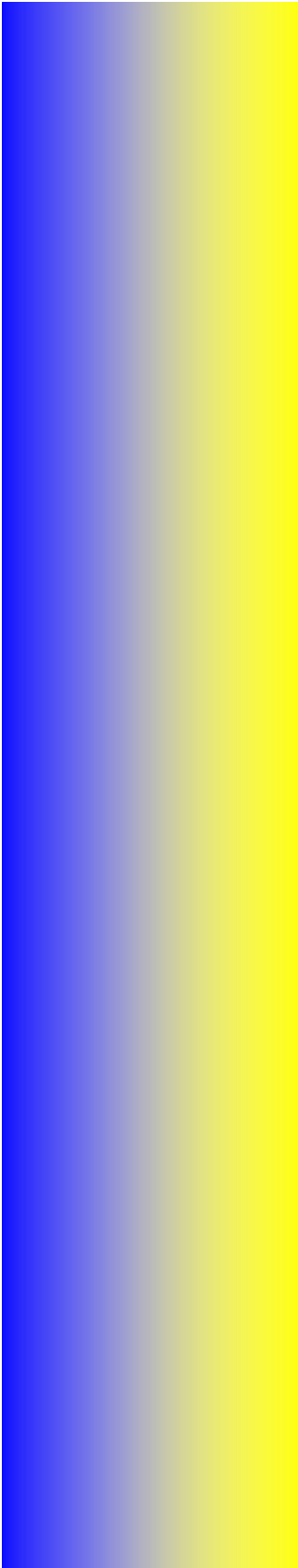


APPENDIX J

ECOLOGICAL ASSESSMENT



MT ARTHUR COAL CONSOLIDATION PROJECT

Ecological Assessment

For:

HANSEN BAILEY PTY LTD

August 2009

Final Report

Cumberland Ecology

PO Box 2474, Carlingford Court 2118

Report No. 8067RP2

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology

Approved by: David Robertson

Position: Project Director

Signed: 

Date: 27 August, 2009

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Executive Summary

INTRODUCTION

Cumberland Ecology Pty Ltd (Cumberland Ecology) was commissioned by Hansen Bailey Pty Ltd on behalf of Hunter Valley Energy Coal (HVEC) to complete an ecological assessment of the Mt Arthur Coal Consolidation Project ('the Project'). Mt Arthur Coal is applying to the Minister for Planning for a new Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to gain a single, contemporary planning approval for its open cut operations and the mining of additional areas (Mine Extension Areas) within its current Mining Leases (the Project).

The purpose of this report is to describe the ecological values within the Environmental Assessment Boundary (EA Boundary) and assess the impacts of the Project on flora and fauna, particularly threatened species and communities as listed under the New South Wales *Threatened Species Conservation Act 1995* (TSC Act). This report will be incorporated into an Environmental Assessment (EA) being prepared by Hansen Bailey for submission to the Minister for Planning for assessment under Part 3A of the EP&A Act. This report also addresses impacts on Matters of National Environmental Significance as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

METHODS

The flora and fauna composition of Mt Arthur Coal's 12,675 ha mining and exploration leases is comparatively well known as surveys have been conducted across the area since the 1960s. Detailed flora and fauna investigations were conducted in 2000 as part of the Mt Arthur North (MAN) Environmental Impact Statement (EIS), with further surveys undertaken as part of subsequent expansions of the Mt Arthur Coal mining development to include the South Pit Extension and development of the Mt Arthur Underground (MAU). Flora and fauna monitoring work has also been conducted at a series of monitoring sites between 2003 and 2008. The survey effort and resulting data from previous survey work has been summarised and relied upon for the purposes of this assessment. Additionally, to take account of new information about endangered ecological communities, Cumberland Ecology has undertaken further flora survey work between spring 2008 and autumn 2009 to investigate the nature and extent of woodland communities across the five new Mine Extension Areas that form part of the Project.

The surveys for fauna and flora at Mt Arthur Coal have spanned 1993 to autumn 2009 and have included:

- Flora surveys within 400 m² and 1000 m² quadrats;
- Flora surveys entailing random meanders to explore for threatened and regionally significant plant species;
- Fauna habitat assessments; and
- Targeted survey for fauna, including:
 - Mammals: trapping (ground and arboreal Elliot trapping), hair tubes, anabat call recording, harp traps;
 - Birds: bird point call census; and
 - Frog and reptile searches.

The surveys have been conducted over a series of years under different seasonal and annual conditions, providing a comprehensive data set to use for the EA.

RESULTS

The Hunter Valley landscape was settled by Europeans over 100 years ago and the vegetation was heavily cleared for pastoral usage. The land within the EA Boundary has been historically cleared for grazing purposes, with the exception of areas of difficult terrain on Mount Arthur itself. This has resulted in an absence of original woodland and forest, although some large, old individual trees are scattered across the remaining woodland patches. A number of soil types of low to moderate fertility occur within the EA Boundary and include earthy sands; skeletal and shallow, gravelly soils; and uniform or gradational clay soils.

The vegetation across the Central Hunter Valley has been mapped by the Hunter-Central Rivers Catchment Management Authority (CMA) and this mapping includes land within the EA Boundary. Additional mapping studies have been conducted across the EA Boundary as part of vegetation studies commissioned for environmental impact assessments of subsequent mining proposals within mining and exploration leases held by Mt Arthur Coal^{8,52}. The major vegetation communities that occur in the EA Boundary are listed in **Table S.1** below. Most of the names used to describe these communities follow those used in the CMA mapping study.

Table S.1 VEGETATION COMMUNITIES WITHIN THE EA BOUNDARY

Vegetation Community Name	TSC Act Status	EPBC Act Status
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	Nominated	
Mount Arthur Forest Complex	Listed	Listed
Spotted Gum Forest		
Blakely's Red Gum Woodland	Listed	Listed
Central Hunter Box - Ironbark Woodland	Nominated	
Hunter Floodplain Red Gum Woodland	Listed	Listed
Hunter Floodplain Red Gum Woodland - Weedy Understory		
Narrabeen Foothills Slaty Gum Woodland	Nominated	
Upper Hunter Hills Exposed - Ironbark Woodland		
Upper Hunter White Box - Ironbark Grassy Woodland	Listed	
Central Hunter Bullock Forest Regeneration		
Native derived grassland	Listed*	
Exotic Grassland		
Planted vegetation		

*Areas of this community conform to the TSC Act listing for Box Gum Woodland.

Some of the mapping units used by CMA incorporate areas of "Box Gum Woodland" - a Critically Endangered Ecological Community (CEEC) as defined under the EPBC Act and an Endangered Ecological Community (EEC) as defined under the TSC Act. Box Gum Woodland occurs where White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*) are present in sufficient numbers to be at least co-dominants of woodlands.

The communities present within the EA Boundary include several communities that, in part, conform to the State and Commonwealth listing for Box Gum Woodland or Derived Grassland. The woodland and open forest communities named by the CMA mapping are dominated by a variety of tree species and vary in their composition from patch to patch. Some patches are dominated or co-dominated by tree species that define Box Gum Woodland, namely *Eucalyptus melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum). The majority of patches however are dominated by other tree species that are not mentioned as characteristic species within the EPBC Act CEEC or TSC Act EEC final determination.

The Box Gum Woodland and Derived Grassland CEEC is essentially a "super-community" that originally occurred across a vast area of Victoria, Australian Capital Territory, New South Wales and Queensland and includes several recognisable variants. The results of the most recent mapping study by Cumberland Ecology indicate that the CEEC Box Gum Woodland and Derived Grassland are present in parts of the EA Boundary (the Conservation Areas on Saddlers Creek and Mount Arthur itself and within an area north of the Mt Arthur Coal access road). These areas will not be disturbed as part of the Project.

The predominant vegetation element within the EA Boundary is native derived grassland and understory that has been created by the clearing of the original woodland and forest communities. This is dominated by a variety of native grass and forb species but many exotic species are present as is typical of grazing lands.

Several threatened flora species as listed under the TSC Act and/or the EPBC Act have been identified within the EA Boundary including *Diuris tricolor* (Painted Diuris), *Cymbidium canaliculatum* (Tiger Orchid), *Bothriochloa biloba* (Lobed Bluegrass) and *Acacia pendula* (Weeping Myall).

Threatened fauna species listed under the TSC Act and/or the EPBC Act that were detected in the EA Boundary during past surveys include, but is not limited to the following suite of birds and mammals:

- Birds: Speckled Warbler (*Pyrrholaemus saggitata*), Diamond Firetail (*Stagonopleura guttata*), Hooded Robin (*Melanodryas cucullata cucullata*), Grey Crowned Babbler (*Pomatostomus temporalis temporalis*) and Turquoise Parrot (*Neophema pulchella*).
- Bats: the Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Freetail Bat (*Mormopterus norfocensis*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing Bat (*M. schreibersii oceaenensis*), Large-footed Myotis (*Myotis macropus*), Greater Broad-nosed Bat (*Scoteanax ruepelli*), Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*) and Eastern Cave Bat (*Vespadelus trouhptoni*).
- Non-flying Mammals: Squirrel Glider (*Petaurus norfolcensis*).

While not detected during past surveys, land in the EA Boundary also contains suitable habitat for a range of other threatened species and they are discussed within this report.

IMPACT ASSESSMENT

Approximately 240 ha of forest and woodland and 750 ha of derived native grassland, are proposed to be cleared over the life of the Project. This includes the clearance of 116 ha of TSC Act listed Box Gum Woodland, and 700 ha of TSC Act listed Derived Grassland. No EPBC Act listed communities will be disturbed as a result of the Project. A summary of the proposed clearing of vegetation communities under the Project is outlined in **Table S.2**.

The Project will progressively clear a range of woodland and open forest patches together with broad areas of native grassland. The clearance will directly remove habitat for a range of threatened flora species. Known patches of the TSC listed grass *Bothriochloa biloba* will be cleared, as will potential habitat for this species; however large numbers of this species will be retained. No other threatened plants are considered likely to be cleared.

The Project will also result in the progressive removal of forest and woodland habitat for threatened fauna. The removal of such habitat is a key threatening process and will remove foraging, roosting and breeding habitat for most of the known threatened fauna species that have previously been found on site. The Project will also initially increase the degree of fragmentation of treed habitats within the landscape of Mt Arthur Coal, and so can potentially reduce the ability of some species to disperse across the landscape in the short to medium term. It will also result in the removal of tree hollows, which are an important wildlife resource and which are used by a number of threatened bats, birds and the Squirrel Glider.

Without additional mitigation or compensation measures, the proposed mining of the five Mine Extension Areas will have a significant impact upon TSC Act listed Box Gum Woodland and Derived Grassland and at least some of the aforementioned woodland fauna. This is because it will remove a sizeable amount of forest and woodland habitat (240 ha), exacerbate the key threatening processes of native vegetation removal and tree hollow loss in a highly cleared landscape, and increase the degree of fragmentation of existing patches of habitat. The Project will, in the short to medium term, reduce the effectiveness of local and regional habitat linkages that have been proposed in Mt Arthur Coal's existing Rehabilitation and Management Strategy.

Table S.2 SUMMARY OF IMPACTS OF PROJECT UPON VEGETATION COMMUNITIES

Vegetation Community	Status*	Project Disturbance Areas					Total Vegetation Impacted by the Project	Vegetation Remaining within EA Boundary	
		Total Vegetation within EA Boundary^	Mine Extension Areas			Edderton Rd Realignment Option 2			Rail Load Out Conveyor
			1	2	3				
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	E ^c	0					0	0	
Mount Arthur Forest Complex	E ^{a, b}	132.69					0	132.69	
Spotted Gum Forest		4.90	0.90				0.90	4.00	
Blakely's Red Gum Woodland	E ^{a, b}	2.89					0	2.89	
Central Hunter Box - Ironbark Woodland	E ^c	312.45				2.00	2.00	310.45	
Hunter Floodplain Red Gum Woodland	E ^{a, b}	50.47					0	50.47	
Hunter Floodplain Red Gum Woodland - Weedy Understorey		7.04				0.66	0.66	6.38	
Narrabeen Footholpes Slaty Gum Woodland	E ^c	26.44	24.21				24.21	2.23	
Upper Hunter Hills Exposed - Ironbark Woodland		49.42	38.20				38.20	11.22	
Upper Hunter White Box - Ironbark Grassy Woodland	E ^b	169.15	33.20	66.45		16.80	116.45	52.70	
Central Hunter Bulloak Forest Regeneration		72.08				58.14	58.14	13.94	
Total area of native Forest and Woodland		827.53	71.40	91.56	0	2.66	240.56	586.97	

Table S.2 SUMMARY OF IMPACTS OF PROJECT UPON VEGETATION COMMUNITIES

Vegetation Community	Status*	Project Disturbance Areas							Total Vegetation Impacted by the Project	Vegetation Remaining within EA Boundary	
		Total Vegetation within EA Boundary^	Mine Extension Areas					Edderton Rd Realignment Option 2			Rail Load Out Conveyor
			1	2	3	4	5				
Box - Ironbark Derived Grassland		1612.57					6.10		6.10	1606.47	
Slaty Gum Derived Grassland		43.70		43.70					43.70	0	
Spotted Gum Derived Grassland		17.25							0	17.25	
White Box - Ironbark Derived Grassland	E ^b	2977.11	50.40	307.82	28.30	8.48	268.15	36.39	699.54	2277.57	
Total area of native Derived Grassland		4650.63	50.40	351.52	28.30	8.48	268.15	42.49	749.34	3901.29	
Exotic Grassland		434.37		75.58			10.77	1.83	88.18	346.19	
Planted Areas		37.48							0	37.48	
GRAND TOTAL		5950.01	121.80	518.66	28.30	8.48	353.86	45.15	1078.08	4871.93	

*E^a = Critically Endangered Ecological Community (EPBC Act); E^b = Endangered Ecological Community (TSC Act), E^c = Preliminary Determination under the TSC Act.

[^]Does not include vegetation that is approved to be cleared under existing Open Cut planning approvals at Mt Arthur Coal.

MITIGATION MEASURES

In an effort to reduce the potential impacts of the Project, a number of mitigation measures will be implemented. Foremost amongst the measures will be the designation of Proposed Offset Areas where woodland and open forest communities will be permanently protected and regenerated.

Mt Arthur Coal currently has an established strategy that was developed to mitigate and offset the ecological impacts arising from previous mining approvals within the EA Boundary. This strategy is known as the Mt Arthur Coal Rehabilitation and Landscape Management Strategy.

As part of the Project, the existing Mt Arthur Coal Rehabilitation and Landscape Strategy will be superseded by an updated and consolidated strategy called the Mt Arthur Coal Complex Offset Strategy, (the "Offset Strategy"), which will cover the entire Mt Arthur Coal Complex. The Offset Strategy will build upon the previous Rehabilitation and Landscape Strategy and incorporate new offsets that address additional impacts predicted for the Project. The Offset Strategy has been designed to increase the net area and condition of native vegetation and rehabilitated flora and fauna habitats in the medium to long term. The consolidated Mt Arthur Coal Complex Offset Strategy is described and discussed in Chapter 5.

The new offset areas proposed for the Project will be provided through the protection and enhancement of 495 ha of land offsite and 222 ha of land within the EA Boundary (the 'Proposed Offset Areas'), and through the revegetation and protection of approximately 500 ha of land that will be returned to native woodland and forest after mining ('Proposed Regenerated Woodland'). The Proposed Offset Areas will be implemented as part of the overall Mt Arthur Coal Complex Offset Strategy.

A key principle of the offset design is to provide "like for like" or better habitat. To this extent, the 495 ha Proposed Offset Area will provide frontage to two permanent creeks that will provide significant wildlife refuges. No permanent creeks exist in the impact areas. Also, the Proposed Offset Areas contain four EEC/significant communities that are not to be impacted by the Project: Hunter Valley River Oak Forest, Hunter Floodplain Red Gum Woodland, Blakely's Red Gum Woodland and Central Hunter Box-Ironbark Woodland. These have been included in the offset package as an alternative to Central Hunter Bullock Forest Regeneration, which is a habitat of lower biodiversity and is not an EEC.

The Proposed Offset Areas also provide habitat for a suite of threatened birds and bats that are known to occur in the EA Boundary and include a threatened population of the orchid, *Diuris tricolor*. Regeneration of woodland and open forest habitat following cessation of cattle grazing will progressively benefit these species.

The Mt Arthur Coal Complex Offset Strategy will offset the impacts to biodiversity as a result of the Project, with a 2:1 offset ratio for the loss of all native forest and woodland, and a 1:1 offset ratio for derived native grassland proposed to be cleared by the Project.

The derived native grassland areas are artificial grasslands that have been cleared of their original tree and shrub cover for farming. Under ongoing pastoral management, derived grasslands would not regenerate to forest and woodland. However, under the offset proposal, areas of such grassland will have tree and shrub cover restored and so this will significantly increase the cover of forest and woodland in the long term. When offsets are combined with forest and woodland generated by rehabilitation, there will be almost a five fold increase in forest and woodland in the EA Boundary in the long term.

The Proposed Offset Areas will be reserved for conservation and will be managed in accordance with Mt Arthur Coal's ISO14001 accredited Environmental Management System, which includes a Flora and Fauna Management Program. The program will be updated upon approval of the Mt Arthur Coal Consolidation Project. The Flora and Fauna Management Program will prescribe management and monitoring of existing vegetation, revegetation of cleared areas, fire management and management of the habitats of threatened species of flora and fauna.

The Proposed Offset Area will build upon existing vegetation and wildlife reserves, through its linkage to travelling stock routes and proximity to Drayton Mine's existing wildlife reserve resulting in not net loss in the region.

Other mitigation measures for the Project include:

- Mine rehabilitation: areas will be replanted to local native plant species in order to provide additional flora and fauna habitats in the long term;
- Ecological monitoring: Mt Arthur Coal has a monitoring program for native flora and fauna that will provide ongoing feedback about the condition of vegetation across the EA Boundary;
- Threatened Species Management: The threatened orchid *Cymbidium canaliculatum* (Tiger Orchid) individual known from Mine Extension Area 5 will be translocated to a conservation area and nest boxes will be established where necessary to maintain an effective fauna monitoring program at Mt Arthur Coal; and
- Pre-clearance surveys will be conducted within areas to be cleared and where possible, threatened flora and fauna detected will be translocated into protected habitat.

With the implementation of these measures it is believed that habitat for threatened flora and fauna of the EA Boundary will remain viable in the long term and at a minimum maintain the biodiversity conservation value of the region.

CONCLUSION

The proposed Mt Arthur Coal Consolidation Project will remove areas of forest and woodland that form habitat for a range of native flora and fauna species. The impacts will be potentially significant for TSC Act listed Box Gum Woodland and a number of threatened species in the short term, as foraging and roosting habitat will be lost. However, in the longer term, the impacted species are predicted to remain in viable numbers due to the retention and protection of existing Conservation Areas (Mount Arthur and Saddlers Creek), Proposed Offset Areas, and rehabilitation areas. The performance of such conservation measures on site will continue to be monitored in the long term to verify that species and their habitats are being conserved. Where corrective action is required, such as additional replanting of native vegetation, this will be undertaken by Mt Arthur Coal.

Introduction

1.1 Purpose of this Report

Cumberland Ecology Pty Ltd (Cumberland Ecology) was commissioned by Hansen Bailey Pty. Ltd. (Hansen Bailey) on behalf of Hunter Valley Energy Coal (HVEC) to complete an ecological assessment of the Mt Arthur Coal Consolidation Project ('the Project').

The purpose of this report is to describe the ecological values of the Environmental Assessment Boundary (referred to as the "EA Boundary") and assess the impacts of the proposed Project on flora and fauna, particularly threatened species and communities as listed under the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act). This report will be incorporated into an Environmental Assessment (EA) being prepared by Hansen Bailey for submission to the Minister for Planning for assessment under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This report also addresses impacts on Matters of National Environmental Significance (MNES) as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Specifically, the objectives of the assessment are to:

- Describe and map vegetation communities within the EA Boundary, identifying threatened communities listed under the TSC Act and EPBC Act;
- Identify and map the location of threatened species;
- Assess the likelihood that threatened species of flora and fauna could occur in the EA Boundary;
- Identify and map key areas of habitat for fauna and faunal movement corridors;
- Describe the types and extent of potential impacts arising from the proposed development;
- Provide advice regarding the referral of the Project to the Commonwealth; and
- Where relevant, recommend measures for mitigation in order to manage impacts on threatened species and areas of high conservation value.

1.2 Background

HVEC, a wholly owned subsidiary of BHP Billiton, operates the Mt Arthur Coal Mine Complex (Mt Arthur Coal). Mt Arthur Coal includes the combined operations of the Mt Arthur North Mine, the Bayswater No. 2 Mine, Bayswater No. 3 Mine, South Pit Extension and the Mt Arthur Underground project. Mt Arthur Coal is located south-west of Muswellbrook in the Muswellbrook Shire Council (MSC) Local Government Area (LGA) in the Upper Hunter Valley of NSW.

1.2.1 Existing Operations

The Mt Arthur Coal complex consists of the following approved mining areas (see **Figure 1.1**):

- Bayswater No. 2 open cut pit (extraction completed);
- Bayswater No. 3 open cut pit (operated since 1995);
- Mt Arthur North (MAN) open cut pit (operated since 2001);
- South Pit Extension open cut pit (approved in 2008 – extends the MAN South Pit 2.5 km south);
- Exploration Adit (commenced operations in 2007); and
- Mt Arthur Underground Project (MAU) approved in 2008.

Mt Arthur Coal currently has approval to produce up to 28 Million tonnes per annum (Mtpa) of Run of Mine (ROM) coal from the combined complex, of which 8 Mtpa is from underground mining methods.

Coal production from the MAN mining area has been the focus of Mt Arthur Coal's operations since 2002. Open cut coal mining is conducted via shovel and excavator. In 2008, coal was mined from the Glen Munro seam to the Ramrod Creek seam within the Whittingham coal measures. Open cut mining methods at Mt Arthur Coal allow the extraction of all coal down to the Ramrod Creek seam.

Coal Handling and Preparation is largely undertaken in a centralised Coal Handling and Preparation Plant (CHPP), which is strategically located in a valley to minimise environmental impacts. Export coal is loaded onto trains via the Bayswater Rail Loading Facility whilst domestic coal is transported via conveyor directly to Macquarie Generation's Bayswater Power Station.

1.2.2 The Project

HVEC is applying for a new Project Approval under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) to gain a single, contemporary planning approval for its open cut operations and the mining of additional areas within Mt Arthur Coal's current Mining Leases (ML). The EA Boundary is shown in **Figure 1.2** and is consistent with the Project Approval area for the MAU.

The Project continues all aspects of Mt Arthur Coals current activities and specifically, seeks approval for the following:

- Consolidation of all of Mt Arthur Coal's open cut mining related planning approvals into one contemporary Project Approval;
- Extending the mine footprint to uncover additional coal reserves within the current MLs;
- Increasing the Mt Arthur Coal complex approved production levels by 8 Mtpa up to 36 Mtpa ROM coal. This will be achieved by;
 - Increasing open cut coal production by up to 8 Mtpa; and
 - Having the flexibility to increase either open cut or underground production by an additional 4 Mtpa if the maximum production from either underground or open cut methods is not being met.
- Relocating a section of Edderton Road in approximately 2019;
- Upgrading the existing Mt Arthur CHPP to wash up to 36 Mtpa of ROM coal and to allow the inclusion of an ultra-fine coal circuit to re-process fines, which will facilitate increased resource recovery and reduce water demand;
- Increasing in the approved rail haulage capacity (in line with the increased coal production) from 19 Mtpa to 27 Mtpa, with the construction of a second rail loading facility and associated conveyor system;
- Modifications to existing infrastructure (such as workshop and bath house), construction of additional ROM coal hoppers and the extension of ROM and product coal stockpiles; and
- A total workforce of approximately 2,600 at peak production, which represents an increase of approximately 1,610 from current staffing levels and an estimated additional 720 positions directly attributable to the Project.

No changes to the mining method or hours of operation are proposed, although a gradual increase in the mobile equipment fleet will be required.

1.2.3 Environmental Characteristics of the EA Boundary

The Muswellbrook area experiences warm wet summers and cool dry winters, with regular frosts and fogs occurring from mid – autumn to late spring⁴⁰.

The Hunter Valley landscape is highly modified as a result of a number of land uses such as agriculture (e.g. dairy farming, crop farming, cattle, horse breeding and viticulture) and industry (e.g. mining and support industries). The region has developed into a major industrial area over recent years mainly through the increase in coal mining activities and associated companies⁴⁰.

The general terrain is gently undulating and comprises low, hilly lands that have broad crests and moderate slopes, occurring over skeletal and shallow soils to gradational clay soils of moderate fertility. Within the EA Boundary, the land becomes progressively steeper towards the slopes of Mount Arthur, which is approximately south-west of the MAN open cut pit. The terrain also becomes slightly steeper north of the MAN open cut pit at Mine Extension Area 1, which encompasses the foothills of Macleans Hill (**Figure 1.2**).

Sub-catchments within the EA Boundary include those associated with Whites Creek, Fairford Creek, Saddlers Creek and some smaller, unnamed creeks in the northern part of the EA Boundary. The land generally drains from the south-east towards the Hunter River, which is located to the north-west. Saddlers Creek catchment drains south-west to the Hunter River.

The land within the EA Boundary has been historically cleared, predominantly for grazing. As a result, no old-growth woodland or forest exists. Old-growth forest is forest that contains significant amounts of vegetation at its oldest growth stage in the upper stratum – these are usually senescing trees. Evidence of physical disturbance (like fire, logging, grazing, mining) and biological disturbance (such as introduced weeds or pathogens) are either absent or low, such that the effects are negligible.

Remnant vegetation, which are areas of mature vegetation that are less than 100 years old, exist as scattered patches across the EA Boundary and individual old-growth trees occasionally occur among these remaining patches. The remnant patches are comprised of low density woodland and the understorey vegetation is currently subject to low-intensity grazing and varying degrees of weed invasion. Nevertheless, some areas of vegetation, particularly around Saddlers Creek and the slopes of Mount Arthur are in relatively good condition with a high diversity of understorey species present.

The flora and fauna within the EA Boundary has been extensively studied since the Flora and Fauna Impact Assessment by Resource Planning Pty Limited (1993) was undertaken as part of the Environmental Impact Statement (EIS) for the Bayswater No. 3 mining approval, and for subsequent mine developments and extensions comprising the existing approved Mt Arthur Coal Complex. Thus, a considerable diversity of woodland and open forest fauna and flora have been identified in previous environmental impact surveys for the existing approved mining areas and a variety of flora and fauna are also known to occur in the locality surrounding the EA Boundary.

1.3 Statutory Context

The legislation relevant to this ecological assessment is listed below:

- NSW *Environmental Planning and Assessment Act 1979*;
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*;
- NSW *Threatened Species Conservation Act 1995*;
- NSW *Fisheries Management Act 1994* (FM Act); and
- NSW *State Environmental Planning Policy (SEPP) 44 – Koala Habitat Protection* (SEPP 44).

The application of the above legislation to this ecological assessment is discussed below. The survey findings in relation to these legislative requirements are discussed in Chapter 3 (Survey Results) and Chapter 4 (Impact Assessment).

1.3.1 NSW Environmental Planning and Assessment Act 1979

The EP&A Act is the overarching planning legislation in NSW. This Act provides for the creation of planning instruments that guide land use. The Act also provides for the consideration of biodiversity values, which is addressed in Section 5A (Significant effect on species, populations or ecological communities or their habitats). The Act requires that an “Assessment of Significance” under Section 94A of the TSC Act, also known as the “Seven-Part Test”, is undertaken in relation to species, communities, habitat and processes listed under either the TSC Act or the FM Act.

Part 3A of the EP&A Act consolidates the assessment and approval regime for all Major Projects previously addressed under Part 4 (Development Assessment) or Part 5 (Environmental Assessment) of the Act. There is no statutory requirement to undertake an “Assessment of Significance” for a development being assessed under Part 3A. An EA is required for development proposals and must be prepared in accordance with the Director-General’s environmental assessment guidelines.

The NSW Department of Planning (DoP) has declared the Project a “Major Project” and as such an EA is required for the Project. This report forms the Flora and Fauna assessment component of the EA that is required to enable the Project to be assessed under Part 3A of the EP&A Act. The Director-General’s Requirements (DGRs) for the Project, pursuant to section 75 F(2) of the EP&A Act and as pertains to biodiversity issues, and are as follows:

- “Accurate predictions of the proposed vegetation clearing;
- A detailed assessment of the potential impacts of the project on any:

- *Terrestrial and aquatic threatened species, populations, ecological communities or their habitats; and*
 - *Existing or approved offset areas;*
- *A revised offset strategy for the mining complex to ensure that the project will maintain or improve the biodiversity conservation value of the region.”*

The areas of vegetation communities proposed for clearing under the Project have been calculated and are presented in Chapter 4 of this report. Chapter 4 also provides an assessment of the potential impacts of the Project (direct and indirect) on threatened species, threatened populations and endangered ecological communities and their habitats. Chapter 5 discusses existing and recommended mitigation measures, the Proposed Offset Areas for the Project and the presents the consolidated Mt Arthur Coal Complex Offset Strategy.

1.3.2 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Approval from the Commonwealth Minister for the Environment is required under the EPBC Act if an action, which includes a development, project or activity, will have, or is likely to have a significant effect on MNES. These matters include:

- Nationally threatened species and ecological communities;
- Ramsar wetlands;
- Migratory species;
- Heritage items or places that are listed under the Act;
- Commonwealth marine areas; and
- Nuclear actions.

If the proposed action will or is likely to have a significant impact on MNES, the proponent is required to make a “referral” to the Department for the Environment, Water Heritage and the Arts (DEWHA). DEWHA will then determine whether the impact is likely to be significant. If the action is determined to be likely to have a significant impact on MNES, the Project is declared a “controlled action” and additional assessments will be required to gain approval from the Commonwealth Minister for the Environment.

The EA Boundary contains ecological communities that are listed as MNES. The Project will not significantly impact on any MNES (discussed in Chapter 4). Notwithstanding this, a referral for the Complex, which includes the Project, will be referred to the Commonwealth Minister under the EPBC Act.

1.3.3 NSW Threatened Species Conservation Act 1995

The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities that are listed under the Act, through threat abatement and species recovery programs.

The TSC Act requires consideration of whether a development (Part 4) or an activity (Part 5) is likely to significantly impact threatened species, populations, communities or their habitat. The potential impacts of any developments, land use changes or activities would need to undergo an "Assessment of Significance" under Section 5A of the EP&A Act. However, there is no statutory requirement for an assessment of significance for this Project as the Project will be assessed under Part 3A of the EP&A Act.

1.3.4 SEPP 44 – Koala Habitat Protection

Muswellbrook is identified on Schedule 1 of NSW *State Environmental Planning Policy 44 – Koala Habitat Protection* (SEPP 44) as an LGA to which this instrument applies. In accordance with this SEPP, it must be ascertained whether the EA Boundary contains Potential Koala Habitat, if so, whether the EA Boundary then contains Core Koala Habitat. The SEPP defines Potential and Core Koala Habitat as follows:

"Potential koala habitat" means areas of native vegetation where the trees of the types listed in Schedule 2 (see Table 1.1) constitute at least 15% of the total number of trees in the upper or lower strata of the tree component; and

"Core koala habitat" means an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

Table 1.1 LISTED KOALA FEED TREE SPECIES (SEPP 44 – SCHEDULE 2)

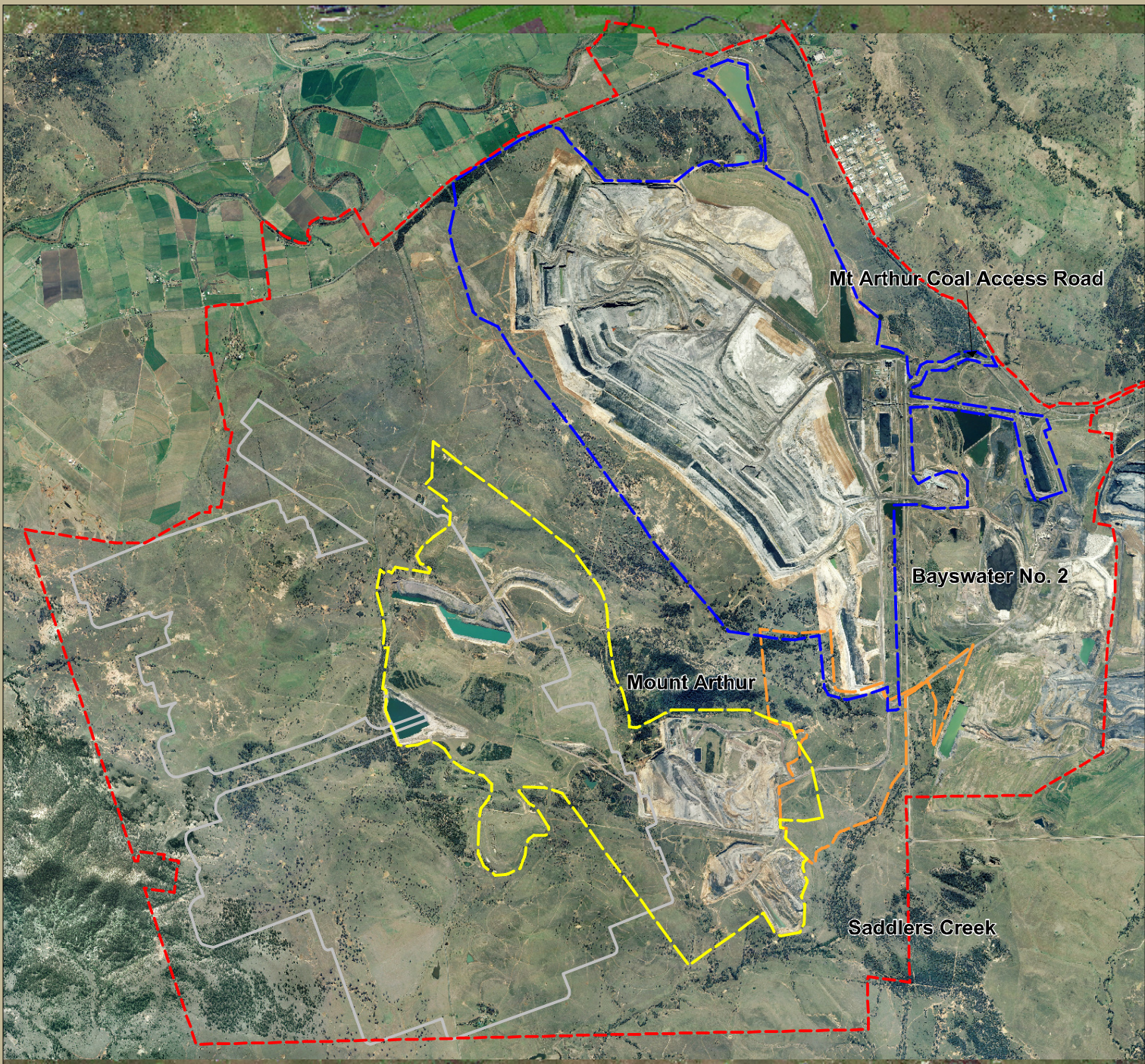
Scientific Name	Common Name
<i>Eucalyptus tereticornis</i>	Forest red gum
<i>Eucalyptus microcorys</i>	Tallowwood
<i>Eucalyptus punctata</i>	Grey gum
<i>Eucalyptus viminalis</i>	Ribbon or manna gum
<i>Eucalyptus camaldulensis</i>	River red gum
<i>Eucalyptus haemastoma</i>	Broad leaved scribbly gum
<i>Eucalyptus signata</i>	Scribbly gum
<i>Eucalyptus albens</i>	White box
<i>Eucalyptus populnea</i>	Poplar box
<i>Eucalyptus robusta</i>	Swamp mahogany

There is no Koala Plan of Management for Muswellbrook Shire Council. Section 4.4.1 of this report outlines if any of the SEPP 44 Listed Koala Feed Tree Species are present in the EA Boundary.

1.4 Terms and Abbreviations

Box Gum Woodland:	The abbreviated name for White Box-Yellow Box-Blakely's Red Gum Woodland and Derived Native Grasslands as defined under the TSC Act and EPBC Act. This ecological community includes native grassland derived from the clearing of the characteristic canopy trees.
Conservation Areas:	Refers to the conservation areas established over Mount Arthur and Saddlers Creek. These areas will be consolidated into the Mt Arthur Coal Complex Offset Strategy, which is being presented for the Project.
EEC:	Endangered Ecological Community
CEEC:	Critically Endangered Ecological Community
DECC:	NSW Department of Environment and Climate Change.
DEWHA:	Commonwealth Department for the Environment, Water, Heritage and the Arts.
EA Boundary:	Environmental Assessment Boundary. Refers to the total area being assessed under the Project. (Figure 1.1)
EP&A Act:	NSW <i>Environmental Planning and Assessment Act 1979</i> .
EPBC Act:	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
LGA:	Local Government Area
MAN:	Mt Arthur North.
MAU:	Mt Arthur Underground.
Mine Extension Areas:	The five additional mining disturbance areas that are proposed as part of the Project. (Figure 1.2)

ML:	Mining Leases.
MNES:	Matters of National Environmental Significance that are listed under the EPBC Act.
Mt Arthur Coal Complex Offset Strategy:	The offset strategy that will be presented for the entire Mt Arthur Coal Complex. This will include offsets for the Project and supersede all previous offset strategies that were established for previous approvals within the Mt Arthur Coal Complex.
The Project:	Mt Arthur Coal Consolidation Project.
TSC Act:	NSW <i>Threatened Species Conservation Act 1995</i> .
Project Disturbance Area:	The total area that will be disturbed as part of the Project, including the Mine Extension Areas, the new rail loading infrastructure areas and the Edderton Road realignment option.
Proposed Offset Areas:	New offset areas proposed as part of the Mt Arthur Coal Complex Offset Strategy. Includes a linear strip of land (222 ha) bounded to the east by Thomas Mitchell Drive, and 495 ha of land to the east side of Thomas Mitchell Drive.
Proposed Regenerated Woodland:	The revegetation and protection of approximately 500 ha of land that will be returned to native woodland and forest after mining.
ROM:	Run of Mine.

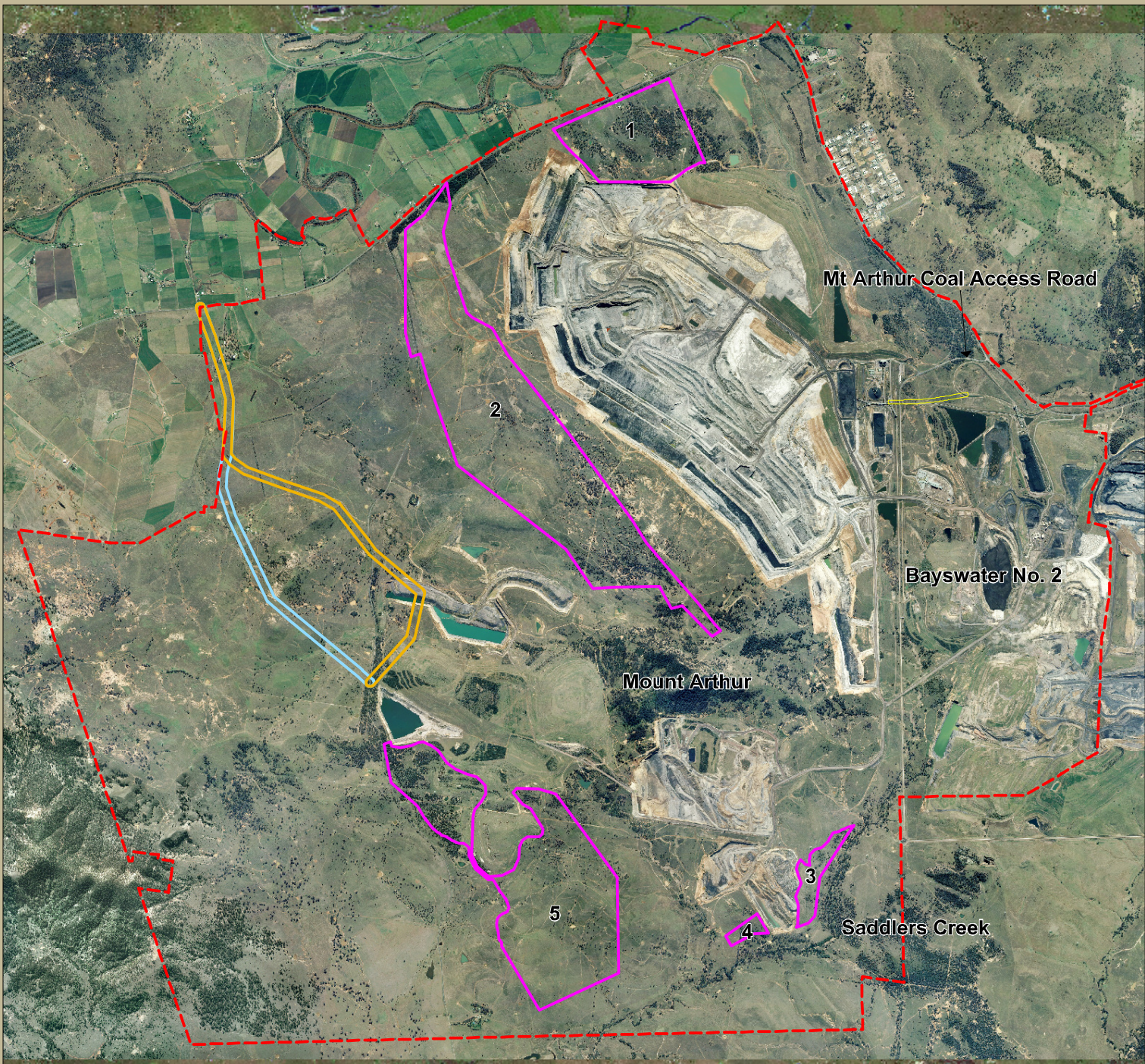


Map Legend

-  EA Boundary
-  Mt Arthur North Disturbance Boundary
-  South Pit Extension Disturbance Boundary
-  Bayswater No. 3 Disturbance Boundary
-  Mt Arthur Underground Disturbance Boundary



Figure 1.1 Approved Mt Arthur Coal Operations - Existing Mining Areas



Map Legend

- EA Boundary
- Mine Extension Areas
- Edderton Road realignment Option 1
- Edderton Road realignment Option 2
- Rail loading conveyor

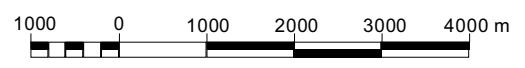


Figure 1.2 New Project Approval - Project Application Boundary (EA Boundary) and Key Natural Features

Methodology

2.1 Introduction

The EA Boundary has been extensively studied since the 1960s when mining first commenced for Bayswater No. 2 and for subsequent mining extensions and annual monitoring within the Mt Arthur Coal Complex. As a result, survey data exists for 1993, 2000, 2003, 2004, 2005, 2006, 2007 and 2008. The objective of this study was thus to review existing information of the EA Boundary and to build upon this information through further investigation of the Mine Extension Areas. In order to do this, the following documents have been comprehensively reviewed:

Resource Planning (1993). **Bayswater No. 3 Coal Mine Project Environmental Impact Statement**. Prepared for Bayswater Colliery Company Pty Limited⁴³

Dames & Moore (2000). **Mt Arthur North Coal Project: Flora and Fauna Report**. For Coal Operations Australia Limited;

Umwelt (2003). **2003 Ecological Monitoring Report**. For Mt Arthur Coal⁴⁷;

Umwelt (2005). **2004 Ecological Monitoring Report**. For Mt Arthur Coal⁴⁸;

Umwelt (2006). **Draft 2005 Ecological Monitoring Report**. For Mt Arthur Coal⁴⁹;

Umwelt (2006). **Ecological Assessment: Proposed South Pit Extension Project**. For Mt Arthur Coal⁵⁰;

Umwelt (2007). **2006 Ecological Monitoring Report**. For Mt Arthur Coal⁵¹;

Umwelt (2007). **Ecological Assessment: Proposed Mt Arthur Underground Project**. For Mt Arthur Coal⁵²;

Umwelt (2008). **Results of 2007 Nest Box Monitoring – Mt Arthur Coal**. For Mt Arthur Coal⁵³;

Umwelt Environmental Consultants (2008) **Plan of Management for the Painted Diuris (*Diuris Tricolor*) at A171** Umwelt (Australia) Pty. Ltd., Toronto, NSW⁵⁴;

Wildthing Environmental Consultants (2008). **2007 Ecological Monitoring Report.** For Mt Arthur Coal^{55,55}; and

Cumberland Ecology (2009). **Mt Arthur Coal 2008 Flora and Fauna Monitoring Program: Ecological Monitoring Report.** For BHP Billiton⁷.

Ecological studies have also been completed for neighbouring sites including Drayton Mine to the east of the EA Boundary, Bengalla Mine and Mount Pleasant to the north of the EA Boundary, and Mangoola Mine to the west of the EA Boundary. The results in the following documents were therefore also considered:

ERM (1997). **Mount Pleasant Mine: Environmental Impact Statement.** For Coal and Allied Operations Pty. Limited³⁵;

Hansen Bailey (2007). **Drayton Mine Extension: Flora and Fauna Impact Assessment.** For Anglo Coal (Drayton Management) Pty. Limited³⁶;

Umwelt (2007). **Anvil Hill Project Ecological Assessment.** For Centennial Hunter Pty Limited⁴⁶; and

Envirosciences Pty Ltd (1993). **Environmental Impact Statement for Bengalla Coal Mine.** For Bengalla Mining Company Pty Ltd³⁴.

2.2 Database Analysis

Other existing information on the biodiversity values of the EA Boundary and its surrounds were obtained through the consultation of the Department of Environment and Climate Change (DECC) Atlas of NSW Wildlife database²⁸ and DEWHA EPBC Protected Matters Search Tool³¹. The number and age of records of threatened species recorded within a 10 km radius of the EA Boundary was useful supplementary information when assessing the likelihood of threatened species using the habitat within the EA Boundary. The Protected Matters Search Tool provides a list of MNES that are predicted to occur based on the presence of suitable habitat, which was useful to guide threatened species searches during field survey.

2.3 Field Surveys

The landscape of the EA Boundary has been extensively cleared for farmland but there is the possibility that flora and fauna habitats of conservation significance may remain. Box Gum Woodland and Derived Native Grasslands ('Box Gum Woodland'), a Critically Endangered Ecological Community (CEEC) listed under the EPBC Act, and an Endangered Ecological Community (EEC) under the TSC Act, is known to occur in the general locality. A number of threatened plant and animal species have been detected in previous studies of the EA Boundary and include the grass *Bothriochloa biloba* and

passerine birds such as Speckled Warbler (*Pyrrholaemus saggitatus*) and Grey-crowned Babbler (*Pomatostomus temporalis temporalis*). Squirrel Gliders (*Petaurus norfolcensis*) have also been detected in the EA Boundary.

Cumberland Ecology conducted field surveys to comply with standards provided in the DECC 'Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities' (2004)¹⁰. Vegetation communities were sampled according to methodology that is prescribed within the EPBC Act Policy Statement for assessing Box Gum Woodland²⁹ to determine the presence of this community (described briefly in Section 2.3.1 below). Box Gum Woodland as listed under the TSC Act was assessed in accordance with the legislative community listing provided in the TSC Act. Vegetation and flora field surveys were completed over the following dates:

- 28 August 2008;
- 21-23 September 2008;
- 30 September – 2 October 2008;
- 10-12 November 2008;
- 19-23 January 2009;
- 4 March 2009;
- 8-9 April 2009;
- 9-10 July 2009; and
- 13-14 July 2009.

2.3.1 Flora Survey Methodology

Key remnant areas of vegetation as well as grassland areas were ground-truthed and the plant species recorded. Specifically, this included:

- Quadrat sampling (20m x 50m) to obtain information on floristic composition and community structure;
- Random meander surveys to detect additional flora species not recorded within the quadrats;
- Meander-transect surveys to ground-truth the occurrence and extent of different community types, making records of boundary changes using a handheld Global Positioning Systems (GPS) unit; and
- Targeted threatened species searches for threatened flora previously recorded within the Mine Extension Areas and in the locality of the EA Boundary.

i. Quadrat Sampling

A total of 25 quadrats were sampled during the survey periods. The locations of these quadrats were chosen so that sampling was conducted in areas most representative of the condition and composition of the vegetation patch. These quadrat locations are shown in **Figure 2.1**. Quadrat locations from previous surveys have also been shown where sufficient information was available to do so. In each quadrat, the following information was recorded as a minimum:

- All vascular flora species present within the plot or directly adjacent to the plot;
- The stratum in which each species occurred;
- The relative frequency of occurrence of each plant species;
- Vegetation structural data (i.e. height and percentage cover of each stratum);
- A waypoint to mark the location of the quadrat, using a handheld GPS; and
- Photographs of the quadrat.

The relative abundance and cover of each species within the quadrat was approximated using a scoring system based on the Braun-Blanquet scoring system². The scores used are provided in **Table 2.1** below (and also shown in **Appendix A**).

Table 2.1 MODIFIED BRAUN-BLANQUET SCORES USED IN QUADRAT SURVEYS

Class	Cover-abundance*	Notes
+	Rare (less than 1% cover)	Herbs, sedges and grasses: within 4 m ² Shrubs and small trees: less than 5 individuals.
1	Few Individuals (less than 5 % cover)	Herbs, sedges and grasses: within 20 m ² Shrubs and small trees: 5 or more individuals Medium - large overhanging tree.
2	5 - less than 25 % cover	-
3	25 - less than 50 % cover	-
4	50 - less than 75 % cover	-
5	75 – 100 % cover	-

ii. Criteria for defining EPBC Act listed Box Gum Woodland

To determine the presence of this community within the EA Boundary, the EPBC Act Policy Statement for assessing Box Gum Woodland²⁹ was referred to in addition to the Commonwealth listing advice to the Minister for the Environment from the Threatened

Species Scientific Committee (TSSC). This Policy Statement includes a prescriptive, detailed methodology for determining the presence of Box Gum Woodland.

The flow chart that summarises the DEWHA method for identifying of Box Gum Woodland is provided in the Policy Statement and is reproduced in **Appendix C**. It demonstrates that to confirm the presence of this CEEC as listed under the EPBC Act, it is firstly essential to confirm the presence of White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*) in sufficient numbers to be at least co-dominants of woodlands. Then, if one or more of these trees are present in woodland as dominants, a vegetation survey should be completed within a plot of 1,000 m² (0.1ha). DEWHA has published a list of plants characteristics of Box Gum Woodlands; if the survey plot contains 12 native herb species (excluding native grasses) and at least one "important" native plant as signified in the list of characteristic species, then the plant community is said to be present.

The DEWHA method is simple and is not dependent upon soil type, slope or aspect. The Upper Hunter Region is just within the area where the Box Gum Woodlands are known to occur, albeit at the eastern edge of the known range. Thus, the quadrat data were analysed according to this criteria to determine the presence of Box Gum Woodland within the EA Boundary. The quadrat data collected are presented in **Appendix A**.

The Commonwealth listing advice does not mention White Box-Grey Box intergrades (*Eucalyptus albens* x *E. moluccana*). Thus, for the purposes of the DEWHA method of assessment, EPBC Act listed Box Gum Woodland does not include remnant vegetation and its associated derived grassland where the dominant canopy tree species is, or once was White Box-Grey Box intergrade.

iii. *Defining TSC Act listed Box Gum Woodland according to Final Determinations*

There is no such prescriptive methodology to identify Box Gum Woodland under the TSC Act. Instead, the Final Determination made by the NSW Scientific Committee to list Box Gum Woodland as an Endangered Ecological Community under the TSC Act includes a comprehensive and detailed description that defines the community. The presence of the community is determined on the basis of its consistency with the community described within the Final Determination.

The following extracts have been taken directly from the Final Determination for Box Gum Woodland:

"White Box Yellow Box Blakely's Red Gum Woodland is the name given to the ecological community characterised by the assemblage of species listed in paragraph 3 [of this determination]."

"White Box Yellow Box Blakely's Red Gum Woodland includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations – Eucalyptus albens

(*White Box*), *Eucalyptus melliodora* (*Yellow Box*) or *Eucalyptus blakelyi* (*Blakely's Red Gum*)."

"In some locations, the tree overstorey may be absent as a result of past clearing or thinning and at these locations only an understorey may be present."

"Woodlands including Eucalyptus crebra, Eucalyptus dawsonii and Eucalyptus moluccana (and intergrades with Eucalyptus albens)...are also included. Intergrades between Eucalyptus blakelyi and Eucalyptus teretecornis may also occur here."

The presence of the community as it is defined under the TSC Act was identified in the EA Boundary firstly by determining whether White Box, White Box-Grey Box intergrade, Yellow Box or Blakely's Red Gum were present or once present as the characteristic canopy species, and secondly by determining whether the assemblage of characteristic species listed in paragraph 3 of the Final Determination was present. As the TSC Act recognises intergrades, the extent of Box Gum Woodland under the TSC Act was expected to be greater than that of EPBC Act listed Box Gum Woodland. The Final Determination for Box Gum Woodland has been included within **Appendix C** for reference.

Identification guidelines for Box Gum Woodland listed under the TSC Act have been published and is based on an interpretation of the Final Determination. These guidelines have been prepared to assist in the identification of the community; however, consistency with the Final Determination takes precedence. These guidelines have also been reproduced in **Appendix C**.

iv. Plant Identification and Taxonomic Convention

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (1992, 1993, 2000 and 2002)³⁷. Other references used to assist identification of more cryptic specimens include Richardson *et al.* (2006)⁴⁴ and Brooker and Kleinig (2006)³. Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from *PlantNET*¹. Any specimens that were not readily identifiable were lodged with the National Herbarium of NSW at the Royal Botanic Gardens, Sydney. Eucalypt specimens were also sent to the National Herbarium to verify the identifications of White Box-Grey Box intergrades and Blakely's Red Gum. Other species that were sent to the National Herbarium for verification included threatened species like the grass *Bothriochloa biloba*.

2.3.2 Fauna Surveys

The EA Boundary has been comprehensively surveyed over previous studies for fauna species in a range of habitats and vegetation types and using a variety of trapping/detection methods. These studies covered the following habitat types:

- Remnant woodland;
- Remnant open forest;
- Wetland (including dams);
- Riparian vegetation associated with Saddlers Creek and minor tributaries; and
- Grassland (derived native, exotic and rehabilitation).

The total fauna survey effort within the EA Boundary is a cumulative result of a series of surveys conducted over a period of nine years. There has been over 6,900 trap nights and over 280 person hours of fauna surveys conducted within the EA Boundary, using detection methods like Anabat echolocation recordings and active searches, and trapping methods like hair funnels/tubes, Elliott traps, harp traps and pitfall traps.

Survey method and survey effort for the EA Boundary are summarised in **Table 2.2** below. Where there was sufficient information to do so, the survey locations of previous studies^{7,8,47-53,55} have been mapped and are shown in **Figure 2.2**.

The cumulative results of all fauna studies completed within the EA Boundary and its surrounds have provided comprehensive information on the fauna diversity of the EA Boundary. In this study, the existing information was supported by additional opportunistic sight records and through assessment of the availability and quality of different habitat types present within the EA Boundary.

Table 2.2 CUMULATIVE FAUNA SURVEY EFFORT AT MT ARTHUR COAL^{7, 8, 47-53, 55}

SURVEY METHOD	Environmental Impact Assessments			Ecological Monitoring Program						
	SOUTH PIT	MAU	MAN	2003	2004	2005	2006	2007	2008	TOTAL SURVEY EFFORT
Bird Searches	6	11.75	4.5	5	5	5	5	5	8	55.25 person hours
Diurnal Reptile/Amphib Searches	6	10	8	10	5	5	5	6	8	63 person hours
Nocturnal Reptile/Amphib Searches	6	7	4	-	-	5	5	8	8	43 person hours
Spotlighting	8.5	14.5	14	10	10	10	10	4	12	93 person hours
Mist Nets	-	-	33	-	-	-	-	-	-	33 person hours
Harp Traps	6	6	5	-	-	-	-	-	-	17 trap nights
Anabat Echolocation Recordings	3	4.5	5	5	5	5	10	2	12	51.5 trap nights
Arboreal Elliott B	320	419	24	-	-	-	-	-	-	763 trap nights
Terrestrial Elliott A	300	336	400	-	-	-	-	-	-	1036 trap nights
Cage Traps	60	68	20	-	-	-	-	-	-	148 trap nights
Hair Funnels/Tubes	480	2340	72	600	600	750	-	-	-	4842 trap nights
Arboreal PVC traps	-	-	72	-	-	-	-	-	-	72 trap nights
Pitfall	-	-	27	-	-	-	-	-	-	27 trap nights
Call Playback	3	7	-	-	-	-	-	-	-	10 trap nights
Nest Boxes (50)	no	no	no	yes	yes	yes	yes	yes	yes	6 monitoring years

*Note: Setting a single trap per night is classified as a trap night (i.e. if 100 traps are set on a single night, this equates to 100 trap nights). Trap nights are defined within the DECC 'Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities' (2004)*¹⁰.

2.3.3 Fauna Habitat Assessment

The characteristic attributes of different types of fauna habitat generally influences the assemblage of fauna species that can be found within each habitat and also affects the general value of the habitat for fauna. The EA Boundary contains five broad habitat types that vary in its value for fauna. These are:

- Remnant woodland;
- Remnant open forest;
- Wetland;
- Riparian vegetation associated with Saddlers Creek and minor tributaries; and
- Grassland (derived native, exotic and rehabilitation).

Remnant woodland and open forest areas within the EA Boundary are areas of native vegetation that existed prior to the commencement of mining. These areas represent patches of mature vegetation that are less than 100 years old and have previously subjected to cattle grazing, which were removed in 2003. Wetland areas can include artificial or man-made wetlands such as dams.

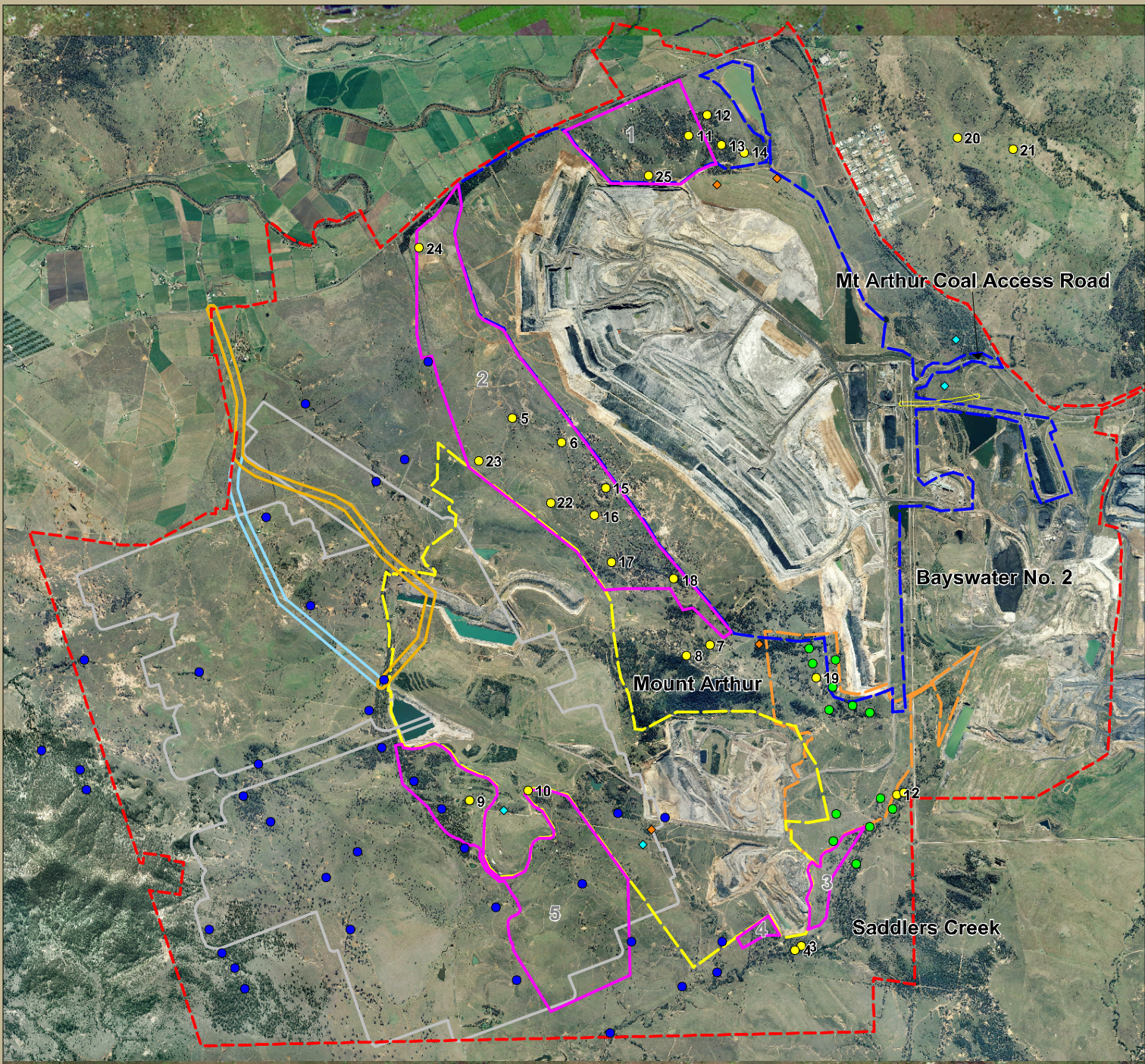
Fauna habitats were first considered in terms of the following general factors: area, configuration and connectivity to other areas of intact vegetation. These factors affect the quality of the habitat on a broader, landscape scale. Habitat condition was then assessed by noting ground, shrub/understorey and canopy cover, number and size of hollows present, habitat features such as bush rock and fallen trees, and signs of fauna usage such as scats and scratches.

Fauna habitat assessments also included consideration of important indicators of habitat condition and complexity including the occurrence of microhabitats such as tree hollows, fallen logs, bush rock and wetland areas such as creeks and soaks. An assessment of the structural complexity of vegetation, the age structure of the forest and the nature and extent of human disturbance throughout the EA Boundary was undertaken and considered.

Hollows are used as a general indication of habitat quality for arboreal fauna, and hollow-dependent birds and bats. Hollows observed during surveys were recorded and the general vegetation condition and tree maturity were used to predict whether trees on site are likely to contain hollows. Indirect indicators of fauna use of the site such as droppings, diggings, footprints, scratches, nests, burrows, paths and runways were also noted.

2.3.4 Survey Conditions

The latest vegetation surveys conducted in 2008 by Cumberland Ecology occurred in excellent seasonal conditions, during which a high proportion of the plant species were detectable and flowering. At the time of survey, there had been a preceding period of wet weather and many species were in peak reproductive season. Thus, it is probable that the majority of flora species have been recorded and issues such as condition and viability of the plant community have been adequately assessed.



Map Legend

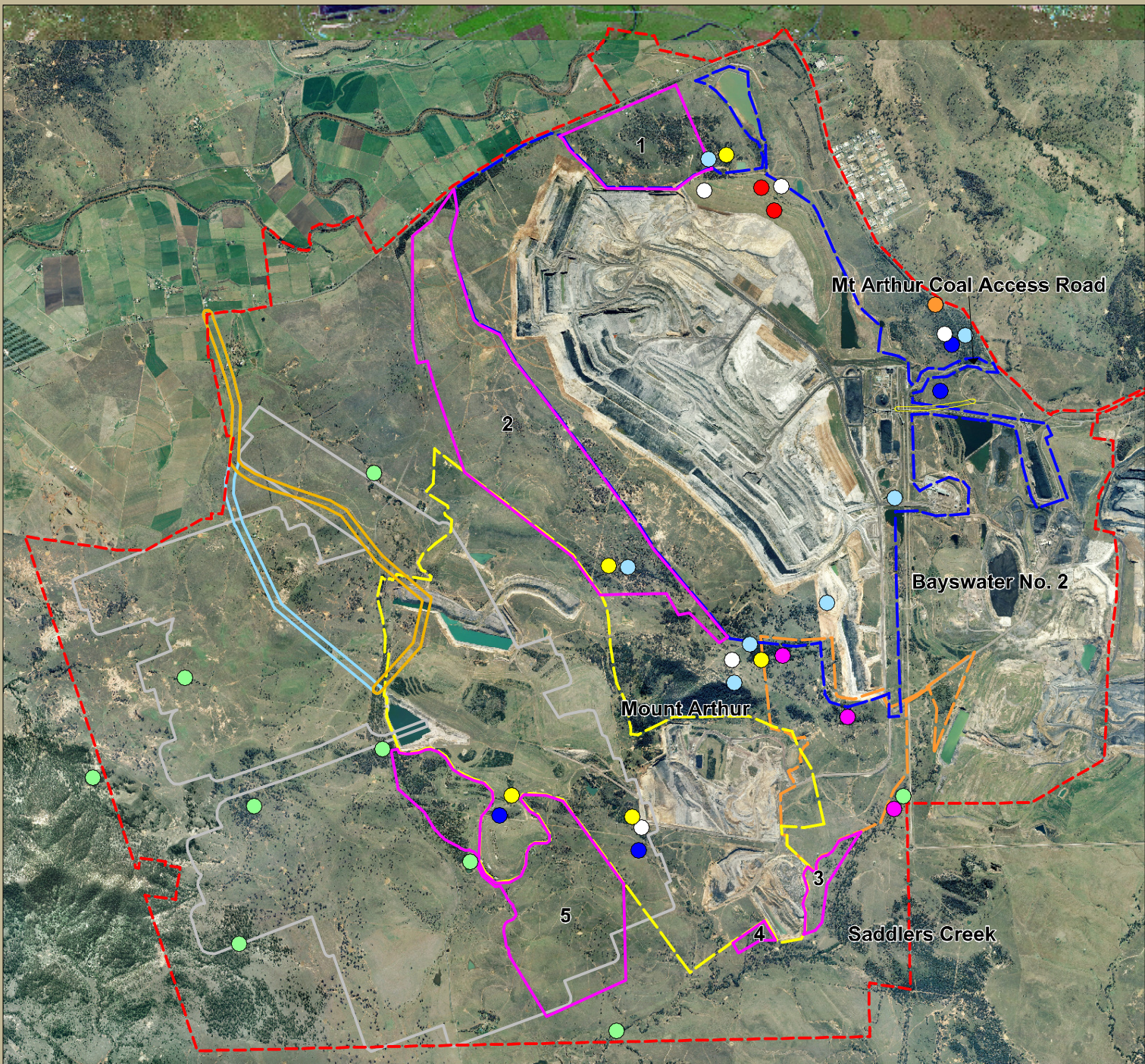
- EA Boundary
- Mt Arthur North Disturbance Boundary
- South Pit Extension Disturbance Boundary
- Bayswater No. 3 Disturbance Boundary
- Mt Arthur Underground Disturbance Boundary
- Mine Extension Areas
- Edderton Road realignment Option 1
- Edderton Road realignment Option 2
- Rail loading conveyor

Vegetation Survey Plots

- Cumberland Ecology, Current Survey
- ◆ Cumberland Ecology, 2008 Monitoring
- ◆ Wildthing, 2007 Monitoring
- UMWELT, South Pit Project Survey
- UMWELT, Underground Project Survey



Figure 2.1 Vegetation Survey Locations



Map Legend

- EA Boundary
- Mt Arthur North Disturbance Boundary
- South Pit Extension Disturbance Boundary
- Bayswater No. 3 Disturbance Boundary
- Mt Arthur Underground Disturbance Boundary
- Mine Extension Areas
- Edderton Road realignment Option 1
- Edderton Road realignment Option 2
- Rail loading conveyor

Previous Fauna Survey Locations

Note: multiple years represent a revisited site

- Dames & Moore 2000
- Umwelt 2003 & 2004
- Umwelt 2004
- Umwelt 2003, 2004 & 2005
- Wildthing 2007
- Cumberland Ecology 2008
- Umwelt 2006
- Umwelt 2007



Figure 2.2 Previous Fauna Survey Locations

Survey Results

3.1 Introduction

This chapter presents the findings of flora and fauna surveys across the EA Boundary. Total flora and fauna species lists are provided in **Appendix A** and **Appendix B**, respectively. Raw quadrat data for the recent flora surveys by Cumberland Ecology is also provided in **Appendix A**.

3.2 Vegetation Communities

The vegetation across the Central Hunter Valley has been mapped by the Hunter-Central Rivers Catchment Management Authority (CMA) and this mapping includes the EA Boundary⁴². Additional mapping studies have been conducted across the EA Boundary as part of vegetation studies commissioned for environmental impact assessments of coal mining proposals within mining tenements held by Mt Arthur Coal^{8,50,52}. The major vegetation communities that occur within the EA Boundary are listed below and are shown in **Figure 3.1**. Most of the names used to describe these communities follow those used in the CMA mapping study.

- Central Hunter Ironbark - Spotted Gum - Grey Box Forest;
- Mount Arthur Forest Complex;
- Spotted Gum Forest;
- Central Hunter Box - Ironbark Woodland;
- Blakely's Red Gum Woodland;
- Hunter Floodplain Red Gum Woodland;
- Narrabeen Foothills Slaty Gum Woodland;
- Upper Hunter Hills Exposed - Ironbark Woodland;
- Upper Hunter White Box - Ironbark Grassy Woodland;

- Central Hunter Bulook Forest Regeneration;
- Grassland; and
- Planted vegetation.

The predominant vegetation element within the EA Boundary is grassland that has been derived from the clearing of the original woodland and forest communities. This is dominated by a variety of native grass and forb species but many exotic species are present as is typical of grazing lands.

Each of the plant communities that have been mapped as occurring in the EA Boundary are described below.

3.2.1 Upper Hunter White Box – Ironbark Grassy Woodland

Status: Endangered Ecological Community (TSC Act)

This is an open woodland community that occurs on gently undulating slopes and hills on clay and earth soils (**Photographs 3.1 and 3.2**). Canopy species that are characteristic of this community include *Eucalyptus crebra* (Narrow-leaved Ironbark), *E. albens* (White Box) and/or *E. albens* x *E. moluccana* (White Box-Grey Box intergrade). Other canopy species that can occur in this community include *Eucalyptus dawsonii* (Slaty Gum), *E. blakelyi* (Blakely's Red Gum), *Brachychiton populneus* ssp. *populneus* (Kurrajong) and *Corymbia maculata* (Spotted Gum).

Common understorey species include *Notelaea microcarpa* var. *microcarpa* (Native Olive), *Myoporum montanum* (Water bush), *Acacia decora* (Western Golden Wattle) and *Maireana microphylla* (Eastern Cottonbush). The groundcover is diverse and is generally dominated by grasses and forbs, such as *Aristida ramosa* (Threeawn Wiregrass), *Cymbopogon refractus* (Barbed Wire Grass), *Austrostipa verticillata* (Slender Bamboo Grass), *Chloris ventricosa* (Windmill Grass), *Austrodanthonia fulva* (Wallaby Grass), *Cynodon dactylon* (Couch Grass), *Calotis lappulaccea* (Yellow Burr-daisy), *Dichondra repens* (Kidney Weed), *Desmodium varians* (Variable Tick-trefoil) and *Einadia nutans* (Climbing Saltbush).

Upper Hunter White Box – Ironbark Grassy Woodland is present in the EA Boundary on the gentle slopes and rises associated with the footslopes of Mount Arthur and with Macleans Hill. It can also be found within the southern extent of Mine Extension Area 5 on moderate, broad crests where the land gently undulates towards Saddlers Creek and its tributaries.



Photograph 3.1 **Upper Hunter White Box – Ironbark Grassy Woodland at the southern end of the MAN open cut pit (Quadrat 19). The large tree in the background is a White Box-Grey Box intergrade.**



Photograph 3.2 **Upper Hunter White Box – Ironbark Grassy Woodland at Macleans Hill north of the MAN open cut pit (Quadrat 25).**

3.2.2 *Blakely's Red Gum Woodland*

Status: Endangered Ecological Community (TSC Act)

Critically Endangered Ecological Community (EPBC Act)

This is an open woodland community that occurs on gently undulating slopes and hills on clay and earth soils that is dominated by almost pure stands of *Eucalyptus blakelyi* (Blakely's Red Gum). It occurs in small, relatively isolated pockets of woodland and is closely related to Upper Hunter White Box – Ironbark Grassy Woodland and Mt Arthur Forest Complex.

The understorey composition is contiguous with that of Upper Hunter White Box – Ironbark Grassy Woodland described above, as Blakely's Red Gum Woodland commonly occurs in small pockets within Upper Hunter White Box – Ironbark Grassy Woodland. Within the EA Boundary, this community was recorded at one location north of the Mt Arthur Coal Access Road. It is not located within the Project Disturbance Area and will not be cleared as part of the Project.

3.2.3 *Spotted Gum Forest*

Status: Not listed.

This is a tall open forest dominated by *Corymbia maculata*, with occasional occurrences of *Brachychiton populneus*, *Eucalyptus crebra* and in gully areas, *E. tereticornis* (Forest Red Gum) and *E. dawsonii* (**Photograph 3.3**). There are no equivalent communities described in the CMA vegetation mapping of the Central Hunter Valley⁴², although a number of communities in the CMA mapping bear some affinities to the Spotted Gum Forest present within the EA Boundary (e.g. Central Hunter Ironbark – Spotted Gum – Grey Box Forest and Lower Hunter Ironbark – Spotted Gum Forest). Spotted Gum Forest in the EA Boundary corresponds to *Corymbia maculata* Forest, which has been described by Dames & Moore⁸.

The understorey layers contain shrub species *Notelaea microcarpa* var. *microcarpa*, *Acacia decora*, *Cassinia arcuata* (Sifton Bush), *Breynia oblongifolia* and *Dodonaea viscosa* (Hop Bush). Typical forbs and grasses include *Goodenia paniculata* (Branched Goodenia), *G. ovata* (Hop Goodenia), *Ozothamnus diosmifolium* (White Dogwood), *Brunoniella australis*, *Glycine tabacina* (Variable Glycine), *Wahlenbergia stricta* (Austral Bluebell), *Calotis cuneifolia* (Purple Burr-daisy), *Dianella longifolia* (syn. *D. laevis*), *Sida corrugata*, *Swainsona galegifolia* (Smooth Darling Pea), *Bothriochloa macra*, *Aristida ramosa*, *Chloris truncata* (Windmill Grass), *Lomandra filiformis* (Wattle Mat-rush), *Themeda australis* (Kangaroo Grass) and *Dichelachne micrantha* (Shorthair Plumegrass).

Spotted Gum Forest is present in the EA Boundary at the lower north eastern slopes of Mount Arthur, near the southern tip of the MAN pit.



Photograph 3.3 **Spotted Gum Forest on the north eastern slopes of Mount Arthur (2008 Flora and Fauna Monitoring Location, north eastern slopes of Mount Arthur).**

3.2.4 Central Hunter Box – Ironbark Woodland

Status: Preliminary Determination as Endangered Ecological Community (TSC Act) (May 2009)

This open woodland community occurs on all aspects of gently undulating slopes and occasionally on rocky knolls. Within the EA Boundary, canopy species can include *Eucalyptus crebra* and *E. albens* x *E. moluccana*. Common co-occurring canopy and small tree species include *Allocasuarina luehmannii* (Buloak), *Angophora floribunda* (Rough-barked Apple), *Callitris endlicheri* (Black Cypress Pine), *Acacia implexa* (Hickory Wattle), *A. salicina* (Cooba) and *Canthium odoratum* (Shiny-leaved Canthium).

Common understorey species include *Notelaea microcarpa* var. *microcarpa*, *Myoporum montanum*, *Acacia decora* and *Maireana microphylla*. It can also include *Breynia oblongifolia* (Coffee Bush), *Cassinia quinquefaria* (Cough-bush) and *Dodonaea viscosa*. Subshrubs are common and can include *Solanum cinereum* (Narrawa Burr) and *Phyllanthus virgatus* (Spurge).

The groundcover is characterised by a variety of forbs, grasses, ferns and twiners. Abundant species include *Aristida ramosa*, *Cymbopogon refractus*, *Austrostipa scabra* (Corkscrew Grass), *Bothriochloa decipiens* (Red Leg Grass), *Chloris ventricosa*, *Cheilanthes sieberi* ssp. *sieberi* (Poison Rock Fern), *Cheilanthes distans* (Bristly Cloak Fern), *Calotis lappulacea* (Yellow Burr-daisy), *Vittadinia cuneata* (Fuzzweed), *Chrysocephalum apiculatum* (Common Everlasting), *Eremophila debilis* (Winter Apple), *Brunoniella australis* (Blue Trumpet), *Ajuga australis* (Austral Bugle), *Lomandra multiflora* ssp. *multiflora* (Many-flowered Mat-rush), *Dichondra repens*, *Desmodium varians*, *Sida corrugata* (Corrugated Sida), *Einadia nutans* and *Einadia trigonos* (Fishweed).

Large remnant patches of this community are located to the west of Mine Extension Area 5. Smaller patches occur in proximity of Saddlers Creek and its tributaries.

3.2.5 Mount Arthur Forest Complex

Status: Endangered Ecological Community (TSC Act)

Critically Endangered Ecological Community (EPBC Act)

Mount Arthur Forest Complex is restricted to the slopes and summit of Mount Arthur (**Photographs 3.4 and 3.5**). This variant of Box Gum Woodland is a mid to tall open forest dominated by *Eucalyptus punctata* (Grey Gum), *E. moluccana* (Grey Box), *Brachychiton populneus* spp. *populneus* (Kurrajong) and *Allocasuarina torulosa* (Forest Oak). Co-occurring tree species include *E. blakelyi* (Blakely's Red Gum), *Angophora floribunda* (Rough-barked Apple) and *Ficus rubiginosa* f. *rubiginosa* (Port Jackson Fig). *Callitris endlicheri* (Black Cypress Pine) and *E. albens* x *E. moluccana* (White Box-Grey Box intergrade) may also be present in low numbers.

The understorey stratum is characterised by *Xanthorrhoea johnsonii* (Grass Tree), *Spartothamnella juncea* (Native Broom), *Notelaea microcarpa* var. *microcarpa*, *Myoporum montanum*, *Acacia decora*, *Canthium odoratum* (Shiny-leaved Canthium) and *Breynia oblongifolia* (Coffee Bush).

Common groundcover species include *Dichondra repens* (Kidney Weed), *Plantago debilis* (Slender Plantain), *Hypericum gramineum* (Small St. John's Wort), *Desmodium varians* (Variable Tick-trefoil), *Lomandra multiflora* ssp. *multiflora* (Many-flowered Mat-rush), *Hardenbergia violacea* (False Sarsparilla), *Cheilanthes sieberi* ssp. *sieberi* (Poison Rock Fern), *Austrostipa verticillata* (Slender Bamboo Grass), *Austrodanthonia fulva* (Wallaby Grass), *Cynodon dactylon* (Couch Grass) and *Aristida ramosa* (Threeawn Wiregrass).

Patches of this community are the EPBC Listed CEEC Box Gum Woodland – these are namely areas that are dominated or co-dominated by *E. blakelyi* that occur on northern hillsides of Mount Arthur. This community is not located within the Project Disturbance Area and will not be cleared as part of the Project.



Photograph 3.4

Mount Arthur Forest Complex on the lower northern footslopes of Mount Arthur (Quadrat 7). This area was dominated by Blakely's Red Gum, *Myoporum acuminatum* and *Notelaea macrocarpa*.



Photograph 3.5 Mount Arthur Forest Complex on the upper footslopes of Mount Arthur (Quadrat 8). This area was dominated by Blakely's Red Gum and was also characterised by smaller shrubs like *Swainsona galegifolia* and *Maireanna microphylla*. This area of the Mount Arthur Forest Complex was differentiated from the area at Quadrat 7 by the additional presence of rock outcrops and grass trees.

3.2.6 Narrabeen Footslopes Slaty Gum Woodland

Status: Preliminary Determination as Endangered Ecological Community (TSC Act) (May 2009)

Narrabeen Footslopes Slaty Gum Woodland occurs in drier areas of the EA Boundary (**Photographs 3.6 and 3.7**). This open woodland is dominated by *Eucalyptus dawsonii* and *E. moluccana*. Other tree species that may be present include *Brachychiton populneus* ssp. *populneus*, *Allocasuarina luehmannii*, *Callitris endlicheri*, *Acacia salicina*, *E. crebra* and *E. punctata*.

Common shrub storey species include *Canthium odoratum*, *Geijera salicifolia* var. *salicifolia* (Brush Wilga), *Notelaea microcarpa* var. *microcarpa*, *Myoporum montanum* and *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop Bush).

The groundcover has relatively low species richness and is generally sparse. It is characterised by *Dichondra repens*, *Aristida ramosa*, *Lomandra multiflora* ssp. *multiflora*, *Brunoniella australis*, *Cymbopogon refractus*, *Desmodium brachypodum* (Large Tick-trefoil) *Eremophila debilis*, *Fimbristylis dichotoma* (Common Fringe-rush) and *Sida corrugata*.

The areas of Narrabeen Foothills Slaty Gum Woodland in the EA Boundary were characterised by scattered old growth Slaty Gum above thickets of African Boxthorn (*Lycium ferocissimum*) and Galenia (*Galenia pubescens*). Although the grassy understorey was low in diversity, it was predominantly native.



Photograph 3.6

Narrabeen Foothills Slaty Gum Woodland west of the MAN open cut pit (Quadrat 5).



Photograph 3.7 **Narrabeen Footslopes Slaty Gum Woodland west of the MAN open cut pit (Quadrat 6).**

3.2.7 Hunter Floodplain Red Gum Woodland

Status: Endangered Ecological Community (TSC Act)

Critically Endangered Ecological Community (EPBC Act)

Hunter Floodplain Red Gum Woodland is found on floodplains of major and intermediate waterways and is therefore associated with alluvial soils. This open woodland was recorded within the EA Boundary along Saddlers Creek and its tributaries and is dominated by *Eucalyptus melliodora* (Yellow Box). *Eucalyptus teretecornis* and *Angophora floribunda* are often associated with this community in low numbers and were recorded along sections of Saddlers Creek (**Photographs 3.8 and 3.9**).

The understorey generally lacks shrub species but can be dominated by a variety of forbs and grasses. Abundant groundcover species include *Cynodon dactylon*, *Austrostipa verticillata*, *Dichondra repens*, *Lepidium pseudohyssopifolium* (Peppercress), *Urtica incisa* (Stinging Nettle), *Einadia hastata*, *Cynoglossum australe* (Australian Hound's Tongue), *Cyperus gracilis*, *Carex inversa* (Knob Sedge), *Glycine tabacina*, *Oxalis exilis*, *Geranium solanderi* (Native Geranium), *Chrysocephalum apiculatum*, *Plantago debilis*, *Echinopogon caespitosus* var. *caespitosus* (Tufted Hedgehog Grass) and *Microlaena stipoides* (Weeping Meadow Grass).

Eucalyptus melliodora dominates the occurrence of this community in the EA Boundary and so the occurrence does classify as being part of the CEEC Box Gum Woodlands. Approximately two hectares of this community was present within Mine Extension Area 5, as a few trees above an understorey dominated by weedy species (Galenia and African Boxthorn), and a number of native grass species. Notwithstanding this, the shape of this Mine Extension Area was subsequently amended to remove impacts to this community.

A patch of Hunter Floodplain Red Gum Woodland occurs over the proposed Edderton Road realignment along a property driveway and about half a hectare will likely be removed for the realignment. This patch is characterised by *Eucalyptus melliodora* but has very little to absent native understorey. It has very little structural integrity remaining of the original community. Therefore, this area of Hunter Floodplain Red Gum Woodland does not constitute the CEEC or EEC Box Gum Woodland.

The remaining occurrence of this community within the EA Boundary is approximately 50 ha in size and is confined to the existing Saddlers Creek Conservation Area and closely adjacent areas, which will not be impacted by the Project.



Photograph 3.8

Hunter Floodplain Red Gum Woodland along a small tributary of Saddlers Creek adjacent to Bayswater No. 3 open cut pit (2008 Flora and Fauna Monitoring Location – Saddlers Creek).



Photograph 3.9 Hunter Floodplain Red Gum Woodland Complex on the banks of Saddlers Creek (Quadrat 1).

3.2.8 Central Hunter Bul oak Forest Regeneration

Status: Not listed.

This community occurs on degraded land with poor soils, particularly in pasture areas where grazing has been removed. It is a variable community and can range from a closed to open forest, with heights varying from mid level to tall. Typically, this community contains a very sparse to absent shrub understorey and is dominated by *Allocasuarina luehmannii*. Occurrences of other tree species are uncommon but can include *Eucalyptus crebra*, *E. moluccana*, *Angophora floribunda* and *Casuarina glauca* (Swamp Oak). It is present within the EA Boundary within and adjacent to Mine Extension Area 5.

The groundcover is also variable but is generally sparse. It typically comprises tussock grasses like *Aristida vagans* (Threeawn Speargrass), *Cynodon dactylon*, *Eragrostic leptostachya* (Paddock Lovegrass), *Austrostipa verticillata*, *Cymbopogon refractus*, *Panicum effusum* (Hairy Panic), *Paspalidium aversum* (Bent Summergrass), *Digitaria divaricatissum* (Umbrella Grass) and *Microlaena stipoides*. Forbs, sedges and ferns can also be present and include *Fimbristylis dichotoma*, *Commelina cyanea* (Scurvy Weed), *Laxmannia gracilis* (Slender Wire Lily), *Lomandra multiflora*, *Cheilanthes sieberi*, *Cheilanthes distans*, *Chrysocephalum apiculatum*, *Glycine tabacina*, *Goodenia hederacea* ssp. *hederacea* and *Lomandra filiformis*.

3.2.9 Upper Hunter Hills Exposed Ironbark Woodland

Status: Not listed.

This is an open forest community that often occurs on drier north-facing slopes receiving high solar radiation and is characterised by the ubiquitous presence of *Eucalyptus crebra*. Other canopy species that can occur in low numbers include *E. blakelyi* (Blakely's Red Gum), *E. albens*, *E. moluccana*, *Angophora floribunda* and *Brachychiton populneus* ssp. *populneus*. This community can grade into Upper Hunter White Box – Ironbark Grassy Woodland as the proportions of *E. crebra*, *E. albens* and *E. albens* x *moluccana* vary with aspect. Therefore, it is not uncommon to find these two communities occurring adjacent to each other. This was observed within the Mine Extension Area 1 on the foothills of Macleans Hill.

This community often has a shrub layer that commonly comprises species like *Acacia paradoxa* (Kangaroo Thorn), *Notelaea microcarpa* var. *microcarpa*, *Breynia oblongifolia* and *Spartothamnella juncea*. It has a similarly diverse understorey as Upper Hunter White Box – Ironbark Grassy Woodland, with an abundant herbaceous component. Typical forbs include *Dichondra repens*, *Daucus glochidiatus* (Native Carrot), *Senecio quadridentatus* (Cotton Fireweed), *Desmodium varians*, *Glycine clandestina* (Twining Glycine), *G. tabacina*, *Clematis glycinoides* (Traveller's Joy) and *Desmodium brachypodum*. Abundant grasses include *Dichelachne micrantha* and *Microlaena stipoides*. *Cheilanthes sieberi* and *C. distans* are also common fern species.

3.2.10 Central Hunter Ironbark – Spotted Gum – Grey Box Forest

Status: Preliminary Determination as Endangered Ecological Community (TSC Act) (May 2009)

This community is an open forest that is dominated by *Eucalyptus crebra*, *Corymbia maculata* and *Eucalyptus moluccana*. A sparse small-tree storey may be present and would typically include *Allocasuarina luehmannii* or *Acacia parvipinnula* (Silver-stemmed Wattle). The shrub layer is typically sparse but can include species like *Daviesia ulicifolia* (Gorse Bitter Pea) and *Bursaria spinosa* (Blackthorn). Ground cover species are often sparse and can consist of a number of forbs and grasses including *Pratia purpurascens*, *Cheilanthes sieberi*, *Lomandra multiflora*, *Cymbopogon refractus* and *Themeda australis*.

In the EA Boundary, small pockets of this community occur just beyond the eastern footslopes of Mount Arthur within the currently approved South Pit Extension disturbance boundary.

3.2.11 Grassland

Status: Endangered Ecological Community (TSC Act) → PARTIAL

The grassland within the EA Boundary comprises both exotic and native derived grassland. Derived grassland (also known as secondary grassland or understorey) is an expression of the ecological community that develops when the tree canopy cover of the grassy woodland is removed or suffers dieback, and natural regeneration is prevented. The understorey of derived grassland remains relatively intact. Areas of exotic grassland are often areas that have been mined and rehabilitated, as well as grassland areas where the topsoil may have been disturbed or where it is dominated by weeds, such that the recovery potential of that area is very low to absent.

Much of the grassland in the EA Boundary has historically been derived from the clearing of trees and shrubs to create pasture for livestock long before mining commenced. As such, the floristic composition of this community can vary according to the forest or woodland community from which it originated and to slope, aspect, soil and underlying geology. The vegetation mapping shown in **Figure 3.1** shows grassland vegetation as different subtypes based on clearance history.

The derived grassland identified within the EA Boundary, whilst predominantly native in composition, is a degraded community that has been affected to varying degrees across its extent within the EA Boundary by past clearing, grazing practices and mining activities. Broadly, the original native understorey would have been dominated by palatable grasses like Kangaroo Grass and various species of Wallaby Grass (*Austrodanthonia* spp.) and a high frequency of herbaceous plants. Most areas of native derived grassland are now dominated by less palatable grasses like *Aristida* spp. and *Austrostipa* spp., with very minor proportions of Kangaroo Grass and Wallaby Grasses and a lower frequency of herbs present.

Within the EA Boundary, areas of this community conform to the TSC Act listing for Box Gum Woodland and native Derived Grassland. These are areas of native grassland characterised by an assemblage of understorey species that is representative of the understorey that typifies Box Gum Woodland, namely Upper Hunter White Box – Ironbark Grassy Woodland (**Figure 3.1**). These areas of grassland are derived from the clearing of canopy trees of these communities.

Based upon the most recent survey by Cumberland Ecology, Derived Grassland within the Mine Extension Areas does not appear to be derived from areas historically dominated by the trees *E. albens*, *E. blakelyi* or *E. melliodora*, which are the defining dominants of the Commonwealth CEEC Box Gum Woodland. As such, although a large proportion of land that is proposed to be disturbed for mining purposes is TSC Act listed native Derived Grassland, it does not conform to any listed community under the EPBC Act.

3.3 Threatened Ecological Communities in the EA Boundary

Some of the mapping units used by CMA incorporate areas of Box Gum Woodland CEEC and EEC as defined under the EPBC Act and TSC Act respectively. That is, the communities present within the EA Boundary include several communities that, in part, conform to the legislative listing for the Box Gum Woodland or Derived Grassland. This is because the woodland and open forest communities named by the CMA mapping are dominated by a variety of tree species and vary in their composition from patch to patch. Some patches are dominated or co-dominated by tree species that define Box Gum Woodland, namely *Eucalyptus melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum). The majority of patches however are dominated by other tree species that are not mentioned as characteristic species within the final determinations.

Box Gum Woodland and Derived Grassland is a CEEC nationally listed by the EPBC Act. It is also listed as an EEC under the NSW TSC Act. The Box Gum Woodland and Derived Grassland community is essentially a "super-community" that originally occurred across a vast area of VIC, ACT, NSW and QLD and includes several recognisable variants. The results of the most recent mapping study indicate that the CEEC "Box Gum Woodland and Derived Grassland" is present on parts of the EA Boundary (Mine Extension Area 5, the Conservation Areas on Saddlers Creek and Mount Arthur itself, and within an area north of the Mt Arthur Coal Access Road). The above areas will not be disturbed as part of the Project.

Within Mine Extension Area 5, *Eucalyptus melliodora* dominates the occurrence of this community in the EA Boundary and so the occurrence does classify as being part of the CEEC Box Gum Woodlands. Approximately two hectares of this community was present within Mine Extension Area 5, as a few trees above an understorey dominated by weedy species (Galenia and African Boxthorn), and a number of native grass species. Notwithstanding this, the shape of this Mine Extension Area was subsequently amended to remove impacts to this community.

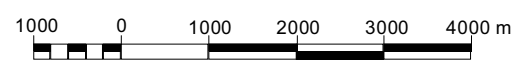
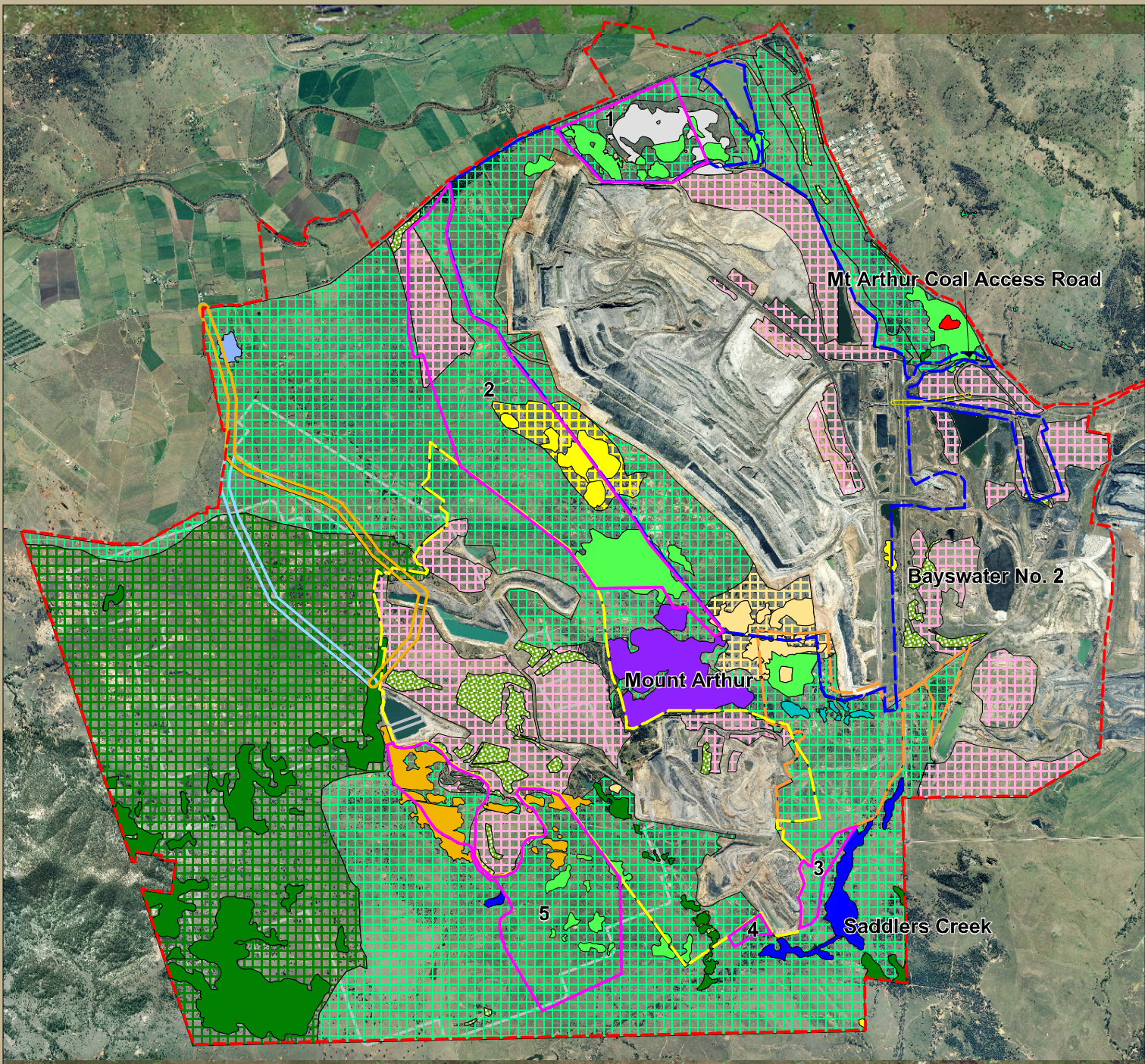
Box Gum Woodland and Derived Grassland is defined differently by the TSC Act and the EPBC Act. The former has a wider definition that specifically includes White Box – Grey Box intergrades together with Slaty Gum and Narrow-leafed Ironbark. Consequently the TSC Act includes a much larger area of the EA Boundary than the listing for the EPBC Act. **Figure 3.2** shows the vegetation that is listed by the EPBC Act Final Determination, while **Figure 3.3** shows the vegetation that is listed by the TSC Act.

The differences in area are significant in that they mean that no EPBC Act listed Box Gum Woodland will be cleared by the Project, whereas most of the five Mine Extension Areas will clear at least some TSC Act listed Box Gum Woodland and native Derived Grassland. The impacts of the Project are covered in detail in the next chapter.

In May 2009, the NSW Scientific Committee made preliminary determinations to list one open forest type and two woodland types that are located in the EA Boundary and which will be partly cleared by the Project. These are:

- Central Hunter Ironbark – Spotted Gum – Grey Box Forest;
- Narrabeen Foothills Slaty Gum Woodland; and
- Central Hunter Box – Ironbark Woodland.

These communities are identified within the Project Impacts section as appropriate.



Map Legend

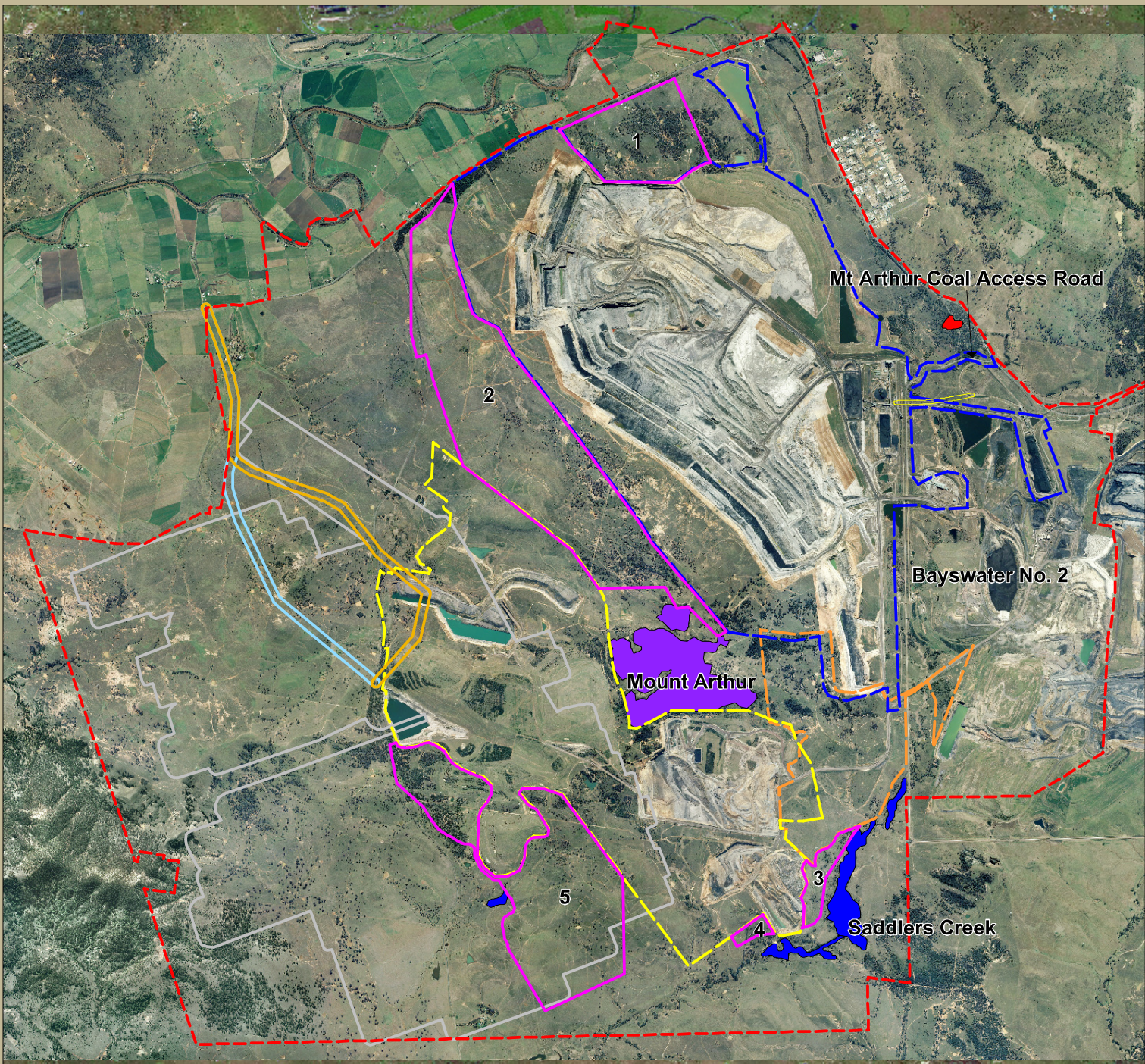
- EA Boundary
- Mt Arthur North Disturbance Boundary
- South Pit Extension Disturbance Boundary
- Bayswater No. 3 Disturbance Boundary
- Mt Arthur Underground Disturbance Boundary
- Mine Extension Areas
- Edderton Road realignment Option 1
- Edderton Road realignment Option 2
- Rail loading conveyor

Vegetation Communities

- Upper Hunter White Box - Ironbark Grassy Woodland
- Upper Hunter Hills Exposed - Ironbark Woodland
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest
- Mount Arthur Forest Complex
- Spotted Gum Forest
- Blakely's Red Gum Woodland
- Hunter Floodplain Red Gum Woodland
- Planted Areas
- Central Hunter Box - Ironbark Woodland
- Narrabeen Foothills Slaty Gum Woodland
- Central Hunter Bullock Forest Regeneration
- Hunter Floodplain Red Gum Woodland - Weedy Understorey

- White Box - Ironbark Derived Grassland
- Exotic Grassland
- Spotted Gum Derived Grassland
- Slaty Gum Derived Grassland
- Box - Ironbark Derived Grassland

Figure 3.1 Vegetation Communities within the EA Boundary



Map Legend

- EA Boundary
- Mt Arthur North Disturbance Boundary
- South Pit Extension Disturbance Boundary
- Bayswater No. 3 Disturbance Boundary
- Mt Arthur Underground Disturbance Boundary
- Mine Extension Areas
- Edderton Road realignment Option 1
- Edderton Road realignment Option 2
- Rail loading conveyor

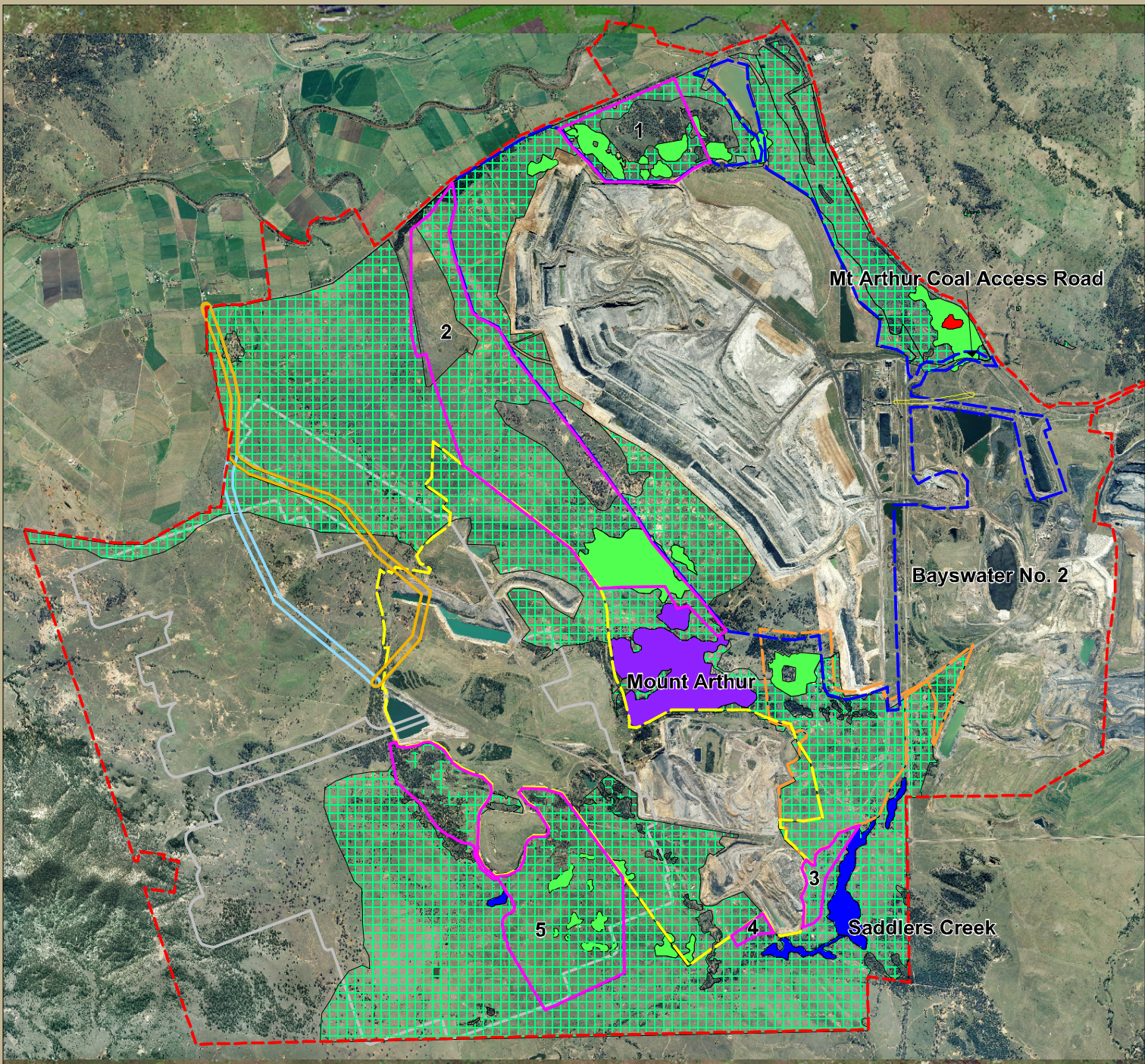
EPBC Act Listed Vegetation Communities

Note: all EPBC Act listed vegetation are variants of Box Gum Woodland

- Mount Arthur Forest Complex
- Blakely's Red Gum Woodland
- Hunter Floodplain Red Gum Woodland



Figure 3.2 Location and Extent of CEEC, Box Gum Woodland (EPBC Act) within the EA Boundary



Map Legend

- EA Boundary
- Mt Arthur North Disturbance Boundary
- South Pit Extension Disturbance Boundary
- Bayswater No. 3 Disturbance Boundary
- Mt Arthur Underground Disturbance Boundary
- Mine Extension Areas
- Edderton Road realignment Option 1
- Edderton Road realignment Option 2
- Rail loading conveyor

Vegetation Communities

Note: All TSC Act listed vegetation are variants of Box Gum Woodland

- Upper Hunter White Box - Ironbark Grassy Woodland
- White Box - Ironbark Derived Grassland
- Blakely's Red Gum Woodland
- Hunter Floodplain Red Gum Woodland
- Mount Arthur Forest Complex

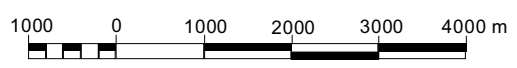


Figure 3.3 Location and Extent of EEC, Box Gum Woodland (TSC Act) within the EA Boundary

3.4 Threatened Flora of the EA Boundary

An analysis of the likelihood that threatened species that are known from, or predicted for the locality could occur in the EA Boundary and thus be impacted by the Project has been completed and is presented as a table in **Appendix D**. This table shows all records of TSC Act listed threatened flora species recorded from the Muswellbrook LGA²⁸ and all EPBC Act listed species predicted to occur based on availability of habitat in the Muswellbrook LGA³¹.

A number of threatened flora species recorded in the EA Boundary during previous studies and the current assessment survey include *Bothriochloa biloba*, *Cymbidium canaliculatum*, *Acacia pendula* and *Diuris tricolor*. These are discussed below and shown on **Figure 3.4**.

i. *Bothriochloa biloba*

Bothriochloa biloba (Lobed Blue Grass), declared Vulnerable under the EPBC Act, was recorded in the EA Boundary during the 2008-09 surveys by Cumberland Ecology. *Bothriochloa biloba* was previously listed as Vulnerable under the TSC Act but has since been removed from the State listing. This species was recorded in two areas: at the southern extent of Mine Extension Area 5 and on Macleans Hill (Mine Extension Area 2). *Bothriochloa biloba* was also recorded during surveys for the MAU at three locations within the EA Boundary (see **Figure 3.4**).

ii. *Cymbidium canaliculatum*

Cymbidium canaliculatum (Tiger Orchid), an endangered population within the Hunter Catchment listed in Part 2 of Schedule 1 of the TSC Act, is known to occur within the EA Boundary. A single individual was recorded during surveys for the MAU along Saddlers Creek. Cumberland Ecology recorded two individuals; one was located in a tree along a small tributary of Saddlers Creek in the southern portion of Mine Extension Area 5. The other was also located in Mine Extension Area 5 growing on a large log within Central Hunter Bullock Forest Regeneration. Subsequent revisions to the Mine Extension Area 5 boundary now places the latter individual just outside the impact area (**Figure 3.4**).

iii. *Acacia pendula*

Acacia pendula (Weeping Myall) is an endangered population in the Hunter Catchment and is listed under the TSC Act. It was recorded in two locations during the MAU Project⁵² (**Figure 3.4**). However, subsequent surveys have not relocated any records nor identified any additional individuals.

iv. *Diuris tricolor*

Diuris tricolor (Painted Diuris) is listed as an endangered population in the Muswellbrook LGA under the TSC Act and as vulnerable under the EPBC Act. The continued presence of a population of the Painted Diuris (also known as the Pine Donkey Orchid) has been confirmed by Cumberland Ecology. This population was found occurring within Upper Hunter White Box – Ironbark Grassy Woodland near the Mt Arthur Coal Access Road (**Figure 3.4**).

v. *Eucalyptus camaldulensis*

Eucalyptus camaldulensis (River Red Gum) is listed as an endangered population in the Hunter Catchment under the TSC Act. This population was recorded along one of the minor tributaries of Saddlers Creek in 1993⁴³. However, no point data was available to locate the records on a map. Subsequent surveys of Saddlers Creek and its tributaries have not relocated any records nor identified any individual *Eucalyptus camaldulensis*.

The locations of threatened flora that have previously been recorded in the EA Boundary are shown in **Figure 3.4**, where sufficient information was provided to allow accurate mapping.

3.5 Threatened Fauna of the EA Boundary

3.5.1 Fauna Habitat

The EA Boundary has been comprehensively surveyed over previous studies for fauna species in a number of habitat types that include the following:

- Remnant woodland;
- Remnant open forest;
- Wetland;
- Riparian vegetation associated with Saddlers Creek and minor tributaries; and
- Grassland (derived native, exotic and rehabilitation).

Remnant woodland and open forest areas within the EA Boundary are areas of native vegetation that existed prior to the commencement of mining. These areas represent patches of mature vegetation that are less than 100 years old and have previously subjected to cattle grazing, which were removed in 2003. Wetland areas can include artificial or man-made wetlands such as dams.

The characteristic attributes of each habitat type generally influences the assemblage of fauna species that can be found within each habitat and also affects the general value of the habitat for fauna.

i. Remnant Forest and Woodland

There are approximately 980 ha of remnant woodland and forest across the EA Boundary of varying condition, structural complexity, density and patch size. Many of these areas contain mature-growth eucalypts over regenerating trees and a diversity of shrub species. A reasonable proportion of the mature trees contain hollows, which range in size from small (26 to 50 mm) to large (100 to 300 mm). The understorey often contains a grassy ground layer that includes dead and fallen logs and rocks. Thus, the habitat presented by these areas provides:

- Roosting and nesting habitat for small woodland birds and some bat species in terms of mature trees and a canopy cover;
- Hollows for roosting and nesting for small bats, small arboreal mammals, woodland and forest birds, and larger birds of prey like the Masked Owl;
- Refugia for ground-dwelling mammals, small bats and small birds;
- Sheltering sites for reptiles and amphibians; and
- Foraging resources; such as a shrub layer for foraging birds and mammals and seasonal flowering resources for nectarivorous birds and bats.

The best examples of this vegetation within the EA Boundary were observed on the upper and lower slopes of Mount Arthur and on Macleans Hill.

ii. Wetland

Wetland habitats are present in the form of farm and mine dams, particularly where fringing vegetation is present. The EA Boundary contains a number of dams, which provide habitat for amphibians and a source of water for native fauna.

iii. Riparian Vegetation

The riparian vegetation present within the EA Boundary is largely associated with Saddlers Creek and its tributaries. Whilst most areas contained a fairly weedy understorey, this vegetation still represents reasonably valuable habitat as it contains mature trees with hollows, a grassy understorey and fallen timber and rocks. Thus it provides seasonal flowering resources, foraging habitat and roosting and nesting habitat for small arboreal mammals and birds. Other habitat values of the riparian vegetation within the EA Boundary include drinking resources for fauna and corridor values.

iv. Grassland

The grassland vegetation is the most widespread habitat in the EA Boundary, totalling approximately 6,820 ha, including derived native grassland, rehabilitated areas and other exotic grassland. Much of these open areas provide foraging habitat for macropods like the Eastern Grey Kangaroo (*Macropus giganteus*) but can also provide habitat for small mammals in areas with a dense grass layer, and reptiles where there is microhabitat available under fallen timber and rocks. Large open areas also represent hunting resources for raptors, owls and some bat species.

3.5.2 General Fauna

A total of 181 fauna species have been recorded within the EA Boundary. This is a cumulative result of a series of surveys conducted since 2000^{7,8,47-53}. Fifteen of these species are listed under environmental legislation. Of these, 13 species are declared threatened under the TSC Act (one of these species is also listed under the EPBC Act) and a further two are listed as Migratory under the EPBC Act. A full list is provided within **Appendix B**. Below is a summary of the fauna of the EA Boundary.

i. Amphibians

A total of nine amphibian species have been detected across the EA Boundary during previous surveys. The most common frog species recorded were the Common Eastern Froglet (*Crinia signifera*) and Spotted Grass Frog (*Limnodynastes tasmaniensis*).

ii. Birds

A total of 108 bird species have been detected across the EA Boundary during previous surveys. Of these species, seven are threatened (two under the EPBC Act and five under the TSC Act). The most frequently recorded species included a suite of woodland birds like the Brown Thornbill (*Acanthiza pusilla*), Weebill (*Smicromis brevirostris*), Grey Fantail (*Rhipidura albiscapa*) and Superb Fairywren (*Malurus cyaneus*). Other species consistently recorded included common urban birds such as Australian Raven (*Corvus coronoides*), Australian Magpie (*Gymnorhina tibicen*) and Pied Currawong (*Strepera graculina*).

iii. Mammals

There have been 44 mammal species recorded across the EA Boundary within previous surveys. Eight of these species are listed as threatened under the TSC Act, with one species, the Large-eared Pied Bat (*Chalinobus dwyeri*) also listed under the EPBC Act. Most of the threatened mammals recorded are microchiropteran bats; in particular, the Eastern Bentwing Bat, which was consistently recorded throughout all the previous years of survey. Non-threatened species that were commonly recorded include feral species

European Red Fox (*Vulpes vulpes*) and Rabbit (*Oryctolagus cuniculus*), macropods Eastern Grey Kangaroo, Swamp Wallaby (*Wallabia bicolor*), Red-necked Wallaby (*Macropus rufogriseus*); and a suite of bat species including White-striped Freetail-bat (*Tadarida australis*), Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*C. morio*) and Little Forest Bat (*Vespadelus vulturnus*). The Common Brushtail Possum (*Trichosurus vulpecula*) and Common Wombat (*Vombatus ursinus*) were also consistently recorded, with the latter species observed around dens along Saddlers Creek and its tributaries. All of the mammalian species mentioned are well represented within the Muswellbrook LGA.

iv. Reptiles

A total of 20 reptile species have been recorded across the EA Boundary within previous surveys. None of these species observed are listed as threatened under legislation. Commonly recorded species include Lace Monitor (*Varanus varius*) in woodland areas, Tree Skink (*Egernia striolata*) and Southern Rainbow-skink (*Carlia tetradactyla*).

3.5.3 Threatened Species

Thirteen TSC Act listed threatened fauna species have been recorded within the EA Boundary in previous surveys and include five bird species, two non-flying mammal species and six microchiropteran bat species. Of these, Large-eared Pied Bat (*Chalinolobus dwyeri*) is also listed under the EPBC Act. An additional two species, White-throated Needletail (*Hirundapus caudacutus*) and Rainbow Bee-eater (*Merops ornatus*), are not listed under the TSC Act but are declared Migratory species under the EPBC Act and would use the site periodically.

The results of the fauna surveys conducted over the EA Boundary show that threatened fauna were generally restricted to areas of remnant vegetation. No threatened species were recorded in grassland habitat in open pastures. The locations of threatened fauna species that have previously been recorded in the EA Boundary are shown in **Figure 3.4**, where sufficient information was provided to allow accurate mapping.

The paragraphs below provide descriptions of the threatened species that were recorded in the EA Boundary, a brief summary of their preferred habitats and where they were recorded within the EA Boundary. There are a number of other threatened species that could potentially occur within the EA Boundary, including Masked Owl (*Tyto novaehollandiae*), Black-chinned Honeyeater (*Melithreptus gularis gularis*) and Brown Treecreeper (*Climacteris picumnus victoriae*). These species are also described similarly in the following paragraphs, which also discusses their potential occurrence within the EA Boundary.

i. *White-throated Needletail (Hirundapus caudacutus)*

Status: Marine - Migratory (EPBC Act)

The White-throated Needletail (*Hirundapus caudacutus*) is a large, insectivorous, tree-roosting swift. It is widespread across south eastern Australia during its non-breeding season and spends its time almost exclusively in the air, seldomly alighting on the ground or on a vertical substrate to catch insects³².

The species occurs over a range of habitats but seems to prefer foraging over open forests and rainforests rather than above woodland, grassland or swamps. The species has been recorded roosting in trees in forests and woodland, either amongst dense foliage in the canopy or in hollows^{6,9,45}. Within the EA Boundary, the species has been detected during dawn census over Spotted Gum Forest on the north eastern slopes of Mount Arthur⁷. The species was also detected opportunistically during surveys for the South Pit Extension, although the precise location of this record is not available⁵⁰.

ii. *Rainbow Bee-eater (Merops ornatus)*

Status: Marine - Migratory (EPBC Act)

The Rainbow Bee-eater (*Merops ornatus*) is a medium-sized bird and the only species of bee-eater in Australia. It is largely insectivorous but will take other small animals like earthworms, usually foraging from open perches. The Rainbow Bee-eater occurs mainly in open forests and woodlands in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water. However, the species can occur in a range of habitats including grasslands, cleared and semi-cleared habitats and in towns and suburbs and around homesteads. The species is also commonly recorded in other disturbed habitats including roadside vegetation and in quarries, mines or gravel pits, where they often breed^{38,39}. On migration, the Rainbow Bee-eater may also fly over the top of non-preferred habitats such as rainforest or treeless plains³³.

The Rainbow Bee-eater was identified in a small and relatively isolated patch of Spotted Gum Forest along a drainage line east of Mount Arthur during surveys for the South Pit Extension although the precise location is not available.

iii. *Speckled Warbler (Pyrrholaemus saggitata)*

Status: Vulnerable (TSC Act)

The Speckled Warbler (*Pyrrholaemus saggitata*) is a small, wren-like ground-dwelling bird. The species lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. As foraging primarily occurs on the ground for seeds and insects around tussocks and under shrubs and trees, important habitat includes scattered native tussock grasses, a sparse shrub layer, some eucalypt

regrowth and an open canopy¹⁵. Large, relatively undisturbed remnants are required for the species to persist in an area, although records in the Hunter Valley region indicate that this species can persist on the fringes of intact patches of remnant vegetation²⁸.

The Speckled Warbler was recorded in a number of studies of the EA Boundary, primarily in the north/north-east sections of the EA Boundary, in the woodland and open forests on Macleans Hill and near the Mt Arthur Coal Access Road (precise location not available). One record was obtained in the Central Hunter Bullock Forest Regeneration during the MAU study and another at the western-most limits of the MAU disturbance boundary, also during the 2006 surveys for the recently approved MAU Project. It has been consistently recorded over a number of years during surveys for the flora and fauna monitoring program and its habitat will be retained near the Mt Arthur Coal Access Road.

iv. *Diamond Firetail (Stagonopleura guttata)*

Status: Vulnerable (TSC Act)

The Diamond Firetail (*Stagonopleura guttata*) is a finch with a bright red bill, red eyes and a red tail. It is widely distributed in NSW; records in Muswellbrook LGA are few but concentrated in Wollemi National Park. The species commonly occurs on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland and nests in tree hollows, logs or posts from August to December. It is often observed foraging in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter and is tolerant of disturbance¹².

The Diamond Firetail was only recorded once during the MAN EIS study. It was largely confined to the dense shrub layers fringing White's Creek in the central portions of what is now MAN open cut pit⁸. However, the Diamond Firetail was also recorded at Drayton Mine located to the east of the EA Boundary.

v. *Hooded Robin (Melanodryas cucullata cucullata)*

Status: Vulnerable (TSC Act)

The Hooded Robin (*Melanodryas cucullata cucullata*) is a large, mostly sedentary robin. The species prefers open eucalypt woodlands that are structurally diverse, comprising mature trees, saplings and shrubs and moderately tall grasses in the groundcover, often at the edges of clearings and grassland. They forage by perching on fallen timber and low-lying branches, pouncing on insect prey. The species breeds between July and November, building nests in tree forks or crevices at heights between one – five metres²¹. The MAN EIS identified the Hooded Robin within the EA Boundary, which was not listed as threatened at the time of the study. Precise locations of this species are not available.

vi. *Grey-crowned Babbler (Pomatostomus temporalis temporalis)*

Status: Vulnerable (TSC Act)

The Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) is the largest of the four Australian babblers, reaching up to 30 cm long. The species inhabits open Box Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. The species are generally unable to cross large open areas. Flight is laboured and the species prefers to hop to the top of a tree and glide down to the next one, foraging for insects on trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses¹⁹.

The species breeds between July and February. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts¹⁹.

This species is known from a few records in the Muswellbrook LGA. It has been detected within the EA Boundary in a number of previous studies and appears to predominantly occur along Saddlers Creek and its tributaries. A nest was also observed during the MAU study along the upper reaches of Saddlers Creek.

vii. *Brown Treecreeper (Climacteris picumnus victoriae)*

Status: Vulnerable (TSC Act)

The Brown Treecreeper (*Climacteris picumnus victoriae*) is Australia's largest treecreeper and is commonly found in Box Gum Woodland. Generally, the species is found in open woodlands and dry open forests dominated by stringybarks or other rough-barked eucalypts. Other habitat characteristics in which this species occurs includes an open grassy understorey, sometimes with one or more shrub species but not a dense shrub understorey. The species can also be found in mallee and *Eucalyptus camaldulensis* (River Red Gum) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. As the Brown Treecreeper is a sedentary species that spends much of its time on the ground foraging, fallen timber is an important habitat component, as well as hollows in standing dead or live trees and tree stumps, which it requires for nesting¹⁸. Although suitable habitat is present, no individuals were recorded within the EA Boundary during previous surveys.

viii. *Black-chinned Honeyeater (Melithreptus gularis gularis)*

Status: Vulnerable (TSC Act)

The Black-chinned Honeyeater (*Melithreptus gularis gularis*) is a large, widespread honeyeater. It occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially *Eucalyptus sideroxylon* (Mugga Ironbark),

Eucalyptus albens (White Box), *Eucalyptus microcarpa* (Grey Box), *Eucalyptus melliodora* (Yellow Box) and *Eucalyptus tereticornis* (Forest Red Gum). However, it can also be found in open forests of smooth-barked eucalypts like Spotted Gum Forest. It forages among the canopy, feeding on nectar and honeydew. Nests are commonly suspended from the upper branches, high up in the crown of the canopy¹¹. The Black-chinned Honeyeater has not been detected in the EA Boundary in previous studies although suitable roosting and foraging habitat does exist.

ix. *Turquoise Parrot (Neophema pulchella)*

Status: Vulnerable (TSC Act)

The Turquoise Parrot (*Neophema pulchella*) is a distinctive parrot that occurs on the edges of eucalypt woodlands that adjoin clearings, timbered ridges and creeks in farmland. The species prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. The species relies on tree hollows, logs or posts for nesting and breeding occurs from August to December.

The Turquoise Parrot was recorded tentatively during surveys for the Bayswater No. 3 EIS⁴³ but precise locations are not available for this species. There are 48 known records for this species in the Muswellbrook LGA but most of these records are concentrated in Wollemi National Park²⁸. Nevertheless, there is suitable habitat available for this species in the EA Boundary around Mount Arthur and Saddlers Creek.

x. *Masked Owl (Tyto novaehollandiae)*

Status: Vulnerable (TSC Act)

The Masked Owl (*Tyto novaehollandiae*) is a large forest owl that inhabits dry eucalypt forests and woodlands where they forage for small arboreal and terrestrial mammals, particularly rats. The Masked Owl will also forage at the margins of forests. The species relies on large hollows in moist eucalypt forest gullies, or in some cases, caves, for breeding and roosting. Breeding pairs have a large home range of about 500-1000 hectares¹⁴. The Masked Owl has not been detected in the EA Boundary in previous studies although suitable roosting and foraging habitat does exist.

xi. *Spotted-tailed Quoll (Dasyurus maculatus maculatus)*

Status: Endangered (EPBC Act); Vulnerable (TSC Act)

The Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) is about the size of a domestic cat and has been recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest. This is a nocturnal species with a large home range; females occupy home ranges up to about 750 ha and males up to

3500 ha and they usually traverse their ranges along densely vegetated creeklines²⁶. There are 25 records for the Spotted-tailed Quoll within the Muswellbrook LGA but no individuals have been detected in current or previous surveys of the EA Boundary.

xii. *Parma Wallaby (Macropus parma)*

Status: Vulnerable (TSC Act)

The Parma Wallaby (*Macropus parma*) inhabits a range of habitats from moist sclerophyll forest with a thick, shrubby understorey to rainforest margins and occasionally drier eucalypt forest. They prefer habitat near grassy, open areas where they forage at night, retreating to dense shrubby cover during the day²⁰.

The Parma Wallaby was identified tentatively from hairs found in predator scats (*Vulpes vulpes*), obtained during the MAN EIS study. The precise location is not known; however, the scats were taken from Spotted Gum Open Forest, presumably near the steep slopes of Mount Arthur, where there is suitable habitat for Parma Wallaby⁸. Records in the locality include one record 60 km north-east of Muswellbrook in the Barrington Tops National Park, and one record approximately 60 km south-west of the EA Boundary in Wollemi National Park²⁸. Dames and Moore (2000)⁸ discuss the possibility that the hairs recovered from the scats belong to Red-necked Wallaby (*Macropus rufogriseus*), which are known to occur in large numbers on Mount Arthur. No other surveys since the Dames and Moore (2000) survey have detected any evidence of the presence of this species. Based on the information above, it is likely that the Parma Wallaby does not occur in the EA Boundary.

xiii. *Koala (Phascolarctos cinereus)*

Status: Vulnerable (TSC Act)

The Koala (*Phascolarctos cinereus*) is a solitary, arboreal marsupial with a fragmented distribution throughout eastern Australia, from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the western region.

Koala habitat includes eucalypt woodlands and forests. The species feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. The home range size varies with quality of habitat, ranging from less than two hectares to several hundred hectares in size.

The Koala spends most of its time in trees and is inactive for most of the day, feeding and moving mostly at night. However, it will descend and traverse open ground to move between trees. It has long, sharp claws that are adapted for climbing. Adult males weigh six to 12 kilograms and adult females weigh five to eight kilograms. Females breed at two years of age and produce one young per year. During breeding, males advertise with loud snarling coughs and bellows²⁷.

No Koala individuals have been recorded within the EA Boundary and no evidence of active use by individuals or a breeding population have been detected.

xiv. *Squirrel Glider (Petaurus norfolcensis)*

Status: Vulnerable (TSC Act)

The Squirrel Glider (*Petaurus norfolcensis*) inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. They live in family groups and nest in tree hollows and prefer eucalypt stands with a shrubby or an *Acacia* midstorey¹⁶.

The Squirrel Glider is known from 21 records in the Muswellbrook LGA and was recorded in the EA Boundary in previous surveys, primarily at Saddlers Creek and on the north western slopes of Mount Arthur where nest boxes were established as part of an ongoing fauna monitoring program at Mt Arthur Coal. However, the South Pit Extension study (Umwelt 2006)⁵⁰ identified Squirrel Gliders along Saddlers Creek independently of nest boxes and records were also obtained at the south western extent of the EA Boundary during the Underground study⁵². Thus, it is not likely that the species is restricted to Saddlers Creek and the slopes of Mount Arthur.

xv. *Yellow-bellied Sheathtail Bat (Saccolaimus flaviventris)*

Status: Vulnerable (TSC Act)

The Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) is a wide-ranging, tree hollow-roosting, insectivorous species that primarily forages above the tree canopy¹⁷. Most records in NSW have been obtained between January and May, leading to speculation that the species may be migratory in the southern portion of its range⁴¹, although very little is currently known about seasonal movements. The species occurs in many habitats, from sclerophyll forests to open woodland⁵.

This species is known from a few records in the Hunter Valley region and is considered to be a 'relatively rare' species nationally⁸. This species was detected using echolocation recording during the MAN EIS study, where it was recorded foraging over Spotted Gum open forest remnants associated with the north eastern slopes of Mount Arthur. The species was also detected during the MAN EIS study foraging over remnant woodland and open forest in the northern and eastern sections of the EA Boundary where the MAN operations are now located but was not detected in open pastures or small areas of riparian vegetation remnants⁸.

Although not detected in subsequent surveys, suitable habitat is still available over Spotted Gum open forest around the slopes of Mount Arthur.

xvi. *Large-eared Pied Bat (Chalinolobus dwyeri)*

Status: Vulnerable (EPBC Act; TSC Act)

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is found mainly in areas with extensive cliffs and caves. The species generally roosts at cave entrances, in cliff crevices and old mine workings. It commonly frequents low to mid-elevation dry open forest and woodland close to these features, particularly areas containing gullies²⁵.

The species is largely concentrated in, but not confined to Wollemi National Park. It has been recorded on one occasion by echolocation recording in 2006 across three sites that include Macleans Hill, the north western slopes of Mount Arthur and the north eastern slopes of Mount Arthur⁵¹.

xvii. *Eastern Freetail Bat (Mormopterus norfolkensis)*

Status: Vulnerable (TSC Act)

The Eastern Freetail Bat (*Mormopterus norfolkensis*) is a solitary, insectivorous bat that inhabits dry sclerophyll forests and roosts in tree hollows and sometimes under bark or in man-made structures.

This species is known from a few records in the Muswellbrook LGA and was recorded in the EA Boundary during the MAU study in 2007⁵² in vegetation along the southern portion of Edderton Road; and during fauna monitoring in 2005 and 2006, in riparian vegetation along the Saddlers Creek tributary near the Bayswater No. 3 operations area, south of Mount Arthur^{49,51}.

xviii. *Eastern Bentwing Bat (Miniopterus schreibersii oceanensis)*

Status: Vulnerable (TSC Act)

The Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) is an insectivorous, cave-roosting species but can also roost in man-made structures such as old mines and storm-water tunnels. However, it requires very specific conditions in terms of temperature and humidity for maternity sites. The species occurs in large colonies of up to 150,000 individuals and forages above the canopy over forested areas for insects²².

This species is well recorded in Muswellbrook LGA and has been consistently detected in the EA Boundary in previous surveys, primarily around Macleans Hill, Saddlers Creek and Mount Arthur.

xix. *Large-footed Myotis (Myotis macropus)*

Status: Vulnerable (TSC Act)

This is a large cave-dwelling bat that was formerly known as *Myotis adversus*. There are only six published records of the Large-footed Myotis for Muswellbrook LGA and these are all located within the EA Boundary²⁸. This is a species that has been consistently recorded within the EA Boundary during previous surveys in remnant vegetation and along creeklines. It generally roosts in groups of 10 - 15 in caves, mine shafts, hollow-bearing trees, storm-water channels, buildings, under bridges and in dense foliage²³. The primary force driving roost selection is the proximity of suitable day-roost sites to suitable waterways; thus, roosting sites are often close to water as the species forages over streams and pools catching insects and small fish by raking their feet across the water surface⁴.

xx. *Greater Broad-nosed Bat (Scoteanax ruepellii)*

Status: Vulnerable (TSC Act)

The Greater Broad-nosed Bat (*Scoteanax ruepellii*) is a large bat that occurs in a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. This species mainly roosts in tree hollows but it can also be found in buildings. The Greater Broad-nosed Bat flies slowly and directly along creek and river corridors in open woodland habitat and dry open forest at low altitudes of up to six metres, foraging for beetles and other large, slow-flying insects after sunset¹³. This species was detected during the MAU surveys in close proximity to the western boundary of the EA Boundary.

xxi. *Eastern Cave Bat (Vespadelus trougtoni)*

Status: Vulnerable (TSC Act)

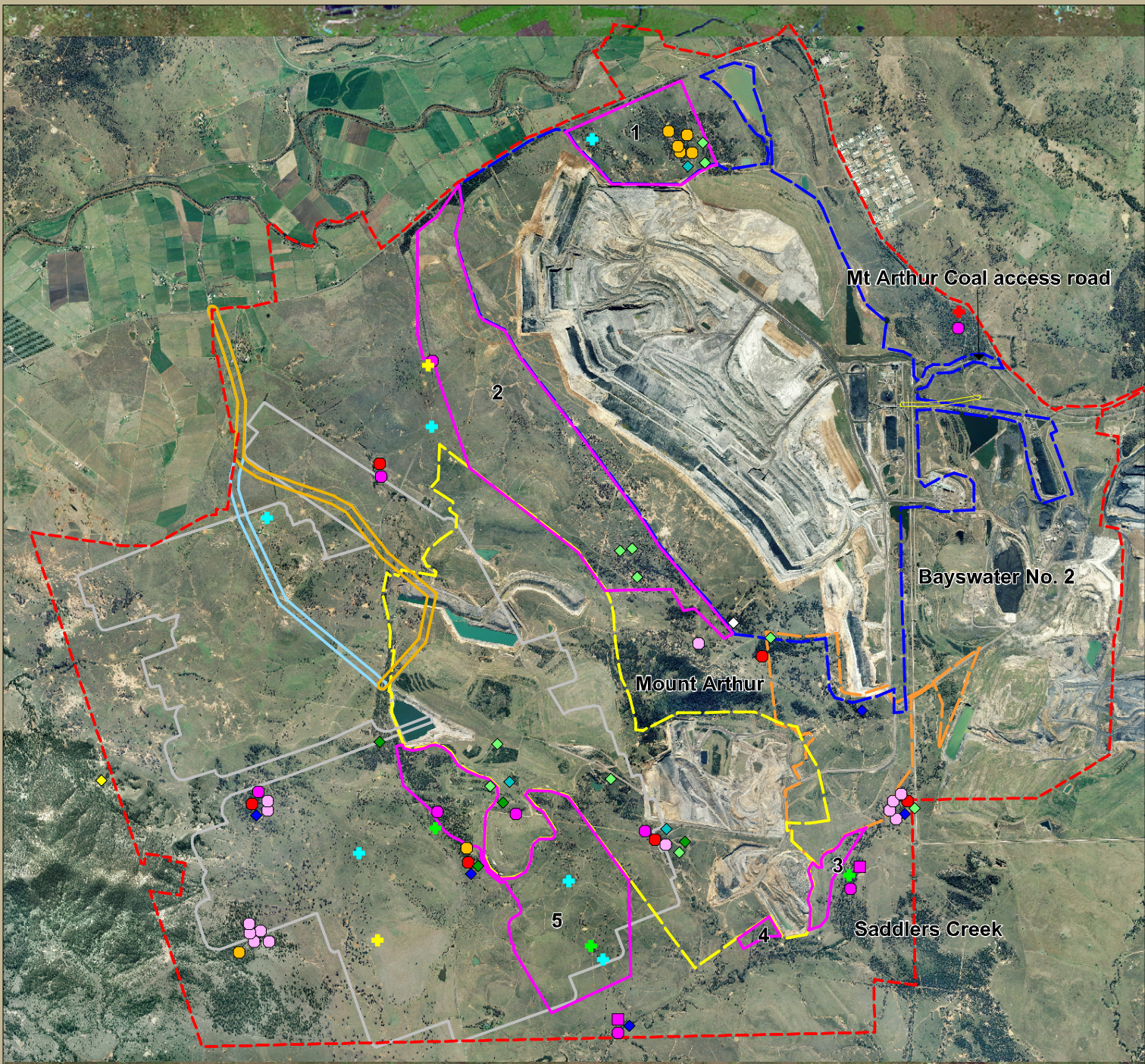
The Eastern Cave Bat (*Vespadelus trougtoni*) is a cave-roosting species that is usually found in dry open forest and woodland, and generally roosts near cave entrances in moderately well-lit areas or in crevices of cliffs and overhangs. It has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals^{5,24}.

The species was recorded in the EA Boundary on the eastern slopes of Mount Arthur in Spotted Gum Forest during surveys for the South Pit Extension. It was recorded again in this location during surveys for the Underground Project and also in additional areas including vegetation along Saddlers Creek.

An analysis of the likelihood that threatened species that are known from, or predicted for the locality could occur in the EA Boundary and thus be impacted by the Project is presented within **Appendix D**. This table shows all records of TSC Act listed threatened

fauna species recorded from the Muswellbrook LGA ²⁸ and all EPBC Act listed species predicted to occur in the Muswellbrook LGA based on availability of habitat in the LGA ³¹.

The locations of threatened fauna are also shown on **Figure 3.4** below, where there has been sufficient information to map precise locations.



Map Legend

- EA Boundary
- South Pit Extension Disturbance Boundary
- Bayswater No. 3 Disturbance Boundary
- Mt Arthur North Disturbance Boundary
- Mt Arthur Underground Disturbance Boundary
- Mine Extension Areas
- Edderton Road realignment Option 1
- Edderton Road realignment Option 2
- Rail loading conveyor

Fauna

- Speckled Warbler
- ▲ Squirrel Glider (remains)
- Large-footed Myotis
- Grey-crowned Babbler
- Grey-crowned Babbler Nest
- ◆ Eastern bent-wing bat
- ◆ Eastern cave bat
- Squirrel Glider
- ◆ Eastern freetail-bat
- ◆ Southern forest bat
- ◇ Large-eared pied bat
- ◆ Greater broad-nosed bat

Flora

- + Cymbidium canaliculatum
- + Diuris tricolor
- + Bothriochloa biloba
- + Acacia pendula



Figure 3.4 Threatened Flora and Fauna Species Recorded in the EA Boundary (Current and Previous Records)

Impact Assessment

4.1 Introduction

The impacts of the Project can be divided into direct and indirect impacts which will occur during varying stages of the Project. The direct impacts entail the impacts of vegetation clearance and are discussed in Section 4.2 and Section 4.3 below. Those sections also discuss the impacts of the Project upon endangered ecological communities and streams and wetlands. The indirect impacts include potential impacts such as edge effects, severance of wildlife corridors and weed invasion. Indirect impacts are discussed in Section 4.4. The Project will have impacts upon a range of threatened species, and the impacts on threatened species are covered in Section 4.5.

4.2 Direct Impacts

4.2.1 Vegetation Clearance

Table 4.1 summarises the extent of clearing that is proposed for the Project Disturbance Areas. The Project will result in the clearance of a range of forest, woodland and derived grassland areas. The Project will be staged such that vegetation clearing will be conducted progressively over the life of the project. Rehabilitation and revegetation work will occur during the life of the Project, which will also progressively restore grassland and tree cover on mined land during the course of the Project.

In total, approximately 240 ha of forest and woodland vegetation, occurring as scattered patches of remnant woodland and forest, will be cleared over the life of the Project. When all forms of native grassland are considered, approximately 750 ha of native derived grassland will be removed.

Approximately 116 ha of TSC Act listed Box Gum Woodland (i.e. Upper Hunter White Box - Ironbark Grassy Woodland) and 700 ha of TSC Act listed Box Gum Woodland-Derived Grassland will be removed as part of the Project, of which the largest continuous areas are 66.45 ha and 307.82 ha respectively. No EPBC Act listed communities will be disturbed as a result of the Project.

All of the woodland areas to be cleared consist largely of trees that have regrown since European settlement. As such, a high proportion of the woodland to be removed consists of relatively young trees. Notwithstanding that, tree hollows occur and are most abundant in the Upper Hunter White Box Ironbark Grassy Woodland and in the Narrabeen Foothills Slaty Gum Woodland.

The major blocks of woodland habitat that are proposed for disturbance are in the southern parts of Mine Extension Areas 1 and 2, and the northern part of Mine Extension Area 5. The loss of such habitat will to a degree, reduce connectivity across the landscape by removing blocks of woodland that would serve as “stepping stones” for mobile animals moving between woodland patches. However, the Project will not remove any major wildlife corridors.

4.2.2 *Impact upon Streams and Wetlands*

The threatened species Schedules of the FM Act comprise lists of endangered species, populations and ecological communities, vulnerable species, species presumed extinct and key threatening processes. These Schedules indicate that the Hunter River drainage basin is outside the known distribution of species, populations and ecological communities listed under this legislation. Therefore, no listed species, populations or ecological communities are expected to occur in the EA Boundary, and none will be impacted by the Project.

Mine Extension Areas 1-5 are essentially dry and no permanent streams or wetlands are likely to be impacted by the Project. A dry, ephemeral stream is located in the gully of Area 2, and another in the southern portion of Area 5. These were dry at the time of the flora and fauna assessments and do not support any permanent riparian or aquatic habitats.

Table 4.1 SUMMARY OF IMPACTS OF PROJECT UPON VEGETATION COMMUNITIES

Vegetation Community	Status*	Project Disturbance Areas					Total Vegetation Impacted by the Project	Vegetation Remaining within EA Boundary	
		Total Vegetation within EA Boundary^A	Mine Extension Areas			Edderton Rd Realignment Option 2			Rail Load Out Conveyor
			1	2	3				
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	E ^c	0				0	0		
Mount Arthur Forest Complex	E ^{a, b}	132.69				0	132.69		
Spotted Gum Forest		4.90	0.90				0.90	4.00	
Blakely's Red Gum Woodland	E ^{a, b}	2.89				0	2.89		
Central Hunter Box - Ironbark Woodland	E ^c	312.45				2.00		310.45	
Hunter Floodplain Red Gum Woodland	E ^{a, b}	50.47				0	50.47		
Hunter Floodplain Red Gum Woodland - Weedy Understorey		7.04				0.66		6.38	
Narrabeen Footslopes Slaty Gum Woodland	E ^c	26.44	24.21				24.21	2.23	
Upper Hunter Hills Exposed - Ironbark Woodland		49.42	38.20				38.20	11.22	
Upper Hunter White Box - Ironbark Grassy Woodland	E ^b	169.15	33.20	66.45				52.70	
Central Hunter Bullock Forest Regeneration		72.08						13.94	
Total area of native Forest and Woodland		827.53	71.40	91.56	0	2.66	0	586.97	

Table 4.1 SUMMARY OF IMPACTS OF PROJECT UPON VEGETATION COMMUNITIES

Vegetation Community	Status*	Project Disturbance Areas					Total Vegetation Impacted by the Project	Vegetation Remaining within EA Boundary	
		Total Vegetation within EA Boundary^	Mine Extension Areas			Edderton Rd Realignment Option 2			Rail Load Out Conveyor
			1	2	3				
Box - Ironbark Derived Grassland		1612.57				6.10		1606.47	
Slaty Gum Derived Grassland		43.70	43.70					0	
Spotted Gum Derived Grassland		17.25				0	17.25		
White Box - Ironbark Derived Grassland	E ^b	2977.11	50.40	307.82	28.30	8.48	268.15	2277.57	
Total area of native Derived Grassland		4650.63	50.40	351.52	28.30	8.48	268.15	3901.29	
Exotic Grassland		434.37		75.58			10.77	346.19	
Planted Areas		37.48				0	37.48		
GRAND TOTAL		5950.01	121.80	518.66	28.30	8.48	353.86	4871.93	

*E^a = Critically Endangered Ecological Community (EPBC Act); E^b = Endangered Ecological Community (TSC Act), E^c = Preliminary Determination under the TSC Act.

[^]Does not include vegetation that is approved to be cleared under existing Open Cut planning approvals within the Mt Arthur Coal Complex.

4.3 Indirect Impacts

In addition to the direct impacts of the Project (direct loss of habitat due to clearing of native vegetation), there are a number of indirect impacts of the Project on EECs and threatened flora and fauna. These are discussed in **Appendix E** to this report as part of a formal Assessment of Significance. The inclusion of the Assessment of Significance is not legally required in the Part 3A process; however, it provides a useful tool in the assessment of impacts.

Broadly, the indirect impacts of the Project include the fragmentation of existing remnant vegetation, which may increase the degradation of habitat for woodland birds and threatened plants through edge effects, and increase the degree of isolation of individual remnant patches. Clearing of native vegetation can also result in a significant loss of hollow-bearing trees and dead wood, which fauna species may rely on for breeding or roosting. These factors can lead to increased likelihood of localised extinction of flora and fauna.

Edge effects resulting from habitat fragmentation can include increased susceptibility to infection (such as infection of native plants by the fungus *Phytophthora cinnamoni*), weed invasion and feral animal invasion. The Project can facilitate the establishment and invasion of weeds into areas of native vegetation because weeds commonly:

- Spread or transfer to nearby areas of remaining vegetation by machinery and vehicles moving around the mining pit;
- Germinate from soil seed bank through topsoil disturbance; and
- Experience prolific growth through increased access to:
 - Sunlight;
 - Nutrients from runoff due to soil compaction;
 - Reduced competition from native species (many weeds are “pioneer” species, which means they are the first to colonise an area recently disturbed).

Habitat fragmentation and associated edge effects reduce the availability and quality of refugia for native fauna and increase feral access to resources, thus increasing the risk of predation and competition for resources for native fauna.

The indirect impacts of the Project also include isolation effects and decreases in corridor connectivity. The Project cuts across a number of local corridors and will reduce the width of a regional habitat link by half at the northern extent of Mine Extension Area 5. This regional habitat link has already been cut by mining within the approved Bayswater No. 3 mining area. Mobile fauna that move between remnant patches can be vulnerable to

predation if vegetated links are impacted. Sedentary species can be isolated if distances between patches are significantly increased. Changes to drainage lines can affect the integrity, structure and composition of surrounding habitat and thus, have secondary impacts on the fauna and flora that rely on them. Rehabilitation of mines will be designed to re-establish the regional habitat link.

4.4 Impacts upon Threatened Species and Communities

Table 4.2 summarises the potential impacts upon threatened species groups in the absence of mitigation measures proposed for the Project as discussed in Section 5. It focuses upon flora and fauna that are known to occur in the EA Boundary, but also applies to the species discussed in Chapter 3 that, although not verified on site, have potential to occur on site from time to time.

There is no legal requirement to prepare an Assessment of Significance (also called the “Seven-part Test”) when preparing an Environmental Assessment under Part 3A of the EP&A Act. Notwithstanding that, a “Seven-part Test” has been prepared in order to use the test as a risk assessment and determine which threatened flora and fauna within the EA Boundary are most at risk from the Project. This is provided in **Appendix E**. This test has been completed as a composite test and examines endangered ecological communities, endangered populations and threatened species that are known to occur within the EA Boundary and which are known to occur in one or more of the proposed Mine Extension Areas.

The Seven-part Test indicates that without additional mitigation or compensation measures, the proposed mining of the Mine Extension Areas will have a significant impact upon TSC Act listed Box Gum Woodland and at least some of the aforementioned woodland fauna. The impact on fauna will result as the Project will remove a sizeable amount of woodland habitat (approximately 240 ha), exacerbate the key threatening processes of native vegetation removal and tree hollow loss in a highly cleared landscape and increase the degree of isolation between existing patches of habitat. However, rehabilitation proposed as part of the proposed offset strategy for the Project will focus on re-establishing local and regional habitat links to provide an effective biodiversity corridor for the long term.

Chapter 5 presents a summary of the existing mitigation and compensation measures, together with a summary of what is proposed to compensate for the Mine Disturbance Areas proposed as part of the Project.

Table 4.2 SUMMARY OF IMPACTS TO THREATENED FLORA AND FAUNA THAT IS KNOWN FROM, OR HAS POTENTIAL TO OCCUR IN THE EA BOUNDARY (IN THE ABSENCE OF OFFSET STRATEGIES)

Scientific Name	Common Name	Impact Area (ha)	Potential Impact Without Mitigation
Endangered Ecological Communities:			
White Box-Yellow Box-Blakely's Red Gum grassy woodlands and derived native grasslands	EPBC Act listed Box Gum Woodland	0	Not to be cleared. No significant impact.
White Box Yellow Box Blakely's Red Gum Woodland	TSC Act listed Box Gum Woodland	116	Significant net loss of habitat.
White Box Yellow Box Blakely's Red Gum Woodland	TSC Act listed Derived Native Grassland	700	Significant net loss of habitat.
Threatened Flora :			
<i>Acacia pendula</i>	Acacia pendula population in the Hunter catchment	0	Not to be cleared. No significant impact.

Table 4.2 SUMMARY OF IMPACTS TO THREATENED FLORA AND FAUNA THAT IS KNOWN FROM, OR HAS POTENTIAL TO OCCUR IN THE EA BOUNDARY (IN THE ABSENCE OF OFFSET STRATEGIES)

Scientific Name	Common Name	Impact Area (ha)	Potential Impact Without Mitigation
<i>Cymbidium canaliculatum</i>	Cymbidium canaliculatum in the Hunter Catchment	75.39	One individual located in Mine Extension Area 5. A second individual recorded just outside the Mine Extension Area boundary. They are at risk of direct clearance or direct disturbance (from machinery accessing the Extension Area or overburden being placed on top of them) and from indirect impacts due to increased weed invasion. The other potential impact will be due to the clearance of woodland areas within this Mine Extension Area as canopy trees and sizable fallen logs can provide habitat for this epiphytic orchid species. Significant loss of habitat as only one other individual has been recorded within the EA Boundary.
<i>Diuris tricolor</i>	Diuris tricolor Fitzg., the Pine Donkey Orchid, in the Muswellbrook LGA	0	Not to be cleared. No significant impact. Including this area as an offset will increase protection of this species.
<i>Bothriochloa biloba</i>	Lobed Blue-grass	318.55	Has been recorded within Mine Extension Areas 1 and 5. The potential impacts will be in the clearance of native grassland areas within these Mine Extension Areas as they provide suitable habitat for this species. However, it is well represented in the locality and has been recorded in three additional areas within the EA Boundary.

Table 4.2 SUMMARY OF IMPACTS TO THREATENED FLORA AND FAUNA THAT IS KNOWN FROM, OR HAS POTENTIAL TO OCCUR IN THE EA BOUNDARY (IN THE ABSENCE OF OFFSET STRATEGIES)

Scientific Name	Common Name	Impact Area (ha)	Potential Impact Without Mitigation
Threatened Fauna:			
Woodland Birds	e.g. Speckled Warbler, Brown Treecreeper, Diamond Firetail, Hooded Robin, Grey-crowned Babbler, Turquoise Parrot.	240.56	Significant net loss of woodland habitat for foraging and nesting. Some species, such as the Brown Treecreeper, are largely sedentary and may have difficulties migrating. Increased risk of predation from loss of shelter habitat.
	e.g. White-throated Needletail, Rainbow Bee-eater	240.56	Net loss of woodland and forest for foraging habitat. The two migratory species identified in the EA Boundary (White-throated Needletail and Rainbow Bee-eater) are largely nomadic and have been recorded in the locality in low numbers. There have been no significant numbers or clusters of records within the LGA and thus, there is not likely to be significant breeding or foraging habitat for migratory birds within the EA Boundary or in the locality. No significant impact.
Nectarivorous Birds	e.g. Black-chinned Honeyeater (eastern subspecies), Regent Honeyeater	240.56	Significant loss of flowering resources for nectar-feeding birds. There will be a short to medium term effect on flowering resources within the EA Boundary as any regenerated canopy species will need time to reach reproductive maturity.

Table 4.2 SUMMARY OF IMPACTS TO THREATENED FLORA AND FAUNA THAT IS KNOWN FROM, OR HAS POTENTIAL TO OCCUR IN THE EA BOUNDARY (IN THE ABSENCE OF OFFSET STRATEGIES)

Scientific Name	Common Name	Impact Area (ha)	Potential Impact Without Mitigation
Predatory Birds	e.g. Masked Owl	240.56	Loss of woodland and forest as potential foraging habitat. Typically have fairly large foraging ranges but will have local effects on prey resources. Moderate level of impact.
Arboreal Non-flying Fauna	e.g. Squirrel Glider Koala	240.56	Significant loss of woodland and forest habitat. Species like the Squirrel Glider are reasonably mobile but rely on larger areas of connected canopy.
Cave-roosting Microbats	e.g. Large-eared Pied Bat, Eastern Cave Bat, Eastern Bentwing Bat, Large-footed Myotis	240.56	There are currently little roosting opportunities for cave-dwelling microbats on the site. Roost sites for some species detected in the EA Boundary are likely to be on Mount Arthur or Mount Ogilvie nearby. However, there will be significant loss of foraging habitat due to the loss of woodland and forest.
Tree hollow-roosting Microbats	e.g. Yellow-bellied Sheath-tail-bat, Eastern Freetail Bat, Large-footed Myotis, Greater Broad-nosed Bat	240.56	Significant loss of foraging and roosting habitat for tree hollow-dependent microbats. Some species, like the Greater Broad-nosed Bat and the Large-footed Myotis, prefer to forage over water and along creeks (i.e. near riparian vegetation) but still rely on mature forest and woodland for tree hollows. Many of these bat species have a large foraging range but rely on fairly connected patches of vegetation as a movement corridor.

Table 4.2 SUMMARY OF IMPACTS TO THREATENED FLORA AND FAUNA THAT IS KNOWN FROM, OR HAS POTENTIAL TO OCCUR IN THE EA BOUNDARY (IN THE ABSENCE OF OFFSET STRATEGIES)

Scientific Name		Common Name	Impact Area (ha)	Potential Impact Without Mitigation
Terrestrial Fauna		e.g. Spotted-tailed Quoll	240.56	Significant loss woodland and forest for shelter, refuge from predators and foraging resources.

4.4.1 NSW State Environmental Planning Policy (SEPP) 44 – Koala Habitat Protection

The Koala is a threatened species that requires additional planning considerations than other threatened species as it is covered by a State Environmental Planning Policy and because it has an approved recovery plan.

Within NSW legislation, SEPP 44 – Koala Habitat Protection has been prepared to assist in the conservation of the Koala. The aim of SEPP 44 is to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas. Schedule 1 lists the LGAs which area covered by SEPP 44 and Schedule 2 lists the feed tree species for the Koala. The EA Boundary falls within a listed LGA (Muswellbrook). Four of the ten feed species listed in SEPP 44 are located within the EA Boundary. An approved Recovery Plan for the Koala has been prepared by DECC²⁷. Within this plan, management areas have been delineated across NSW. Assessments of Koala habitat have been made according to each of these documents below.

i. Approved Recovery Plan for the Koala (DECC 2008)

Koalas occur in the Muswellbrook LGA but have not been recorded within the EA Boundary. The approved Koala Recovery Plan²⁷ divides NSW into a series of Koala Management Areas and the Upper Hunter Valley has forest and woodland that is intermediate between two of these areas, the Central Coast and the Northern Tablelands.

The Koala Recovery Plan mentions a suite of trees that are primary and secondary feed trees for koalas in each management area. The EA Boundary has forest and woodland vegetation that contains a number of these species and are shown in **Table 4.3**.

Table 4.3 PRIMARY AND SECONDARY KOALA FOOD TREES PRESENT WITHIN THE EA BOUNDARY

Koala Management Area 2: Central Coast	Koala Management Area 4: Northern Tablelands
Primary food tree species: <i>Eucalyptus tereticornis</i> (Forest Red Gum)	Primary food tree species: <i>Eucalyptus tereticornis</i> (Forest Red Gum)
Secondary Food Tree Species: <i>E. conica</i> (Fuzzy Box), <i>E. punctata</i> (Grey Gum), <i>E. moluccana</i> (Grey Box)	Secondary Food Tree Species: <i>E. melliodora</i> (Yellow Box), <i>E. conica</i> (Fuzzy Box), <i>E. albens</i> (White Box), <i>E. blakelyi</i> (Blakely's Red Gum), <i>E. moluccana</i> (Grey Box)

The dominant trees across a high proportion of the woodland and open forest within the EA Boundary include species that are regarded as important secondary browse species for this animal, including *Eucalyptus albens* x *moluccana* (White Box x Grey Box

intergrade). There are also areas that include *E. melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum).

The recovery plan also provides two systems to categorise koala habitat which are both based upon the abundance of primary and secondary food tree species. Within the first category system (Option 1) the EA Boundary is considered as Secondary Habitat (Class B) as the primary food tree species is largely absent. According to this category, the EA Boundary is capable of supporting a viable, low density population of koalas. Within the secondary category system (Option 2), the EA Boundary is considered as Secondary Habitat (Class A) as at least 50% of forested or woodland areas are comprised of secondary food tree species. According to this classification, the EA Boundary is considered capable of supporting a viable high-medium density koala population.

ii. State Environmental Planning Policy No 44 – Koala Habitat Protection

The intent of SEPP 44 is to foster conservation and management of areas of natural vegetation that provide habitat for the Koala (*Phascolarctos cinereus*), to ensure permanent free-living populations over their present range and to reverse the current trend of population decline.

The Project is subject to assessment under SEPP 44 because the land occurs in a LGA listed in Schedule 1 of the policy. All development applications that are in a SEPP 44 LGA and impacting areas one hectare or greater, including adjoining lands on the same holding, are required to be assessed under SEPP 44.

Assessment under SEPP 44 is based on an initial determination of whether the land constitutes potential koala habitat. This is determined by assessing whether the eucalypt species present in Schedule 2 constitutes 15 per cent or more of the total number of trees in the upper or lower strata of the tree component. If potential koala habitat is present, the area must be further assessed to determine if the land is core koala habitat. The species listed in Schedule 2 of the policy are identified in **Table 4.4**.

Table 4.4 SEPP 44 TREE SPECIES

Scientific Name	Common Name
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Eucalyptus microcorys</i>	Tallowwood
<i>Eucalyptus punctata</i>	Grey Gum
<i>Eucalyptus viminalis</i>	Ribbon Gum or Manna Gum
<i>Eucalyptus camaldulensis</i>	River Red Gum
<i>Eucalyptus haemastoma</i>	Broad-leaved Scribbly Gum
<i>Eucalyptus signata</i>	Scribbly Gum
<i>Eucalyptus albens</i>	White Box

Table 4.4 SEPP 44 TREE SPECIES

Scientific Name	Common Name
<i>Eucalyptus populnea</i>	Bimble Box or Poplar Box
<i>Eucalyptus robusta</i>	Swamp Mahogany

Of the trees in Schedule 2 and **Table 4.4**, *Eucalyptus albens x moluccana* (White Box x Grey Box intergrade) is recorded within the EA Boundary in relative abundance. Both White Box and Grey Box are known koala secondary food trees (see **Table 4.3**) and thus it is highly probable that koalas would browse on intergrades of these two tree species. White Box x Grey Box intergrade is likely to comprise 15 per cent of overstorey species within several of the proposed mining areas, particularly Mine Extension Areas 2 and 5. As such this indicates that the EA Boundary contains potential koala habitat.

Given that potential koala habitat occurs in the EA Boundary, the policy requires that it must be determined whether the area forms core koala habitat under the definition of SEPP 44. Core koala habitat is defined under this legislation as; "*an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population*". Targeted searches and area searches for scats failed to identify the koala, or evidence of the species and there is no historical record of the species within the EA Boundary.

It is likely that a resident population of koalas does not occur within the EA Boundary, as no evidence of koala use was observed during field surveys. There are also no historical or anecdotal records of koalas occurring in the EA Boundary, although there are previous records from the local area and region. The area is not considered to be core koala habitat as defined under SEPP 44; hence the preparation of a Koala Plan of Management is not required. SEPP 44 therefore does not place any constraints on the Project.

4.5 Conclusion

Analysis of the impacts of the Project indicates that the proposed Mine Extension Areas 1-5 will have significant impacts upon Box Gum Woodland, as defined by the TSC Act, and upon a suite of threatened woodland birds and mammals, without appropriate mitigation measures and provision of compensatory habitat. Chapter 5 outlines the proposed mitigation and compensation package that has been proposed to ensure the project will maintain or improve biodiversity values in the local area.

Mitigation and Compensation Measures

5.1 Introduction

The DECC has prepared principles for the use of biodiversity offsets. Foremost among these is the principle that impacts must be avoided first by using prevention and mitigation measures. This principle means that the ecological impacts of proposed developments should be managed as follows:

- Avoid: to the extent possible, developments should be designed to avoid or minimise ecological impacts;
- Mitigate: where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the proposed development; and
- Compensate: the residual impacts of the project should be compensated for in some way to offset what would otherwise be a net loss of habitat.

This chapter explains the way these points have been applied to manage the impacts of the Project.

As discussed in Section 1.3.1, the DGRs for the EA include the requirement to provide compensatory offsets as follows:

“A revised offset strategy for the mining complex to ensure that the project will maintain or improve the biodiversity conservation value of the region.”

For the purposes of this document, ‘improve and maintain’ is defined as increasing the net area and condition of ecological communities within the locality of the Project in the medium to long term. This will be achieved by permanently conserving and improving the condition of representative examples of vegetation communities and habitats for threatened species that may be impacted by the proposed development.

Mt Arthur Coal currently has an established strategy that was developed to mitigate and offset the ecological impacts arising from previous mining approvals within the EA Boundary. This strategy is known as the Mt Arthur Coal Rehabilitation and Landscape Management Strategy.

As part of the Project, the existing Mt Arthur Coal Rehabilitation and Landscape Strategy will be superseded by an updated and consolidated strategy called the Mt Arthur Coal Complex Offset Strategy, which will cover the entire Mt Arthur Coal Complex. The Mt Arthur Coal Complex Offset Strategy will build upon the previous Rehabilitation and Landscape Strategy and incorporate new offsets that address additional impacts predicted for the Project. The Mt Arthur Coal Complex Offset Strategy has been designed to increase the net area and condition of native vegetation and rehabilitated flora and fauna habitats in the medium to long term. The consolidated Mt Arthur Coal Complex Offset Strategy is described and discussed in Section 5.4 within this Chapter.

5.2 Avoidance Measures

Avoidance measures are problematic for mining projects such as coal mines because commercial deposits occur in fixed locations. Notwithstanding this the design of the Project was examined to see if changes to the footprint could be made to avoid significant ecological impacts and two such changes were made to the design of Mine Extension Area 2 and Mine Extension Area 5.

Mine Extension Area 5 will be used as an out-of-pit overburden emplacement area and the initial design would have impacted a small area (approximately 2 ha) of the threatened ecological community, Hunter Floodplain Red Gum Forest. This community occurs in a degraded condition as a few trees above an understorey dominated by weedy species (*Galenia* and African Boxthorn), and a number of native grass species. *Eucalyptus melliodora* is present as a dominant canopy species and so the occurrence does classify as being part of the EPBC listed CEEC Box Gum Woodland.

To minimise the impacts on the Hunter Floodplain Red Gum Forest, the design was changed to reduce the footprint of Mine Extension Area 5 so that it will now avoid any occurrence of this community near Mine Extension Area 5.

The eastern section of Mine Extension Area 1 (Macleans Hill) was also modified to reduce the mining footprint and retain sections of Box Gum Woodland within this area.

5.3 Mitigation Measures

As Mt Arthur Coal has been in operation since 1960's, a range of management strategies are currently in place to limit impacts on native flora and fauna in the EA Boundary. The strategies include the measures summarised in **Table 5.1**. Many of the existing management strategies will be reviewed and consolidated for the Project. Some of the key measures that will continue to be applied to ensure the ongoing viability of threatened flora, fauna and ecological communities are described briefly below.

i. Modification and Adjustment of Regional and Local Corridors

Connectivity of new and existing offsets will be provided for in the long term through implementation of a connected system of corridors and habitat patches across the EA Boundary, and linkages to other wildlife reserves and areas of native habitat in the locality. This corridor network is an integral part of the Mt Arthur Coal Complex Offset Strategy, discussed further in Section 5.4.5. It has been designed to maintain consistency with the DPI's Synoptic Plan³⁰ and will connect the new Proposed Offset Areas to the existing Conservation Areas at Saddlers Creek and Mount Arthur.

Existing local corridors in several of the proposed Mine Extension Areas will be adjusted to maintain connectivity as mining progresses. In the adjacent mining lease to the east of the EA Boundary, Drayton Mine is proposing to establish rehabilitation areas that adjoin the Saddlers Creek Conservation Area. The linkages between the EA Boundary and Drayton Mine rehabilitation area will be maximised by natural regeneration or rehabilitation planting on the Mt Arthur Coal section of Saddlers Creek.

The corridor network will be adjusted to ensure long term viability of the proposed corridors through and around all of the proposed Mine Extension Areas. The northern end of Mine Extension Area 5 will impinge upon the area previously proposed as a Regional Corridor under the Synoptic Plan for a number of years until rehabilitation is re-established in this area. The corridor function value will increase in this area with the new rehabilitation, as it can be planted with native trees rather than the current grazing grasslands.

ii. Rehabilitation

Rehabilitation of mining areas that will occur across the EA Boundary will be implemented progressively over the life of the mine. Replanting of mine rehabilitation areas will use local native plant species. Where practical, topsoil will be translocated from proposed mining areas to conserve the native seed bank of local ecological communities. This will:

- Maintain or establish corridor connectivity as mining progresses;
- Improve the quality and diversity of native growth in rehabilitation areas;
- Maximise the establishment of a diversity of native species, particularly the understorey species that maintain the ecological function of native vegetation communities; and
- Provide additional habitat for native flora and fauna.

iii. *Pre-clearance and Translocation of Threatened Species and Important Habitat Attributes*

Current mitigation measures include pre-clearance surveys of forest and woodland areas to be removed to identify any threatened flora and fauna species or habitat within areas of impact. This will continue to be implemented for the Project and provides an opportunity to avoid impacts to flora and fauna of conservation significance during clearing. Where it is practical, threatened species or important habitat attributes (such as sizable logs and salvaged tree hollows) will be relocated to rehabilitated areas or offset areas that will be protected in perpetuity (these areas will be described in further detail within Section 5.4).

The threatened orchid, *Cymbidium canaliculatum* identified in Mine Extension Area 5 and immediately outside Mine Extension Area 5 will be relocated to the Saddlers Creek Conservation Area, where good quality habitat will be permanently protected.

iv. *Monitoring and Management*

Mt Arthur Coal has an existing Environmental Management System (EMS) accredited to ISO14001 that includes both the Mt Arthur North Flora and Fauna Management Plan and the Bayswater Rail Loading Facility Flora and Fauna Management Plan. The EMS also incorporates the requirements of Mt Arthur Coal's development consents and other approvals and commitments made in various Environmental Assessments.

In accordance with the requirements of this EMS, an ongoing monitoring program has been implemented. The objective of this monitoring program is to determine whether there is a long term impact of mining operations on flora and fauna habitat at Mt Arthur Coal and to provide management recommendations to improve ecological management^{7,47-49,51,55}.

Mt Arthur Coal's existing flora and fauna monitoring and management plans will be consolidated and reviewed to take into account the impacts of the Project. The monitoring program will be regularly reviewed to ensure it remains effective.

Table 5.1 SUMMARY OF EXISTING ECOLOGICALLY RELEVANT MITIGATION MEASURES AT MT ARTHUR COAL

Existing Mitigation Measures	General Ecological Benefits
Dust minimisation	Control of dust reduces the indirect impacts on vegetation condition and the habitat quality for all native species at Mt Arthur Coal.
Noise minimisation	Minimisation of noise benefits fauna by reducing the potential for disturbance of animals in habitat patches around the mine.
Weed control	Weed control helps to protect the integrity of native vegetation within the EA Boundary and maintains or improves the quality of habitat for plant and animal species.
Feral animal control	Feral animal control helps to control foxes, rabbits and other feral animals that are key threats to many wildlife species.
Rehabilitation of disturbed areas	Rehabilitation of disturbed areas restores forest and woodland cover to disturbed areas and adds habitat for flora and fauna in the long term.
Linkage and integration of rehabilitation areas with existing vegetated areas to improve ecological function and provide habitat	This measure increases the viability of the scattered patches of habitat that occur across the EA Boundary, connecting them and facilitating movement of native species between patches.
Creation of habitat corridors linking isolated remnant vegetation stands	As above.
Management of surface water, erosion and sedimentation	Protects the integrity of the landscape.

Table 5.1 SUMMARY OF EXISTING ECOLOGICALLY RELEVANT MITIGATION MEASURES AT MT ARTHUR COAL

Existing Mitigation Measures	General Ecological Benefits
Ongoing monitoring and maintenance of all revegetation works and habitat enhancement activities	Maintains the viability of the rehabilitated areas in the long term and provides feedback data that can be used for adaptive management.
Pre-clearance inspections and tree felling procedures	Provides an opportunity to avoid impacts to arboreal fauna during clearing and/or enables relocation of fauna to secure areas of vegetation.
Relocation of salvaged tree hollows and (where required) the establishment of nest boxes in adjacent vegetation communities.	Makes efficient use of tree hollows that could otherwise be destroyed. Replaces tree hollows that are to be lost from clearing operations by establishing nest boxes within secure habitat. This maintains the number of tree hollows on site in the short to medium term.
Due diligence inspections for surface infrastructure	Provides data for ongoing adaptive management and protection of adjacent landscape areas if required.
Ongoing monitoring of native flora and fauna across the Mt Arthur Coal Complex	Provides data for ongoing adaptive management of threatened and regionally significant flora and fauna.

5.4 Mt Arthur Coal Complex Offset Strategy

5.4.1 Introduction

The consolidated Mt Arthur Coal Complex Offset Strategy will consolidate and supersede the current Mt Arthur Coal Rehabilitation & Landscape Strategy and will comprise areas of existing native remnant vegetation, future regeneration areas and existing and future rehabilitation areas. These areas are located across the EA Boundary to ensure connectivity of areas and are strategically located to provide linkages to surrounding native vegetation. The Mt Arthur Coal Complex Offset Strategy has evolved over time and has integrated and built on previous commitments regarding final land use, maintaining and enhancing habitat values and achieving conservation outcomes. The Mt Arthur Coal Complex Offset Strategy complements the existing flora and fauna mitigation measures in place at Mt Arthur Coal, and takes account similar strategies of neighbouring mines to maximise biodiversity outcomes on the region.

The Mt Arthur Coal Complex Offset Strategy covers the entire Mt Arthur Coal Complex including the lands to the west of Thomas Mitchell Drive, as shown in **Figure 5.1**. The Mt Arthur Coal Complex Offset Strategy will address the additional impacts predicted for the Project and build upon existing practices on the site. It aims to augment the current strategy to improve and maintain the ecological condition of the landscape within the locality by conserving, improving and creating woodland and forest communities, including habitat for threatened species, such that the net area of such vegetation communities and the condition of habitats increases over time.

The Mt Arthur Coal Complex Offset Strategy is discussed further below. In particular:

- Section 5.4.2 discusses the offsetting principles which have been applied to the Mt Arthur Coal Complex Offset Strategy and indicates how the Complex Offset Strategy achieves these offsetting principles;
- Section 5.4.3 discusses the new Proposed Offset Areas to mitigate disturbance impacts of the Project;
- Section 5.4.4 discusses the existing Conservation Areas in place at Mt Arthur Coal, namely Mount Arthur and Saddlers Creek Conservation Areas;
- Section 5.4.5 details how the new Proposed Offset Areas and the existing Conservation Areas will be integrated as part of the Mt Arthur Coal Complex Offset Strategy; and
- Section 5.4.6 provides an overview of the Mt Arthur Coal Complex Offset Strategy and summarises the benefits for biodiversity in the EA Boundary and the wider locality.

5.4.2 Mt Arthur Coal Complex Offset Strategy: Offsetting Principles

In order to achieve the best environmental outcomes, the Mt Arthur Coal Complex Offset Strategy aims to meet state-wide standards in offsetting. **Table 5.2** below explains how the DECC principles for offsetting have been addressed by the Mt Arthur Coal Complex Offset Strategy. The DECC principles are derived from:

Guidelines for Biodiversity Certification of Environmental Planning Instruments Working Draft – Department of Environment and Climate Change, October 2008.

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
1. Impacts must be avoided first by using prevention and mitigation measures. Offsets are then used to address remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.	Changes have been made to the design of Mine Extension Area 5 to remove the impact upon Hunter Floodplain Red Gum Forest and to Mine Extension Area 1 to minimise disturbance to established forest and woodland area. The predicted impacts of the Project will be offset by the provisions made through the Mt Arthur Coal Complex Offset Strategy as will be discussed in the remaining sections of Section 5.4 of this Chapter.
2. All regulatory requirements must be met. Offsets cannot be used to satisfy approvals or assessments under other legislation, e.g. assessment requirements for Aboriginal heritage sites, pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).	All regulatory requirements for the Offset Strategy will be met.
3. Offsets must never reward ongoing poor performance. Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.	Mt Arthur Coal will manage offset areas to increase their ecological values over time and will not deliberately degrade or mismanage offset areas.

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
4. Offsets will complement other government programs. A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.	The Mt Arthur Coal Complex Offset Strategy will complement other government programs for conservation in that it will address recovery plans and recommendations for management of weeds and feral animals. The Offset Strategy also makes provisions for the establishment / reconstruction of biodiversity corridors that meets the objectives of DPI's Synoptic Plan for an integrated regional landscape.
5. Offsets must be underpinned by sound ecological principles. Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.	The Mt Arthur Coal Complex Offset Strategy will: • Enhance and manage existing habitat and secure these habitats for biodiversity via a zoning mechanism or alternate pathway (see main report for details); • Regenerate new areas of habitat that will be strategically located near existing habitat to effectively provide larger intact areas of habitat in the longer term; • Reconstruct and enhance new and existing woodland corridors to connect offset areas.

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
Offsets must: • Include the consideration of structure, function and compositional elements of biodiversity, including threatened species • Enhance biodiversity at a range of scales	The Offset Strategy will enhance, regenerate and protect woodland and forest community types that will be lost, thus ensuring that ecological structure and function of representative communities in the locality will be maintained and improved. This includes replanting with local or endemic species, and protecting and enhancing habitat for a range of threatened species such as threatened plants <i>Diuris tricolor</i>, <i>Cymbidium canaliculatum</i> and <i>Bothriochloa biloba</i>. Threatened fauna that will benefit include microbats, Squirrel Glider and woodland birds such as Speckled Warbler and Grey-crowned Babbler. The proposed Offset Strategy will enhance biodiversity at a landform scale. The Proposed Offset Areas, in conjunction with areas of regenerated woodland, will form a large viable forest and woodland area supporting habitat for a wide variety of species. The Offset Strategy will link the Proposed Offset Areas to the existing Conservation Areas and to other habitat areas in the locality to enhance ecological function of habitats. The proposed Offset Strategy will also enhance biodiversity at the local scale by protecting a diversity of habitat types across the EA Boundary, including riparian, forest and woodland vegetation. Under the proposed Offset Strategy, understorey complexity and other habitat features such as logs, stags and tree hollows will be preserved and protected to encourage fauna and flora use of these habitats.

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
- Consider the conservation status of ecological communities - Ensure the long-term viability and functionality of biodiversity.	The Offset Strategy will maintain and improve occurrences of endangered ecological communities and regionally significant plant communities and includes targeted preservation of remaining and regenerated White Box Woodland and derived native grassland. Offsets will be conserved in perpetuity and will be actively managed by Mt Arthur Coal during the life of the Project.
6. Offsets should aim to result in a net improvement in biodiversity over time. Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site. Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset against the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation. Offsets may include enhancing habitat, reconstructing habitat in strategic areas to link areas of conservation value, or increasing buffer zones around areas of conservation value and removal of threats by conservation agreements or reservation.	The Offset Strategy will result in a net improvement in woodland and open forest communities over time, with commensurate benefits to threatened species. The Offset Strategy will protect areas of intact vegetation via an appropriate land zoning or other alternative means for the life of the impact (see main report for details). The Offset Strategy will also enhance existing vegetation through management actions that include removal of grazing, translocation of threatened species to protected areas, and reconstructing habitat corridors to link areas of habitat. The Offset Strategy makes provisions for the regeneration of ecological communities, strategically placed to add to the areas of existing habitat to be protected and enhanced. Under the Offset Strategy, enhancement and regeneration works will be implemented progressively over the life of the mine to minimise the impacts of progressive mining across the EA Boundary.

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs. As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or a private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.	The Proposed Offset Areas and Conservation Areas will be secured by an appropriate land zoning or other alternative means for the life of the impact (see main report for details). Additionally, the Offset Strategy includes offsite offsets, ensuring that these areas will not be impacted by the Project.
8. Offsets should be agreed prior to the impact occurring. Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.	The nature and extent of the offsets will be agreed prior to commencement of the Project at Mt Arthur Coal. The disturbance will be staged over the life of the Project. Thus, the Offset Strategy will be progressively implemented over the life of the Project to ensure that at every stage of disturbance, impacts are minimised. Accordingly, the reconstruction of woodland corridors will occur progressively to ensure that corridors are intact at every stage of the Project.

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated. Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include: • The area of impact; • The types of ecological communities and habitat/species affected; • Connectivity with other areas of habitat/corridors; • The condition of habitat; • The conservation status and/or scarcity/rarity of ecological communities; • Management actions; and • Level of security afforded to the offset site.	The Project impacts and Offset Strategy have been assessed using Geographic Information Systems and ortho-rectified aerial photography. The methodology uses ground truthed data to allow for accurate and reliable quantification of the biodiversity losses and gains for the Project. The area of impact, types of communities and species to be impacted, extent of existing and future connectivity, condition of habitat and conservation status of ecological communities have been documented within Chapters 3-5 of this ecological assessment report. The Offset Strategy makes provisions for the management of the offset areas to ensure that there will be a net benefit in biodiversity values. The Proposed Offset Areas, Proposed Regenerated Woodland areas and the existing Conservation Areas will be conserved in perpetuity and will be actively managed by Mt Arthur Coal during the life of the Project, ensuring that there is a net gain in biodiversity in the wider locality in the long term.
The best available information/data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where: • They protect land with high conservation significance	The Proposed Offset Areas and the existing Conservation Areas have high conservation significance in that they contain endangered ecological communities, habitat for threatened species, known occurrences of threatened species and significant riparian habitats.

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
• Management actions have greater benefits for biodiversity • The offset areas are not isolated or fragmented • The management for biodiversity is in perpetuity (e.g. secured through a conservation agreement).	The management actions that are proposed, such as cessation or reduction of cattle grazing, revegetation, weed control and feral animal control have a high probability of providing a significant conservation benefit. The habitat within the locality is largely fragmented in its current state. The Offset Strategy aims to reverse fragmentation effects by locating the Proposed Offset Areas strategically to effectively provide larger areas of habitat. For instance, the Offset Strategy is linked to Drayton's offset areas by Saddlers Creek and a travelling stock route. The offsite Proposed Offset Area also contains two creeks with riparian vegetation that form ecological linkages to the north of the Proposed Offset Areas. The Proposed Offset Areas and Conservation Areas within the mining lease will be linked via a reconstructed woodland corridor. Thus, the Offset Strategy will be consistent with the objectives of DPI's Synoptic Plan for an integrated landscape network. The proposed offsets will be secured by an appropriate land zoning or other alternative means for the life of the impact (see main report for details).

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
10. Offsets must be targeted. They must offset impacts on the basis of like-for-like or better conservation outcome. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.	The offsets are targeted and will deliver a like-for-like or better conservation outcome for endangered ecological communities and threatened species. Under the Offset Strategy, Endangered Ecological Communities will be targeted, including Box Gum Woodland and communities that are currently under preliminary determination at the time of writing. Derived grassland will be offset by their woodland community types as woodland habitats have a higher conservation value. Habitat for threatened species identified in the EA Boundary will also be targeted, including habitat for <i>Diuris tricolor</i>, <i>Cymbidium canaliculatum</i>, threatened woodland birds and habitat for microbats. This is discussed within Section 5.4.3 of this report.
11. Offsets must be located appropriately. Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.	The proposed offsets are located appropriately within the landscape. The Offset Strategy will be implemented on offset areas that are located either within the mining lease or just outside of the mining lease. Thus, the ecological characteristics of the offset areas will be the same as, or very similar to that of the impact areas.

Table 5.2 DECC OFFSET PRINCIPLES VERSUS MT ARTHUR COAL COMPLEX OFFSET STRATEGY

DECC Principles for the use of biodiversity offsets in NSW	Mt Arthur Coal Complex Offset Strategy
12. Offsets must be supplementary. They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space cannot be used as offsets.	The proposed offsets are supplementary in that they are proposed exclusively for the Project and are not already funded or being managed for biodiversity value for another development proposal.
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract. Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.	The proposed offsets will be enforceable through development consent conditions and will be auditable to ensure that actions have been carried out.

5.4.3 New Offset Areas for the Project

i. Introduction

New offset areas for the Project will be implemented as part of the overall Mt Arthur Coal Complex Offset Strategy to offset the impacts to biodiversity, with a 2:1 offset ratio for the loss of all native forest and woodland, and a 1:1 offset ratio for native derived grassland proposed to be cleared by the Project.

The new offset areas proposed for the Project will be provided through the protection and enhancement of 495 ha of land outside the EA boundary and mining lease boundary and 222 ha of land within the EA boundary (the 'Proposed Offset Areas'), and through the revegetation and protection of approximately 500 ha of land that will be returned to native woodland and forest after mining ('Proposed Regenerated Woodland'). **Figure 5.1** shows the component areas of the overall Mt Arthur Coal Complex Offset Strategy and where they are located. The combination of new offset areas will provide a net gain in area of woodland and forest for the Project in the long term. Additionally, it will provide a net

increase in area of Box Gum Woodland to offset the predicted loss of Box Gum Woodland due to the Project (**Table 5.3**).

The native derived grassland areas within the Proposed Offset Areas are artificial grasslands that have been cleared of their original tree and shrub cover for farming. Under ongoing pastoral management, derived grasslands would not regenerate to forest and woodland. However, under the Mt Arthur Coal Complex Offset Strategy, areas of such grassland to be included as offsets will have tree and shrub cover restored over time and so this will significantly increase the cover of forest and woodland in the long term. When offsets are combined with forest and woodland regenerated by rehabilitation there will be almost a five fold increase in forest and woodland in the EA Boundary in the long term.

A key principle of the offset design is to provide “like for like or better” habitat. To this extent, the 495 ha Proposed Offset Area will provide frontage to two permanent creeks that will provide significant wildlife refuges. No permanent creeks exist in the impact areas. Also, the Proposed Offset Areas contain four EEC/significant communities that will not be impacted by the project: Hunter Valley River Oak Forest, Hunter Floodplain Red Gum Woodland, Blakely’s Red Gum Woodland and Central Hunter Box-Ironbark Woodland. These have been included in the offset package to offset impacts to Central Hunter Bullock Forest Regeneration, which is a habitat of lower biodiversity and is not an EEC. This will provide a “like for better” offset for Central Hunter Bullock Forest Regeneration (see **Figure 5.2** for vegetation communities in the Proposed Offset Areas).

Table 5.3 presents a summary of the vegetation areas that will be protected within the Proposed Offset Areas, and the areas of woodland that will be created within the Proposed Regenerated Woodland Area. This table demonstrates that there will be a net increase in the area of woodland and forest.

The management actions to be implemented within the Proposed Offset Areas and the Proposed Regenerated Woodland areas will serve to increase the biodiversity values of the above new offset areas, which will provide a net benefit for threatened species in the wider locality. The Proposed Offset Areas provide habitat for a suite of threatened birds and bats that are known to occur in the EA Boundary and these habitat values will be enhanced by management actions such as cessation of cattle grazing and pest and weed control, which will progressively benefit these species.

The existing flora and fauna management program (discussed in Section 5.3iv) will be revised to guide the long term management of flora and fauna over the entire EA boundary, with emphasis on existing conservative areas, the Proposed Offset Areas and Proposed Regenerated Woodland. The management program will ensure the development and implementation of a scientifically based process for the re-establishment of Box Gum Woodland understorey and in the longer term, overstorey in the Project rehabilitation areas. The Proposed Offset Areas are located within an area where the express intention is that the surface will not be disturbed; however, its creation will not preclude the maintenance of access tracks and fire breaks, the installation of service

utilities and any required water management or erosion control works or other such low impact activities.

The Proposed Offset Areas will be conserved for the life of the impact at the Project, thus securing biodiversity values in the long term. The EA main report for this Project will describe the mechanism by which the Proposed Offset Areas will be protected in the long term.

Table 5.3 SUMMARY OF NEW OFFSETS AND REHABILITATION THAT ARE PART OF THE MT ARTHUR COAL COMPLEX OFFSET STRATEGY

	Status ^a	Vegetation to be Impacted by the Project	Remnant Vegetation within the Proposed Offset Areas	Areas to be Regenerated in the Proposed Regenerated Woodland Area	Total Vegetation provided by new offset areas
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	E ^c		13.81		13.81
Hunter Valley River Oak Forest					
Mount Arthur Forest Complex	E ^{a, b}				
Spotted Gum Forest		0.90		1.80	1.80
Blakely's Red Gum Woodland	E ^{a, b}		2.89		2.89
Central Hunter Box - Ironbark Woodland	E ^c	2.00	45.99		45.99
Hunter Floodplain Red Gum Woodland	E ^{a, b}	0	3.43		3.43
Hunter Floodplain Red Gum Woodland - Weedy Understorey		0.66			
Narrabeen Footslopes Slaty Gum Woodland	E ^c	24.21		92.13	92.13
Upper Hunter Hills Exposed - Ironbark Woodland		38.20		76.41	76.41
Upper Hunter White Box - Ironbark Grassy Woodland	E ^b	116.45	152.53	299.20	933.79
Central Hunter Bullock Forest Regeneration		58.14		30.46	30.46
Total area of native Forest and Woodland		240.56	218.65	500.00	1200.71
Box - Ironbark Derived Grassland		6.10		*	
Slaty Gum Derived Grassland		43.70		*	
Spotted Gum Derived Grassland					
White Box - Ironbark Derived Grassland	E ^b	699.54	482.06	*	*
Total area of native Derived Grassland		749.34	482.06	0.00	0.00

Table 5.3 SUMMARY OF NEW OFFSETS AND REHABILITATION THAT ARE PART OF THE MT ARTHUR COAL COMPLEX OFFSET STRATEGY

Status ^a	Vegetation to be Impacted by the Project		Remnant Vegetation within the Proposed Offset Areas		Areas to be Regenerated in the Proposed Regenerated Woodland Area		Total Vegetation provided by new offset areas	
GRAND TOTAL		989.90		700.71		500.00		1200.71

^aE^a = Critically Endangered Ecological Community (EPBC Act); E^b = Endangered Ecological Community (TSC Act), E^c = Preliminary Determination under the TSC Act.

*Grasslands will be revegetated to forest and woodland and appears in Forest and Woodland subtotals

ii. Offsite Offset

An offset of approximately 495 ha will be provided on the north eastern edge of the EA Boundary on the other side of Thomas Mitchell Drive. This area contains a suite of endangered ecological communities, including Upper Hunter White Box – Ironbark Woodland and native Derived Grassland. It also has riparian forest along two streams that emanate from areas close to the Drayton Wildlife Refuge and is further linked to the Drayton Wildlife Refuge by a Travelling Stock Reserve that abuts it to the south. The offsite Proposed Offset Area therefore is large enough to have merit as a wildlife habitat on its own, and will add to an already substantial block of habitat that has been zoned for conservation.

In its current form, the land has been partially cleared and grazed by cattle. However, it has extensive areas of native grassy understorey that will regenerate well upon cessation of cattle grazing. It also provides potential habitat for a suite of threatened birds and bats that are known to occur in the EA Boundary. Regeneration of woodland and open forest habitat following cessation of cattle grazing will progressively benefit these species.

The existing flora and fauna management program (discussed in Section 5.3iv) will be revised to guide the long term management of native flora and fauna within this area.

iii. Onsite Offsets – Thomas Mitchell Drive

A further offset of approximately 222 ha will be provided within the EA Boundary along Thomas Mitchell Drive. It is located on the opposite side of Thomas Mitchell Drive to the offsite Proposed Offset Area and is bounded at its northern and southern extent by Denman Road and the Mt Arthur Coal Access Road respectively (**Figure 5.1**).

This area contains EEC Upper Hunter White Box – Ironbark Woodland and EEC Derived Grassland. It also contains Blakely's Red Gum Woodland, which is listed as a CEEC under the EPBC Act and Central Hunter Box – Ironbark Woodland, which is nominated for threatened status listing under the TSC Act. Other biodiversity values of the area include a suite of threatened species including birds like the Grey-crowned Babbler and an endangered population of *Diuris tricolor*. The population of *Diuris tricolor* will continue to be managed through incorporation into the revised Flora and Fauna management program.

In its current form, the land has been partially cleared and grazed by cattle. However, it has extensive areas of native grassy understorey that will regenerate well upon cessation or reduction of grazing. It also provides potential habitat for a suite of threatened birds and bats that are known to occur in the EA Boundary. Regeneration of woodland and open forest habitat following cessation or reduction of cattle grazing will progressively benefit these species.

The existing flora and fauna management program (discussed in Section 5.3iv) will be revised to guide the long term management of the native flora and fauna within this area.

iv. *Rehabilitation - Proposed Regenerated Woodland*

Further to the designation of the Proposed Offset Areas, Mt Arthur Coal will reconstruct and regenerate 500 ha of mined area to woodland and open forest using trees, shrubs and native ground covers from the locality in order to offset the predicted loss of Box Gum Woodland Derived Grassland from the Mine Disturbance Areas.

The proportions of forest and woodland types that will be emulated in rehabilitation are shown in **Table 5.3**. The rehabilitation area has been strategically located next to the Proposed Offset Areas to effectively provide a large, contiguous area of woodland and forest habitat in the longer term.

5.4.4 Existing Offset Areas for the Project

Areas that have been identified during previous environmental assessments at Mt Arthur Coal showing high ecological, cultural or archaeological importance are preserved in Conservation Areas. As previously agreed, Conservation Agreements will be entered into affording these areas the highest level of protection, the consolidation Flora and Fauna Management Program will be reviewed and developed to protect these areas in perpetuity. Mt Arthur Coal currently has two Conservation Areas, as discussed below and shown on **Figure 5.1**.

i. *Mount Arthur Conservation Area*

The Mount Arthur Conservation Area is approximately 105 ha in size and covers the upper and lower slopes of Mount Arthur. The Mount Arthur Conservation Area was proposed as part of the MAN EIS Archaeological and Cultural Heritage offset to preserve the Aboriginal cultural heritage values of this area. As part of the South Pit Extension EA, a commitment was made to extend the conservation agreement to include the protection of Mount Arthur's significant ecological values.

The proposed Mount Arthur Conservation Area is of ecological significance for a number of reasons, namely for the:

- Known threatened species records;
- Known regionally significant species;
- Presence of a substantial number of tree hollows; and
- Extensive remnants of a critically endangered vegetation community (Box Gum Woodland).

The proposed Mount Arthur Conservation Area will protect 74 ha of Mount Arthur Forest Complex, which is Critically Endangered Box Gum Woodland (EPBC Act), 15 ha of Box Gum Woodland Derived Grassland and 9 ha of Spotted Gum Derived Grassland. This

Conservation Area contains relatively intact forest and will protect unique habitat features like rock crevices and other rock features. Its proximity to Saddlers Creek enhances its value for mobile threatened species that roost in forest and woodland but forage over creeks and other water sources.

The development of a conservation agreement is currently underway to preserve the Aboriginal cultural heritage and ecological values of the Mount Arthur Conservation Area in perpetuity.

ii. Saddlers Creek Conservation Area

In the MAU EA, the existing Heritage Management and Conservation Area was built upon as part of an ecological offset. This area has also been established to offset the impacts of the MAU Project on Aboriginal cultural heritage. A Conservation Agreement, as required by the MAU Development Consent, will be entered to protect this area in perpetuity.

The proposed Saddlers Creek Conservation Area is approximately 295 ha in size, and includes the main channel of Saddlers Creek, running along the southern and south-eastern boundaries of the EA Boundary. The vegetation of the proposed Saddlers Creek Conservation Area is dominated by White Box Derived Grassland (approximately 212 ha), Hunter Floodplain Red Gum Woodland Complex (approximately 53 ha) and Central Hunter Box - Ironbark Woodland (approximately 29 ha). There are also small areas of aquatic vegetation located along Saddlers Creek. Saddlers Creek riparian vegetation provides known habitat for a number of threatened fauna species and the tiger orchid (*Cymbidium canaliculatum*), which is listed as an endangered population in the Hunter catchment.

To assist in further offsetting the impacts of the approved MAU Project on the threatened species, the following habitat enhancement and protection recommendations are currently being implemented along Saddlers Creek:

- The area will be fenced to protect the riparian corridor and encourage natural regeneration;
- Cattle grazing will be excluded along Saddlers Creek, to promote natural regeneration; and
- Habitat quality is being improved for a range of threatened bird and bat species.

The proposed Saddlers Creek Conservation Area is of ecological significance for a number of reasons, namely for the:

- Known threatened species;
- Known regionally significant species;

- Presence of a substantial number of tree hollows;
- Known examples of the tiger orchid (*Cymbidium canaliculatum*) Endangered Population;
- Riparian corridor values;
- Linkages to Drayton's southern offset area over the offsite portion of Saddlers Creek; and
- Extensive remnants of a critically endangered vegetation community (Box Gum Woodland).

The proposed Saddlers Creek Conservation Area conserves Box Gum Woodland and habitat for a suite of threatened species that occur at Mt Arthur Coal.

5.4.5 Biodiversity Corridors within the Mt Arthur Coal Complex Offset Strategy

An important factor in maintaining the integrity of remaining habitat is to establish or maintain connections between patches of existing habitat. Wildlife corridors connecting key areas of habitat increase the effective amount of habitat that is available for species and reduces the impacts of habitat fragmentation. This is especially important for migratory animals and those with large home ranges. Larger habitats support greater biodiversity, larger populations, and a wider range of food sources and shelter. Corridors also allow populations to interbreed, improving long-term genetic viability.

Connectivity of new and existing offsets will be provided for in the long term through across the EA Boundary, and linkages to other wildlife reserves and areas of native habitat in the locality.

Connectivity of the Proposed Offset Areas, Proposed Woodland areas and the existing Conservation Areas will be provided for in the long term through the implementation of a connected system of corridors and habitat patches comprising the Existing and Proposed Woodland Areas. This corridor network is an integral part of the Mt Arthur Coal Complex Offset Strategy as it will provide a network of biodiversity corridors for flora and fauna and in the long term, will enhance the ecological value of the Project offset areas.

Figure 5.1 shows the locations of the new and existing offset areas and the Existing and Proposed Woodland Areas network. It shows that:

- The Proposed Offset Areas and Proposed Regenerated Woodland Area will be connected to the existing Conservation Areas at Mount Arthur and Saddlers Creek;

- The Proposed Offset Areas are proximate to Drayton Wildlife Refuge and is connected by a Travelling Stock Reserve, which abuts the Proposed Offset Areas to the south; and
- The Saddlers Creek Conservation Area continues into the Drayton southern offset area to the east of the EA Boundary (Drayton southern offset area not shown).

Thus, Mt Arthur Coal Complex Offset Strategy will maintain and enhance local and regional connectivity in the long term through the progressive development of the Existing and Proposed Woodland Areas. This will maintain and improve the ecological function of the new and existing offset areas and enhance the value of the overall Mt Arthur Coal Complex Offset Strategy.

5.4.6 Conclusion

The Mt Arthur Coal Complex Offset Strategy has specifically been developed to integrate with local and regional corridors, adjacent Conservation Areas and build upon existing biodiversity conservation commitments at Mt Arthur Coal, which increases the biodiversity values of the offset areas that will be protected in perpetuity.

Connectivity of the Proposed Offset Areas and the existing Conservation Areas will be provided for in the long term through the implementation of the corridors comprising the Existing and Proposed Woodland Areas. The Proposed Offset Area also abuts a Travelling Stock Reserve that provides connectivity with the Drayton Wildlife Refuge, thus further contributing to the enhancement of the proposed Mt Arthur Coal Complex Offset Strategy, and other local biodiversity conservation efforts.

Overall, the Mt Arthur Coal Complex Offset Strategy will:

- Enhance and manage existing endangered ecological communities and threatened species habitat and secure these habitats for biodiversity via a zoning mechanism or alternate pathway (see main report for details);
- Regenerate new areas of endangered ecological communities and threatened species habitat that will be strategically located near existing habitat to effectively provide larger intact areas of habitat in the longer term;
- Reconstruct and enhance new and existing woodland corridors to connect offset areas, thus improving the ecological function of the woodland and forest in the wider locality in the long term.

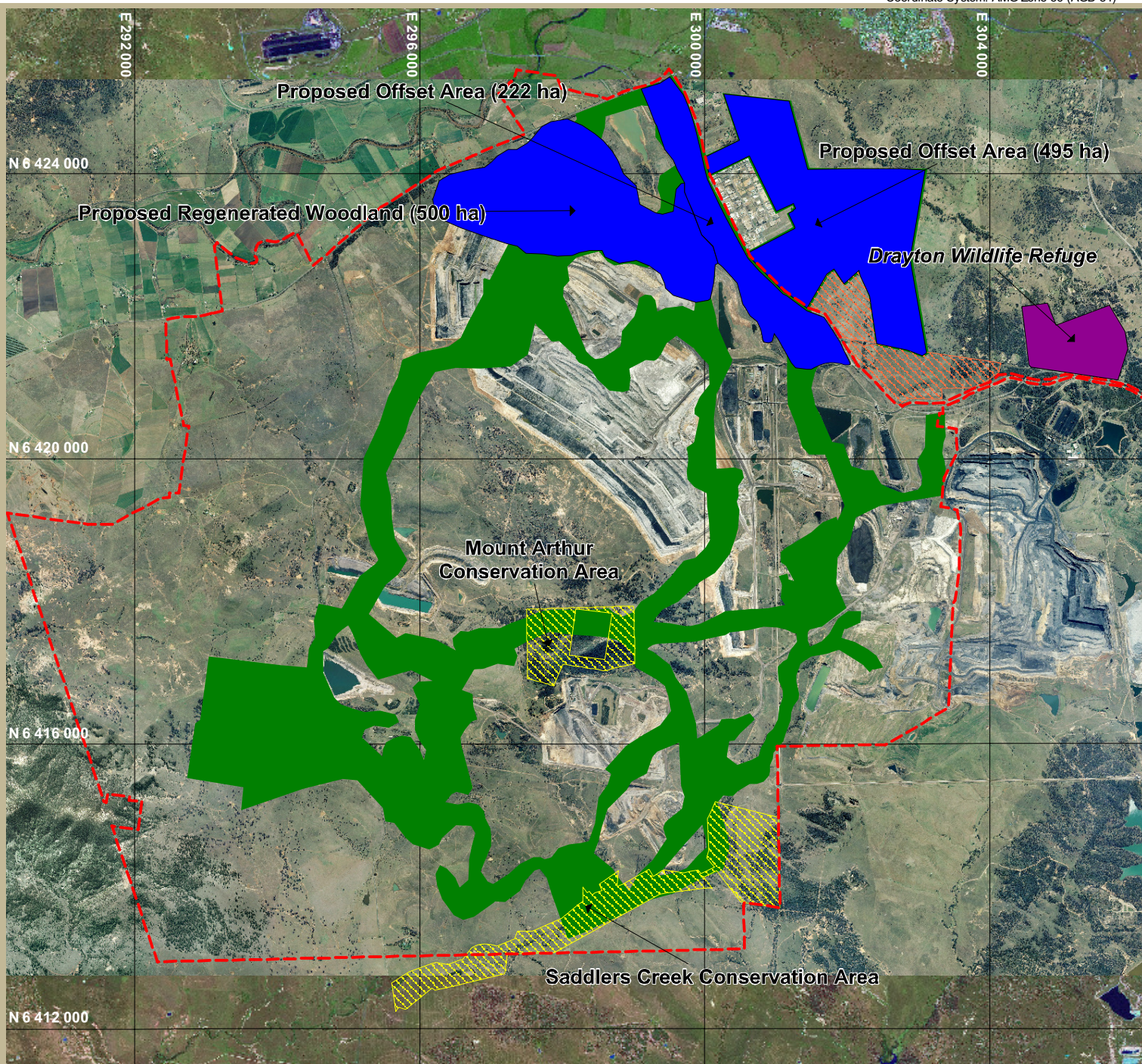
The above points are summarised in **Table 5.4** below:

Table 5.4 SUMMARY OF THE MT ARTHUR COAL COMPLEX OFFSET STRATEGY

	Proposed Offset Areas	Existing Conservation Areas	Proposed Regenerated Woodland Area	Existing and Proposed Woodland Areas
TSC Act or EPBC Act listed Forest and Woodland	158.85	126.79	299.20	
TSC Act or EPBC Act listed Derived Grassland	482.06	29.00		
Area of other native Forest and Woodland	59.80	226.79	200.80	1424.13
Area of other native derived grassland		9.15		
TOTAL AREA	700.71	391.73	500.00	1424.13

In summary, the Mt Arthur Coal Complex Offset Strategy will improve and maintain the biodiversity values of the EA Boundary as it will:

- Provide a net increase in the area of forest and woodland communities in the locality in the long term;
- Provide a net increase in the area of Box Gum Woodland to compensate for the predicted loss of Box Gum Woodland due to the Project;
- Provide a net increase in the area available as habitat for threatened fauna species such as threatened woodland birds, microchiropteran bats and the squirrel glider;
- Provide a net increase in the area available as habitat for threatened flora species including *Diuris tricolor*, *Cymbidium canaliculatum* and *Bothriochloa biloba*;
- Conserve and improve examples of all of the types of woodland and open forest that are to be impacted by the Project;
- Provide a connected system of corridors and habitat patches across the mining lease and linkages to other wildlife reserves and areas of native habitat in the locality; and
- Permanently conserve offset areas.



Map Legend

- EA Boundary
- Proposed Offset Areas
- Existing and Proposed Woodland
- Conservation Areas
- Drayton Wildlife Refuge
- Travelling Stock Reserve

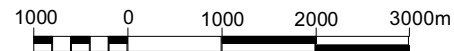
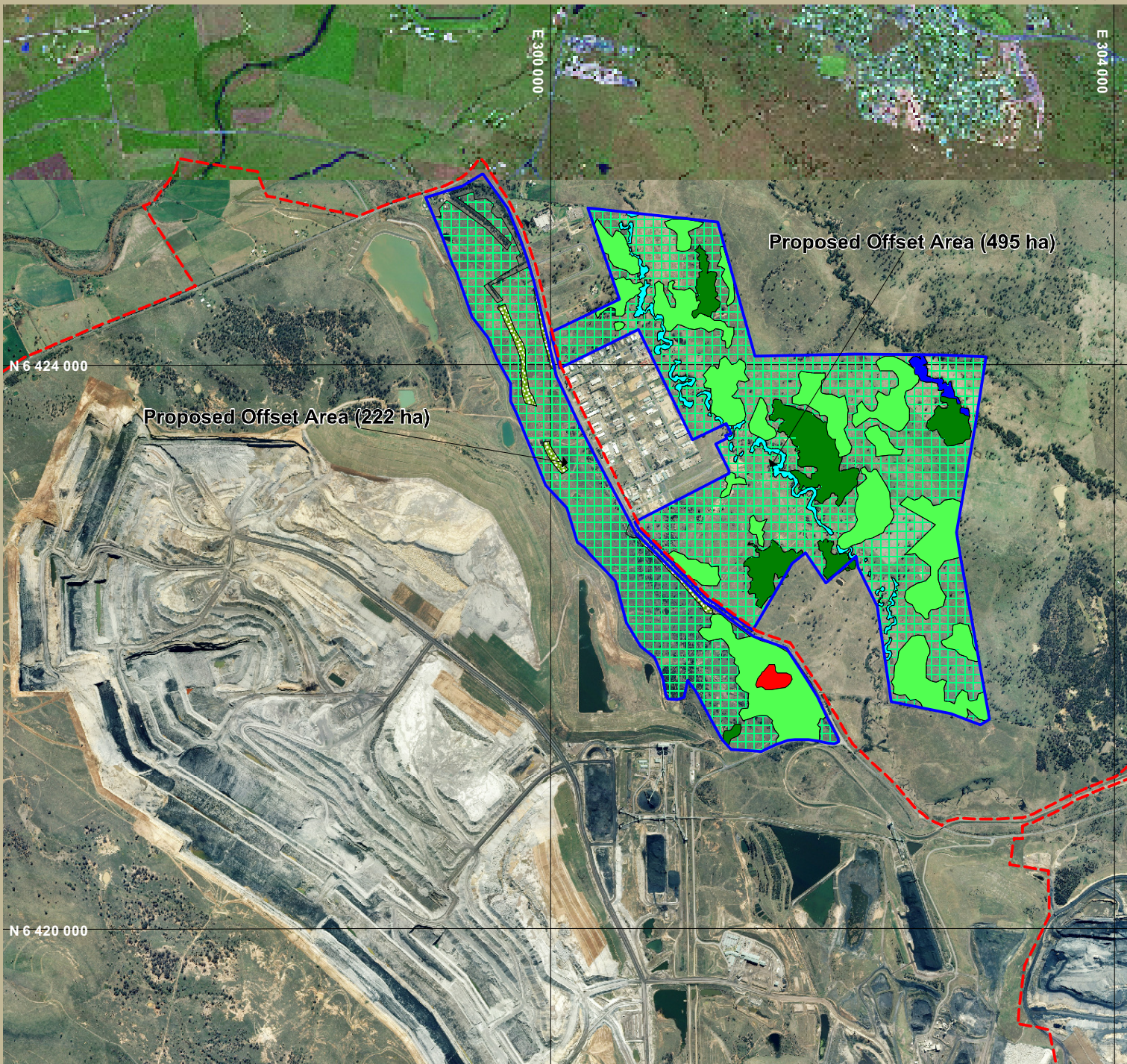


Figure 5.1 The Mt Arthur Coal Complex Offset Strategy



Map Legend

- EA Boundary
- Proposed Offset Areas

Vegetation Communities

- Hunter Floodplain Red Gum Woodland
- Hunter Valley River Oak Forest
- Central Hunter Box - Ironbark Woodland
- Upper Hunter White Box - Ironbark Grassy Woodland
- White Box - Ironbark Derived Grassland
- Blakely's Red Gum Woodland
- Planted Areas

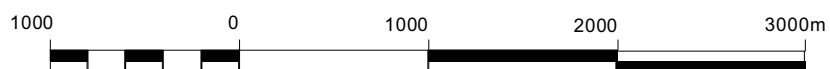


Figure 5.2 Vegetation Communities within the Proposed Offset Areas

Conclusion

The Project will remove areas of forest and woodland that form habitat for a range of native flora and fauna species. The impacts will be potentially significant for TSC Act listed Box Gum Woodland and a number of threatened species in the short term as foraging and roosting habitat will be lost. However, in the longer term the impacted species are predicted to remain in viable numbers within the EA Boundary because of the retention of previously approved conservation areas (Mount Arthur and Saddlers Creek Conservation Areas) and the designation of new offset areas (Proposed Offset Areas and Proposed Regenerated Woodland). The efficiency of such conservation measures on site will continue to be monitored in the long term to verify that species and their habitats are being conserved. Where corrective action is required, such as additional replanting of native vegetation, this will be undertaken by Mt Arthur Coal.

In an effort to reduce the potential impacts of the Project, a number of mitigation measures will be implemented. Foremost amongst the measures will be the designation of two new Proposed Offset Areas of 495 ha and 222 ha to offset Project disturbance impacts, where woodland and open forest communities will be permanently protected and regenerated. The Proposed Offset Areas include Upper Hunter White Box – Ironbark Grassy Woodland, Central Hunter Box – Ironbark Woodland, Hunter Floodplain Red Gum Woodland, Blakely's Red Gum Woodland, Hunter Valley River Oak Forest; and extensive areas of Native Derived Grassland. Approximately 500 ha of land will also be returned to native woodland and forest after mining to complement the Proposed Offset Areas.

The Proposed Offset Areas will be reserved for conservation and will be managed according to Mt Arthur Coal's Flora and Fauna Management Program. The Flora and Fauna Management Program will be consolidated and amended to include these new areas, and will prescribe management of existing vegetation, revegetation of cleared or degraded areas, fire management, weed and pest management and management of the habitats of threatened species of flora and fauna.

The Proposed Offset Areas are linked to an existing wildlife reserve established by Drayton Mine to the east; this means that as regeneration of woodland and forest progresses, the value of the Proposed Offset Areas will increasingly complement existing wildlife reserves. Proposed Offset Areas will also be connected to existing Conservation Areas through the proposed corridor network, adding value to the biodiversity values of all offset areas as an integrated ecological system.

Other mitigation measures for the Project include:

- Mine rehabilitation: areas will be replanted to local native plant species in order to provide additional flora and fauna habitats;
- Ecological monitoring: Mt Arthur Coal has a monitoring program for native flora and fauna that will provide ongoing feedback about the condition of vegetation across the EA Boundary;
- Threatened Species Management: The occurrences of the threatened orchid *Cymbidium canaliculatum* (Tiger Orchid) known from Mine Extension Area 5 will be translocated to a conservation area and nest boxes will be established where necessary to maintain an effective fauna monitoring program at Mt Arthur Coal; and
- Pre-clearance surveys will be conducted within areas to be cleared and threatened flora and fauna detected will be translocated into protected habitat where possible.

The implementation of the above mitigation measures, in conjunction with the Mt Arthur Coal Complex Offset Strategy, will allow the Project to offset the predicted impacts of the Project as they will improve and maintain the biodiversity values of the EA Boundary on a local scale and also in the wider locality.

References

1. Botanic Gardens Trust (2004) **PlantNET**
http://www.rbgsyd.nsw.gov.au/search_plant_net
2. Braun-Blanquet, J. (1927) *Pflanzensoziologie* Wien Springer
3. Brooker, M. I. H. and Kleinig, D. A. (2006) **Field Guide to Eucalypts. Volume 1: South-eastern Australia** Bloomings Books Pty. Ltd., Melbourne.
4. Campbell, Susan (2009) **So long as it's near water: variable roosting behaviour of the large-footed myotis (*Myotis macropus*)** *Australian Journal of Zoology* 57(1):89-98
5. Churchill, S. (1998) **Australian Bats** Reed New Holland, Sydney.
6. Corben, C., Roberts, G., and Smyth, A. (1982) **Roosting of a White-throated Needletail** *Sunbird* 12:47-48
7. Cumberland Ecology (2009) **Mt Arthur Coal 2008 Flora and Fauna Monitoring Program - draft Ecological Monitoring Report** Cumberland Ecology Pty Ltd, Carlingford Court, NSW.
8. Dames & Moore (2000) **Mount Arthur North Coal Project - Flora and Fauna Report** Dames & Moore Pty. Ltd., Brisbane, QLD.
9. Day, N. (1993) **Tree perching and presumed roosting of White-throated Needleetails** *Hirundapus caudacutus* *Australian Bird Watcher* 15:43-44
10. DEC (NSW) (2004) **Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)** New South Wales Department of Environment and Conservation, Hurstville, NSW.
11. DEC (NSW) (2005) **Black-chinned Honeyeater - profile** Department of Environment and Conservation (NSW), Hurstville, NSW.
12. DEC (NSW) (2005) **Diamond Firetail - profile** Department of Environment and Conservation (NSW), Hurstville, NSW.
13. DEC (NSW) (2005) **Greater Broad-nosed Bat - profile** Department of Environment and Conservation (NSW)
14. DEC (NSW) (2005) **Masked Owl - profile** Department of Environment and Conservation (NSW)

15. DEC (NSW) (2005) **Speckled Warbler - profile** Department of Environment and Conservation (NSW), Hurstville, NSW.
16. DEC (NSW) (2005) **Squirrel Glider - profile** Department of Environment and Conservation (NSW)
17. DEC (NSW) (2005) **Yellow-bellied Sheathtail-bat - profile** Department of Environment and Climate Change (NSW)
18. DECC (NSW) (2005) **Threatened Species Profile - *Climacteris picumnus victoricae* Brown Treecreeper (eastern subspecies)** New South Wales Department of Environment and Conservation, Hurstville, NSW.
19. DECC (NSW) (2005) **Threatened Species Profile - Grey-crowned Babbler (eastern subspecies)** New South Wales Department of Environment and Conservation, Hurstville, NSW.
20. DECC (NSW) (2005) **Threatened Species Profile - *Macropus parma* Parma Wallaby** New South Wales Department of Environment and Climate Change, Hurstville, NSW.
21. DECC (NSW) (2005) **Threatened Species Profile - *Melanodryas cucullata cucullata* Hooded Robin** New South Wales Department of Environment and Climate Change, Hurstville, NSW.
22. DECC (NSW) (2005) **Threatened Species Profile - *Miniopterus schreibersii oceanensis* Eastern Bentwing Bat** New South Wales Department of Environment and Climate Change, Hurstville, NSW.
23. DECC (NSW) (2005) **Threatened Species Profile - *Myotis macropus* Large-footed Myotis** New South Wales Department of Environment and Climate Change, Hurstville, NSW.
24. DECC (NSW) (2005) **Threatened Species Profile - *Vespadelus troughtoni* Eastern Cave Bat** New South Wales Department of Environment and Climate Change, Hurstville, NSW.
25. DECC (NSW) (2005) **Threatened Species Profiles - *Chalinolobus dwyeri* Large-eared Pied Bat** New South Wales Department of Environment and Climate Change, Hurstville, NSW.
26. DECC (NSW) (2005) **Threatened Species Profiles - *Dasyurus maculatus maculatus* Spotted-tailed Quoll** New South Wales Department of Environment and Climate Change, Hurstville, NSW.
27. DECC (NSW) (2008) **Recovery Plan for the Koala (*Phascolarctos cinereus*)** Department of Environment and Climate Change, Sydney, NSW.

28. DECC (NSW) (2009) **Atlas of NSW Wildlife**
<http://wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp> *last accessed*
 2009
29. DEH (2006) **EPBC Act Policy Statements - White Box - Yellow Box - Blakely's Red Gum grassy woodlands and derived native grasslands** Department of the Environment and Heritage, Canberra.
30. Department of Mineral Resources (1999) **Synoptic Plan: Integrated Landscapes for Coal Mine Rehabilitation in the Hunter Valley of NSW** for Department of Primary Industries
31. DEWHA (2009) **EPBC Protected Matters Search Tool**
<http://www.environment.gov.au/erin/ert/epbc/index.html>
32. DEWHA (2009) **Species Profile and Threats Database - *Hirundapus caudacutus* White-throated Needletail** Department of the Environment, Water, Heritage and the Arts, Canberra.
33. DEWHA (2009) **Species Profile and Threats Database - *Merops ornatus* Rainbow Bee-eater** Department of the Environment, Water, Heritage and the Arts, Canberra.
34. Envirosciences Pty Ltd (1993) **Environmental Impact Statement for Bengalla Coal Mine.** For Bengalla Mining Company Pty Ltd
35. ERM Mitchell McCotter (1997) **Mount Pleasant Mine Environmental Impact Statement** ERM Mitchell McCotter, Sydney.
36. Hansen Bailey (2007) **Drayton Mine Extension Flora and Fauna Impact Assessment. Prepared for Anglo Coal (Drayton Management) Pty Limited** Hansen Bailey, Brisbane, QLD.
37. Harden, G. J. (1990-1993) **Flora of NSW** Volumes 1-4 University of New South Wales Press, Kensington.
38. Higgins, P. J. (1999) **Handbook of Australian, New Zealand and Antarctic Birds Volume 4** Oxford University Press, Melbourne.
39. Lill, A. (1993) **Breeding of Rainbow Bee-eaters in southern Victoria** *Corella* 17:100-106
40. MSC Environmental Services Department (2006) **Muswellbrook Shire Council State of the Environment Report 2005-2006** Muswellbrook Shire Council, Muswellbrook, NSW.
41. (1992) **An Interim Guide To Identification of Insectivorous Bats of South-Eastern Australia.** Australian Museum

42. Peake, Travis C. (2006) **The Vegetation of the Central Hunter Valley, New South Wales. A Report on the Findings of the Hunter Remnant Vegetation Project. Final Draft.** Hunter-Central Rivers Catchment Management Authority, Paterson.
43. Resource Planning Pty Limited (1993) **Bayswater No. 3 Coal Coal Mine Project Environmental Impact Statement. Report prepared for Bayswater Colliery Company Pty Limited**
44. Richardson, F. J., Richardson, R. G., and Shepherd, R. C. H. (2006) **Weeds of the South-East: An Identification Guide for Australia** R.G. & F.J. Richardson, Victoria.
45. Tarburton, M. K. (1993) **Radiotracking a White-throated Needletail to roost** *Emu* 93:121-124
46. Umwelt (Australia) Pty. Limited (2006) **Anvil Hill Project environmental assessment Volume 3 - Appendices 7-8** Report prepared for Centennial Hunter Pty. Limited Umwelt (Australia) Pty. Limited, Toronto.
47. Umwelt Environmental Consultants (2003) **Mt Arthur Coal - Ecological Monitoring Report** Umwelt (Australia) Pty. Limited., Toronto.
48. Umwelt Environmental Consultants (2005) **Mt Arthur Coal - 2004 Ecological Monitoring Report** Umwelt (Australia) Pty. Limited., Toronto.
49. Umwelt Environmental Consultants (2006) **Mt Arthur Coal - 2005 Ecological Monitoring Report. DRAFT** Umwelt (Australia) Pty. Limited., Toronto.
50. Umwelt Environmental Consultants (2006) **Mount Arthur Coal - Ecological Assessment Proposed South Pit Extension** Umwelt (Australia) Pty. Ltd., Toronto, NSW.
51. Umwelt Environmental Consultants (2007) **2006 Ecological Monitoring Report - Mt Arthur Coal** Umwelt (Australia) Pty. Limited, Toronto.
52. Umwelt Environmental Consultants (2007) **Ecological Assessment - Proposed Mount Arthur Underground Project** Umwelt (Australia) Pty. Ltd. Toronto, NSW.
53. Umwelt Environmental Consultants (2008) **Results of 2007 Nest Box Monitoring - Mt Arthur Coal** Umwelt (Australia) Pty. Limited, Toronto.
54. Umwelt Environmental Consultants (2008) **Plan of Management for the Painted Diuris (*Diuris Tricolor*) at A171** Umwelt (Australia) Pty. Ltd., Toronto, NSW.
55. Wildthing Environmental Consultants (2008) **Draft 2007 Ecological Monitoring Report - Mount Arthur Coal** Wildthing Enterprises Pty. Ltd., Wallsend, NSW.

Appendix A

Flora Data

The cover-abundance scores used to measure the relative frequency of occurrence of plant species occurring within a 1000 m² sampling quadrat are shown in **Table A.1** below. The quadrat data collected are presented in **Table A.3** and is followed by a complete flora list of all the species that have been detected over the cumulative years of survey (**Table A.4**).

Table A.1 MODIFIED BRAUN-BLANQUET COVER-ABUNDANCE SCORES

Class	Cover-abundance	Notes
R	Rare (less than 0.1% cover)	Herbs, sedges and grasses: within 1 m ² Shrubs and small trees: 1 individual
+	Few Individuals (less than 1% cover)	Herbs, sedges and grasses: within 10 m ² Shrubs and small trees: <5 individuals medium - large overhanging tree
1	Many Individuals (less than 5% cover)	Herbs, sedges and grasses: within 50 m ² Shrubs and small trees: 5 or more individuals One medium - large tree
2	5 - less than 25% cover	-
3	25 - less than 50% cover	-
4	50 - less than 75% cover	-
5	75 - 100% cover	-

Table A.2 FLORA QUADRAT KEYS

(Keys used in quadrat data table. Refer to Table A.3 following)

* = exotic species

n = Species listed as a characteristic native species under EPBC Act for Box Gum Woodland

i = Important species listed under minimum condition criteria

Dominant canopy tree species

x = occurs adjacent and outside of sampling quadrat

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Trees																											
Casuarinaceae	<i>Allocasuarina leuhmannii</i>	n								3				+												+	
Myrtaceae	<i>Angophora floribunda</i>	n			+			+																			
	<i>Eucalyptus albens</i>	n											2														
	<i>Eucalyptus albens</i> x <i>moluccana</i>	x	3	1			2	1	2	3	2	3	2	+			x	3	1	+	1		x	x		+	
	<i>Eucalyptus blakelyi</i>	n	+	1	2			1	2																		
	<i>Eucalyptus crebra</i>												2						2			x					
	<i>Eucalyptus dawsonii</i>					2									+							x					
	<i>Eucalyptus melliodora</i>	n	1	1	1																						
Sterculiaceae	<i>Brachychiton populneus</i>	n					R				x	+				+		+	2	+			+				
Shrubs																											
Asclepidaceae	<i>Gomphocarpus fruticosus</i> *			+		+	R				R	+	+	+	+		+		+	+						+	
Asteraceae	<i>Cassinia quinquefaria</i>	n							+							+	+	+	+	+							
Casuarinaceae	<i>Allocasuarina verticillata</i> (juvenile)	n																+									
Chenopodiaceae	<i>Enchylaena tomentosa</i>		+	+						1	+																
	<i>Maireana microphylla</i>	n	1	+	+	+			+	+	+	+	+	+	+			+		+	+				+	+	
	<i>Sclerolaena birchii</i> (syn. <i>Bassia birchii</i>)												+					+							+		
Chloanthaceae	<i>Spartothamnella juncea</i>							+	+									+	+	+							

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Crassulaceae	<i>Bryophyllum delagoense</i> *	1			1																					
Euphorbiaceae	<i>Breynia oblongifolia</i>							R																		
Fabaceae	<i>Acacia decora</i>	i														+		2								+
	<i>Acacia implexa</i>	n					1					+														+
	<i>Acacia salicina</i>																		+							
	<i>Bossiaea prostrata</i>	i						R	+																	
	<i>Senna aciphylla</i>															+				+						
	<i>Templetonia stenophylla</i>	i															+						+			+
Goodeniaceae	<i>Goodenia ovata</i>																		+							
Myoporaceae	<i>Myoporum acuminatum</i>							2			1	+								+						
	<i>Myoporum parvifolium</i>										1															
Oleaceae	<i>Notolaea microcarpa</i>	n		+	+			2	2		x							+	+	+						+
	<i>Olea europea ssp cuspidata</i> *																			+						
Pittosporaceae	<i>Bursaria spinosa</i>	n		+				+										1								
Rubiaceae	<i>Canthium odoratum</i>							+	+									+		+						
Rutaceae	<i>Geijera parviflora</i>	n																								
Solanaceae	<i>Lycium ferocissimum</i> *					1	+		1	+	2	+				+									+	+
	<i>Solanum cinereum</i>											+	+	+	+	+	+	+	+	+	+					
Thymelaceae	<i>Pimelea curviflora</i>	i															+		+	+	+		+			
	<i>Pimelea sp.</i>	i						R			+								+	+						

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Grasses																										
Poaceae	<i>Aristida ramosa</i>	n	3	+	1			+	+	2	1					3		2	+							
	<i>Aristida vagans</i>																	2	2	+						+
	<i>Austrodanthonia fulva</i>											+				+										
	<i>Austrodanthonia racemosa</i>	n											+			+	+		+	+						
	<i>Austrodanthonia sp</i>															+						+				1
	<i>Austrodanthonia tenuior</i>					1		+	+	+	+															
	<i>Austrostipa scabra</i>	n											2	+		+		+	+							
	<i>Austrostipa sp</i>																					3				
	<i>Austrostipa verticillata</i>				2	+	1	+	+	1	2	3	1	+					+	+	1	+				+
	<i>Avena barbata</i> *											+														
	<i>Axonopus affinis</i> *								+																	
	<i>Bothriochloa macra</i>	n	1	1	1	1	+		1	1			+	+		+	+	+	+	+	+	+	+	2		+
	<i>Briza minor</i> *											+		+					+				+			
	<i>Bromus cathartica</i> *																							+	+	+
	<i>Bromus molliformis</i> *	+				1							+	+		+			+	+		+			+	+
	<i>Chloris truncata</i>	n		+	+		1			2		+			+	+	+						+	+		+
	<i>Chloris ventricosa</i>	n	+	+	+		3	+	+	+	+	+	+	+				+	+	+			+			+
	<i>Cymbopogon refractus</i>	n			+	+	1	+	1	1	+	+	+	+			+	+	+	+			+			+
	<i>Cynodon dactylon</i>	1	+	+	+				+			+	+	+								+			3	
	<i>Cynosurus echinatus</i> *																									+

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	<i>Dichelachne crinita</i>	i																	+	+				+	+	
	<i>Dichelachne micrantha</i>	i					+							+	+		2									3
	<i>Digitaria brownii</i>															+					+					
	<i>Elymus scaber</i>	n		+			+					+	1	+	+	+	1	+		+	+	+	+	3		1
	<i>Entolasia stricta</i>	1																								
	<i>Eragrostis leptostachya</i>			1		1	+	+	+	+		+		+	+				+				+			+
	<i>Hordeum glaucum*</i>													+	+											3
	<i>Hordeum leporinum*</i>																				+					
	<i>Lachnagrostis filiformis</i> (syn. <i>Agrostis avenacea</i>)				+	+	3	+	+	+		+	+			+	1	+				+	+	+	+	
	<i>Lolium rigidum*</i>													+							2		+			1
	<i>Lolium sp.*</i>		+	+							+			+								+				
	<i>Microlaena stipoides</i>	n	1	3	2	3	+	+	+	+	+						+		2	+		+				
	<i>Panicum effusum</i>	n						+			+				+											
	<i>Paspalidium distans</i>																+					+	+	+	+	+
	<i>Paspalum dilatatum*</i>					1								+												
	<i>Pennisetum clandestinum*</i>																+									
	<i>Poa sieberiana</i>	n					+	+	+			+	+						2	+						
	<i>Setaria geniculata*</i>																					+				
	<i>Sorghum leiocladium</i>	i																	+	+						
	<i>Sporobolus creber</i>	n										+	+	+			+				+					+

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	<i>Themeda australis</i>	i			+	1	+	+	+									+								
	<i>Vulpia bromoides</i> *																		+							
Herbs																										
Acanthaceae	<i>Brunoniella australis</i>	n						+							+	+	+	+		+			+			+
	<i>Rostellularia adscendens</i>	n													+	+	+	+					+			+
Adiantaceae	<i>Cheilanthes distans</i>	i																		+						+
	<i>Cheilanthes sieberi</i>	n	1	+	+	+	+	+	+	+					+	+	+	+	+	+		+	+			+
Aizoaceae	<i>Galenia pubescens</i> *		+	+		2	3		2	3		1	+	+	+	+				+		+	+	+	+	+
Alliaceae	<i>Nothoscordum borbonicum</i> *																					+				
Anthericaceae	<i>Arthropodium milleflorum</i>	i	+		+	+	R	+	+		+										+					+
	<i>Arthropodium sp.</i>	i																				+				
	<i>Dichopogon fimbriatus</i>	i																						X	X	X
Apiaceae	<i>Ciclospermum leptophyllum</i> *		+	+	+				+	+																
	<i>Daucus glochidiatus</i>	i		+	+			+	+	+	+	+	+	+	+	+	+	+	+							
	<i>Hydrocotyle laxiflora</i>																X		+							
	<i>Xanthosia sp.</i>								+																	
Apocynaceae	<i>Marsdenia sp</i>															+		+		+			+			
Asphodelaceae	<i>Asphodelus fistulosus</i> *								1			+				+			+	+						+
Asteraceae	<i>Arctotheca calendula</i> *				+		+			+																
	<i>Bidens pilosa</i> *												+													

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	<i>Calotis cuneifolia</i>	i			+							+	+			+			+				+			+
	<i>Calotis lappulacea</i>	i	+	1	+	+	+	+	+	+	+	1	+	+	+	+	+	2	+	+	+	+	+	+	+	+
	<i>Calotis</i> sp.	i	+																							
	<i>Chrysocephalum apiculatum</i>	i	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Chrysocephalum semipapposum</i>	i																+								
	<i>Cirsium vulgare</i> *	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	2	+	+	+	+	1	+
	<i>Conyza bonariensis</i> *	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+		+	+	1	2	+	+	+	+
	<i>Cotula australis</i>	n	+	+																						
	<i>Cymbonotus lawsonianus</i>	n	+	+	+	+	+	+		+		+								+				+		
	<i>Euchiton sphaericum</i>	n	+		+								2			+			+	+	+	+			+	
	<i>Glossogyne tannensis</i>																		+	+	+	+				+
	<i>Gnaphalium</i> sp.													+	+				+	+	+	+	+	+	+	+
	<i>Gnaphalium spicatum</i> *	+	+	+	+	+	+		+			+														
	<i>Hypochoeris radicata</i> *	+		+	+	+			+			+														
	<i>Lactuca seriola</i> *																		+				+			+
	<i>Senecio madagascariensis</i> *	1	+	+	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1	+	+	+	+
	<i>Senecio quadridentatus</i>	n	+	+	+							+	+	+	+	+	+	+	+	+	+		+	+	+	+
	<i>Sigesbeckia orientalis</i>	R						+	+				+						+							

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	<i>Silybum marianum</i> *																									+
	<i>Solenogyne belliodes</i>	R				R			+																	
	<i>Sonchus oleraceus</i> *	+	+	+	+	+	+	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Taraxacum officinale</i> *					+																				
	<i>Vittadinia cuneata</i>	n		+							+		+		+		+	+	+	+	+	+	+	+	+	+
	<i>Vittadinia muelleri</i>		+	+				+	+		+															
	<i>Vittadinia pterochata</i>		+			+					+	+														
	<i>Vittadinia</i> sp.	+																								
Boraginaceae	<i>Cynoglossum suaveolens</i>	n							+										+							
Brassicaceae	<i>Lepidium</i>				+						+	+	+		+	+										+
	<i>pseudohyssopifolium</i>																									
	<i>Lepidium</i> sp.																									+
Cactaceae	<i>Opuntia stricta</i> *	R	+	+				+	+	+		+	+					+	+	+	+	+	+			+
Campanulaceae	<i>Wahlenbergia communis</i>	n		+	+	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+			+	+
	<i>Wahlenbergia gracilis</i>	n																+					+			+
	<i>Wahlenbergia stricta</i>	n	+	+	+	+	+	+	+	+	+				+											+
Caryophyllaceae	<i>Cerastium glomeratum</i> *	+																								
	<i>Petrophagia dubia</i> *				+						+		+				+	+	+	+	+	+	+	+	+	+
Chenopodiaceae	<i>Einadia hastata</i>	1	+	+	+	+	+		+			+	+	+		+			+	+	+	+				
	<i>Einadia nutans</i> ssp <i>linifolia</i>	n	R	+		+	+	+	+	+	+	+				+										
	<i>Einadia polygonoides</i>											+				+					+	+	+	+	3	+

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	<i>Enchylaena tomentosa</i>												+	+		+		+				+				+
Clusiaceae	<i>Hypericum gramineum</i>	i						+									+		+							
Convolvulaceae	<i>Convolvulus erubescens</i>	n	+				+		+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Dichondra repens</i>	i	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Crassulaceae	<i>Crassula decumbens</i> var. <i>decumbens</i> (syn. <i>C. macrantha</i>)	+		+								+	+			+		+			+					
Cyperaceae	<i>Carex inversa</i>	n	+	+	+		+				+								+	+	+					
	<i>Cyperus tenellus</i>											+														
Euphorbiaceae	<i>Chamasyce drummondii</i>	n		+				+		+										+				+		+
	<i>Phyllanthus virgatus</i>																+	+	+	+		+				
	<i>Poranthera microphylla</i>	i							+																	
Fabaceae	<i>Desmodium brachypodium</i>	i						R	+			+			+											
	<i>Desmodium varians</i>	i	+	R				+	+			+														
	<i>Glycine clandestina</i>	i		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	<i>Glycine microphylla</i>						R		+							+			+	+		+				
	<i>Glycine tabacina</i>	i	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1	+	+	+
	<i>Hardenbergia violacea</i>								+																	
	<i>Medicago polymorpha</i> *																			+						2
	<i>Medicago</i> sp.*								+	+	+	+		+												
	<i>Mimosa pudica</i> *																								+	

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	<i>Swainsona galegifolia</i>								+																	
	<i>Trifolium arvense</i> *																					+			+	
	<i>Trifolium dubium</i> *		+	+	+	+	+				+	+	+				+									
	<i>Trifolium sp</i> *																	+	+	+						
	<i>Trifolium subterraneum</i> *																					+	+			
Gentianaceae	<i>Centaurium spicatum</i> *												+	+	+		+	+	+	+	+	+	+	+	+	+
Geraniaceae	<i>Erodium crinitum</i>	n	R				+		+	+	+							+	+	+	+	+			+	+
	<i>Geranium solanderi</i>	n																+	+							
	<i>Geranium sp.</i>	+			+				+																	
Goodeniaceae	<i>Goodenia sp.</i>		R		+										+	+	+			+		+		+		
	<i>Hibbertia sp.</i>																									
	<i>Scaevola aemula</i>																		+							
	<i>Scaevola albida</i>																	+								
Iridaceae	<i>Romulea rosea</i> *			+	+	+			+				+				+		+			+	+	+	+	+
Juncaceae	<i>Luzula sp.</i>	n			+																					
Lamiaceae	<i>Ajuga australis</i>	i	+				+	+																		
	<i>Marrubium vulgare</i> *												+					+	+	+	+					
	<i>Mentha satuireioides</i>	n								+	+															
Linaceae	<i>Linum marginale</i>	i					x		+								+		+			+	+	+	+	+
	<i>Linum trigynum</i> *																		+							
Lobeliaceae	<i>Pratia purpurescens</i>	n			+														+					+	+	+

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Lomandraceae	<i>Lomandra filiformis</i>	n							+					+	+	+	+	+	2	+			3			+
	<i>Lomandra longifolia</i>	n		1																						
	<i>Lomandra multiflora</i>	n	+	R	+	+	1	+	2	+	+	+			+	+	+	+	+	+		+				+
Luzuriagaceae	<i>Eustrephus latifolius</i>				+																					
	<i>Geitonoplesium cymosum</i>																+	+	+							
Malvaceae	<i>Modiola caroliniana*</i>													+						+	+	+		+		
	<i>Sida corrugata</i>	i										+	+	+	+	+	+	+	+	+	+	+	+	1		+
	<i>Sida rhombifolia *</i>		+	+	1	+	+	+		+		+		+	+	X	+		+	+	+	+	+			+
Myoporaceae	<i>Eremophila debilis</i>		+			+		+	+		+	+	+	+	+	+	+	+	+	+						+
Myrsinaceae	<i>Anagallis arvensis*</i>		+	+	+	+	+	+	+	+	+	+		+			+		+			+	+			+
Nyctaginaceae	<i>Boerhavia dominii</i>																			+			+			
Orchidaceae	<i>Microtus unifolia</i>	i														+	+		+	+						
	<i>Thysanotus pattersonii</i>	i																+								
Oxalidaceae	<i>Oxalis exilis</i>	n	1	+	+	+	+			+	+	+	+							+	+	+				
	<i>Oxalis perennans</i>	n												+				+		+	+					
Phormiaceae	<i>Dianella longifolia</i>	i	R	1				+	+								+	+	+	+	+					
Plantaginaceae	<i>Plantago debilis</i>	n	+	+		+			+	+	+	+	+			+	+	+	+	+	+	+	+	+	X	+
	<i>Plantago lanceolata*</i>		+	+	+	+	+		+	+	+	+	+	+	+		+	+	+	+		+		+		+
Polygonaceae	<i>Rumex brownii</i>	n	+		+														+							
Ranunculaceae	<i>Clematis glycinoides</i>		+					+	+								+	+	+	+						
Rosaceae	<i>Acaena novae-zelandiae</i>	n																	+	+	+					

Table A.3 CUMBERLAND ECOLOGY FLORA QUADRAT DATA (2008-09)

Family	Species Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Rubiaceae	<i>Asperula conferta</i>	i	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1
	<i>Galium propinquum</i> *																			+						
	<i>Opuncularia aspera</i>																	+								
	<i>Richardia stellaris</i> *																			+						
Scrophulariaceae	<i>Verbascum thapsis</i> *																	+	+							
	<i>Veronica plebia</i>	n	+	+	+	+	+	+	+	+	+							+								
Solanaceae	<i>Solanum nigrum</i> *								+	+	+	+				+	+	+	+	+						
	<i>Solanum pseudocapsicum</i> *		R																							
	<i>Solanum</i> sp.	+	+	+																						
Stackhousiaceae	<i>Stackhousia viminea</i>	n			R			+	+							+		+								+
Urticaceae	<i>Urtica dioica</i> *		+																							
Verbenaceae	<i>Verbena bonariensis</i> *	+	+											+	+		+			+				+		+
	<i>Verbena littoralis</i> var. <i>brasiliensis</i> *																							+		

Table A.4 FLORA SPECIES DETECTED OVER ALL SURVEYS WITHIN THE EA BOUNDARY

Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program				
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007
Trees												
Casuarinaceae	<i>Allocasuarina leuhmannii</i>	Buloak			X	X	X	X		X		X
	<i>Allocasuarina torulosa</i>	Forest Oak			X							
	<i>Allocasuarina verticillata</i>	Drooping Sheoak						X				
	<i>Casuarina cunninghamiana</i>	River Oak			X							
	<i>Casuarina glauca</i>	Swamp Oak					X					
Cupressaceae	<i>Callitris endlicheri</i>	Black Cypress Pine			X							
Lauraceae	* <i>Cinnamomum camphora</i>	Camphor Laurel				X						
Loranthaceae	<i>Amyema cambagei</i>				X							
	<i>Amyema miquelii</i>							X				
	<i>Amyema pendulum subsp. pendulum</i>							X	X	X		
	<i>Amyema sp.</i>						X				X	

Table A.4 FLORA SPECIES DETECTED OVER ALL SURVEYS WITHIN THE EA BOUNDARY

Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Moraceae	<i>Ficus rubiginosa</i>	Port Jackson Fig			X								
Myrtaceae	<i>Angophora floribunda</i>	Rough-barked Apple			X	X	X						
	<i>Corymbia maculata</i>	Spotted Gum			X	X				X	X	X	X
	<i>Eucalyptus albens</i>	White Box			X			X					
	<i>Eucalyptus albens</i> x <i>moluccana</i>	White Box-Grey Box intergrade				X	X	X	X	X	X		
	<i>Eucalyptus blakelyi</i>	Blakely's Red Gum			X		X	X			X	X	X
	<i>Eucalyptus camaldulensis</i>	River Red Gum			X								
	<i>Eucalyptus canaliculata</i>	Large-fruited Grey Gum			X								
	<i>Eucalyptus conica</i>	Fuzzy Box							X				
	<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark			X	X	X	X	X	X	X	X	
	<i>Eucalyptus dawsonii</i>	Slaty Gum			X		X	X					
	<i>Eucalyptus melliodora</i>	Yellow Box			X		X	X				X	X
	<i>Eucalyptus moluccana</i>	Grey Box			X	X	X	X				X	
	<i>Eucalyptus punctata</i>	Grey Gum			X	X	X	X					

Table A.4 FLORA SPECIES DETECTED OVER ALL SURVEYS WITHIN THE EA BOUNDARY

Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Salicaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum			X	X		X					
	<i>Melaleuca armillaris</i>	Bracelet Honey-myrtle			X								
	<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree			X								
	* <i>Salix babylonica</i>	Weeping Willow			X								
	<i>Brachychiton populneus</i>	Kurrajong			X			X					
Sterculiaceae	<i>Brachychiton populneus subsp. populneus</i>												
	<i>Notothixos cornifolius</i>	Kurrajong Mistletoe						X					
	<i>Notothixos sp.</i>						X						
Shrubs													
Asclepidaceae	* <i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush			X	X		X	X	X		X	
	* <i>Gomphocarpus sp.</i>							X					
Asteraceae	<i>Cassinia arcuata</i>	Sifton Bush			X								

Table A.4 FLORA SPECIES DETECTED OVER ALL SURVEYS WITHIN THE EA BOUNDARY

Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Celastraceae	<i>Cassinia quinquefaria</i>	Cough bush					X	X	X	X	X	X	X
	<i>Cassinia sp.</i>						X						
	<i>Olearia elliptica</i>	Sticky Daisy-bush					X						
	<i>Ozothamnus diosmifolius</i>	White Dogwood	X										
	<i>Maytenus silvestris</i>	Narrow-leaved Orangebark						X					
Chenopodiaceae	<i>Maireana microphylla</i>	Small-leaf Bluebush			X	X	X	X	X	X	X		
	<i>Maytenus silvestris</i>	Ruby Saltbush			X			X					
	<i>Sclerolaena birchii</i> (syn. <i>Bassia birchii</i>)							X					
	<i>Spartothamnella juncea</i>	Bead Bush			X	X	X	X	X	X	X		X
Euphorbiaceae	<i>Beyeria viscosa</i>	Pinkwood			X								
	<i>Breynia oblongifolia</i>	Coffee Bush			X		X	X	X	X	X		X
Fabaceae -	<i>Senna aciphylla</i>	Sprawling Cassia						X					
Caesalpinoideae													
Fabaceae -	<i>Bossiaea prostrata</i>							X					
Faboideae													

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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Fabaceae - Mimosoideae	<i>Bossiaea rhombifolia</i> <i>subsp. rhombifolia</i>						X						
	<i>Daviesia acicularis</i>			X									
	<i>Daviesia genistifolia</i>	Broom Bitter Pea				X							
	<i>Indigofera australis</i>	Australian Indigo			X	X	X					X	X
	<i>Indigofera pratensis</i>	Forest Indigo			X								
	<i>Jacksonia scoparia</i>	Dogwood					X						
	<i>Swainsona galegifolia</i>	Smooth Darling-pea			X			X					X
	<i>Templetonia stenophylla</i>	Leafy Templetonia							X				
	<i>Acacia parvipinnula</i>	Silver-stemmed Wattle					X						
	<i>Acacia ?pyncnantha</i>	Golden Wattle							X				
	<i>Acacia amblygona</i>	Fan Wattle					X						
	<i>Acacia binervia</i>	Coast Myall			X								
	<i>Acacia decora</i>	Western Golden Wattle			X		X	X				X	
	<i>Acacia excelsa</i>	Ironwood			X								

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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Goodeniaceae	<i>Acacia falcata</i>								X	X		X	X
	<i>Acacia genistifolia</i>	Early Wattle				X							
	<i>Acacia gunnii</i>	Ploughshare Wattle					X						
	<i>Acacia implexa</i>	Hickory Wattle				X	X	X		X		X	
	<i>Acacia melanoxylon</i>	Blackwood			X								
	<i>Acacia paradoxa</i>	Kangaroo Thorn					X						
	<i>Acacia parramattensis</i>	Parramatta Wattle			X								
	<i>Acacia pendula</i>	Weeping Myall		E2			X						
	<i>Acacia podalyriifolia</i>	Queensland Silver Wattle			X								
		<i>Acacia salicina</i>	Cooba			X	X	X	X				
Malvaceae	<i>Acacia sp.</i>				X								
	<i>Goodenia ovata</i>	Hop Goodenia			X			X					
	<i>Hibiscus sturtii</i>	Hill Hibiscus			X		X						
	<i>Hibiscus sturtii</i> var. <i>sturtii</i>						X	X					
	<i>Lagunaria patersonia</i>	Norfolk Island Hibiscus			X								

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Myoporaceae	<i>Myoporum acuminatum</i>							X					
	<i>Myoporum montanum</i>	Western Boobialla					X		X				X
	<i>Myoporum parvifolium</i>	Creeping Boobialla						X					
	<i>Jasminum suavisissimum</i>							X					
Oleaceae	<i>Notelaea longifolia</i>	Large Mock-olive			X								
	<i>Notelaea microcarpa</i>	Native Olive			X	X	X	X					
	<i>Notelaea microcarpa</i>					X	X		X	X	X	X	X
	<i>var. microcarpa</i>												
	<i>Olea europea ssp cuspidata</i>	African Olive				X		X					
Pittosporaceae	<i>Billardiera scandens</i>	Hairy Apple Berry			X								
	<i>Bursaria spinosa</i>	Blackthorn			X	X		X					
	<i>Bursaria spinosa</i>						X		X	X	X	X	X
	<i>subsp. spinosa</i>												
Rhamnaceae	<i>Cryptandra amara</i>	Bitter cryptandra						X					
Rubiaceae	<i>Psydrax odorata (syn. Canthium odoratum)</i>	Lamboto			X	X	X	X					
	<i>Psydrax odorata f. buxifolia</i>												
							X						

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Rutaceae	<i>Geijera parviflora</i>	Wilga						X					
Santalaceae	<i>Exocarpos cupressiformis</i>	Native Cherry			X								
Sapindaceae	<i>Dodonaea viscosa</i>				X								
Solanaceae	* <i>Lycium ferocissimum</i>	African Boxthorn			X	X	X	X	X	X	X	X	
	* <i>Nicotiana glauca</i>	Tree Tobacco			X								
	<i>Solanum brownii</i>	Violet Nightshade			X	X	X	X	X	X	X	X	
	<i>Solanum cinereum</i>	Narrawa Burr						X					
	* <i>Solanum pseudocapsicum</i>	Jerusalem Cherry						X					
Thymelaceae	<i>Pimelea curviflora</i>												X
	<i>Pimelea curviflora</i> var. <i>divergens</i>					X							
	<i>Pimelea curviflora</i> var. <i>sericea</i>							X					
	<i>Pimelea glauca</i>							X					
	<i>Pimelea linifolia</i>	Slender Rice Flower				X	X		X				
	<i>Pimelea linifolia</i> subsp.											X	

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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	<i>linifolia</i>												
	<i>Pimelea</i> sp.							X		X			
Verbenaceae	* <i>Lantana montevidensis</i>	Trailing Lantana			X								
Violaceae	<i>Melicytus dentatus</i>	Tree Violet					X						
Herbs - Dicots													
Acanthaceae													
	<i>Brunoniella australis</i>	Blue Trumpet			X			X		X		X	
	<i>Pseuderanthemum variabile</i>	Pastel Flower							X				
	<i>Rostellularia adscendens</i>						X	X					X
	<i>Rostellularia adscendens</i> var. <i>adscendens</i>								X	X	X		
Aizoaceae	* <i>Galenia pubescens</i>	Galenia						X		X		X	X
	<i>Tetragonia tetragonioides</i>	New Zealand Spinach			X								
Alismataceae	<i>Damasonium minus</i>	Starfruit			X								
Amaranthaceae	* <i>Alternanthera pungens</i>	Khaki Weed						X					

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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Apiaceae	* <i>Amaranthus quitensis</i>	South American Amaranth			X								
	* <i>Gomphrena celosioides</i>	Gomphrena Weed					X						
	<i>Ptilotus semilanatus</i>						X						
	<i>Centella asiatica</i>	Indian Pennywort			X								
	* <i>Cyclospermum leptophyllum</i>	Slender Celery			X		X						
	<i>Daucus glochidiatus</i>	Native Carrot					X				X		
	* <i>Foeniculum vulgare</i>	Fennel			X								
	<i>Hydrocotyle laxiflora</i>	Stinking Pennywort			X		X			X			
	<i>Xanthosia</i> sp.							X					
	* <i>Asphodelus fistulosus</i>	Onion Weed			X		X			X			
Asphodelaceae													
Asteraceae	<i>?Millotia</i> sp.							X					
	* <i>Ambrosia artemisiifolia</i>	Annual Ragweed			X								
	* <i>Ambrosia tenuifolia</i>	Lacy Ragweed			X								
	* <i>Arctotheca calendula</i>	Capeweed			X			X					
	* <i>Aster subulatus</i>	Wild Aster				X							
	* <i>Bidens pilosa</i>	Farmers Friend			X		X	X	X	X	X	X	X

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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	<i>Brachyscome angustifolia</i>				X								
	<i>Brachyscome multifida</i>	Cut-leaved Daisy			X	X							
	<i>Calocephalus citreus</i>	Lemon Beauty-heads						X					
	<i>Calotis cuneifolia</i>	Purple Burr-daisy			X			X			X		
	<i>Calotis lappulacea</i>	Yellow Burr-daisy			X	X	X	X	X	X	X	X	X
	<i>Calotis</i> sp.					X		X					
*	<i>Carduus nutans</i>	Nodding Thistle			X								
*	<i>Carthamus lanatus</i>	Saffron Thistle			X			X			X		X
*	<i>Chondrilla juncea</i>	Skeleton Weed				X							
	<i>Chrysocephalum apiculatum</i>	Common Everlasting				X	X	X	X	X	X	X	X
	<i>Chrysocephalum semipapposum</i>	Clustered Everlasting						X					
	<i>Chrysocephalum</i> sp.											X	
*	<i>Cirsium vulgare</i>	Spear Thistle			X			X	X	X	X	X	X
*	<i>Conyza bonariensis</i>	Flaxleaf Fleabane			X			X					X

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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*	<i>Conyza sumatrensis</i>	Tall Fleabane			X	X	X		X				X
*	<i>Coreopsis lanceolata</i>	Coreopsis				X							
	<i>Cotula australis</i>	Common Cotula			X			X					
*	<i>Cotula coronopifolia</i>	Water Buttons			X								
	<i>Craspedia variabilis</i>				X								
*	<i>Crepis capillaris</i>	Smooth Hawksbeard						X					
	<i>Cymbonotus lawsonianus</i>	Bears-ear						X					
	<i>Euchiton gymnocephalus</i>	Creeping Cudweed					X						
	<i>Euchiton involucratus</i>	Star Cudweed			X						X	X	
	<i>Euchiton sp.</i>						X						X
	<i>Euchiton sphaericus</i>				X				X				
*	<i>Galinsoga parviflora</i>	Potato Weed			X								
*	<i>Gamochaeta americana</i>	Cudweed										X	
	<i>Glossogyne tannensis</i>	Cobblers Tack			X			X	X	X			X

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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	<i>Gnaphalium</i> sp.	a cudweed						X					
*	<i>Hedynois rhagadioloides</i>				X								
*	<i>Hypochoaeris radicata</i>	Catsear			X	X	X	X	X	X		X	
*	<i>Lactuca saligna</i>	Willow-leaved Lettuce			X								
*	<i>Lactuca serriola</i>	Prickly Lettuce						X					X
	<i>Minuria</i> sp.											X	
*	<i>Onopordum acanthium</i> subsp. <i>acanthium</i>	Scotch Thistle				X	X						
	<i>Podolepis jaceoides</i>	Showy Copper-wire Daisy			X								
	<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed			X								
	<i>Senecio hispidulus</i>	Hill Fireweed						X					
*	<i>Senecio madagascariensis</i>	Fireweed			X	X			X	X	X	X	X
	<i>Senecio quadridentatus</i>	Cotton Fireweed						X				X	X
	<i>Senecio</i> sp.										X		

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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	<i>Sigesbeckia orientalis</i>							X					
	<i>Sigesbeckia</i> sp.							X					
*	<i>Silybum marianum</i>	Variegated Thistle			X			X					
	<i>Solenogyne bellicoides</i>							X					
*	<i>Soliva sessilis</i>	Bindyi			X								
*	<i>Sonchus oleraceus</i>	Common Sowthistle			X			X		X		X	X
*	<i>Tagetes minuta</i>	Stinking Roger					X						
*	<i>Taraxacum officinale</i>	Dandelion					X	X					
*	<i>Tragopogon porrifolius</i>	Salsify					X	X					
	<i>Vernonia cinerea</i>						X	X				X	
	<i>Vernonia cinerea</i> var. <i>cinerea</i>						X	X		X		X	X
	<i>Vittadinia cuneata</i>	Fuzzweed			X		X						X
	<i>Vittadinia cuneata</i> var. <i>cuneata</i>						X	X					
	<i>Vittadinia muelleri</i>						X	X					
	<i>Vittadinia pterochaeta</i>	Winged New										X	X

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program						
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Boraginaceae		Holland Daisy												
		<i>Vittadinia sp.</i>					X	X	X					X
		<i>Vittadinia sulcata</i>								X				
	*	<i>Xanthium spinosum</i>	Bathurst Burr					X						
		<i>Cynoglossum australe</i>									X			
		<i>Cynoglossum suaveolens</i>			X				X					X
Brassicaceae	*	<i>Capsella bursa-pastoris</i>	Shepherd's Purse		X									
	*	<i>Hirschfeldia incana</i>	Buchan Weed		X									
	*	<i>Lepidium africanum</i>			X			X		X	X	X		
	*	<i>Lepidium bonariense</i>												X
		<i>Lepidium</i>	Peppercress				X	X	X					
		<i>pseudohyssopifolium</i>												
		<i>Lepidium sp.</i>												
	*	<i>Raphanus raphanistrum</i>	Wild Radish			X		X	X					
	*	<i>Rapistrum rugosum</i>	Turnip Weed											
	*	<i>Harrisia martinii</i>			X									

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Campanulaceae	* <i>Opuntia aurantiaca</i>	Tiger Pear					X			X			
	* <i>Opuntia stricta</i>	Common Prickly Pear			X				X				X
	* <i>Opuntia stricta</i> var. <i>stricta</i>	Common Prickly Pear				X	X		X	X	X		
	<i>Wahlenbergia communis</i>	Tufted Bluebell					X		X	X	X	X	
	<i>Wahlenbergia gracilis</i>	Sprawling Bluebell			X				X	X	X	X	X
Caryophyllaceae	<i>Wahlenbergia</i> sp.					X	X			X		X	
	<i>Wahlenbergia stricta</i>	Australian Bluebell			X				X				
	* <i>Agrostemma githago</i>	Corn Cockle			X								
	<i>Cerastium fontanum</i>						X						
	* <i>Cerastium glomeratum</i>	Mouse-ear Chickweed							X				
	* <i>Paronychia brasiliiana</i>	Chilean Whitlow Wort					X		X				
	* <i>Petroghagia dubia</i>										X		
	* <i>Petroghagia</i> sp.							X					
	<i>Petroghagia nanteuillii</i>				X								

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Chenopodiaceae	* <i>Petrohragia velutina</i>												X
	<i>Polycarpon tetraphyllum</i>	Four-leaved Allseed					X	X					
	* <i>Polycarpon tetraphyllum</i>	Four-leaved Allseed			X								
	<i>Silene ?gallica</i>							X					
	* <i>Silene gallica var. gallica</i>	French Catchfly				X			X				
	<i>Silene nocturna</i>								X				
	* <i>Spergularia rubra</i>	Sandspurry					X						
	<i>Stellaria flaccida</i>							X					
	<i>Atriplex semibaccata</i>	Creeping Saltbush						X					X
	<i>Atriplex sp.</i>						X						
	<i>Chenopodium sp.</i>							X					
	<i>Einadia hastata</i>	Berry Saltbush				X	X	X		X	X		X
	<i>Einadia nutans</i>	Climbing Saltbush				X	X			X	X		
	<i>Einadia nutans ssp linifolia</i>						X	X		X	X		X

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Clusiaceae	<i>Einadia polygonoides</i>						X						X
	<i>Einadia trigonos</i>	Fishweed				X			X				
	<i>Enchylaena tomentosa</i>	Ruby Saltbush					X		X		X	X	X
	<i>Hypericum gramineum</i>	Small St. John's Wort			X		X		X		X	X	
Convolvulaceae	* <i>Hypericum perforatum</i>	St. Johns Wort											X
	<i>Convolvulus erubescens</i>	Blushing Bindweed			X	X	X		X		X	X	X
	<i>Dichondra repens</i>	Kidney Weed			X	X	X		X	X	X	X	X
	<i>Evolvulus alsinoides</i>						X						
Crassulaceae	<i>Evolvulus alsinoides</i>												
	<i>var. decumbens</i>												
	* <i>Bryophyllum delagoense</i>	Mother-of-Millions			X	X	X		X				
	<i>Crassula decumbens</i>												
	<i>var. decumbens</i> (syn. <i>C. macrantha</i>)												
	<i>Crassula sieberiana</i>	Australian Stonecrop											

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Euphorbiaceae	<i>Chamaesyce ?drummondii</i>	Caustic Weed					X						
	<i>Chamaesyce drummondii</i>	Caustic Weed			X	X							
	<i>Phyllanthus similis</i>					X							
	<i>Phyllanthus sp.</i>				X	X			X				
	<i>Phyllanthus virgatus</i>			X	X	X		X	X	X	X	X	X
	<i>Poranthera microphylla</i>												
	<i>Senna clavigera</i>							X					
Fabaceae - Caesalpinioideae													
Fabaceae - Faboideae	<i>Desmodium brachypodium</i>	Large Tick-trefoil			X				X				
	<i>Desmodium gunni</i>	Slender Tick-trefoil						X					
	<i>Desmodium sp.</i>							X					
	<i>Desmodium varians</i>	Slender Tick-trefoil			X		X	X	X	X	X	X	X
*	<i>Medicago ?polymorpha</i>	Burr Medic					X						
*	<i>Medicago polymorpha</i>	Burr Medic			X				X				
*	<i>Medicago sativa</i>	Lucerne			X							X	X

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Fabaceae - Mimosoideae	*	<i>Medicago sp.</i>					X		X				
	*	<i>Medicago truncatula</i>			X								
		<i>Melilotus indicus</i>			X	X							
	*	<i>Trifolium arvense</i>					X		X				
	*	<i>Trifolium campestre</i>					X				X		
	*	<i>Trifolium dubium</i>							X				
	*	<i>Trifolium repens</i>				X	X		X		X		
	*	<i>Trifolium sp.</i>					X		X				X
	*	<i>Trifolium subterraneum</i>			X				X				
	*	<i>Vicia sativa</i>			X								
	*	<i>Vicia sp.</i>						X					
	<i>Zornia dyctiocarpa</i> var. <i>dyctiocarpa</i>										X		
	*	<i>Mimosa pudica</i>							X				
	*	<i>Centaureum erythraea</i>			X							X	

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			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007
Geraniaceae	* <i>Centaurium tenuiflorum</i>								X	X		
	* <i>Schenkia spicata</i> (syn. <i>Centaurium spicatum</i>)	Spike Centaury				X		X		X		
	* <i>Erodium cicutarium</i>	Common Crowfoot									X	
	<i>Erodium crinitum</i>	Blue Storksbill					X					
	<i>Erodium</i> sp.		X		X							
	* <i>Geranium dissectum</i>				X							
	<i>Geranium solanderi</i>	Native Geranium					X					
	<i>Geranium solanderi</i> var. <i>solanderi</i>										X	
	<i>Geranium</i> sp.					X		X				
	<i>Goodenia paniculata</i>	Branched Goodenia		X				X				
Goodeniaceae	<i>Goodenia pinnatifida</i>					X				X		X
	<i>Goodenia</i> sp.				X			X				
	<i>Hibbertia</i> sp.						X					
	<i>Scaevola aemula</i>	Fairy Fan-flower						X				
	<i>Scaevola albida</i>	Pale Fan-flower									X	

Table A.4 FLORA SPECIES DETECTED OVER ALL SURVEYS WITHIN THE EA BOUNDARY

Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Lamiaceae	<i>Scaevola humilis</i>						X						
	<i>Scaevola sp.</i>			X									
	<i>Ajuga australis</i>	Austral Bugle					X	X				X	
	<i>Clerodendrum tomentosum</i>	Hairy Clerodendrum						X					
	* <i>Marrubium vulgare</i>	White Horehound			X	X	X	X					
	<i>Mentha satureioides</i>	Creeping Mint				X	X	X				X	
	<i>Plectranthus parviflorus</i>				X								
	<i>Salvia sp.</i>					X							
	<i>Scutellaria humilis</i>	Dwarf Skullcap						X					
	* <i>Stachys arvensis</i>	Stagger Weed										X	
Linaceae	<i>Linum marginale</i>	Native Flax					X	X					
	* <i>Linum trigynum</i>	French Flax					X	X				X	
	* <i>Linum usitatissimum</i>	Flax			X								
	<i>Pratia purpurascens</i>	Whiteroot					X	X					
Malvaceae	<i>Abutilon oxycarpum</i>	Flannel Weed					X						
	<i>Abutilon sp.</i>							X					

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
	* <i>Modiola caroliniana</i>	Red-flowered Mallow						X			X	X	X
	<i>Sida cordifolia</i>				X								
	<i>Sida corrugata</i>		X			X		X	X	X	X		
	<i>Sida cunninghamii</i>							X					X
	<i>Sida filiformis</i>				X								
	* <i>Sida rhombifolia</i>	Paddy's Lucerne		X	X		X	X	X	X	X	X	X
	<i>Sida sp.</i>							X		X			
	<i>Eremophila debilis</i>	Winter Apple			X	X		X	X	X	X	X	X
Myoporaceae	<i>Eremophila deserti</i>	Turkeybush		X									
	* <i>Anagallis arvensis</i>	Scarlet Pimpernel		X	X		X	X	X		X		
Nyctaginaceae	<i>Boerhavia dominii</i>	Tarvine						X	X				
	* <i>Oxalis corniculata</i>	Creeping Oxalis		X									
Oxalidaceae	<i>Oxalis exilis</i>					X	X	X	X	X	X		X
	<i>Oxalis perennans</i>			X									
	* <i>Oxalis pes-caprae</i>	Soursob		X									
Plantaginaceae	<i>Plantago debilis</i>					X	X	X	X				
	* <i>Plantago lanceolata</i>	Lamb's Tongues		X	X	X	X	X	X	X	X	X	X

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Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Environmental Assessments					Monitoring Program			
					MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
	* <i>Plantago myosuros</i>							X					
	<i>Veronica calycina</i>	Hairy Speedwell					X	X					
	<i>Veronica plebeia</i>	Trailing Speedwell						X				X	
	<i>Veronica sp.</i>					X	X						
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed			X								
	* <i>Polygonum arenastrum</i>	Wireweed					X						
	* <i>Polygonum aviculare</i>	Wireweed							X			X	
	<i>Rumex brownii</i>	Swamp Dock				X	X	X				X	
Portulacaceae	<i>Portulaca oleracea</i>	Pigweed							X				
Ranunculaceae	<i>Ranunculus inundatus</i>	River Buttercup			X								
Rosaceae	<i>Acaena novae-zelandiae</i>	Bidgee-widgee				X		X					
	<i>Asperula conferta</i>	Common Woodruff						X					
Rubiaceae	* <i>Galium propinquum</i>	Maori Bedstraw						X		X			
	<i>Galium sp.</i>						X			X			
	<i>Opercularia aspera</i>	Coarse Stinkweed						X					
	<i>Opercularia diphylla</i>							X					
	<i>Opercularia sp.</i>						X						

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Scrophulariaceae	<i>Pomax umbellata</i>					X							
	<i>Richardia sp.</i>					X							
	* <i>Richardia stellaris</i>					X	X	X				X	
	* <i>Linaria pelisseriana</i>	Pelisser's Toadflax				X	X		X			X	
	* <i>Verbascum thapsus</i>	Great Mullein						X					
	* <i>Verbascum virgatum</i>	Twiggy Mullein			X								
	* <i>Solanum</i>	Whitetip						X					
Solanaceae	<i>?chenopodioides</i>	Nightshade											
	* <i>Solanum nigrum</i>	Black-berry			X			X					
		Nightshade											
	<i>Solanum opacum</i>	Green-berry					X					X	
Stackhousiaceae		Nightshade											
	<i>Solanum sp.</i>												
	<i>Stackhousia viminea</i>	Slender			X			X	X				X
		Stackhousia											
Urticaceae	* <i>Urtica dioica</i>	Stinging Nettle							X				
Verbenaceae	* <i>Verbena aristigera</i>						X						
	* <i>Verbena bonariensis</i>	Purpletop			X	X	X	X				X	

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Herbs - Monocots	<i>Verbena gaudichaudii</i>						X						
	<i>Verbena litoralis</i>						X						
	* <i>Verbena littoralis x brasiliensis</i>							X					
	* <i>Verbena rigida</i>	Veined Verbena			X	X						X	
	<i>Verbena sp.</i>						X						
	* <i>Nothoscordum borbonicum</i>	Onion Weed			X			X					
	<i>Arthropodium milleflorum</i>	Pale Vanilla-lily						X					X
	<i>Arthropodium minus</i>							X					
	<i>Arthropodium sp.</i>							X	X			X	
	<i>Dichopogon fimbriatus</i>	Nodding Chocolate Lily			X	X		X					X
<i>Dichopogon sp.</i>													
<i>Dichopogon strictus</i>	Chocolate Lily								X		X		
								X					

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
Commelinaceae	<i>Laxmannia compacta</i>											X	
	<i>Thysanotus tuberosus</i>	Common Fringe-lily			X								
	<i>Commelina cyanea</i>	Native Wandering Jew			X	X						X	
	<i>Commelina ensifolia</i>	Scurvy Grass				X	X						
	<i>Murdannia graminea</i>											X	
Cyperaceae	<i>Bolboschoenus caldwelii</i>				X	X							
	<i>Carex inversa</i>							X	X			X	
	* <i>Cyperus eragrostis</i>	Umbrella Sedge			X								
	<i>Cyperus fulvus</i>	Sticky Sedge					X						
	<i>Cyperus gracilis</i>	Slender Flat-sedge				X	X		X	X		X	
	* <i>Cyperus rotundus</i>	Nutgrass			X								
	<i>Cyperus sp.</i>						X						
	* <i>Cyperus tenellus</i>								X				
	<i>Eleocharis acuta</i>				X								
	<i>Eleocharis dulcis</i>			X									
	<i>Fimbristylis dichotoma</i>	Common Fringe-			X		X					X	

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program							
			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008		
Haloragaceae	<i>Myriophyllum sp.</i>	sedge			X										
Hydrocharitaceae	<i>Ottelia sp.</i>				X										
Hypoxidaceae	<i>Hypoxis hygrometrica</i>		Golden Weather-grass						X					X	
Iridaceae	* <i>Romulea rosea</i>	Onion Grass						X							
Juncaceae	<i>Juncus ?subglaucus</i>							X							
	* <i>Juncus acutus</i>	Sharp Rush			X										
	* <i>Juncus acutus subsp. acutus</i>	Sharp Rush						X							
	<i>Juncus sp.</i>							X							
	<i>Juncus usitatus</i>				X	X									
	<i>Luzula flaccida</i>								X						
	<i>Luzula sp.</i>								X						
Lomandraceae	<i>Lomandra confertifolia</i>				X								X		
	<i>Lomandra filiformis</i>	Wattle Mat-rush			X					X	X	X		X	
	<i>Lomandra filiformis subsp. filiformis</i>	Wattle Mat-rush							X					X	

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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Orchidaceae	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush						X					
	<i>Lomandra multiflora</i>	Many-flowered Mat-rush				X		X					
	<i>Lomandra multiflora subsp. multiflora</i>	Many-flowered Mat-rush					X		X	X	X	X	X
	<i>Cymbidium canaliculatum</i>	Tiger Orchid		E2				X					
	<i>Cymbidium suave</i>	Snake Orchid			X								
	<i>Dendrobium speciosum</i>	Rock Lily			X								
	<i>Diuris tricolor</i>	Painted Diuris	V	V, E2				X					
	<i>Microtis unifolia</i>	Common Onion Orchid						X					
	<i>Thysanotus patersonii</i>	Twining Fringe-lily						X					
	<i>Dianella caerulea</i>	Blue Flax-lily				X	X		X	X	X		
Phormiaceae	<i>Dianella caerulea</i> var. <i>caerulea</i>						X						
	<i>Dianella longifolia</i>	Blue Flax-Lily						X					
	<i>Dianella longifolia</i> var. <i>X</i>				X								

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Family		Scientific Name	Common Name	EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
		<i>longifolia</i>												
		<i>Dianella revoluta</i>	Blue Flax-Lily										X	
		<i>Dianella revoluta</i> var. <i>vinosa</i>												X
		<i>Dianella</i> sp.				X		X						
Potamogetonaceae		<i>Potamogeton crispus</i>	Curly Pondweed			X								
Typhaceae		<i>Typha orientalis</i>	Broad-leaved Cumbungi			X	X	X						
Xanthorrhoeaceae		<i>Xanthorrhoea glauca</i>				X								
Grasses														
Poaceae		<i>Aristida jerichoensis</i>	Jericho Wiregrass					X		X	X	X	X	X
		<i>Aristida personata</i>	Purple Wire-grass			X								
		<i>Aristida ramosa</i>	Purple Wiregrass			X		X	X					
		<i>Aristida</i> sp.						X						
		<i>Aristida vagans</i>	Threeawn				X	X	X					
			Speargrass											
		<i>Austrodanthonia bipartita</i>	Wallaby Grass				X		X					

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Family	Scientific Name	Common Name	Environmental Assessments					Monitoring Program					
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	<i>Austrodanthonia fulva</i>	Wallaby Grass					X	X	X	X	X	X	X
	<i>Austrodanthonia racemosa</i>							X					
	<i>Austrodanthonia racemosa</i> var. <i>obtusata</i>											X	X
	<i>Austrodanthonia racemosa</i> var. <i>racemosa</i>					X							
	<i>Austrodanthonia richardsonii</i>	Wallaby Grass			X				X	X	X		X
	<i>Austrodanthonia sp</i>				X		X	X					
	<i>Austrodanthonia tenuior</i>				X			X					
	<i>Austrostipa aristiglumis</i>	Plains Grass			X								
	<i>Austrostipa scabra</i>	Speargrass					X	X	X	X	X	X	
	<i>Austrostipa scabra</i> ssp. <i>scabra</i>	Speargrass						X	X				X
	<i>Austrostipa sp</i>				X			X	X				
	<i>Austrostipa verticillata</i>	Slender Bamboo Grass				X	X	X	X	X	X	X	X

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Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Environmental Assessments					Monitoring Program				
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*	<i>Avena barbata</i>	Bearded Oats			X			X						
*	<i>Axonopus fissifolius</i>	Narrow-leaved						X						
	<i>(syn. A. affinis)</i>	Carpet Grass												
	<i>Bothriochloa biloba</i>	Lobed Blue-grass	V				X	X						
	<i>Bothriochloa decipiens</i>	Redleg Grass						X						
	<i>Bothriochloa macra</i>	Red-leg Grass			X		X	X	X	X		X	X	
	<i>Bothriochloa</i> sp.						X					X		
*	<i>Briza minor</i>	Shivery Grass			X			X						
*	<i>Bromus catharticus</i>	Prairie Grass						X						
*	<i>Bromus hordeaceus</i>	Soft Brome					X							
*	<i>Bromus molliformis</i>	Soft Brome						X						
*	<i>Chloris gayana</i>	Rhodes Grass			X	X	X				X			
	<i>Chloris truncata</i>	Windmill Grass			X	X	X	X	X			X		
	<i>Chloris ventricosa</i>	Plump Windmill Grass				X	X	X	X	X	X	X	X	
	<i>Cymbopogon refractus</i>	Barbed Wire Grass			X	X	X	X	X	X		X	X	
*	<i>Cynodon dactylon</i>	Couch			X	X	X	X	X	X	X	X	X	

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			EPBC Act Status	TSC Act Status	MAN	South Pit	MAU	current	2004	2005	2006	2007	2008
	<i>Dactyloctenium ?radicans</i>	Button Grass					X						
	<i>Dichanthium sericeum</i>	Queensland Bluegrass			X	X	X	X	X			X	
	<i>Dichelachne crinita</i>	Longhair Plumegrass						X					
	<i>Dichelachne micrantha</i>	Shorthair Plumegrass			X			X					
	<i>Dichelachne sp.</i>												X
	<i>Digitaria brownii</i>	Cotton Panic Grass			X			X					
*	<i>Echinochloa esculenta</i>	Japanese Millet										X	
	<i>Echinopogon ovatus</i>	Forest Hedgehog Grass				X						X	
*	<i>Eleusine tristachya</i>	Goose Grass					X						
	<i>Elymus scaber</i>								X	X	X	X	X
	<i>Elymus scaber</i> var. <i>scaber</i>	Common Wheatgrass					X				X	X	
	<i>Enneapogon nigricans</i>	Niggerheads							X				
	<i>Enteropogon acicularis</i>										X	X	

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	<i>Entolasia stricta</i>	Winy Panic						X	X	X			
	<i>Eragrostis brownii</i>	Brown's Lovegrass			X				X	X	X		
*	<i>Eragrostis curvula</i>	African Lovegrass					X						
	<i>Eragrostis leptostachya</i>	Paddock Lovegrass					X	X					
	<i>Eriochloa pseudoacrotricha</i>	Early Spring Grass					X	X					
	<i>Eulalia aurea</i>	Silky Browntop			X		X	X					
*	<i>Hordeum glaucum</i>	Northern Barley Grass						X					
*	<i>Hordeum leporinum</i>	Barley Grass			X			X					
*	<i>Hyparrhenia hirta</i>	Coolatai Grass						X					
	<i>Lachnagrostis filiformis</i> (syn. <i>Agrostis avenacea</i>)							X					
*	<i>Lolium perenne</i>	Perennial Ryegrass										X	
*	<i>Lolium rigidum</i>	Wimmera Ryegrass						X					
*	<i>Lolium sp.</i>							X					
*	<i>Megathyrsus maximus</i>												X

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*	<i>Melinis repens</i>	Red Natal Grass						X				X	
	<i>Microlaena stipoides</i>	Weeping Meadow Grass						X					
	<i>Microlaena stipoides</i> var. <i>stipoides</i>								X	X			X
	<i>Panicum effusum</i>	Hairy Panic				X	X	X				X	X
*	<i>Panicum maximum</i> var. <i>maximum</i>	Guinea Grass											X
	<i>Panicum queenslandicum</i>	Yadbila Grass					X						
	<i>Panicum sp.</i>						X			X	X		
	<i>Paspalidium criniforme</i>							X					
	<i>Paspalidium distans</i>							X					
	<i>Paspalidium gracile</i>	Slender Panic				X	X						
*	<i>Paspalum dilatatum</i>	Paspalum			X	X	X	X				X	
	<i>Paspalum distichum</i>	Water Couch			X								
	<i>Paspalum sp.</i>						X						
*	<i>Pennisetum clandestinum</i>	Kikuyu Grass			X			X				X	X

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	<i>Phragmites australis</i>	Common Reed			X								
*	<i>Poa annua</i>	Winter Grass			X								
	<i>Poa labillardierei</i>	Tussock Grass					X						
	<i>Poa sieberiana</i>								X	X			X
	<i>Setaria geniculata</i> *								X				
*	<i>Setaria gracilis</i>	Slender Pigeon Grass					X						
													X
*	<i>Sorghum halepense</i>	Johnson Grass					X						
	<i>Sorghum leiocladium</i>	Wild Sorghum						X					
	<i>Sporobolus creber</i>	Slender Rat's Tail Grass				X	X	X	X	X		X	X
	<i>Sporobolus elongata</i>	Slender Rat's Tail Grass						X					
*	<i>Stenotaphrum secundatum</i>	Buffalo Grass					X						
	<i>Themeda australis</i>	Kangaroo Grass			X	X			X		X		
*	<i>Urochloa mutica</i>	Para Grass			X								
*	<i>Urochloa panicoides</i>	Urochloa Grass			X								

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Vines	* <i>Vulpia bromoides</i>	Squirrel Tail Fescue						X					
	<i>Marsdenia sp</i>												
	<i>Parsonsia eucalyptophylla</i>	Gargaloo						X					
	<i>Pandorea pandorana</i>	Wonga Wonga Vine						X					
	<i>Glycine clandestina</i>						X	X	X	X			
Fabaceae - Faboideae	<i>Glycine microphylla</i>	Small-leaf glycine						X					
	<i>Glycine tabacina</i>				X	X	X	X	X	X	X	X	X
Luzuriagaceae	<i>Hardenbergia violacea</i>	False Sarsparilla		X	X	X	X	X	X	X	X		
	<i>Eustrephus latifolius</i>	Wombat Berry				X	X	X	X	X	X		
	<i>Geitonoplesium cymosum</i>	Scrambling Lily				X	X	X	X	X	X		X
Ranunculaceae	<i>Clematis aristata</i>	Old Man's Beard		X									
	<i>Clematis glycinoides</i>	Headache Vine				X	X	X				X	

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Rosaceae	<i>Clematis glycinoides</i> <i>var. glycinoides</i>					X	X	X	X	X	X	X	X
	* <i>Rubus fruticosus</i>	Blackberry				X	X						
	<i>Rubus parvifolius</i>	Native Raspberry			X		X						
	<i>Rubus</i> sp.					X							
Vitaceae	<i>Cayratia clematidea</i>	Slender Grape					X						
Ferns and Allies													
Adiantaceae	<i>Adiantum aethiopicum</i>	Common Maidenhair			X		X						
	<i>Cheilanthes distans</i>	Bristly Cloak Fern					X	X	X	X	X		
	<i>Cheilanthes sieberi</i>	Poison Rock Fern			X		X	X					X
	<i>Cheilanthes sieberi</i> <i>subsp. sieberi</i>					X	X		X	X	X		
Aspleniaceae	<i>Asplenium flabellifolium</i>	Necklace Fern											X

Appendix B

Fauna Data

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments		Monitoring Program												
Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	South			MAN	Pit	MAU	2003	2004	2005	2006	2007	2008
Amphibia																
Hylidae	<i>Litoria caerulea</i>	Green Tree Frog			X						X					
	<i>Litoria fallax</i>	Eastern Dwarf Tree Frog			X						X					
	<i>Litoria freycineti</i>	Freycinet's Frog			X											
	<i>Litoria latopalmata</i>	Broad-palmed Frog			X	X					X	X		X		X
	<i>Litoria peronii</i>	Peron's Tree Frog			X						X	X	X	X		X
Myobatrachidae	<i>Crinia signifera</i>	Common Eastern Froglet			X	X					X	X	X		X	
	<i>Limnodynastes ornatus</i>	Ornate Burrowing Frog			X									X		X
	<i>Limnodynastes peronii</i>	Brown-striped Frog			X											
	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog			X	X						X	X	X		X
	<i>Uperoleia laevisgata</i>	Smooth Toadlet			X							X	X		X	
	<i>Uperoleia tyleri</i>	Tyler's Toadlet			X											
Aves																
Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill			X	X						X	X	X	X	X
	<i>Acanthiza nana</i>	Yellow Thornbill			X						X					

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments		Monitoring Program											
Family	Scientific Name	Common Name	TSC Act	EPBC Act	South			2003	2004	2005	2006	2007	2008		
			Status	Status	MAN	Pit	MAU								
Accipitridae	<i>Acanthiza pusilla</i>	Brown Thornbill			X		X								
	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill			X			X		X					
	<i>Gerygone fusca</i>	Western Gerygone				X				X	X				
	<i>Gerygone mouki</i>	Brown Gerygone					X								
	<i>Gerygone olivacea</i>	White-throated Gerygone			X			X				X			
	<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	V					X	X	X	X		X		
	<i>Sericornis frontalis</i>	White-browed Scrubwren						X							
	<i>Smicromis brevirostris</i>	Weebill			X	X			X	X	X				
	<i>Accipiter fasciatus</i>	Brown Goshawk						X							
	<i>Aquila audax</i>	Wedge-tailed Eagle			X	X			X	X	X				
Aegothelidae	<i>Circus assimilis</i>	Spotted Harrier					X								
	<i>Elanus axillaris</i>	Black-shouldered Kite				X		X							
	<i>Aegotheles cristatus</i>	Australian Owllet-nightjar			X		X	X	X	X	X		X		
	<i>Alauda arvensis</i> *	Eurasian Skylark			X										
Alcedinidae	<i>Mirafra javanica</i>	Horsfield's Bushlark										X	X		
	<i>Dacelo novaeguineae</i>	Laughing Kookaburra			X	X			X	X	X	X	X		
	<i>Todiramphus sanctus</i>	Sacred Kingfisher			X										

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments		Monitoring Program											
Family	Scientific Name	Common Name	TSC Act	EPBC Act	MAN	Pit	MAU	2003	2004	2005	2006	2007	2008		
			Status	Status											
Anatidae	<i>Anas gracilis</i>	Grey Teal					X								
	<i>Anas rhynchos</i>	Australasian Shoveler					X								
	<i>Anas superciliosa</i>	Pacific Black Duck			X		X								
	<i>Aythya australis</i>	Hardhead				X									
	<i>Chenonetta jubata</i>	Australian Wood Duck			X		X					X			
	<i>Cygnus atratus</i>	Black Swan				X									
	<i>Hirundapus caudacutus</i>	White-throated Needletail					X		X				X		
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron			X				X			X			
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow							X		X				
	<i>Artamus superciliosus</i>	White-browed Woodswallow									X				
	<i>Cracticus nigrogularis</i>	Pied Butcherbird			X	X	X	X	X		X	X	X		
	<i>Cracticus torquatus</i>	Grey Butcherbird			X	X	X	X	X	X	X		X		
	<i>Gymnorhina tibicen</i>	Australian Magpie			X	X	X	X	X	X	X	X	X		
	<i>Strepera graculina</i>	Pied Currawong			X	X	X	X	X	X	X	X	X		
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo			X	X	X	X	X	X	X	X	X		
	<i>Eolophus roseicapillus</i>	Galah			X	X	X	X	X	X	X	X	X		
Campephagidae	<i>Coracina</i>	Black-faced Cuckoo-shrike			X	X	X	X	X	X	X	X	X		

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments		Monitoring Program													
Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	South			MAN	Pit	MAU	2003	2004	2005	2006	2007	2008	
novaehollandiae																	
Charadriidae	Lalage tricolor	White-winged Triller											X	X			
	Eiseyornis melanops	Black-fronted Dotterel						X									
	Vanellus miles	Masked Lapwing				X	X	X	X				X			X	
	Cisticolidae	Cisticola exilis	Golden-headed Cisticola														X
Climacteridae	Cormobates leucophaea	White-throated Treecreeper				X						X	X			X	
Columbidae	Ocyphaps lophotes	Crested Pigeon				X	X	X				X		X		X	
Coraciidae	Eurystomus orientalis	Dollarbird													X		
Corcoracidae	Corcorax																
	melanorhamphos	White-winged Chough				X	X	X			X	X	X	X	X	X	
	Corvus coronoides	Australian Raven				X	X	X			X	X	X	X	X	X	
Cuculidae	Corvus orru	Torresian Crow									X						
	Cacomantis flabelliformis	Fan-tailed Cuckoo						X									
	Chalcites lucidus	Shining Bronze-Cuckoo						X									
	Eudynamys orientalis	Pacific Koel						X									
	Scythrops																
	novaehollandiae	Channel-billed Cuckoo				X						X					

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments		Monitoring Program												
Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	South			MAN	Pit	MAU	2003	2004	2005	2006	2007	2008
Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird			X	X	X				X	X	X	X		
Dicruridae	<i>Grallina cyanoleuca</i>	Magpie-lark			X	X	X				X	X	X	X	X	X
	<i>Rhipidura albiscapa</i>	Grey Fantail			X		X				X	X	X			
	<i>Rhipidura leucophrys</i>	Willie Wagtail			X	X	X				X	X	X	X	X	X
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch			X						X					X
	<i>Stagonopleura guttata</i>	Diamond Firetail	V		X											
	<i>Taeniopygia bichenovii</i>	Double-barred Finch			X	X	X				X	X	X	X		X
	<i>Taeniopygia guttata</i>	Zebra Finch			X		X				X					
Falconidae	<i>Falco berigora</i>	Brown Falcon			X	X	X				X					X
	<i>Falco cenchroides</i>	Nankeen Kestrel			X	X	X				X	X	X	X	X	X
	<i>Falco longipennis</i>	Australian Hobby			X	X	X									
	<i>Falco peregrinus</i>	Peregrine Falcon									X				X	
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow			X										X	
	<i>Petrochelidon ariel</i>	Fairy Martin			X											
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren			X	X	X				X	X	X	X	X	X
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill			X											

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments			Monitoring Program											
Family	Scientific Name	Common Name	TSC Act	EPBC Act	South			MAN	Pit	MAU	2003	2004	2005	2006	2007	2008
			Status	Status	Status	MAN	Pit									
	<i>Anthochaera carunculata</i>	Red Wattlebird			X											
	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater				X										
	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater					X	X				X	X			
	<i>Lichenostomus virescens</i>	Singing Honeyeater														
	<i>Manorina melanocephala</i>	Noisy Miner				X	X	X				X	X	X		X
	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater										X		X		
	<i>Melithreptus lunatus</i>	White-naped Honeyeater				X										
	<i>Philemon citreogularis</i>	Little Friarbird										X		X		
	<i>Philemon corniculatus</i>	Noisy Friarbird				X	X	X				X	X	X	X	X
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater		Migratory					X	X						
Motacillidae	<i>Anthus australis</i>	Australian Pipit			X	X	X	X				X		X		X
	<i>Daphoenositta chrysoptera</i>	Varied Sittella														
Neositidae												X	X			
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole										X		X		
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush				X						X				
	<i>Pachycephala pectoralis</i>	Golden Whistler									X	X		X		X

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments		Monitoring Program													
Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	South			MAN	Pit	MAU	2003	2004	2005	2006	2007	2008	
Pardalotidae	<i>Pachycephala rufiventris</i>	Rufous Whistler			X			X			X	X	X	X	X		
	<i>Pardalotus punctatus</i>	Spotted Pardalote			X						X	X	X		X	X	
	<i>Pardalotus striatus</i>	Striated Pardalote			X	X					X	X	X	X		X	
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican									X						
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin													X		
	<i>Melanodryas cucullata</i>	Hooded Robin	V		X												
	<i>Petroica goodenovii</i>	Red-capped Robin											X				
Phasianidae	<i>Coturnix pectoralis</i>	Stubble Quail					X										
	<i>Coturnix ypsilophora</i>	Brown Quail											X			X	
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth			X	X		X	X		X	X	X	X	X		
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe			X					X							
	<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V					X			X					X	
Psittacidae	<i>Alisterus scapularis</i>	Australian King-Parrot			X	X		X	X		X	X	X				
	<i>Glossopsitta pusilla</i>	Little Lorikeet					X										
	<i>Platycercus adscitus</i>	Eastern Rosella			X	X		X	X		X	X	X	X	X	X	

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

Environmental Assessments						Monitoring Program							
Family	Scientific Name	Common Name	TSC Act	EPBC Act	South			2003	2004	2005	2006	2007	2008
			Status	Status	MAN	Pit	MAU						
	<i>eximius</i>												
	<i>Platycercus elegans</i>	Crimson Rosella										X	
	<i>Psephotus haematonotus</i>	Red-rumped Parrot						X				X	X
Rallidae	<i>Fulica atra</i>	Eurasian Coot				X							
	<i>Gallinula tenebrosa</i>	Dusky Moorhen				X							
	<i>Porphyrio porphyrio</i>	Purple Swamphen						X					
	<i>Ninox boobook</i>	Southern Boobook			X								
Strigidae	<i>Acridotheres tristis</i> *	Common Myna			X			X					
Sturnidae	<i>Sturnus vulgaris</i> *	Common Starling			X		X		X				
Sylviidae	<i>Cincloramphus mathewsi</i>	Rufous Songlark							X		X		
Tytonidae	<i>Tyto alba</i>	Barn Owl					X						
Zosteropidae	<i>Zosterops lateralis</i>	Silvereye			X		X						
Mammalia													
Bovidae	<i>Bos taurus</i> *	European cattle			X								
Canidae	<i>Canis lupus familiaris</i> *	Dog			X		X						
	<i>Vulpes vulpes</i> *	Fox			X		X		X			X	X

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

Environmental Assessments					Monitoring Program									
Family	Scientific Name	Common Name	TSC Act	EPBC Act	MAN	Pit	South	MAU	2003	2004	2005	2006	2007	2008
			Status	Status										
Dasyuridae	<i>Antechinus stuartii</i>	Brown Antechinus				X								
Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	V		X									
Felidae	<i>Felis catus*</i>	Cat			X									
Leporidae	<i>Lepus capensis*</i>	Brown Hare			X	X	X	X	X	X	X	X	X	X
	<i>Oryctolagus cuniculus*</i>	Rabbit			X	X	X	X	X				X	X
Macropodidae	<i>Macropus giganteus</i>	Eastern Grey Kangaroo			X	X	X	X	X	X	X	X	X	X
	<i>Macropus parma</i>	Parma Wallaby	V		X									
	<i>Macropus robustus</i>	Common Wallaroo			X			X	X	X	X	X	X	X
	<i>Macropus rufogriseus</i>	Red-necked Wallaby			X		X	X	X	X	X	X	X	X
	<i>Wallabia bicolor</i>	Swamp Wallaby			X				X					
Molossidae	<i>Mormopterus "Species 2"</i>	Undescribed Freetail Bat					X				X			
	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V				X					X	X	
	<i>Mormopterus planiceps</i>	Little Mastiff-bat			X		X	X	X	X	X	X		
	<i>Mormopterus sp.</i>	mastiff-bat						X						
	<i>Tadarida australis</i>	White-striped Freetail-bat			X		X	X	X	X	X	X	X	X
Muridae	<i>Mus musculus*</i>	House Mouse			X	X	X	X	X	X			X	X

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments		Monitoring Program						
Family	Scientific Name	Common Name	TSC Act		EPBC Act		South			
			Status		Status		MAN	Pit	MAU	2003 2004 2005 2006 2007 2008
	<i>Rattus fuscipes</i>	Bush Rat					X			
	<i>Rattus norvegicus</i> *	Brown Rat						X		
	<i>Rattus sp.</i>	rat							X	
Peramelidae	<i>Isodon macrourus</i>	Northern Brown Bandicoot					X			
	<i>Perameles nasuta</i>	Long-nosed Bandicoot					X			
Petauridae	<i>Petaurus norfolcensis</i>	Squirrel Glider	V					X		
Phalangeridae	<i>Trichosurus sp.</i>	brushtail possum						X		
	<i>Trichosurus vulpecula</i>	Common Brushtail Possum					X	X	X	X
	<i>Pseudocheirus</i>									
Pseudocheiridae	<i>peregrinus</i>	Common Ringtail Possum						X		
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna							X	
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V		V					
	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat					X	X	X	X
	<i>Chalinolobus morio</i>	Chocolate Wattled Bat					X	X	X	
	<i>Miniopterus schreibersii</i>									
	<i>oceanensis</i>	Eastern Bentwing-bat	V				X	X	X	X
	<i>Myotis adversus</i>	Large-footed Myotis	V					X	X	X

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

		Environmental Assessments		Monitoring Program														
Family	Scientific Name	Common Name	TSC Act		EPBC Act		South			MAN	Pit	MAU	2003	2004	2005	2006	2007	2008
			Status	Act	Status	Act												
Vombatidae	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat							X		X							
	<i>Nyctophilus sp.</i>	long-eared bat							X									
	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V								X							
	<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat						X		X		X						
	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat						X										
	<i>Vespadelus pumilus</i>	Eastern Forest Bat							X									
	<i>Vespadelus regulus</i>	Southern Forest Bat						X	X	X		X						
	<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V					X		X					X		X	
	<i>Vespadelus vulturnus</i>	Little Forest Bat						X	X	X		X			X	X	X	
	<i>Vombatus ursinus</i>	Common Wombat						X				X	X		X	X	X	X
Reptilia																		
Agamidae	<i>Amphibolurus muricatus</i>	Jacky Lizard							X							X		
	<i>Pogona barbata</i>	Bearded Dragon						X	X		X							
Chelidae	<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle																
	<i>Cryptophis nigrescens</i>	Eastern Small-eyed Snake							X		X		X		X		X	

Table B.1 FAUNA SPECIES DETECTED OVER ALL PREVIOUS SURVEYS WITHIN THE EA BOUNDARY

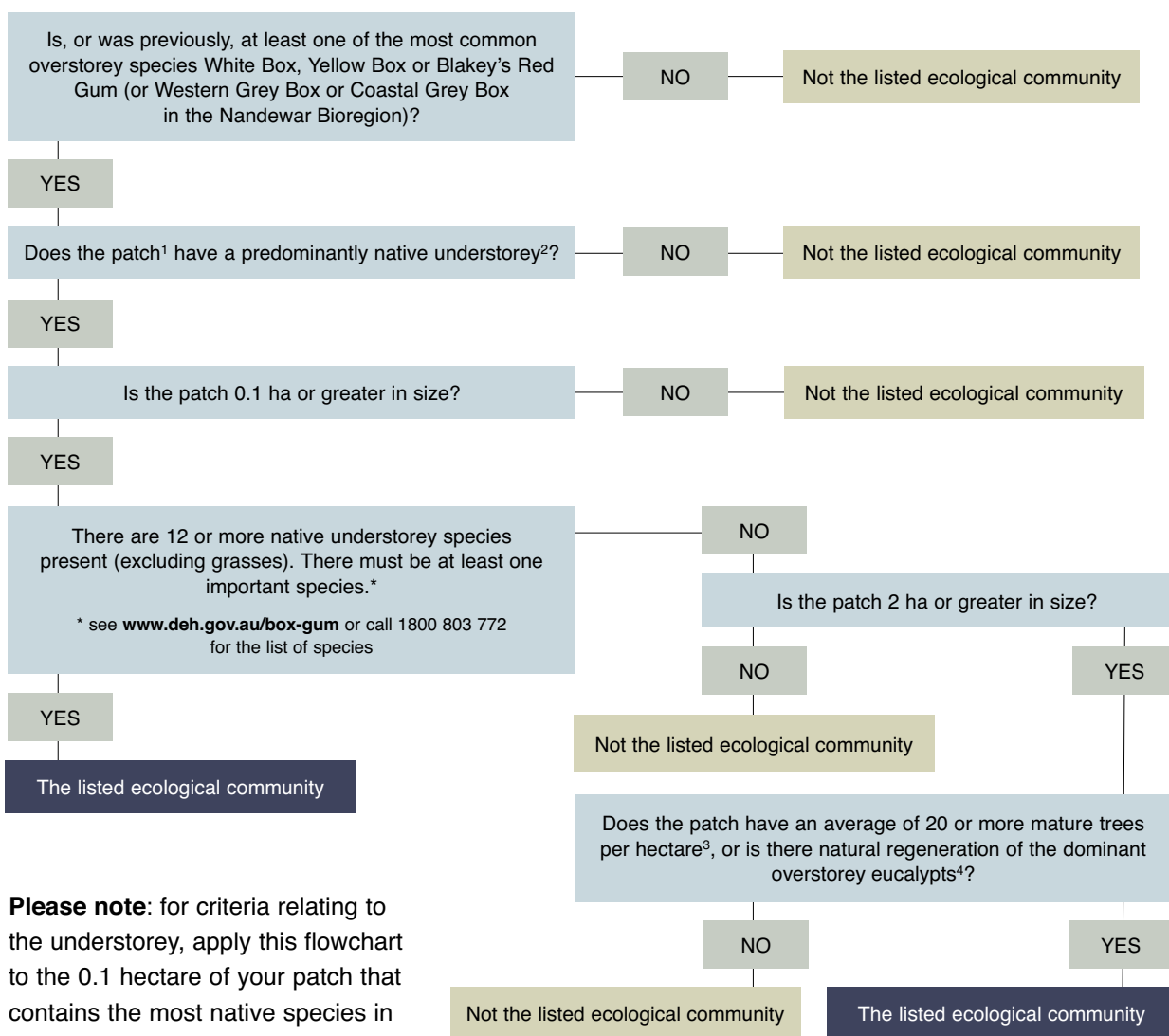
		Environmental Assessments			Monitoring Program										
Family	Scientific Name	Common Name	TSC Act	EPBC Act	MAN	Pit	MAU	2003	2004	2005	2006	2007	2008		
			Status	Status											
Gekkonidae	<i>Furina diadema</i>	Red-naped Snake			X		X								
	<i>Parasuta dwyeri</i>	Dwyer's Snake											X		
	<i>Pseudechis guttatus</i>	Spotted Black Snake				X									
	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake					X		X						
	<i>Pseudonaja textilis</i>	Eastern Brown Snake			X				X						
	<i>Diplodactylus vittatus</i>	Wood Gecko			X			X			X		X		
	<i>Oedura robusta</i>	Robust Velvet Gecko			X										
Scincidae	<i>Underwoodisaurus milii</i>	Thick-tailed Gecko			X										
	<i>Carlia tetradactyla</i>	Southern Rainbow-skink			X	X	X	X	X	X		X	X		
	<i>Ctenotus robustus</i>	Robust Ctenotus			X						X	X	X		
	<i>Ctenotus taeniolatus</i>	Copper-tailed Skink			X	X	X								
	<i>Egernia modesta</i>	Eastern Ranges Rock-skink			X				X						
	<i>Egernia striolata</i>	Tree Skink			X	X	X	X	X	X	X	X	X		
	<i>Lampropholis delicata</i>	Dark-flecked Garden Sunskink						X							
Varanidae	<i>Tiliqua scincoides</i>	Eastern Blue-tongue			X	X									
	<i>Varanus varius</i>	Lace Monitor				X	X		X		X	X	X		

Appendix C

Box Gum Woodland: EPBC Act Policy
Statement and TSC Act Final
Determination

The flowchart below represents the lowest condition at which patches are included in the listed ecological community. This is not the ideal state of the ecological community. Large patches, those that link remnants in the landscape, those that occur in highly cleared areas, those that contain rare, declining or threatened species, and those that represent the entire range of the ecological community, are important for the long-term future of the ecological community.

Determining if your land has an area of the listed ecological community



Please note: for criteria relating to the understorey, apply this flowchart to the 0.1 hectare of your patch that contains the most native species in the ground layer.

- ¹ Patch – a patch is a continuous area containing the ecological community (areas of other ecological communities such as woodlands dominated by other species are not included in a patch). In determining patch size it is important to know what is, and is not, included within any individual patch. The patch is the larger of:
 - an area that contains five or more trees in which no tree is greater than 75 m from another tree, or
 - the area over which the understorey is predominantly native.
 Patches must be assessed at a scale of 0.1 ha (1000m²) or greater.
- ² A predominantly native ground layer is one where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species. The best time of the year to determine this is late autumn when the annual species have died back and have not yet started to regrow. (At other times of the year, you can determine whether something is perennial or not if it is difficult to pull out of the soil. Annual species pull out very easily.)
- ³ Mature trees are trees with a circumference of at least 125 cm at 130 cm above the ground.
- ⁴ Natural regeneration of the dominant overstorey eucalypts when there are mature trees plus regenerating trees of at least 15 cm circumference at 130 cm above the ground.



New South Wales Government

Department of

Environment and Climate Change

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White box yellow box Blakely's red gum woodland - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the White Box Yellow Box Blakely's Red Gum Woodland as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee previously made a Preliminary Determination to support the proposal to list the White Box-Yellow Box Woodland. The Scientific Committee considers that the White Box Yellow Box Blakely's Red Gum Woodland is a more appropriate name for this Community.

The Scientific Committee has found that:

1. White Box Yellow Box Blakely's Red Gum Woodland is the name given to the ecological community characterised by the assemblage of species listed in paragraph 3. White Box Yellow Box Blakely's Red Gum Woodland is found on relatively fertile soils on the tablelands and western slopes of NSW and generally occurs between the 400 and 800 mm isohyets extending from the western slopes, at an altitude of c. 170m to c. 1200 m, on the northern tablelands (Beadle 1981). The community occurs within the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands and NSW South Western Slopes Bioregions.

2. White Box Yellow Box Blakely's Red Gum Woodland includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations - *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box) or *Eucalyptus blakelyi* (Blakely's Red Gum). Grass and herbaceous species generally characterise the ground layer. In some locations, the tree overstorey may be absent as a result of past clearing or thinning and at these locations only an understorey may be present. Shrubs are generally sparse or absent, though they may be locally common.

3. White Box Yellow Box Blakely's Red Gum Woodland is characterised by the following assemblage of species.

- *Acacia buxifolia*
- *Acacia implexa*
- *Acacia paradoxa*
- *Allocasuarina verticillata*
- *Alectryon oleifolius*
- *Aristida behriana*
- *Aristida ramosa*
- *Asperula conferta*
- *Atalaya hemiglauca*
- *Austrodanthonia auriculata*
- *Austrodanthonia bipartita*
- *Austrodanthonia racemosa*
- *Austrodanthonia richardsonii*
- *Austrostipa aristiglumis*
- *Austrostipa blackii*
- *Austrostipa nodosa*
- *Austrostipa scabra*
- *Bothriochla macra*
- *Brachychiton populneus*
- *Brachyloma daphnoides*
- *Bracteantha viscosa*
- *Brunoniella australis*
- *Bulbine bulbosa*
- *Bursaria spinosa*
- *Callitris endlicheri*
- *Callitris glaucophylla*
- *Capparis mitchellii*
- *Cassinia longifolia*
- *Cassinia quinquefaria*
- *Cheilanthes sieberi*
- *Chloris truncata*
- *Chloris ventricosa*
- *Chrysocephalum apiculatum*
- *Cymbopogon refractus*
- *Dianella longifolia*
- *Dianella revoluta*
- *Dichanthium sericeum*
- *Dichelachne micrantha*

- *Dichelacne sciurea*
- *Diuris dendrobioides*
- *Dodonaea viscosa*
- *Echinopogon caespitosus*
- *Ehretia membranifolia*
- *Elymus scaber*
- *Eremophila mitchellii*
- *Eucalyptus blakelyi*
- *Eucalyptus albens*
- *Eucalyptus bridgesiana*
- *Eucalyptus conica*
- *Eucalyptus goniocalyx*
- *Eucalyptus melliodora*
- *Eucalyptus microcarpa*
- *Eucalyptus nortonii*
- *Eulalia aurea*
- *Exocarpos cupressiformis*
- *Geijera parviflora*
- *Geranium solanderi*
- *Glycine clandestina*
- *Glycine tabacina*
- *Glycine tomentella*
- *Gonocarpus elatus*
- *Goodenia pinnatifida*
- *Hibbertia linearis*
- *Hibbertia obtusifolia*
- *Hypericum gramineum*
- *Jacksonia scoparia*
- *Jasminum lineare*
- *Jasminum suavisimum*
- *Leptorhynchus squamatus*
- *Lissanthe strigosa*
- *Lomandra filiformis*
- *Melichrus urceolatus*
- *Microseris lanceolata*
- *Notelaea microcarpa*
- *Olearia elliptica*
- *Olearia viscidula*
- *Oxalis perennans*
- *Pandorea pandorana*
- *Panicum queenslandicum*
- *Parsonsia eucalyptophylla*
- *Pimelea curviflora*
- *Plantago debilis*
- *Plantago gaudichaudii*
- *Poa labillardieri*
- *Poa sieberiana*
- *Rostellularia adscendens*
- *Rumex brownii*
- *Sida corrugata*
- *Sorghum leiocladum*
- *Stackhousia monogyna*
- *Stackhousia viminea*
- *Swainsona galegifolia*
- *Templetonia stenophylla*
- *Themeda australis*
- *Wahlenbergia communis*

The total flora and fauna species list for the community is considerably larger than that given above, with many species present in only some sites or in very small quantity. In any particular site not all of the assemblage listed above may be present. At any one time, seeds of some species may only be present in the soil seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site, recent rainfall or drought conditions, its disturbance history and geographic and topographic location. The community is an important habitat for a diverse fauna (vertebrates and invertebrates), but detailed records are not available from most stands and the invertebrate fauna is poorly known.

4. Woodlands with *Eucalyptus albens* are most common on the undulating country of the slopes region while *Eucalyptus blakelyi* and *Eucalyptus melliodora* predominate in grassy woodlands on the tablelands. Drier woodland areas dominated by *Eucalyptus albens* often form mosaics with areas dominated by *Eucalyptus blakelyi* and *Eucalyptus melliodora* occurring in more moist situations, while areas subject to waterlogging may be treeless. *E. microcarpa* is often found in association with *E. melliodora* and *E. albens* on the south western slopes. Woodlands including *Eucalyptus crebra*, *Eucalyptus dawsonii* and *Eucalyptus moluccana* (and intergrades with *Eucalyptus albens*), for example in the Merriwa plateau, Goulburn River National Park and western Wollemi National Park, are also included. Intergrades between *Eucalyptus blakelyi* and *Eucalyptus tereticornis* may also occur here.

5. Latitudinal and climatic gradients in the patterns of species present are found across the range of the community (eg. see Prober 1996 for variation in White Box). This is reflected in a gradual change in herb and grass species from northern to southern NSW (eg. Prober 1996). Within White Box Yellow Box Blakely's Red Gum Woodland, species such as *Rostellularia adscendens*, *Chloris ventricosa*, *Austrodanthonia racemosa*, *Brunoniella australis*, *Cymbopogon refractus*, *Swainsona galegifolia*, *Notelaea microcarpa*, *Stackhousia viminea*, *Olearia elliptica*, *Jasminum suavisimum*, *Plantago gaudichaudii*, *Dichanthium sericeum*, *Plantago debilis* and *Wahlenbergia communis* are generally more restricted to more northern areas (eg. Prober 1996). Some other species in White Box Yellow Box Blakely's Red Gum

Woodland were generally restricted to southern areas. These include *Gonocarpus elatus*, *Austrostipa blackii*, *Aristida behriana*, *Bracteantha viscosa*, *Austrodanthonia auriculata* and *Austrostipa nodosa* (Prober 1996).

6. White Box Yellow Box Blakely's Red Gum Woodland includes vegetation described as *Eucalyptus albens* alliance and *E. melliodora* / *E. blakelyi* alliance in Beadle (1981), the *Eucalyptus albens* alliance in Moore (1953a,b), the grassy white box woodlands of Prober and Thiele (1993,1995) and Prober (1996) and the Grassy white box woodland of the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999. In the southern tablelands and parts of the southwest slopes, White Box Yellow Box Blakely's Red Gum Woodland are described in Thomas et al. (2000).

7. Related communities are the *Eucalyptus microcarpa*, *Eucalyptus pilligaensis* Grey Box/ *Eucalyptus populnea* Poplar Box communities of the western slopes and plains and the *Eucalyptus moluccana*, Grey Box, communities of the Clarence, lower Hunter Valley and Western Sydney. These are not covered by this Determination. Similarly the natural temperate grasslands and the *Eucalyptus pauciflora* grassy woodlands of the cooler parts of the southern tablelands are not covered by this Determination.

8. White Box Yellow Box Blakely's Red Gum Woodland has been drastically reduced in area and highly fragmented because of clearance for cropping and pasture improvement. Austin et al. (2000) found the community had been reduced to less than 1% of its pre-European extent in the Central Lachlan region. Comparable degrees of reduction have been documented for NSW south western slopes and southern Tablelands (estimated <4% remaining, Thomas et. al. 2000), and for the Holbrook area (estimated <7% remaining, Gibbons and Boak (2000). Gibbons and Boak (2000) found remnants of woodlands dominated by *Eucalyptus albens*, *E. melliodora* and *E. blakelyi* were severely fragmented. Further remnants of the community are degraded as a consequence of their disturbance history. Some remnants of these communities survive with the trees partly or wholly removed by post European activities, and conversely, often remnants of these communities survive with these tree species largely intact but with the shrub or ground layers degraded to v

arying degrees through grazing or pasture modification. Remnants are subject to varying degrees of threat that jeopardise their viability. These threats include: further clearing (for cropping, pasture improvement or other development); deterioration of remnant condition (caused by firewood cutting, increased livestock grazing, weed invasion, inappropriate fire regimes, soil disturbance and increased nutrient loads); degradation of the landscape in which remnants occur (including soil acidification, salinity, and loss of connectivity between remnants).

9. The understorey may be highly modified by grazing history and disturbance. A number of native species appear not to tolerate grazing by domestic stock and are confined to the least disturbed remnants (*Dianella revoluta*, *Diuris dendroboides*, *Microseris lanceolata*, *Pimelea curviflora*, *Templetonia stenophylla* (Prober & Thiele 1995). Dominant pasture species typically change from *Themeda australis*, *Austrostipa aristiglumis* and *Poa* spp. to *Austrostipa falcata*, *Austrodanthonia* spp. and *Bothriochla macra* as grazing intensity increases (Moore 1953a). This may reflect differences in palatability of these species and their ability to tolerate grazing pressure. Light grazing and burning may also be a problem and lead to *Aristida ramosa* dominance (Lodge & Whalley 1989).

10. The condition of remnants ranges from relatively good to highly degraded, such as paddock remnants with weedy understoreys and only a few hardy natives left. A number of less degraded remnants have survived in Travelling Stock Routes, cemeteries and reserves, although because of past and present management practices understorey species composition may differ between the two land uses. Some remnants of the community may consist of only an intact overstorey or an intact understorey, but may still have high conservation value due to the flora and fauna they support. Other sites may be important faunal habitat, have significant occurrences of particular species, form part of corridors or have the potential for recovery. The conservation value of remnants may be independent of remnant size.

11. Disturbed remnants are still considered to form part of the community including remnants where the vegetation, either understorey, overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soil and associated seed bank are still at least partially intact.

12. The community is poorly represented in conservation reserves. There are small occurrences of White Box Yellow Box Blakely's Red Gum Woodland in Border Ranges National Park, Goobang National Park, Goulburn River National Park, Manobalai Nature Reserve, Mt Kaputar National Park, Oxley Wild Rivers National Park, Queanbeyan Nature Reserve, Towari National Park, Warrumbungle National Park, Wingen Maid Nature Reserve and Wollemi National Park. The community also occurs in the following State Conservation Areas, Copeton State Conservation Area, Lake Glenbawn State Conservation Area and Lake Keepit State Conservation Area.

13. Fauna species of conservation significance found in some stands of White Box Yellow Box Blakely's Red Gum Woodland include,

- *Aprasia parapulchella* - Pink-tailed Legless Lizard
- *Burhinus grallarius* - Bush Stone-curlew
- *Cacatua leadbeateri* - Major Mitchell's Cockatoo
- *Climacteris picumnus victoriae* - Brown Treecreeper
- *Dasyurus maculatus* - Spotted-tailed Quoll
- *Delma impar* - Striped Legless Lizard
- *Grantiella picta* - Painted Honeyeater
- *Hoplocephalus bitorquatus* - Pale-headed Snake
- *Lathamus discolor* - Swift Parrot
- *Lophoictinia isura* - Square-tailed Kite
- *Melanodryas cucullata cucullata* - Hooded Robin
- *Melithreptus gularis gularis* - Black-chinned Honeyeater
- *Neophema pulchella* - Turquoise Parrot
- *Ninox connivens* - Barking Owl
- *Petaurus norfolcensis* - Squirrel Glider
- *Phascolarctos cinereus* - Koala
- *Polytelis swainsonii* - Superb Parrot
- *Pomatostomus temporalis temporalis* - Grey-crowned Babbler
- *Pyrrholaemus sagittata* - Speckled Warbler
- *Saccolaimus flaviventris* - Yellow-bellied Shearwater
- *Stagonopleura guttata* - Diamond Firetail
- *Synemon plana* - Golden Sun Moth
- *Tyto novaehollandiae* - Masked Owl

- *Varanus rosenbergi* - Rosenberg's Goanna
- *Xanthomyza phrygia* - Regent Honeyeater

A number of plant species of conservation significance are likely to occur in White Box Yellow Box Blakely's Red Gum Woodland

- *Ammobium craspedioides*
- *Bothriochloa biloba*
- *Dichanthium setosum*
- *Discaria pubescens*
- *Diuris* spp.
- *Prasophyllum petilum*
- *Pterostylis* spp.
- *Rutidosis leptorhynchoides*
- *Swainsona* spp.

A number of key threatening processes also occur in White Box Yellow Box Blakely's Red Gum Woodland. These include: Clearing of native vegetation, Predation by the European Red Fox *Vulpes vulpes*, Predation by the Feral Cat, *Felis catus*.

14. In view of the small size of existing remnants, and the threat of further clearing, disturbance and degradation, the Scientific Committee is of the opinion that White Box Yellow Box Blakely's Red Gum Woodland is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate and that listing as an endangered ecological community is warranted.

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Exhibition period: 15/03/02 - 19/04/02

References

Austin, M.P., Cawsey, E.M., Baker, B.L., Yialeoglou, M.M., Grice, D.J. & Briggs, S.V. (2000) Predicted vegetation cover in the Central Lachlan Region. CSIRO Wildlife & Ecology Final Report for Natural Heritage Trust Project AA 1368.97.

Beadle, N.C.W. (1981) *The Vegetation of Australia*. Cambridge University Press, Cambridge.

Gibbons, P. & Boak, M. (2000) The importance of paddock trees for regional conservation in agricultural landscapes. A discussion paper for consideration by Riverina Highlands Regional Vegetation Committee. NSW National Parks and Wildlife Service, Southern Directorate unpublished report.

Lodge, G.M. & Whalley, R.D.B. (1989) Native and natural pastures on the northern slopes and tablelands of New South Wales: a review and annotated bibliography. Technical Bulletin 35, NSW Agriculture.

Moore, C.W.E. (1953a) The vegetation of the south-eastern Riverina, New South Wales. I. The climax communities. *Australian Journal of Botany* 1, 489-547.

Moore, C.W.E. (1953b) The vegetation of the south-eastern Riverina, New South Wales. II. The disclimax communities. *Australian Journal of Botany* 1, 548-567.

Prober, S.M. (1996) Conservation of the grassy white box woodlands: rangewide floristic variation and implications for reserve design. *Australian Journal of Botany* 44, 57-77.

Prober, S.M. & Thiele, K.R. (1993) The ecology and genetics of remnant grassy white box woodlands in relation to their conservation. *Victorian Naturalist* 110, 30-36.

Prober, S.M. & Thiele, K.R. (1995) Conservation of grassy white box woodlands: relative contributions of size and disturbance to floristic composition and diversity of remnants. *Australian Journal of Botany* 43, 349-366.

Thomas, V., Gellie, N. & Harrison, T. (2000) Forest ecosystem classification and mapping for the Southern CRA region, Volume II Appendices. NSW National Parks & Wildlife Service, Southern Directorate. A report undertaken for the NSW CRA/RFA Steering Committee.

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White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland)

Introduction

These guidelines provide background information and assist land managers and approval authorities to identify remnants of White Box Yellow Box Blakely's Red Gum Woodland (hereafter referred to as Box-Gum Woodland) Endangered Ecological Community (EEC). The Scientific Committee published this Determination on 15/3/2002. Copies of the Determination are available on the NPWS website at

<http://www.npws.nsw.gov.au/news/tscdets/f020315a.htm>

Text in italics in this document is taken from the Final Determination, unless otherwise indicated.

What is Box-Gum Woodland?

Box-Gum Woodland is characterised by the presence or prior occurrence of White Box, Yellow Box or Blakely's Red Gum. The EEC occurs predominantly on the western slopes of NSW from Victoria to Queensland on soils that are moderately to highly fertile. Consequently, Box-Gum Woodland has been extensively cleared and modified by thinning, clearing, grazing, pasture improvement and cultivation. Remaining stands of Box-Gum Woodland are generally highly fragmented. Less than 5% of the pre-European extent is estimated to remain in the south and up to 10% in the north of the State. Less than 0.5% is estimated to retain pre-European levels of diversity and species composition.

The Final Determination defines Box-Gum Woodland broadly. There are five main features in the Determination that govern whether the EEC exists at a site:

1. Whether the site is within the area defined in the Determination.
2. Whether the characteristic trees of the site are (or are likely to have been) White Box, Yellow Box or Blakely's Red Gum.
3. Whether the site is mainly grassy.

4. Whether any of the listed characteristic species occur (including as part of the seedbank in the soil).
5. If the site is degraded, whether there is potential for assisted natural regeneration of the overstorey or understorey.

It is important to note that the size or ages of the remnant are not determining factors as to whether it constitutes the listed EEC or not.

The condition of remnants of this EEC varies. Examples of the various conditions the community may occur in include:

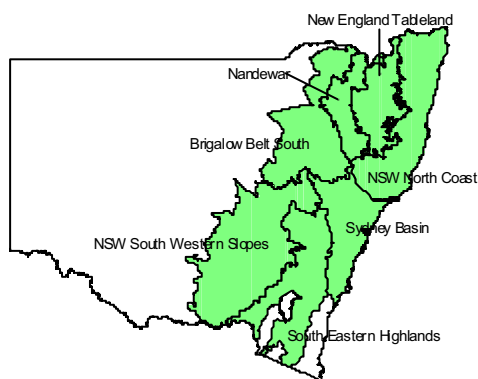
1. Multi-aged overstorey with a grassy, herb-rich understorey:
 - Remnants in this condition are very scarce and are generally confined to travelling stock reserves, roadside vegetation, cemeteries, some national parks and the occasional private property.
2. Partially cleared/thinned stands with a mixture of native and exotic understorey species:
 - This condition is far more common than the above, however its long-term future is often insecure due to inadequate regeneration of overstorey species. Often current management (e.g. set-stocking) is inconsistent with tree regeneration.
3. Stands where White Box, Yellow Box or Blakely's Red Gum have been killed and other species dominate the canopy:
 - This condition occurs in woodlands where the characteristic trees occur in conjunction with White Cypress Pine. The understorey is often in reasonable to very good condition.
4. Grasslands (secondary or derived grasslands), where the tree overstorey has been removed and only the Box-Gum Woodland understorey is present:
 - This condition is likely to be reasonably common in some areas

and is likely to be relatively easy to rehabilitate if appropriate management strategies are implemented.

5. Degraded remnants that have few, if any, native species in the understorey:
 - This condition is typical of Box-Gum Woodland where agricultural practices have been more intensive (e.g. pasture improvement over long periods).

Where is Box-Gum Woodland found?

Box-Gum Woodland is found on relatively fertile soils on the tablelands and western slopes of NSW, extending from an altitude of approximately 170 m on the lower slopes to and including the tablelands. Rainfall is between 400 and 800 mm with a slight winter dominance in the south to a slight summer dominance in the north. According to the Final Determination, the EEC is confined to the IBRA bioregions (EA 2000) as mapped below.



The overstorey

The characteristic trees are White Box, Yellow Box or Blakely's Red Gum. The density of trees is not relevant to the existence of the EEC. Where White Box, Yellow Box or Blakely's Red Gum trees have been killed, and the overstorey is now dominated by other species (e.g. White Cypress Pine), the EEC still exists (see section on Degraded Sites). The Final Determination specifically includes treeless areas in the EEC "as a result of past clearing or thinning."

The understorey

Box-Gum Woodland includes vegetation where "Grass and herbaceous species generally characterise the ground layer.... Shrubs are generally sparse or absent, though they may be locally common."

The term "locally common" is not defined, but the intent of the statement is that shrubs may be

dominant over parts of an EEC site. Shrub species are recognised as important constituents of the community as 27 of the 95 characteristic species listed in the Final Determination are shrubs.

However, shrubby woodlands, which generally occur in upper or midslope situations on shallower soils, are not part of the EEC. Such woodlands are more prevalent on hillsides of the North Western Slopes (Nandewar and Brigalow Belt South Bioregions). Where shrubby woodlands dominated by White Box, Yellow Box or Blakely's Red Gum intergrades with the Box-Gum Woodland the more shrub-free sections of the community should be regarded as Box-Gum Woodland.

In some other instances, the shrub layer is primarily *Acacia* spp. or *Cassinia* spp., which are characteristically pioneer colonising species that invade sites after disturbances such as clearing, overgrazing or fires. These species generally only live 10-15 years and are replaced with a predominantly grassy understorey. These areas are regarded as Box-Gum Woodland.

In most locations the understorey will vary considerably depending on the season, management history and rainfall in preceding months. Care in assessing a site is required when a flush of annual exotic species obscures native perennial species. Reassessment of the site after the annuals have died is desirable. Ideally sites should be assessed in both spring and in autumn so that seasonal native species such as orchids, lilies and native annuals can be identified.

Characteristic species

The Final Determination of Box-Gum Woodland has a list of 95 species that are characteristic of the community.

The Final Determination for Box-Gum Woodland, in common with other Endangered Ecological Community Determinations, states, "In any particular site not all the assemblage listed above may be present. At any one time, seeds of some species may only be present in the soil seed bank with no above-ground individuals present". Hence the potential of the seedbank must be considered when assessing degraded sites.

The NSW *Threatened Species Conservation Act*, 1995 defines an ecological community as "an assemblage of species occupying a particular area." Thus any EEC includes species occurring in association with the species listed as characteristic for the community.

For example, Box-Gum Woodland includes fauna and fungi, although these groups are not included in the lists of characteristic species.

Fauna

Many sites may be degraded and yet remain important for fauna. Fauna habitat value of individual trees is dependent on a number of features. Generally large old trees have greater value to fauna. Such trees support a diverse and abundant array of insects and the animals that feed upon them, and have numerous hollows, cracks or fissures that provide shelter and nesting sites.

Mature box and gum trees readily form hollows and thus provide important habitat for hollow-dependent fauna such as Squirrel Gliders, Barking Owls and Superb Parrots. Critically, in some areas, White Box and Yellow Box provide significant nectar flows during winter when such resources are crucial for threatened species such as the Regent Honeyeater and Swift Parrot. Large old trees on more fertile sites have been observed to produce more significant nectar flows for fauna than nearby trees on poorer sites such as hillsides.

Degraded sites

The definition of the Box-Gum Woodland explicitly recognises that some remnants are degraded. Highly disturbed sites that have few if any native species in the understorey are specifically included in the community provided *“vegetation, either understorey or overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soil and associated seed bank are still at least partially intact.”*

In some parts of NSW Box-Gum Woodlands are only represented by isolated paddocks trees with a highly modified understorey. Such remnants or vestiges of the community may still constitute valuable fauna habitat in agricultural areas and may provide a valuable source of seed for potential future regeneration.

Determining whether the vegetation will respond to assisted natural regeneration will often be highly problematic. Sites where there is unlikely to be sufficient seed remaining in the soil for the understorey or overstorey to regenerate are not part of the EEC. For example, trees under which intensive cropping of annual crop species has occurred and is ongoing, and trees within urban backyards are unlikely to be part of the community. Conversely, trees with exotic pastures underneath and those in larger urban

open spaces will generally be part of the community.

Inevitably difficulties will arise when faced with decisions on whether particular sites are able to respond to assisted natural regeneration. Expert advice may need to be sought in these circumstances. One of the recovery actions for this community is the further investigation of the regeneration potential of various conditions of this EEC in a range of environmental situations. Only then will definitive advice be able to be given.

Identifying Box-Gum Woodland

Following is a key for use in determining whether Box-Gum Woodland exists on a site. Where doubt exists over an appropriate category (e.g. whether the site is mainly grassy or is shrubby), use a precautionary approach that assumes that the community is present.

At each stage there are two alternatives. Choose which is most like the site under consideration, and proceed to the alternative numbered in the right margin.

- 1 The site is in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands or NSW South Western Slopes Bioregions: **2**
- 1* The site is outside the above bioregions: **2**
the site is not Box-Gum Woodland
- 2 There are no native species in the understorey, and the site is unlikely to respond to assisted natural regeneration (see section on Degraded Sites, page 3): **2**
the site is not Box-Gum Woodland
- 2* The understorey is otherwise: **3**
- 3 The site has trees: **4**
- 3* The site is treeless, but is likely to have supported White Box, Yellow Box or Blakely's Red Gum prior to clearing: **5**
- 4 White Box, Yellow Box or Blakely's Red Gum, or a combination of these species, are or were present: **5**
- 4* White Box, Yellow Box or Blakely's Red Gum have never been present: **5**
the site is not Box-Gum Woodland
- 5 The site is predominantly grassy: **5**
the site is Box-Gum Woodland
- 5* The understorey of the site is dominated by shrubs excluding pioneer species (see section on The Understorey: page 2): **5**
the site is not Box-Gum Woodland

Determining the conservation value of remnants

The condition of remnants of Box-Gum Woodland varies. The conservation value of a remnant, whatever its condition, will vary according to the locality. For example, whilst Box-Gum Woodland persisting as isolated paddock trees may be of limited conservation value in some areas, in highly modified agricultural landscapes they may be all that remain and thus their loss would be significant.

Additional guidelines are being prepared to assist in determining the local and regional conservation significance of Box-Gum Woodland remnants.

Useful References

Eddy D., Mallinson D., Rehwinkel R., Sharp S., (1998) *Grassland Flora: a field guide for the Southern Tablelands*. EACT, NSW NPWS, WWF, ANBG.

Environment Australia (2000) Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the Development of Version 5.1. - Summary Report. Department of Environment and Heritage, Canberra.

Grassy Box Woodlands Conservation Management Network, (2000-2002), *Woodland Wanderings* (magazine). GBWCMN.

Lambert J., Elix J., (2002) *Grassy White Box Woodlands: Information Kit*. Community Solutions.

NSW NPWS, (2001) *Paddock Tree Brochure*. NSW NPWS.

NSW NPWS, (2002) *White Box-Yellow Box-Blakely's Red Gum (Box-Gum) Woodland: Fact-sheet for NSW*.

Southern Tablelands Grassy Ecosystems Conservation Management Network, (2002), *Austral Bugle* (magazine). STGECMN.

Threatened Species Conservation Act 1995, NSW Scientific Committee, (March 2002) *Final Determination: White Box Yellow Box Blakely's Red Gum Woodland*.

Walker K., Burrows G., McMahon L., (2001) *'Bidgee Bush*. Greening Australia.

Website: Community Solutions
http://www.communitysolutions.com.au/gwbw_project/index.html

Website: Conservation Management Network
<http://www.conservation-management-networks.net/>

Website: NPWS <http://www.npws.nsw.gov.au>

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Appendix D

Likelihood of Occurrence of Known and
Predicted Threatened Species in the EA
Boundary

Table D.1 LIKELIHOOD OF OCCURRENCE OF THREATENED FLORA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LGA

Family	Scientific Name	Common Name	EPBC Status [^]	TSC Status [^]	LGA Count [~]	Habitat Requirements	Recorded on site?	Likelihood of occurrence
Apocynaceae	<i>Cynanchum elegans</i>	White-flowered Wax Plant	Endangered	E1	1	Usually found on the edge of dry rainforest communities but is also associated with littoral rainforest, Coastal Tea-tree - Coastal Banksia scrub, Forest Red Gum open forest and woodland, Spotted Gum open forest and woodland and Bracelet Honeymyrtle scrub.	No	Not likely to occur.
Araucariaceae	<i>Wollemia nobilis</i>	Wollemi Pine	Endangered	E1	Predicted to occur*	Restricted to remote sandstone canyons in Wollemi National Park.	No	Not likely to occur.
Asteraceae	<i>Olearia cordata</i>		Vulnerable	V	Predicted to occur*	Occurs in dry open sclerophyll forest and open shrubland on sandstone ridges.	No	Not likely to occur.
Asteraceae	<i>Ozothamnus tessellatus</i>		Vulnerable	V	Predicted to occur*	Grows in eucalypt woodland, restricted to a few sites north of Rylstone.	No	Not likely to occur.
Asteraceae	<i>Senecio linearifolius</i> var. <i>dangarensis</i>		-	E1	1	Restricted to a single known population in Goulburn River National Park where it occurs on an open scree slope in	No	Not likely to occur.

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Family	Scientific Name	Common Name	EPBC Status [^]	TSC Status [^]	LGA Count~	Habitat Requirements	Recorded on site?	Likelihood of occurrence
Fabaceae (Faboideae)	<i>Kennedia refrorsa</i>		Vulnerable	V	12	woodland and rainforest communities on basalt. Occurs in a variety of habitats from mountainsides to riparian zones, sheltered forest to exposed ridgelines. Restricted to Mt Dangar area and Goulburn River catchment.	No	Not likely to occur.
Fabaceae (Faboideae)	<i>Pultenaea glabra</i>	Smooth Bush-pea, Swamp Bush-pea	Vulnerable	V	Predicted to occur*	Restricted to Blue Mountains with all known sightings within the Blue Mountains local government area. Occurs within dry sclerophyll forest and tall damp heath on sandstone.	No	Not likely to occur.
Fabaceae (Mimosoideae)	<i>Acacia flocktoniae</i>		Vulnerable	V	Predicted to occur*	Found only in southern Blue Mountains in dry sclerophyll forest on sandstone.	No	Not likely to occur.
Fabaceae (Mimosoideae)	<i>Acacia pendula</i>	Acacia pendula population in the Hunter catchment	Vulnerable	E2	4	Occurs on heavy soils on margins of small floodplains but also in more undulating locations.	MAU	Identified in EA Boundary at two locations.
Lamiaceae	<i>Prostanthera</i>	Wollemi Mint-bush	Vulnerable	V	10	Grows in dry sclerophyll forest,	No	Not likely to

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Family	Scientific Name	Common Name	EPBC Status ^A	TSC Status ^A	LGA Count [~]	Habitat Requirements	Recorded on site?	Likelihood of occurrence
	<i>cryptandroides subsp. cryptandroides</i>					often in rocky sites.		occur.
Lamiaceae	<i>Prostanthera discolor</i>		Vulnerable	V	1	Restricted to a few localities from Bylong to Baerami Valley, grows in dry sclerophyll forest in the side gullies of main creeklines.	No	Not likely to occur.
Lamiaceae	<i>Prostanthera stricta</i>	Mount Vincent Mintbush	Vulnerable	V	9	Grows in areas of skeletal soils or deeper well-drained soils on steep rocky sideslopes, cliff lines, sandstone platforms or gentle slopes with sandstone outcropping.	No	Not likely to occur.
Myrtaceae	<i>Baeckea kandos</i>		-	E1	1	Known from Kandos area and one population in Wollemi National Park.	No	Not likely to occur.
Myrtaceae	<i>Darwinia peduncularis</i>		-	V	1	Grows on or near rocky outcrops on sandy, well-drained, low nutrient soil over sandstone.	No	Not likely to occur.
Myrtaceae	<i>Eucalyptus camaldulensis</i>	Eucalyptus camaldulensis population in the	-	E2	24	Forms stands of woodland and open woodland on the major floodplains of the Hunter and	No	Not likely to occur within the proposed Mine

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		Hunter catchment				Goulburn rivers.		Extension Areas. No suitable habitat.
Myrtaceae	<i>Eucalyptus glauca</i>	Slaty Red Gum	Vulnerable	V	Predicted to occur*	Grows in grassy woodland and dry eucalypt forest on deep, moderately fertile and well-watered soils.	No	Not detected within EA Boundary and not likely to occur within the proposed Mine Extension Areas.
Myrtaceae	<i>Eucalyptus macrorhyncha subsp. cannonii</i>	Cannon's Stringybark	Vulnerable	V	Predicted to occur*	Occurs in sclerophyll woodland on shallow soils on slopes.	No	Not likely to occur.
Myrtaceae	<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint	Vulnerable	V	1	Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite.	No	Not likely to occur.
Myrtaceae	<i>Homoranthus darwinoides</i>		Vulnerable	V	1	Occurs in woodland habitats with shrubby understoreys, usually in gravely sandy soils.	No	Not likely to occur.
Orchidaceae	<i>Cymbidium canaliculatum</i>	Cymbidium canaliculatum in the	Vulnerable	E2	2	Epiphytic orchid common in dry open forests.	MAU; CE	Identified on site at three

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Family	Scientific Name	Common Name	EPBC Status [^]	TSC Status [^]	LGA Count [~]	Habitat Requirements	Recorded on site?	Likelihood of occurrence
		Hunter Catchment						locations in the EA Boundary.
Orchidaceae	<i>Diuris tricolor</i>	Diuris tricolor Fitzg., the Pine Donkey Orchid, in the Muswellbrook local government area	Vulnerable	E2	9	Found in sclerophyll vegetation on flats or small rises, on a range of substrates including sandy or loamy soils derived from granite, porphyry, laterite or alluvium.	Umwelt; CE	Identified on site. Presence confirmed in current study.
Poaceae	<i>Bothriochloa biloba</i>	Lobed Blue-grass	Vulnerable	-	Predicted to occur*	Lobed Blue-grass grows in cleared eucalypt forests and relict grassland; it prefers heavier-textured soils such as brown or black clay soils.	MAU; CE 2009	Identified on site within Derived Grassland
Poaceae	<i>Digitaria porrecta</i>	Finger Panic Grass	Endangered	E	Predicted to occur*	Native grassland, woodlands or open forest with a grassy understorey, on richer soils. Often found along roadsides and travelling stock routes where there is light grazing and occasional fire.	No	Potential to occur but not detected in a suite of past surveys of the EA Boundary.
Proteaceae	<i>Grevillea evansiana</i>		Vulnerable	V	Predicted to occur*	Occurs in dry sclerophyll forest or woodland, or occasionally	No	Not likely to occur.

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Family	Scientific Name	Common Name	EPBC Status ^A	TSC Status ^A	LGA Count~	Habitat Requirements	Recorded on site?	Likelihood of occurrence
Rhamnaceae	<i>Pomaderris bodalla</i>	Bodalla Pomaderris	-	V	1	swampy heath, usually over Hawkesbury Sandstone. Occurs in open forest or woodland on open slopes.	No	Not likely to occur.
Rhamnaceae	<i>Pomaderris brunnea</i>	Rufous Pomaderris	Vulnerable	V	Predicted to occur*	Grows in moist woodland or forest on clay and alluvial soils or floodplains and creek lines.	No	Not likely to occur.
Rhamnaceae	<i>Pomaderris queenslandica</i>	Scant Pomaderris	-	E1	8	Occurs in moist eucalypt forest or sheltered woodlands with a shrubby understorey, occasionally along creeks.	No	Not likely to occur.
Rhamnaceae	<i>Pomaderris reperta</i>	Denman Pomaderris	Critically Endangered	E1	5	Very restricted area of occupation. Prefers woodland in association with <i>Eucalyptus crebra</i> , <i>E. blakelyi</i> , <i>Notelaea microcarpa</i> , and <i>Allocasuarina littoralis</i> . Associated soil is a sandy loam on sandstone or conglomerate.	No	Not likely to occur.
Rutaceae	<i>Leionema sympetalum</i>	Rylstone Bell	Vulnerable	V	Predicted to occur*	Restricted to Rylstone local government area, within Wollemi National Park, in dry sclerophyll	No	Not likely to occur.

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Family	Scientific Name	Common Name	EPBC Status ^A	TSC Status ^A	LGA Count [~]	Habitat Requirements	Recorded on site?	Likelihood of occurrence
Rutaceae	<i>Philotheca ericifolia</i>		Vulnerable	V	Predicted to occur*	forest with pagoda sandstone formations. Usually occurs in dry sclerophyll forest and heath on damp sandy flats and gullies.	No	Not likely to occur.
Santalaceae	<i>Thesium australe</i>	Austral Toadflax, Toadflax	Vulnerable	V	Predicted to occur*	Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (<i>Themeda australis</i>).	No	Potential to occur but not detected in a suite of past surveys within the EA Boundary.
Sterculiaceae	<i>Commersonia rosea</i>	Sandy Hollow Commersonia	Endangered	E1	7	Known only from four locations within an 8km radius of Sandy Hollow, occurs on skeletal sandy soils in scrub or heath communities.	No	Not likely to occur.
Sterculiaceae	<i>Lasiopetalum longistamineum</i>		Vulnerable	V	4	Grows on rich alluvial deposits in the Gungal-Mt Dangar area.	No	Not likely to occur.
Sterculiaceae	<i>Rulingia procumbens</i>		Vulnerable	V	Predicted to occur*	Grows in sandy sites and appears to colonise disturbed areas including roadsides,	No	Not likely to occur.

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Family	Scientific Name	Common Name	EPBC Status [^]	TSC Status [^]	LGA Count [~]	Habitat Requirements	Recorded on site?	Likelihood of occurrence
						quarry edges, gravel stockpiles and recently cleared powerline easements.		

Note: [^] TSC Act status codes, **V**=Vulnerable; **E1**=Endangered; **E2**=Endangered Population
 [~] The LGA count is the combined search results from the EPBC Protected Matters Search Tool and NSW TSC Act Wildlife Atlas.
 * The EPBC Protected Matters Search Tool does not provide sighting counts, rather a description if it is predicted to occur.

Table D.2 LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LG

Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Amphibia								
Hylidae	<i>Litoria aurea</i>	Green and Golden Bell Frog	Vulnerable	E1	2	Marshes, dams, stream sides, particularly those containing bullrushes or spikerushes; unshaded water bodies free of Gambusia form optimum habitat; vegetation and/or rocks are needed for sheltering.	No	No suitable habitat. Unlikely to occur.
	<i>Litoria booroolongensis</i>	Booroolong Frog	Endangered	E1	Predicted to occur*	Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses.	No	No suitable habitat. Unlikely to occur.
	<i>Litoria littlejohni</i>	Littlejohn's Tree Frog, Heath Frog	Vulnerable	V	Predicted to occur*	Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops.	No	No suitable habitat. Unlikely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Myobatrachidae	<i>Heleioporus australiacus</i>	Giant Burrowing Frog	Vulnerable	V	3	Found in heath, woodland and open forest with sandy soils. Generally lives in the heath or forest and will travel several hundred metres to creeks to breed. Burrows into deep litter or loose soil, emerging to feed or breed after rain.	No	No suitable habitat. Unlikely to occur.
	<i>Mixophyes balbus</i>	Stuttering Frog	-	E1	1	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range.	No	No suitable habitat. Unlikely to occur.
	<i>Pseudophryne australis</i>	Red-crowned Toadlet	-	V	17	Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of	No	No suitable habitat. Unlikely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Aves								
Acanthizidae	<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	-	V	85	dense vegetation or thick piles of leaf litter. Lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	MAU, Flora/Fauna Monitoring (Umwelt 2004, 2005, 2006, Wildthing 2007, CE 2008)	Recorded within the EA Boundary.
Anatidae	<i>Stictonetta naevosa</i>	Freckled Duck	-	V	1	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.	No	No suitable habitat. Unlikely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Apodidae	<i>Hirundapus caudacutus</i>	White-throated Needletail	Migratory	-	Predicted to occur*	In Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland and treeless areas, such as grassland or swamps. The species has been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows.	South Pit, Flora/Fauna Monitoring (CE 2008)	Recorded within the EA Boundary.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Burhinidae	<i>Burhinus grallarius</i>	Bush Stone-curlew	-	E1	1	Inhabits woodlands and open forests with a grassy ground layer with fallen timber.	No	No suitable habitat. Unlikely to occur.
Cacatuidae	<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	-	V	40	In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. May also occur in sub-alpine Snow Gum <i>Eucalyptus pauciflora</i> woodland and occasionally in temperate rainforests. Move to lower altitudes in winter, preferring more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest	No	No suitable habitat. Unlikely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
						in coastal areas. Favours old growth attributes for nesting and roosting.		
	<i>Calyptrorhynchus lathamii</i>	Glossy Black-Cockatoo	-	V	71	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly Black She-oak (<i>Allocasuarina littoralis</i>), Forest She-oak (<i>A. torulosa</i>) or Drooping She-oak (<i>A. verticillata</i>) occur. Feeds almost exclusively on the seeds of several species of she-oak (<i>Casuarina</i> and <i>Allocasuarina</i> species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites.	No	No suitable habitat. Unlikely to occur.
Ciconiidae	<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	-	E1	1	Inhabits permanent freshwater wetlands including margins of	No	No suitable habitat. Unlikely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
						billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands; can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries.		
	<i>Climacteris picumnus victorinae</i>	Brown Treecreeper (eastern subspecies)	-	V	120	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; fallen timber is an important habitat component for foraging; also recorded,	No	Suitable habitat within the EA Boundary. Likely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Estrildidae	<i>Stagonopleura guttata</i>	Diamond Firetail	-	V	31	though less commonly, in similar woodland habitats on the coastal ranges and plains. Hollows in standing dead or live trees and tree stumps are essential for nesting. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December.	MAN	Recorded within the EA Boundary.
Megapodiidae	<i>Leipoa ocellata</i>	Malleefowl	Vulnerable	-	Predicted to occur*	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300-450 mm mean annual rainfall) areas. Less frequently found in other eucalypt woodlands (e.g., mixed Western Grey Box and Yellow Gum or Bimble Box, Ironbark-	No	Sub-optimal habitat exists within the EA Boundary. Unlikely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Meliphagidae	<i>Grantiella picta</i>	Painted Honeyeater	-	V	1	Callitris Pine, Callitris Pine, Mulga (Acacia aneura), and Gidgee (A. cambagei). Prefers areas of light sandy to sandy loam soils and habitats with a dense but discontinuous canopy, dense and variable shrub and herb layers.	No	Sub-optimal habitat exists within the EA Boundary. Unlikely to occur.
	<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	-	V	39	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (Eucalyptus sideroxylon).	No	Suitable habitat within the EA Boundary. Likely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
						White Box (<i>Eucalyptus albens</i>), Grey Box (<i>Eucalyptus microcarpa</i>), Yellow Box (<i>Eucalyptus melliodora</i>) and Forest Red Gum (<i>Eucalyptus tereticornis</i>).		
	<i>Xanthomyza phrygia</i>	Regent Honeyeater	Endangered	E1	16	Inhabits dry open forest and woodland, particularly Box-ironbark woodland, and riparian forests of River Sheoak.	No	Suitable habitat within the EA Boundary. Potential to occur.
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	Migratory	-	Predicted to occur*	Occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water. It also	South Pit Extension EA	Recorded within the EA Boundary.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Petroicidae	<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	-	V	11	occurs in inland and coastal sand dune systems, and in mangroves in northern Australia, and has been recorded in various other habitat types including heathland, sedgeland, vine forest and vine thicket, and on beaches. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	MAN	Recorded within the EA Boundary.
Pomatostomidae	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler (eastern)	-	V	28	Inhabits open Box-Gum Woodlands on the slopes, and	MAU, Flora/Fauna	Recorded within the EA Boundary.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
	<i>temporalis</i>	subspecies)				Box-Cypress-pine and open Box Woodlands on alluvial plains.	Monitoring (Umwelt 2003, 2005, Wildthing 2007, CE 2008)	
Psittacidae	<i>Lathamus discolor</i>	Swift Parrot	Endangered	E1	Predicted to occur*	Migrates irregularly to the locality in the winter to forage on winter-flowering tree species such as Swamp Mahogany and Spotted Gum.	No	Suitable habitat within the EA Boundary. Potential to occur.
	<i>Neophema pulchella</i>	Turquoise Parrot	-	V	48	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Feeds on seeds of grasses and herbaceous plants, or browses on vegetable matter. Nests in tree hollows, logs or posts, from August to December.	Bayswater No. 3	Recorded within the EA Boundary
	<i>Polytelis swainsonii</i>	Superb Parrot	Vulnerable	V	Predicted to occur*	Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red	No	Suitable habitat within the EA Boundary.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Rostratulidae	<i>Rostratula australis</i>	Australian Painted Snipe	Vulnerable	E1	Predicted to occur*	Gum Forest. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	No	Potential to occur. No suitable habitat. Unlikely to occur.
Strigidae	<i>Ninox connivens</i>	Barking Owl	-	V	13	Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as <i>Acacia</i> and <i>Casuarina</i> species, or the dense clumps of canopy leaves in large <i>Eucalypts</i> .	No	Sub-optimal habitat exists within the EA Boundary. Potential to occur.
	<i>Ninox strenua</i>	Powerful Owl	-	V	15	The Powerful Owl requires large tracts of forest or	No	Sub-optimal habitat exists within the EA

Table D.2 LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LG

Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Tytonidae	<i>Tyto novaehollandiae</i>	Masked Owl	-	V	9	woodland habitat but can occur in fragmented landscapes as well. Nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old.	No	Suitable habitat within the EA Boundary. Likely to occur.
Insecta	<i>Tyto tenebricosa</i>	Sooty Owl	-	V	2	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	No	No suitable habitat. Unlikely to occur.
Petaluridae	<i>Petalura gigantea</i>	Giant Dragonfly	-	E1	1	Live in permanent swamps and bogs with some free	No	No suitable habitat. Unlikely to occur.

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Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Mammalia								
Dasyuridae	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	Endangered	V	25	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.	No	Suitable habitat within the EA Boundary. Likely to occur.
Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	-	V	6	Roosts in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country.	MAN	Recorded within the EA Boundary.
Macropodidae	<i>Macropus parma</i>	Parma Wallaby	-	V	1	Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas,	MAN	Recorded tentatively within the EA Boundary.

Table D.2 LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LG

Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
						rainforest margins and occasionally drier eucalypt forest. Typically feed at night on grasses and herbs in more open eucalypt forest and the edges of nearby grassy areas.		
	<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Vulnerable	E1	33	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north.	No	No suitable habitat. Unlikely to occur.
Molossidae	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	-	V	8	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures.	MAU, Flora/Fauna Monitoring (Umwelt 2005, 2006)	Recorded within the EA Boundary.
Petauridae	<i>Petaurus australis</i>	Yellow-bellied Glider	-	V	71	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils.	No	No suitable habitat. Unlikely to occur.

Table D.2 LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LG

Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Phascolarctidae	<i>Petaurus norfolcensis</i>	Squirrel Glider	-	V	21	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey.	MAU, South Pit, Flora/Fauna Monitoring (Umwelt 2003, 2005)	Recorded within the EA Boundary.
	<i>Phascolarctos cinereus</i>	Koala	-	V	21	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	No	Suitable habitat within the EA Boundary. Potential to occur.
Pteropodidae	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Vulnerable	V	2	Rainforest, mangroves, paperbark swamps, wet/dry sclerophyll forests.	No	Suitable habitat within the EA Boundary. Likely to occur.

Table D.2 LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LG

Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Vulnerable	V	40	Found in well-timbered areas containing gullies. Roosts in caves, crevices in cliffs and old mine workings frequenting low to mid-elevation dry open forest and woodland close to these features.	Flora/Fauna Monitoring (Umwelt 2006)	Recorded within the EA Boundary.
	<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	-	V	16	Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	No	Suitable habitat within the EA Boundary. Likely to occur.
	<i>Miniopterus australis</i>	Little Bentwing-bat	-	V	1	Prefer well timbered areas including rainforest, wet and dry sclerophyll forest, <i>Melaleuca</i> swamps and coastal forests. Roosting in caves and eat insects.	No	Sub-optimal habitat exists within the EA Boundary. Potential to occur.
	<i>Miniopterus schreibersii</i>	Eastern Bentwing-bat	-	V	84	Prefers forested valleys but also found in rainforests,	MAN, South Pit, MAU,	Recorded within the EA Boundary.

Table D.2 LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LG

Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
	<i>oceanensis</i>					wet/dry sclerophyll forests, monsoon forests, open woodlands, paperbark forests & open grasslands. Roosting in caves or tunnels.	Flora/Fauna Monitoring (Umwelt 2003, 2004, 2005, 2006)	
	<i>Myotis macropus</i>	Large-footed Myotis	-	V	6	Most habitats near water, including mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River red gum woodland.	South Pit, MAU, Flora/Fauna Monitoring (Umwelt 2003, 2004, 2005, 2006)	Recorded within the EA Boundary.
	<i>Nyctophilus timoriensis</i>	Eastern Long-eared Bat	Vulnerable	V	16	Inhabits a variety of vegetation types, including mallee, buloak <i>Allocasuarina leuhmanni</i> and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of	No	Suitable habitat within the EA Boundary. Potential to occur.

Table D.2 LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LG

Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	-	V	10	NSW and southern Queensland. Cool temperate to tropical moist forests, woodland and rainforest. Prefer moist gullies within mature coastal forest or rainforest. May roost in tree hollows and feed along forest edges or streams.	MAU	Suitable habitat within the EA Boundary. Potential to occur.
	<i>Vespadelus troungtoni</i>	Eastern Cave Bat	-	V	11	A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings.	South Pit, MAU, Flora/Fauna Monitoring Flora/Fauna Monitoring (Umwelt 2006, Wildthing 2007)	Recorded within the EA Boundary.
Reptilia								
Elapidae	<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	Vulnerable	E1	1	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during	No	No suitable habitat. Unlikely to occur.

Table D.2 **LIKELIHOOD OF OCCURRENCE OF THREATENED FAUNA SPECIES PREVIOUSLY RECORDED OR PREDICTED TO OCCUR IN THE MUSWELLBROOK LG**

Family	Scientific Name	Common Name	EPBC Act Status	^TSC Act Status	LGA Count~	Habitat Requirements	Recorded on Site?	Likelihood of occurrence
Varanidae	<i>Varanus rosenbergi</i>	Rosenberg's Goanna	-	V	2	autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer. Hawkesbury sandstone outcrop specialist. Inhabits woodlands, dry open forests and heathland sheltering in burrows, hollow logs, rock crevices and outcrops. Requires terrestrial termite mounds for nesting.	No	No suitable habitat. Unlikely to occur.

Note: ^ TSC Act status codes, **V**=Vulnerable; **E1**=Endangered; **E2**=Endangered Population
 ~ The LGA count is the combined search results from the EPBC Protected Matters Search Tool and NSW TSC Act Wildlife Atlas.
 * The EPBC Protected Matters Search Tool does not provide sighting counts, rather a description if it is predicted to occur.

Appendix E

Assessment of Significance EP&A Act (the
'seven part test')

E.1 Section 5A: Assessment of Significance (Environmental Planning and Assessment Act 1979)

There is no legal requirement to prepare an Assessment of Significance (the “Seven Part test”) when preparing an Environmental Assessment under Part 3A of the EP&A Act. Notwithstanding that, a Seven Part test has been prepared in order to use the test as a risk assessment and determine which threatened flora and fauna of the EA Boundary are most at risk from the proposed Project.

This test has been completed as a composite test and examines endangered ecological communities, endangered populations and threatened species that are known to occur within the EA Boundary and which are known to occur in one or more of the Project Disturbance Areas

The threatened flora and fauna considered in the test include:

Box Gum Woodland and Derived Grassland is an endangered ecological community that occurs across parts of several of the Mine Extension Areas.

Several threatened flora species as listed under the TSC Act or EPBC Act have been detected on the subject site including the Painted Diurus (*Diuris tricolor*), Tiger Orchid (*Cymbidium canaliculatum*), *Bothriochloa biloba* and Weeping Myall (*Acacia pendula*).

Threatened fauna species that were detected on the subject land during past surveys include a suite of birds and mammals as follows:

- Birds: Speckled Warbler (*Pyrrholaemus saggitata*), Diamond Firetail (*Stagonopleura guttata*), Hooded Robin (*Melanodryas cucullata cucullata*), Grey Crowned Babbler (*Pomatostomus temporalis temporalis*) and Turquoise Parrot (*Neophema pulchella*).
- Bats: the Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Freetail Bat (*Mormopterus norfocensis*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Common Bentwing Bat (*Miniopterus schreibersii*), Eastern Bentwing Bat (*M. schreibersii ozeaanensis*), Large-footed Myotis (*Myotis macropus*), Greater Broad-nosed Bat (*Scoteanax ruepelli*), Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventrus*) and Eastern Cave Bat (*Vespadelus troughtoni*).
- Non-flying Mammals: Squirrel Glider (*Petaurus norfolcensis*)

In addition to the threatened fauna that are known to occur, Koala (*Phascolarctus cinereus*), Spotted-tailed Quoll (*Dasyurus maculatus*) and the Masked Owl (*Tyto novaehollandiae*) are considered as species that could potentially occur. They are also considered in the assessment below.

- a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*

None of the threatened plant species that occur in the EA Boundary are likely to be threatened with extinction as a result of the proposed Project. No Painted Diuris (*Diuris tricolor*) or Weeping Myall (*Acacia pendula*) are known to occur in any of the five Mine Extension Areas. *Bothriochloa biloba*, which is listed as Vulnerable on the EPBC Act but not the TSC Act, occurs in patches across Mine Extension Area 5 but is well represented in areas that will not be cleared. Extensive areas of habitat for the species will be conserved in the long term.

Amongst the fauna, the following species will lose approximately 240 ha of woodland and open forest habitat from the EA Boundary over the life of the project:

- Birds: Speckled Warbler (*Pyrrholaemus saggitata*), Diamond Firetail (*Stagonopleura guttata*), Hooded Robin (*Melanodryas cucullata cucullata*), Grey Crowned Babbler (*Pomatostomus temporalis temporalis*) and Turquoise Parrot (*Neophema pulchella*).
- Bats: the Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Freetail Bat (*Mormopterus norfocensis*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Common Bentwing Bat (*Miniopterus schreibersii*), Eastern Bentwing Bat (*M. schreibersii oceaenensis*), Large-footed Myotis (*Myotis macropus*), Greater Broad-nosed Bat (*Scoteanax ruepelli*), Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventrus*) and Eastern Cave Bat (*Vespadelus troughtoni*).
- Non-flying Mammals: Squirrel Glider (*Petaurus norfolcensis*).

Notwithstanding that habitat loss, extensive areas of habitat will be retained for these species in the Saddlers Creek Conservation Area, the Mount Arthur Conservation Area and the Proposed Offset Areas. Additional habitat will be created in the Proposed Regenerated Woodland area. These areas will be linked to a large block of such habitat centered on Drayton Wildlife Reserve by a travelling stock route that abuts the Proposed Offset Areas and by a corridor network to be implemented in stages during and after the life of the mine. Additionally, habitat for all species listed above occurs off site in the locality to the south, east and west. For these reasons, despite the predicted habitat loss, it is likely that local populations of all species will remain in the EA Boundary.

- b) *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.*

The endangered populations that occur in the area include Tiger Orchid (*Cymbidium canaliculatum*) and Weeping Myall (*Acacia pendula*). Two known individuals of Tiger Orchid occur in Mine Extension Area 5 and has potential to be cleared. These will be

translocated to the Saddlers Creek Conservation Area, where the Tiger Orchid is known to occur.

No Weeping Myall occurs within the Mine Extension Areas and no specimens are proposed to be cleared.

For this reason, it is unlikely that the proposed action will place a viable local population at risk of extinction.

- c) *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.*

The Mine Extension Areas will clear approximately 116 ha of Upper Hunter White Box – Ironbark Grassy Woodland and a further 700 ha of native grassland that were derived from the clearance of the woodland. These communities equate to the Box Gum Woodland that is listed on the TSC Act.

Other higher quality remnants of this community will be retained in the conservation areas that include Saddlers Creek Conservation Area, the Mount Arthur Conservation Area and the additional Proposed Offset Areas. Furthermore, local native plant species from this community are being used in the rehabilitation areas.

The Proposed Offset Areas will include sizeable areas of this woodland (152 ha) and native grassland (482 ha) that will be regenerated to the woodland.

Approximately 52 ha of the woodland and 2,277 ha of the grassland will remain in the EA Boundary post mining. For this reason, it is unlikely that the proposed development will make the local occurrence of such vegetation extinct.

- d) *In relation to the habitat of a threatened species, population or ecological community:*
- (i) *The extent to which habitat is likely to be removed or modified as a result of the action proposed, and*

As stated above, the amount of habitat to be removed for threatened plants is not likely to be significant.

With regard to fauna species, approximately 240 ha of forest and woodland habitat will be removed from the EA Boundary, together with over 700 ha of derived native grassland. In

the context of the upper Hunter Valley, this is a sizeable area of habitat to be removed for the threatened fauna species that are known to occur in the EA Boundary.

Similarly, the proposal will remove 116 ha of Box Gum Woodland, which is listed as endangered under the TSC Act. Such an area is potentially significant in the context of the remaining habitat in the Hunter Valley, particularly when it is considered that this community is poorly reserved in the Hunter Valley and elsewhere throughout its range. However, the Proposed Offset Areas will include sizeable areas of this woodland (152 ha) and native grassland (482 ha) that will be regenerated to the woodland. The Proposed Offset Areas will be maintained in the long term for conservation according to a site specific management plan.

- (ii) *Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*

Areas of woodland and open forest surrounding Mount Arthur will be cleared under the proposal, including:

- Woodland in the southern portion of Mine Extension Area 2 that links to Mount Arthur;
- The southern end of a proposed local corridor in Mine Extension Area 5 that links Saddlers Creek to Mount Arthur; and

These aspects of the proposed mining have potential to increase the degree of isolation of the forest and woodland communities on Mount Arthur, but they will not completely isolate the Mount Arthur habitat areas. Moreover, as mining proceeds, additional rehabilitation from the approved mining work will serve to redress some of the issues associated with this process.

The entire EA Boundary will be covered by corridor network that includes will be adjustments to maintain and enhance local habitat connectivity, and maintain the proposed east-west Regional Habitat Links.

- (iii) *The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.*

The areas of habitat to be removed are important to the current survival of endangered ecological communities and threatened species. However, in the long term they are not vital to the survival because habitat will remain, be improved or be created in other areas of the EA Boundary. Such habitat is likely to ensure the continuity of habitats for threatened flora and fauna.

- e) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).*

No critical habitat has been listed for any of the threatened flora or fauna that occur in the EA Boundary.

- f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

A recovery plan exists for the Koala, and the Forest Owls (particularly Masked Owl) which have potential habitat in the EA Boundary. The Project will clear sizeable areas of forest and woodland (240 ha). This will remove foraging habitat for koala and foraging and potential roost sites for owls such as Masked Owl. As such the Project is not consistent with recovery plans for these species.

No threat abatement plans are relevant to the assessed species.

- g) *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action will add to several key threatening processes, including clearance of native vegetation and removal of tree hollows. It also has potential to lead to the spread of perennial exotic grasses, some of which are key threats to native grassy woodland. Hence the proposed mining could worsen several key threatening processes.

The proposal may further impact the assessed species through the following processes:

- **Clearing of native vegetation:** Over 700 ha of derived grassland EEC, including known and potential habitat for threatened species and populations is to be removed as part of the proposal. Areas of similar habitat will be retained, improved and created within the EA Boundary;
- **Invasion of native plant communities by exotic perennial grasses and Exotic vines and scramblers:** Activities proposed within the EA Boundary may lead to an increase in the distribution of exotic species. Mt Arthur Coal has a Land Management Program incorporating weed management, and this is not seen to be a significant risk. Management programs implemented within the lease are likely to reduce the impact of these processes;
- **Loss of Hollow-bearing trees and Removal of dead wood and dead trees:** The hollow-bearing trees, dead wood and dead trees within the EA Boundary support known and potential habitat for threatened species.
- **Competition and grazing by the feral European rabbit, Predation by feral cats and Predation by the European red fox:** These exotic fauna species have previously been recorded in the EA Boundary. Management plans implemented within the lease are likely to reduce the impact of these processes;
- **Competition from feral honeybees;**

- Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations;
- Infection of native plants by *Phytophthora cinnamomi*;
- Ecological consequences of high frequency fires;
- Human-caused climate change; and
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.

Some native vegetation will be cleared as a result of the proposal but larger areas will be maintained within the EA Boundary. The Proposed Offset Areas will include sizeable areas of open forest, woodland and native grassland that will be regenerated to the woodland. The Offset Area will be maintained in the long term for conservation according to a site specific management plan.

The key threatening process of “Loss of hollow-bearing trees” will be worsened in the short term by the proposal, but tree hollows cleared will be replaced at a ratio of 1:1 so that in the medium to long term hollows will at least be maintained. Furthermore, because much of the treed habitat in conservation areas is young-mature, further hollows will be generated as these trees age.

E.1.1 Conclusion

Without additional mitigation or compensation measures, the Project will have a significant detrimental impact upon Box Gum Woodland and at least some of the aforementioned woodland fauna. This is because it will remove a sizeable amount of forest and woodland habitat (240 ha), exacerbate the key threatening processes of native vegetation removal and tree hollow loss in a highly cleared landscape, and increase the degree of fragmentation of existing patches of habitat. The Project will, in the short term, reduce the effectiveness of local and regional habitat linkages that were proposed in the Rehabilitation and Management Strategy.

In order to address such forecast impacts to threatened flora and fauna, a suite of measures is proposed. These include the adjustment of Mine Extension Area 5 to remove impacts to Box Gum Woodland, translocation of threatened species out of impact areas, and mitigation measures to minimise the impacts of the Project (including rehabilitation, implementation of a Biodiversity Corridor network and revision of existing management and monitoring plans). Provisions for the protection, enhancement and revegetation of communities will be presented in an Offset Strategy to compensate for the loss of vegetation communities as a result of the Project.