Yes
Haliaeetus leucogaster White-bellied Sea-eagle	M	-	A migratory species that is generally sedentary in Australia, although immature individuals and some adults are dispersive (Marchant and Higgins 1993). Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and salt marshes. It hunts over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roosts and makes nest in trees (Marchant and Higgins 1993).	20/07/2006	Yes
Hieraaetus morphnoides Little Eagle	-	V	The Little Eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species (NSW Scientific Committee 2009b). It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests (Marchant and Higgins 1993).	08/10/2009	Yes
Gallinago hardwickii Latham's Snipe	M	-	Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997).	Not previously recorded within 10km	Yes
Calidris ruficollis Red-necked Stint	M	-	Inhabits mainly coastal environments; salt marshes, tidal mudflats, saline and freshwater wetlands, sandy or shelly beaches and sewage ponds (Higgins and Davies 1996).	11/11/2005	Yes, but limited
Tringa stagnatilis Marsh Sandpiper	M	-	Inhabits permanent or ephemeral wetlands, including swamps, billabongs, lagoons, salt marshes and estuaries. Forages at the edge of wetlands in shallow water (Higgins and Davies 1996).	11/11/2005	Yes, but limited

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Rostratula australis Australian Painted Snipe	VM	E1	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993).	Not previously recorded within 10km	Yes
Calyptorhynchus lathami Glossy Black-cockatoo	-	V	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999a). Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	22/09/2002	Yes, but limited
Callocephalon fimbriatum Gang-gang Cockatoo	-	V	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997).	18/10/2002	Yes, but limited
Glossopsitta pusilla Little Lorikeet	-	V	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2m and 15m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (NSW Scientific Committee 2008c).	24/03/2007	Yes, but limited
Lathamus discolor Swift Parrot	E	E1	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens.* Commonly used lerp infested trees include Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis* (DEC 2005r). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997).	Not previously recorded within 10km	Yes, foraging habitat only
Neophema pulchella Turquoise Parrot	-	V	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999).	Not previously recorded within 10km	Yes

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Ninox strenua Powerful Owl	-	V	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100cm (Gibbons and Lindenmayer 1997). Has a large home range of between 450 and 1450ha (DEC 2005o).	27/08/2009	Yes (possible pellet recorded within study area during current surveys)
Tyto novaehollandiae Masked Owl	-	V	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997; Higgins 1999). Has a large home range of between 500 and 1000ha (DEC 2005l).	12/11/2000	Yes, foraging habitat only
Apus pacificus Fork-tailed Swift	M	-	Almost exclusively aerial. The Fork-tailed Swift breeds in Asia but migrates to Australia from September to April (Higgins 1999). Individuals or flocks can be observed hawking for insects at varying heights from only a few metres from the ground and up to 300m high (Boehm 1944).	Not previously recorded within 10km	Yes, foraging habitat only
Hirundapus caudacutus White-throated Needletail	M	-	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breed in Asia (Pizzey and Knight 1997).	19/12/2001	Yes, foraging habitat only
Merops ornatus Rainbow Bee-eater	M	-	Usually occurs in open or lightly timbered areas, often near water. Nest in embankments, including banks of creeks and rivers, in sand dunes, in quarries and in roadside cuttings. Breeding occurs from November to January. It has complex migratory movements in Australia. NSW populations migrate north for winter (Higgins 1999).	31/10/2008	Yes
Climacteris picumnus victoriae Brown Treecreeper (eastern subspecies)	-	V	Lives in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000).	24/03/2007	No

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Chthonicola sagittata Speckled Warbler	-	V	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers *et al.* 1984; NSW Scientific Committee 2008b). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984; NSW Scientific Committee 2008b). Home ranges vary from 6 – 12ha (NSW Scientific Committee 2008b).	31/10/2008	No
Anthochaera phrygia Regent Honeyeater	E	E1	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999c; Pizzey and Knight 1997). Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: *E. microcarpa, E. punctata, E. polyanthemos, E. mollucana, Corymbia robusta, E. crebra, E. caleyi, Corymbia maculata, E. mckieana, E. macrorhyncha, E. laevopinea*, and *Angophora floribunda*. Nectar and fruit from the mistletoes *A. miquelii, A. pendula, A. cambagei* are also eaten during the breeding season (DEC 2005p). Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and sheoaks. Also nest in mistletoe haustoria. An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female (DEC 2005p).	20/10/1991	Yes, foraging habitat only
Petroica phoenicea Flame Robin	-	V	Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border (Australian Museum 2009). The species is also found in Tasmania. The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January (Morcombe 2003).	03/10/2002	Yes
Petroica multicolor Scarlet Robin	-	V	The Scarlet Robin's range includes all state capitals. Occurs in forests, woodlands; and heavier vegetation when breeding. During autumn and winter occurs in more open and cleared areas. The species has dispersive or locally migratory seasonal movements. Is conspicuous in open and suburban habitats (Morcombe 2003).	28/07/2003	No
Melanodryas cucullata cucullata Hooded Robin (south-eastern form)	-	V	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).	12/07/2006	No
Pomatostomus temporalis temporalis Grey-crowned Babbler (eastern subsp.)	-	V	Occurs in drier, more open forests, scrubby woodlands, trees bordering roads, farmland with isolated trees (Simpson and Day 1996).	06/06/2008	No (no suitable connectivity)

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Daphoenositta chrysoptera Varied Sittella	-	V	Inhabit a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia (Higgins and Peter 2002). Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows.	25/05/2008	No
Monarcha melanopsis Black-faced Monarch	M	-	A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey and Knight 1997).	04/02/2005	No
Myiagra cyanoleuca Satin Flycatcher	M	-	Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey and Knight 1997).	Not previously recorded within 10km	No
Rhipidura rufifrons Rufous Fantail	M	-	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey and Knight 1997).	04/02/2005	No
Stagonopleura guttata Diamond Firetail	-	V	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997). Often occur in vegetation along watercourses (Higgins *et al.* 2006).	24/03/2007	Yes
Acrocephalus stentoreus Clamorous Reed-warbler	M	-	This species lives singly or in pairs usually in wetlands with reeds. It feeds on insects (Blakers *et al.* 1984).	11/11/2005	Yes
Mammals					
Dasyurus maculatus maculates Spotted-tailed Quoll (south-eastern mainland)	E	V	Occurs along the east coast of Australia and the Great Dividing Range (Belcher *et al.* 2008). Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas (NPWS 1999k). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). Seventy per cent of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage (NPWS 1999d). The home range of a female is between 180 – 1000ha, while males have larger home ranges of between 2000 – 5000ha. Breeding occurs from May to August (Belcher *et al.* 2008).	30/06/2006	Yes, but limited

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Phascogale tapoatafa Brush-tailed Phascogale	-	V	Scattered distribution centred on the Great Dividing Range. Prefers open forest with a sparse ground cover, but also occurs from mallee to rainforest. Feed on insects and nectar, particularly in rough-barked trees. Nests and shelters in tree hollows, tree stumps and occasionally birds nests, and can use more than 40 nests in a year (Soderquist and Rhind 2008). Suitable tree hollows have entrances 25 – 40mm wide (Soderquist 1995). Females have exclusive territories of approximately 20 – 60ha, while males have overlapping territories of up to 100ha. Breeding occurs from May to July, after which all the males die (Soderquist and Rhind 2008).	31/03/2004	No
Petrogale penicillata Brush-tailed Rock-wallaby	V	E1	Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from 2 – 30ha (Eldridge and Close 1995).	13/11/2002	No
Petaurus norfolcensis Squirrel Glider	-	V	Sparsely distributed along the east coast and immediate inland areas as far west as Coonabarabran (DEC 1999) in the northern part of the state and as far west as Tocumwal along the southern border of the state. Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Require abundant hollow-bearing trees and a mix of eucalypts, banksias and acacias (Van der Ree and Suckling 2008). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al.* 1988). They live in family groups of 2 – 10 individuals and maintain home ranges from 0.65 to 10.5ha, varying according to habitat quality and food resource availability (Quin 1995; Goldingay and Jackson 2004).	31/03/2004	No
Phascolarctos cinereus Koala	-	V	In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region (DEC 2005h). Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally (Martin *et al.* 2008). Primary feed trees include *Eucalyptus robusta, E. tereticornis, E. punctata, E. haemostoma* and *E. signata*. They are solitary with varying home ranges. In high quality habitat home ranges may be 1 – 2ha and overlap, while in semi-arid country they are usually discrete and around 100ha (Martin *et al.* 2008).	30/06/2006	No

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Pteropus poliocephalus Grey-headed Flying-fox	V	V	Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15km of the day roost (Tidemann 1995) although some individuals may travel up to 70km (Augee and Ford 1999).	07/09/2004	Yes, foraging habitat only
Saccolaimus flaviventris Yellow-bellied Sheathtail Bat	-	V	Found throughout NSW. They have been reported from southern Australia between January and April. Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert. They roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. It forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country (Churchill 2008; Richards 2008).	31/03/2004	Yes
Chalinolobus dwyeri Large-eared Pied Bat	V	V	Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley (van dyck and Strahan 2008). Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands (Churchill 2008; Hoye and Schulz 2008). Forages on small, flying insects below the forest canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals. Likely that it hibernates during the cooler months (Churchill 2008). The only known existing maternity roost is in a sandstone cave near Coonabarabran (Pennay 2008).	27/08/2009	Yes (recorded within study area during current surveys)
Falsistrellus tasmaniensis Eastern False Pipistrelle	-	V	Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet sclerophyll and coastal mallee, preferring wet forests with a dense understorey but being found in open forests at lower altitudes (Churchill 2008). Roosts in tree hollows and sometimes in buildings and caves, in colonies of between 3 and 80. Often change roosts every night. Has a large foraging range, up to 136ha (Churchill 2008; Law *et al.* 2008). Records show movements of up to 12km between roosting and foraging sites (Menkhorst and Lumsden 1995).	Not previously recorded within 10km	No

Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Miniopterus australis Little Bentwing-bat	-	V	Occurs from Northern Queensland to the Hawkesbury River near Sydney. Roost sites encompass a range of structures including caves, tunnels and stormwater drains (van dyck and Strahan 2008). Young are raised by the females in large maternity colonies in caves in summer. Shows a preference for well timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. The Little Bentwing-bat forages for small insects (such as moths, wasps and ants) beneath the canopy of densely vegetated habitats (Churchill 2008; Hoye and Hall 2008b).	31/03/2004	No
Miniopterus schreibersii oceanensis Eastern Bentwing-bat	-	V	Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill 2008; Hoye and Hall 2008a).	27/08/2009	Yes (recorded within study area during current surveys)
Myotis macropus Large-footed Myotis	-	V	Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects (Richards *et al.* 2008). Will also roost in phragmites/typha stands along open water (B. Ryan per obs)	27/08/2009	Yes (recorded within study area during current surveys)
Nyctophilus bifax Eastern Long-eared Bat	V	V	Occurs across northern Australia in habitats ranging from rainforests to riparian woodlands (van dyck and Strahan 2008). It frequently roosts communally in foliage and tree hollows and under exfoliated bark (van dyck and Strahan 2008). They change roosts seasonally, from rainforest edges in winter to the centre of rainforest patches in summer (van dyck and Strahan 2008).	Not previously recorded within 10km	No
Vespadelus troughtoni Eastern Cave Bat	-	V	Found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. It roosts in small groups, often in well-lit overhangs and caves, mine tunnels, road culverts, and occasionally in buildings (van dyck and Strahan 2008).	Not previously recorded within 10km	Yes, but limited

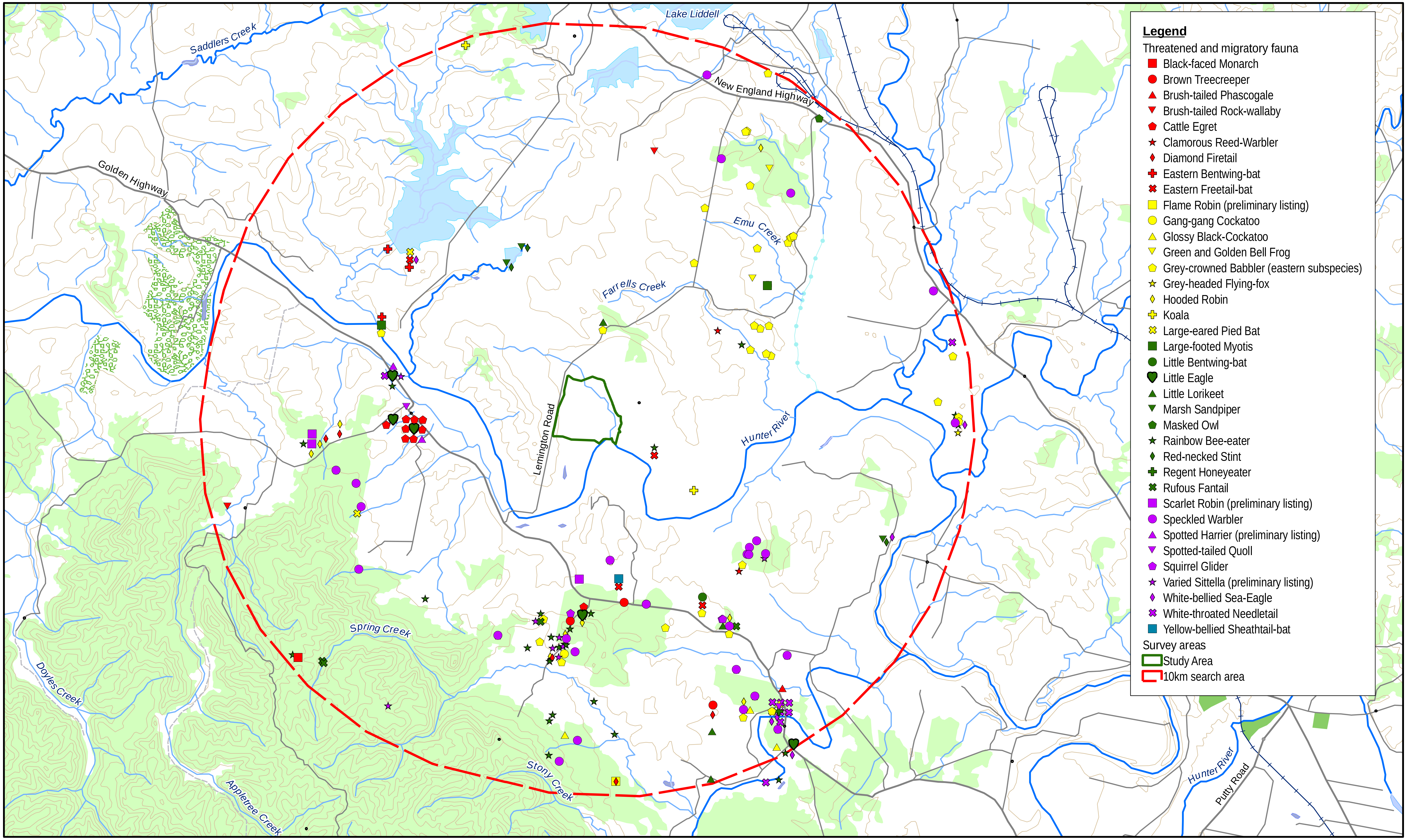
Scientific Name / Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Last record date within 10km	Potential habitat within study area?
Mormopterus norfolkensis Eastern Freetail Bat	-	V	Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney. Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites (Churchill 2008; Hoye *et al.* 2008).	27/08/2009	Yes (recorded within study area during current surveys)

4.3.4 Wildlife corridors

Wildlife corridors can be best defined as "retained and/or restored systems of (linear) habitat which, at a minimum, enhance connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation" (Wilson and Lindenmayer 1995). Alternatively, they can be defined as "linear habitats that differ from a more extensive surrounding matrix; frequently they link one or more patches of habitat in the landscape, but they may also occur as isolated lines of habitat" (Bennett 1990).

Vegetation cover in a corridor may not always be continuous. Corridors may include smaller remnants, wetlands, roadside vegetation, groups of trees, and even individual trees. Corridors may be broken, or fragmented, by currently degraded or cleared areas but still contribute to landscape connectivity. Discontinuous corridors can provide important stepping-stone links (Scotts *et al.* 2000).

The majority of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation and have not been mapped or described as a native plant community. Wildlife corridors in the study area, therefore, are limited, however include the riparian vegetation along the Hunter River. Threatened species such as the Spotted-tailed Quoll, Diamond Firetail and Large-footed Myotis, and migratory species such as the Rainbow Bee-eater, may utilise this wildlife corridor to move between areas of habitat throughout the locality. Predominantly isolated stands of trees occurring in the study area may provide limited value as stepping-stone links for highly mobile species.



Biosis Research Pty. Ltd.
18-20 Mandible Street
Alexandria
NEW SOUTH WALES
2015

Figure 7: Threatened and migratory fauna within 10km

Date: 23 August 2010	Drawn by: RS
File: S5421	Checked by: JC/KMC
Location: ..5421\Mapping\S5421 F7_fauna.mxd	

Acknowledgements:
Species data from DECCW, Birds Australia
and Biosis Research Pty. Ltd.
This product contains Data which is copyright
to the Commonwealth of Australia (c.2003-)

0 1.25 2.5 5 7.5
Kilometres

Scale: 1:100,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

4.4 Aquatic fauna

Aquatic flora within the study area broadly correspond to the vegetation types and conditions described in Section 4.2.2.

Semi-permanent Pool / Ephemeral unnamed tributary

The ephemeral unnamed tributary flows from north to south across the eastern portion of the study area. From the confluence with the Hunter River, the unnamed tributary extends upstream for a length of approximately 6.5km. Based on topographic data, the size and complexity of the unnamed tributary would be categorised as a fourth order stream under the Strahler Stream Order (Strahler 1957). Current and previous land uses have altered the natural hydrological regimes of the unnamed tributary, resulting in reduced flows that are more typically representative of a first order stream that generally lacks riparian vegetation and aquatic habitats. Flows within the unnamed tributary are only established following rain events.

Currently the unnamed tributary lacks significant riparian vegetation, indicative of its ephemeral nature and current land use. However, the unnamed tributary does include scattered Yellow Box (*Eucalyptus melliodora*) within the riparian zone in proximity to the semi-permanent pool (Plate 4). Stands of Coobah (*Acacia salicina*) and River Oak (*Casuarina cunninghamiana*) are also present within the riparian zone close to the confluence with the Hunter River. The majority of the unnamed tributary is devoid of native vegetation and subject to gully erosion which is particularly evident at the southern end (Plate 3).

4.4.1 Aquatic fauna habitat

The stream habitat in the surveyed reach was predominately dry at the time of sampling, with the only water present represented by one semi permanent pool. Stream widths within the pool were estimated at a minimum of 1.0m and maximum of 4m. Channel widths along the entire length of the unnamed tributary (within the study area) were estimated at between 4m to 15m. Width of riparian zone habitats was estimated at < 1m across the study area, providing limited aquatic fauna habitats.

The creek beds and banks of the study area were generally clay/silt substrates, with mobile eroded sediments and some sands. The unnamed tributary would generally flow during storm events or heavy rain periods, washing much eroded sediment downstream. Edge / backwater habitats present included trailing bank vegetation in the form of the exotic perennial grass, Kikuyu (*Pennisetum clandestinum*). Large woody debris was present and filamentous algae was observed in the semi permanent pool. Several sedges and rushes such as Common Spike Rush (*Eleocharis acuta*), Billabong Rush (*Juncus usitatus*), Broadleaf Cumbungi (*Typha orientalis*) and floating attached species Swamp Lily (*Ottelia ovalifolia*) were also present.

Based on a modified HABSCORE assessment, the unnamed tributary in the southern part of the study area (Plate 3) was classed poor habitat. The severely eroded beds and banks of the unnamed tributary present a barrier to fish migration and provide limited habitat such as trailing bank vegetation or epifaunal substrate cover.

The semi permanent pool (Plate 4) present in the unnamed tributary was assessed as having a marginal habitat. The presence of submerged vegetation, large woody debris and trailing bank vegetation provide potential habitat for aquatic fauna. However, due to the lack of connectivity and barriers to fish migration located further downstream, it is unlikely that fish would utilise this habitat during moderate flow. Marginal habitat was present close to the confluence with the Hunter River (Plate 7), with trailing bank vegetation, permanent connection to the Hunter River and marginal fish cover.

Due to low flow regimes the extent of the unnamed tributary within the study area provides limited habitat for fish species. In general, the habitat assessment considers that the aquatic environments provided by the unnamed tributary are of low aquatic significance, and contain habitats that range from poor to marginal quality for native fish and macroinvertebrate species.

4.4.2 Significant aquatic fauna

Database searches have indicated that no known threatened fish species listed under the FM Act and/or EPBC Act have been recorded within a 10km radius of the study area (DPI Fisheries Database and Bionet Online Database). However, the Purple-spotted Gudgeon (*Mogurnda adspersa*) has been recorded in Goorangoola and Dawleys Creeks approximately 15km from the study area. The Purple-spotted Gudgeon is listed under Schedule 4 of the FM Act as an endangered species.

Habitat preferences for this species include rivers, creeks and billabongs, in slow flowing sections over rocks or among vegetation (Allen *et al.* 2002). Due to the barriers to fish migration in the form of steeply eroded stream channels the Purple-spotted Gudgeon would be unlikely to travel upstream into the study area. Additionally, the Purple-spotted Gudgeon is known to be sensitive to migratory barriers (Boxall *et al.* 2002). On this basis, no potential habitat for the Purple-spotted Gudgeon is considered to be present in the study area.

4.5 Critical habitat

Critical habitat can de declared under both the EPBC and TSC Acts. Under the EPBC Act, it is an offence for a person to take an action that the person knows will significantly damage the critical habitat of a listed threatened species. Under the TSC Act, the declaration of critical habitat serves primarily as a guide for planning under Part 3 of the EP&A Act and a trigger which ensures a rigorous environmental assessment of all activities and development proposed, and any other action that has the potential to damage the species or its habitat (NPWS 2002b).

No areas of critical habitat for flora or fauna have been declared within the locality.

5.0 IMPACT ASSESSMENT

The primary direct impact on terrestrial and aquatic flora and fauna values will be through the removal of native vegetation, diversion of the unnamed tributary and associated habitat loss. A number of indirect impacts may result from the proposal including changes in surface water flows and water quality, habitat removal, weed invasion, erosion and siltation, deposition of dust and increased noise and vibrations. All of these indirect impacts occur in the study area presently. It is judged that the proposal may alter the way these indirect impacts occur on the study area. Further discussions of impacts that are considered relevant to the proposal are provided below. Impacts that are considered specific to threatened species are included in the Assessments of Significance (see Sections 5.2 and 5.2.4).

This section details the types of impacts that may result as a consequence of the proposal. However, many of these are indirect impacts which can be mitigated, greatly reducing or eliminating the potential impacts on threatened biota.

5.1 Potential impacts of the proposal

5.1.1 Vegetation clearing and habitat loss

‘Clearing of native vegetation’ is listed as a Key Threatening Process (KTP) under Schedule 3 of the TSC Act, and ‘Land clearance’ is listed as a KTP under the EPBC Act. One plant community within the study area is currently listed as an EEC under the TSC Act.

The Final Determination in the TSC Act for this KTP lists some of the impacts of the clearing of native vegetation on biological diversity as:

- Destruction of habitat resulting in the loss of local populations of individual species;
- Fragmentation (unlikely to result from the current proposal);
- Expansion of dryland salinity (unlikely to result from the current proposal);
- Riparian zone degradation;
- Increased habitat for invasive species;
- Loss of leaf litter layer;
- Loss or disruption of ecological function; and,
- Changes to soil biota.

While the majority of the study area is already cleared of native vegetation, remaining areas allow for the provision of habitat, food and other resources that is currently being used by native biota. Vegetation clearing would primarily be associated with the proposed pit extension. Further scattered trees and revegetated areas would be removed for out-of-pit overburden emplacement, the installation of utilities, auxiliary infrastructure (including drainage channels) and access and egress haulage roads. A total of approximately 100 mature native trees (including dead stags) from within the woodland area and nearby scattered trees would be removed, a large proportion of which were identified as hollow-bearing trees. All vegetation within the proposed out-of-pit emplacement areas is represented by immature revegetation previously sown onto former overburden emplacement associated with the nearby Carrington Pit.

Table 4: Area (ha) of each plant community in the study area and locality

Plant community (adapted from Peake 2005)	Subject site	Retained in study area	Locality (5km radius)
Central Hunter Box - Ironbark Woodland	0.89	0.17	911.60
Central Hunter Bulloak Forest Regeneration			11.45
Central Hunter Ironbark - Spotted Gum – Grey Box Forest			302.35
Central Hunter Swamp Oak Forest			24.98
Derived Native Grassland	1.35	1.07	2.42
Hunter Floodplain Red Gum Woodland Complex			7.24
Hunter Valley River Oak Forest		0.85	11.94
Hunter Valley Vine Thicket			10.76
Hunter Valley Weeping Myall Woodland			1.82
Narrabeen Footslopes Slaty Box Woodland			76.11
Planted Areas (including Eucalypt plantation)	3.43		93.94
Semi-permanent Pools	0.24		0.24
Total(ha)	**5.91**	**2.09**	**1454.85**

Vegetation clearing associated with the proposal will impact on two plant species (Tiger Orchid and River Red Gum) that are part of endangered populations in the Hunter catchment. For fauna species, the degree of impact will depend upon the extent of clearing and the ability, or inability, of individuals to emigrate to suitable local habitats. Fauna injury or death can occur as a result of the clearing and or disturbance of habitats. Habitat clearance may result in the injury or death of resident or visiting fauna.

‘Loss of hollow-bearing trees’ and ‘removal of dead wood and dead trees’ are both KTP’s under Schedule 3 of the TSC Act. Species with specific habitats for nesting, breeding and/or roosting, such as hollow-bearing trees, are vulnerable where these habitats are disturbed or removed. Some species can more readily evade injury by flying (birds) or ‘running’ away (e.g. the larger mammals). Many species, however, are unlikely to move quickly enough to avoid being caught.

For example, many nocturnal species (possums, gliders, bats) shelter during the day and smaller ground-dwelling species, such as lizards and snakes, are unable to move rapidly and over large distances.

Mitigation measures included in this report are expected to be implemented to manage the risk of fauna mortality during clearing activities.

‘The degradation of native riparian vegetation along NSW water courses’ is listed as a KTP under Schedule 6 of the FM Act. The Final Determination in the FM Act for this KTP lists some of the impacts as:

- Increasing the amount of sediment and nutrients reaching streams as runoff, and increasing light penetration of the water body;
- Reducing the inputs of organic carbon, via leaves, twigs, and branches;
- Reducing the amount of large woody debris entering the aquatic ecosystem and thereby negatively impacting on habitat and spawning sites of several vulnerable and endangered species listed under the FM Act; and,
- Destabilising river banks.

The proposal will result in impacts within riparian habitats through the diversion of the unnamed tributary. Scattered paddock trees occur in the riparian zone and would be removed by the proposal. The degradation of riparian vegetation as part of the proposal is considered negligible due to the current absence and or poor condition of existing riparian vegetation.

‘The removal of large woody debris’ is listed as a KTP under Schedule 6 of the FM Act. The Final Determination in the FM Act for this KTP lists some of the impacts of the removal of large woody debris as:

- Habitat for benthic plants;
- Organic enrichment by capturing detritus and contributing to secondary production by degradation of the debris itself;
- Refuges from predators and interactions between competitors;
- Velocity refuges that minimise energy costs of swimming;
- Spawning sites essential for successful reproduction;
- Refuge and spawning habitats in the riparian zone during overbank flooding;
- Erosion prevention by sedimentary stabilisation of stream banks and riparian zones; and,

- Temperature and drought refuges formed by scouring of deep holes adjacent to large woody debris.

The proposal will result in the removal of a small quantity of woody debris (Plate 4) from within the unnamed tributary.

Mitigation measures have been prescribed in this report and include the re-establishment of in-channel habitat with large woody debris, similar to the current tributary.

5.1.2 Changes in drainage patterns and water quality

Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands is a KTP listed under Schedule 3 of the TSC Act. The Final Determination for this KTP states that alteration to natural flow regimes can occur through reducing or increasing flows, altering seasonality of flows, changing the frequency, duration, magnitude, timing, predictability and variability of flow events, altering surface and sub-surface water levels and changing the rate of rise or fall of water levels.

The current proposal will require the diversion of a tributary which is currently in poor condition and extends from north to south along the eastern side of the study area before discharging into Hunter River. Furthermore, the potential for changes to shallow groundwater flows through floodplain portions of the study area may affect groundwater connectivity with the Hunter River. Changes in groundwater have been addressed in more detail separate to this report (Mackie Environmental Research 2010).

‘The installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of river and streams’ is listed as a KTP under Schedule 6 of the FM Act. The Final Determination in the FM Act for this KTP lists some of the impacts as:

- Changes to natural seasonality and variability of flow regimes (duration, extent and rate), as a result of water regulation for flood mitigation and irrigation, impact on native species by disrupting natural environmental cues necessary for reproductive cycles (including migration, spawning, growth and recruitment);

- Reduction of habitat due to changes in the area, frequency and duration of inundation of floodplains and terminal wetlands limits distributions and reduces spawning successes; and,

- Alteration to the natural flow regimes by in stream structures and other mechanisms can cause changes in physical, chemical and biological conditions that in turn alter the biota. Disruption of ecological processes may continue long after initial flow alteration, causing continued decline in biological diversity.

The proposal would remove approximately 1.5km of the ephemeral unnamed tributary and its catchment and has the potential to affect downstream aquatic ecosystems associated through changes to water flows and quality. The unnamed tributary will be removed as mining progresses, with the construction of a levee system and drainage channel between years 1-3 and the diversion of the unnamed tributary between years 4-6. The loss of poor to marginal aquatic habitat in the form of the unnamed tributary will result from the proposal.

The proposed diversion of surface drainage around the subject site has the potential to maintain the existing flows into the Hunter River catchment. Assessment of the changes in surface water flows is provided by WRM (WRM 2010). Based on the study by WRM, the loss of catchment runoff to the Hunter River during the life of the project is considered negligible due to the relative magnitude of flows in the Hunter River.

The construction of the diverted tributary has the potential to impact the aquatic habitats associated with the ephemeral unnamed tributary. Potential impacts include:

- Downstream degradation of water quality and aquatic habitat through increase sedimentation, pollutants and altered hydrology. Pollution could potentially enter waterways via runoff, airborne transport of spray and dust, or a spillage event and could result in physical or chemical changes in water quality;

- Physical changes - sedimentation can have detrimental ecological effects, including a reduction in substrate and depth heterogeneity, smothering and killing of demersal eggs, smothering of macroinvertebrates, smothering of food sources, smothering of vegetation, impacts on fish respiration (gills become clogged), reduced feeding ability, transportation of pollutants attached to sediment and reduced light penetration for aquatic vegetation; and,
- Chemical changes - that is, chemical contaminants with the potential to exert toxic effects at concentrations that might be encountered in the environment. Free chemicals or chemicals compounds utilised during construction works could potentially be toxic to aquatic biota in small concentrations.

At the end of mining within the proposed extension area, the unnamed tributary will be reinstated to its original position. The channel of the unnamed tributary will be reconstructed post mining to be a similar shape to pre-mining conditions and will be vegetated with appropriate species to reflect natural conditions along similar streams in the region. Detailed design plans for the temporary diversion and reinstatement of the unnamed tributary will be provided in a Management Plan to be developed. This Management Plan is discussed further in Section 6.4.

With respect to potential impacts on the riparian and ecological values of the Hunter River, downstream of the proposal, it is noted that the proposal does not include removal of any Hunter River riparian vegetation and is unlikely to have any direct impacts on the riparian zone of the Hunter River. The surface water assessment prepared by WRM (2010) found that there would be little impact on runoff water quality to the Hunter River and no increase in erosion potential of the Hunter River channel as a result of the proposal. The WRM (2010) report included a number of management measures which will be implemented as part of the proposal to minimise the potential for indirect impacts to the Hunter River. The surface water assessment by WRM (2010) concluded that 'the proposed management measures will ensure no measurable adverse impacts on riparian and ecological values of watercourses on the site and downstream of the proposal'. More detailed discussion of potential impacts to the Hunter River, and the proposed measures to address these is provided in the WRM (2010) report.

5.1.3 Weed invasion

Weed invasion has the potential to occur in all areas cleared and disturbed by the proposal. Weeds are currently the dominant feature of the study area (see Section 4.2.2). The dominant weed species present in the study area include both herbaceous weeds and exotic perennial grasses. Other common weeds include exotic vines and scramblers. Invasion of native plant communities by exotic perennial grasses and invasion and establishment of exotic vines and scramblers are both listed as a Key Threatening Processes under Schedule 3 of the TSC Act.

Exotic perennial grass species recorded in the study area include Rhodes Grass (*Chloris gayana*) Kikuyu (*Pennisetum clandestinum*) and Paspalum (*Paspalum dilatatum*). Exotic vines and scramblers recorded in the study area include Balloon Vine (*Cardiospermum grandiflorum*).

Weed propagules may be dispersed during construction and operation of the mine. Apart from altering local flora assemblages and competitively displacing native plant species, weed invasion also has the potential to modify habitat features for local fauna species. Given that the study area is mostly cleared and disturbed, already dominated by weeds, the proposal is unlikely to significantly increase the prevalence of weeds in the vicinity of the study area.

5.1.4 Erosion and siltation

Erosion and siltation can result from vegetation clearing and physical effects of frequent vehicle movements and soil disturbance from construction. The potential impact of erosion and subsequent sedimentation within small drainages is expected to be greater in cleared and unstable areas as a result of increased run off.

Any attempt to control erosion or contamination will be limited by the efficacy of mitigation strategies and will depend on the type of structure(s) used and the level of maintenance throughout the construction and operational phases of the proposal.

5.1.5 Dust

No studies are known to have investigated the cumulative, long-term impacts of mining generated dust on flora and fauna. Dust may be generated at coal mine sites during site preparation, excavation, blasting, transportation, and coal processing and truck movements. Anecdotal observations of vegetation surrounding the existing Carrington Pit found no visible deposition of dust.

5.1.6 Noise

Noise and vibration will result from blasting and recurrent truck and heavy plant movements. This may startle some fauna species and may cause disruption and emigration from vegetated areas nearby to the subject site.

5.2 Part 3A guidelines for threatened species assessment (EP&A Act)

The impacts of the proposal on threatened species, populations and ecological communities listed under the TSC Act have been assessed following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act (DEC & DPI 2005). Where threatened species, populations and/or communities **are recorded** within a study area, an impact assessment is required under the EP&A Act. When threatened species, populations and/or communities **are not recorded** during a survey, the presence of potential habitat for a species (or population or community) is used to determine the need to undertake an impact assessment under the EP&A Act. Where there is no potential habitat in the study area for threatened species, populations and/or communities, there is unlikely to be any impact and therefore these species (or populations or communities) are not required to be considered further.

Key thresholds

The Part 3A Guidelines of the EP&A Act (DEC & DPI 2005) set out a number of key thresholds which need to be addressed to justify the impacts of the proposal on threatened species, populations and ecological communities. The key thresholds are (DEC & DPI 2005):

- Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values;
- Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;
- Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and,
- Whether or not the proposal will adversely affect critical habitat.

Based on the impact assessments following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act, the following conclusions have been attributed to the proposal.

5.2.1 Endangered ecological communities

One Endangered Ecological Community (EEC) as recently listed under the NSW TSC Act: *Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* (NSW Scientific Committee 2010) was recorded in the study during the surveys.

According to Peake (2005) the mapped extent of the community is approximately 46,920ha which is estimated to be 32 per cent of the pre-European distribution. Approximately 1.06ha (<0.002 per cent) of this community occurs in the study area represented by small (<1ha) highly fragmented and disturbed remnants.

According to the NSW Scientific Committee Determination for this EEC (NSW Scientific Committee 2010), species composition of this community will be influenced by the size of the site, recent rainfall, drought condition and by its disturbance (including fire and grazing) history. The number of species and the above ground relative abundance of species will change with time since disturbance, and may also change in response to changes in disturbance regime (including changes in fire frequency). At any one time, above ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers (NSW Scientific Committee 2010).

The proposal would result in direct impacts to approximately 0.89ha of this community, with a further 0.17ha potentially subject to indirect impacts. According to the vegetation mapping (Peake 2005) a total of 911.6ha of this vegetation occurs within the locality (Table 4).

Based on the impact assessment completed for this EEC (see Appendix 4) the proposal is considered unlikely to constitute a significant impact, on the basis that:

- The magnitude of impacts from the proposal on the extent of this community in the locality is relatively small;
- The proposal would not result in further fragmentation or isolation of this community; and,
- Patches of this community in the study area are already subject to indirect impacts from existing land uses.

Despite this, in acknowledgement of the proposed removal of 0.89ha of Central Hunter Box – Ironbark Woodland, the proposal includes post-mining rehabilitation of a nominal four hectares of this community. This is proposed to be located within the area of rehabilitated woodland at the out-of-pit overburden emplacement areas.

5.2.2 Flora

Two plant species recorded in this subject site, Tiger Orchid (*Cymbidium canaliculatum*) and River Red Gum (*Eucalyptus camaldulensis*), are listed under Schedule 1 of the TSC Act as part of endangered populations in the Hunter catchment.

Furthermore, due to the proximity of previous records and/or the presence of identified habitat preferences, potential habitat may exist within the study area for four threatened plant species (including endangered populations): Weeping Myall (*Acacia pendula*), White-flowered Wax Plant (*Cynanchum elegans*), Tricolour Diuris (*Diuris tricolor*) and Slaty Gum (*Eucalyptus glaucina*). Three of these species, Weeping Myall (*Acacia pendula*), White-flowered Wax Plant (*Cynanchum elegans*) and Slaty Gum (*Eucalyptus glaucina*) are considered relatively conspicuous and if present within the subject site, would have been observed. One species, the Tricolour Diuris (*Diuris tricolor*) is small and inconspicuous, and also has a flowering period outside of the current survey period.

On the basis of the above, impact assessment following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act have been completed (see Appendix 4) for Tiger Orchid (*Cymbidium canaliculatum*), River Red Gum (*Eucalyptus camaldulensis*) and the Tricolour Diuris (*Diuris tricolor*).

Tiger Orchid

This species grows in the hollows of trees in dry sclerophyll forest or woodland (Harden 1993). The root and rhizome system extends deep into the decaying heartwood of the host tree, with rhizomes emerging from other hollows metres away from the original clump (Jones 2006).

C. canaliculatum was recorded in a tree immediately south of the remnant patch of Central Hunter Box – Ironbark Woodland in the north east of the subject site (Figure 6). Several large clumps were recorded growing on a single senescent remnant, Grey Box (*Eucalyptus mollucana*) which occurs on the western edge of the existing Carrington Pit. Potential habitat in the Upper Hunter Valley is considered to include: Central Hunter Box - Ironbark Woodland, Central Hunter Spotted Gum - Ironbark - Grey Box Forest, and Hunter Valley Vine Thicket, and is also expected to occur in Central Hunter Bulloak Forest Regeneration (Peake 2005).

The size of the Hunter population of *C. canaliculatum* is estimated to be very low, as few as 90, although there may be as many as 300-500 individuals in the population (NSW Scientific Committee 2006). The species is found in two conservation reserves (Wollemi and Goulburn River National Parks), however 90 per cent of the population occurs on land not managed for conservation (NSW Scientific Committee 2006).

The nearest known recent (2009) record of *C. canaliculatum* occurs at Archerfield, Warkworth, approximately 8 km east of the study area (Cumberland Ecology 2010). The next closest known record is approximately 20km to the north of the study area. The study area is close to the currently known southern limit of distribution for this species; with the only known records of *C. canaliculatum* further south of Archerfield, represented by five records dated between 1899 and 1939, with no more recent records in this area. The lack of records may not accurately reflect the local or regional extent of the population given that similar host trees, landform and climatic conditions occur in the region.

Given that the proposal would impact one of the few known local occurrences of *C. canaliculatum*, it is considered that unless the occurrence of the species can be avoided or the impacts mitigated (e.g. through a successful translocation), the proposal would have a significant impact on the local population (this record). It should be noted that approximately 1,261ha of potential habitat for the species has been mapped as occurring in the locality and that further searches within these areas of potential habitat may yield additional local records of the species. Furthermore, the isolated occurrence of the *C. canaliculatum* in a highly fragmented landscape in immediate proximity to the edge of the operational Carrington Pit means that its long term survival in the current location is already subject to considerable doubt. Mitigation measures (e.g. translocation) included in Section 6.0 have been prescribed to reduce the likely impacts on this species.

Within the broader operations of Coal & Allied in the region, a number of colonies of *C. canaliculatum* are being conserved within existing or proposed biodiversity offset areas. A single colony/individual is protected and conserved at Archerfield near the Hunter Valley South Coal Mine. The proposed offset area at the Coal &Allied owned Broomfield property near the Mount Pleasant Mine and the Goulburn River offset proposed for the Warkworth Mine both include colonies of *C. canaliculatum*. Although the latter two offsets are not specific for any impact to *C. canaliculatum* they do provide long term conservation localities for this species and add to its conservation across the region.

The colony occurring within the impact footprint of the current proposal is to be translocated (see section 6.2 for details).

River Red Gum

Eucalyptus camaldulensis occurs in grassy woodland or forest on deep rich alluvial soils adjacent to large permanent water bodies (Harden 2002). The size of the Hunter population of *E. camaldulensis* is estimated to be between 600 - 1000 mature or semi mature trees in 19 known stands, occupying at most around 100ha (DECC 2005).

A single tree of *E. camaldulensis* was recorded on the subject site, in the rural land in the centre of the subject site (Figure 6) in a cleared and grazed landscape with exotic species dominating the ground layer. This tree appeared remnant but was in poor to moderate condition, with a healthy canopy but obvious trunk damage from chicken wire around the base including compaction of the root zone from cattle disturbance around the tree.

A group of eight mature trees of *E. camaldulensis* was also recorded just outside the study area, to the south east at the top of a steep hill above the Hunter River. The eight trees are growing adjacent to a dilapidated house and it is unknown whether the specimens are planted or naturally occurring. A further and larger population occurs at Carrington Billabong, approximately 1.2km to the east of the subject site and is subject to ongoing management and enhancement (Umwelt 2010).

The proposal will result in the removal of the single *E. camaldulensis* specimen from a cleared agricultural landscape which currently represents poor habitat for this species. Provided that mitigation measures (see Section 6.0) are implemented, including ongoing management of the existing nearby population and commitments to protect the potential habitat adjoining the Hunter River, it is considered highly unlikely that the proposal will have a significant impact on the endangered population.

Tricolour Diuris

Diuris tricolor was not recorded in the study area. The closest record of this species is approximately 17km north of the study area. According to Peake (2005), *D. tricolor* is known to occur at Muswellbrook and Wybong, but is likely to occur more widely west of Singleton. *D. tricolor* has previously been recorded in Central Hunter Box - Ironbark Woodland and is expected to occur in Central Hunter Bulloak Forest Regeneration, Central Hunter Spotted Gum - Ironbark - Grey Box Forest and Hunter Valley Weeping Myall Woodland (Peake 2005). This species may also occur in Derived Grasslands (DEC 2005) such as that which occurs in the study area.

There may be potential habitat for this species in the Central Hunter Box - Ironbark Woodland and Derived Native Grassland in the study area and in other communities in the locality. *D. tricolor* is a deciduous orchid and would not be detected outside of the flowering period, which occurs between September and November (DEC 2005). Advice from DECWW (2010) states the flowering period as September to October (excluding late October).

The study area was surveyed in late August 2009 during the current surveys. Nearby areas have been surveyed on the 18-20 October 2004 (ERM 2005a) and 23 October 2002 (ERM 2003). As these surveys likely occurred outside the flowering period of *D. tricolor* (DECCW 2010), an impact assessment has been completed, based on potential habitat only. Cumberland Ecology (2010) conducted targeted flora surveys between 7 and 11 October 2009 however these surveys took place between 9.4 and 19.4 km south east of the current study area. The species was not detected during these surveys.

The proposal will remove up to 2.24ha of potential habitat for *D. tricolor*. A targeted survey for *D. tricolor* was undertaken in potential habitat within the subject site on 22 September 2010, when a known population in the region was in flower. *D. tricolor* was not detected during this survey (See Appendix 5 for details). Given the extremely low likelihood of occurrence, the proposal is considered unlikely to result in a significant impact on this species.

5.2.3 Fauna

Where there is potential habitat (foraging or breeding resources) for threatened species in the study area, further consideration must be given to the potential impact of the proposal on these species. The proposal may impact on threatened species by causing any of the following:

- Death or injury of individuals;
- Loss or disturbance of limiting foraging resources; or
- Loss or disturbance of limiting breeding resources.

Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest/maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However, for some species, limiting resources include specialised foraging habitats that have a restricted distribution (e.g. Koalas feeding only on specific tree species).

Five threatened species were recorded during the current field surveys: Powerful Owl, Eastern Freetail Bat, Eastern Bentwing-bat, Large-footed Myotis and Large-eared Pied Bat. Potential habitat exists in the study area for an additional 16 TSC Act-listed species (Table 3).

Table 5 summarises the possible impacts from the proposal on the 21 TSC Act-listed threatened fauna with known and/or potential habitat in the study area, and determines the need for Part 3A impact assessments. Based on the nature of the proposal (see Section 2.4.2), database interrogation, literature review regarding the ecology of each species, and information gathered during field surveys within the study area, 14 of these species are considered as unlikely to be subject to negative impacts resulting from the proposal. Accordingly, no Part 3A impact assessments have been prepared for these species.

Part 3A impact assessments have been prepared for the remaining seven species: Turquoise Parrot, Powerful Owl, Eastern Freetail Bat, Eastern Bentwing-bat, Large-footed Myotis, Large-eared Pied Bat and Yellow-bellied Sheathtail Bat (Appendix 4). The assessments concluded a major impact to be unlikely.

Table 5 Potential impact and Part 3A impact assessment requirements for threatened fauna listed on the TSC Act with potential habitat in the study area

Common Name	EPBC Act	TSC Act	Potential Impacts on Threatened Species			Impact Assessment required?	Reasoning
			Individual death or injury?	Loss or disturbance of limiting foraging resources?	Loss or disturbance of limiting breeding resources?		
Spotted Harrier	-	V	Unlikely	No	No	No	The species occurs in open and wooded country with grassland nearby for hunting. It is more common in drier inland areas. Nests in trees (Marchant and Higgins 1993). Previously recorded three times within the locality, between 3.7 and 5km west of the study area. The Spotted Harrier may forage over the exotic pastures and possibly nest in trees within the study area. However, no limiting breeding or foraging resources would be impacted. The loss of approximately 4.32ha non-limiting woodland/plantation habitat and non-limiting farmland is not likely to impact this species. A Part 3A impact assessment is not considered necessary.
Little Eagle	-	V	Unlikely	No	No	No	The Little Eagle occurs in lightly timbered areas with open areas nearby providing an abundance of prey species (NSW Scientific Committee 2009b). Previously recorded once within the locality, approximately 4.9km south west of the study area. The Little Eagle may forage over the exotic pastures and possibly nest in trees within the study area. However, no limiting breeding or foraging resources would be impacted. The loss of approximately 4.32ha non-limiting woodland/plantation habitat and non-limiting farmland is not likely to impact this species. A Part 3A impact assessment is not considered necessary.
Gang-gang Cockatoo	-	V	Unlikely	No	No	No	In low altitudes occurs in drier, more open eucalypt forests and woodlands. Breeds in tree hollows in montane forests (Higgins 1999). Not previously recorded within the locality. One record of the Gang-gang Cockatoo occurs within 10km, located approximately 6km south of the study area. The Gang-gang Cockatoo may forage among the eucalypt trees of the study area. Although suitably-sized tree hollows occur in the study area, the Gang-gang Cockatoo nests and roosts within forests, favouring old growth forests (DEC 2005e). The study area is therefore considered unlikely to provide potential breeding habitat for this species. Given that no limiting breeding resources and only 0.89ha of non-limiting potential foraging habitat (Box-Ironbark woodland) would be removed, the proposal is not likely to impact this species. A Part 3A impact assessment is not considered necessary.

Common Name	EPBC Act	TSC Act	Potential Impacts on Threatened Species: Individual death or injury?	Potential Impacts on Threatened Species: Loss or disturbance of limiting foraging resources?	Potential Impacts on Threatened Species: Loss or disturbance of limiting breeding resources?	Impact Assessment required?	Reasoning
Glossy Black Cockatoo	-	V	Unlikely	No	No	No	Inhabits forest with low nutrients, characteristically with key *Allocasuarina* spp. Breeds in tree hollows (NPWS 1999a). Not previously recorded within the locality. Four records of the Glossy Black-cockatoo occur within 10km, located between 8 and 10km south and south east of the study area. The Glossy Black-cockatoo is dependent on *Allocasuarina* spp. and is rarely observed away from *Allocasuarina* spp. (Higgins 1999). Within the study area only one, young *Allocasuarina luehmannii* was observed. This particular species is not listed as a preferred feed tree (DEC 2005f) nor is a single tree considered to provide a limiting foraging resource. The study area is not considered to provide potential breeding habitat due to the lack of *Allocasuarina* spp. and as the Glossy Black-cockatoo mainly breeds within remnant woodland (Higgins 1999). Given that no limiting foraging or breeding resources would be removed, the proposal is not likely to impact this species. A Part 3A impact assessment is not considered necessary.
Regent Honeyeater	E	E1	Unlikely	No	No	No	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999c; Pizzey and Knight 1997). Not previously recorded within the locality. One record of the Regent Honeyeater occurs within 10km, located approximately 9km south east of the study area. The study area contains a preferred feed tree of the Regent Honeyeater (Grey Box), however, given the small area containing the tree (0.89ha) and the disturbed nature of the habitat (surrounded by cleared paddocks and adjacent to an open cut coal mine), this potential foraging resource is not considered to be limiting. Further, the study area does not provide any breeding habitat for the species. The loss of approximately 0.89ha non-limiting eucalypt woodland habitat is considered unlikely to impact this mobile species. Therefore, a Part 3A impact assessment is not considered necessary.

Common Name	EPBC Act	TSC Act	Potential Impacts on Threatened Species			Impact Assessment required?	Reasoning
			Individual death or injury?	Loss or disturbance of limiting foraging resources?	Loss or disturbance of limiting breeding resources?		
Diamond Firetail	-	V	Unlikely	No	No	No	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997). Often occur in vegetation along watercourses (Higgins *et al.* 2006). Not previously recorded within the locality. The Diamond Firetail has been previously recorded at five locations within 10km of the study area, approximately 6km to the west and between 6 and 9.5km south. The Diamond Firetail may occur within the riparian vegetation and lightly wooded parts of the study area, foraging on the ground and nesting in the understorey. However, no limiting breeding or foraging resources would be impacted. The loss of approximately 0.89ha non-limiting eucalypt woodland habitat (no riparian habitat would be removed) is not likely to impact this species. A Part 3A impact assessment is not considered necessary.
Flame Robin	-	V	Unlikely	No	No	No	The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands (Morcombe 2003). Not previously recorded within the locality. One record of the Flame Robin occurs within 10km, located approximately 9.5km south of the study area. The Flame Robin may forage among the eucalypt trees and farmland of the study area for invertebrates and may build a nest near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank (NSW Scientific Committee 2009a). However, no limiting breeding or foraging resources would be impacted. The loss of approximately 4.32ha non-limiting woodland/plantation habitat and non-limiting farmland is not likely to impact this species. A Part 3A impact assessment is not considered necessary.
Little Lorikeet	-	V	Unlikely	No	No	No	Mostly occurs in dry, open eucalypt forests and woodlands. Nest in hollows, particularly in *Eucalyptus viminalis*, *E. blakelyi* and *E. dealbata* (NSW Scientific Committee 2009c). Previously recorded once within the locality, approximately 1.5km to the north. Three additional records outside the locality occur between 6 and 10km to the south east. Within the study area the Little Lorikeet may forage on nectar and pollen from among the eucalypt trees. The study area is considered unlikely to provide potential breeding habitat for this species as it nests in living, smooth-barked eucalypts (NSW Scientific Committee 2009c), which are scare within the study area. Given that no limiting breeding resources and only 0.89ha of potential foraging habitat (Box-Ironbark woodland) would be removed, the proposal is not likely to impact this species. A Part 3A impact assessment is not considered necessary.

Common Name	EPBC Act	TSC Act	Potential Impacts on Threatened Species			Impact Assessment required?	Reasoning
			Individual death or injury?	Loss or disturbance of limiting foraging resources?	Loss or disturbance of limiting breeding resources?		
Swift Parrot	E	E1	Unlikely	No	No	No	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). Breeds in Tasmania (Pizzey and Knight 1997). Not previously recorded within 10km of the study area. The closest record occurs approximately 18km to the south east, recorded in 2002 (NSW Government 2009). The study area contains a preferred feed tree of the Swift Parrot (Grey Box), however, given the small area containing the tree (0.89ha) and the disturbed nature of the habitat (surrounded by cleared paddocks and adjacent to an open cut coal mine), this potential foraging resource is not considered to be limiting. Further, the study area does not provide any breeding habitat as the species breeds exclusively in Tasmania. The loss of approximately 0.89ha non-limiting eucalypt woodland habitat is considered unlikely to impact this mobile species. Therefore a Part 3A impact assessment is not considered necessary.
Turquoise Parrot	-	V	Possible	No	Yes	**Yes**	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps (Higgins 1999). Not previously recorded within 10km of the study area. The closest record occurs approximately 12km to the south east, recorded in 2002 (NSW Government 2009). Within the study area the Turquoise Parrot may forage among the eucalypt trees and surrounding farmland, and nest in tree hollows. Given the loss of potential limiting breeding resources (i.e. tree hollows), a Part 3A impact assessment has been completed for this species.
Australian Painted Snipe	V	E1	Unlikely	No	No	No	Prefers freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993). Not previously recorded within 10km of the study area. Potential habitat occurs within the study area in the form of wetlands with emergent vegetation associated with the unnamed tributary. Some farm dams surrounded by a grassy seepage area may also provide potential habitat for this species. Given the poor quality of potential habitat in the study area, the absence of records of the species within 10km (closest record occurs approximately 70km south east, recorded in 1992 (NSW Government 2009)) and the presence of higher quality potential habitat in the locality (e.g. dams identified during an avifauna survey by HLA-Envirosciences (2006)), it is considered unlikely that the loss of a few non-limiting, small wetlands/dams would impact this species. A Part 3A impact assessment is not considered necessary.

Common Name	EPBC Act	TSC Act	Potential Impacts on Threatened Species			Impact Assessment required?	Reasoning
			Individual death or injury?	Loss or disturbance of limiting foraging resources?	Loss or disturbance of limiting breeding resources?		
Powerful Owl	-	V	Unlikely	No	No	**Yes**	Inhabit a range of wooded habitats, including rainforest (Higgins 1999). This species was recorded within the study area with probable certainty, identified (by Barbara Triggs of Dead Finish) from an owl pellet collected beneath a roost tree. No other records occur within 10km. This species forages over a large home range for ground-dwelling and/or arboreal mammals and the study area occurs within this foraging range. The study area is not considered to provide potential breeding habitat as no suitably-sized hollows were observed and there is no understorey, which is an important habitat component for newly fledged young (Higgins 1999). Although impacts to this species may be negligible, a Part 3A impact assessment has been completed given the likely occurrence of the Powerful Owl within the study area.
Masked Owl	-	V	Unlikely	No	No	No	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Not previously recorded within the locality. One record of the Masked Owl occurs within 10km, located approximately 9.5km north east of the study area. This species forages over a large home range for ground-dwelling and/or arboreal mammals and the study area may occur within this foraging range. However, the foraging habitat within the study area is not considered to be limiting for this mobile species. The study area is not considered to provide potential breeding habitat as no suitably-sized hollows were observed (i.e. hollows >40cm diameter in living or dead trees). Given that no breeding resources and only non-limiting potential foraging habitat would be removed, the proposal is not likely to impact this species. A Part 3A impact assessment is not considered necessary.

Common Name	EPBC Act	TSC Act	Potential Impacts on Threatened Species			Impact Assessment required?	Reasoning
			Individual death or injury?	Loss or disturbance of limiting foraging resources?	Loss or disturbance of limiting breeding resources?		
Spotted-tailed Quoll	E	V	Unlikely	No	No	No	Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Habitat requirements include suitable den sites, including hollow logs, hollow-bearing trees, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). Previously recorded once within the locality, approximately 4.2km to the west. One other record occurs within 10km, located approximately 8.8km to the south east. The study area is not considered to provide any limiting breeding or foraging resources for the Spotted-tailed Quoll, however, the species may move through the study area from time to time, particularly along the Hunter River riparian vegetation. This part of the study area would not be directly impacted by the proposal. Given the above, it is considered unlikely that the Spotted-tailed Quoll would be impacted by the proposal. A Part 3A impact assessment is not considered necessary.
Grey-headed Flying-fox	V	V	Unlikely	No	No	No	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation (Tidemann 1995). Not previously recorded within the locality. One record of the Grey-headed Flying-fox occurs within 10km, located approximately 9.6km east of the study area. The study area provides limited potential foraging habitat within the wooded parts of the study area. The study area does not provide potential breeding habitat. Given that no breeding habitat would be removed, and the high mobility of this species (known to travel up to 50km to forage (DEC 2005g)), the loss of approximately 4.32ha non-limiting woodland/plantation habitat is not likely to impact this species. A Part 3A impact assessment is not considered necessary.

Common Name	EPBC Act	TSC Act	Potential Impacts on Threatened Species			Impact Assessment required?	Reasoning
			Individual death or injury?	Loss or disturbance of limiting foraging resources?	Loss or disturbance of limiting breeding resources?		
Large-eared Pied Bat	V	V	Unlikely	No	No	**Yes**	This species roosts in caves, Fairy Martin nests and mines, and beneath rock overhangs. Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands (Churchill 2008; Hoye and Schulz 2008). Recorded once during the field surveys with possible certainty (using Anabat) on the edge of the Hunter River. This species may roost among outcropping rocks and boulder piles along the edge of the Hunter River within the study area (this area would not be directly impacted by the proposal). However, no limiting breeding habitat (i.e. caves) occurs in the study area. The species may also forage throughout the study area for flying insects. Although impacts to this species may be negligible, a Part 3A impact assessment has been completed given the known occurrence of the Large-eared Pied Bat within the study area.
Eastern Bentwing-bat	-	V	Unlikely	No	No	**Yes**	Form maternity roosts in caves and mines. Also roost in culverts, buildings and under bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands (Churchill 2008). Recorded a number of times during the field surveys with definite confidence (using Anabat) on the edge of the Hunter River and within the Box-Ironbark woodland. Within the study area, this species may roost in buildings, however, no limiting breeding habitat (i.e. caves or mines) occurs in the study area. The species may also forage throughout the study area for flying insects. Although impacts to this species may be negligible, a Part 3A impact assessment has been completed given the known occurrence of the Eastern Bentwing-bat within the study area.
Large-footed Myotis	-	V	Unlikely	No	No	**Yes**	Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to permanent water bodies. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects ((Richards *et al.* 2008)). Recorded once during the field surveys with definite certainty (using Anabat) on the edge of the Hunter River. This species may roost within the riparian vegetation and/or outcropping rocks along the Hunter River, and forage over the Hunter River for aquatic insects and fish (these areas would not be directly impacted by the proposal). The species is considered unlikely to utilise tree hollows within the Box-Ironbark woodland or buildings as these habitats do not occur near permanent water sources. Although impacts to this species may be negligible, a Part 3A impact assessment has been completed given the known occurrence of the Large-footed Myotis within the study area.

Common Name	EPBC Act	TSC Act	Potential Impacts on Threatened Species: Individual death or injury?	Potential Impacts on Threatened Species: Loss or disturbance of limiting foraging resources?	Potential Impacts on Threatened Species: Loss or disturbance of limiting breeding resources?	Impact Assessment required?	Reasoning
Eastern Cave Bat	-	V	Unlikely	No	No	No	Roosts in small groups, often in well-lit overhangs and caves, mine tunnels, road culverts, and occasionally in buildings (van dyck and Strahan 2008). This species has not been previously recorded within 10km of the study area (closest record occurs approximately 13km south west, recorded in 2005 (NSW Government 2009)). This species may roost among outcropping rocks and boulder piles along the edge of the Hunter River within the study area (this area would not be directly impacted by the proposal). Although unlikely, the species may also roost within buildings of the study area. However, no limiting breeding habitat (i.e. caves) occurs in the study area. The species may also forage throughout the study area for flying insects. Given that no limiting breeding or foraging resources would be impacted, and the absence of records for 13km, the Eastern Cave Bat is unlikely to be impacted by the proposal. A Part 3A impact assessment is not considered necessary.
Yellow-bellied Sheathtail Bat Eastern Freetail Bat	-	V	Possible	No	Yes	**Yes**	These two species have been assessed together as they share similar habitat requirements. Both of these species primarily roost and breed within tree hollows. Both bat species also forage aerially for insects and may fly through the study area hunting for moths, beetles, weevils, etc. However, the foraging habitat within the study area is not considered to be limiting for these mobile species. The Eastern Freetail Bat was recorded during the field survey with definite confidence (using Anabat) on the edge of the Hunter River and within the Box-Ironbark woodland. The Yellow-bellied Sheathtail Bat has been previously recorded once within the locality (approximately 3.7km to the south). Given the known occurrence of the Eastern Freetail Bat within the study area and the loss of a limiting breeding resource (i.e. tree hollows), a Part 3A impact assessment has been completed for these species.

5.2.4 Aquatic Fauna

No threatened fish species as listed under Schedule 4 of the FM Act have been previously recorded in vicinity of the study area. However, the Purple-spotted Gudgeon (*Mogurnda adspersa*) is considered to have potential habitat within the Hunter River Catchment preferring rivers, creeks and billabongs of slow flowing sections over rocks or among vegetation (Allen *et al.* 2002).

Furthermore, the study area does not provide potential habitat for any aquatic threatened species, populations and/or communities as listed under the FM Act. On this basis, impact assessment following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act has not been completed for any aquatic fauna.

5.3 Commonwealth Significant Impact Criteria (EPBC Act)

Under the Commonwealth EPBC Act, if the proposal has the potential to have an adverse impact on threatened species, populations and/or ecological communities as listed under the Act, the proposal must be referred to the Federal Minister for the Environment for further consideration. The Significant Impact Criteria are used to assess the likelihood of impact in accordance with the DEWHA publication *EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Environmental Significance* (DEH 2005).

5.3.1 Endangered ecological communities

No EECs listed under the EPBC Act were recorded in or adjoining the study area.

5.3.2 Flora

No threatened plant species listed under the EPBC Act were recorded in the study area. Tricolour Diuris (*Diuris tricolor*) was previously listed as Vulnerable under the EPBC Act and is considered to have potential habitat within the study area, however this species was removed from the EPBC Act threatened list on 19 August 2010.

5.3.3 Fauna

Endangered fauna

Three animal species listed as Endangered under the EPBC Act have potential habitat in the study area: Regent Honeyeater, Swift Parrot and Spotted-tailed Quoll. As shown above (Table 5), no limiting breeding habitat or foraging habitat is expected to be impacted for any of these species. The proposal is unlikely to have a significant impact on these three species as there is not a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population;
- Reduce the area of occupancy of these species;
- Fragment an existing population into two or more populations;
- Adversely affect habitat critical to the survival of these species;
- Disrupt the breeding cycle of a population;
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that these species are likely to decline;
- Result in invasive species that are harmful to an Endangered species becoming established in the Endangered species' habitat;
- Introduce disease that may cause these species to decline; or,
- Interfere with the recovery of these species.

As such, no assessments have been carried out for the Regent Honeyeater, Swift Parrot or Spotted-tailed Quoll, in accordance with the Significant Impact Criteria (DEH 2006).

Three species listed as Vulnerable under the EPBC Act that have known and/or potential habitat in the study area comprise the Australian Painted Snipe, Grey-headed Flying-fox and Large-eared Pied Bat (the latter recorded during field surveys). As shown above (Table 5), no limiting breeding habitat or foraging habitat is expected to be impacted for these species. If present within the study area, individuals of these species are not considered 'important populations' as they are not likely to be key source populations either for breeding or dispersal; populations that are necessary for maintaining genetic diversity; and/or populations that are near the limit of the species range. In addition, the proposal is not likely to:

- Adversely affect habitat critical to the survival of any of these species;
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that any of these species are likely to decline;
- Result in invasive species that are harmful to any of these Vulnerable species becoming established in the Vulnerable species' habitat;
- Introduce disease that may cause any of these species to decline; or

- Interfere substantially with the recovery of any of these species.

As such, no assessments have been carried out for the Australian Painted Snipe, Grey-headed Flying-fox or Large-eared Pied Bat, in accordance with the Significant Impact Criteria (DEH 2006).

A Referral to the Federal Environment Minister is not considered necessary for any threatened fauna.

Migratory species

The list of migratory species under the EPBC Act is a compilation of species listed under four international conventions: China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Fourteen migratory species (or their habitat) have been previously recorded within 10km of the study area. No migratory species were recorded during the field survey, however, potential habitat exists in the study area for 11 migratory species (Table 3).

Migratory waders with potential habitat in the study area may utilise dams and lakes within the locality on occasion or regularly. Individuals of these species that may be recorded in the study area are not considered likely to be an ecologically significant proportion of their populations. Similarly, individuals of other migratory birds (e.g. forest/woodland birds) that may be recorded in the study area are not considered likely to be an ecologically significant proportion of their populations. Potential habitat in the study area is not considered important for the migratory species listed in Table 3. Only sub-optimal potential habitat in the form of disturbed, ephemeral water bodies (poor condition) and small areas of isolated woodland (poor to moderate condition) surrounded by farmland and adjacent to an open cut coal mine, would be removed by the proposal. Riparian vegetation along the Hunter River (poor to moderate condition) may be subject to indirect impacts, however, would remain largely unaffected by the proposal. Fragmentation of potential habitat therefore would not occur. Given the low importance of potential habitat for these species within the study area and that habitat connectivity would not be impacted, no assessments have been carried out for these species, in accordance with the Significant Impact Criteria (DEH 2006).

A Referral to the Federal Environment Minister is not considered necessary for any migratory fauna.

5.3.4 Aquatic Ecology

No threatened aquatic species as listed under the EPBC Act have previously been recorded in vicinity of the study area.

Therefore impact assessment in accordance with the EPBC Act significant impact criteria (DEH 2005) are not considered necessary for any potential impacts on aquatic biota.

6.0 MITIGATION

The mitigation measures recommended for the proposal are directed towards the following potential impacts:

- vegetation clearing and potential fauna habitat loss;
- threatened plant species recorded in the study area;
- diversion of the ephemeral unnamed tributary; and,
- indirect impacts including weed invasion and sedimentation and erosion.

The mitigation measures recommended within the report are expected to be implemented, in order to meet the key thresholds and maintain biodiversity.

6.1 Vegetation clearing and potential fauna habitat loss

Approximately 100 trees (including dead stags) will be removed by the proposal. Given the isolation of habitat trees in the study area, a fauna specialist will be required to relocate fauna utilising hollows on the site prior to clearing and during clearing. Mitigation of direct impacts on fauna will be in accordance with Coal & Allied's existing environmental procedures for the management of flora, fauna, disturbance and rehabilitation (Coal & Allied 2007; Coal & Allied 2003).

These procedures detail the requirements for pre-clearing, clearing and injured fauna as follows:

- All areas proposed for clearing will be clearly pegged and mapped to ensure clearing does not take place outside of these areas;
- All vehicles, plant and personnel will keep clear of areas of retained native vegetation (e.g. riparian areas and rehabilitation areas);
- Trees containing seed will be identified and seed collected for use in rehabilitation (see 6.3 and 6.4 below);
- The clearing of hollow-bearing trees will take place outside of spring to avoid the busiest breeding time of year for most species;
- A pre-clearing inspection by an environmental specialist (fauna ecologist) will be undertaken to ascertain the presence of fauna or evidence (i.e. fresh scats, scratches, remains of prey or inspection of hollows using camera equipment) of presence prior to any clearing. During the pre-clearing survey, tree marking of hollow bearing trees and/or other fauna containing habitat trees will be undertaken in a manner which allows clear

identification/demarcation of these trees. Hollow bearing trees will be marked and recorded in a GIS database. Disused buildings (including sheds) should also be inspected prior to demolition for occupancy of native fauna, including possums and microchiropteran bats;

- If necessary, fauna will be removed pre-clearing and relocated to the nearest appropriate habitat by the environmental specialist;
- Clearing of hollow bearing trees will be performed in a two stage process where surrounding non habitat trees are cleared separately, one day before the removal of habitat trees to allow fauna an opportunity to move;
- During the felling process, felled trees should be temporarily left insitu and immediately inspected by a fauna specialist;
- Where fauna is encountered during survey, clearing activities will cease to allow for safe relocation;
- Species specific procedures for the relocation of non-injured fauna from clearing operations will address the appropriate location, timing and weather conditions for the relocation of non-injured fauna;
- Injured fauna will be taken to an appropriate care facility (e.g. WIRES or a Veterinarian);
- Thorough records of all fauna relocation during clearing will be kept and a report provided to relevant stakeholders post clearing;
- All large wood debris, felled trees and hollows are to be relocated to rehabilitation areas (including the tributary diversion) and or to nearby areas of retained woodland; and,
- Salvage of significant aquatic fauna (if present) within the ephemeral unnamed tributary to be diverted is to be considered prior to construction, but any salvage is to occur only after upstream and downstream fencing and sandbags have been installed.

The proposed rehabilitation strategy includes the rehabilitation of more than 50ha of woodland across the study area (see Appendix 6), which would aim to mitigate longer term impacts of vegetation clearances. The restoration of woodland communities across the re-landscaped site would also aim to provide habitat for native floral and faunal species thus potentially improving the biodiversity values of the area in the medium to longer term.

6.2 Translocation of threatened flora

Translocation is the deliberate transfer of plants or regenerative plant material from one place to another in a deliberate attempt to create a new or maintain an existing population (Vallee *et al.* 2004). Translocation in this case refers to the relocation of the Tiger Orchid (*Cymbidium canaliculatum*) from within the subject site.

Translocation of threatened flora is generally not seen as a viable option for the mitigation of impacts on native flora by the DECCW. Transplanted specimens frequently die without reproducing in their new environment and therefore translocation is generally viewed as a last resort (Vallee *et al.* 2004). Avoidance of the Tiger Orchid has been considered. Given the static location of the coal resource, avoidance is not possible to access the resource. The objective of translocation in this case relates to threatened plant species identified within the subject site that would otherwise be destroyed. As discouraging as past results have been, attempts at translocation still offer some worthwhile results. For example, Biosis Research has previously performed translocation of a threatened terrestrial shrub species achieving greater than 60 per cent success rates (Mueck 2000).

Tiger Orchid (*Cymbidium canaliculatum*)

Cymbidium canaliculatum can survive on a dead tree while the tree is still standing and could probably survive for some time on a fallen tree so long as it ended up on the upper side of the trunk or branches. When its host eventually rots away, it will eventually die too (Peter Weston, Senior Principal Research Scientist, Botanic Gardens Trust, pers. comm. 17 November 2009).

The long term survival of the *C. canaliculatum* in the current location is already subject to considerable doubt as its occurrence is within a highly fragmented landscape in immediate proximity to edge of the operational Carrington Pit. Given that the current proposal is unable to avoid direct impacts, translocation is considered the only viable option. It is therefore proposed to translocate the *C. canaliculatum* on the subject site to an appropriately identified donor site. It is possible that the clumps on the tree could be successfully translocated, provided there is minimal root disturbance, as the thick fleshy roots of this species can penetrate deep into the heartwood of the host tree for metres (Peter Weston, Senior Principal Research Scientist, Botanic Gardens Trust, pers. comm. 17 November 2009). Any proposed translocation of the orchid will therefore require moving as much of the host tree as possible, or the whole tree if applicable. Care will need to be taken to minimise disturbance to the orchid, particularly the root system, during translocation. Monitoring of the translocated plant will be required for some years following translocation in order to determine success.

Strapping of fallen or loose orchids (observed on site) to another tree may also be trialled and may allow the orchid to colonise a new living tree over time. This would probably only happen if the orchid was able to grow over a break in the trunk into which its roots could penetrate.

Prior to clearing of the Tiger Orchid from the study area, a translocation plan will be prepared in consultation with DECCW, relevant botanical experts and with reference to best practice guidelines such as those identified in the publication: *Guidelines for the Translocation of Threatened Plants in Australia* (Vallee *et al.* 2004).

In summary, the translocation plan will include the following:

- An assessment of background information on the ecology of the species;
- Selection of appropriate recipient sites (including host trees for *Cymbidium canaliculatum*) for translocation;
- Details of the design of experimental translocation;
- Timing of translocation;
- Post translocation care; and,
- Identification of post translocation management and monitoring.

6.3 Weed management

Weed management will be undertaken in accordance with Coal & Allied's existing environmental procedures (Coal & Allied 2007). Weed management will be integrated within disturbance and rehabilitation procedures (see below) and mine operation plans for the project.

Weed management of the study area will include the following:

- Weed inspections will be undertaken annually to identify areas where weed control is required;
- Regular inspections of soil stockpiles will be undertaken for weed and erosion control;
- Noxious and environmental weeds will be removed and or suppressed by an appropriately qualified personnel;
- Areas subject to weed control will be inspected two weeks after treatment to ensure success. Follow up controls will be undertaken as required;

- Areas where weed control has been undertaken will be recorded on the GIS database maintained by the site Environmental Coordinator;
- Weed control will be undertaken prior to topsoil stripping (as below) including mechanically scaping back the weed layer; and,
- Weeds will be buried in pit or disposed of or disposed of in another appropriate manner.

6.4 Landscape disturbance and rehabilitation

Landscape disturbance and rehabilitation will be undertaken in accordance with Coal & Allied's Disturbance and Rehabilitation procedures (Coal & Allied 2007). These procedures include requirement for the habitat reinstatement, topsoil stripping and handling, surface preparation, drainage works, revegetation and access restrictions.

The post extraction landscape will be re-surfaced with the existing soil and rehabilitated into varying forms of grassland and woodland, including re-vegetation and planting of locally sourced tree and understorey species. Further details of the proposed rehabilitation are provided in the surface water assessment of the proposal prepared by WRM (2010), the soils and land resource study prepared by GSS Environmental (2010) and the EMGA Mitchell McLennan (2010) Environmental Assessment for the current proposal. The proposed rehabilitation will aim to return areas of the site to a woodland environment in a form that returns habitat values for locally occurring biodiversity.

The proposed rehabilitation strategy includes rehabilitation of more than 50ha of 'Rehabilitated woodland (biodiversity)', i.e. 47.58ha around the proposed out-of-pit overburden emplacement areas, and 7.16ha in the south-western corner of the proposed pit extension area.

Rehabilitation will be undertaken progressively and completed as soon as possible after mining. The stripping of land for mining will be conducted progressively on a needs basis to minimise the amount of land remaining in a disturbed state at any time during the life of the mine (Coal & Allied 2007). Furthermore, design of the final landform will be such that it blends in with the surrounding landscape (GSS Environmental, 2010). Rehabilitation objectives include 'post-mining land use compatible with surrounding land uses, capable of supporting viable grazing and ecological values and providing environmental and community benefits' (EMGA Mitchell McLennan, 2010). Accordingly, the restoration aims to provide a net gain in woodland locally in the medium to long term, with the objective of improving habitat for the local biodiversity.

Note, the NSW Department of Primary Industries' policy and guidelines (NSW DPI 1999) require no net loss in relation to stream length which requires that the rehabilitated tributary should be equivalent to that removed by the proposal. To address the overall goal of no net loss of aquatic flora and fauna values in the study area in the medium to long term, the unnamed tributary will be reinstated to its original position at the conclusion of mining. The end of mine channel will be constructed to of similar shape to the pre-mining conditions. Native trees and shrubs should be planted along the drainage alignment to enhance the long term stability of the drainage system and to provide suitable habitat for native fauna. In-channel habitat in the post mining landscape should include habitats, similar to those existing in the current unnamed tributary.

Detailed design plans for the temporary diversion and reinstatement of the Unnamed Tributary will be provided in a Management Plan to be developed in consultation with the NSW Office of Water and NSW Industry and Investment. The Management Plan would include those details of:

- Existing and proposed channel alignment, longitudinal section and cross-sections;
- Proposed locations of cut and fill;
- Sediment and erosion control measures to be implemented during construction;
- Proposed revegetation of the channel bed, banks and riparian zone;
- A proposed monitoring regime to ensure ongoing stability and ecological health of the stream, which would include periodic inspection for erosion or deposition and a photographic record of key cross-section locations, supplemented by ground survey if instability is detected; and,
- Contingency measures to be implemented to address any observed issues with establishment of the modified channel.

Landscape disturbance and rehabilitation procedures will include (but not be limited to) the following:

- Areas where topsoil contains native plant propagules that are useful for revegetation (e.g. low weed cover) will be identified for reuse;
- Topsoil will be stripped to a depth of 100mm, and, where possible, directly respread over shaped areas;
- Machinery movements over topsoil will be kept to a minimum during stripping operations;
- Soil stockpiles will be located at least 10m from existing retained trees and watercourses;

- The collection and propagation of native species present in the study area;
- Revegetation will be undertaken progressively and as soon as practicable after the completion of surface preparation;
- Re-instatement of native aquatic habitat in the post mining landscape; and,
- The length of the diversion channel should be the same length as the current creekline, including where possible, incorporation of meander design for the drainage diversion including features contributing to habitat complexity (for example pool and riffle sequences, snags and shade etc) in the design of the post mining landscape.

6.4.1 River Red Gum Rehabilitation and Restoration Strategy

A River Red Gum Rehabilitation and Restoration Strategy (Umwelt 2010) has been produced, which aims to preserve, enhance and manage stands of River Red Gums across the locality, including at the nearby Carrington Billabong. Goals of this strategy include to reduce the impacts of threatening processes on the stands; to enhance the River Red Gum population to enable it to persist as a viable, functioning population; and to increase biodiversity including residence habitat, foraging habitat and native flora and fauna species.

The Strategy documents goals and objectives for the restoration and rehabilitation of Carrington Billabong and other priority sites within HVO, together with preliminary completion criteria and performance measures for Carrington Billabong. A series of performance criteria and performance measures are documented for all these priority sites. Management commitments are established for the low priority sites to ensure that these sites are adequately captured by Coal & Allied’s comprehensive land management and maintenance activities. A comprehensive implementation plan is established to guide the means through which restoration and rehabilitation is to be achieved, such as through fencing, access control, weed management, planting and natural regeneration (Umwelt 2010).

6.5 Sediment and erosion controls

In addition to the establishment of vegetation (see rehabilitation), erosion controls will be implemented in accordance with Coal & Allied’s disturbance and rehabilitation procedures (Coal & Allied 2007).

Sediment and erosion control practices will include the following;

- Minimising unnecessary disturbance to adjacent native vegetation and the soil profile;

- Revegetation of bare areas as soon as possible;
- Appropriate site management practices – including scheduling of construction, sequencing of erosion control measures and restriction of access to non-essential areas; and,
- Use of sediment control structures where required.

6.6 Ecological monitoring

Given the current cleared and disturbed nature of the study area and surrounds, limited scope for monitoring is associated with the proposal. The requirement or otherwise from the consent authority has not yet been determined, however, as a basis, ecological monitoring will include monitoring of rehabilitation and the success of plant translocation efforts (detailed separately in translocation plan). As described above, general monitoring inspections will also be carried out pre-clearing, during clearing, and post weed and erosion controls. The results of monitoring will be incorporated into the Annual Environmental Monitoring Report provided to stakeholders.

Where monitoring identifies a requirement for further actions, these will be implemented and may include requirements for additional planting, the need for weed and feral animal controls and soil remediation requirements. Appropriate adaptive management will be undertaken as required.

7.0 CONCLUSION

This report assesses the potential impacts from the proposal on ecological communities, threatened plant and animal species that occur, or have the potential to occur, in accordance with the EP&A Act, the TSC Act and the EPBC Act.

The majority of the study area and surrounds is cleared and disturbed grazing land in poor condition in terms of flora and fauna habitats. One EEC was recorded in the study area and would be impacted by the proposal. Approximately 1.06ha of Central Hunter Box – Ironbark Woodland would be impacted by the proposal (from 0.89ha directly and 0.17ha indirectly). According to vegetation mapping (Peake 2005) the mapped extent of the community in the locality is approximately 911.6ha.The extent of this EEC in the study area was considered to be in a moderate to poor condition, with a sparse canopy, absence of the shrub layer and scattered weed infestations. Given the small area (approximately 1.06ha) to be impacted and the current degree of isolation and fragmentation of this patch of vegetation, which is already subject to indirect impacts from existing land uses, it is considered unlikely that the proposal would result in a significant impact on this community. Further, it is proposed to rehabilitate a nominal four hectares of this community post-mining.

Two plant species recorded in the study area, Tiger Orchid (*Cymbidium canaliculatum*) and River Red Gum (*Eucalyptus camaldulensis*) are listed under Schedule 1 of the TSC Act as part of endangered populations in the Hunter catchment. A further threatened plant species, Tricolour Diuris (*Diuris tricolor*) listed under the TSC Act, has potential habitat in the study area and is considered a cryptic or difficult to detect species. Impact assessments following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act have been followed for each of these species.

The loss of a single River Red Gum is unlikely to represent a significant impact upon the local River Red Gum population. Further, Coal & Allied has a comprehensive River Red Gum Rehabilitation and Restoration Strategy in place for stands of River Red Gums in the region, including at the nearby Carrington Billabong, which aims to enhance the local population of River Red Gum in the medium to longer term.

The proposal is likely to have a significant impact on the local population of Tiger Orchid (*Cymbidium canaliculatum*). However, translocation of this single tree harbouring the colony will be undertaken with the aim of reducing the significance of this impact and to maintain the colony indefinitely in conservation lands. As part of the broader operations of Coal & Allied in the region, a number of colonies of *C. canaliculatum* are being conserved within existing or proposed biodiversity offset areas.

The flora impact assessments determined that the proposal is unlikely to have a significant impact upon the Tricolour Diuris (*Diuris tricolor*) A targeted survey for *D. tricolor* undertaken in potential habitat within the subject site on 22 September 2010, when a known population in the region was in flower, did not detect this species. It should be noted that approximately 1,229ha of potential habitat for the *D. tricolor* has been mapped as occurring in the locality and that further searches within these areas of potential habitat may yield local records of the species.

Five threatened and no migratory animal species were recorded during the field surveys. Based on the proximity of current and previous records and the presence of identified habitat preferences, known and/or potential habitat exists within the study area for 21 threatened and 11 migratory animal species. Impacts to the potential habitat of 14 threatened species were considered negligible and therefore, impact assessments were not conducted for these species. Impact assessments were carried out for the remaining seven threatened animal species (seven listed on TSC Act and one listed on EPBC Act). The Part 3A impact assessments concluded a major impact by the proposal to be unlikely on any TSC Act-listed species. Consideration against the Significant Impact Criteria for EPBC Act-listed species concluded a significant impact by the proposal to be unlikely.

Database searches indicated that no records of threatened fish species have occur within a 10km radius of the study area. However, the Purple-spotted Gudgeon (*Mogurnda adspersa*) has been recorded in the Goorangoola and Dawleys Creeks approximately 15km from the study area. No potential aquatic habitat for the Purple-spotted Gudgeon is considered present in the study area. Impacts were therefore considered negligible and impact assessments were not conducted for this species.

A Referral to the Federal Environment Minister is not recommended for any EPBC Act-listed communities or species. Recommendations to minimise potential impacts of the proposal on flora and fauna are provided in Section 6.0.

It is important to note that Rio Tinto Coal Australia, as part of its broader operations within the Hunter Valley, is currently managing and/ or developing 2742.2 hectares (ha) of Woodland as biodiversity offsets for its operations in the region. These conservation areas aim to offset potential losses of biodiversity in the region as a result of mining operations. In conjunction with the River Red Gum Rehabilitation and Restoration Strategy, they seek to maintain or improve biodiversity.

In addition, this report has provided details of proposed biodiversity mitigation measures specifically for the proposal. Notably, these include the rehabilitation and reinstatement of the unnamed tributary and more than 50ha of woodland for biodiversity purposes; translocation of the single tree harbouring the Tiger Orchid colony away from the disturbance area to an area to be conserved for biodiversity; ecological monitoring; and implementation of Coal & Allied's existing environmental procedures for the management of flora, fauna, disturbance and rehabilitation and weed management.

PLATES

Plate 1: Looking east across the largely cleared and disturbed study area

Plate 2: Remnant patch of Central Hunter Box – Ironbark Woodland

Plate 3: Ephemeral unnamed tributary (southern part of study area)

Plate 4: Northern section of ephemeral unnamed tributary with semi permanent pools

Plate 5: Disturbed River Oak Forest along the Hunter River.

Plate 6: Derived Native Grassland and woodland fragments on slopes in south east of the study area.

Plate 7: Unnamed tributary at the confluence with the Hunter River.

APPENDICES

APPENDIX 1

Biosis Research Curriculum Vitae

BRENDAN JOHN SMITH

POSITION:

Senior Botanist

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:

Ecological Consultants Association of NSW
Australian Network for Plant Conservation

QUALIFICATIONS:

B.Sc. Environmental Biology (Distinction Average). **2005**
University of Technology, Sydney.
Accredited Biobanking Assessor **2009**
Ryde TAFE College / NSW Department of Environment and Climate Change
AUSRIVAS Certificate (Australian River Assessment System). **2005**
DEH Accreditation, University of Technology, Sydney.
Associate Diploma of Applied Science, Horticulture. **1996**
Ryde TAFE College.
Certificate In Horticulture **1992**
Padstow TAFE

EMPLOYMENT PROFILE:

2006 - 2010	Botanist, Biosis Research
2004 – 2006	Project Officer Total Earth Care Pty Ltd
2004 – 2005	Interpretive Ranger (Part time), Kur-ring-gai Council
2004 – 2004	Bush Regenerator / Seed Collection Officer, Total Earth Care Pty Ltd
2001 – 2003	Interpretive Hiking Guide – Blue Mountains, Wildframe Ecotours
2000 – 2000	Contracts Administration Clerk, Warner Bros. London
1998 – 1999	TAFE Teacher, Native Plant Propagation, Ryde TAFE College
1995 – 1999	Nursery team leader, Kur-ring-gai Council Community Nursery
1995 – 1999	Native Seed Collection Workshops, Facilitator, Various Councils

FIELDS OF COMPETENCE:

- ✓ flora survey and identification
- ✓ bushland management & site assessment
- ✓ native plant and weed identification
- ✓ threatened species assessment (including EECs)
- ✓ native vegetation classification
- ✓ habitat restoration
- ✓ weed density mapping
- ✓ indigenous plant collection and production
- ✓ project management and report preparation
- ✓ monitoring rehabilitation of vegetation
- ✓ options and constraints assessment

PROFESSIONAL EXPERIENCE:

Brendan is a Senior Botanist with Biosis Research, Sydney office. Brendan has approximately 10 years experience working with indigenous plant species in flora surveys, natural area restoration, weed management and native plant production. Brendan is an accredited Biobanking Assessor. Brendan's experience includes consulting projects involving both flora and fauna assessment. While working at Biosis, Brendan has been involved in long term vegetation monitoring projects (including plot based surveys), threatened flora and vegetation impact assessment and the preparation of species impact statements, options and constraints reports and vegetation management plans. Brendan has experience in the survey and identification of a wide range of threatened species and endangered ecological communities from a variety of locations across the Sydney Basin Bioregion and surrounds.

Brendan's previous experience has included restoration projects undertaken throughout the Sydney region involving the translocation of threatened species, soil translocations, large scale seed collection, revegetation, weed control and erosion controls. He has managed an indigenous plant nursery and was responsible for all facets of local provenance plant production for small and large scale revegetation projects. Brendan has prepared successful proposals for bush regeneration projects, annual work plans and reports, weed and native species lists, site plans and weed density maps. These contracts have involved post-bushfire weeding, the creation of Fire Access Management Zones, large-scale revegetation projects, riparian and storm-water remediation, weed control and supervision of volunteers.

A sample of key professional experience at Biosis Research is presented below.

Botanist, long-term monitoring of the potential effects of subsidence due to longwall mining on rainforest, sclerophyll woodland and upland swamps in the Sydney Catchment Area.

Botanist, survey and impact assessment of coal mining exploration activities in the Sydney Catchment Area.

Botanist, survey and impact assessment, including preliminary constraints assessment and options assessment, F3 to Raymond Terrace.

Botanist, survey and impact assessment, including preliminary constraints assessment and options assessment, Princess Highway Upgrade, Gerringong to Bomaderry.

Botanist, tagging of threatened species in Bargo area for proposed upgrade of electricity easement.

Botanist survey and impact assessment for the proposed electricity adjustments associated with the planned F3 to Branxton Link in the Hunter Valley.

Botanist long-term monitoring of the potential impacts of Rhyolite mining in Hartley area.

Botanist survey and impact assessment of freshwater wetlands for the proposed road widening Moorelands to Herons Creek, Port Macquarie.

Botanist survey and impact assessment of proposed Aged Care facility in Western Sydney.

Botanist survey and impact assessment for proposed residential sub-division in Duffys Forest, Sydney.

Botanist survey and impact assessment for proposed of West Cliff coal wash emplacement area.

Botanist and workshop facilitator for seed collection and site rehabilitation training workshop for BHP Billiton field staff.

Botanist survey and impact assessment for proposed Area 3 longwall mining operation in Cordeaux Catchment Area.

CONSULTANT REPORTS:

A sample of the reports that Brendan has contributed to while working at Biosis Research are listed below:

Crosby, K., **Smith, B**. Charlton, J., Lam, A., Starling, M., Harrington, R. (2008) Tomago Switching Station Augmentation and Associated Powerlines – Species Impact Statement. Biosis Research Pty Ltd (Prepared for Transgrid and EnergyAustralia)

Smith, B. Crosby, K. (2008) Cessnock Landfill Extension – Species Impact Statement. Biosis Research Pty Ltd (Prepared for National Environmental Consulting Services)

Smith, B. Crosby, K. (2008) Long Reef Walking Track Upgrade – Flora and Fauna Assessment (prepared for Warringah Council)

Smith, B. Crosby, K. (2008) Grose Vale Transmission Line Upgrade – Flora and Fauna Assessment (prepared for Integral Energy)

Smith, B. (2007) Castlereagh Waste Management Centre – Opportunities and Constraints Assessment (prepared on behalf of WSN Environmental Services)

Smith, B. English, T. (2007) Tabulam Telecommunications Installation – Flora and Fauna Impact Assessment (prepared for Visionstream Pty Ltd on behalf of Telstra)

Smith, B. (2007) Hoxton Park Vegetation Management Plan (prepared for Integral Energy)

Muir, G. Wilkins, S. **Smith, B**. O'Sullivan, T. (2007) Gerringong to Bomaderry Princes Highway Upgrade Constraints Assessment - Terrestrial Flora and Fauna (prepared for Maunsell Aecom on behalf of the NSW Roads and Traffic Authority)

Richardson, M. Harrington, R. Smith, N. Muir, G. **Smith, B**. Wilkins, S. Cartner, K. Charlton, J. Blakey, R. (2007) West Cliff Colliery - Stage 3 Coal Wash Emplacement Application Volume 3 Species Impact Statement (Prepared for BHP Billiton Illawarra Coal)

Smith, B. Blakey, R. (2007) Galston Zone Substation Flora and Fauna Assessment (Prepared for EnergyAustralia)

Smith, B. (2007) Hoxton Park Training Facility Vegetation Management Plan (Prepared for Integral Energy)

Richardson, M. Harrington, R. Smith, N. Muir, G. **Smith, B**. Wilkins, K. Charlton, J. Blakey, R. (2007) Vegetation and Fauna Management Plan Westcliff Colliery and Stage 3 Coal Wash Emplacement (Prepared for BHP Billiton Illawarra Coal)

Charlton, J. **Smith, B.** Cartner, K. (2007) Dendrobium Area 2 Longwalls 3-5a Impacts of Subsidence on Terrestrial Flora and Fauna (Prepared for BHP Billiton Illawarra Coal)

Smith, B. Smith. N. (2007) Flora and Fauna Assessment Delta Colliery - Longwall 17 End of Panel Report (Prepared for BHP Billiton Illawarra Coal)

Smith B. Cartner, K. (2006) Tower 62 Access Trail, Lane Cover National Park. (prepared for Energy Australia)

Smith B. Cartner, K. (2006). Tallawarra Power Station, Transmission Line Installation. (prepared for URS Pty Ltd on behalf of TRUenergy)

Smith B. Bietzel, M. (2006). Tahmoor Transmission Line Upgrade. (Prepared for Centennial Coal)

Harrington, R., Muir, G. **Smith, B.**, Wilkins, S., Charlton, J., Blakely, R. (2006) Species Impact Statement for Proposed Electricity Adjustments. (Prepared for the NSW Roads and Traffic Authority)

Smith, B (2006) Flora and Fauna Assessment – Hammondcare Aged Facility, Stage 2. (Prepared for Grindley)

Muir, G. Harrington, R. **Smith, B**. Austen Quarry Winter 2006 Flora and Fauna Monitoring Report

JENNIFER CHARLTON

POSITION:

Consultant Zoologist

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:

Birds Australia.
Frog and Tadpole Study Group.
Waterfall Springs Conservation Association, NSW, Australia.

QUALIFICATIONS:

Bachelor of Science in Zoology, University of New South Wales, Sydney.
Other:
Senior First Aid Certificate – St John Ambulance, January 2008.
4WD Vehicle Bush Course – Rear Wheel Plus Training Services, December 2007.
South-eastern Australia Tadpole Course – Marion Anstis, November 2007.
Basic Height Safety & Tree Access – Total Height Safety, November 2006.
OHS Construction Induction – Work Cover NSW, December 2006.
Wildlife Course (Frog, Bat and Reptile Species Identification and Survey Skills), Dorrigo – Sate Forest, September 2005.

EMPLOYMENT PROFILE:

2004-	Zoologist, Biosis Research Pty. Ltd.
2003-2004	Technical Officer, Australian Museum Business Services.
2003-2004	Mammal & Bird Keeper Volunteer, The Australian Reptile Park, Somersby.
2003-2004	Records Officer, Waterfall Springs Sanctuary, Kulnura.
2001-2004	Database Co-ordinator, Wildlife ARC, Central Coast, NSW.

FIELDS OF COMPETENCE:

- ✓ Zoology
- ✓ Fauna survey and identification (amphibians, birds, reptiles, mammals)
- ✓ Radio-tracking
- ✓ Habitat assessment
- ✓ Rare and threatened species survey and assessment
- ✓ Terrestrial fauna monitoring
- ✓ Experimental design
- ✓ Database design and management
- ✓ Project Management

PROFESSIONAL EXPERIENCE:

Jennifer is a Consultant Zoologist with the Sydney Resource Group of Biosis Research. Jennifer has six years experience conducting ecological surveys in the Illawarra, Greater Sydney, Central Coast, Northern NSW regions and the ACT. Jennifer’s particular strengths lie in the areas of amphibians and birds however, she is also experienced in the ecology and identification of mammals and reptiles. Jennifer’s field experience includes terrestrial and arboreal mammal trapping, frog surveys, bird surveys, reptile surveys, spotlighting, radio-tracking, bat trapping and detection, and invertebrate surveys. Jennifer also has considerable experience in conducting fauna monitoring programs, fauna habitat assessments and threatened species surveys and assessments, including targeted surveys for the Pink-tailed Worm-lizard, Giant Burrowing Frog, Red-crowned Toadlet, Littlejohn's Tree Frog, Green and Golden Bell Frog, Broad-headed Snake, Rosenberg's Goanna, Eastern Pygmy-possum, Squirrel Glider, Eastern Bent-wing Bat, threatened woodland birds and threatened species of Owls.

Jennifer has been the project manager on a number of investigations and is experienced in the application of state and federal legislation which relates to the conservation of threatened species, populations and communities, and related planning instruments, including State Environmental Planning Policies and Regional Environmental Plans. She has worked on a number of major projects including Species Impact Statements relating to highway upgrades, utility upgrades and the coal mining industry where a large number of subject species were considered.

A sample of key professional experience is presented below.

Zoologist, Terrestrial fauna habitat assessment for proposed Yass Dam wall raising (*2010 for Department of Services, Technology and Administration*).

Zoologist, Terrestrial fauna habitat assessment and targeted surveys for Inner West Long-nosed Bandicoot Endangered Population for proposed Sydney Light Rail Extension (*2010 for NSW Department of Transport and Infrastructure*).

Project Manager/Zoologist, Fauna advice and inspections for two-stage vegetation clearing in relation to the Great Western Highway upgrades at Lawson (*2010 & 2009 for Abigroup*).

Project Manager/Zoologist, Summer monitoring of terrestrial hair tubes deployed in bushland at Tomago to monitor habitat connectivity in relation to the power augmentation project (*2010 for TransGrid*).

Project Manager/Zoologist, Terrestrial fauna habitat assessment and impact assessment for proposed upgrades (including extension of APZ) at Illawong Pubic School (*2010 for Abigroup*).

Zoologist, Photo point monitoring within Dendrobium Colliery Areas 2 and 3 to assess the potential impacts of subsidence (*2009 for BHP Billiton*).

Project Manager/Zoologist, Spring monitoring of nest boxes installed in bushland at Tomago to offset habitat loss in relation to the power augmentation project (*2009 for TransGrid*).

Zoologist, Frog monitoring to assess the potential impacts of subsidence from Wongawilli Colliery, seasonal surveys (*2009 for NRE Gujarat*).

Team Leader/Zoologist, Site selection and photo point monitoring for Wongawilli Colliery frog monitoring program (*2009 for NRE Gujarat*).

Team Leader/Zoologist, Terrestrial fauna monitoring to assess the potential impacts of subsidence in Dendrobium Area 3, seasonal surveys (*2009 for BHP Billiton*).

Team Leader/Zoologist, Targeted surveys for threatened frog species Littlejohn's Tree Frog, *Litoria littlejohni* and Giant Burrowing Frog, *Heleioporus australiacus* in Dendrobium Area 2 and Area 3 (*2009 for BHP Billiton*).

Zoologist, Targeted fauna surveys (including Elliott trapping, cage trapping, hair tubes, call-playback and Anabat surveys) for biodiversity study in Baulkham Hills Shire Council (*2009 for Baulkham Hills Shire Council*).

Project Manager/Zoologist, Terrestrial fauna habitat assessment and targeted fauna surveys for Littlejohn's Tree Frog, Giant Burrowing Frog, Red-crowned Toadlet, Green and Golden Bell Frog, Broad-headed Snake and Rosenberg's Goanna for NRE Gujarat's proposed Wonga longwall mines (*2009 for ERM Australia*).

Zoologist, Targeted spring and autumn fauna surveys of preferred route of Gerringong to Bomaderry Princess Highway Upgrade (*2008 & 2009 for Maunsell Australia*).

Zoologist, Elouera Portal Closures – targeted microchiropteran bat surveys using harp traps and Anabats (*2008 for Gujarat NRE Minerals Limited*).

Zoologist, Terrestrial fauna habitat assessment and impact assessment for proposed generator box at Glen Davis within the Capertee Valley (*2008 for Integral Energy*).

Project Manager/Zoologist, Terrestrial fauna habitat assessment for Telstra fibre optic cable and targeted surveys for Purple Copper Butterfly at Lidsdale (*2008 for Telstra*).

Zoologist, Preparation of fauna management plans for F3 to Branxton highway link (*2008 for RTA*).

Zoologist, Species Impact Statement for the Tomago Transmission Project (*2008 for TransGrid & EnergyAustralia*).

Project Manager/Zoologist, Terrestrial fauna habitat assessment for Dudley – Hunter Water Wastewater System Upgrade (*2008 for then Connell Wagner*).

Project Manager/Zoologist, Terrestrial fauna habitat assessment for the Central Coast Highway intersection upgrades – Modified Option 1A, Kariong (*2008 for Arup and NSW RTA*).

Project Manager/Zoologist, Terrestrial fauna habitat assessment of proposed road widening, Telstra cables, compound building and compensatory habitat assessment at Ballina (*2008 for Ballina Bypass Alliance*).

Project Manager/Zoologist, Terrestrial fauna habitat assessment of proposed design changes to the Ballina Bypass (*2008 for RTA*).

Project Manager/Zoologist, Terrestrial fauna monitoring (summer) at Austen Quarry to assess potential impacts of the quarry works on birds and frogs (*2008 for RW Corkery & Co Pty Limited).*

Project Manager/Zoologist, Terrestrial fauna habitat assessment of the Central Coast Hwy (The Entrance Rd) upgrade – Carlton to Matcham Rd *(2007 for Connell Wagner Pty Ltd)*.

Team Leader/Zoologist, Targeted threatened fauna surveys for Dendrobium Area 3 Species Impact Statement (*2007 for BHP Billiton*).

Project Manager/Zoologist, Targeted Giant Barred Frog *Mixophyes iteratus* and arboreal mammal surveys, Moorland to Herons Creek Pacific Highway Upgrade (*2007 for Acacia Environmental and NSW RTA*).

Zoologist, Installation of invertebrate pitfall traps within Dendrobium Area 2 to obtain pre-mining data on ant communities (*2007 for BHP Billiton*).

Zoologist, Targeted surveys (summer) for threatened species of birds, mammals, frogs and reptiles at West Cliff's Coalwash Emplacement Area 3 (*2006 for BHP Billiton*).

Zoologist, Targeted surveys for threatened microbats for the F3 to Branxton Electricity Adjustments (*2006 for NSW RTA*).

Zoologist, Terrestrial fauna habitat assessment for Calderwood Telecommunications Tower (*2006 for Daly International*).

Zoologist, Targeted surveys (winter) for Broad-headed Snake *Hoplocephalus bungaroides* and threatened owl species Powerful Owl, Barking Owl, Masked Owl and Sooty Owl at West Cliff's Coalwash Emplacement Area 3 (*2006 for BHP Billiton*).

Zoologist, Terrestrial fauna surveys including targeted searches for threatened species for F3 to Raymond Terrace Pacific Highway Upgrade, Summer Survey (*2006 for Maunsell Australia*).

Project Manager/Zoologist, Terrestrial flora and fauna assessment for proposed Hamlyn Terrace Primary School, Hamlyn Terrace (*2005 for Department of Education and Training*).

Zoologist, Terrestrial fauna assessment for Third Crossing of the Hunter River, Maitland (*2005 for NSW RTA*).

Zoologist, Terrestrial fauna habitat assessment for proposed temporary boardwalk, The Entrance Rd, Erina *(2005 for RTA*).

Zoologist, Terrestrial fauna surveys including targeted searches for threatened species for F3 to Raymond Terrace Pacific Highway Upgrade, preliminary constraints overview (*2004 for Maunsell Australia*).

Technical Officer, Targeted surveys for threatened frog species at Sydney Olympic Park, including the Green and Golden Bell Frog, *Litoria aurea.*

CONSULTANT REPORTS:

A sample of the reports that Jennifer has contributed to while working at Biosis Research are listed below:

Charlton J. 2010. Kenthurst Park Proposed Sportsground Extensions: Terrestrial Fauna Assessment (for The Hills Shire Council).

Charlton J. and Baker L. 2010. Detailed Threatened Species Assessment for Illawong Public School in relation to the Building the Education Revolution (for Abigroup).

Smith B. and **Charlton J.** 2009. Berry to Bomaderry Princes Highway Upgrade Flora and Fauna Assessment (for Accom and NSW RTA).

Smith B., Rodd, J., **Charlton J.** and Crosby K. 2009. Princes Highway Upgrade Project 2: Toolijooa Road to Schofield's Lane Flora and Fauna Assessment (Part 3A for Maunsell and NSW RTA).

Smith B., **Charlton J.** and Crosby K. 2009. Princes Highway Upgrade Project 1: Mt Pleasant to Toolijooa Road Flora and Fauna Assessment (for Maunsell and NSW RTA).

Charlton J., Baker L. and Roberts M. 2009. Flora and Fauna Assessment: Proposed Avon and Nebo Boreholes (for NRE Gujarat).

Smith B. and **Charlton J.** 2009. Mt Victoria, Katoomba North and Leura North Electricity Tower Earthing: Flora and Fauna Assessment (for Integral Energy).

Charlton J. and Smith B. 2009. Carrington West Wing Modification – Constraints Analysis Report (for Coal and Allied).

Harrington R., Smith N., Smith B., **Charlton J.**, Muir G., Blakey R., Wilkins S. and Baker L. 2009. F3 to Branxton Link Electricity Adjustments Species Impact Statement (updated) (for NSW RTA and Energy Australia).

Harrington R., O'Sullivan T. and **Charlton J.** 2008. National Highway Link F3 to Branxton: Fauna Mitigation Measures (for NSW RTA).

Harrington R., O'Sullivan T., Crosby K. and **Charlton J.** 2008. National Highway Link F3 to Branxton: Fauna Monitoring Program (for NSW RTA).

Harrington R., O'Sullivan T. and **Charlton J.** 2008. National Highway Link F3 to Branxton: Fauna Rescue and Relocation of Habitat (for NSW RTA).

Crosby K., Smith B., **Charlton J.**, Lam A., Starling M. and Harrington R. 2008. Tomago Switching Station Augmentation and Associated Powerlines Species Impact Statement (for TransGrid and Energy Australia).

Charlton J. (2008). Flora & Fauna Assessment: H30 Central Coast Hwy & Woy Woy Rd Intersection Upgrade (Revised Option 1A) (for Arup Sustainability).

Charlton J. and Smith B. 2008. Dudley **-** Hunter Water Wastewater System Upgrade: Draft Terrestrial Flora and Fauna Assessment (for then Connell Wagner).

Charlton J., Wilkins S., Ryan D. and Beitzel M. 2008. Ballina Bypass Additional Assessments - Terrestrial and Aquatic Flora and Fauna Report (for Ballina Bypass Alliance).

Charlton J., Wilkins S., Ryan D. and Beitzel M. 2008. Proposed Design Modifications between Bruxner Hwy Interchange and Teven Rd Interchange - Terrestrial and Aquatic Flora and Fauna Assessment (for Ballina Bypass Alliance).

Charlton J., Smith B. and Ryan D. 2008. Austen Quarry Flora and Fauna Monitoring Report 2007-2008 (for RW Corkery & Co Pty Limited).

Charlton J., Drudge J. and Smith N. 2008. Terrestrial Flora and Fauna Assessment for the HW30 Central Coast Hwy Upgrade (Carlton Rd to Matcham Rd) (for then Connell Wagner).

Richardson M., Harrington R., Smith N., Smith B., Wilkins S., **Charlton J.**, Cartner K., Blakey R. and English T. 2007. Dendrobium Area 3 Species Impact Statement (for BHP Billiton Illawarra Coal).

Charlton J. and Harrington R. 2007. Broad-headed Snake Management Plan for West Cliff Colliery - Stage 3 Coal Wash Emplacement Area (for BHP Billiton Illawarra Coal).

Richardson M., Harrington R., Smith N., Muir G., Smith B., Wilkins S., Cartner K., **Charlton J.** and Blakey R. 2007. West Cliff Colliery - Stage 3 Coal Wash Emplacement Application - Volume 3 Species Impact Statement (for BHP Billiton Illawarra Coal).

Smith B., **Charlton J.**, Muir G., Smith N., Blakey R., Wilkins S. and Harrington R. 2006. F3 to Branxton Link Electricity Adjustments Species Impact Statement (for NSW RTA and Energy Australia).

Wilkins S. and **Charlton J.** 2006. Third Crossing of the Hunter River, Maitland: Terrestrial Flora and Fauna Assessment (for NSW RTA).

Wilkins S. and **Charlton J.** 2005. Appin Area 3 Longwalls 301A, 301 and 302 Impacts of Subsidence on Terrestrial Flora and Fauna (for BHP Billiton).

Wilkins S. and **Charlton J.** 2005. Pacific Highway Upgrade: F3 to Raymond Terrace Terrestrial Flora and Fauna Route Options Assessment Expanded Study Area (for Maunsell Australia Pty Ltd).

AARON KEVIN TROY

POSITION

Aquatic Ecologist

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS

2010 – Ongoing	Ecological Consultants Association of NSW
2010 – Ongoing	Australian Society of Fish Biology
2003 – Ongoing	Australian Society of Limnology
2002 – Ongoing	Society of Wetland Scientists
2002 – Ongoing	Victorian National Parks Association

QUALIFICATION/CERTIFICATION

Bachelor of Science (Environmental Management and Ecology), La Trobe University
Bachelor of Science Honours First Class (Aquatic Ecology), La Trobe University
Doctor of Philosophy (Aquatic Ecology), La Trobe University (Ongoing)

Current USFWS: Principles & Techniques of Electrofishing Certification
Current NSW Fisheries Research Permit
Current NSW Scientific Research and Ethics Permit
Current NSW, ACT and VIC AUSRIVAS accreditation
Current NSW Construction Site OH&S Induction Certificate - WorkCover NSW
Current Red Cross Senior First Aid Certificate
Current Drivers and Riders License (with 4WD Operation & Recovery Training)

KEY EXPERIENCE AREAS

Aaron Troy is an Aquatic Ecologist with Biosis Research Pty. Ltd. with over eight years experience in aquatic ecology and related fields. He has a sound understanding and knowledge of aquatic environmental issues, management and legislation in NSW and Victoria.

Aaron is experienced in aquatic assessments, surveys, monitoring, research and management. Aaron's field experience covers freshwater lotic and lentic environments throughout catchments of NSW and Victoria, with a particular focus on fish, crayfish, macroinvertebrates and water quality, but also broadly encompasses other aquatic fauna.

Aaron is widely experienced in investigating the current values (e.g. habitats, threatened species and communities) and condition of aquatic ecosystems, particularly wetlands, together with assessing the existing and potential impacts of anthropogenic sources of disturbance.

PROFESSIONAL EXPERIENCE

Aaron has over eight years experience in aquatic ecology and related fields.
A sample of his professional experiences is listed below:

Project Manager/Aquatic Ecologist, Aquatic Ecological Assessment – Rezoning for proposed employment lands, Maldon. (2010 for *Wollondilly Shire Council*)

Aquatic Ecologist, Ecological Review of the Badgee Lagoon Environment. (2010 for *Locale Consulting / Shoalhaven Council*)

Aquatic Ecologist, Remondis Integrated Recycling Park – Grand Avenue, Camellia Flora and Fauna Assessment. (2010 for *NECS / Remondis*)

Aquatic Ecologist, Review of Badgee Lagoon LES information and supporting studies for the Sussex Inlet Area. (2010 for *Locale Consulting*)

Aquatic Ecologist, Hunter Economic Zone Ecological Constraints Assessment. (2010 for *Ernst and Young*)

Project Manager/Aquatic Ecologist, Surface Water Quality Monitoring for the Belrose Road Corridor. (2010 for *Worley Parsons*)

Project Manager/Aquatic Ecologist, Wet Weather Turbidity Monitoring for the Belrose Road Corridor. (2010 for *Worley Parsons*)

Project Manager/Aquatic Ecologist, Mosquito Risk Assessment for the Warriewood Road Development, Warriewood. (2010 for *Worley Parsons*)

Project Manager/Aquatic Ecologist, RBA Signal2 Assessment for the Warriewood Road Development, Warriewood. (2010 for *Worley Parsons*)

Aquatic Ecologist, Additional Crossing of the Clarence River at Grafton. (2010 for *ARUP / RTA*)

Project Manager/Aquatic Ecologist, Aquatic Ecology Monitoring for the Belrose Road Corridor. (2010 for *Worley Parsons*)

Project Manager/Aquatic Ecologist, Mangoola Coal Stream Health Monitoring (Autumn Sample). (2010 for *Xstrata Coal*)

Project Manager/Aquatic Ecologist, Wollondilly Shire Council Local Environmental Study - Aquatic Ecology. (2010 for *Cardno Forbes Rigby / Wollondilly Shire Council*)

Aquatic Ecologist, Victorian Snowy Basin Rapid Bioassessment Reference River Health Program 2009/2010

Aquatic Ecologist, Victorian East Gippsland Snowy Basin Rapid Bioassessment - Southern Basins Program 2009/2010

Project Manager/Aquatic Ecologist, Aquatic Ecological Monitoring of sites within the Wongawilli ESSMP area. (2010 for *Gujarat NRE FCGL*)

Project Manager/Aquatic Ecologist, Initial Site Assessment for Aquatic Ecological Monitoring Sites within the Wongawilli ESSMP area. (2010 for *Gujarat NRE FCGL*)

Aquatic Ecologist, Enlarged Cotter Dam Inundation Zone - Fish habitat assessment. (2010 for *ACTEW BWA)*

Aquatic Ecologist, Carrington West Wing Extension. (2010 for *Environmental Management Group Australia)*

Project Manager/Aquatic Ecologist, Aquatic Flora and Fauna Assessment of a Tributary of Dee Why Lagoon. (2010 for *Warringah Council*)

Project Manager/Aquatic Ecologist, Translocation of Macquarie Perch and Murray Crayfish. (2010 for *ACTEW BWA*)

Ecologist, Christies Rd/Western Hwy Ravenhall: Targeted flora and fauna surveys. (2009 for *Melbourne Water Corporation*)

Aquatic Ecologist, Targeted survey of Australian Mudfish *Neochanna cleaveri* at selected sites in the lower Maribrynong River catchment (2009 for *Melbourne Water*)

Ecologist, Sub-regional survey: Golden Sun Moth (GAA). (2009 for *Growth Areas Authority*)

Aquatic Ecologist, Hamilton Pipeline. Additional Aquatic Fauna Surveys. (2009 for *Padbury Amber Civil Contractors*)

Project Coordinator/Aquatic Ecologist, Caddies Creek Stream Health Monitoring (Spring Sample). (2009 for *Worley Parsons*)

Aquatic Ecologist, Mangoola Coal Stream Health Monitoring (Spring Sample). (2009 for *Xstrata Coal*)

Aquatic Ecologist, Mangoola Coal Stream Health Monitoring (Autumn Sample). (2009 for *Xstrata Coal*)

Aquatic Ecologist, Murrumbidgee to Googong Water Transfer Project: Early Discharge Option Aquatic Assessment. (2009 for *ACTEW*)

Aquatic Ecologist, Murrumbidgee to Googong Water Transfer Project: Aquatic Impact Assessment. (2009 for *ACTEW*)

Aquatic Ecologist, Yass Dam Raising: Aquatic and Flora Impact Assessment. (2009 for *Yass Council*)

Project Manager/Aquatic Ecologist, Conducted and coordinated the bi-monthly sampling of wetlands to assess the ecological benefits of wetland rehabilitation along the Murray River floodplain (2003/2006 for *NECMA and La Trobe University*)

Project Coordinator/Aquatic Ecologist, Investigation into the influences of Dartmouth Dam on macroinvertebrate assemblages. (2006 for *La Trobe University*)

Project Coordinator/Aquatic Ecologist, Coordinated the investigation into wetland vegetation communities affected by river regulation along the Murray River floodplain (2004 for *La Trobe University*)

Project Coordinator/Aquatic Ecologist, Teaching senior staff of 'government departments' current sampling techniques for inferring 'environmental health' of our waterways (2004 for *La Trobe University*)

Project Coordinator/Aquatic Ecologist, Coordinated the investigation into the seed-bank viability of wetland plant communities along the Murray River floodplain (2003 for *La Trobe University*)

Aquatic Ecologist, Bogong High Plains study of grazing affects on macrophytes, invertebrates and stream hydrology. (2003 for *La Trobe University*)

Project Manager/Aquatic Ecologist, Conducted and coordinated sampling trips to assess the effect of grazing on the physico-chemistry and biota in dams associated with travelling stock reserves in southern NSW (2002 for *La Trobe University*)

Ecologist, Soil microinvertebrate communities and nutrient composition (2002 for *La Trobe University*)

Project Coordinator/Aquatic Ecologist, Investigation into the influences of Dartmouth Dam on macroinvertebrate assemblages (2002 for *La Trobe University*)

Aquatic Ecologist, Phillip Island marine community investigation. (1999 for *La Trobe University*)

Ecologist, Wooragee National Heritage Trust surveys of vegetation and invertebrates (1999 for *La Trobe University)*

PAPERS / PUBLICATIONS:

Troy, A. K. and Suter, P. J. (In Prep.) Effect of grazing on the physico-chemistry and biota in dams associated with travelling stock reserves in southern NSW.

McDonald, G., **Troy, A. K.** and Suter, P. J. (In Prep.) The impact of grazing intensity on aquatic invertebrate populations and water chemistry of dams on grassy woodland remnant sites in south east Australia.

APPENDIX 2

Flora Results

Plant species recorded in the study area and surrounds.

Scientific Name	Common Name	Weed	Quadrats / Cover Abundance Scores 1	2	3	4	A
Acacia salicina	Coomba		1	2	4		
Anagallis arvensis	Scarlet/Blue Pimpernel	*			1		+
Angophora floribunda	Rough-barked Apple						+
Aristida ramosa var. *ramosa*	Purple Wiregrass				4		
Asphodelus fistulosus	Onion Weed	*					+
Austrodanthonia sp.	Austrodanthonia				2	2	
Austrostipa scabra subsp. *scabra*	Rough Spear-grass				2		+
Austrostipa verticillata	Austrostipa					5	+
Avena barbata	Bearded Oats	*					+
Avena sativa	Oats	*	1				+
Bidens pilosa	Cobbler's Pegs	*			2		+
Bothriochloa macra	Bothriochloa						+
Brachychiton populneus subsp. *populneus*	Kurrajong						+
Brachyscome sp.	Brachyscome						+
Brassica rapa	Field Mustard	*	2	1			+
Bromus catharticus	Prairie Grass	*					+
Calotis lappulacea	Yellow Burr-daisy				2	3	+
Cardiospermum grandiflorum	Balloon Vine	*	4	2			
Casuarina cunninghamiana subsp. *cunninghamiana*	Casuarina		4	2			+
Cheilanthes sieberi subsp. *sieberi*	Narrow Rock-fern					1	
Chloris gayana	Rhodes Grass	*					+
Chloris truncata	Windmill Grass				2	3	+
Chloris ventricosa	Tall Chloris						+
Chrysocephalum apiculatum	Common Everlasting				2		

Scientific Name	Common Name	Weed	Quadrats / Cover Abundance Scores 1	2	3	4	A
Cirsium vulgare	Spear Thistle	*					+
Citrullus lanatus	Camel Melon	*					+
Convolvulus erubescens	Convolvulus				1		
Cyclospermum leptophyllum	Slender Celery	*					+
Cymbidium canaliculatum	**Tiger Orchid**						**+**
Cymbopogon refractus	Barbed Wire Grass				2		+
Cynodon dactylon	Common Couch		3	3			
Cyperus eragrostis	Umbrella Sedge	*	1				+
Dianella caerulea var. *caerulea*	Paroo Lily			1	2		
Dichanthium sericeum subsp. *sericeum*	Silky Blue-grass			1	2		+
Echium plantagineum	Patterson's Curse	*			3		+
Ehrharta erecta	Panic Veldtgrass	*		3			
Einadia hastata	Berry Saltbush						+
Einadia nutans subsp. *linifolia*	Einadia				2	3	
Eleocharis acuta	Common Spike Rush						+
Eremophila debilis	Amulla				2	1	
Erodium crinitum	Blue Storksbill					1	
Eucalyptus camaldulensis	**River Red Gum**						**+**
Eucalyptus crebra	Narrow-leaved Ironbark					2	+
Eucalyptus melliodora	Yellow Box						+
Eucalyptus moluccana	Grey Box				2	3	+
Eucalyptus tereticornis	Forest Red Gum						+
Exocarpos cupressiformis	Native Cherry						+
Foeniculum vulgare	Fennel	*		2			
Fumaria capreolata	Ramping Fumitory	*		4			
Galenia pubescens	Galenia	*			2	3	+

Scientific Name	Common Name	Weed	Quadrats / Cover Abundance Scores				A
			1	2	3	4	
Galium aparine	Goosegrass	*	2	1			+
Geijera parviflora	Wilga					2	+
Geitonoplesium cymosum	Scrambling Lily			2			
Glycine tabacina	Variable Glycine				3	1	+
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	*		1			
Hardenbergia violacea	False Sarsaparilla						+
Hordeum leporinum	Barley Grass	*					+
Juncus usitatus	Billabong Rush						+
Lepidium africanum	Common Peppercress	*					+
Lolium perenne	Perennial Ryegrass	*		2	3		
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush				3	2	+
Ludwigia peploides subsp. *montevidensis*	Water Primrose						+
Lycium ferocissimum	African Boxthorn	*					+
Maireana microphylla	Small-leaf Bluebush				3	3	+
Maireana sp.	Maireana		1				
Malva sp.	Malva			3			
Marrubium vulgare	Horehound	*					+
Melinus repens	Red Natal Grass	*					+
Mimulus repens	Creeping Monkey-flower				1		
Nicotiana glauca	Tree Tobacco	*					+
Olea europaea subsp. *cuspidata*	Olea	*					+
Opuntia stricta	Prickly Pear	*				1	+
Ottelia ovalifolia subsp. *ovalifolia*	Swamp Lily						+
Oxalis perennans	Oxalis					1	
Oxalis sp.	Oxalis	*		2	1		+
Paspalum dilatatum	Paspalum	*		2			+

Scientific Name	Common Name	Weed	Quadrats / Cover Abundance Scores 1	2	3	4	A
Pavonia hastata	Pink Pavonia	*	1				
Pennisetum clandestinum	Kikuyu Grass	*					+
Phragmites australis	Common Reed		2				
Plantago lanceolata	Lamb's Tongues	*		1		1	
Plantago major	Large Plantain	*					+
Poa annua	Winter Grass	*					+
Polygonum aviculare	Wireweed	*					+
Pratia concolor	Poison Pratia						+
Prunus sp.	Prunus	*					+
Punica granatum	Pomegranite	*		1			
Ranunculus repens	Creeping Buttercup	*	1				
Ricinus communis	Castor Oil Plant	*	4				
Romulea rosea	Onion Grass	*					+
Rosa rubiginosa	Sweet Briar	*		1			
Rubus moluccanus var. *trilobus*	Molucca Bramble			3			
Rumex crispus	Curled Dock	*		1			
Salix babylonica	Weeping Willow	*		1			
Salix sp.	Salix	*		1			
Schinus areira	Pepper Tree	*		1			
Senecio hispidulus	Hill Fireweed						+
Senecio madagascariensis	Fireweed	*				2	+
Sida rhombifolia	Paddy's Lucerne	*	1			2	+
Silybum marianum	Variegated thistle	*					+
Solanum prinophyllum	Forest Nightshade					1	
Sonchus oleraceus	Common Sowthistle	*	2	1			
Tagetes minuta	Stinking Roger	*	2	2			

Scientific Name	Common Name	Weed	Quadrats / Cover Abundance Scores 1	2	3	4	A
Typha orientalis	Broad-leaved Cumbungi						+
Urtica dioica	Giant Nettle	*	4				+
Verbena bonariensis	Purpletop	*		3			
Vernonia cineria var. *cineria*	Vernonia				2		
Veronica arvensis	Wall Speedwell	*					+
Vittadinia cuneata	Vittadinia						+
Wahlenbergia communis	Tufted Bluebell				1		
Wahlenbergia gracilis	Sprawling or Australian Bluebell						+

LEGEND

* Denotes exotic species **A:** Denotes opportunistic records of all plant species

Cover abundance scores:

Score	Species Cover in Quadrat	Other Attributes
1	< 5 %	3 or less individuals of a species
2	<5%	More than 3 individuals of a species
3	<5%	Species common throughout plot
4	5% - 25%	-
5	25% - 50%	-
6	50% - 75%	-
7	75% - 100%	-

APPENDIX 3

Fauna Results

Animal species recorded in the study area during current surveys.

Scientific Name	Common Name	EPBC Act	TSC Act	Whole Study Area	Anabat Survey	
					Site 1	Site 2
Amphibians						
Litoria fallax	Eastern Dwarf Tree Frog			W		
Crinia signifera	Common Eastern Froglet			W		
Limnodynastes tasmaniensis	Spotted Grass Frog			W		
Birds						
Columba livia	Rock Dove		U	OW		
Acridotheres tristis	Common Myna		U	OW		
Sturnus vulgaris	Common Starling		U	OW		
Aquila audax	Wedge-tailed Eagle			OW		
Elanus axillaris	Black-shouldered Kite			OW		
Anas gracilis	Grey Teal			O		
Chenonetta jubata	Australian Wood Duck			O		
Egretta novaehollandiae	White-faced Heron			OW		
Cracticus nigrogularis	Pied Butcherbird			OW		
Cracticus torquatus	Grey Butcherbird			W		
Grallina cyanoleuca	Magpie-lark			OW		
Gymnorhina tibicen	Australian Magpie			OW		
Cacatua galerita	Sulphur-crested Cockatoo			OW		
Cacatua roseicapilla	Galah			OW		
Cacatua sanguinea	Little Corella			OW		
Coracina novaehollandiae	Black-faced Cuckoo-shrike			OW		
Vanellus miles	Masked Lapwing			OW		
Geopelia humeralis	Bar-shouldered Dove			W		
Ocyphaps lophotes	Crested Pigeon			OW		
Corcorax melanorhamphos	White-winged Chough			W		
Corvus coronoides	Australian Raven			OW		
Rhipidura albiscapa	Grey Fantail			OW		
Rhipidura leucophrys	Willie Wagtail			OW		
Falco cenchroides	Nankeen Kestrel			OW		
Dacelo novaeguineae	Laughing Kookaburra			OW		
Hirundo neoxena	Welcome Swallow			OW		
Hirundo nigricans	Tree Martin			OW		
Malurus cyaneus	Superb Fairy-wren			OW		
Lichenostomus chrysops	Yellow-faced Honeyeater			OW		
Manorina melanocephala	Noisy Miner			OW		
Melithreptus lunatus	White-naped Honeyeater			O		
Philemon corniculatus	Noisy Friarbird			W		
Anthus novaeseelandiae	Richard's Pipit			O		
Pachycephala pectoralis	Golden Whistler			W		
Acanthiza reguloides	Buff-rumped Thornbill			W		
Pardalotus punctatus	Spotted Pardalote			OW		
Pardalotus striatus	Striated Pardalote			OW		
Sericornis frontalis	White-browed Scrubwren			W		
Taeniopygia bichenovii	Double-barred Finch			OW		

Scientific Name	Common Name	EPBC Act	TSC Act	Whole Study Area	Anabat Survey	
					Site 1	Site 2
Phalacrocorax carbo	Great Cormorant			O		
Platycercus eximius	Eastern Rosella			OW		
Psephotus haematonotus	Red-rumped Parrot			OW		
Ninox strenua	**Powerful Owl**		**V**	**Z***		
Threskiornis spinicollis	Straw-necked Ibis			O		
Tyto alba	Barn Owl			O		
Zosterops lateralis	Silvereye			W		
Mammals						
Vulpes vulpes	Fox		U	O		
Oryctolagus cuniculus	Rabbit		U	O		
Mus musculus	House Mouse		U	O		
Macropus giganteus	Eastern Grey Kangaroo			O		
Mormopterus norfolkensis	**Eastern Freetail Bat**		**V**		**AD**	**AD**
Mormopterus sp.4	Southern Freetail Bat					AM
Tadarida australis	White-striped Freetail Bat				AM	
Chalinolobus dwyeri	**Large-eared Pied Bat**	**V**	**V**			**AM**
Chalinolobus gouldii	Gould's Wattled Bat				AD	AD
Chalinolobus morio	Chocolate Wattled Bat				AD	AD
Miniopterus schreibersii oceanensis	**Eastern Bentwing-bat**		**V**		**AD**	**AD**
Myotis macropus	**Large-footed Myotis**		**V**			**AD**
Vespadelus regulus	Southern Forest Bat				AM	
Vespadelus vulturnus	Little Forest Bat				AD	AP
Vombatus ursinus	Common Wombat			I		
Reptiles						
Chelodina longicollis	Eastern Long-necked Tortoise			O		
Pseudechis porphyriacus	Red-bellied Black Snake			O		
Eulamprus quoyii	Eastern Water Skink			O		
Varanus varius	Lace Monitor			O		

Key: Site 1 = large Grey Box patch in north-eastern corner of study area;
Site 2 = edge of Hunter River near confluence with the unnamed tributary;
V = listed as Vulnerable under the TSC and/or EPBC Act;
U = Unprotected/introduced species;
O = observed;
W = heard;
I = indirect evidence (e.g. scats, skull, burrows);
Z = owl pellet;
AD = definite Anabat result;
AP = probable Anabat result; and,
AM = possible Anabat result.
* possible Powerful Owl pellet – also may represent regurgitated remains from another raptor species.

APPENDIX 4

EP&A Act Part 3A Impact Assessments

Flora

Endangered populations

Cymbidium canaliculatum	Tiger Orchid

Occurrences of *Cymbidium canaliculatum* in the Hunter Valley are part of an Endangered Population under the TSC Act.

C. canaliculatum is an epiphytic orchid species. It has succulent, rigid, linear leaves that are 10 to 30cm long and 1.5 to 4cm wide; V-shaped in cross-section and not shiny. The flower stalk is between 15 and 58cm long with 12 to 60 flowers, which are often olive-green mottled with purple markings (Harden 1993).

C. canaliculatum was recorded in the study area, in a single tree located just south of the remnant patch of Central Hunter Box – Ironbark Woodland in the north-east of the subject site (Figure 6). Several large clumps were recorded growing on a senescent remnant Grey Box (*Eucalyptus moluccana*) tree which occurs on the western edge of the Carrington Pit. The isolated occurrence of the *C. canaliculatum* in a highly fragmented landscape within immediate proximity to the edge of the operational Carrington Pit means that its long term survival in the current location is already subject to considerable doubt.

The nearest known recent (2009) record of *C. canaliculatum* occurs at Archerfield, Warkworth, approximately 8 km east of the study area (Cumberland Ecology 2010). The next closest known record is approximately 20km to the north of the study area. The study area is close to the currently known southern limit of distribution for this species; with the only known records of *C. canaliculatum* further south of Archerfield, represented by five records dated between 1899 and 1939, with no more recent records in this area. The lack of records may not accurately reflect the local or regional extent of the population given that similar host trees, landform and climatic conditions occur in the region.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Cymbidium canaliculatum is pollinated by small native bees of the genus *Trigona* (Adams and Lawson 1993). The pollination syndrome is a chemical reward system whereby fragrance chemicals are collected by bees from the flowers where the pollen sacs are attached to the bees to be transferred to the next flower. Orchid seeds are minute and dust-like (Weston *et al.* 2005) and wind is considered likely to be the predominant mechanism of dispersal.

The nearest known recent (2009) record of *C. canaliculatum* occurs at Archerfield, Warkworth, approximately 8km east of the study area (Cumberland Ecology 2010). The next closest known record is approximately 20km to the north of the study area. It is noted that the NPWS Wildlife Atlas records are denatured (so as to protect rare collectable species) and could be up to 10km from the actual location of the species. It should be noted that approximately 1,261ha of potential habitat for the species has been mapped as occurring in the locality and that further searches within these areas of potential habitat may yield additional local records of the species.

Direct impacts associated with the proposal involve removal of individuals as well as trees or tree limbs that may provide suitable habitat for this species. The extent to which the proposal will affect the lifecycle of other individuals of *C. canaliculatum* in the region is unclear due to the paucity of records of this species in the region.

It is proposed to translocate the *C. canaliculatum* on the subject site to an appropriate donor site. It is possible that the clumps on the tree, or the whole tree could be successfully translocated, provided there is minimal root disturbance, as the thick fleshy roots of this species can penetrate deep into the heartwood of the host tree for metres (Peter Weston, Senior Principal Research Scientist, Botanic Gardens Trust, pers. comm. 17 November 2009). Any proposed translocation of the orchid would therefore require moving as much of the host tree as possible. Care would need to be taken to minimise disturbance to the orchid, particularly the root system, during translocation. Monitoring of the translocated plant would be required for some years following translocation in order to determine success A detailed translocation plan will need to be prepared in consultation with the NSW Department of Environment, Climate Change and Water with reference to translocation guidelines (Vallee *et al.* 2004).

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Within the Hunter Valley *C. canaliculatum* commonly occurs in *Eucalyptus albens* woodlands, growing in tree hollows between 2 and 6m from the ground (NSW Scientific Committee 2006). *Cymbidium canaliculatum* is also known to occur on the following hosts: Narrow Leaved Ironbark (*Eucalyptus crebra*), Grey Box (*Eucalyptus moluccana*), Rough Barked Apple (*Angophora floribunda*) and Cooba (*Acacia salicina*) (NSW Scientific Committee 2006) all of which occur within the study area.

C. canaliculatum has been previously recorded from the following plant communities within the Upper Hunter Valley: Central Hunter Box - Ironbark Woodland, Central Hunter Spotted Gum - Ironbark - Grey Box Forest, and Hunter Valley Vine Thicket; and is also expected to occur in Central Hunter Bulloak Forest Regeneration (Peake 2005). Potential habitat within the study area is considered to include Central Hunter Box - Ironbark Woodland.

The patch of Central Hunter Box - Ironbark Woodland in the north-east and the smaller fragments of this community in the south-east of the study area are currently isolated from other areas of this community in the locality. The closest patch of Central Hunter Box - Ironbark Woodland is a 4.5ha patch approximately 1km to the north-west. Larger patches are mapped approximately 2.2km to the west and 2.4km to the south west.

Within the broader operations of Coal & Allied in the region, a number of colonies of *C. canaliculatum* are being conserved within existing or proposed biodiversity offset areas. A single colony/individual is protected and conserved at Archerfield near the Hunter Valley South Coal Mine. The proposed offset area at the Coal &Allied owned Broomfield property near the Mount Pleasant Mine and the Goulburn River offset proposed for the Warkworth Mine both include colonies of *C. canaliculatum*. Although the latter two offsets are not specific for any impact to *C. canaliculatum* they do provide long term conservation localities for this species and add to its conservation across the region.

Direct impacts associated with the proposal include clearing of the existing plants as well as approximately 0.89ha of vegetation that is considered potential habitat for the species. A further 0.17ha of potential habitat to the south east of the subject site may be indirectly impacted by the proposal (e.g. via weed invasion, erosion and sedimentation). There are approximately 1,261ha of potential habitat for the species mapped as occurring in the locality. Therefore, the proposal is likely to impact on approximately 0.01 per cent of similar habitats in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The species occurs in northern and eastern Australia. In New South Wales, it occurs in the North Coast, Northern Tablelands, North and Central Western Slopes and the North West Plains botanical bioregions. The population of *C. canaliculatum* in the Hunter Valley is at the eastern and southern limit of the species' distribution (NSW Scientific Committee 2006).

The study area represents the southernmost recent record of this species in the last 70 years. There are five records of *C. canaliculatum* to the south east of the study area; however they are dated between 1899 and 1939, with no more recent records in this area. It is noted that the NPWS records are adjusted and could be up to 10km from the actual location of the species.

How is the proposal likely to affect current disturbance regimes?

The Final Determination for *C. canaliculatum* in the Hunter Valley (NSW Scientific Committee 2006) lists four threats to the species; land clearing, habitat fragmentation, tree removal and illegal collecting of the species. Peake (2005) also regards the general lack of trees with hollows as a further threat to the Hunter Valley population of this species.

The study area currently consists largely of cleared agricultural land. The proposal will require removal of the clumps of *C. canaliculatum* which occurs on the edge of an existing cleared area. Given the lack of connectivity in the study area and surrounds, it is unlikely that the proposal would further fragment or isolate the potential habitat of this species.

It is unlikely that the proposal will result in illegal collection of *C. canaliculatum.* However this threat should be considered when selecting a suitable donor site for translocation.

How is the proposal likely to affect habitat connectivity?

There is currently limited connectivity for *C. canaliculatum* in the study area. The nearest known recent (2009) record of *C. canaliculatum* occurs at Archerfield, Warkworth, approximately 8km east of the study area (Cumberland Ecology 2010). The next closest known record is approximately 20km to the north of the study area. The removal of the plants of *C. canaliculatum* from the subject site may therefore increase the distance between known records, however, it is considered unlikely that these populations are associated in terms of pollination and or dispersal.

The patch of Central Hunter Box – Ironbark Woodland in the north east of the subject site, as well as the smaller fragments in the south east, are isolated from other areas of this community in the locality. The closest Central Hunter Box – Ironbark Woodland is a 4.5ha patch approximately 1km to the north-west. Larger patches are mapped approximately 2.2km to the west and 2.4km to the south west.

The proposal will increase the distance between the patches of potential habitat for *C. canaliculatum* in the locality, however the patches in the study area are currently isolated and have no connectivity to other areas of native vegetation to the north and west.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared under the TSC Act for the *C. canaliculatum* Hunter Valley endangered population.

Conclusion

The proposal will result in the removal of the only known occurrence of *Cymbidium canaliculatum* within up to a 8 km radius. On this basis, a significant impact is predicted to occur on the local population (that which occurs in the locality or 5km radius) of this species. It should be noted that approximately 1,261ha of potential habitat for the species has been mapped as occurring in the locality and that further searches within these areas of potential habitat may yield additional local records of the species. Mitigation measures including translocation and the management to nearby potential habitat have been proposed in this assessment in order to minimise the significance of the impacts on this local population.

Eucalyptus camaldulensis	River Red Gum

Occurrences of *Eucalyptus camaldulensis* in the Hunter Catchment are part of an endangered population under the TSC Act.

E. camaldulensis is a tree to 30m tall. It has smooth white, grey to red-brown bark shedding in short ribbons and disjunct, narrow-lanceolate or lanceolate green or grey-green leaves (Harden 2002).

The size of the Hunter population of *E. camaldulensis* is estimated to be between 600 - 1000 mature or semi mature trees in 19 known stands, occupying at most *c.* 100ha (DECC 2005). A single tree of *E. camaldulensis* was recorded on the subject site, in the rural land in the centre of the subject site (Figure 6). This tree is isolated from all other native vegetation and appears to be remnant. The tree was in a poor to moderate condition, with a healthy canopy but obvious basal trunk damage and partial ringbarking from chicken wire. The tree's root zone is subject to significant compaction, probably from cattle disturbance around the tree.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Based on the reported visitation of other similar and closely-related eucalypts, *E. camaldulensis* is likely to be pollinated by parrots, honeyeaters, flying-foxes, bees and other insects, (Benson and McDougall 1998). Due to the high mobility of these pollinators, it is unlikely that the proposal will disrupt the pollination of this species in adjoining areas.

E. camaldulensis disperses by seed, with a dispersal distance of approximately 20m, based on figures for similar and closely-related eucalypt species (Benson and McDougall 1998). Floods are also recognised as an important dispersal mechanism with seed being dispersed greater distances during flood events post seed fall. No fruit was found around the tree recorded on the subject site, and no evidence of recruitment was observed. Given the grazing land use and the ground layer dominated by weedy grasses, it is unlikely that new seedlings would establish within 20m of the tree.

It is unlikely that the proposal will remove seed of *E. camaldulensis* from the soil seedbank, as trees of this species store little or none of their seed in the soil (CSIRO 2004). Furthermore, it is unlikely that removal of the one tree in the study area would affect other trees known to occur in the locality. However, if available, seed should be collected from the tree for use in existing rehabilitation and restoration strategy (Umwelt 2010) for the population located to the east of the study area.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The subject site is located on alluvium on the Hunter River floodplain. However, it appears to consist of relatively poor habitat for *E. camaldulensis.* The single tree of *E. camaldulensis* recorded on the subject site was an isolated individual in a grazed agricultural landscape dominated by exotic grass species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Eucalyptus camaldulensis is widespread across mainland Australia. However, the Hunter catchment population is at the limit of the known distribution of this species, being the only coastal catchment in which it occurs (NSW Scientific Committee 2005). The closest known population to the Hunter population is at Mudgee (NSW Scientific Committee 2005).

The study area is not at the limits of the Hunter catchment population of *E. camaldulensis* with numerous further records known to occur in the locality (Umwelt 2007a).

How is the proposal likely to affect current disturbance regimes?

Threats to this species include changes in hydrology, cropping and grazing of the understorey or weed infestation by species including *Galenia pubescens*, *Pennisetum clandestinum* (Kikuyu) and *Ricinus communis* (Castor oil plant) (DECC 2005).

The proposal has the potential to affect the natural flooding regime for the habitat of *E. camaldulensis,* which is a critical environmental factor for this species. The unnamed tributary of the Hunter River that flows southwards across the east of the subject site is to be diverted. A levee system may be installed to the south of the subject site to protect the extended pit area from flooding from the Hunter River.

The isolated individual tree of *E. camaldulensis* recorded on the subject site is located in a cleared and grazed landscape with exotic species dominating the ground layer. The vegetation within the riparian zone of the Hunter River, in the study area to the south of the subject site, is currently in poor condition with weed species dominant within most structural layers.

Coal & Allied has developed a comprehensive River Red Gum Rehabilitation and Restoration Strategy, which aims to preserve, enhance and manage stands of River Red Gums across the locality, including at the nearby Carrington Billabong. The Carrington Billabong immediately south of the current study area includes more than 136 mature River Red Gums over an approximate five hectare area. Goals of this strategy aim to reduce the impacts of threatening processes on the stands; to enhance the River Red Gum population to enable it to persist as a viable, functioning population; and to increase biodiversity, including foraging habitat for native flora and fauna species.

How is the proposal likely to affect habitat connectivity?

The proposal is unlikely to affect habitat connectivity between populations of *Eucalyptus camaldulensis*. Habitat for *E. camaldulensis* occurs on the floodplain of the Hunter River, on and to the south of the subject site. Peake (2008) recorded a number of occurrences of *E. camaldulensis* along the Hunter River to the east of the study area. The proposal is unlikely to impact on connectivity between these occurrences.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared under the TSC Act for the *Eucalyptus camaldulensis* Hunter Valley endangered population.

Conclusion

The proposal will result in the removal of a single tree of *Eucalyptus camaldulensis* from a cleared agricultural landscape which currently represents poor habitat for this species. Provided that weed and erosion control measures are implemented to protect the potential habitat adjoining the Hunter River, it is considered **unlikely** that the proposal will have a significant impact on the broader endangered population which occurs within the locality.

The single *E. camaldulensis* to be removed is considered likely to be remnant. It is recommended that seed (if available) is collected from this tree prior to its removal for cultivation of tube stock for use in revegetation and management of the existing nearby populations.

Vulnerable species

Diuris tricolor	**Pine Donkey Orchid**

Diuris tricolor is listed as a vulnerable species under the TSC Act. The population of *D. tricolor* in the Muswellbrook LGA is listed as an endangered population under the TSC Act.

D. tricolor is a terrestrial orchid species. It has between one and three linear leaves to 4 mm wide and 30cm long. The flower stalk grows from 20-40cm high and has 2-6 flowers, which are bright yellow to orange, speckled with red to purple and white markings. The sepals are very long and often crossed (DEC 2005a).

D. tricolor grows in sclerophyll vegetation among grass, often with native Cypress Pine (*Callitris* spp*)* on flats or small rises (DEC 2005).

The population of *D. tricolor* in the Muswellbrook LGA is disjunct and at the eastern limit of the geographic range of the species. All other populations of the species are located west of the Great Dividing Range. The distance of the Muswellbrook LGA population to the nearest population of the species to the west is c. 100km. The area of occupancy of the Muswellbrook population is less than $50km^2$ (NSW Scientific Committee 2007c).

D. tricolor was not recorded in the study area. The closest record of this species is approximately 17km north of the study area. According to Peake (2005), *D. tricolor* is known to occur at Muswellbrook and Wybong, but is likely to occur more widely west of Singleton. *D. tricolor* has previously been recorded in Central Hunter Box - Ironbark Woodland and is expected to occur in Central Hunter Bulloak Forest Regeneration, Central Hunter Spotted Gum - Ironbark - Grey Box Forest and Hunter Valley Weeping Myall Woodland (Peake 2005). This species may also occur in Derived grasslands (DEC 2005), such as those recorded in the study area.

There may be limited potential habitat for this species in the Central Hunter Box - Ironbark Woodland and Derived Native Grasslands in the study area and in this and other communities in the locality. *D. tricolor* is a deciduous orchid and would not be detected outside of the flowering period, which occurs between September and November (DEC 2005). Advice from DECCW (2010) states the flowering period as September to October (excluding late October). The study area was surveyed in late August 2009 during the current field surveys, outside the known flowering period. Nearby areas have been surveyed on the 18-20 October 2004 (ERM 2005a) and 23 October 2002 (ERM 2003). These surveys likely occurred outside the flowering period of *D. tricolor* (DECCW 2010) also.

A targeted survey for *D. tricolor* was undertaken in potential habitat within the subject site on 22 September 2010, when a known population in the region was in flower. *D. tricolor* was not detected during this survey (See Appendix 5 for details).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The pollinator for *Diuris tricolor* is not currently known. It has been suggested that the beetle *Hiparetrus globulus* is the pollinator (Adams and Lawson 2008). However beetle pollination is considered likely to be a chance, nonspecific event (Adams and Lawson 2008) and most *Diuris* are pollinated by small native bees attracted by bright floral colours (Jones 2006). Orchid seeds are minute and dust-like (Weston 2005) and wind is considered likely to be the predominant mechanism of dispersal.

D. tricolor was not recorded in the surveys and only small areas of degraded woodland and derived grasslands represent the limited potential habitat for this species across the study area. Direct impacts associated with the proposal involve removal of this potential habitat in the Central Hunter Box - Ironbark Woodland and Derived Native Grassland in the east of the subject site. It is unlikely that the proposal will have any impact on the lifecycle of *D. tricolor* individuals (should they occur) occurring outside of the study area.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Diuris tricolor was not recorded in the study area, but has previously been recorded in Central Hunter Box - Ironbark Woodland (Peake 2005). This species may also occur in Derived Native Grassland (DEC 2005).

Approximately 0.89ha of Central Hunter Box - Ironbark Woodland and 1.35ha of Derived Native Grassland occurs on the subject site.

Direct impacts associated with the proposal include clearing approximately 2.24ha of vegetation that is considered potential habitat for the species. A further 1.25ha of potential habitat to the south of the subject site may be indirectly impacted by the proposal (e.g. via weed invasion, erosion and sedimentation). There are approximately 1,229ha of potential habitat for the species mapped as occurring in the locality. Therefore, the proposal is likely to impact on approximately 0.28 per cent of similar habitats in the locality.

The potential habitat to be impacted by the proposal was assessed as being in a poor to moderate condition due to its already modified nature resulting from previous disturbances, including historic clearing and grazing.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Diuris tricolor is sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the far north of NSW (DEC 2005a). The population of *D. tricolor* in the Muswellbrook LGA is disjunct and at the eastern limit of the geographic range of the species. All other populations of the species are located west of the Great Dividing Range (NSW Scientific Committee 2007b).

Although the closest record of *D. tricolor* is approximately 17km to the north of the study area, Peake (2005) states that this species is likely occur more widely west of Singleton. The potential habitat for *D. tricolor* in the Central Hunter Box – Ironbark Woodland in the study area is at the eastern limit of the known distribution of the species.

How is the proposal likely to affect current disturbance regimes?

A number of sites at which *Diuris tricolor* is known to occur in the Muswellbrook LGA are fragmented and degraded patches of native vegetation, exposed to invasion by weedy exotic grasses which compete with *D. tricolor* for space and light and may threaten its persistence at several sites (NSW Scientific Committee 2007a).

The ground layer in the Central Hunter Box – Ironbark Woodland in the study area is currently dominated by native grasses, however there is also some occurrence of exotic weeds and grasses including Galenia (*Galenia pubescens*) and Kikuyu (*Pennisetum clandestinum*). This vegetation was considered to be in moderate to poor condition and is isolated from other areas of habitat in the region.

How is the proposal likely to affect habitat connectivity?

There is currently limited connectivity for *D. tricolor* in the study area. The nearest known record of *D. tricolor* occurs approximately 17km to the north of the subject site. It is noted that the NPWS records are denatured and could be up to 10km from the actual location of the species.

Potential habitat in the study area is currently isolated and has no connectivity to other areas of native vegetation to the north and west. The proposal is unlikely to affect habitat connectivity for the potential habitat of this species.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared under the TSC Act for *D. tricolor*.

Conclusion

D. tricolor was not recorded in the study area in the August 2009 survey nor in a targeted survey of potential habitat within the subject site on 22 September 2010, when a known population in the region was in flower. There may be potential habitat for this species in the Central Hunter Box – Ironbark Woodland and Derived Native Grassland, however it is considered extremely unlikely that *D. tricolor* occurs on the site. The proposal will remove up to 2.24ha of potential habitat for *D. tricolor*. Given the low likelihood of occurrence, the proposal is considered **unlikely** to result in a significant impact on this species.

Endangered Ecological Communities

Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions

Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions is listed as an EEC under Part three, Schedule one of the NSW TSC Act.

According to vegetation mapping (Peake 2005) the mapped extent of the community in the locality is approximately 911.6ha. Approximately 1.06ha of this community occurs in the study area represented by small (<1ha) highly fragmented and disturbed remnants. Given the existing degree of fragmentation and evidence of modification, the extent of this community within the study area is considered to be in a moderate to poor condition (see condition categories prescribed in Section 3.2.3.).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

N/A

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Based on the vegetation mapping, approximately 911.6ha of this EEC exists within the locality (5 km radius of the study area). Approximately 1.07ha of this EEC in the study area would be impacted (directly and indirectly) by the proposal, which equates to 0.12% of similar habitat types in the locality and this is not considered to be significant.

Given the condition and area of this EEC to be impacted, this patch of vegetation is not considered to be vital for the long term survival of the community in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

This EEC is known to occur in the LGAs of Cessnock, Singleton and Muswellbrook. The study area is not at the limit of distribution for this community.

How is the proposal likely to affect current disturbance regimes?

Current disturbance regimes affecting this community are largely related to grazing and weeding invasion. Natural disturbance regimes such as fire are no longer likely to influence the extent or functioning of this community within the study area.

The proposal will remove small patches of this community from the study area. Patches of this community in the study area are already subject to indirect impacts from existing land uses.

How is the proposal likely to affect habitat connectivity?

The extent of this EEC in the study area is represented by isolated patches with no connectivity to other areas in the locality (See Figure 2). The proposal will not significantly affect habitat connectivity between existing areas of this EEC.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for this EEC (DECC 2008).

The proposal will not have an adverse effect on critical habitat (directly or indirectly).

Conclusion:

The impact of the proposal on the Central Hunter Grey Box-Ironbark Woodland EEC is considered **unlikely** to constitute a significant impact on the basis that:

- The magnitude of impacts from the proposal on the extent of this community in the locality is relatively small;
- The proposal would not result in further fragmentation or isolation of this community; and,
- Patches of this community in the study area are already subject to indirect impacts from existing land uses.

Fauna

Turquoise Parrot	***Neophema pulchella***

The Turquoise Parrot is listed as Vulnerable under Schedule 2 of the TSC Act.

The Turquoise Parrot has not been previously recorded within 10km of the study area. The closest record occurs approximately 12km to the south east, recorded in 2002 (NSW Government 2009).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Turquoise Parrots occur in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). The species is found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999).

The Turquoise Parrot is usually seen in pairs or small, possibly family, groups and has also been reported in flocks of up to thirty individuals. The species prefers to feed in the shade of trees and spends most of the day on the ground searching for the seeds of grasses and herbaceous plants, or browsing on vegetable matter (DEC 2005t). It nests in hollow-bearing trees or hollows in tree stumps and prefers to breed in open grassy forests and woodlands, and gullies which are moist (Higgins 1999).

The study area provides potential foraging and breeding habitat for the Turquoise Parrot within the open Central Hunter Box – Ironbark Woodland and surrounding grassy farmland. The proposal is likely to remove approximately 0.89ha of the woodland habitat which contains a high number of tree hollows (potential breeding habitat). A further 0.17ha would be indirectly impacted.

The Turquoise Parrot has not been previously recorded within 12km of the study area. If present within the study area, the proposal is likely to have a major impact on individuals nesting in the tree hollows as most of the woodland containing hollows (0.89ha of 1.06ha) would be removed. Further, this species is considered resident and long-distance movements have not been recorded (Higgins 1999). Therefore, the loss of potential breeding and foraging habitat could have flow-on effects for a local population as (surviving) individuals from the study area (if present) seek and establish new territory.

However, given the reasonably high mobility of the species (local seasonal movements recorded (Higgins 1999) and post-breeding dispersal (Forshaw and Cooper 2002)) and the extent of similar habitat resources within the locality (1,297.30ha), it is unlikely the proposal would significantly disrupt the lifecycle of a local population of the Turquoise Parrot or the species as a whole.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would remove 0.89ha potential foraging and breeding habitat in the form of Central Hunter Box – Ironbark Woodland containing hollow-bearing trees. An additional 0.17ha Central Hunter Box – Ironbark Woodland would be indirectly impacted by the proposal. Although the remaining 0.17ha would not be removed, it may become unsuitable as potential habitat given its location adjacent to an open cut coal mine. Impacts to 1.06ha of Central Hunter Box – Ironbark Woodland occurring in the study area equates to 0.08 per cent of similar habitat resources within the locality (1,297.30ha). Therefore, the proposal is considered unlikely to have a major impact on potential habitat for the Turquoise Parrot.

Does the proposal affect any threatened species that are at the limit of its known distribution?

The range of the Turquoise Parrot extends from southern Queensland through to northern Victoria, along the coastal plains and to the west of the Great Dividing Range (DEC 2005t). The study area is not at, or near, the limit of distribution for this species.

How is the proposal likely to affect the current disturbance regimes?

The study area has been largely cleared of native vegetation and what remains is subject to ongoing disturbances primarily from grazing. An open cut coal mine occurs immediately east of the study area, from which noise and dust may disturb habitats within the study area periodically. Immediately west of the study area lies Lemington Road. Given the cleared nature of the study area alongside Lemington Road, edge effects are likely to be negligible.

The proposal would affect the current disturbance regimes by eliminating grazing and replacing it with an open cut coal mine. This may increase the incidence of noise and dust on the Hunter River riparian vegetation within the study area, south of the subject site. The loss of woodland and scattered trees from the subject site would reduce the number of stepping-stone links however; the Hunter River riparian vegetation would not be removed.

How is the proposal likely to affect habitat connectivity?

The majority of the study area is cleared and contains little native vegetation. Wildlife corridors in the study area, therefore, are limited; however include the riparian vegetation along the Hunter River. The Turquoise Parrot occurs within eucalypt woodlands however may move through the Hunter Valley River Oak Forest (dominated by *Casuarina cunninghamii*) bordering the Hunter River. This riparian vegetation would not be directly impacted or fragmented by the proposal.

Predominantly isolated stands of trees occurring in the study area may provide limited value as stepping-stone links for highly mobile species. In most districts there is a post-breeding dispersal of Turquoise Parrots and local movements may also occur as a result of rainfall and water availability, which in turn affect food availability (Forshaw and Cooper 2002). Given the mobility of the Turquoise Parrot it is unlikely the proposal would create new barriers or exacerbate existing barriers for this species.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Turquoise Parrot (DECCW 2009a).

Conclusion

Based on the above assessment the proposal is considered **unlikely** to have a major impact on the Turquoise Parrot.

Powerful Owl	***Ninox strenua***

The Powerful Owl is listed as Vulnerable under Schedule 2 of the TSC Act.

The Powerful Owl was recorded within the study area with probable certainty, identified (by Barbara Triggs of Dead Finish) from an owl pellet collected beneath a roost tree. No other records occur within 10 km.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Powerful Owl occupies wet and dry eucalypt forests and rainforests. It can occupy both unlogged and lightly logged forests, as well as undisturbed forests (Debus and Chafer 1994a). The species' foraging range can include urban areas. Large mature trees with hollows at least 0.5m deep and greater than 45cm in diameter are required for nesting (Garnett 1992; DEC 2005o). Nest trees for this species are usually emergent with a diameter at breast height of at least 100cm (Gibbons and Lindenmayer 1997). Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and occupy a large home range of between 450 and 1450ha (DEC 2005o). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997).

The Powerful Owl is likely to forage within the study area as evidenced by an owl pellet located beneath a roost tree within the Central Hunter Box – Ironbark Woodland. The owl pellet contained the remains of the introduced House Mouse, which was also recorded during the field survey. The Powerful Owl may forage over the entire study area, including both wooded and cleared areas for mammals, birds and reptiles. The preferred prey item for the Powerful Owl is medium-sized arboreal mammals (DEC 2005o), most of which are tree-hollow dependant. Although tree hollows are numerous in the study area, connectivity is poor and the presence of arboreal mammals is likely to be low.

The study area is not considered to provide potential breeding habitat for the Powerful Owl as no suitably-sized hollows were observed and there is no understorey in areas containing hollows, which is an important habitat component for newly fledged young (Higgins 1999).

The proposal would remove 5.91ha of known and potential foraging habitat of the Powerful Owl (woodland/plantation/native grassland/unnamed tributary) as well as cleared farmland. A further 2.09ha potential habitat (woodland/native grassland/riparian vegetation) would be indirectly impacted. Given the large home range of the Powerful Owl, that removal of nesting habitat is unlikely, that preferred prey items such as arboreal mammals are likely to be scarce and the extent of habitat resources within the locality (1454.85ha), it is unlikely that the proposal would have a major impact on the lifecycle of the Powerful Owl.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would remove foraging habitat for the Powerful Owl including the removal of trees with hollows that may provide habitat for arboreal prey species (although the presence of such species is considered to be low due to poor connectivity). Approximately 5.91ha of known and potential foraging habitat of the Powerful Owl (woodland/plantation/native grassland/unnamed tributary) as well as cleared farmland would be removed from the subject site. A further 2.09ha potential habitat (woodland/native grassland/riparian vegetation) would be indirectly impacted. Impacts to a total of 8ha foraging habitat equate to 0.55 per cent of the available habitat resources within the locality (1454.85ha). Given the extent of potential foraging and breeding resources within the locality and the high mobility of the Powerful Owl, the proposal is considered unlikely to have a major impact on potential habitat for the species.

Does the proposal affect any threatened species that are at the limit of its known distribution?

The Powerful Owl is found in south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria (DEC 2005o). The study area is not at, or near, the limit of distribution for this species.

How is the proposal likely to affect the current disturbance regimes?

The study area has been largely cleared of native vegetation and what remains is subject to ongoing disturbances primarily from grazing. An open cut coal mine occurs immediately east of the study area from which noise and dust may disturb habitats within the study area periodically. Immediately west of the study area lies Lemington Road. Given the cleared nature of the study area alongside Lemington Road, edge effects are likely to be negligible.

The proposal would affect the current disturbance regimes by eliminating grazing and replacing it with an open cut coal mine. This may increase the incidence of noise and dust on the Hunter River riparian vegetation within the study area, south of the subject site. The loss of woodland and scattered trees from the subject site would reduce the number of stepping-stone links however; the Hunter River riparian vegetation would not be removed.

How is the proposal likely to affect habitat connectivity?

The majority of the study area is cleared and contains little native vegetation. Wildlife corridors in the study area, therefore, are limited; however include the riparian vegetation along the Hunter River. This riparian vegetation would not be directly impacted or fragmented by the proposal.

Predominantly isolated stands of trees occurring in the study area may provide limited value as stepping-stone links for highly mobile species. These stands of trees would be removed by the proposal.

The Powerful Owl is a highly mobile species, known to occupy home ranges of between 450 and 1450ha (DEC 2005o). Given the mobility of this species, it is unlikely the proposal would create new barriers or exacerbate existing barriers for the Powerful Owl.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Powerful Owl (DECCW 2009a).

Conclusion

Based on the above assessment the proposal is considered **unlikely** to have a major impact on the Powerful Owl.

Large-eared Pied Bat	***Chalinolobus dwyeri***

The Large-eared Pied Bat is listed as Vulnerable under Schedule 2 of the TSC Act. This species is also listed as Vulnerable under the EPBC Act.

The Large-eared Pied Bat was recorded within the study area during the current field survey. The species was recorded once, with possible confidence, using an Anabat placed on the edge of the Hunter River. The species has also been previously recorded at two other locations within 10km of the study area (DECCW 2009b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Large-eared Pied Bat is located in a variety of drier habitats, (Hoye and Dwyer 1995), however, can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 2008). The Large-eared Pied Bat requires caves or rock overhangs for breeding (DEC 2005i). While the species will roost in caves, it can also use man-made structures such as mines and road culverts for roosting (Churchill 2008; DEC 2005i).

Little is known of the foraging behaviour and diet of the Large-eared Pied Bat although they are known to have a relatively slow flight and have been observed flying low along creek beds and foraging within the canopy (DEC 2005i; Churchill 2008). Their diet is thought to consist of small flying insects (Hoye and Schulz 2008).

The Large-eared Pied Bat may roost among outcropping rocks and boulder piles along the edge of the Hunter River within the study area. However, no potential breeding habitat (i.e. caves or overhangs) occurs. The species may also forage throughout the study area for flying insects, particularly within the Hunter River riparian vegetation.

The proposal would not directly impact potential roosting habitat (i.e. outcropping rocks and boulder piles) or the likely preferred foraging habitat within the study area (i.e. Hunter River riparian vegetation) for this species, as it occurs outside the subject site. This habitat may be subject to indirect impacts such as increased noise and dust levels.

The proposal would directly impact other areas of potential foraging habitat, including approximately 1.13ha Central Hunter Box – Ironbark Woodland and unnamed tributary habitat. However, given that no potential breeding or roosting habitat would be removed, that the likely preferred foraging habitat along the Hunter River would not be directly impacted and the extent of similar habitat resources within the locality (1,360.91ha), it is unlikely the proposal would significantly disrupt the lifecycle of a local population of the Large-eared Pied Bat, or the species as a whole.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would remove approximately 1.13ha potential foraging habitat of the Large-eared Pied Bat (Central Hunter Box – Ironbark Woodland and unnamed tributary habitat). A further 1.02ha potential foraging and roosting habitat (woodland/riparian vegetation with boulders) would be indirectly impacted. Impacts to a total of 2.15ha foraging and/or roosting habitat equate to 0.16 per cent of the available habitat resources within the locality (1,360.91ha). Given the extent of potential foraging and roosting resources within the locality and the reasonably high mobility of this species, the proposal is considered unlikely to have a major impact on habitat for the Large-eared Pied Bat.

Does the proposal affect any threatened species that are at the limit of its known distribution?

The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. The study area is not at, or near, the limit of distribution for this species.

How is the proposal likely to affect the current disturbance regimes?

The study area has been largely cleared of native vegetation and what remains is subject to ongoing disturbances primarily from grazing. An open cut coal mine occurs immediately east of the study area from which noise and dust may disturb habitats within the study area periodically. Immediately west of the study area lies Lemington Road. Given the cleared nature of the study area alongside Lemington Road, edge effects are likely to be negligible.

The proposal would affect the current disturbance regimes by eliminating grazing and replacing it with an open cut coal mine. This may increase the incidence of noise and dust on the Hunter River riparian vegetation within the study area, south of the subject site. The loss of woodland and scattered trees from the subject site would reduce the number of stepping-stone links however; the Hunter River riparian vegetation would not be removed.

How is the proposal likely to affect habitat connectivity?

The majority of the study area is cleared and contains little native vegetation. Wildlife corridors in the study area, therefore, are limited; however include the riparian vegetation along the Hunter River. This riparian vegetation would not be directly impacted or fragmented by the proposal.

Predominantly isolated stands of trees occurring in the study area may provide limited value as stepping-stone links for highly mobile species. These stands of trees would be removed by the proposal.

Within the study area, the Large-eared Pied Bat is most likely to utilise the riparian vegetation corridor of the Hunter River. Given the mobility of this species, and that the Hunter River riparian vegetation would not be fragmented, it is unlikely the proposal would create new barriers or exacerbate existing barriers for the Large-eared Pied Bat.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Large-eared Pied Bat (DECCW 2009a).

Conclusion

Based on the above assessment the proposal is considered **unlikely** to have a major impact on the Large-eared Pied Bat.

Eastern Bentwing-bat	***Miniopterus schreibersii oceanensis***

The Eastern Bentwing-bat is listed as Vulnerable under Schedule 2 of the TSC Act.

The Eastern Bentwing-bat was recorded within the study area during the current field survey. The species was recorded with definite confidence using Anabats placed on the edge of the Hunter River and within the Central Hunter Box – Ironbark Woodland. The species has also been previously recorded at four other locations within 10km of the study area (DECCW 2009b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Eastern Bentwing-bat forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. The Eastern Bentwing-bat has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill 2008; Hoye and Hall 2008a).

Given the definite recording of the Eastern Bentwing-bat at two sites within the study area, this species is known to at least forage within the study area. The species is likely to forage above the tree canopy, over cleared grassy areas and/or over waterways (e.g. Hunter River and wetland). This foraging habitat is not considered to be a limiting resource for the Eastern Bentwing-bat given its non-specialised foraging requirements. No potential breeding or preferred roosting habitat (i.e. caves or mine tunnels) occur within the study area. There is limited roosting opportunity for the Eastern Bentwing-bat within the scattered buildings of the study area (e.g. farm sheds with corrugated iron roofs). However, these structures are considered unlikely to provide anything more than temporary shelter due to their poor thermoregulatory properties.

Given that no potential breeding or preferred roosting habitat would be impacted, that no limiting foraging resources would be lost, the high mobility of this species and the extent of similar habitat resources within the locality (1454.85ha), it is unlikely the proposal would significantly disrupt the lifecycle of a local population of the Eastern Bentwing-bat, or the species as a whole.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would remove approximately 5.91ha known and/or potential foraging habitat of the Eastern Bentwing-bat (woodland/plantation/native grassland/unnamed tributary) as well as cleared farmland. A further 2.09ha known and/or potential foraging habitat (woodland/native grassland/riparian vegetation) would be indirectly impacted. In addition, a number of potential, temporary roost sites (i.e. farm sheds) would be removed by the proposal. Impacts to a total of 8ha foraging habitat equate to 0.55 per cent of the available habitat resources within the locality (1454.85ha). Given the extent of potential habitat within the locality and the high mobility of the Eastern Bentwing-bat (known to disperse up to 300km from maternity roosts (DEC 2005c)), the proposal is considered unlikely to have a major impact on potential habitat for the species.

Does the proposal affect any threatened species that are at the limit of its known distribution?

Eastern Bentwing-bat populations are found along the east and north-west coasts of Australia (DEC 2005c). The study area is not at, or near, the limit of distribution for this species.

How is the proposal likely to affect the current disturbance regimes?

The study area has been largely cleared of native vegetation and what remains is subject to ongoing disturbances primarily from grazing. An open cut coal mine occurs immediately east of the study area from which noise and dust may disturb habitats within the study area periodically. Immediately west of the study area lies Lemington Road. Given the cleared nature of the study area alongside Lemington Road, edge effects are likely to be negligible.

The proposal would affect the current disturbance regimes by eliminating grazing and replacing it with an open cut coal mine. This may increase the incidence of noise and dust on the Hunter River riparian vegetation within the study area, south of the subject site. The loss of woodland and scattered trees from the subject site would reduce the number of stepping-stone links however; the Hunter River riparian vegetation would not be removed.

How is the proposal likely to affect habitat connectivity?

The majority of the study area is cleared and contains little native vegetation. Wildlife corridors in the study area, therefore, are limited; however include the riparian vegetation along the Hunter River. This riparian vegetation would not be directly impacted or fragmented by the proposal.

Predominantly isolated stands of trees occurring in the study area may provide limited value as stepping-stone links for highly mobile species. These stands of trees would be removed by the proposal.

The Eastern Bentwing-bat is a highly mobile species known to disperse up to 300km from maternity roosts (DEC 2005c). Given the mobility of this species, it is unlikely the proposal would create new barriers or exacerbate existing barriers for the Eastern Bentwing-bat.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Eastern Bentwing-bat (DECCW 2009a).

Conclusion

Based on the above assessment the proposal is considered **unlikely** to have a major impact on the Eastern Bentwing-bat.

Large-footed Myotis	***Myotis macropus***

The Large-footed Myotis is listed as Vulnerable under Schedule 2 of the TSC Act.

The Large-footed Myotis was recorded within the study area during the current field survey. The species was recorded once, with definite confidence, using an Anabat placed on the edge of the Hunter River. The species has also been previously recorded at two other locations within 10km of the study area (DECCW 2009b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Large-footed Myotis roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Breeding habitat is likely to be as per roosting habitat (DEC 2005j). Colonies occur close to permanent water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects (Richards *et al.* 2008).

Given the definite recording of the Large-footed Myotis over the Hunter River within the study area, it is considered likely the Large-footed Myotis forages over the Hunter River and within the surrounding riparian vegetation. The species may also roost and breed within tree hollows and dense foliage of the riparian vegetation. Given that this species requires permanent water bodies for foraging (Churchill 2008), it is considered less likely that the Large-footed Myotis would forage over the unnamed tributary and associated wetland, or use the nearby woodland, given their distance from a permanent water source. Further, these areas are surrounded by cleared farmland and an open cut coal mine.

The proposal would not directly impact the Hunter River or its riparian vegetation within the study area. Indirect impacts such as increased noise and dust levels may occur. Given that no potential breeding or preferred foraging habitat would be directly impacted and that connectivity associated with the Hunter River riparian vegetation would not be fragmented, it is unlikely the proposal would significantly disrupt the lifecycle of a local population of the Large-footed Myotis, or the species as a whole.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would remove approximately 1.13ha Central Hunter Box – Ironbark Woodland and unnamed tributary habitat however, the Large-footed Myotis is considered unlikely to rely on this habitat within the subject site as it does not occur close to permanent water. No potential breeding or preferred foraging habitat would be directly impacted, however approximately 1.02ha (woodland and riparian vegetation) would be indirectly impacted. It is difficult to determine the extent of potential habitat available within the locality but is likely to include the Hunter River and associated riparian vegetation, dams with permanent water (such as those described by HLA-Envirosciences (2006)) and forests and woodlands close to permanent water. Given that no potential breeding or preferred foraging habitat would be directly impacted and that connectivity associated with the Hunter River riparian vegetation would not be fragmented, the proposal is considered unlikely to have a major impact on habitat for the Large-footed Myotis

Does the proposal affect any threatened species that are at the limit of its known distribution?

Large-footed Myotis populations are found along the coast from the north-west of Australia, across the top-end and south to western Victoria (DEC

2005k). The study area is not at, or near, the limit of distribution for this species.

How is the proposal likely to affect the current disturbance regimes?

The study area has been largely cleared of native vegetation and what remains is subject to ongoing disturbances primarily from grazing. An open cut coal mine occurs immediately east of the study area from which noise and dust may disturb habitats within the study area periodically. Immediately west of the study area lies Lemington Road. Given the cleared nature of the study area alongside Lemington Road, edge effects are likely to be negligible.

The proposal would affect the current disturbance regimes by eliminating grazing and replacing it with an open cut coal mine. This may increase the incidence of noise and dust on the Hunter River riparian vegetation within the study area, south of the subject site. The loss of woodland and scattered trees from the subject site would reduce the number of stepping-stone links however; the Hunter River riparian vegetation would not be removed.

How is the proposal likely to affect habitat connectivity?

The majority of the study area is cleared and contains little native vegetation. Wildlife corridors in the study area, therefore, are limited; however include the riparian vegetation along the Hunter River. This riparian vegetation would not be directly impacted or fragmented by the proposal.

Predominantly isolated stands of trees occurring in the study area may provide limited value as stepping-stone links for highly mobile species. These stands of trees would be removed by the proposal.

Within the study area, the Large-footed Myotis is most likely to utilise the riparian vegetation corridor of the Hunter River. Given the mobility of this species, and that the Hunter River riparian vegetation would not be fragmented, it is unlikely the proposal would create new barriers or exacerbate existing barriers for the Large-footed Myotis.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Large-footed Myotis (DECCW 2009a).

Conclusion

Based on the above assessment the proposal is considered **unlikely** to have a major impact on the Large-footed Myotis.

Hollow-dependent Micro-bats

Saccolaimus flaviventris and *Mormopterus norfolkensis*

The Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) and Eastern Freetail Bat (*Mormopterus norfolkensis*) are listed as Vulnerable under Schedule 2 of the TSC Act. These two species have been considered together for this assessment based on their similar habitat requirements (i.e. tree hollow-dependant).

Note: a taxonomic revision of Australian molossids has lead to a change of the Eastern Freetail Bat's scientific name from *Mormopterus norfolkensis* to *Micronomus norfolkensis* (Churchill 2008) however, as CAVs and DECCW are yet to adopt the name change, *Mormopterus norfolkensis* is used in this report.

The Eastern Freetail Bat was recorded within the study area during the current field survey. The species was recorded with definite confidence using Anabats placed on the edge of the Hunter River and within the Central Hunter Box – Ironbark Woodland. The species has also been previously recorded at five other locations within 10km of the study area (DECCW 2009b).

The Yellow-bellied Sheathtail Bat has not been previously recorded within the study area. This species has been previously recorded once within 10km of the study area, approximately 3.7km to the south (DECCW 2009b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Both microchiropteran bat species are known to be tree-hollow dependent (Churchill 2008). The Eastern Freetail Bat tends to forage along gaps and edges of forests and bushland patches, usually within a few kilometres of the roost site (Churchill 2008). The Yellow-bellied Sheathtail Bat is a fast flier and usually forages above the canopy or lower over open spaces and edges of forests (Churchill 2008).

The study area provides known and/or potential foraging and/or breeding habitat for both bat species within the open Central Hunter Box – Ironbark Woodland, riparian vegetation, wetlands and surrounding grassy farmland. The proposal is likely to remove and/or disturb trees that provide potential breeding habitat for these species; remove and/or disturb cracks within the banks of the unnamed tributary that provide potential roosting habitat for the Yellow-bellied Sheathtail Bat; and, remove and/or disturb known/potential foraging grounds.

The proposal is likely to have a major impact on individuals roosting, or particularly if breeding, in the tree hollows as most of the woodland containing hollows (0.89ha of 1.06ha) would be removed. Although these species are highly mobile, the loss of known and/or potential foraging and breeding habitat could temporarily effect a local population as (surviving) individuals from the study area seek and establish new territory. The Yellow-bellied Sheathtail Bat in particular appears to be territorial (Churchill 2008) and the proposal may result in some intra-specific competition until new roost sites are established.

However, given the reasonably high mobility of these species, the extent of similar habitat resources within the locality (1,360.91ha) and that connectivity associated with the Hunter River riparian vegetation would not be fragmented, it is unlikely the proposal would significantly disrupt the lifecycle of a local population of the Yellow-bellied Sheathtail Bat or Eastern Freetail Bat, or these species as a whole.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal would remove approximately 2.48ha of known and/or potential foraging habitat of the Eastern Freetail Bat and Yellow-bellied Sheathtail Bat (woodland/native grassland/ unnamed tributary) as well as cleared farmland. Approximately 0.89ha of this foraging habitat contains potential roosting and breeding habitat in the form of hollow-bearing trees. A further 2.09ha potential habitat (woodland/native grassland/riparian vegetation) would be indirectly impacted. Impacts to a total of 4.57ha foraging and/or breeding habitat equate to 0.34 per cent of the available habitat resources within the locality (1,360.91ha). Given the extent of potential foraging and breeding resources within the locality and the high mobility of these two bat species, the proposal is considered unlikely to have a major impact on habitat for the Eastern Freetail Bat or Yellow-bellied Sheathtail Bat.

Does the proposal affect any threatened species that are at the limit of its known distribution?

The Yellow-bellied Sheathtail Bat has a large distribution extending across northern and eastern Australia (DEC 2005u). The Eastern Freetail Bat is found along the entire east coast from south Queensland to southern New South Wales (DEC 2005d). As a result the study area is not at, or near, the limit of distribution for either species.

How is the proposal likely to affect the current disturbance regimes?

The study area has been largely cleared of native vegetation and what remains is subject to ongoing disturbances primarily from grazing. An open cut coal mine occurs immediately east of the study area from which noise and dust may disturb habitats within the study area periodically. Immediately west of the study area lies Lemington Road. Given the cleared nature of the study area alongside Lemington Road, edge effects are likely to be negligible.

The proposal would affect the current disturbance regimes by eliminating grazing and replacing it with an open cut coal mine. This may increase the incidence of noise and dust on the Hunter River riparian vegetation within the study area, south of the subject site. The loss of woodland and scattered trees from the subject site would reduce the number of stepping-stone links however; the Hunter River riparian vegetation would not be removed.

How is the proposal likely to affect habitat connectivity?

The majority of the study area is cleared and contains little native vegetation. Wildlife corridors in the study area, therefore, are limited; however include the riparian vegetation along the Hunter River. This riparian vegetation would not be directly impacted or fragmented by the proposal.

Predominantly isolated stands of trees occurring in the study area may provide limited value as stepping-stone links for highly mobile species. These stands of trees would be removed by the proposal.

The Eastern Freetail Bat and Yellow-bellied Sheathtail Bat are highly mobile species, with the Eastern Freetail Bat being capable of flying several kilometres from a roost site (Churchill 2008). Given the mobility of these species, and that the Hunter River riparian vegetation would not be fragmented, it is unlikely the proposal would create new barriers or exacerbate existing barriers for the Yellow-bellied Sheathtail Bat or Eastern Freetail Bat.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Yellow-bellied Sheathtail Bat or Eastern Freetail Bat (DECCW 2009a).

Conclusion

Based on the above assessment the proposal is considered **unlikely** to have a major impact on the Yellow-bellied Sheathtail Bat or Eastern Freetail Bat.

APPENDIX 5

Diuris tricolor survey at Carrington West Wing – Addendum to Ecology Assessment

Jodi Kelehear
Senior Environmental Scientist
EMGA Mitchell McLennan
Ph: 02 9493 9504
Email: jkelehear@emgamm.com

27 September 2010

Our Ref: 12323

Dear Jodi,

RE: *Diuris tricolor* survey at Carrington West Wing – Addendum to Ecology Assessment

This letter style report should be included as an addendum to the Carrington West Wing Ecology Assessment (Biosis Research 2010). The Ecology Assessment undertaken by Biosis Research 2010 (field surveys undertaken August 2009) identified habitats within the Carrington West Wing development site which have the potential to support the threatened species *Diuris tricolor* (Tricolour Orchid, Pine Donkey Orchid), listed as Vulnerable under the TSC Act. As this species is cryptic and impossible to detect when not in flower, it was recommended that additional surveys be undertaken targeting this species during its short flowering season.

Targeted surveys for *D. tricolor* were undertaken on 22nd September 2010 from approximately 12 noon to 3 pm by two Biosis Research staff. The weather was sunny and warm (24°C). The areas surveyed concentrated on the Central Hunter Box – Ironbark Woodland and Derived Native Grassland habitats which were identified in the ecology assessment as providing potential habitat for *D. tricolor* (see attached map for survey effort).

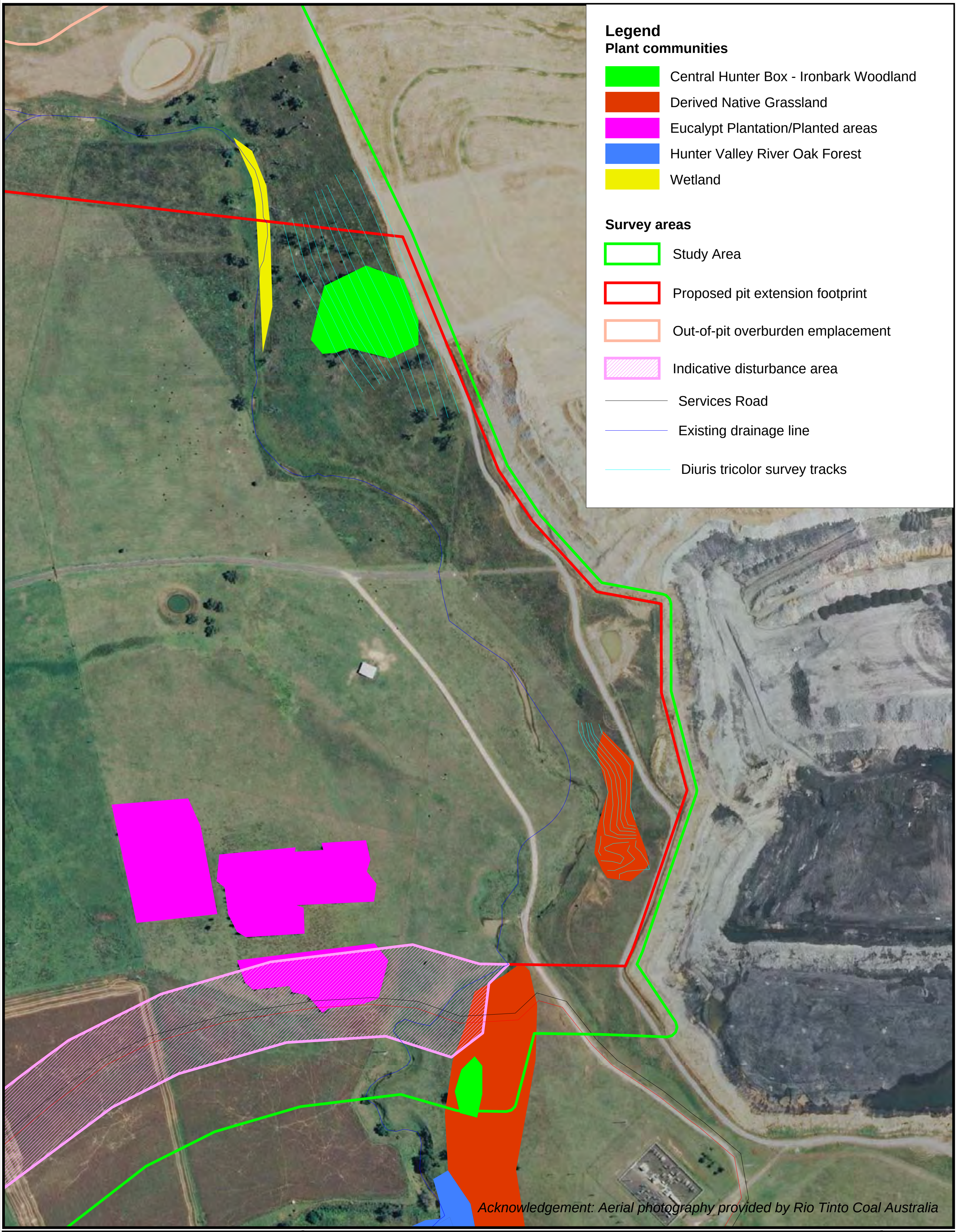
Surveys were undertaken at a time when a nearby population was confirmed to be in flower: *D. tricolor* was recorded in flower at the Mount Arthur Conservation Area, approximately 16.5 km north-west of the study area, on 22 September (Nathan Campbell, Ecologist, Cumberland Ecology pers. comm. 23 September 2010).

The habitats within the impact area were comprehensively searched using the following survey methodology: two Biosis Research staff walked parallel transects approximately 3m apart scanning the ground looking for the distinctive flower of the *D. tricolor*. The Central Hunter Box – Ironbark Woodland habitat occurs on the eastern boundary of the study area and covers an area of 0.89 ha within the subject site while the Derived Native Grasslands lies to the south-east of the study area and covers an area of 1.35 ha within the subject site. In addition to the transect lines walked over these habitats within the subject site, adjacent areas to the north and south of the Central Hunter Box – Ironbark Woodland with similar understorey to the woodland were paced searching for the orchid.

Diuris tricolor was not detected during the surveys conducted on the 22nd September 2010 at the Carrington West Wing site. Given the extent of survey effort and the record of flowering individuals in regional populations on the day of the survey, it is considered extremely unlikely that *D. tricolor* occurs on the site. The results of the survey support the conclusion in the Ecology Assessment (Biosis Research 2010) that the proposal is unlikely to result in a significant impact on this species.

Yours sincerely,

Jane Rodd
Consultant Botanist
Ph: 0400 988 963



BIOSIS RESEARCH Pty. Ltd.
18-20 Mandible Street
Alexandria
NEW SOUTH WALES 2015

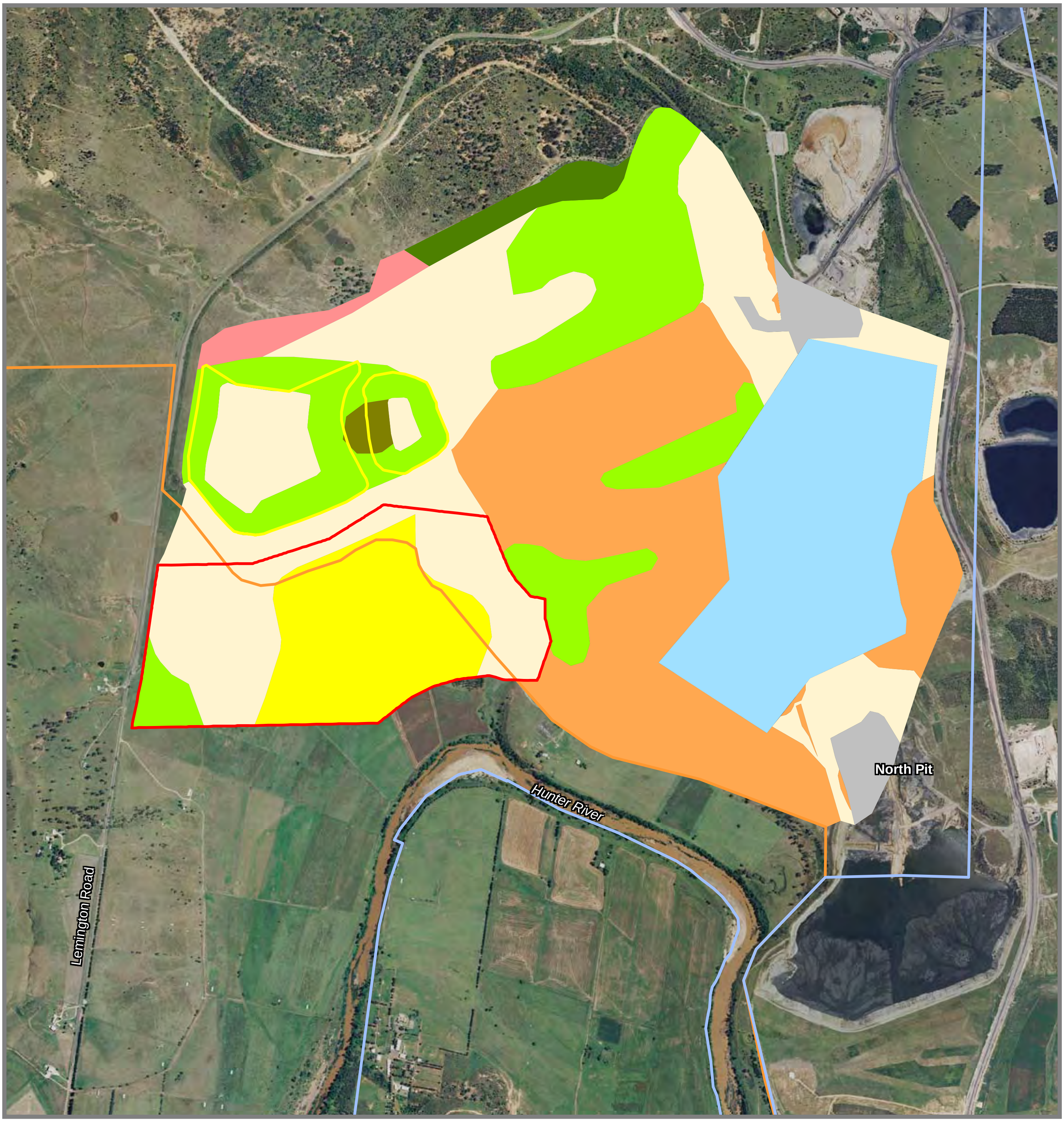
Figure 1:Diuris tricolor surveys

Date: 28/09/2010	Drawn by: JER
File number: 12323	Checked by: BJR
Location: P:\12300s\12323\Mapping\ 12323 Diuris tricolor surveys.WOR	

APPENDIX 6

Proposed final Landform figure highlighting the area of rehabilitation and restoration following mining operations

C:\GIS\EMGA\9016 Carrington West Wing Modification\Figures\August 2010



- Regenerated Grassland (grazing)
- Regenerated Woodland (biodiversity)
- Rehabilitated Grassland (grazing/cropping)
- Rehabilitated Woodland (biodiversity)
- Rehabilitated Woodland (grazing)
- Void / dam / mining area
- Rehabilitated Woodland (Central Hunter Box - Ironbark Woodland) - indicative location
- Rehabilitated Grassland (grazing/ cropping) - Class II land capability
- HVO North current development consent boundary
- HVO South project approval boundary
- Proposed footprint of evaporative sink
- Out-of-pit overburden emplacement
- Proposed extension area

0 0.5 1 1.5
Kilometres

Figure 3.4

Proposed final landuse

REFERENCES

REFERENCES

Adams PB and Lawson SD (2008) Pollination in Australian orchids: A critical assessment of the literature 1882-1992. *Australian Journal of Botany* 41**,** 553-575.

Allen GR *et al.* (2002) 'Field Guide to the Freshwater Fishes of Australia.' West Australian Museum and CSIRO Publishing, Perth.

Augee M and Ford D (1999) Radio-tracking studies of Grey-headed Flying-foxes, *Pteropus poliocephalus*, from the Gordon colony, Sydney. *Proceedings of the Linnaean Society of New South Wales* 121**,** 61-70.

Australian Museum (2009). Flame Robin Fact File, http://www.austmus.gov.au/factsheets/flame_robin.htm, Australian Museum

Australian National Botanic Gardens (2007). Australian Plant Name Index, http://www.anbg.gov.au/cpbr/databases/apni.html, Australian National Botanic Gardens

Barbour MT, Gerritsen J, Snyder BD, and Stribling JB (1999) 'Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish.' U.S. Environmental Protection Agency, Office of Water, Washington, No. 841-B-99-002.

Barker J *et al.* (1995) 'A Field Guide to Australian Frogs.' Surrey Beatty and Sons, Sydney.

Belcher C *et al.* (2008) Spotted-tailed Quoll *Dasyurus maculatus*. Pp. 60-62 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Bennett AF (1990) 'Habitat Corridors: Their Role in Wildlife Management and Conservation.' Department of Conservation and Environment, Sydney.

Bishop T (1996) 'Field Guide to the Orchids of New South Wales and Victoria.' UNSW Press, Sydney.

Blakers M *et al.* (1984) 'The Atlas of Australian Birds.' Melbourne University Press, Melbourne.

Boehm EF (1944) The Fork-tailed Swift in South Australia. *South Australian Ornithology* 15**,** 54-58.

G. A Boxall, J. J Sandberg, and F. J Kroon. (2002). Population structure, movement and habitat preferences of the purple-spotted gudgeon, *Mogurnda adspersa*. Marine and Freshwater Research 53, 909-917

Churchill S (2008) 'Australian Bats. Second Edition.' Allen & Unwin, Sydney.

Coal & Allied (2003) 'Environmental procedure 5.1 disturbance and rehabilitation.' Coal & Allied Rio Tinto Australia.

Coal & Allied (2007) 'Environmental procedure EP10.2 flora and fauna.' Coal & Allied, Rio Tinto Australia.

Commonwealth of Australia. (2008). EPBC Act Policy Statement 1.1 Significant Impact Criteria. Department of the Environment and Heritage

Commonwealth Threatened Species Scientific Committee (2008). Approved Conservation Advice for *Diuris sheaffiana* (syn *D. tricolor*) (Spotted-throat Cowslip), http://www.environment.gov.au/biodiversity/threatened/species/pubs/23189-conservation-advice.pdf, Department of the Environment, Water, Heritage and the Arts

Cropper SC (1993) 'Management of Endangered Plants.' CSIRO Australia, Melbourne.

Cumberland Ecology (2010) 'Proposed Warkworth Extension Environmental Assessment - Volume 2 Technical Report Ecology Study.'.

Debus S and Chafer C (1994a) The Powerful Owl *Ninox strenua* in New South Wales. *Australian Birds* 28**,** 21-39.

Debus S and Chafer C (1994b) The Sooty Owl, *Tyto tenebricosa* & Powerful Owl, *Ninox strenua* in NSW. *Australian Birds* 28 Supplement**,** 2.

DEC (1999). Squirrel Glider: Threatened Species Information, http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_squirrel_glider.pdf, Department of Environment and Conservation

DEC (2004) 'Compliance Performance Report, Industry Sector: Coal Mines.' NSW Department of Environment and Conservation (now NSW Department of Environment, Climate Change and Water).

DEC (2005a). *Diuris tricolor* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10243, Department of Environment and Conservation

DEC (2005b). Draft recovery plan for the Green and Golden Bell Frog (*Litoria aurea*), http://www.environment.nsw.gov.au/resources/nature/recoveryplanGreenGoldBellFrogDraft.pdf, Department of Environment and Conservation

DEC (2005c). Eastern Bentwing-bat: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10534, Department of Environment and Conservation

DEC (2005d). Eastern Freetail Bat: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10544, Department of Environment and Conservation

DEC (2005e). Gang-gang Cockatoo - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10975, Department of Environment and Conservation

DEC (2005f). Glossy Black-cockatoo: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10140, Department of Environment and Conservation

DEC (2005g). Grey-headed Flying-fox - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10697, Department of Environment and Conservation

DEC (2005h). Koala: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10616, Department of Environment and Conservation

DEC (2005i). Large-eared Pied Bat: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10157, Department of Environment and Conservation

DEC (2005j). Large-footed Myotis: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10549, Department of Environment and Conservation

DEC (2005k) 'Large-footed Myotis: Threatened Species Profile.' NPWS, Hurstville.

DEC (2005l). Masked Owl: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10820, Department of Environment and Conservation

DEC (2005m). Olearia cordata - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10576, Department of Environment and Conservation

DEC (2005n). *Pomaderris brunnea* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=1

0647, Department of Environment and Climate Change and Water

DEC (2005o). Powerful Owl: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10562, Department of Environment and Conservation

DEC (2005p). Regent Honeyeater: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10841, Department of Environment and Conservation (NSW)

DEC (2005q). River Red Gum population in the Hunter Catchment - profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10968, NSW Department of Conservation (now NSW Department of Environment, Climate Change and Water)

DEC (2005r). Swift Parrot: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10455, Department of Environment and Conservation

DEC (2005s). Threatened Species Profile, *Cynanchum elegans*, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10196, Department of Environment and Climate Change and Water

DEC (2005t). Turquoise Parrot: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10555, Department of Environment and Conservation

DEC (2005u). Yellow-bellied Sheathtail-bat: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10741, Department of Environment and Conservation

DEC & DPI (2005) 'Draft Guidelines for Threatened Species Assessment - Part 3A of the Environmental Planning and Assessment Act 1979.' NSW Department of Environment and Conservation and Department of Primary Industries.

DECC (2008). Critical habitat register, http://www.environment.nsw.gov.au/criticalhabitat/CriticalHabitatProtectionByDoctype.htm, Department of Environment and Climate Change

DECCW (2009a). Critical habitat register, http://www.environment.nsw.gov.au/criticalhabitat/CriticalHabitatProtectionByDoctype.htm, Department of Environment and Climate Change

DECCW. (2009b). DECCW Atlas of NSW Wildlife: Muswellbrook, Camberwell & Howes Valley 1:100 000 map sheets.

DECCW (2010) 'Adequacy comments: Draft Environmental Assessment Hunter Valley Operations North - Carrington West Wing Modification (DA 450-10-2003 MOD 3).'.

DEH (2005) 'EPBC Act - Principal Significant Impact Guidelines 1.1 Matters of National Environmental Significance.' Department of the Environment and Heritage, Canberra.

DEH (2006) 'EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Significance.' Department of Environment and Heritage, Canberra.

Department of Planning (2010) 'Hunter Valley Operations North - Carrington West Wing Extension Modification (DA 450-10-2003 MOD 3): Adequacy of Environmental Assessment.'.

DEWHA (2009). Census of Australian Vertebrates, http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/cavs/index.html, Department of the Environment, Water, Heritage and the Arts

Dickman CR and Read DG (1992) 'The biology & management of dasyurids of the arid zone in NSW.' NPWS, NSW, No. 11.

DUAP (2000) 'Coal mines and associated infrastructure.' NSW Department of Urban Affairs and Planning.

Edgar R and Belcher C (1995) Spotted-tailed Quoll. Pp. 67-68 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

Eldridge MDB and Close RL (1995) Brush-tailed Rock-wallaby. Pp. 383-385 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

EMGA Mitchell McLennan (2010) Carrington West Wing Environmental Assessment, Volume 1.

ERM (2003) 'Hunter Valley Operations West Pit Extension and Minor Modifications Environmental Impact Statement.' Environmental Resource Management Australia on behalf of Coal and Allied.

ERM (2005a) 'Carrington Pit Extended - Flora and Fauna Assessment.' Environmental Resources Management Australia.

ERM (2005b) 'Carrington Pit Extended - Statement of Environmental Effects.' Environmental Resources Management Australia.

ERM (2008) 'Threatened Flora and Fauna of Hunter Valley Operations North, Hunter Valley Operations South and Mount Thorley Warkworth. Literature Review and Gap Analysis.' Environmental Resource Management Australia on behalf of Coal and Allied.

Fairfull S and Witheridge G (2003) 'Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings.' NSW Fisheries, Cronulla.

Forshaw JM and Cooper WT (1981) 'Australian Parrots (2nd Ed).' Lansdowne Press, Melbourne.

Forshaw JM and Cooper WT (2002) 'Australian Parrots (3rd Ed).' Lansdowne Press, Melbourne.

Garnett S (1992) 'Threatened and Extinct Birds of Australia.' York Press, Richmond.

Gibbons P and Lindenmayer DB (1997) Conserving Hollow-dependent Fauna in Timber Production Forest. *Environmental Heritage Monograph* 3**,** 110.

Goldingay RL and Jackson SM (2004) A review of the ecology of the Australian Petauridae. Pp. 376-400 In 'The Biology of Australian Possums and Gliders' (Eds RL Goldingay and SM Jackson). Surrey Beatty & Sons, Chipping Norton.

Harden G (1990) 'Flora of New South Wales Volume 1.' NSW University Press, Kensington.

Harden G (1992) 'Flora of New South Wales Volume 3.' NSW University Press, Kensington.

Harden G (1993) 'Flora of New South Wales Volume 4.' NSW University Press, Kensington.

Harden G (2002) 'Flora of New South Wales Volume 2 (Revised Edition).' University of New South Wales Press Ltd., Kensington.

Harden G and Murray LJ (2000) 'Supplement to Flora of New South Wales, Volume 1.' NSW University Press, Kensington.,

Harris JH and Gehrke PC (1997) 'Fish and Rivers in Stress: The NSW Rivers Survey.' NSW Fisheries Office of Conservation, Cronulla.

Higgins PJ (1999) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird.' Oxford University Press, Melbourne.

Higgins PJ and Davies SJJF (1996) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to Pigeons.' Oxford University Press, Melbourne.

Higgins PJ and Peter JM (2002) 'Handbook of Australian, New Zealand & Antarctic Birds. Volume 6: Pardalotes to shrike -thrushes.' Oxford University Press, Victoria.

Higgins PJ *et al.* (2006) 'Handbook of Australian, New Zealand & Antarctic Birds. Volume 7: Boatbills to Starlings.' Oxford University Press, Melbourne.

HLA-Envirosciences Pty Ltd (2006) 'Avifauna Survey Hunter Valley Operations.'.

Hoye GA and Dwyer PD (1995) Large-eared Pied Bat. Pp. 510-511 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

Hoye GA and Hall LS (2008a) Eastern Bent-winged Bat: *Miniopterus schreibersii oceanensis*. Pp. 507-508 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Hoye GA and Hall LS (2008b) Little Bent-winged Bat: *Miniopterus australis*. Pp. 503-504 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Hoye GA *et al.* (2008) East-coast Free-tailed Bat *Mormopterus norfolkensis*. Pp. 491-492 In 'The Mammals of Australia' (Eds S van dyck and R Strahan). Reed New Holland, Sydney.

Hoye GA and Schulz M (2008) Large-eared Pied Bat: *Chalinolobus dwyeri*. Pp. 531-532 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

James T *et al.* (1999) 'Rare Bushland Plants of Western Sydney.' Royal Botantical Gardens,

Jones D (2006) 'A complete guide to Native Orchids of Australia. Including island territories.' Reed New Holland,

Kovac M and Lawrie JW (1991) 'Soil Landscapes of the Singleton 1:250 000 Sheet.' Soil Conservation Service of NSW, Sydney.

Law BS *et al.* (2008) Eastern False Pipistrelle *Falsistrellus tasmaniensis*. Pp. 542-543 In 'Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Lintermans M and Osborne W (2002) 'Wet & Wild. A Field Guide to Freshwater Animals of the Southern Tablelands and High Country of the ACT and NSW.' Environment ACT, Canberra.

Mackie Environmental Research (2010) 'Carrington West Wing Modification Groundwater Assessment.'.

Marchant S and Higgins PJ (1990) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 1 Ratites to Ducks: Part B Australian Pelican to Ducks.' Oxford University Press, Melbourne.

Marchant S and Higgins PJ (1993) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 Raptors to Lapwings.' Oxford University Press, Melbourne.

Martin RW *et al.* (2008) Koala *Phascolarctos cinereus*. Pp. 198-201 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Menkhorst PW and Lumsden LF (1995) Eastern False Pipistrelle. In 'Mammals of Victoria' (Ed. PW Menkhorst). Oxford University Press, Melbourne.

Menkhorst PW, Weavers BW, and Alexander JSA (1988) Distribution, habitat and conservation status of the Squirrel Glider *Petaurus australis* (Petauridae: Marsupialia) in Victoria. *Australian Wildlife Research* 15**,** 59-71.

Moore MED (1955) The Use of Photososciological Methods in Ecological Investigations. I. The Braun-Blanquet System. *Journal of Ecology* 43**,** 226-244.

Morcombe M (2003) 'Field Guide to Australian Birds.' Steve Parish Publishing, Brisbane.

Morgan G and Terry J (1992) Natural regions of western New South Wales and their use for environmental management.

Proceedings of the Ecological Society of Australia 16**,** 467-473.

Morris AK (1980) The status and distribution of the Turquoise Parrot in New South Wales. *Australian Birds* 14**,** 57-67.

Mueck SG (2000) Translocation of Plains Rice-flower (Pimelea spinescens ssp. spinescens), Laverton, Victoria. *Ecological Management and Restoration* 1**,** 111-116.

NPWS (1999a). Glossy Black Cockatoo: Threatened Species Information, http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_glossy_black_cockatoo.pdf , NSW National Parks and Wildlife Service

NPWS (1999b). Green and Golden Bell Frog: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_green_golden_bell_frog.pdf, National Parks and Wildlife Service

NPWS (1999c). Regent Honeyeater: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_regent_honeyeater.pdf, NSW National Parks and Wildlife Service

NPWS (1999d). Spotted-tailed Quoll: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_spotted_tailed_quoll.pdf, New South Wales National Parks and Wildlife Service

NPWS (2004) 'Vegetation Survey, Classification and Mapping. Lower Hunter and Central Coast Region.' NPWS for LHCCREMS, Hurstville.

NSW DPI (1999) 'Policy and Guidelines, Aquatic Habitat Management and Fish Conservation.'.

NSW Government (2009). BioNet, http://www.bionet.nsw.gov.au/Area.cfm , NSW Government

NSW Scientific Committee (2005). Acacia pendula (a tree) in the Hunter catchment - endangered population listing, http://www.environment.nsw.gov.au/determinations/AcaciaPendulaHunterCatchmentEndangeredpop.htm, NSW Department of Environment, Climate Change and Water

NSW Scientific Committee (2006). Cymbidium canaliculatum - endangered population listing, http://www.nationalparks.nsw.gov.au/npws.nsf/Content/cymbidium_canaliculatum_endangered,

NSW Scientific Committee (2007a). Final Determination to list *Diuris tricolor*, the Pine Donkey Orchid population in the Muswellbrook local government area as an endangered population, http://www.environment.nsw.gov.au/determinations/DiurisTricolorEndPop.htm, Department of Environment, Climate Change and Water

NSW Scientific Committee (2007b). Final Determination to list *Diuris tricolor*, the Pine Donkey Orchid population in the Muswellbrook local government area as an endangered population, http://www.environment.nsw.gov.au/determinations/DiurisTricolorEndPop.htm, Department of Environment, Climate Change and Water

NSW Scientific Committee (2007c). Final Determination to list *Diuris tricolor*, the Pine Donkey Orchid population in the Muswellbrook local government area as an endangered population, http://www.environment.nsw.gov.au/determinations/DiurisTricolorEndPop.htm, Department of Environment, Climate Change and Water

NSW Scientific Committee (2008a). Final Determination to list *Litoria booroolongensis* as an Endangered species on Schedule 1 of the Act, http://www.environment.nsw.gov.au/determinations/BooroolongFrogEndSpListing.htm

NSW Scientific Committee (2008b). Final Determination to list Speckled Warbler as a Vulnerable species under the TSC Act, http://www.nationalparks.nsw.gov.au/np ws.nsf/Content/Speckled+warbler+-+vulnerable+species+listing, NSW Department of Environment and Climate Change

NSW Scientific Committee (2008c). Little Lorikeet *Glossopsitta pusilla* - proposed vulnerable species listing, http://www.environment.nsw.gov.au/determinations/littlelorikeetpd.htm, NSW Scientific Committee (2009a). Flame Robin *Petroica phoenicea* - proposed vulnerable species listing, http://www.environment.nsw.gov.au/determinations/flamerobinpd.htm,

NSW Scientific Committee (2009b). Little Eagle *Hieraaetus morphnoides* - proposed vulnerable species listing, http://www.environment.nsw.gov.au/determinations/littleeaglepd.htm, NSW Scientific Committee

NSW Scientific Committee (2009c). Little Lorikeet *Glossopsitta pusilla* - final determination, http://www.environment.nsw.gov.au/determinations/littlelorikeetFD.htm, Department of Environment and Conservation

NSW Scientific Committee (2010). Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions - endangered ecological community listing, http://www.environment.nsw.gov.au/determinations/centralhuntergreyboxFD.htm, NSW Department of Environment, Climate Change and Water

Peake TC (2005) 'The Vegetation of the Central Hunter Valley, New South Wales. A Report on the Findings of the Hunter Remnant Vegetation Project. Final Draft Version 1.' Hunter-Central Rivers Catchment Management Authority, Paterson.

Pennay M (2008) A maternity roost of the Large-eared Pied Bat *Chalinolobus dwyeri* (Ryan) (Microchiroptera: Vespertilionidae) in central New South Wales Australia. *Australian Zoologist* 34**,** 564-569.

Pizzey G and Knight F (1997) 'The Field Guide to the Birds of Australia.' Angus and Robertson, Sydney.

Quin DG (1995) Population ecology of the Squirrel Glider (*Petaurus norfolcensis*) and the Sugar Glider (*P. breviceps*) (Marsupialia: Petauridae) at Limeburners Creek, on the central North Coast of New South Wales. *Wildlife Research* 22**,** 471-505.

Richards GC (2008) Yellow-bellied Sheath-tailed Bat *Saccolaimus flaviventris*. Pp. 472-473 In 'Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Richards GC *et al.* (2008) Large-footed Myotis: *Myotis macropus*. Pp. 544-545 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Scotts D, Drielsma M, and Kingma L (2000) 'Key habitats and corridors for fauna: A landscape framework for bioregional conservation planning in North-east New South Wales. II. Methods, decision rules, assumptions and mapped outputs.' NPWS, Coffs Harbour.

Shields J and Crome F (1992) 'Parrots and Pigeons of Australia.' Angus and Robertson, Sydney.

Simpson K and Day N (1996) 'Field guide to the birds of Australia.' Viking. Penguin Books Australia Ltd., Ringwood.

Soderquist T (1995) Brush-tailed Phascogale, *Phascogale tapoatafa*. Pp. 104-106 In 'The Mammals of Australia' (Ed. R Strahan). Reed Books, Sydney.

Soderquist T and Rhind S (2008) Brush-tailed Phascogale, *Phascogale tapoatafa*. Pp. 105-107 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Strahler AN (1957) Quantitative analysis of watershed geomorphology. *Transactions of the American Geophysical Union* 8**,** 913-920.

R. Thackway and I. Cresswell. (1995). Biogeographic regionalisation for Australia: A framework for establishing the national system of reserves, Version 4.0. Nature Conservation Agency, Canberra.

Tidemann CR (1995) Grey-headed Flying-fox. Pp. 439-440 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

Traill BJ and Duncan S (2000) 'Status of birds in the New South Wales temperate woodlands region.' Consultancy report to the NSW National Parks and Wildlife Service by the Australian Woodlands Conservancy, Chiltern, Victoria.

Umwelt (2007a) 'Assessment of the Current Status and Recommendations for Management Strategies and Recovery Actions for Endangered Population of River Red Gum (Eucalyptus camaldulensis) in the Hunter Valley.' Umwelt Pty Limited on behalf the NSW Department of Environment and Conservation.

Umwelt (2008) 'Survey of River Red Gums at Hunter Valley Operations and Mt Thorley - Warkworth, Hunter Valley.' Umwelt Pty Limited on behalf of Coal and Allied - Rio Tinto Coal Australia.

Umwelt (2010) 'Hunter Valley Operations River Red Gum Rehabilitation and Restoration Strategy ' - Umwelt Pty Limited on behalf of EMGA Mitchell McLennan

Vallee L *et al.* (2004) 'Guidelines for the Translocation of Threatened Plants in Australia. Second Edition.' Australian Network for Plant Conservation, Canberra.

Van der Ree R and Suckling GC (2008) Squirrel Glider *Petaurus norfolcensis*. In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). New Holland Publishers (Australia) Pty Ltd, Sydney.

van dyck S and Strahan R (2008) 'The Mammals of Australia Third Edition.' Reed New Holland, Sydney.

Webb JK (1996) Ecology and Conservation of the Threatened Broad-headed Snake *Hoplocephalus bungaroides*. PhD Dissertation,' University of Sydney.

Webb JK and Shine R (1998) Ecological characteristic of an endangered snake species *Hoplocephalus bungaroides* (Sepentes: Elapidae). *Animal Conservation* 1**,** 185-193.

Weston PHPAJaET (2005) More than symbioses: orchid ecology, with examples from the Sydney Region. *Cunninghamia* 9.

White AW and Pyke GH (1996) Distribution and conservation status of the Green and Golden Bell Frog *Litoria aurea* in New South Wales. *Australian Zoologist* 30**,** 177-189.

Wilson A and Lindenmayer DB (1995) 'Wildlife Corridors and the Conservation of Biodiversity: A Review.' National Corridors of Green Program, Green Australia Ltd., Canberra.

WRM (2010) 'Surface Water Assessment for proposed Carrington West Wing Extension.'.

www.coalandallied.com.au

www.coalandallied.com.au