Flora and Fauna Assessment of

No 1 Open Cut Extension

Muswellbrook Coal Company Limited

Prepared for

Muswellbrook Coal Company Limited
PO Box 123
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HLA-Envirosciences Project No U883/3

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EXECUTIVE SUMMARY

A detailed flora and fauna survey and assessment was completed for Muswellbrook Coal Company Limited at its No. 1 Open Cut operation located north-east of Muswellbrook. This assessment forms part of its development application to Muswellbrook Shire Council seeking consent for the extension of open cut coal mining operations for the No. 1 Open Cut Mine.

Flora and fauna survey methodologies were conducted in general accordance with standard National Parks and Wildlife Service Flora and Fauna Survey methodologies used for regional assessments (NPWS, 1997). Surveys were carried out on 29 October and 14 - 17 November inclusive in a manner that ensured reasonable potential for the detection of all identified potential threatened species that may be present within the study area. Flora surveys utilised systematic (quadrat and transects) and non-systematic (random meander) techniques to sample the study area. Fauna surveys were carried out over five days and four nights and included the use of Elliot traps, an Anabat detector, Owl Caller, Call Playback and other measurement instruments to sample the study area.

Flora surveys of the study area identified a total of 157 species, which comprised of 106 natives and 51 exotics. Fauna surveys of the study area identified a total of 76 species, which comprised of 50 avifauna species, 10 reptiles species, 13 mammals and three amphibians species. Whilst no threatened flora species were observed within the study area, a total of two threatened fauna species were detected including the Grey-crowned Babbler (Vulnerable) and Eastern False Pipistrelle (Vulnerable).

An assessment pursuant to Section 5A of the Environmental Planning and Assessment Act (1979) (EP&A Act, 1979) identified that there will be no significant impact on threatened species or their habitat either locally or for the Sydney Region. For both these species, particularly the Grey-crowned Babbler, it was determined that the removal of foraging and breeding habitat would represent a short to medium term impact that would be minimised in the long-term site by extensive habitat rehabilitation and reconstruction works. Short-term impacts are likely to be minimised by the preservation and management of directly adjoining tracts of vegetation to the north and south of the study area.

ABBREVIATIONS

AHD	Australian Height Datum.
AMG	Australian Map Grid co-ordinates.
DBH	Diameter at Breast Height
DLWC	Department of Land and Water Conservation
EEC	Endangered Ecological Community
EP&A Act (1979)	Environmental Planning and Assessment Act (1979)
EPBC Act (1999)	Environmental Protection and Biodiversity Act (1999)
FM Act (1994)	Fisheries Management Act (1994)
HLA	HLA-Envirosciences Pty Limited
LGA	local government area
KTP	Key Threatening Process
MCC	Muswellbrook Coal Company Pty Limited
MSC	Muswellbrook Shire Council
NPWS	National Parks and Wildlife Service
NSW	New South Wales
SEPP	State Environmental Planning Policy.
TSC Act (1995)	Threatened Species Conservation Act (1995)

GLOSSARY OF TERMS

Avifauna	Birds
Consent authority	Muswellbrook Shire Council
Conservation	The protection, maintenance, management, sustainable use, restoration and enhancement of the natural environment (NPWS 1997).
Caepitose	Growing in tufts.
Critical Habitat	Habitat declared to be critical habitat under Part 3 of the TSC Act (1995).
Culms	An aerial stem bearing the flower in grasses, rushes etc.
Development Application	An application for consent under Part 4 of the EP&A Act (1979), to carry out development.
Ecological Community	An assemblage of species occupying a particular area.
Ecotones	A transition between two communities where the key characteristics from each of these communities are clearly evident (i.e. flora communities).
Endangered Ecological Community	An ecological community specified in Part 3 of Schedule 1 of the TSC Act (1995).
Endangered Population	A population specified in Part 2 of Schedule 1 of the TSC Act (1995).
Endangered Species	A species specified in Part 1 of Schedule 1 of the TSC Act (1995).
EP&A Act (1979)	Refers to the Act that regulates development within the state of NSW.
EPBC Act (1999)	Refers to the Act that regulates the management, recovery, conservation and assessment of threatened species, populations, ecological communities, migratory species and world heritage areas within the country of Australia.
Exotic Fauna	Any animal that is not native to the local area.
Exotic Flora	Any plant that is not native to the local area that has invaded the native vegetation.
Fauna	Means any animal, whether vertebrate or invertebrate, and at whatever stage of development, but does not include fish within the meaning of the FM Act (1994) other than amphibians or aquatic or amphibious mammals or aquatic or amphibious reptiles.
Forb	A non-woody plant other than a grass, sedge, rush i.e. herb.
Flora	Means any plant-life that is indigenous to New South Wales, whether vascular or non-vascular and in any stage of biological development, and includes fungi and lichens, but does not include marine vegetation within the meaning of the FM Act (1994).
FM Act (1994)	Refers to the Act that regulates the management of marine and aquatic ecosystems within the state of NSW.
Habitat	An area or areas occupied, or periodically or occasionally occupied by a species,

	population or ecological community and includes any biotic or abiotic components.
Key Threatening Process	A threatening process specified in Schedule 3 of the TSC Act (1995). Threatening process is defined as a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities.
Likely	Taken to be a real chance or possibility (NPWS, 1996).
Lifecycle	The sequence of events from the origin as a species, to the death of an individual (NPWS 1996).
Limit of its geographic range	The final or furthest boundary or point that a plant or animal species continues to extends to, in relation to the known geographical extent of distribution of that species (NPWS 1996).
Local population	The population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated (NPWS 1996).
Nodes	The level of a stem at which one or more leaves arise.
Population	A group of organisms, all of the same species, occupying a particular area.
Region	The Director-General of National Parks and Wildlife, has determined pursuant to section 4(1) of the TSC Act (1995) and section 4(6A) of the EP&A Act that the national system of bioregionalisation identified in the map entitled *An Interim Biogeographic Regionalisation of Australia* and its accompanying report *An Interim Biogeographic Regionalisation of Australia (IBRA): A Framework for Setting Priorities in the National Reserves System Cooperative Program*. Version 4.0, published by the Australian Nature Conservation Agency on 31 March 1995, is appropriate for the purposes of the provisions in which the term region is used.
Risk of extinction	A species is at risk of extinction if its numbers are reduced to such a critical level, or its habitats have been so drastically reduced, that it is in danger of becoming extinct (NPWS 1996).
Scientific Committee	Scientific Committee constituted under Part 8 of the TSC Act (1995).
Significant	Important, weighty or more than ordinary (NPWS 1996).
Species	Of animal or plant includes any defined sub-species and taxon below a sub-species and any recognisable variant of a sub-species or taxon.
Species Impact Statement	A statement referred to in Division 2 of Part 5 of the TSC Act (1995) and includes an environmental impact statement, prepared under the EP&A Act, that contains a species impact statement.
Stag	A standing dead and dry tree greater than 30 centimetres DBH, and greater than three metres in height (NSW Forestry 1999).
Study area	The subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly (NPWS 1996).

Taxon	A term used to describe a member of any taxonomic category eg species, genus.
Taxonomic Group	A term used to describe a group of similar members of a taxonomic category.
Threatened Species	A species specified in Schedule 1 Part 1 (endangered species), Part 4 (presumed extinct) and Schedule 2 (vulnerable species) of the TSC Act (1995).
Threatened species, populations and/or ecological communities	Means a species, population and/or ecological community identified in either Schedule 1 or Schedule 2 of the TSC Act (1995) (NPWS 1996).
Threatening Process	A process that threatens, or may have the capability to threaten, the survival or evolutionally development of the species, population or ecological community.
TSC Act (1995)	Refers to the Act that regulates the management, recovery, conservation and assessment of threatened species, populations and ecological communities within the state of NSW.
Vegetation Community	An assemblage of flora species occupying a particular area.
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (NPWS 1996).
Vulnerable species	A species specified in Schedule 2 of the TSC Act (1995).

1.0 INTRODUCTION

HLA-Envirosciences Pty Limited (HLA) was commissioned by Muswellbrook Coal Company Limited (MCC) to undertake a flora and fauna assessment of the area to be affected by the proposed extension of the No.1 Open Cut coal mine (the proposed development) at Muswellbrook. Details of the location and proposed development are provided in **Section 1.1** and **Section 1.2** respectively.

This assessment will have regard for all the relevant environmental legislation relating to flora and fauna that regulates development within New South Wales (NSW), with a particular focus on the key objectives identified in **Section 1.3**. The limitations of this assessment are discussed **Section 1.4**, with a brief overview of the structure assessment provided in **Section 1.5**.

1.1 The Location

MCC's No. 1 Open Cut coal mine operation is located approximately 1.3 km to the east of the nearest residential areas of the northern section of the Muswellbrook Township, a major regional centre of the Upper Hunter Valley. Muswellbrook Township and surrounding district are situated within the Upper Hunter River catchment where it forms part of the northern boundary to the Sydney Basin Bio-region.

The Sydney Basin Bio-region is characterised by the sandstone valleys and plateaux, which are found in the southern and western ranges of the greater Muswellbrook district. It is generally regarded that the Sydney Basin bio-region is cooler and less fertile than its neighbouring bio-region to the north, the North Coast Bio-region, which is renown for its stronger sub-tropical influences. Given the proximity of the study area to these two distinctly different bio-regions, both of which are characterised by a wide range of distinctly different flora and fauna assemblages, it is considered that there is great potential for substantial variability in local plant and animal species, populations and ecological communities.

1.2 The Proposed Development

MCC wishes to extend operations in the existing Muswellbrook No. 1 Open Cut within Consolidated Coal Lease 713 (CCL713). The proposal, when combined with the No. 2 Open Cut operation, has the potential to allow mining to continue for up to nine years at a production rate of between 1.8 and 2.0 million tonnes per annum (Mtpa). The general layout of the existing No. 1 Open Cut and proposed extensions A and B is shown in **Figure 1**.

1.3 Assessment Objectives

This flora and fauna assessment was undertaken in accordance with the following objectives:

- Identify the flora and vegetation communities present within the study area;
- Identify the fauna and their habitats present within the study area;

- Complete targeted surveys for threatened species, populations, ecological communities and critical habitat;

- Review survey findings in accordance with existing legislation; and

- Assess the potential impact of the proposed development in accordance with Section 5A of the *Environmental Planning and Assessment Act* (1979) (EP&A Act 1979), Threatened Species Conservation Act (1995) (TSC Act, 1995) and *Environmental Protection and Biodiversity Conservation Act* (1999) (EPBC Act, 1999).

1.4 Constraints and Opportunities

This assessment was completed in two separate components comprising of a desktop review and targeted field survey of the study area for threatened species. The desktop review relied heavily on past surveys, databases, scientific literature, topographic maps and aerial photography of the study area and general locality. Accordingly, it is recognised that the accuracy of information procured from past local studies was limited by their respective aims and objectives. Inadequacies in background information, if any at all, will be identified and discussed within this assessment. A review of the surveys constraints and opportunities is presented in **Section 5.4** of this assessment.

1.5 Structure of this Assessment

This flora and fauna assessment has been prepared in accordance with the requirements of:

- Section 5A of the EP&A Act (1979); and

- Director General's requirements issued by the Department of Urban Affairs and Planning (DUAP), dated 4 October 2001.

The contents of this flora and fauna assessment are as follows:

Executive Summary

Glossary of Terms

Section 1.0 : Introduction

Provides a background to the proposed development and the assessment objectives.

Section 2.0 : Planning Context

Explains the statutes that define the flora and fauna assessment process.

Section 3.0 : The Existing Environment

Documents the existing environment and its surrounds of the study area including geology, soils, topography, drainage and existing impacts on the environment. A summary of the biological environment, constructed from past surveys of the locality, has also been included as a background to this assessment.

Section 4.0 : Field Survey Results

Provides a full description of the current biological resources present within the study area. This section has been prepared in accordance with a set of detailed and scientifically repeatable field survey methodologies.

Section 5.0 : Analysis of Ecological Environment

Provides an assessment of the likely impact of the proposal on the biological environment.

Section 6.0 : Mitigation Measures

Provides an outline of measures proposed to eliminate or reduce any impacts arising from the proposed development.

Section 7.0 : Conclusions

Concludes what the likely impact of the proposed development will be on the natural environment. Identifies the need for any further field survey, mitigation, amelioration and / or additional assessment.

Section 8.0 : References

Appendices

2.0 PLANNING CONTEXT

2.1 Statutory Requirements

MCC seeks development consent pursuant to Part IV of the EP&A Act (1979) for the purpose of extracting coal from CCL713. The consent sought is for activities involving open cut operations, coal transport/storage and site rehabilitation.

Pursuant to Schedule 3 of the EP&A Regulation (2000), coal mines producing more than 500 tonnes of coal or carbonaceous material per day is a "designated development". As such, an Environmental Impact Statement (EIS) must accompany the development application. This document fulfils the ecological assessment component for the EIS, and in doing so meets all the requirements of the EP&A Act 1979 and EP&A Regulation (2000).

2.1.1 Environmental Planning and Assessment Act (1979)

The assessment of the proposed development requires the consent authority to consider the potential for a significant impact on threatened flora, fauna, endangered populations, endangered ecological communities and critical habitat. Factors considered by the consent authority in their determination are detailed in Section 5A of the EP&A Act (1979), with an assessment carried out in accordance with Section 5A often referred to as the 'Eight Part Test of Significance'.

The Eight Part Test of Significance refers to the schedules of the TSC Act (1995), which contain registers of threatened species, populations, ecological communities, critical habitat and key threatening processes for New South Wales. Only scheduled species, populations, ecological communities, key threatening processes and critical habitat located within or nearby the study area, identified through survey, habitat assessment and database searches, are required to be assessed in accordance with the Eight Part Test of Significance. A significant adverse impact on any threatened species, populations, ecological communities, key threatening processes and critical habitat may require further assessment through the preparation of a Species Impact Statement (SIS).

2.1.2 Threatened Species Conservation Act (1995)

The TSC Act (1995) was introduced by the NSW State Government to conserve threatened species, populations and ecological communities of animals and plants. This Act amends the National Parks and Wildlife Act (1974), the EP&A Act (1979) and repealed the Endangered Fauna (Interim Protection) Act (1991).

If the determining authority identifies that the proposed development is likely to have a significant affect on threatened species populations or ecological communities, or their habitats, the proponent must be notified that if the proposed development is to proceed then a SIS must be prepared.

A SIS must be prepared in accordance with the NPWS Director General's requirements and the provisions outlined in Part 6 Division 2 of the Act. Factors taken into account include the following:

a) The principles of ecologically sustainable development;

b) Whether the proposed development is likely to irretrievably reduce the long term viability of the species population or ecological community in the region; and

c) Whether the proposed development is likely to accelerate the extinction of the species population or ecological community or place if at risk of extinction.

In the assessment of the SIS, the Director General must also consider the likely social and economic consequences of granting or refusing consent to the development application.

2.1.3 Environmental Protection and Biodiversity Conservation Act (1999)

Environment Australia (EA) is the regulatory authority responsible for the assessment and management of nationally threatened species, conservation reserves, Ramsar wetlands and migratory species. The EPBC Act, (1999) requires the proponent to refer the proposal to EA where a scheduled item may potentially interact with the proposed development.

Referrals reviewed by EA include an assessment of public submissions provided during the public exhibition period. This review process will identify whether the development constitutes a Controlled Action (CA). A CA requires further review and assessment by EA and an approval must be sought for the proposal in accordance with the legislative requirements of the EPBC Act (1999).

2.1.4 State Environmental Planning Policy (SEPP) No.44 – Koala Habitat Protection

This SEPP encourages the conservation and management of koala habitats, thus ensuring permanent free-living koala populations will be maintained over their present range. The policy applies to 107 local government areas including Muswellbrook Shire Council (MSC) local government area (LGA). Development cannot be approved in the areas covered by the policy without a prior investigation of koala habitat.

3.0 THE EXISTING ENVIRONMENT

3.1 The Physical Environment

The study area consists of a number of physical attributes that has assisted in shaping the site's biological environment. Key physical attributes include geology, soils, topography and drainage, which are briefly described in the following sections.

3.1.1 Geology

The study area is situated on the Greta Coal Measures, which consists of a range of parent rock types including sandstone, shale, mudstone, conglomerate and coal. The Greta Coal Measures form part of the Sydney Basin geological province, which was formed during the Permian period mostly through freshwater and marine sedimentation. Many species and ecological communities are endemic to the Sydney Basin bio-region due to the age and nature of this geological province.

3.1.2 Soils

The study area consists of a number of soils including Podzolics (Yellow and Brown), Lithosils, Solodics and Sylothes. The localised combination of these soils have been collectively described as the Roxburgh Soil Landscape (Kovacs and Lawrie, 1991), which is characterised by hardsetting, moderately well drained soils of low fertility. Minor to moderate sheet erosion is common and, combined with the soils low fertility, it is considered that this soil landscape represents a land capability classification of V (land suitable only for grazing) (Kovacs and Lawrie, 1991).

3.1.3 Topography

The study area is situated within the central lowlands topographic zone of the Singleton 1 250,000 map sheet. This zone is characterised by undulating to rolling hills with elevations ranging from 10-140 metres (Kovacs and Lawrie, 1991).

An analysis of field observation and topographic data of the study area generally confirms this topographical description. However, local elevations exceed those mentioned by Kovac and Lawrie (1991), being between 200 m and 260 m. The topographic character of the study area is presented in **Figure 2**.

Open cut pits from past mining activities are located within the study area. The open cut void of Muswellbrook No. 1 Open Cut is as deep as 70 metres below the lowest natural elevation of the study area. Other significant topographic features include areas of overburden and rehabilitation zones that have been formed through overburden emplacements.

3.1.4 Drainage

Surface waters flowing from the study area flow in a northwesterly direction via a network of small ephemeral primary and secondary creeks. A tertiary creek to the north of the study area collects the majority of runoff from the site and flows in a northwesterly direction into Sandy Creek, whilst the remainder of runoff drains into the No. 1 Open Cut Mine and to the northeast into Muscle Creek. Much of the study area is situated within the catchment of Sandy Creek, which flows in a southwesterly direction from McCullys Gap, situated between Bells Mountain and Colonel Mountain, prior to it meeting the Hunter River on the northern outskirts of Muswellbrook Township. The remainder of the study area is situated within the catchment of Muscle Creek. The hydrological character of the study area is presented in **Figure 2**.

3.2 The Biological Environment

A review of recent flora and fauna surveys for the Muswellbrook locality has been used to briefly describe the general ecological characteristics of the locality that surrounds the study area. Sources reviewed include:

- Maunsell McIntyre Pty Ltd (2000) *Muswellbrook Bypass Route Selection Study – Volume 2 Working Papers* Report to the NSW RTA;
- HLA Envirosciences Pty Limited (1998) *Sandy Creek Colliery Muswellbrook EIS.* Report to Muswellbrook Coal Company Limited; and
- CH2MHILL (1998) *Bells Ridge Waste Management Facility, Muswellbrook EIS.* Report to Collex Waste Management Pty Limited.

A detailed analysis of the biological environment is presented in **Section 4.0** of this report including detailed results of recent field surveys targeting each flora community present within the study area.

3.2.1 Flora

The majority of the study area is extensively altered from its natural state through past agricultural activity and current mining operations. Impacts associated with European occupation include land clearing, pasture improvement and the grazing of cattle. However, scattered throughout this landscape are remnants of native vegetation including grassland and dry sclerophyll open woodland (HLA 1998).

The grasslands of the locality are dominated by a variety of native and introduced grass species including *Chloris ventricosa, Danthonia spp., Bromus spp*., and *Trifolium subterranean*. The remnant dry sclerophyll open woodland consists of large native trees scattered over much of the study area. The three dominant species are *Eucalyptus moluccana* (Grey Box), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus blakelyi* (Blakely's Red Gum). *Casuarina luehmannii* (Bull Oak) is sparsely scattered through the study area with the occasional *Brachychiton populneus* (Kurrajong) also present. Creek lines contain *Angophora floribunda* (Rough Bark Apple) in conjunction with the species previously mentioned (CH2MHILL, 1998; HLA 1998).

Previous searches of the NSW Wildlife Atlas Database, conducted in 1998 and 2000, identified no threatened species or populations within a ten (10) kilometre radius of the study area. Further, detailed field studies undertaken by CH2MHILL (1998) and HLA (1998) consolidated this result with no threatened species being present within or adjacent to the study area. However, Maunsell McIntyre (2000) have identified one (1) regionally significant Eucalypt within the Muswellbrook locality that being the Slaty Box (*Eucalyptus dawsonii*).

3.2.2 Fauna

The study area offers limited faunal habitat values due to the extent of clearing and intensive agricultural usage (CH2MHILL, 1998; HLA, 1998; Maunsell McIntyre, 2000). However, the faunal habitat present within the aquatic environments in and around the farm dams is considered to be of moderate value (HLA, 1998; Maunsell McIntyre, 2000). Some microhabitat exists for herptofauna within rock exfoliates (rock on rock) and thermal fractures (rifts), and the Cumbungi (*Typha orientalis*) may offer suitable frog habitat (HLA, 1998).

Only one threatened fauna species has been detected in close proximity to the study area that being the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (CH2MHILL, 1998; Maunsell McIntyre, 2000). Further, it is possible that the Green and Golden Bell Frog *(Litoria aurea*), which is a listed Endangered Species under the TSC Act (1995), may occur on a sporadic or permanent basis within suitable dams throughout the locality, but has not been located within the study area (HLA, 1998; Maunsell McIntyre, 2000). Other species that have been detected within a ten (10) kilometre radius of the study area include the Spotted-tailed Quoll, Koala, Freckled Duck and Square-tailed Kite (Maunsell McIntyre, 2000).

3.3 Impacts On The Existing Environment

3.3.1 Human Impacts

Most of the study area has been directly or indirectly influenced by human activity, particularly in the post-European settlement period. Main influences on the natural environment include coal mining, agriculture and permanent human occupation.

Agriculture has been present within the Muswellbrook district for over 150 years. Grazing of cattle predominated the use of undulating lands not suited to cropping. Conversely, the more fertile alluvial areas of the Hunter River and its main tributaries allowed for cropping, eventuating in extensive clearing of native vegetation from these areas.

Coal mining has been active within the general locality since 1907 and has incorporated a combination of both open cut and underground mining operations. Further clearing of native vegetation was required particularly where open cut pits were constructed. Logging of Ironbark for the creation of underground mine supports was also undertaken during early mine operations.

3.3.2 Natural Impacts

Since European settlement there have been many non-indigenous species introductions to the Hunter Valley region. Agricultural activity has resulted in the introduction of many grass, herb and woody plant species that have colonised throughout suitable habitats including previously undisturbed vegetation.

Concurrent with the naturalisation of non-indigenous flora has been the introduction of exotic fauna species including the European Rabbit, European Fox, Cat, Dog, House Mouse, Black Rat and various avifauna. Many of these species have had a significant and possibly irreversible affect on native flora and fauna. The majority, if not all, of these species have contributed to the decline or displacement of native species within the Muswellbrook locality.

3.3.3 Geomorphological Impacts

The majority of geological impacts on the natural environment have occurred many millions of years prior to this date, thus resulting in a relatively stable ecological environment.

Human activity over the last 150 years is accelerating change to the natural environment within the study area. Soil erosion has increased since the onset of agricultural and mining activity within the Muswellbrook locality due to vegetation clearing and exposure of unconsolidated soils. However, recent mining operations have substantially reversed past management practices, with a focus on impact minimisation through ecologically sustainable landuse management and rehabilitation activities a priority. Despite this there is one substantial environmental impact that is contributing to both land and air degradation. Spontaneous combustion with the Muswellbrook No. 2 underground coalmine is resulting in severe surface subsidence over localised areas and emission of greenhouse gases into the atmosphere. This issue is of primary concern and will be addressed by the proponent in their proposal, which will include the extinguishment of this fire together with the restoration of the surface topography.

3.3.4 Summary of Existing Impacts

A summary of the existing impacts affecting the natural environment of the study area is provided in **Table 1**.

TABLE 1
CURRENT IMPACTS ON THE NATURAL ENVIRONMENT

Impact	Time since disturbance (years)			Percentage of study area affected by impact (%)	Notes
	+30	15-30	0-15		
Clearing	✓	✓	✓	70*	Most clearing occurred during the later part of the 19th Century for agriculture and early to mid part of the 20th Century for mining. Recent clearing only small, isolated and mine related.
Agriculture	✓	✓		20	At one stage nearly all of this study area (up to 70%) was used for agriculture. Recent mine activity has extinguished much of this landuse activity from the site.
Mining/ Infrastructure	✓	✓	✓	15	Current mine activity and infrastructure placements are situated at the eastern and western sections of the study area. No native vegetation exists within these areas.
Rehabilitation		✓	✓	20	Areas of overburden have been rehabilitated to prevent erosion and improve scenic amenity.
Earthworks		✓	✓	25	Mine related earthworks including excavation, overburden placements and road construction. Additional earthworks include the erection of a borrow pit to assist in filling voids created by subsidence.
Exotic flora	✓	✓	✓	60*	Agriculture has assisted in the introduction of many grass species and some woody invasive species.
Exotic fauna	✓	✓	✓	80*	There is evidence of exotic fauna including cats, goats, rabbits and foxes.

* Denotes identified impacts overlap with areas affected by agriculture, mining, rehabilitation and earthworks.

4.0 FIELD SURVEY RESULTS

This section of the report summarises the results of the desktop and field survey components of this study in accordance with the objectives identified in **Section 1.3**. Surveys were conducted in general accordance with techniques recommended by the Regional Biodiversity Survey and Assessment Guidelines – Draft for Comment (NPWS and SMEL, 2001). Survey methodologies utilised in this assessment are provided in **Appendix 2** of this report.

The field survey of the study area, targeting the identification and classification of flora and fauna was conducted over a five (5) day period. Dates defining the survey period are provided in **Table 2**.

TABLE 2
DATES DEFINING THE SURVEY PERIOD

Date	Flora Survey Activities	Fauna Survey Activities	
		Diurnal	Nocturnal
29 October 2001	✓	✓	
14 November 2001	✓	✓	✓
15 November 2001	✓	✓	✓
16 November 2001	-	✓	-
17 November 2001	-	✓	-

In addition to field survey was a review of background literature (as discussed in **Section 3.0**) and database records. Literature and data sources examined as part of this assessment include:

- Aerial photographs and topographical maps of the study area (scale 1:25000);
- Rare or Threatened Australian Plants (ROTAP) (Briggs and Leigh, 1995);
- NPWS *Wildlife Atlas* database (NPWS, 2001);
- The schedules of the TSC Act (1995) and EPBC Act (1999);
- NSW Bureau of Meteorology climatic data;
- Research papers and literature that describe Australian flora, fauna and ecosystems; and
- Previous reports and surveys within the local area.

Information obtained from these sources has been used to define and classify the study area's ecological values (**Section 4.0**), with a view to assessing the impact of the proposed development (**Section 5.0**).

4.1 Meteorological Data

The meteorological parameters that define the prevailing weather conditions during the survey period are provided in **Table 3**.

TABLE 3
METEOROLOGICAL PARAMETERS DEFINING THE STUDY PERIOD*

Date	Temperature (˚C)		Rainfall (mm)	Wind @ 9am		Humidity (%)	
	9 a.m.	3 p.m.		Direction	Speed	9 a.m.	3 p.m.
29 October 2001	24.1	31.8	0.0	NW	18 km/h	25	14
14 November 2001	15.9	27.9	0.0	SE	11 km/h	65	28
15 November 2001	20.5	23.4	0.0	E	5 km/h	68	55
16 November 2001	21.0	20.9	2.4	N	5 km/h	66	63
17 November 2001	19.5	30.6	0.0	E	9 km/h	73	20

* Weather data sourced from the NSW Bureau of Meteorology – Jerrys Plains Meteorological Station

Note: It is considered that temperature, humidity, precipitation and wind conditions identified within **Table 3** are all conducive to high quality survey conditions.

4.2 The Flora Environment

Survey effort for each flora community identified within the study area is provided in **Table 4**. A map showing the location of survey transects and stations is provided in **Figure 3**. Flora species identified within each stratified unit is presented in **Appendix 2**, with descriptions for each flora community provided in **Section 4.2.2**.

TABLE 4
FLORA SURVEY EFFORT

Flora community	Transect (100m length)	Quadrat (20m×20m)	Random Meander
1	2	0	✓
2	0	1	✓
3	4	4	✓
4	4	3	✓
5	2*	1*	-

* Transect / Quadrat orientated in a circular arrangement, 4m×100m, outlining the margin of the dam (littoral zone).

4.2.1 Flora of the Study Area

A total of 157 species were observed during the flora survey including 106 native and 51 exotic species. A detailed list of the species observed within the study area is provided in **Appendix 3**. Detailed descriptions of the flora communities of the study area are provided in the following section (**Section 4.2.2**) with notes regarding survey results for threatened species, populations and ecological communities provided in **Section 4.2.3**.

4.2.2 Flora Communities of the Study Area

The flora of the study area was categorised into five (5) separate flora communities, including:

1. Rehabilitated Grasslands / Forest;
2. Red Gum - Rough-barked Apple Open Forest;
3. Narrow-leaved Ironbark Woodland;
4. Grassland; and
5. Aquatic Forbland.

A description for each of these flora communities is provided below, with a map identifying the spatial distribution of these flora communities provided in **Figure 4**. Lands excluded from this assessment, including the area of major subsidence (6.4 ha) and hardstand zones (19.7 ha), are identified within **Figure 4** and comprise of approximately 26.1 ha or 27.2% of the study area.

4.2.2.1 Rehabilitated Grasslands / Forest

Rehabilitation of lands within the study area has been established throughout the overburden emplacement areas to prevent erosion, improve scenic amenity, restore past land uses and create native wildlife habitat. Much of this environment has been created through deliberate plantings of specific grass and tree species capable of withstanding the newly created soil profile, which often lacks substantial development in terms of organic matter content, biological diversity and pedal structure. Consequently, it should be noted that few of the species introduced into this area for the purpose of rehabilitation are locally indigenous. **Table 5** provides details on the physical and biological characteristics of this community.

TABLE 5 FLORA COMMUNITY 1 - REHABILITATED GRASSLANDS / FOREST		
Structure	Tree Canopy Shrub Canopy Groundcover	Very sparse to dense (5-75% cover). Maximum height of 10 m. Sparse to open (15-30% cover) within a height range of 0.5 m to 4 m. Dense (75-100% cover) within a height range of 0.0 m to 1.0 m
Common Species	Tree Canopy Shrub Canopy Groundcover	A mix[1] of Eucalypts including *Corymbia citriodora, C. maculata, Eucalyptus camaldulensis, E. cladocalyx, E. crebra, E. microtheca, E. punctata* and *E. tereticornis*. A mix[1] of Wattles including *Acacia decurrens, A. falcata, A. implexa, A. saligna* and *A. salicina.* *Chloris gayana*, Phalaris aquatica** and *Avena fatua**
Description	The Rehabilitated Grasslands / Shrublands flora community is a grassland – shrubland complex characterised by open expanses of grassland throughout isolated open to dense shrub growths to a maximum height of 10m. This community is restricted to the eastern and western limits of the study area and has been artificially created through deliberate plantings and ongoing management.	
Area	23.1 ha (24.6% of the study area)	
Disturbance History	The growth medium for this community is sourced from mine overburden, which consists of a variety of specific chemical and physical qualities that are derived from the Greta Coal Measures geological formation. Very minor erosion is present at some selected areas. Medium to large mammal grazing by the European Rabbit, Feral Goat and Eastern Grey Kangaroo is also evident.	
Weeds	Many weedy species are present throughout this vegetation community. Apart from those mentioned above, other species include Whiskey Grass (*Andropogon virginicus**), Castor Oil Plant (*Ricinis communis**), Fennel (*Foeniculum vulgare**) and Dock (*Rumex crispus**).	

[1] The mix of Eucalypts and Wattles present within the rehabilitated areas have originated from deliberately sown seed stock that is not necessarily representative of local flora communities.

* Denotes exotic species.

4.2.2.2 Red Gum - Rough-barked Apple Open Forest

Small isolated vegetation remnants located approximately 400 metres to the west of Bimbadeen homestead represent the total extent of this flora community within the study area. The higher abundance of Red Gum and Rough-barked Apple, relative to the locally dominant Narrow-leaved Ironbark, appears to set this flora assemblage apart from the adjoining Narrow-leaved Ironbark Woodland. However, a closer examination of the understorey flora characteristics indicates that these two flora communities are relatively similar, with similarities / dissimilarities related to their close proximity and past disturbance history respectively. Dissimilarities between this community and the Narrow-leaved Ironbark Woodland flora community may be due to increased sandstone outcropping, sandier soils or a higher soil moisture content. **Table 6** provides details on the physical and biological characteristics of this community.

TABLE 6
FLORA COMMUNITY 2 - RED GUM - ROUGH-BARKED APPLE OPEN FOREST

Structure	Tree Canopy Shrub Canopy Groundcover	Open (30-50% cover) with a height range of 15 m to 18 m. Sparse to open (15-30% cover) within a height range of 0.5 m to 3.5 m. Open (30-50% cover) within a height range of 0.0 m to 0.5 m.
Common Species	Tree Canopy Shrub Canopy Groundcover	*Eucalyptus tereticornis, E. crebra, E. blakelyi, Angophora floribunda.* *Acacia falcata, Ozothamnus diosmifolia, Exocarpos cupressiformis, Bursaria spinosa.* *Danthonia linkii, Dichelachne micrantha, Lomandra confertifolia.*
Description	The Red Gum - Rough-barked Apple Open Forest flora community is restricted in its occurrence to an isolated remnant within the central western portion of the study area. It is characterised by a mixture of grasses and shrub to a maximum height of 3.5m. Much of the tree canopy is even-aged suggesting past clearing activities, however regeneration is well advanced. Approximately 3% of the ground's surface within this area is characterised by natural bush rock (sandstone-conglomerate).	
Area	1.1 ha (1.2% of the study area)	
Disturbance History	Approximately 40% of this community has been subject to disturbance including power line maintenance and grazing pressure from feral goats, rabbits and kangaroos. The current remnant, may be resultant from natural rehabilitation.	
Weeds	Galena *(Galena pubescens**), African Boxthorn (*Lycium ferocissimum**), Fireweed (*Senecio madagascariensis**) and Shivery Grass (*Briza minor**).	

* Denotes exotic species.

4.2.2.3 Narrow-leaved Ironbark Woodland

This native flora community is the most common within the study area. Comprising over 25% of the study area, the Narrow-leaved Ironbark Woodland occurs throughout moderately flat to steeply sided slopes where it has been allowed to persist and naturally regenerate. Some small variability in this flora community was noted including the presence of Grey Box as a minor associate throughout the higher elevations of the study area, including the immediate surrounds of Bimbadeen homestead and the ridgeline that runs parallel to the coal haul road in the east. A grass-herb complex, with scattered dense growths of woody shrubs, dominates the understorey. **Table 7** provides details on the physical and biological characteristics of this flora community.

TABLE 7
FLORA COMMUNITY 3 - NARROW-LEAVED IRONBARK WOODLAND

Structure	Tree Canopy Shrub Canopy Groundcover	Sparse (15-30% cover) with a height range of 14m to 20m. Sparse (15% cover) within a height range of 0.5m to 2m. Open (30-50% cover) within a height range of 0.0m to 0.8m.
Common Species	Tree Canopy Shrub Canopy Groundcover	*Eucalyptus crebra.* *Acacia paradoxa, O. diosmifolia* and *Notolaea longifolia.* *Cymbopogon refractus, Themeda australis, Danthonia linkii.*
Description	The Narrow-leaved Ironbark flora community is a eucalypt - grassland complex characterised by a sparse to open canopy of Narrow-leaved Ironbark, with a well-developed grassy understorey amid isolated dense shrub growths. This community is present within the central and western sections of the study area, with the largest and highest quality representative of this vegetation present to the north of Bimbadeen homestead.	
Area	23.7 ha (25.2% of the study area)	
Disturbance History	This community has experienced a range of human induced impacts including selective logging, clearing for agriculture, cattle grazing, subsidence, minor gully erosion and small mammal grazing by exotic species including the European Rabbit, Feral Goat and Eastern Grey Kangaroo.	
Weeds	Prickly Pear (*Opuntia stricta*), Mother of Millions (*Bryophyllum delagoense*), Thistle (*Cirsium vulgare*).	

* Denotes exotic species.

4.2.2.4 Grassland

The Grassland flora community of the study area is representative of a regenerating agricultural landscape that has been not been intensively grazed for a number of years. Whilst there is little evidence of regeneration in the tree and shrub canopy strata, there is substantial regrowth and diversity in the groundcover strata including a number of native and exotic grasses and forbs. **Table 8** provides details on the physical and biological characteristics of this flora community.

TABLE 8
FLORA COMMUNITY 4 – GRASSLAND

Structure	Tree Canopy Shrub Canopy Groundcover	Very sparse (<10% cover) with a height range of 10 m to 16 m. Very sparse (<15% cover) within a height range of 0.5 m to 2.5 m. Dense (75-100% cover) within a height range of 0.0 m to 1.0 m.
Common Species	Tree Canopy Shrub Canopy Groundcover	*E. crebra* and *E. moluccana.* *A. decora, A. paradoxa, A. falcata* and *N. longifolia.* Dominant species including *Chrysocephalum semipapposum, Dichelachne micrantha, Themeda australis* and *Austrodanthonia bipartita.*
Description	The Grassland community is characterised by an open expanse of grasses and non-woody forbs throughout an area that is predominantly void of trees and shrubs. Natural regeneration within this community appears to be ongoing due to the absence of cattle grazing and other significant human related impacts. This community dominates the majority of the western and central portions of the study area.	
Area	19.1 ha (20.3% of the study area)	
Disturbance History	This community has experienced a range of human induced impacts including selective logging, clearing for agriculture, cattle grazing, subsidence, minor gully erosion and small mammal grazing by exotic species including the European Rabbit, Feral Goat and Eastern Grey Kangaroo.	
Weeds	Pimpernel (*Anagalis arvensis**), Quacking Grass (*Briza maxima**), Soft Brome (*Bromus molliformis**), Saffron Thistle (*Carthamus lanatus*), Century Plant (*Centaurium solstitialis**) and Galenia (*Galenia pubescens**).	

* Denotes exotic species.

4.2.2.5 Aquatic Forbland

The Aquatic Forbland flora communities of the study area vary substantially in structure and diversity. The dam nearest Bimbadeen and the dam near the open cut void at the western extremity of the study area are dominated by Cumbungi emergent vegetation, with no evidence of any other aquatic species present. In contrast, vegetation within the largest dam of the study area situated approximately midway between Bimbadeen and the open cut void in the west is completely dominated by Blunt Pondweed, a submerged native aquatic forb. **Table 9** provides details on the physical and biological characteristics of this flora community.

TABLE 9
FLORA COMMUNITY 5 - AQUATIC FORBLAND

Structure	Submerged Surface-Floating Emergent	Absent to dense (0-75% cover). Absent. Sparse to dense (15-75% cover) within a height range of 0.0 m to 2.0 m.
Common Species	Submerged Surface-Floating Emergent	*Potamogeton ochreatus*. Absent. *Typha orientalis*.
Description	The Aquatic Forbland community is characterised by either an emergent growth of Cumbungi or submerged growth of Blunt Pondweed, with neither species co-existing within the same environment. This community is restricted to open water bodies.	
Area	0.9 ha (1.0% of the study area)	
Disturbance History	Minor salinity may be present within these water bodies, as evidenced by a high-water mark stained by an unknown white compound.	
Weeds	None.	

4.2.3 Threatened Species, Populations and Ecological Communities

A habitat assessment of the study area for threatened species, combined with a 10 km radius search of the NPWS *Wildlife Atlas* database (NPWS, 2001), identified a total of two (2) threatened flora species requiring further consideration. **Table 10** lists the results of this assessment together with a statement identifying any further assessment requirements under Section 5A of the EP&A Act (1979). **Appendix 3** (Table 3) provides details of the assessment process used to assist the collation of **Table 10**.

TABLE 10
THREATENED FLORA SPECIES SUMMARY AND ASSESSMENT REQUIREMENTS

Species	Conservation Status		Section 5A Assessment
	TSC Act (1995)	EPBC Act (1999)	
Bothriochloa biloba	Vulnerable	Vulnerable	Yes
Olearia cordata	Vulnerable	Vulnerable	No

Note: The 10km radius search of the NSW Wildlife Atlas Database resulted in no threatened species within the identified locality.

4.3 The Fauna Environment

Survey effort within each flora community identified within the study area is provided in **Table 11**. **Figure 5** identifies the locations where particular fauna survey techniques were employed.

TABLE 11
FAUNA SURVEY EFFORT

Flora Community	Trapping Transect (100m length)	Spotlighting (0.5hr transect)	Anabat (0.5hr quadrat)	Habitat Search (0.5hr quadrat)	Call Playback (1hr quadrat)	Opportunistic Observations
1	0	0	0	0	1	✓
2	1	1	0	1	1	✓
3	3	4	2	4	2	✓
4	0	1	2	2	1	✓
5	0	2	0	2	0	✓

Fauna species identified within each flora community are listed in **Appendix 4**, with notes on fauna observations and habitat values provided in **Sections 4.3.1** and **4.3.2** respectively.

4.3.1 Fauna of the Study Area

A total of seventy-six (76) vertebrate fauna species were observed during the course of field investigations. The most common taxonomic group were avifauna species, of which fifty (50) species were observed including two (2) exotic species. Other taxonomic groups observed within the study area include reptiles (total of 10 species), mammals (total of 13 species) and amphibians (total of three species).

Most of the avifauna observed within the study area was recorded from the woodland flora communities. Ecological specialists, including ducks, grebes, herons and other waterfowl were mostly restricted to the aquatic habitats of the study area. Exceptions to this rule include the common Wood Duck, which was occasionally observed foraging around the Bimbadeen homestead and other suitably prosperous foraging grounds.

Nesting activity was evident within the woodlands of the study area, including species such as the Currawong, Grey Butcher Bird, Variegated Fairy Wren, White-winged Cough and Grey-crowned Babbler. A pair of Spur-winged Plovers was also noted to be restricting their movements to the immediate surrounds of Bimbadeen homestead and is similarly likely to be nesting within this locality. Other important observations include substantial nesting activity by the introduced Indian Myna within hollows of dead or dying trees situated nearby the open cut void in the west.

Noisy Friarbirds were frequently observed foraging on insects and limited nectar supplies available within a few flowering Narrow-leaved Ironbarks. Large numbers of Eastern Rosellas were observed foraging within the grasslands of the study area. Corellas and Sulphur-crested Cockatoos were also observed, however their occurrence was restricted primarily to the immediate surrounds of Bimbadeen as dusk approached.

A number of native mammals were observed within the study area including the Eastern Grey Kangaroo, Yellow-footed Antechinus, Common Dunnart, Brush tailed Possum and Echidna. The Eastern Grey Kangaroo was considered to be the most abundant native mammal species and was frequently observed foraging in both the woodlands and grasslands of the study area. Both the Yellow-footed Antechinus and Common Dunnart were observed only once during the Elliot trapping survey. Brush-tailed possums were regularly encountered during the spotlighting transects, with at least 14 individuals observed in the first night of spotlighting. Evidence of foraging activity by Echidnas was noted, as indicated by substantial excavations into a number of termite mounds.

Introduced mammal fauna were also observed within the study area including the European Rabbit, Feral Goat, Feral Cat and European Fox. Grazing pressure and territory usage by the European Rabbit and Feral Goat have substantially affected selected areas throughout the western section of the study area including the Grassland and Woodland flora communities. Predation by the Feral Cat and European Fox was not

quantitatively assessed within this study, however it is considered that this ecological aspect is having a negative impact on the site's native and exotic faunal populations due to the relative low abundance of small to medium sized mammals.

The field survey identified the presence of a number of reptile species, with the most common species encountered being *Egernia modesta* beneath logs and scattered bark. Hidden underneath bark exfoliating from tree stumps of average height 0.8 metres was the next most common reptile being *Egernia striolata*. Observed scuttling throughout grass clumps and leaf litter was the Southern Rainbow Skink *Carlia tetradactyla* with an infrequent observation of *Anomalous leuckartii* noted beneath thin loose rock and large accumulations of exfoliated bark. Two geckos were observed including the Thick-tailed Gecko *Underwoodisaurus milii*, which was observed beneath a large rock, and the Robust Velvet Gecko *Oedura robusta* observed climbing a tree during the spotlight survey.

Target surveys for amphibians resulted in the identification of two species within the immediate surrounds of the study areas Aquatic Forblands flora communities. The Dwarf Green Tree Frog and Peron's Tree Frog were heard calling from the Cumbungi growths near the Bimbadeen homestead. North of the Bimbadeen homestead, within the Narrow-leaved Ironbark Woodland flora community, both the Peron's Tree Frog and Green Tree Frog were heard vocalising during the humid / wet conditions of 15 November 2001.

4.3.2 Habitats of the Study Area

The detailed field survey of the study area identified a number of fauna habitats providing opportunities for a range of fauna activity including foraging, breeding and movement. Microhabitats were present within each of the identified flora communities, as identified in **Figure 6**, and include:

- Open Forest / Woodland upper canopy cover (trees) dominated by Eucalypt species of dry sclerophyll environments;
- Open Forest / Woodland mid-strata cover (shrubs) dominated mostly by Wattle species of dry sclerophyll environments;
- Open Forest / Woodland lower-strata cover (groundcovers) dominated mostly by grasses and herbs of dry sclerophyll environments;
- Scattered trees throughout the Grassland flora community (<5% occurrence);
- Scattered shrubs throughout the Grassland flora community (<5% occurrence);
- Dense growths of emergent macrophytes within the Aquatic Forbland flora community;

- Pollen producing plants, principally Grasses and Wattles;
- Sparse distribution of tree hollows (<1% occurrence);
- Sparse to moderate distribution of fallen timber, hollow logs and bark (5% occurrence);
- Scattered rock outcrops consisting of boulder shaped rock and some flatter stone (average diameter >25cm);
- Rock ledges and cliff lines associated with the open cut pits; and
- Occasional rubbish debris (corrugated and sheet iron).

The study area's native vegetation and physical characteristics provide a range of diverse habitats. Habitats include a small number of hollow bearing trees, an understorey consisting of shrubs and grasses, fallen branches / logs, scattered accumulations of bark, outcrops of scattered sandstone and conglomerate rock and stagnant aquatic environments represented by farm dams. Cracks in the ground resultant from localised surface subsidence and scattered debris and objects around the Bimbadeen homestead were also noted. All these habitat features provide a number of specific niches for birds, amphibians, reptiles and small mammals to occupy.

The rehabilitated areas of the study area provide a very narrow range of suitable habitat features for native fauna species. Few species were observed within these areas, with the only native species being the Brown Quail. There are few habitat features of ecological value within this area.

Both of the woodland flora communities are characterised by a sparse to open shrub strata and grass / forb groundcover. The shrub layer affords some cover to small and medium sized terrestrial species from predation by the European Fox and feral cat.

The groundcover, which mostly consists of grass species, provides a large range of potential foraging habitat for a number of reptile, mammal and avifauna species. Ground litter, including fallen trees, logs and bark is relatively common throughout these communities and provides substantial refuge localities for reptiles, amphibians and small mammals. Hollow bearing trees are present, however their abundance is limited. The majority of the tree canopy is young and lacks hollow development. Hollows identified within the study area are mostly small to medium sized and are situated within larger and older growth trees that have been spared from selective logging activities.

The Grassland flora community contributes only a small proportion of these habitat values. This community is, or has been, mostly being used for grazing by cattle, with the presence of the Eastern Grey

Kangaroo, European Rabbit and feral goat representing the most recent herbivore activity. Only a few avifauna species were observed within this area and are mostly restricted to the common native species the Noisy Miner, Eastern Rosella and Magpie and the exotic species of the Indian Myna and the Common Starling. Very little habitat for reptiles and amphibians is present within this area.

The Aquatic Forbland is located adjacent to both the woodland and grassland flora communities and provides various habitat values for a range of vertebrate species. Amphibians, reptiles and aquatic birds have been observed either foraging, wading or breeding within these areas.

4.3.3 Threatened Species, Populations and Ecological Communities

A habitat assessment of the study area for threatened species, combined with a 10 km radius search of the NPWS *Wildlife Atlas* database (NPWS, 2001), identified a total of fourteen (14) threatened fauna species requiring further consideration. **Table 12** lists the results of this assessment together with a statement identifying any further assessment requirements under Section 5A of the EP&A Act (1979). **Appendix 4** (Table 2) provides details of the assessment process used to assess the requirement for a Section 5A assessment.

TABLE 12
THREATENED FAUNA SPECIES SUMMARY AND ASSESSMENT REQUIREMENTS

Species	Conservation Status		Section 5A Assessment
	TSC Act (1995)	EPBC Act (1999)	
Green and Golden Bell Frog	Endangered	Vulnerable	Yes
Freckled Duck*	Vulnerable	Migratory	No
Square-tailed Kite*	Vulnerable	Migratory	Yes
Regent Honeyeater*	Endangered	Endangered	No
Grey-crowned Babbler†	Vulnerable	-	Yes
Spotted-tailed Quoll*	Vulnerable	Vulnerable	Yes
Koala*	Vulnerable	-	No
Large-eared Pied Bat	Vulnerable	Vulnerable	Yes
Eastern False Pipistrelle†	Vulnerable	-	Yes
Eastern Little Mastiff Bat	Vulnerable	-	Yes
Little Bent-wing Bat	Vulnerable	-	Yes
Common Bent-wing Bat	Vulnerable	-	Yes
Large-footed Myotis	Vulnerable	-	Yes
Greater Broad-nosed Bat	Vulnerable	-	Yes

* Species listed on the NSW Wildlife Atlas database within 10km of the study area.
† Species observed / recorded within the study area.

4.4 Wildlife Connectivity

The study area is situated within MSC LGA, which is an area that is characterised by a wide range of landuse activities including agriculture, forestry, residential, industrial, commercial, mining and wildlife conservation. The study area situated within the freehold lands owned by MCC, has over the past been subjected to land clearing for agriculture, forestry and mining. Recent activity has been restricted mostly to that of mining, with some rehabilitation activity present around both the open cut voids. Inactivity throughout other areas of the study area has resulted in some natural regeneration, as indicated by a mix of native / exotic grasses and forbs throughout former agricultural lands.

Approximately 70% of the study area is currently cleared of its original vegetation coverage, leaving the remaining 30% in a state that resembles, to varying degrees, the pre-European landscape. Of the 70% of lands that have been cleared within the study area, there is approximately 10-15% that is currently being rehabilitated or is regenerating, by targeted mine rehabilitation practises or natural processes respectively. Remnant trees within this fragmented landscape offer some value to local arboreal / avifauna, which may utilise the study area for foraging, breeding or localised movement or migrations.

Generally, it is the larger uncleared remnants combined with these regenerating areas consisting of remnant trees that assist the movement of flora and fauna within the general locality. Field observations have confirmed that the majority of intra-site fauna activity is restricted to the vegetation surrounding Bimbadeen homestead and vegetation to the north of this location. Fauna located to the south of the study may take advantage of this narrow wildlife linkage during daily or more long-term migrations to and from vegetation situated to the north and north-west including Browns Mountain, Colonel Mountain and more specifically the closer and more prominent Bells Mountain.

Not-withstanding the apparent quality of wildlife linkages present within the study area, it appears that a similar connectivity does not apply for the value of movement corridors for small to medium sized terrestrial mammals. Constrained by mining activities, roads and open cleared lands, it appears that the ground fauna is poorly represented in terms of native small and medium sized mammals. Larger-sized mammals including the Eastern Grey Kangaroo and Common Wombat have been able to persist within this environment due, principally, to their ability to avoid predation by the European Fox and Feral Cat. However, small to medium sized mammals are severely limited in their capacity to move efficiently through disturbed lands, particularly where the European Fox is known to forage (Catling and Burt, 1995).

In summary, it is considered that the study area affords good quality wildlife linkage values between vegetation situated to the north and south of the study area. Faunal groups most likely to safely negotiate this linkage include arboreal species such as avifauna, microchiropteran bats and megachiropteran bats. Further, it is considered that large sized mammals will also benefit from the current wildlife linkage values. However, small to medium sized mammals are less fortunate and are considered open to the pressures of predation from both exotic and native predators. The more sedentary species, including the majority of reptiles and amphibians, appear to be resilient to the majority of intra-site predation and are less likely to utilise this wildlife linkage on a regular basis, given that the site provides ample habitat for these species.

4.4.1 Current and Predicted Mine Site Rehabilitation

A series of maps prepared by the DLWC in conjunction with the DMR (DLWC, 1998a; DLWC, 1998b; DLWC, 1998c; DLWC, 1998d) have identified the levels of mine site rehabilitation present in 1998 and the expected rehabilitation for 2020. Comparisons between these maps and on-site vegetation / mine infrastructure placements appears to be relatively consistent. Key features identified by DLWC include tracts of natural vegetation, unshaped emplacements areas, grassed rehabilitation and mine infrastructure placements. The mine void associated with Muswellbrook No. 1 Open Cut is similarly shown. However, the current level of tree rehabilitation has not been identified within these maps (DLWC, 1998a; DLWC, 1998c), which is probably attributable to the time elapsed since the publication of this information.

Synoptic plans for the year 2020 identify a similar landscape to that currently present within the study area. Some distinct differences are evident including the reduction of mine infrastructure placements, increased area of rehabilitation and filling of the No.1 Open Cut void. The mine plan associated with this proposed development will result in a substantially different landscape to that predicted by DLWC (1998b) and DLWC (1998d). Differences include:

- Changes to local topography;
- Removal of natural vegetation; and
- Removal of existing rehabilitated zones including grassed and treed areas.

It is expected that differences between the 2020 synoptic plan and the outcomes of the proposed development will be mitigated by the implementation of a new rehabilitation plan that will take into account a number of key issues, particularly the removal of natural vegetation. Improvements in the post mine landscape are likely to exceed the current predictions outlined by the 2020 synoptic plan. However, the formulation of a detailed rehabilitation plan in conjunction with the proposed development is likely to result in a long-term improvement in local wildlife connectivity and flora and fauna habitat.

4.5 Woodland Avifauna

Targeted surveys for threatened woodland avifauna were undertaken during the specified survey period, this being 29 October and 14 –17 November 2001 inclusive. Surveys considered the potential for species influenced by seasonal migration. Species subject to detailed site survey were the:

- Hooded Robin;
- Diamond Fire-tail;
- Grey-crowned Babbler;
- Black-chinned Honeyeater;
- Regent Honeyeater,
- Painted Honeyeater;
- Brown Treecreeper; and
- Speckled Warbler.

The majority of these species require substantial tracts of native vegetation for viable populations to persist with a given area of suitable foraging and breeding habitat. For many of these species it has been reported that local viable populations have suffered serious decline in localities where woodland remnants have been cleared to an area that consists of less than 100 ha of continuous woodland vegetation (Reid, 1999; NSW Scientific Committee, 2001). Connectivity between areas of known / potential habitat is similarly important, as these species are susceptible to predation by birds of prey and other carnivorous species that readily frequent grassland and open woodland environments.

The habitat assessment of the study area identified potential habitat for some of the above-identified species, these being the Hooded Robin, Grey-crowned Babbler, Brown Treecreeper and Speckled Warbler. Viable populations of these species within the Upper Hunter Valley require suitably large areas of dry sclerophyll woodlands with a moderate shrub understorey for sheltering and breeding (NSW Scientific Committee, 2001). Given that the study area has experienced substantial pressure from past agriculture / land clearing, it is considered that the observation of only one of these threatened species within the study area, this being the Grey-crowned Babbler within the moderately disturbed surrounds of Bimbadeen homestead, is a result in line with expectations.

Despite detailed targeted surveys for the remaining species identified within the above list, none were identified within the study area during the survey period. Past land clearing, agriculture and predation by the feral cat and European fox is likely to have represented the most significant limiting influence on the presence of woodland avifauna at this location. Land clearing for agriculture has resulted in an increase in scattered, poorly connected woodland remnants of mostly less than 5 ha in area. The fragmentation of local native vegetation within close proximity to lands affected by agriculture, and possibly mining, is known to increase the presence and predatory influence of the European fox (Catling and Burt, 1995). When combined with an overall reduction of quality breeding and foraging habitat at this location, it is

considered that the decline of a sensitive woodland avifauna population at this location is a predictable outcome.

None of the remnant vegetation present within the study area is greater than 100 ha in area, with the majority of the remaining vegetation considered as consisting of low to moderate ecological values for the identified threatened woodland avifauna species. In summary it is considered that the existing factors contributing to the absence of the majority of sensitive woodland avifauna species from the study area is likely to be related more to the reduced quantity of native vegetation, its fragmented state and presence / influence of higher order exotic predatory species, these being the feral cat and European fox.

5.0 ANALYSIS OF ECOLOGICAL ENVIRONMENT

5.1 Section 5A Assessment of Proposed Development (EP&A Act)

The determining authority is bound by legislation to consider the potential impact of a proposed activity on threatened species in accordance with Section 5A of the EP&A Act (1979) – 'The Eight Part Test of Significance'. This impact assessment is used as a guide to determine whether the proposed development requires a more detailed review by way of a Species Impact Statement (SIS).

Site specific target surveys and habitat assessments, combined with an interrogation of the NPWS *Wildlife Atlas* database, identified one (1) threatened flora and 11 threatened fauna species requiring an assessment in accordance with Section 5A of the EP&A Act (1979). The species identified for consideration within this assessment are listed below in **Table 13**.

TABLE 13
THREATENED FLORA AND FAUNA SPECIES IDENTIFIED FOR ASSESSMENT

• *Bothriochloa biloba*	• Green and Golden Bell Frog
• Square-tailed Kite	• Grey-crowned Babbler
• Spotted-tailed Quoll	• The Large-eared Pied Bat
• Eastern False Pipistrelle	• Eastern Little Mastiff Bat
• Little Bent-wing Bat	• Common Bent-wing Bat
• Large-footed Myotis	• Greater Broad-nosed Bat

The following section discuss the habitat requirements for each of the threatened species, endangered populations and endangered ecological communities identified above together with a summary of the Section 5A assessment that is provided in detail in **Appendix 4** of this report.

5.1.1 Threatened Species

Field survey and habitat assessment, combined with a review of the existing literature, were used to identify the threatened species constraints of the study area. Below is a brief description for each species that may potentially utilise habitat features identified within the study area. Details regarding the field survey results and habitat assessment are presented in **Appendix 2** and **3** of this report. The location of threatened species is presented in **Figure 6**.

Bothriochloa biloba is an erect or decumbent caespitose perennial to 1 m high with culms branching from nodes situated on the main growth axis. This species flowers mostly in summer within woodlands on poorer soils throughout a distribution that extends north from the NSW Central Coast to Queensland including the adjacent northern tablelands, western slopes and plains.

Detailed survey of the study area for this species, which included both systematic and non-systematic survey techniques involving quadrats, transects and random meanders, failed to detect this species within the study area. Whilst potential habitat is present within the study area, it is considered that this species is likely to be absent from those environments that may potentially harbour this species. Surveys are considered to be comprehensive and conducted during the appropriate season.

The Green and Golden Bell Frog prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds where it is often located under debris including corrugated iron, timber and rock. Until recently this species was a common inhabitant in coastal NSW, but has now drastically declined for unknown reasons. The former distribution of this species includes coastal swamps from Grafton in the north to the east Gippsland district of Victoria. Breeding occurs in spring and early summer, starting August, after heavy rains (Barker et al, 1995).

Potential habitat identified within the study area is restricted to two of the five farm dams. These two dams consist of dense growths of Cumbungi and appear to lack known predators of the Green and Golden Bell Frog including the Mosquito Fish and Silver / Golden Perch. This threatened species was targeted in the fauna survey period, particularly during the wet, warm and humid conditions of 16-17 November 2001. Targeted survey during that period indicated that the Green and Golden Bell Frog is likely to be absent from the study area. Accordingly it is considered that potential habitat situated within the study area does not contain any known foraging or breeding populations of Green and Golden Bell Frog.

Square-tailed Kite soars low over the canopy of woodland, exploiting ecotones while hunting. This species is known to favour *Angophora floribunda* and *Angophora subvelutina* woodland in association with box / ironbark eucalypt species along moist valleys on the coast of NSW. There is usually profuse blossom associated with this type of vegetation, which provides an abundance of nesting birds on which the kite typically preys (State Forests of NSW, 1995).

Potential habitat identified within the study area is present throughout the woodland flora communities, particularly to the north of Bimbadeen homestead. This threatened species was targeted in the fauna survey period, particularly within the woodland habitat areas where riparian vegetation was present. Targeted survey during that period indicated that the Square-tailed Kite is likely to be absent from the study area. Accordingly, it is considered that potential habitat situated within the study area does not contain any known foraging or breeding populations of Square-tailed Kite.

The Grey-crowned Babbler is a species that lives and breeds in a highly co-ordinated group. Groups generally consist of a pair of breeding adults, which are accompanied by sub-adults or offspring ranging from 5-12 individuals, with some groups containing as many as 16 during excellent breeding conditions (Mark Aitkens, *pers. obs*.). Groups often forage and breed within a territory up to 12 ha in area, and often interact with adjoining groups during territory battles. Foraging activity ranges from ground rummaging to active searches of tree bark and branches. Aerial prey is also readily targeted, however their ability in this regard is considered poor (Readers Digest, 1982).

Overnight roosting occurs within two nest types including breeding and dormitory style structures, with their relative usage dependant on the time of year. Breeding is most often during the spring period, immediately or soon after significant rainfall, with autumn breeding less frequent and only apparent during particularly good seasons. Breeding success is considered to be poor, with larger groups often more successful than smaller ones. Accordingly, it is apparent that Grey-crowned Babblers are a long-lived species, relying on continued breeding attempts by life-long breeding partners rather than successful short breeding life cycles (Readers Digest, 1982).

Detailed survey of the study area for this species, which included both systematic and non-systematic survey techniques, resulted in the detection of this species within the study area. A pair of Grey-crowned Babblers was observed constructing a nest within the outer canopy of a Grey Box adjacent to Bimbadeen homestead. After observing this species at this locality, a wider search for live specimens and typical nest constructions was undertaken for the remaining areas of suitable habitat located within the study area. This additional survey failed to detect any further activity of this species within the study area.

Survey outside the study area was not undertaken, however records from the Upper Hunter River indicate that the nearest populations are situated approximately 19 km and 22 km to the south south-west and south-east respectively (NPWS, 2001). Recent surveys conducted by HLA within the Upper Hunter River catchment indicate that the Grey-crowned Babbler is well established within the Jerry's Plains to Mt Thorley district, including a substantial population of at least 12 individuals at Glennies Creek (HLA, 2001).

Spotted-tailed Quoll inhabits a variety of habitats including dry to moist open forests or closed forests containing rock caves, hollow logs or trees for shelter / breeding. Populations of the Spotted-tailed Quoll are very sensitive to changes in the predator-prey relationship of their chosen environment (Catling and Burt, 1995). An area containing an abundant source of medium sized mammals (0.2-6.0 kg) is likely to indicate that the given area may contain the Spotted-tailed Quoll and not the European Red Fox. Conversely, the opposite relation is true, with a low abundance of medium sized mammals indicating that the Spotted-tailed Quoll is likely to be absent and the European Fox is present (Catling and Burt, 1995).

Surveys of the study area identified relatively low species richness and abundance of medium sized mammals, including only European Rabbits and Brush-tailed Possums. Given the observation of the European Fox, combined with the relatively low abundance of medium-sized mammals, it is considered that the habitat values of the study area are not conducive to the presence of a viable Spotted-tailed Quoll population. Targeted survey during the survey period indicates that the Spotted-tailed Quoll is likely to be absent from the study area. Accordingly, it is considered that potential habitat situated within the study area does not contain any known foraging or breeding populations of Square-tailed Kite.

The Large-eared Pied Bat has a restricted distribution from south central Queensland to central and northern NSW and is localised and uncommon throughout its range occurring in Rainforest, wet sclerophyll forest to dry sclerophyll forest and woodland habitats (State Forests of NSW, 1997). It has been recorded in the Richmond and Nightcap Ranges and on the Central Coast, near Singleton (State Forests of NSW, 1997). Strahan (1998) indicates a more extended range, with recordings from Rockhampton in central coastal Queensland to Bungonia in southern NSW.

This species roosts by day in caves, emerging at night to forage over a wide range of habitats targeting airborne insects. Targeted field surveys prioritised potential flyways as a means for detecting this species, as no suitable roosting habitat is present within the study area. Despite the presence of potential foraging habitat, this species was not recorded within the study area.

The Eastern False Pipistrelle is widely distributed and known from rainforest, wet and dry sclerophyll forests (State Forests of NSW, 1997) and is more common at cool elevations (Strahan, 1998). They prefer wet habitats where trees are more than 20 metres high (Churchill, 1998). This species roosts in tree hollows, abandoned buildings and has also been found in caves. Foraging resources include moths, beetles and ants around or just below the tree canopy or over water (State Forests of NSW, 1997).

Targeted field surveys prioritised potential roosts and flyways as a means of detecting this species. Anabat recordings indicate that this species is present within the study area, foraging within the Eucalypt canopy of the Narrow-leaved Ironbark Woodland flora community. Stag watching of two dead trees within the Narrow-leaved Ironbark Woodland flora community, with the aid of the Anabat II detector, failed to detect any specimens of this species emerging at dusk from potential roost sites. However, this stag watch survey was not exhaustive and given the quantity of potential roosts identified within the Narrow-leaved Ironbark Woodland flora community, it is possible that this species may be roosting within the study area.

The Eastern Little Mastiff Bat is known to frequent a variety of habitats including sclerophyll forests and woodlands. It has been recorded in a variety of forest types ranging from rainforest to dry-hardwood forest (State Forests of NSW, 1995). The Eastern Little Mastiff Bat hunts insects above the forest canopy or in clearings (Strahan 1983). It is known to roost in tree hollows (State Forests of NSW, 1997), under

loose bark and also in houses and outbuildings (State Forests of NSW, 1995). Strahan (1998) states that it tends to be predominantly tree dwelling.
This species roosts by day in tree hollows and other similar habitat niches, emerging at night to forage over a wide range of habitats targeting airborne insects. Targeted field surveys prioritised potential roosts and flyways as a means for detecting this species status within the study area. Despite the presence of potential foraging and roosting habitat, this species was not recorded within the study area.

The Little Bent-wing Bat has been recorded in rainforest, wet sclerophyll forest, dense coastal scrub and other habitat with dense understoreys forages below the canopy within open forests and woodlands, feeding on small insects (Dwyer, 1995b; State Forests of NSW, 1997). Melaleuca swamps and dry sclerophyll forests are also frequently utilised habitats (Strahan, 1998). The Little Bent-wing Bat has been mostly found roosting in caves, mines, culverts, old buildings and tunnels, however it has also been infrequently observed in tree hollows (although its importance is unknown) (Dwyer 1995b).

This species roosts by day in caves, emerging at night to forage over a wide range of habitats targeting airborne insects. Targeted field surveys prioritised potential flyways as a means for detecting this species, as no suitable roosting habitat is present within the study area. Despite the presence of potential foraging habitat, this species was not recorded within the study area.

The Common Bent-wing Bat has been recorded in rainforest, wet and dry sclerophyll forest, and woodland (State Forests of NSW, 1997). Core habitat is restricted to a relatively small number of caves that are used for breeding (Australian Museum Business Services, 1995). This species feeds on small insects at night above and beneath the canopy of well-timbered valleys (Strahan, 1998).

This species roosts by day in caves, emerging at night to forage over a wide range of habitats targeting airborne insects. Targeted field surveys prioritised potential flyways as a means for detecting this species, as no suitable roosting habitat is present within the study area. Despite the presence of potential foraging habitat, this species was not recorded within the study area.

The Large-footed Myotis inhabits rainforests and sclerophyll forests near creeks and lakes over which it forages for aquatic insects and small fish. This species is known to roost in tree hollows, caves, mines and tunnels.

This species roosts by day in caves and tree hollows, emerging at night to forage over aquatic habitats targeting surface feeding fish and insects. Targeted field surveys prioritised potential roosts and foraging grounds (farm dams) as a means for detecting this species. Despite the presence of potential roosting and foraging habitat, this species was not recorded within the study area.

The Greater Broad-nosed Bat inhabits a wide variety of habitats from woodland through moist and dry eucalypt forest to rainforest. This species is known to roost in tree hollows and feed on small vertebrates /

insects in the understorey vegetation. It is also known to forage in the interface of clearings and vegetation woodland (State Forests of NSW, 1995). It has been found in roof spaces of old buildings (Strahan, 1998).

This species roosts by day in tree hollows, emerging at night to forage near aquatic habitats and through riparian corridors targeting surface airborne insects. Targeted field surveys prioritised potential roosts and foraging grounds as a means for detecting this species. Despite the presence of potential roosting and foraging habitat, this species was not recorded within the study area.

5.1.2 Summary of Section 5A Assessment

A detailed impact assessment, in accordance with Section 5A of the EP&A Act (1979), is provided for each of these species in **Appendix 5** of this report. A summary of this assessment is provided below in **Table 14**.

TABLE 14
SUMMARY OF SECTION 5A ASSESSMENT

Species	a) In the case of a threatened species ..... is likely to be placed at risk of extinction.	b) In the case of an endangered population, ... is likely to be significantly compromised.	c) In relation to the regional distribution of the habitat ..... to be modified / removed.	d) Whether an area .... is to become isolated ..... for a threatened species.	e) Whether critical habitat will be affected.	f) Whether a threatened species is adequately represented in the regions conservation reserves.	g) Whether the development or activity recognised as a threatening process	h) Whether any threatened species is at the limit of its known distribution.
Bothriochloa biloba	✗	N/A	✗	✗	N/A	✗	✓	✗
Green and Golden Bell Frog	✗	N/A	✗	✗	N/A	✗	✓	✗
Square-tailed Kite	✗	N/A	✗	✗	N/A	✗	✓	✗
Grey-crowned Babbler*	✗	N/A	✗	✗	N/A	✗	✓	✗
Spotted-tailed Quoll	✗	N/A	✗	✗	N/A	✓	✓	✗
Large-eared Pied Bat	✗	N/A	✗	✗	N/A	✗	✓	✗
Eastern False Pipistrelle	✗	N/A	✗	✗	N/A	✗	✗	✗
Eastern Little Mastiff Bat	✗	N/A	✗	✗	N/A	✗	✗	✗
Little Bent-wing Bat	✗	N/A	✗	✗	N/A	✗	✗	✗
Common Bent-wing Bat	✗	N/A	✗	✗	N/A	✓	✗	✗
Large-footed Myotis	✗	N/A	✗	✗	N/A	✗	✗	✗
Greater Broad-nosed Bat	✗	N/A	✗	✗	N/A	✗	✓	✗

N/A Indicates that the assessment in not applicable to that species [as in (b) and (e)].

✗ Indicates that the proposed development is not likely to significantly affect threatened species (a), their distribution of habitat within the region (c) or their range limits (h). Indicates that the proposed development will not isolate a threatened species (d) and is not recognised as a key threatening process (g). Indicates that the threatened species is not adequately represented in conservation reserves (f).

✓ Indicates that the proposed development is likely to significantly affect threatened species (a), their distribution of habitat within the region (c) or their range limits (h). Indicates that the threatened species is adequately represented within conservation reserves (f). Indicates that the proposed development will isolate a threatened species (d) and is recognised as a key threatening process (g).

* Result reliant on the implementation of management plans that consider the recommended mitigation measures outlined in **Section 6.0** of this report.

5.1.3 Endangered Populations

No endangered populations listed under the TSC Act (1995) were identified within the study area. No further consideration of this issue is required within this assessment.

5.1.4 Endangered Ecological Communities

No endangered ecological communities (EEC) listed under the TSC Act (1995) were identified within the study area. No further consideration of this issue is required within this assessment.

5.1.5 Key Threatening Processes (KTP)

5.1.5.1 Currently Prevailing KTP

Three (3) key threatening processes (KTP) are currently active within the study area. These KTP are identified as follows:

- Predation by the European Fox (NSW Scientific Committee, 1999);
- Predation by the Feral Cat (NSW Scientific Committee, 2000); and
- Anthropogenic Climate Change (NSW Scientific Committee, 2000).

None of the above-identified KTP are or have been promoted by current operations associated with MCC's activities or the proposed development presented within this report. Predation by the European Fox has been active within the locality for decades and has principally resulted from unmitigated agricultural activity since the mid to late 19th century. Similarly, predation by the Feral Cat is related to off-site activity including the release or poor control of domesticated cats within the general Muswellbrook locality.

Underground spontaneous combustion in the St Heliers Seam to the south-west of Bimbadeen homestead is currently contributing to the production and uncontrolled release of carbon monoxide (CO), carbon dioxide (CO_2) and methane (CH_4) gases into the atmosphere. This event is assisting the incremental affects of global warming and is referred to under the TSC Act (1995) as the KTP 'Anthropogenic Climate Change'.
MCC has informed HLA that the underground spontaneous combustion present within the study area is an existing condition that predates the activities identified by the proposed development within this report. Further, MCC have identified this as a significant issue requiring action to minimise damage to the environment and safety risks. Accordingly MCC aims to extinguish the spontaneous combustion within the affected coal seam by mining the coal seams as part of the proposed development.

The proposed development will result in the extraction of thermal coal, which will lead to the production of greenhouse gases through the creation of energy at a power station. The proposal will supply coal to established markets. If coal were not to be supplied by MCC, the current customers would seek supplies of coal from other coal companies.

5.1.5.2 Development Related KTP

One (1) KTP is likely to occur as a direct result of the proposed development. This KTP is:

- Clearing of Native Vegetation (NSW Scientific Committee, 2001).

Activities associated with the proposed development will result in the removal of native vegetation from the study area. Vegetation of particular importance is situated to the north of the Bimbadeen homestead. Further, vegetation in the immediate surrounds of the Bimbadeen homestead is similarly significant as this area promotes connectivity between vegetation to the north with vegetation remnants to the south.

In an *unmitigated* form, the proposed development will effectively sever current vegetation links for a minimum period of approximately five years, with the length of time taken to achieve an appropriate level of rehabilitation marking the maximum impact period. During the maximum impact period it is foreseeable that an *unmitigated* form of the proposed development will facilitate the action of the following impacts:

- The destruction of habitat resulting in the loss of individual species situated within the study area;
- Increased habitat / vegetation fragmentation;
- Riparian zone degradation;

- Increased habitat for invasive species;
- Loss of leaf litter layer;
- Loss or disruption of ecological function; and
- Changes to the soil biota.

Potential threatened species habitats that may be adversely affected by this action include *Bothriochloa biloba*, Green and Golden Bell Frog, Square-tailed Kite, Spotted-tailed Quoll, Large-eared Pied Bat and Greater Broad-nosed Bat. Known habitat for the Grey-crowned Babbler will be similarly affected. Further, the proposed development may also significantly affect non-threatened species vulnerable to vegetation clearing including the Yellow-footed Antechinus and Common Brush-tailed Possum (NSW Scientific Committee, 2001).

Of particular concern is the long-term status of the Grey-crowned Babbler local population within the post-development environment. As the proposed development will result in the removal of known habitat, it is considered that both the mine operations plan and rehabilitation operation should provide adequate allowances for this species such that a significant impact can be averted.

Suggested mitigation measures proposed for the minimisation of the proposed development's impact on the natural environment is provided in **Section 6.0** of this report.

5.1.6 Critical Habitat

No critical habitat mapped under the TSC Act (1995) was identified within the study area. No further consideration of this issue is required within this assessment.

5.2 EPBC Act Assessment of Proposed Development

Habitat assessments indicated the potential for a number of nationally threatened species including the Green and Golden Bell Frog and Spotted-tailed Quoll. Further, it was identified that the proposed development is likely to result in the activation of the nationally listed KTP referred to as 'Land Clearance'.

A review of the proposed development, by consideration of the results of the field survey and schedules of the EPBC Act (1999), identified no threatened species, populations or ecological communities to be present within the study area. However, it was considered that the proposed development is likely to promote the KTP known as 'Land Clearance'. Proposed strategies targeting the minimisation of this potential impact, as discussed in **Section 5.1.5.2**, demonstrates that there is a range of potential actions that, if implemented, are likely to result in the avoidance of a long-term significant impact. Given that the

proposed development will involve the preparation of an appropriate management plan, which will detail the staging and implementation of these proposed strategies, it is considered that the proposal does not represent a CA.

Not-withstanding-this conclusion, a referral to EA was prepared and issued for review, as the project will result in the removal of potential habitat for nationally significant threatened species. The independent review and assessment of the proposal by EA determined that the proposed development does not represent a CA, with correspondence confirming this determination provided in **Appendix 1**.

5.3 Assessment of Relevant SEPP's

Section 2.1.4 of this report identified that this flora and fauna assessment need only assess the proposed development against the aims and objectives of SEPP 44 - Koala Habitat Protection. The following sub-section provides an assessment in accordance with this policy.

5.3.1 SEPP 44

The study area was assessed for koala activity using the following methods.

i. A search of the NPWS *Wildlife Atlas* Database (NPWS 2002);

ii. The site was surveyed on foot, with koala food trees being inspected for signs of koala usage. Trees were inspected and identified for the presence of koalas, characteristic scratch and claw marks on the trunk and scats around the base of each tree. The proportion of trees showing signs of koala use was calculated. Additionally the location and density of droppings, if found, were documented;

iii. Koalas were also targeted during spotlight surveys; and

iv. Identification and an assessment of the density of tree species listed as koala feed trees in SEPP No. 44 - Koala Habitat Protection was undertaken across the site. An estimate of the percentage density of each tree species across the site was determined by averaging the percentage of stems counted.

Eucalyptus tereticornis (koala food tree species listed on Schedule 2 of SEPP No. 44 - Koala Habitat Protection) was observed within the study area. Specimens of this species comprised less than 1% of the total number of trees within the study area, which is less than the minimum 15% threshold that defines potential koala foraging habitat.

No koalas were observed during the fauna survey and there was no evidence of recent koala activity within close proximity to the study area. A check of the NPWS *Wildlife Atlas* Database (NPWS, 2002) identified one (1) koala record for the local area, which is old and unlikely to represent the current status of this species within the study area. Given that the evidence collected during the field and desktop survey clearly indicate that there are no current koala populations utilising the study area as foraging or core habitat, it is considered that there are no requirements of MCC to provide a koala management plan.

5.4 Review of Limitations

5.4.1 Survey

Due to the implementation of a stratified randomised survey design, targeting both native and exotic flora and fauna species, it is considered that there are few constraints associated with the field survey of the study area and ensuing impact assessment. However, some survey constraints are apparent and are listed below for consideration.

Flora

The flora survey was conducted on three separate days including one day in late October and two days in mid November. Whilst it is considered that this survey period was adequate for the detection of most flora species, consideration should be given to the affects of seasonality including the flowering period of various orchards and other cryptic species.

In review of the survey methodology, relative to its potential constraints in terms of seasonality, it is considered that the flora survey period is adequate for the purposes of this assessment. No threatened orchards or cryptic flora species are expected to occur within the study area, indicating that the affects of seasonality are not critical to this assessment. Accordingly, it is recommended that no further survey be required to assess the status of the study areas flora species and communities.

Fauna

The fauna survey was conducted on five separate days including one day in late October and four days in mid November. Whilst it is considered that this survey period was adequate for the detection of most fauna species, consideration should be given to the affects of seasonality and recent weather conditions, particularly when assessing migratory or cryptic species reliant on specific conditions.

Warm, humid and dry conditions prevailed throughout the survey period, with some precipitation falling on 15 November 2001. Further, wind conditions were relatively calm. These weather conditions, combined with the time of year, provide excellent opportunities for identifying most native and exotic fauna species. Further, it is considered that all predicted threatened fauna species were adequately targeted during the survey period.

In general it is important to note that the collection of field survey data during the survey period is representative of species occurring within the study area for that survey period. Due to the effects of fire, breeding cycles, migratory patterns, camouflage, weather conditions, visibility and / or feeding patterns, an increased species frequency or richness may be observed outside the nominated survey period. Accordingly, the identification and assessment of microhabitat by an experienced principal surveyor of five (5) years experience or more has been used to overcome this limitation.

5.4.2 Assessment

To adequately assess threatened species in accordance with Section 5A of the EP&A Act (1979), the assessor requires a certain level of information before a well-informed judgement can be presented. As discussed within **Section 5.4.1**, the main constraint to the assessment of threatened species is the scope of the field survey component. In the absence of local information on threatened species, it is considered that the survey results may be biased and potentially lead to a false indication that a species is locally rare.

In this case it is considered that there is a reasonable source of information within the Muswellbrook locality. Survey of the study area combined with the use of background literature, local knowledge and targeted survey for threatened flora and fauna species and their habitats throughout the study area resulted in an appropriate appraisal of the immediate distribution and abundance of threatened species. Accordingly, it is considered that an assessment can be prepared and be assessed by Council in their review and final determination of the proposed development.

6.0 MITIGATION MEASURES

To ensure that the various flora and fauna values identified within the study area are maintained to an ecologically sustainable level in the post-development environment, including issues such as habitat viability, population viability, wildlife connectivity, minimisation of fox / cat predation and spread of invasive plants, it is considered that the following mitigatory measures should be incorporated and implementation into the relevant management plans prepared for the proposed development. These are:

- Minimise vegetation clearing throughout areas to the north of the Bimbadeen homestead to reduce the time period between vegetation removal and rehabilitation / habitat re-instatement activities;

- The restriction of vegetation clearing throughout areas to the north of the Bimbadeen homestead to periods outside the breeding cycle of the Grey-crowned Babbler and Eastern False Pipistrelle;

- The appropriate collection and stockpiling of vegetation, soil and ground / arboreal habitat features for use in the creation of compensatory habitat, land rehabilitation and habitat re-instatement activities;

- Establish ecologically functional compensatory habitat for threatened and migratory species prior to clearing events within areas adjacent to the study area to promote the retention and preservation of local flora and fauna populations;

- The inspection of fauna habitat that may harbour species of poor dispersal capabilities prior to land clearing, with a view to the capture and relocation of those species to suitable areas of compensatory habitat situated outside the study area. Fauna of particular interest include reptiles and hollow-dwelling mammals;

- The implementation of appropriate rehabilitation activities, in accordance with the approved mine sequence, that minimises the medium and long-term impact on species vulnerable to the vegetation clearing;

- The collection of local seed providence from the majority of flora species identified within the area to be cleared, thus maximising the value of vegetation rehabilitation and habitat re-instatement;
- The implementation of exotic flora and fauna control programs targeting in particular the predatory pressures associated with the European Fox and feral cat, grazing pressures exerted by the European rabbit and feral goat and ecological competitiveness exerted by invasive exotic plants;

- Minimise the edge to area ratio and improve alternative short-term vegetation connectivity by undertaking supplementary planting and rehabilitation activities throughout lands adjacent to the affected area prior to and during the mine operations plan;

- Undertake ongoing monitoring programs to measure progression of site rehabilitation; and

- Undertake a status review of the Eastern Grey Kangaroo within the study area, with the view to assessing and potentially ameliorating any deleterious grazing pressures exerted on native vegetation by excessively large populations of this species.

The final mining strategy will fully detail the scope and timing of all mitigatory measures and be contained within the framework of a specific management plan that ties in with the staged events identified within the mine operations plan.

7.0 CONCLUSIONS

Based on the results of detailed field survey and information provided in this report it is concluded that:

i. The scope of vegetation clearing within the study area, particularly that within the sensitive environs adjoining Bimbadeen homestead, will have a short to medium term impact on the population of the Grey-crowned Babbler present within the study area. This impact will be minimised by medium to long-term mitigatory measures targeting the rehabilitation and re-instatement of habitat for this species;

ii. The scope of vegetation clearing within the study area, particularly the woodlands and environs adjoining Bimbadeen homestead, will have a short to medium term impact on local species vulnerable to the clearance of native vegetation. This impact will be minimised by medium to long-term mitigatory measures targeting the rehabilitation and re-instatement of vegetation and habitat, particularly focusing on the improvement of local vegetation connectivity;

iii. The proposed development is **unlikely** to result in a significant impact on threatened species or their habitats such that a viable local population will be placed at risk of extinction provided that appropriate mitigatory measures are developed and implemented;

iv. The proposed development will not aid in the promotion of the KTP referred to as 'Clearing of Native Vegetation' in the medium to long-term, provided an appropriate management plan targeting the re-instatement of local flora and fauna habitat values and wildlife connectivity is implemented;

v. A Species Impact Statement is **not** required to further assess this proposed development; and

vi. The proposed development has been assessed in accordance with the EPBC Act (1999) and was **not** considered to be a CA, thus approval under Part 9 of the Act is not required.

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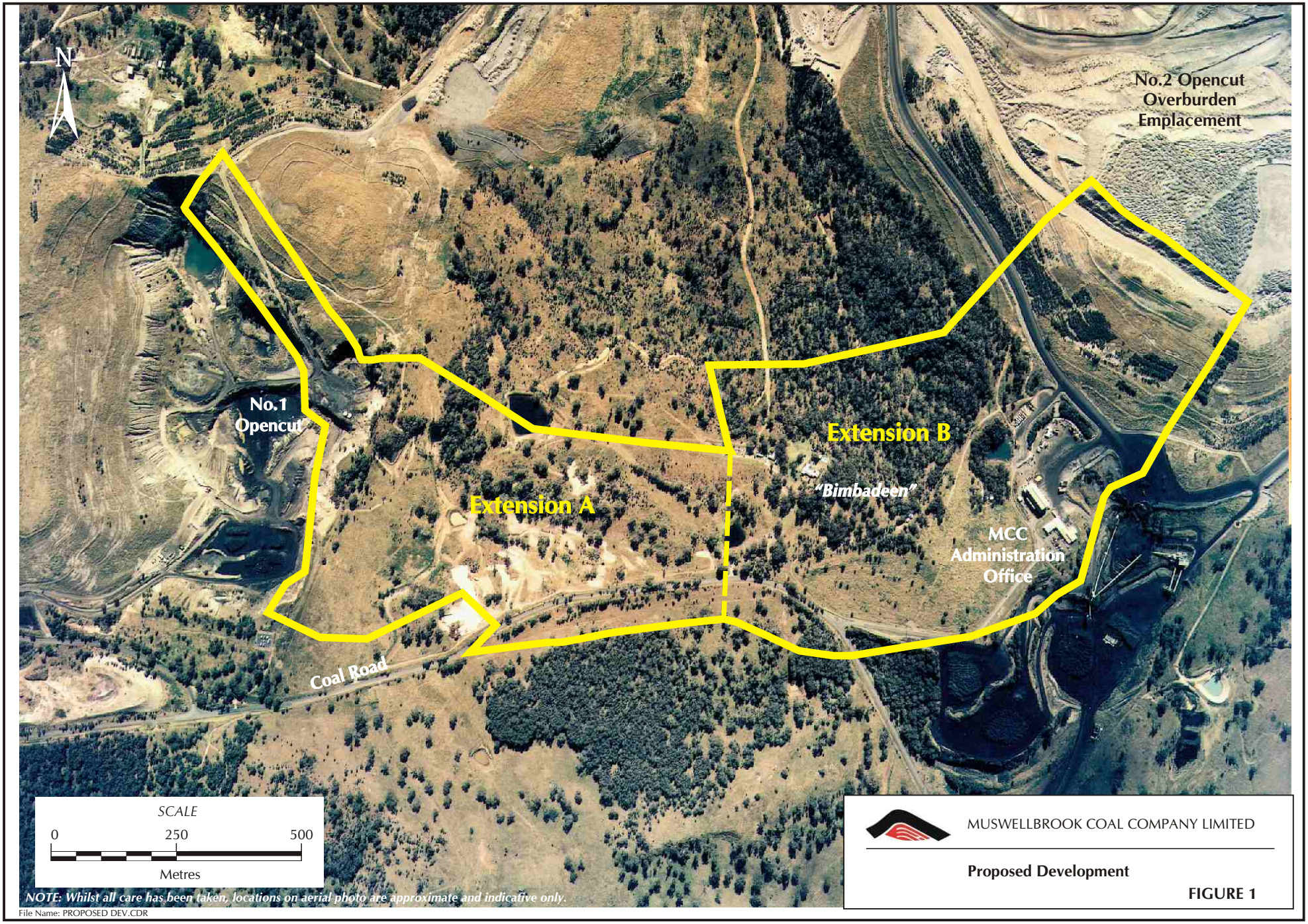

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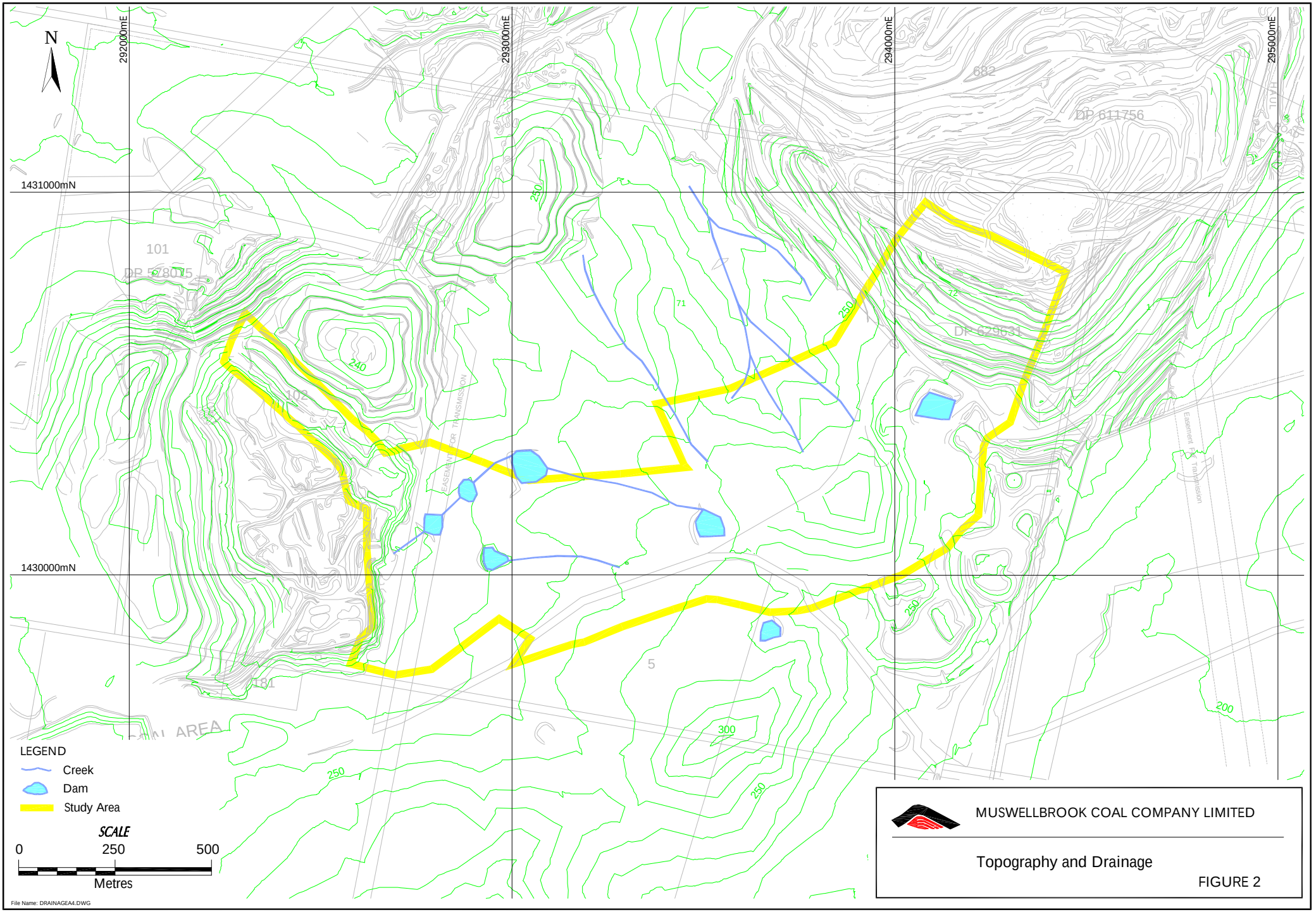
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12
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Easement for Transmission
LEGEND
Creek
Dam
Study Area
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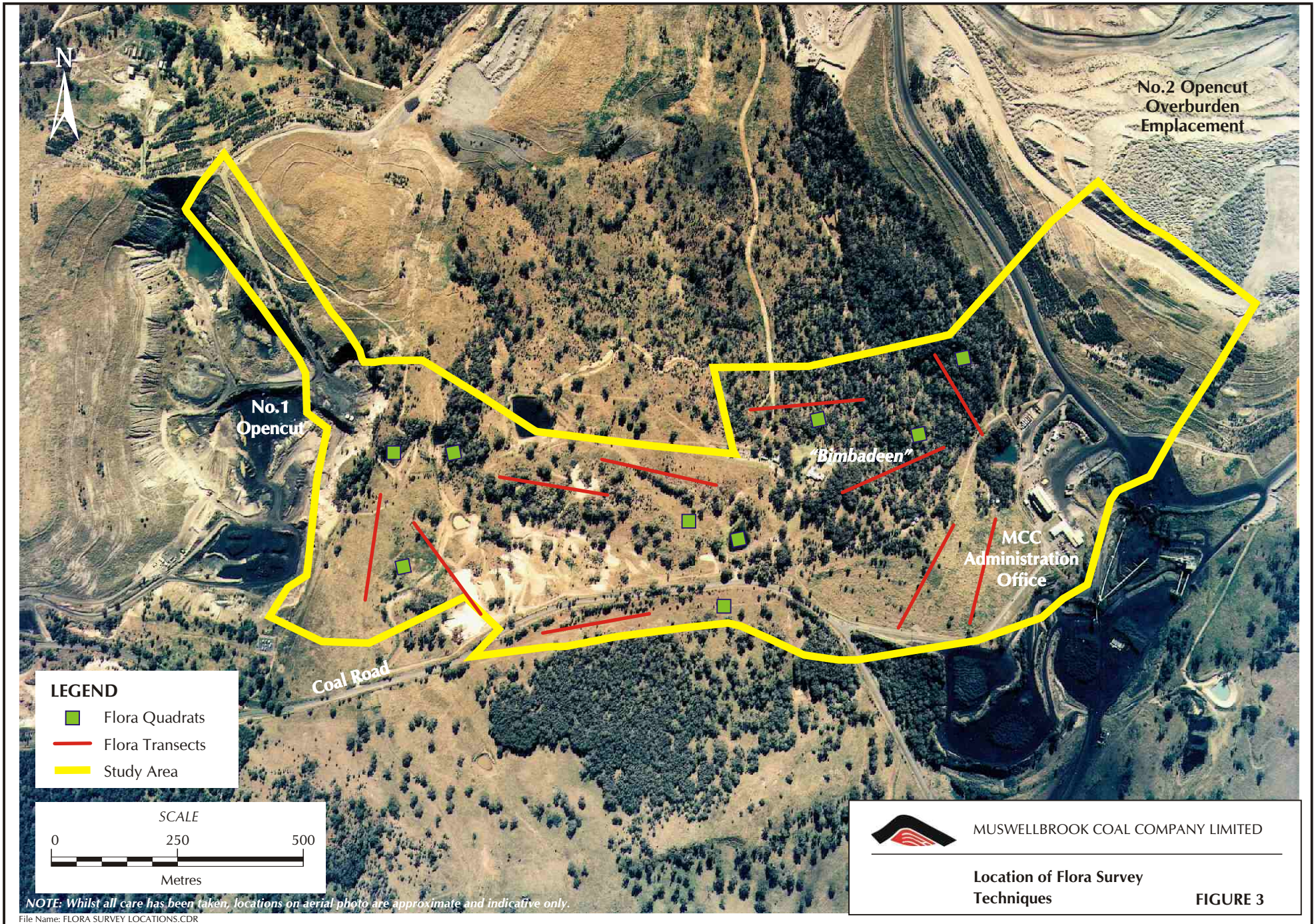
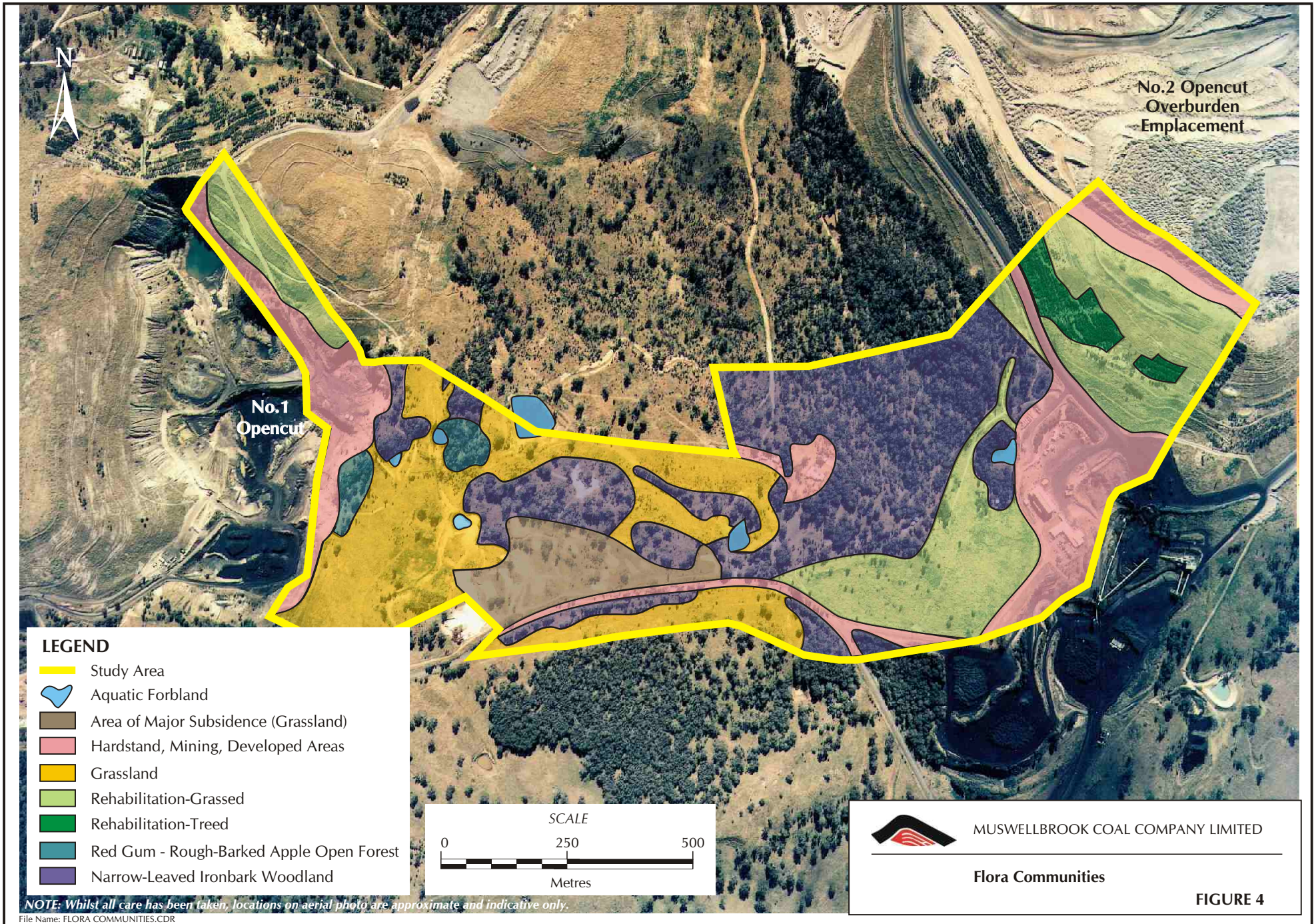
MUSWELLBROOK COAL COMPANY LIMITED
Topography and Drainage
FIGURE 2



MUSWELLBROOK COAL COMPANY LIMITED

Location of Flora Survey Techniques **FIGURE 3**

File Name: FLORA SURVEY LOCATIONS.CDR



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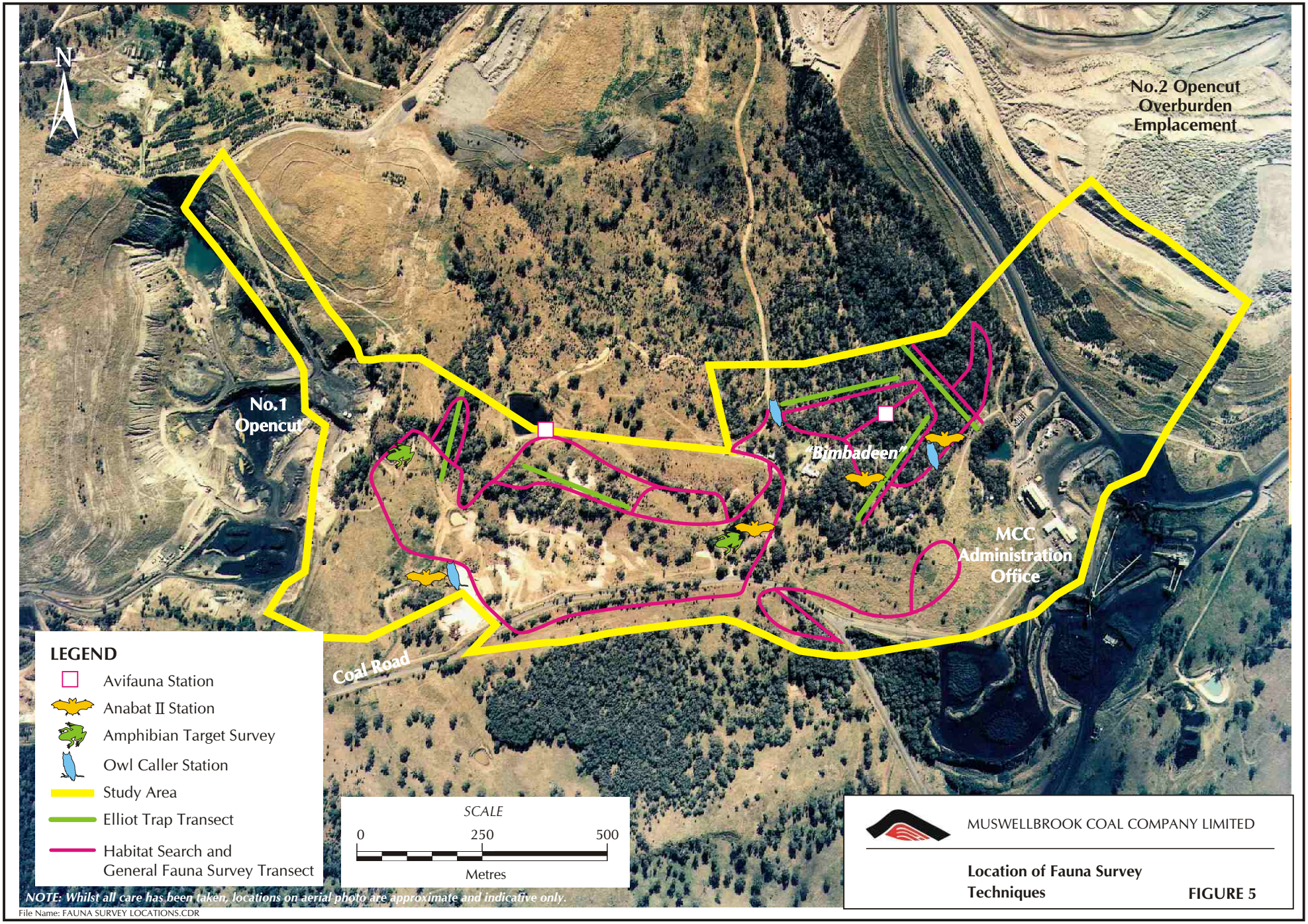
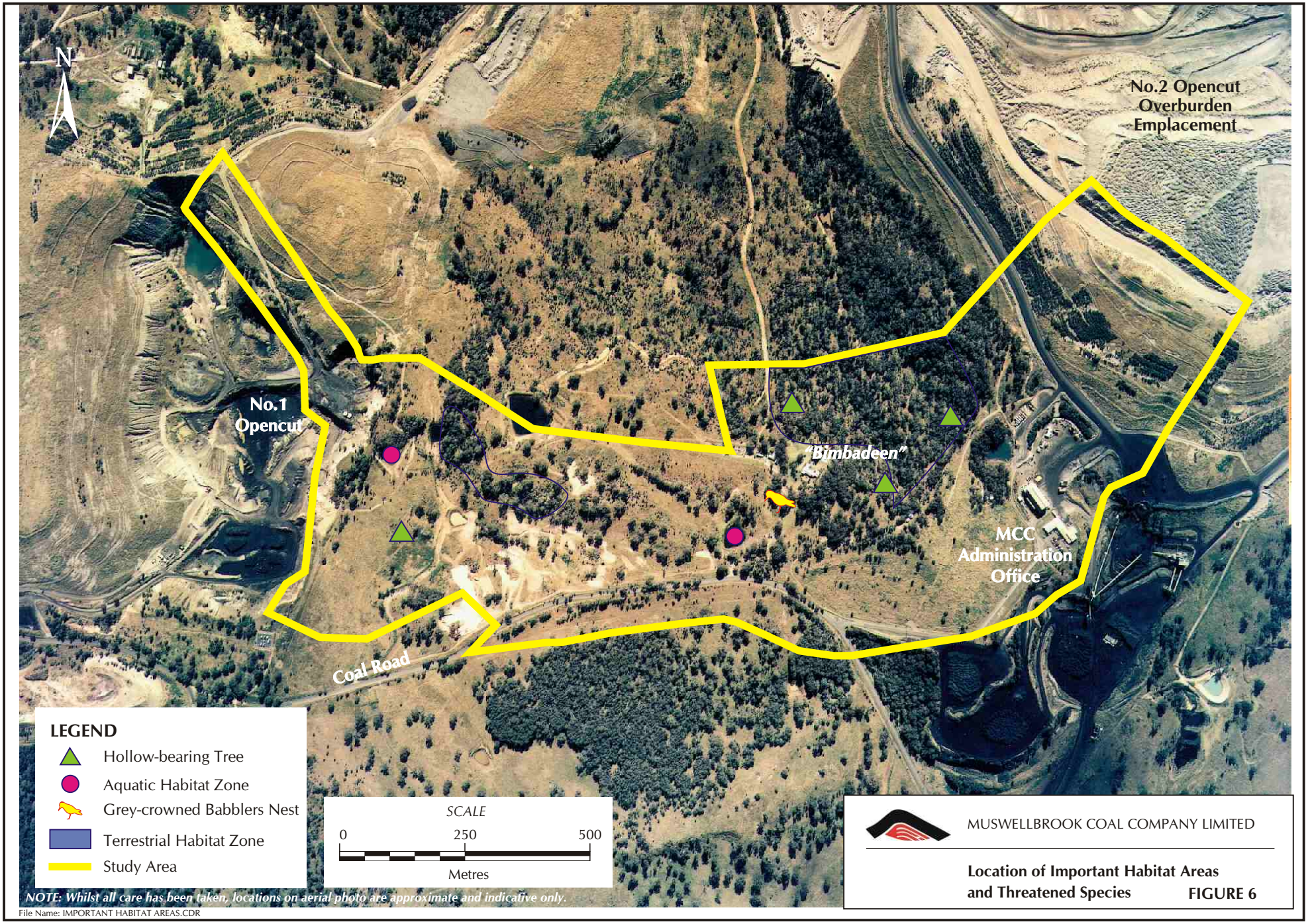

N
No.2 Opencut Overburden Emplacement
No.1 Opencut
"Bimbadeen"
MCC Administration Office
Coal Road
LEGEND
Avifauna Station
Anabat II Station
Amphibian Target Survey
Owl Caller Station
Study Area
Elliot Trap Transect
Habitat Search and General Fauna Survey Transect
SCALE
0
250
500
Metres
NOTE: Whilst all care has been taken, locations on aerial photo are approximate and indicative only.
MUSWELLBROOK COAL COMPANY LIMITED
Location of Fauna Survey Techniques
FIGURE 5
File Name: FAUNA SURVEY LOCATIONS.CDR



File Name: IMPORTANT HABITAT AREAS.CDR

DISTRIBUTION

Flora and Fauna Assessment of
Proposed Open Cut Extension to
Consolidated Coal Lease 713
(Muswellbrook Coal Company Limited)

30 April 2002

Original	Muswellbrook Coal Company Limited PO Box 123 Muswellbrook NSW 2333
Copy	Project File

Quality Control Reviewer

Colin Phillips BSc MEngSc MEnvStudies
Senior Environmental Scientist

APPENDIX 1

CORRESPONDENCE WITH ENVIRONMENT AUSTRALIA

Environment Australia

Department of the Environment and Heritage

Mr Mark Aitkens
Environmental Scientist
HLA-Envirosciences Pty Limited
PO Box 73
HRMC NSW 2310

Dear Mr Aitkens

Muswellbrook Coal Company Ltd/Mining/Muswellbrook/NSW/
Extension of operations to existing Muswellbrook No 1 Open Cut mine
(Reference: EPBC 2002/614)

The above action was referred by HLA-Envirosciences Pty Ltd, on behalf of the Muswellbrook Coal Company Limited, and received on 21 March 2001, for decision whether or not approval is needed under Chapter 4 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The referral has now been considered under the EPBC Act and I have decided that the action is not a controlled action. Approval is therefore not needed under Part 9 of the Act before the action can proceed.

A copy of the document recording my decision is attached for your information.

Yours sincerely

Stephanie Martin
Assistant Secretary
Policy and Compliance Branch

22 April 2002

GPO Box 787 Canberra ACT 2601 Telephone 02 6274 1113 Facsimile 02 6274 1666
Internet: www.environment.gov.au

GREENHOUSE CHALLENGE MEMBER

INTERNATIONAL ENVIRONMENTAL MANAGEMENT SYSTEM

HLA

COMMONWEALTH OF AUSTRALIA

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

DECISION THAT ACTION IS NOT A CONTROLLED ACTION

Pursuant to section 75 of the *Environment Protection and Biodiversity Conservation Act 1999*, I, STEPHANIE ROSE MARTIN, Assistant Secretary, Policy and Compliance Branch, Environment Australia, decide that the proposed action, set out in the Schedule, is not a controlled action.

SCHEDULE

The proposed action by the Muswellbrook Coal Company Limited to extend operations in the existing Muswellbrook No 1 Open Cut mine within Consolidated Coal Lease 713 and as described in the referral received under the Act on 21 March 2001 (EPBC 2002/614).

Dated this 22nd day of April 2002

Stephanie Martin

ASSISTANT SECRETARY
POLICY AND COMPLIANCE BRANCH
ENVIRONMENT AUSTRALIA

APPENDIX 2

SURVEY METHODOLOGIES

CONTENTS

1.0 SURVEY METHODOLOGY

1.1 Flora

This section discusses the key aspects of the vegetation survey for the study area, including:

- sampling techniques;
- description of sampling sites;
- targeting threatened plant species; and
- voucher specimens

1.1.1 Sampling Techniques

To ensure that the study area was adequately sampled a combination of transects and plot-based surveys were used to provide information on vegetation boundaries, floristic diversity and the possible presence of threatened species, populations and ecological communities, and their habitats.

A general walk of the study area was undertaken prior to the initiation of a randomised stratified vegetation survey. This initial overview of the study area provided:

- an understanding of the plant communities in the study area and assisted in the identification of ecological community boundaries;
- additional assistance in identifying locations for quadrat or transect sampling within the various flora communities;
- additional assistance in identifying the potential distribution of threatened plants and recording inconspicuous species; and
- opportunistic plant (and animal) sightings.

1.1.1.1 Transects

Transects are valuable for obtaining an understanding of the vegetation communities in the area, identifying community boundaries, and recording species.

Transects were undertaken on foot with the number and length of transects varying depending on the size, dimensions, topographic diversity and number of flora communities of the study area. Information recorded while undertaking transects included all plant species observed, as well as other relevant information relating to the distribution of plant species such as aspect, topographic position, elevation, and vegetation community boundaries.

1.1.1.2 Plot Based (or Quadrat) Surveys

Plot-based (or quadrat) survey techniques have some distinct advantages over transects. LMCC (1997) list the following advantages of plot-based surveys, as they:

- Enable a quantitative examination of species distribution and abundance;
- Are more likely to detect inconspicuous or threatened species as a smaller area is sampled in a concentrated search; and
- Provide a basis for any subsequent monitoring required.

All quadrats were placed parallel with the contour where the stratification unit allowed for this configuration. The typical dimensions of each plot was 20 metres by 20 metres, however, where vegetation occupies a linear space, the plot shape can be changed to fit within the vegetation type as long as the total area remains the same (Walker and Hopkins, 1990; York *et al.,* 1991; NPWS, 1995).

Table 1 below describes the survey effort for transects and quadrats utilised within the survey of the study area.

TABLE 1
SURVEY TECHNIQUES AND EFFORT FOR THE PLANT CENSUS OF THE STUDY AREA

Survey technique	Suggested minimum effort	Information recorded
Transect	1x100 m traverse per stratification unit <2 hectares 2x100 m traverse per 2-50 hectares of stratification unit 3x100 m traverse per 51-250 hectares of stratification unit 5x100 m traverse per 251-500 hectares of stratification unit 10x100 m traverse per 501-1000 hectares of stratification unit, plus 1 additional 100 m traverse for each extra 100 hectares thereof.	Floristics, structure, vegetation boundaries

TABLE 1 SURVEY TECHNIQUES AND EFFORT FOR THE PLANT CENSUS OF THE STUDY AREA		
Survey technique	Suggested minimum effort	Information recorded
Quadrat	At least 1 quadrat per stratification unit <2 hectares 2 quadrats per 2-50 hectares of stratification unit 3 quadrats per 51-250 hectares of stratification unit 5 quadrats per 251-500 hectares of stratification unit 10 quadrats per 501-1000 hectares of stratification unit, plus 1 additional quadrat for each extra 100 hectares thereof.	Floristics, structure, threatened species

1.1.2 Plot Description

A range of descriptive data was recorded at each plot (quadrat) location on a specific survey pro-forma. All sheets were filled in at the site, with irrelevant sections crossed through rather than left blank to indicate the section was not relevant rather than not considered.

Types of data that are recorded in survey pro-formas are:

- date;
- plot number or unique identifier;
- name(s) of observers;
- plot size (and dimensions);
- location – refer to Australian map grid (AMG) giving map name and number, six digit easting, seven digit northing. Use global positioning system (GPS) reading if available and state accuracy if known;
- locality description to assist relocation, for example, distance from road, track or distinctive landmark, giving walking distance and direction. Include property name or reserve name if known;
- landform type;
- soil type (clay, loam, sand, organic);
- geology (rock outcrops);
- slope (using clinometer); and
- aspect (estimated using compass bearing).

All vascular plant species present within the plot were identified and recorded. Plants were identified as far as possible to the species or subspecies level. Plants not identified in the field were collected for identification using the *Flora of New South Wales* (Harden 1990, 1991, 1992, 1993) taxonomic key and/or other reference material. Specimens not identifiable in the laboratory, if encountered, were sent to the National Herbarium for identification.

Dominant species within each plot were categorised in accordance with their strata to assist in the preparation of detailed vegetation descriptions within the report.

1.1.3 Targeting Threatened Plants

Threatened species, populations and ecological communities were targeted during transect or plot surveys or by opportunistic observations such as walking or driving between sampling sites. Specific targeted surveys were conducted for threatened species, populations and ecological communities, and their habitats, considered likely to occur in the locality.

In areas of preferred habitat for threatened species, populations and ecological communities, a random meander technique was adopted (Cropper, 1993). This technique allowed for a greater coverage than a plot and/or transects based approach. As the name suggests, the random meander technique involves traversing areas of suitable habitat in no set pattern, but roughly back and forth, whilst searching for a particular, or several, threatened plants.

The following information was recorded where a threatened species, population(s) or ecological community(ies) was identified:

- species (or ecological community) name and location;
- population area and size (or extent);
- reproductive state;
- age structure;
- land conservation status;
- fire response (if known);
- observer;
- date; and
- threats.

All threatened species, populations and ecological communities recorded within the study area were mapped.

1.1.4 Voucher Collections

Specimens of threatened plant species and other plant species of conservation significance were collected and lodged at the National Herbarium of NSW for verification. Plant specimens were collected and processed in accordance with the guidelines prepared by the National Herbarium of NSW (Bedford and James, 1995). Orchids that cannot be identified in the field, if encountered, were preserved in orchid vials in 80% ethanol and kept away from light and heat.

1.2 Fauna

This section discusses the effort and methods appropriate for use in the assessment of animals, including:

- Sampling design;
- Survey limitations;
- Sampling methods and effort; and
- Voucher specimens;
- Handling and ethics.

1.2.1 Sampling Design

A range of fauna survey techniques were adopted in the undertaking of this survey of the study area to ensure the adequate census of the four (4) vertebrate groups including mammals, avifauna, reptiles and amphibians. Survey techniques used during this survey include:

- mammal trapping (Elliot traps);
- stationary and mobile time quadrats targeting avifauna populations;
- active and passive searches of habitat for reptiles and amphibians;
- spotlighting for mammals, avifauna, reptiles and amphibians;
- call playback for nocturnal avifauna, mammals and amphibians; and
- echolocation detection for microchiropteran bats.

Opportunistic sightings at any location in or near the study site were also recorded and discussed in the report. Further, stationary stag watches of hollow-bearing trees, conducted prior to and after sunset for nocturnal species, was undertaken for habitat features of particular interest to the assessment process.

An assessment of the study areas habitat features including vegetation layers, leaf litter, fallen timber, tree hollows (position on tree & size), rock shelves, soil type, presence of water and any man-made habitats was also compiled. Climatic variables such as rainfall, temperature, wind speed and cloud cover at the time of the survey were also recorded.

1.2.2 Survey Limitations

The aim of the survey is to provide a list of species present, and potential habitat for threatened species not detected, in the study site. However, the effectiveness of a survey in detecting a given species will be affected by:

- the species behaviour;
- the species life cycle, in particular the time of the breeding cycle;
- the range of methods used;
- the experience of the observer;
- the weather (rainfall, temperature, wind);
- the type of vegetation;
- season when the survey is undertaken;
- time of day when the survey is undertaken; and
- the amount of time spent surveying.

Some species are only present in an area in certain seasons (e.g. many species of threatened migratory birds), others are always present but can only be detected in certain seasons (e.g. breeding season for certain frogs) while other species are inactive in cool weather (e.g. microchiropteran bats, reptiles, frogs). Even if sampling can only be carried out in one season, it must be undertaken over a reasonable time period to maximise the chance of detecting species. Certain species are nomads or have very large home ranges and may be attracted to patchy availability of food such as blossoms, other species may go through cycles of activity related to breeding, cloud cover, wind speed, rainfall, or short term temperature changes.

Where limitations cannot be overcome an assessment of the likelihood of threatened species utilising the habitat was made.

1.2.3 Sampling Methods and Effort

The following sections list the methods that were used to survey fauna species of the study area. The selection of methods employed in the survey was based on the study area's physical and floral characteristics and habitat values. Methods were used consistently and recorded and mapped in detail to allow replication. The area and time spent searching and personnel involved were also noted. All

recordings of frog and bat tapes were retained to confirm species identifications. In areas where threatened species, populations or ecological communities, or their habitats, potentially exist, more specific methods targeting their detection were employed.

1.2.3.1 Amphibians

Methods

A combination of listening for frog calls, spotlighting, habitat searches and call recording was used to survey the study area's amphibian populations. Systematic diurnal searches for tadpoles and adult frogs were conducted within the suitable habitat zones. Watercourse, dams and adjacent areas were searched including under logs and rocks, in shrubs and trees, under bark, and in litter. Additional surveys were undertaken at night to supplement diurnal surveys. Where appropriate call playback techniques were utilised to target specific threatened species such as the Green and Golden Bell Frog.

Suitable habitat zones were visited on two separate nights for 30 minutes each to search for amphibians. Incorporation of wet, warm and/or overcast humid conditions were incorporated in to the survey where possible to enhance the outcome of survey techniques and effort. Amphibian identification was undertaken using Barker *et al* (1995), Robinson (1994) and Cogger (2000).

Effort

Table 2 identifies the survey effort expended on amphibian surveys during the specified study period.

TABLE 2
AMPHIBIAN SURVEY METHODS AND EFFORT UNDERTAKEN WITHIN STUDY AREA

Method	Survey effort	Survey Period
Systematic diurnal habitat searches	1 hour per stratification unit	November
Night habitat search of damp and watery sites	30 minutes at 2 separate nights per stratification unit	November

1.2.3.2 Reptiles

Methods

A range of sampling techniques including active searches, car transects and spotlighting on foot was incorporated into the survey of the study area. Timed, diurnal, active searches were undertaken during warm, calm, dry weather with windy, cold and overcast or rainy weather conditions avoided where possible. Thirty-minute searches on two separate days per stratification unit were undertaken before mid-morning when reptiles have not reached their optimal body temperature.

Cryptic species not observed during visual searches were targeted using destructive searches of fallen logs, litter, decorticating and fallen bark and rock outcrops (NPWS, 1997). Burrowing species were detected by raking of substrate under rocks. Rubbish and building materials such as corrugated iron were also lifted and examined.

Nocturnal spotlighting of tree trunks and other habitat was used to detect geckoes and nocturnal snakes. Thirty minutes on two separate nights were undertaken per stratification unit.

Effort

Table 3 identifies the survey effort expended on reptile surveys during the specified study period.

TABLE 3
REPTILE SURVEY METHODS AND EFFORT UNDERTAKEN WITHIN STUDY AREA

Method	Survey effort	Survey Period
Habitat search	30 minutes on 2 separate days targeting specific habitat.	November
Spotlighting	30 minutes on 2 separate nights targeting specific habitat.	November

1.2.3.3 Diurnal Avifauna

Methods

The area search method, where observers walk around an area of predetermined size for a predetermined length of time, was implemented as the main census method for avifauna populations. By recording presence data within a 2 ha (400 m x 500 m) 60 minute search (Loyn, 1986), the study area was systematically surveyed for its avifauna values. This method is noted for its capacity to detect small cryptic birds that inhabit isolated or restricted habitat niches, which are otherwise missed through inappropriate survey design.

Birds were observed both by sight and call vocalisations. Surveys were conducted during the early morning (at dawn), when avifauna activity is at its peak. Opportunistic sightings and/or vocalisations were noted during other parts of the day / night. Wet, windy and extremely hot weather was avoided, where practicable, as avifaunal activity decreases under these conditions.

At natural wetlands, a one hour bird observation period was conducted at dawn and / or dusk. Avifauna was recorded as present within the wetland, flying overhead or outside the habitat. A 20-minute census, at dawn or an hour before dusk should also be conducted at each identified source of water in the survey area. Opportunistic species sightings were recorded.

Effort

Table 4 identifies the survey effort expended on avifauna surveys during the specified study period.

TABLE 4
AVIFAUNA SURVEY METHODS AND EFFORT UNDERTAKEN WITHIN STUDY AREA

Method	Survey effort	Survey Period
Area search	Per stratification unit.	November
Wetland census	A one hour census at dawn or dusk for each identified wetland.	November
Water source census	A 20 minute census at dawn or dusk for each identified water source.	November

1.2.3.4 Nocturnal Birds

Methods

Owls call most frequently in the early evening and before dawn and surveys should be undertaken at these times. Wet and windy weather was avoided, as owls are most vocal on calm dry nights. A technique involving a combination of quiet listening for owl vocalisations, call broadcasting and spotlighting was undertaken during the survey period. At each call playback site an initial listening period of 10 to 15 minutes was undertaken, followed by a spotlight search for 10 minutes to detect any animal in the immediate vicinity. The calls of each target species were then played intermittently for five minutes followed by a 10 minute listening period. After all the calls have been played, another 10 minutes of spotlighting and listening was conducted in the vicinity to check for birds attracted by the calls but not vocalising.

Diurnal searches for suitable nest / roost trees was also undertaken to establish whether the study area contains any potential breeding habitat. Further, owl pellets were also collected on each survey site and sent to a specialist for identification.

Other nocturnal birds were similarly surveyed by spotlighting, generally using a 12v 100w spotlight. This can be combined with spotlighting for mammals. Species such as Plains Wanderer require spotlighting by foot or from a vehicle in first gear.

Effort

Table 5 identifies the survey effort expended on nocturnal avifauna surveys during the specified study period.

TABLE 5
NOCTURNAL SURVEY METHODS AND EFFORT UNDERTAKEN WITHIN STUDY AREA

Method	Survey effort	Survey Period
Call playback	One site was visited twice, on different nights, and sampled for the Powerful Owl, Barking Owl and the Masked Owl.	November
Day habitat search	Search study area for owl pellets and likely roost hollows.	November
Spotlighting	Spotlighting for Powerful Owl, Barking Owl and Masked Owl.	November

1.2.3.5 Mammals (excluding bats)

Methods

A variety of survey methods appropriate for the study area were used to survey local mammal populations.

Elliott trapping
Elliott traps were numbered and tagged and established in a systematic manner following a specified sampling regime for the study area. Sampling involved a minimum of 25 traps set for at least three nights, but a maximum of four nights. Trap lines were established with a spacing of 20-50 metres. The effect of trap saturation was considered where common species were regularly entrapped.

Elliott traps need to be checked every morning to ensure that any animals caught are not left to dehydrate during the course of the day, and then reset in the evening. The trap contained materials that allow the animal to keep warm during the course of the evening.

Tracks, scats and scratches

Survey effort involved at least a 30 minute search within appropriate habitats for tracks, scats and scratches. Unidentified hair samples and predator scats were sent to a specialist with expertise in scat analysis.

Spotlighting

Survey effort on foot or by car involved two searches each for one hour with a hand-held spotlight of appropriate power for the conditions. This was conducted on each of two separate nights along a traverse of at least one kilometre, which samples the least disturbed parts within the stratification unit.

Call playback

Observation of nocturnal vocalisations, including call playback was undertaken for arboreal mammals. Call playback techniques for arboreal mammals require the same technique as that described for nocturnal birds.

Effort

Table 6 identifies the survey effort expended on mammal surveys during the specified study period.

TABLE 6
MAMMAL SURVEY METHODS AND EFFORT UNDERTAKEN WITHIN STUDY AREA

Method	Survey effort	Fauna Targeted
Small Elliott traps	150 trap nights over 3 consecutive nights	small mammals
Large Elliott traps	24 trap nights over 3 consecutive nights	medium-to large mammals
Spotlighting on foot	2 x 1 hour and 1 km walking at approximately 1 km per hour, on 2 separate nights	arboreal and terrestrial mammals
Call playback	One site was visited twice, on different nights, and sampled for the Koala, Squirrel Glider and Yellow-bellied Glider.	gliders, koala
Search for scats and signs	30 minutes searching each relevant habitat, including trees for scratch marks	all mammals
Collection of predator scats	Opportunistic collection of predator scats for analysis	all mammals

1.2.3.6 Bats

Given the decline in bats within NSW, the lack of knowledge on their ecological requirements, and the difficulty in identifying all the bats that may utilise an area, it is particularly important that the suitability of habitat is assessed for bats during survey, and taken into account during the assessment of significance.

Methods for Microchiropteran Bat Surveys

The location of tree hollows, dense vegetation canopies caves, derelict mines, bridges, and other human-made structures with the potential to support bats were investigated for any sign of bat inhabitation. Signs of bats or their scats were actively searched for during this period.

Suitable roosting locations were then targeted using survey methodologies including ultrasonic echolocation detectors and / or trapping and physical identification. Ultrasonic echolocation detectors were placed in a suitable position during dusk and or dawn periods for the purpose of recording bats moving too and from potential roost sites.

In addition, ultrasonic echolocation detectors where positioned in the areas of greatest potential activity. Watering points are often areas of high bat activity and were therefore targeted (e.g. dam, small pools in streams, water tanks or irrigation channels) or across a stream or gully. Many species also use regular flyways, which may be located by observation or ultrasonic detection. Potential short-term foraging grounds, such as areas of flowering Eucalypts or other insect attracting phenomena, were similarly targeted.

Where practicable bats were sampled in their most active period, which is from October to March. High wind, heavy rain and full moon conditions were avoided when undertaking bat surveys.

Methods for Megachiropteran Bat Surveys

Spotlight searches combined with listening for audible calls were undertaken for megachiropteran bat species.

Effort

Table 7 identifies the survey effort expended on microchiropteran and megachiropteran bat surveys during the specified study period.

TABLE 7 BAT SURVEY METHODS AND EFFORT UNDERTAKEN WITHIN STUDY AREA		
Method	Survey effort	Survey Period
Ultrasonic call recording	Sound activated recording devices utilised for entire night starting at dusk, for two nights	October to March
Spotlighting and transect walking	for targeted survey near likely food resources: 2 x 1 hour spotlighting on two separate nights	All year
Day habitat search	Search for bat excreta at or near potential habitats	All year

1.2.3.7 Invertebrates

Invertebrates occupy a wide range of habitats and exhibit enormous spatial and temporal variability. It cannot be assumed that invertebrate associations will exhibit strong associations with vegetation types or vertebrate assemblages.

At present, it is generally acceptable to target only threatened invertebrate species for animal assessments. The NPWS threatened species (Environmental Impact Assessment) profiles should be referred to for specific techniques for these species (where completed for that species).

APPENDIX 3

FLORA SPECIES LISTS

TABLE 1
NATIVE FLORA SPECIES OF THE STUDY AREA

Common Name	Scientific Name	Flora Community
-	*Abutilon oxycarpum*	3
Western Golden Wattle	*Acacia decora*	4
Black Wattle	*Acacia decurrens*	1
Sickle Wattle	*Acacia falcata*	1,2,3,4
Hickory	*Acacia implexa*	1,3
Kangaroo-thorned Wattle	*Acacia paradoxa*	3,4
-	*Acacia salicina*	1
Common Maidenhair	*Adiantum aethiopicum*	4
Bull Oak	*Allocasuarina luehmannii*	4
Rough-barked Apple	*Angophora floribunda*	2,4
Pale Vanilla Lily	*Arthropodium milleflorum*	3
Common Woodruff	*Asperula conferta*	3,4
Wallaby Grass	*Austrodanthonia bipartita*	2,3,4
-	*Bossiaea heterophylla*	3
-	*Bossiaea prostrata*	3
Kurrajong	*Brachychiton populneus*	3
Blackthorn	*Bursaria spinosa*	3
-	*Calocephalus citreus*	3
Shiny-leaved Canthium	*Canthium odoratum*	3
Knob Sedge	*Carex inversa*	4
-	*Cassinia sp. D*	3
Mulga Fern	*Cheilanthes sieberi*	3,4,4
Windmill Grass	*Chloris truncata*	4
Tall Chloris	*Chloris ventricosa*	4
Yellow Buttons	*Chrysocephalum semipapposum*	2,3,4
Clematis	*Clematis glycinoides*	3
Wandering Jew	*Commelina cyanea*	3
-	*Convolvulus erubescens*	3
-	*Cryptandra amara*	3,4
Barbwire Grass	*Cymbopogon refractus*	4
Common Couch	*Cynodon dactylon*	3,4, Dams Edge
Dirty Dora	*Cyperus difformis*	Dams Edge
-	*Desmodium brachypodum*	3
Flax Lily	*Dianella caerulea*	3,4
Flax Lily	*Dianella longifolia*	3
Plume Grass	*Dichelachne crinita*	2,3,4
Short-hair Plume Grass	*Dichelachne micrantha*	3
Kidney Weed	*Dichondra repens*	3,4
Hop Bush	*Dodonaea viscosa*	3
Rasp Fern	*Doodia aspera*	3
Berry Saltbush	*Einadia hastata*	2
-	*Einadia polygonoides*	Dams Edge
Ruby Saltbush	*Enchylaena tomentosa*	3
Paddock Lovegrass	*Eragrostis leptostachya*	3
Winter Apple	*Eremophila debilis*	3,4
Blakely's Red Gum	*Eucalyptus blakelyi*	2
River Red Gum	*Eucalyptus camaldulensis*	1
-	*Eucalyptus cladocalyx*	1
Narrow Leafed Ironbark	*Eucalyptus crebra*	1,2,3,4
-	*Eucalyptus microtheca*	1
Grey Box	*Eucalyptus moluccana*	3,4

TABLE 1
NATIVE FLORA SPECIES OF THE STUDY AREA

Common Name	Scientific Name	Flora Community
Grey Gum	*Eucalyptus punctata*	1
Forest Red Gum	*Eucalyptus tereticornis*	4
Wombat Berry	*Eustrephus latifolius*	3
Native Cherry	*Exocarpos cupressiformis*	3,4
-	*Geranium solanderi*	3,4
Twining Glycine	*Glycine clandestina*	3
Twining Glycine	*Glycine microphylla*	3,4
Twining Glycine	*Glycine tabacina*	3,4
-	*Goodenia hederacea ssp. hederacea*	3,4
-	*Haloragis heterophylla*	Dam Edge
False Sarsparilla	*Hardenbergia violacea*	2,3,4
Guinea Flower	*Hibbertia obtusifolia*	2,3,4
Little St Johns Wort	*Hypericum gramineum*	4
Blady Grass	*Imperata cylindrica*	4
Native Indigo	*Indigofera australis*	3
Common Rush	*Juncus usitatus*	Dams Edge
-	*Lomandra confertifolia*	2, 3
-	*Lomandra glauca*	2
Spiky-headed Mat-rush	*Lomandra longifolia*	3
Many-flowered Mat-rush	*Lomandra multiflora*	2,3,4
-	*Maireana microphylla*	3,4
Native Pear	*Marsdenia viridiflora*	3
Mistletoe	*Muellerina eucalyptoides*	3
Boobialla	*Myoporum montanum*	3
Mock Olive	*Notelaea longifolia*	3,4
-	*Notolaea microcarpa var. microcarpa*	2
-	*Opercularia diphylla*	3
-	*Oplismenus imbecillis*	4
-	*Oxalis exilis*	3,4
Ball Everlasting	*Ozothamnus diosmifolius*	2,3,4
Rice Flower	*Pimelea curviflora ssp.*	3
-	*Plantago gaudichaudii*	3
-	*Poa labillardieri*	2,3,4
Blunt Pondweed	*Potamogeton ochreatus*	5
Tall Leek Orchid	*Prasophyllum elatum*	4
Whiteroot	*Pratia purpurascens*	3
-	*Pultenaea microphylla*	3
-	*Ranunculus sessiliflorus*	4
-	*Rulingia dasyphylla*	4
-	*Rumex brownii*	4
-	*Senecio quadridentatus*	3
-	*Sida corrugata*	3,4
Nightshade	*Solanum brownii*	3, Dams Edge
Eastern Nightshade	*Solanum prinophyllum*	3
Wild Sorghum	*Sorghum leiocladum*	3
-	*Stackhousia viminea*	3,4
-	*Stipa scabra*	4
Nodding Blue Lily	*Stypandra glauca*	2,4
Kangaroo Grass	*Themeda australis*	3,4
Cumbungi	*Typha orientalis*	5
-	*Velleia paradoxa*	4
Fuzzweed	*Vittadina cuneata*	3,4

TABLE 1
NATIVE FLORA SPECIES OF THE STUDY AREA

Common Name	Scientific Name	Flora Community
Tufted Bluebell	*Wahlenbergia communis*	3,4
Australian Bluebell	*Wahlenbergia gracilis*	3,4
Grasstree	*Xanthorrhoea johnsonii*	2,4

TABLE 2
EXOTIC FLORA SPECIES OF THE STUDY AREA

Common Name	Scientific Name	Flora Community
Exotic Palm	-	3
Golden Wreath Wattle	*Acacia saligna*	1
Pimpernel	*Anagalis arvensis*	3,4
Whisky Grass	*Andropogon virginicus*	4
Cape Dandelion	*Arctotheca calendula*	4
Wild Oats	*Avena fatua*	3,4
Oats	*Avena sativa*	3,4
Cobblers Pegs	*Bidens pilosa*	3
Quaking Grass	*Briza maxima*	2,3,4
Shivery Grass	*Briza minor*	2,3,4
Soft Brome	*Bromus molliformis*	3,4
Mother of Millions	*Bryophyllum delagoense*	3
Saffron Thistle	*Carthamus lanatus*	3,4
Century Plant	*Centaurium tenuiflorum*	4
Goosefoot	*Chenopodium ambrosioides*	Dams Edge
Rhodes Grass	*Chloris gayana*	4
-	*Cirsium vulgare*	3,4
Tall Fleabane	*Conyza albida*	4
Patterson's Curse	*Echium vulgare*	Dams Edge
-	*Facelis retusa*	4
Fennel	*Foeniculum vulgare*	4
Galenia	*Galenia pubescens*	3,4
Cleavers	*Galium aparine*	3
-	*Galium liratum*	4
Cudweed	*Gnaphalium americanum*	4
Narrow Leaf Cotton Bush	*Gomphocarpus fruticosus*	3,4
Barley Grass	*Hordeum leporinum*	3
Perennial Ryegrass	*Lolium perenne*	3,4
African Boxthorn	*Lycium ferocissimum*	3,4
Horehound	*Marrubium vulgare*	4
Hexham Scent	*Melilotus indicus*	Dams Edge
Prickly Pear	*Opuntia stricta*	4
Kikuyu	*Pennisetum clandestinum*	Dams Edge
Prolific Pink	*Petrorhagia nanteilii*	4
Phalaris	*Phalaris aquatica*	1
Inkweed	*Phytolacca octandra*	Dams Edge
Ribwort	*Plantago lanceolata*	3,4
Castor Oil Plant	*Ricinis communis*	1
Onion Grass	*Romulea rosea*	4
Curled Dock	*Rumex crispus*	1
Fireweed	*Senecio madagascariensis*	3,4
Paddy's Lucerne	*Sida rhombifolia*	4
Variegated Thistle	*Silybum marianum*	1
Dandelion	*Taraxacum officinale*	3
-	*Tolpis umbellata*	4
Salsify	*Tragopogon porrifolius*	4
Hares foot Clover	*Trifolium arvense*	3,4
White Clover	*Trifolium repens*	3,4
Twiggy mullein	*Verbascum virgatum*	4
Purple Top	*Verbena bonariensis*	4
Noogoora Burr	*Xanthium occidentale*	Dams edge

TABLE 3 THREATENED FLORA SPECIES		
Bothriochloa biloba	Erect or decumbent grass to 1 m high growing in Woodlands on poorer soils. Distribution limits N- Tweed Heads S- Sydney.	Identified within 10 km of the study area. Potential habitat present within study area. Not observed during survey.
Olearia cordata	Shrub to 2 m high. Grows in dry sclerophyll forest and shrubland on Hawkesbury sandstone. Distribution limits N - Wollombi S - Wiseman's Ferry	Identified within 10 km of the study area. No potential habitat present within study area. Not observed during survey.

APPENDIX 4

FAUNA SPECIES LISTS

TABLE 1
FAUNA RECORDED WITHIN THE STUDY AREA

Common name	Scientific name	Method Observed
Birds		
Australasian Grebe	*Tachybaptus novaehollandiae*	O
Australian King Parrot	*Alisterus scapularis*	O
Australian Magpie	*Gymnorhina tibicen*	O C
Australian Magpie-Lark	*Grallina cyanoleuca*	O C
Australian Raven	*Corvus coronoides*	O C
Australian Wood Duck	*Chenonetta jubata*	O
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O C
Black-fronted Dotterel	*Charadrius melanops*	O
Black-shouldered Kite	*Elanus axillaris*	O
Brown Quail	*Coturnix ypsilophora*	O
Channel-billed Cuckoo	*Scythrops novaehollandiae*	O C
Chestnut Teal	*Anas castanea*	O
Clamorous Reed-Warbler	*Acrocephalus stentoreus*	C
Common Koel	*Eudynamys scolopacea*	O C
Common Starling *	*Sturnus vulgaris*	O
Crested Pigeon	*Ocyphaps lophotes*	O
Dusky Moorhen	*Gallinula tenebrosa*	O
Eastern Rosella	*Platycercus eximius*	O C
Eurasian Coot	*Fulica atra*	O
Galah	*Cacatua roseicapilla*	O C
Grey Butcherbird	*Cracticus torquatus*	O C
Grey-crowned Babbler	*Pomatostomus temporalis*	O
Grey Fantail	*Rhipidura fuliginosa*	O
Grey Shrike-thrush	*Colluricincla harmonica*	O C
Grey Teal	*Anas gracilis*	O
Indian Myna *	*Acridotheres tristis*	O
Jacky Winter	*Microeca fascinans*	O
Laughing Kookaburra	*Dacelo novaeguineae*	O C
Little Corella	*Cacatua pastinator*	O C
Masked Lapwing	*Vanellus miles*	O C
Mistletoe Bird	*Dicaeum hirundinaceum*	O
Nankeen Kestrel	*Falco cenchroides*	O
Noisy Friarbird	*Philemon corniculatus*	O C
Noisy Miner	*Manorina melanocephala*	O C
Pacific Black Duck	*Anas supercilliosa*	O
Pied Butcherbird	*Cracticus nigrogularis*	O C
Pied Cormorant	*Phalacrocorax varius*	O
Pied Currawong	*Strepera graculina*	O C
Red-rumped Parrot	*Psephotus haematonotus*	O
Spotted Pardalote	*Pardalotus punctatus*	C
Sulphur Crested Cockatoo	*Cacatua galerita*	O C
Superb Fairy-wren	*Malurus cyaneus*	O
Varied Sittella	*Daphoenositta chrysoptera*	O C
Varied Triller	*Lalage leucomela*	O
Variegated Fairy-wren	*Malurus lamberti*	O
Welcome Swallow	*Hirundo neoxena*	O
White-faced Heron	*Egretta novaehollandiae*	O
White-winged Chough	*Corcorax melanorhhamphos*	O
Willie Wagtail	*Rhipidura leucophrys*	O
Yellow Thornbill	*Acanthiza nana*	O
Mammals		
Echidna	*Tachyglossus aceleatus*	Sc

TABLE 1
FAUNA RECORDED WITHIN THE STUDY AREA

Common name	Scientific name	Method Observed
Eastern Grey Kangaroo	*Macropus giganteus*	O Sc
Common Dunnart	*Sminthopsis murina*	E
Common Brush-tail Possum	*Trichosurus vulpecula*	O Sc
Common Wombat	*Vombatus ursinus*	O Sc
Yellow-footed Antechinus	*Antechinus flavipes*	E
Chocolate Wattled Bat	*Chalinolobus morio*	An
Eastern False Pipistrelle [v]	*Falsistrellis tasmaniensis*	An
Eastern Forest Bat	*Vespadelus pumilus*	An
Feral Goat*	*Capra hircus*	O Sc
Rabbit *	*Oryctolagus cuniculus*	O Sc
European Red Fox *	*Vulpes vulpes*	O Sc
Cat*	*Felis cattus*	O
Reptiles		
-	*Anomalopus leuckartii*	O
Eastern Snake-necked Turtle	*Chelodina longicollis*	O Sc
Rainbow Skink	*Carlia tetradactyla*	O
-	*Egernia modesta*	O
Tree Skink	*Egernia striolata*	O
Velvet Skink	*Oedura robusta*	O
Bearded Dragon	*Pogona barbata*	O
Eastern Brown Snake	*Pseudonaja textilis*	O
Thick-tailed Gecko	*Underwoodisaurus milii*	O
Lace Monitor	*Varanus varius*	O S
Amphibians		
Green Tree Frog	*Litoria caerulea*	C
Dwarf Tree Frog	*Litoria fallax*	C
Perons Tree Frog	*Litoria peronii*	C

Note: * indicates introduced species
[v] indicates vulnerable species

A	-	Anabat II	C	-	Call Identification
O	-	Observation	P	-	Call Playback Response
E	-	Elliott Trap	S	-	Habitat Search
Sp	-	Spotlight	Sc	-	Scat, Track or Sign Identification

TABLE 2

THREATENED SPECIES

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS
Green and Golden Bell Frog *Litoria aurea*	Prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds. Often found under debris. Distribution Limit – N-Byron Bay. S-South of Eden	Identified within 10 km of the study area. Potential habitat present within study area. Not observed during survey.
Freckled Duck *Stictonetta naevosa*	Occurs mainly within the Murray-Darling basin and the channel country within large cool temperate to sub-tropical swamps, lakes and floodwaters with cumbungi, lignum or melaleucas. Distribution Limit – N-Tenterfield. S-Albury.	Identified within 10 km of the study area. No potential habitat present within study area. Not observed during survey.
Square-tailed Kite *Lophoictinia isura*	Utilises mostly coastal and sub-coastal open forest, woodland or lightly timbered habitats and inland habitats along watercourses and mallee that are rich in passerine birds. Distribution Limit – N-Goondiwindi. S-South of Eden.	Identified within 10 km of the study area. Potential habitat present within study area. Not observed during survey.
Regent Honeyeater *Xanthomyza phrygia*	Found in temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts. Distribution Limit – N-Urbenville. S-Eden	Identified within 10 km of the study area. No potential foraging habitat present within study area. Not observed during survey.
Grey-crowned Babbler *Pomatostomus temporalis*	Occupies open woodlands dominated by mature eucalypts, with regenerating trees, tall shrubs and an intact ground cover of grass and forbs. Builds conspicuous dome-shaped nests and breeds co-operatively in sedentary family groups. Distributional Limit – N-Qld Border S – Vic Border.	Not identified within 10 km of the study area. Potential foraging and breeding habitat present within study area. Observed within study area, constructing nest near Bimbadeen homestead.
Spotted-tailed Quoll *Dasyurus maculatus*	Dry and moist open forests containing rock caves, hollow logs or trees. Distribution Limit-N-Mt Warning National Park S-South of Eden.	Identified within 10 km of the study area. Potential foraging habitat present within study area. Not observed during survey.

TABLE 2

THREATENED SPECIES

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS
Koala *Phascolarctos cinereus*	Inhabits both wet & dry eucalypt forest on high nutrient soils containing preferred feed trees. Distribution Limit - N-Tweed Heads. S-South of Eden	Identified within 10 km of the study area. No potential foraging or breeding habitat present within study area. Not observed during survey.
Large-eared Pied Bat *Chalinolobus dwyeri*	Warm-temperate to subtropical dry sclerophyll forest and woodland. Roosts in caves, tunnels and tree hollows in colonies of up to 30 animals. Distribution Limit - N-Border Ranges Nation Park. S-Wollongong.	Not identified within 10 km of the study area. Potential foraging habitat present within study area. Not recorded during survey.
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	Recorded roosting in caves, old buildings and tree hollows. Distribution Limit- N-Border Ranges National Park S-Pambula	Not identified within 10 km of the study area. Potential foraging and breeding habitat present within study area. Recorded during survey.
Eastern Little Mastiff Bat *Mormopterus norfolkensis*	Inhabits open forests and woodlands foraging above the canopy and along the edge of forests. Roosts in tree hollows, under bark and buildings. Distribution Limit - N-Woodenbong. S-Pambula.	Not identified within 10 km of the study area. Potential foraging and breeding habitat present within study area. Not recorded during survey.
Little Bent-wing Bat *Miniopterus australis*	Roosts in caves, old buildings and tree hollows in the higher rainfall forests along the south coast of Australia. Distribution Limit - N-Border Ranges National Park. S-Sydney.	Not identified within 10 km of the study area. Potential foraging habitat present within study area. Not recorded during survey.
Common Bent-wing Bat *Miniopterus schreibersii*	Prefers caves, old mines, old buildings, stormwater drains & well timbered areas. Distribution Limit - N-Border Ranges National Park. S-South of Eden.	Not identified within 10 km of the study area. Potential foraging habitat present within study area. Not recorded within study area.
Large-footed Myotis *Myotis adversus*	Rainforests and sclerophyll forests near creeks and lakes over which it feeds. Roosts in tree hollows, caves, mines and tunnels. Distribution Limit - N-Border Ranges National Park. S-South of Eden.	Not identified within 10 km of the study area. Potential foraging and breeding habitat present within study area. Not recorded within study area.

TABLE 2

THREATENED SPECIES

COMMON NAME *Scientific Name*	PREFERRED HABITAT	COMMENTS
Greater Broad-nosed Bat *Scoteanax rueppellii*	Inhabits areas containing moist river & creek systems especially tree lined creeks. Distribution Limit - N-Border Ranges National Park. S-Pambula.	Not identified within 10 km of the study area. Potential foraging and breeding habitat present within study area. Not recorded within study area.

APPENDIX 5

SECTION 5A ASSESSMENT OF THE EP&A ACT (1979)

Section 5A of the EP&A Act (1979) - Assessment of Significance

The determining authority is required by legislation to consider the potential impact of a proposed activity on threatened species in accordance with Section 5A of the EP&A Act (1979) – 'The Eight Part Test of Significance'. This impact assessment is used as a guide to determine whether the proposed development requires a more detailed review by way of a Species Impact Statement (SIS).

Site specific target surveys and habitat assessments, combined with an interrogation of the NPWS *Wildlife Atlas* database, identified one (1) threatened flora and eleven (11) threatened fauna species requiring an assessment in accordance with Section 5A of the EP&A Act (1979). The species identified for consideration within this assessment are listed below in **Table 1**.

TABLE 1
THREATENED FLORA AND FAUNA SPECIES FOR CONSIDERATION

• *Bothriochloa biloba*	• Green and Golden Bell Frog
• Square-tailed Kite	• Grey-crowned Babbler
• Spotted Tailed Quoll	• The Large-eared Pied Bat
• Eastern False Pipistrelle	• Eastern Little Mastiff Bat
• Little Bent-wing Bat	• Common Bent-wing Bat
• Large-footed Myotis	• Greater Broad-nosed Bat

The 'Eight Part Test of Significance' is as follows.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

Bothriochloa biloba

Bothriochloa biloba is an erect or decumbent caespitose perennial to 1m high with culms branching from nodes situated on the main growth axis. This species flowers mostly in summer within woodlands on poorer soils throughout a distribution that extends north from the NSW Central Coast to Queensland including the adjacent northern tablelands and western slopes and plains. Targeted surveys conducted by HLA indicate that the study area provides potential habitat for this species within the Grassland and Narrow-leaved Ironbark Woodland flora communities. However, presence / absence data collected during this survey indicates that there are no *Bothriochloa biloba* populations present within the study area. Given the likely absence of the *Bothriochloa biloba* from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Green and Golden Bell Frog

The Green and Golden Bell Frog prefers the edges of permanent water, streams, swamps, creeks, lagoons, farm dams and ornamental ponds where it is often located under debris including corrugated iron, timber and rock. Targeted surveys conducted by HLA indicate that the study area provides potential foraging and breeding habitat for this species within selected aquatic environments of the study area. However, presence / absence data collected during this survey indicates that there are no Green and Golden Bell Frog populations present within the study area. Given the likely absence of the Green and Golden Bell Frog from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Square-tailed Kite moves low over the canopy of woodland, exploiting ecotones while hunting. It is known to favour *Angophora floribunda* and *Angophora subvelutina* woodland in association with box / ironbark eucalypt species along moist valleys on the coast of NSW. There is usually profuse blossom associated with this type of vegetation, which provides an abundance of nesting birds on which the kite typically preys (State Forests of NSW, 1995). Targeted surveys conducted by HLA indicate that the study area provides potential foraging and breeding habitat for this species throughout the Narrow-leaved Ironbark Woodland flora community. However, presence / absence data collected during this survey indicates that there are no Square-tailed Kite populations present within the study area. Given the likely absence of the Square-tailed Kite from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Grey-crowned Babbler

The Grey-crowned Babbler is an inhabitant of drier woodlands and adjoining grasslands throughout the western slopes of the Great Dividing Range, with isolated historical and current range extensions to the NSW east coast within the Clarence, Nymboida, Hunter and Nepean River systems. This species forages and breeds within large groups, up to 12-16 individuals, throughout an average territory area of 12ha. Targeted surveys conducted by HLA identified the presence of one population of this species, totalling two individuals, within the Narrow-leaved Ironbark Woodland flora community adjacent to Bimbadeen homestead.

Past and present surveys of the Upper Hunter, as indicated by the NPWS Wildlife Atlas Database (2001) and other various local studies conducted by HLA/other consultancies (HLA, 2001; ERM, 1995; ERM 1999), indicate that the Grey-crowned Babbler is widespread and locally common throughout the Singleton to Muswellbrook district. Recent observations indicate that this species is particularly active in areas that are vegetated with Bull Oak in association with minor occurrences of Narrow-leaved Ironbark.

At a district level, this species appears to be persisting within areas of mixed landuse, including a combination of suitable natural vegetation with mining and/or agriculture. Areas of low intensity agriculture appear to greatly assist the local abundance and distribution of this species. However, it should be recognised that this species is reliant on the presence of vegetation cover for foraging, breeding and protection from potential predators.

Given that the current pre-development environment offers little assistance to the preservation of this Grey-crowned Babbler population within the study area, it is considered that there remains substantial potential for this population to be negatively influenced by its surrounding environment. Observations collected during the survey period suggest that the population is insufficiently large enough to endure an unmitigated stochastic or catastrophic event. Current information on the flora and fauna values present within the study area indicate that the loss of one animal from this group of two individuals would be sufficient enough to terminate this as a viable population.

However, the proposed development in combination with a plan targeting the conservation, rehabilitation and long-term management of this species and its habitat, exhibits a predictable and more certain future that is highly likely to positively resolve the long-term viability of this population at this locality. In summary, it is considered that the do nothing approach represents a long-term risk to the population that may be suitably avoided through appropriate planning, monitoring and management programs.

Given that these management plans are suitably produced and implemented, it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Spotted-tailed Quoll inhabits a number of habitats including dry to moist open forests or closed forests containing rock caves, hollow logs or trees for shelter / breeding. Targeted surveys conducted by HLA indicate that the study area provides potential foraging and breeding habitat for this species throughout the Narrow-leaved Ironbark Woodland flora community and adjoining environments where there is suitable cover from predators. However, presence / absence data collected during this survey indicates that there are no Spotted-tailed Quoll populations present within the study area. Given the likely absence of the Spotted-tailed Quoll from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Large-eared Pied Bat

The Large-eared Pied Bat has restricted distribution from south central Queensland to central and northern NSW and is localised and uncommon throughout its range occurring in Rainforest, wet sclerophyll forest to dry sclerophyll forest and woodland habitats (State Forests of NSW, 1997). Targeted surveys conducted by HLA indicate that the study area provides potential foraging habitat for this species throughout the majority of the study area. However, presence / absence data collected during this survey indicates that there are no Large-eared Pied Bat populations inhabiting this area of potential foraging habitat. Given the likely absence of the Large Pied Bat from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Eastern False Pipistrelle

The Eastern False Pipistrelle has been recorded roosting in caves, old buildings and tree hollows. This species forages throughout woodlands and open forest. Targeted surveys conducted by HLA indicate that the study area provides potential foraging habitat for this species throughout the majority of the study area. Presence / absence data collected during this survey identified that the Eastern False Pipistrelle was actively foraging within the Narrow-leaved Ironbark Woodland flora community during the survey period. Suitable roosting habitat is present both within the area to be cleared of natural vegetation as well as vegetation to the north and south of the study area, areas that will remain intact in the post development landscape. Provided appropriate clearing techniques are adopted, including tree hollow inspection, animal capture and relocation, combined with habitat re-instatement, it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Eastern Little Mastiff Bat

The Eastern Little Mastiff Bat inhabits open forests and woodlands foraging above the canopy and along the edge of forests. This species is known to roost in tree hollows, under bark and buildings. Targeted surveys conducted by HLA indicate that the study area provides potential foraging and breeding habitat for this species throughout the majority of the study area. However, presence / absence data collected during this survey indicates that there are no Eastern Little Mastiff Bat populations inhabiting this area of potential habitat. Given the likely absence of the Eastern Little Mastiff Bat from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Little Bent-wing Bat

The Little Bent-wing Bat forages below the canopy within open forests and woodlands, feeding on small insects (Dwyer 1995b). This species is known to roost in caves, tunnels, tree hollows and occasionally old buildings (Dwyer 1995b). Targeted surveys conducted by HLA indicate that the study area provides potential foraging habitat for this species throughout the majority of the study area. However, presence / absence data collected during this survey indicates that there are no Little Bent-wing Bat populations inhabiting this area of potential foraging habitat. Given the likely absence of the Little Bent-wing Bat from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Common Bent-wing Bat

The Common Bent-wing Bat inhabits areas where there are caves, old mines, old buildings, stormwater drains for shelter and well timbered areas for foraging. Targeted surveys conducted by HLA indicate that the study area provides potential foraging habitat for this species throughout the majority of the study area. However, presence / absence data collected during this survey indicates that there are no Common Bent-wing Bat populations inhabiting this area of potential foraging habitat. Given the likely absence of the Common Bent-wing Bat from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Large-footed Myotis

The Large-footed Myotis inhabits rainforests and sclerophyll forests near creeks and lakes over which it forages for aquatic insects and small fish. This species is known to roost in tree hollows, caves, mines and tunnels. Targeted surveys conducted by Environmental Appraisal and Planning (1999) indicate that the study area provides potential foraging habitat for this species throughout the majority of the study area. However, presence / absence data collected during this survey indicates that there are no Large-footed Myotis populations inhabiting this area of potential foraging habitat. Given the likely absence of the Large-footed Myotis from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

Greater Broad-nosed Bat

The Greater Broad-nosed Bat inhabits moist habitats associated with river & creek systems especially tree-lined creeks for foraging and breeding. Targeted surveys conducted by Environmental Appraisal and Planning (1999) indicate that the study area provides potential foraging habitat for this species throughout the majority of the study area. However, presence / absence data collected during this survey indicates that there are no Greater Broad-nosed Bat populations inhabiting this area of potential foraging habitat. Given the likely absence of the Greater Broad-nosed Bat from the site it is considered that the proposed development will not knowingly disrupt the life cycle of a viable local population of this species such that it is likely to be placed at risk of extinction.

(b) In the case of an endangered population, whether the life cycle or the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

No endangered populations listed within the *Threatened Species Conservation Act (1995)* have been identified within the study area.

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

The detailed field survey of the study area identified a number of fauna habitats providing opportunities for a range of fauna activity including foraging, breeding and movement. Microhabitats were present within each of the identified flora communities and include:

- Open Forest / Woodland upper canopy cover (trees) dominated by Eucalypt species of dry sclerophyll environments;
- Open Forest / Woodland mid-strata cover (shrubs) dominated mostly by Wattle species of dry sclerophyll environments;
- Open Forest / Woodland lower-strata cover (groundcovers) dominated mostly by grasses and herbs of dry sclerophyll environments;
- Scattered trees throughout the Grassland flora community (<5% occurrence);
- Scattered shrubs throughout the Grassland flora community (<5% occurrence);
- Dense growths of emergent macrophytes within the Aquatic Forbland flora community;
- Pollen producing plants, principally Grasses and Wattles;
- Sparse distribution of tree hollows (<1% occurrence);
- Sparse to moderate distribution of fallen timber, hollow logs and bark (5% occurrence);
- Scattered rock outcrops consisting of boulder shaped rock and some flatter stone (average diameter >25cm);
- Rock ledges and cliff lines associated with the open cut pits; and

- Occasional rubbish debris (corrugated and sheet iron).

Habitats identified within the study area containing potential for threatened species, populations and ecological communities, are yet to be formally described / mapped for the Upper Hunter catchment. Current efforts towards identifying the regional status of these habitats is being completed by the Hunter Catchment Management Trust in a project called the Hunter Remnant Vegetation Project.

A comparative study has been completed for the Lower Hunter River catchment, which has identified the type and location of vegetation communities that contain a variety of habitats similar to those identified within the study area. Habitats identified within the study area are likely to be present within the following vegetation communities described / mapped by NPWS (2000):

- Central Hunter Ironbark Spotted Gum Grey Box Forest.

According to the NPWS (2000) this flora community is diminishing within its former range and is mostly restricted to the central Hunter River catchment consisting of the City of Cessnock LGA and City of Maitland LGA. The presence of this flora community within locally occurring conservation reserves is restricted and is likely to be found only within the Lower Hunter National Park.

Known habitat for threatened species, populations and ecological communities identified within the Grassland flora community is well represented throughout the Sydney Basin Bio-region. Habitat values associated with Grassland flora community are not generally targeted for conservation due to their low values for threatened species and other native flora and fauna assemblages. For this reason this flora community is not currently represented within the regional reserve network, nor is it likely to be included in the future for conservation purposes.

It is considered that the operational phase associated with the proposed development will not remove or modify a significant area of habitat for those threatened species identified in **Table 1** within the local area or region.

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

The larger uncleared remnants combined with transitional areas regenerating from past land clearing activities, which consists of remnant trees amidst an open grass-forb groundcover, generally assists the movement of most flora and fauna species within the Muswellbrook locality. Field observations have confirmed this hypothesis, with the majority of intra-site fauna activity restricted mostly to the vegetation surrounding Bimbadeen homestead and vegetation to the north and south of this location. Fauna located to the south of the study area may take advantage of this narrow wildlife linkage during daily or more long-term migrations to and from vegetation situated to the north and north-west including Browns Mountain, Colonel Mountain and more specifically the closer and more prominent Bells Mountain.

Not-withstanding the apparent wildlife linkage values present within the study area, it appears that the same cannot be said for the value of movement corridors for small to medium sized terrestrial mammal faunal assemblages. Constrained by mining activities, roads and open cleared lands, it appears that the ground fauna is poorly represented in terms of native small and medium sized mammals. Larger sized mammals including the Eastern Grey Kangaroo and Common Wombat have been able to persist within this environment due principally to their ability to avoid predation by the European Fox and Feral Cat. However small to medium sized mammals are severely limited in their capacity to move efficiently through disturbed lands, particularly where the European Fox is known to forage (Catling and Burt, 1995).

Generally speaking, it is considered that the study area affords good quality wildlife linkage values between vegetation situated to the north and south of the study area. Faunal groups most likely to safely negotiate this linkage include arboreal species such as avifauna, microchiropteran bats and megachiropteran bats. Further, it is considered that large sized mammals will also benefit from the current wildlife linkage values. However, small to medium sized mammals are less fortunate and are considered open to the pressures of predation from both exotic and native predators. The more sedentary species, including the majority of reptiles and amphibians, appear to be resilient to the majority of intra-site predation and are less likely to utilise this wildlife linkage on a regular basis given that the site provides ample habitat for the continuance of these faunal assemblages.

In summary it is considered that there will be a short to medium term impact on local wildlife connectivity. Long-term wildlife connectivity will be managed through detailed rehabilitation and habitat re-instatement. Whilst short to medium-term mining activities is likely result in the isolation of currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community, it is considered that the long-term mine plan will reverse this situation and probably improve on the current level of local vegetation connectivity.

(e) Whether critical habitat will be affected

The study area has not been identified as critical habitat within the provisions of the *Threatened Species Conservation Act* 1995. This matter does not require further consideration.

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

The study area provides potential habitat for a range of threatened species as identified within **Table 1**. A review focusing on the conservation status of these species within the region is provided as follows:

Bothriochloa biloba is not known to occur within any conservation reserves throughout the Sydney Basin Bio-region (NPWS, 1997; NPWS, 2001).

The Green and Golden Bell Frog is known to occur within three (3) conservation reserves throughout the Sydney Basin Bio-region: Kooragang Island Nature Reserve (NR), Royal National Park (NP) and Seven Mile Beach NP (NPWS, 1997; NPWS, 2001).

The Square-tailed Kite is known to occur within four (4) throughout the Sydney Basin Bio-region including Morton NP, Royal NP, Wollemi NP and Cattai NP (NPWS, 1997; NPWS, 2001).

The Grey-crowned Babbler is not currently known to occur within conservation reserves throughout the Sydney Basin Bio-region.

The Spotted-tailed Quoll is known to occur within five (5) conservation reserves throughout the Sydney Basin Bio-region including: Brisbane Water NP, Dharug NP, Ku-ring-gai Chase NP, Popran NP and Wollemi NP (NPWS, 1997; NPWS, 2001).

The Large-eared Pied Bat is known to occur within one (1) conservation reserve throughout the Sydney Basin Bio-region: Wollemi NP (NPWS, 2001).

The Eastern False Pipistrelle is not currently known to occur within conservation reserves throughout the Sydney Basin Bio-region.

The Eastern Little Mastiff Bat is known to occur within two (2) conservation reserves throughout the Sydney Basin Bio-region: Brisbane Water NP and Yengo NP (NPWS, 1997; NPWS, 2001).

The Little Bent-wing Bat is not known to occur within conservation reserves throughout the Sydney Basin Bio-region (NPWS, 1997; NPWS, 2001).

The Common Bent-wing Bat is known to occur within seven (7) conservation reserves throughout the Sydney Basin Bio-region: Brisbane Water NP, Dharug NP, Nattai NP, Wollemi NP, Wyrrabalong NP and Yengo NP (NPWS, 1997; NPWS, 2001) and Watagans NP (State Forests, 1995).

The Large-footed Myotis is known to occur within three (3) conservation reserves throughout the Sydney Basin Bio-region: Dharug NP, Royal NP and Wyrrabalong NP (NPWS, 1997; NPWS, 2001).

The Greater Broad-nosed Bat is known to occur within four (4) conservation reserves throughout the Sydney Basin Bio-region: Dharug NP, Scheyville NP, Wyrrabalong NP and Yengo NP (NPWS, 1997; NPWS, 2001).

A definitive assessment of the distribution and conservation status of threatened species, populations and ecological communities throughout the Sydney Basin Bio-region is yet to be determined. Despite the presence of potential habitat for threatened species throughout the regional reserve network, the distribution and conservation status of these threatened species should be considered inadequate, until further regional surveys and assessments have been completed and published.

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

Activities associated with the proposed development will result in the removal of native vegetation from the study area. Vegetation of particular importance is situated to the north of the Bimbadeen homestead. Further, vegetation throughout the immediate surrounds of the Bimbadeen homestead is similarly significant as this area promotes connectivity between vegetation identified to the north with vegetation remnants to the south. Accordingly, it is considered that this activity falls within the general description of the KTP referred to as 'Clearing of Native Vegetation (NSW Scientific Committee, 2001)'.

To ensure that the various flora and fauna values identified within the study area are maintained to an ecologically sustainable level in the post-development environment, including issues such as habitat viability, population viability, wildlife connectivity, minimisation of fox / cat predation and spread of invasive plants, it is considered that the following mitigatory measures should be incorporated and implementation into the relevant management plans prepared for the proposed development. These are:

- Minimise vegetation clearing to minimum amount throughout areas to the north of the Bimbadeen homestead to reduce the time period between vegetation removal and rehabilitation / habitat re-instatement activities;

- The restriction of vegetation clearing throughout areas to the north of the Bimbadeen homestead to periods outside the breeding cycle of the Grey-crowned Babbler and Eastern False Pipistrelle;

- The appropriate collection and stockpiling of vegetation, soil and ground / arboreal habitat features for use in the creation of compensatory habitat, land rehabilitation and habitat re-instatement activities;

- The inspection of fauna habitat that may harbour species of poor dispersal capabilities prior to land clearing, with a view to the capture and relocation of those species to suitable areas of compensatory habitat situated outside the study area. Fauna of particular interest include reptiles and hollow-dwelling mammals;

- The implementation of appropriate rehabilitation activities, in accordance with the approved mine sequence, that minimises the medium and long-term impact on species vulnerable to the initial vegetation clearing action;

- The collection of local seed providence from the majority of flora species identified within the area to be cleared, thus maximising the value of vegetation rehabilitation and habitat re-instatement;

- The implementation of exotic flora and fauna control programs targeting in particular the predatory pressures associated with the European Fox and Feral Cat, grazing pressures exerted by the European Rabbit and Feral Goat and ecological competitiveness exerted by invasive exotic plants;

- Minimise the edge to area ratio and improve alternative short-term vegetation connectivity by undertaking supplementary planting and rehabilitation activities throughout lands adjacent to the affected area prior to and during the mine operations plan;

- Undertake ongoing monitoring programs to measure progression of site rehabilitation; and

- Undertake a status review of the Eastern Grey Kangaroo within the study area, with the view to assessing and potentially ameliorating any deleterious grazing pressures exerted on native vegetation by excessively large populations of this species.

In summary it is considered that mine rehabilitation, vegetation regeneration, the construction of compensatory habitat and vegetation re-instatement within and outside the affected area prior to, during and after the mining activity will satisfactorily offset impacts associated with the KTP 'Clearing of Native Vegetation'.

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

No. None of the species that have been identified as occurring or potentially occurring within the study area are approaching their natural limits of distribution within the Muswellbrook locality.